

## R390A PTOs

Which are the best PTOs? What makes them that way?

- Progressitron - Best all around. Very linear, end points hold and the adjustment will compensate for about 8kc. This Collins design uses corrector stacks.
- Cosmos - Excellent PTO, very linear. However, the endpoint adjustment will only accommodate about 4kc of error maximum. With errors greater than 5kc, a turn must be removed from the internal compensator coil. A different design and patent than the others. The Cosmos PTO does not use corrector stacks.
- Collins - Good PTO but some are the least linear. Linearity adjustment very difficult due to the need to set the internal corrector stacks. This takes a jig to do correctly.
- Motorola - Same as the Collins
- Dubrow - Good PTO, sets up nicely and the linearity is excellent.  
A corrector stack design.

Identifying and correcting one type of PTO instability. Ever tune your R390A through a carrier with the BFO on and get a "warble?": does the PTO seem unstable while tuning? If the answer is yes, this fix may apply:

First, test for the problem by turning the radio on and allowing it to warm up about 30 minutes. Tune in a calibrator point and turn on the BFO. Tune the radio through the calibrator signal. The BFO note should change smoothly and without any warble or instability. If it does not, the problem may be as below:

There is an angled piece of metal fastened to the front of the PTO. It makes a 90 degree bend then engages the tuning shaft just in front of the forward PTO shaft bearing. This piece of metal serves as the ground return for the PTO. The points where it engages the PTO tuning shaft and its connection point on the housing can become contaminated causing unstable PTO tuning. I have even seen well meaning but uninformed owners incorrectly apply grease or oil to the point where the return strap engages the PTO shaft.

After unplugging the radio from the AC mains, try this easy fix:

Remove the PTO by first removing the shielded cable (center plug next to J-208 on the left rear of the RF deck). Turn the receiver upside down and unplug P109 on the back of the PTO. Loosen the two screws holding the rear PTO bracket. Do not completely remove them. Loosen the 3 captive, green headed screws which hold the PTO to the chassis. Carefully remove the spring on the Oldham coupler and set it in a safe place. Carefully maneuver the PTO from the main chassis being careful to guide the shielded cable which was attached to the RF deck past the antenna cables and through the hold in the main chassis. Place the now

completely free PTO assy in a clean, well lighted place so it can be worked on.

Its a good time to clean out the PTO cavity in the main chassis with some WD-40 on a rag and apply a few drops of oil to the tuning shaft at the bearing in the main chassis located in front of the PTO. Because it will never harden, I use synthetic Mobil-1 90W rear end lube.

Remove V-701, the 5749 tube from the PTO.

Using plenty of light, you should now be able to see the ground return strap. There are 2 small screws holding it on the the PTO housing. The opposite end of the strap engages the PTO tuning shaft after making a 90 degree bend. On some PTOís, this end of the strap rides in a small groove machined into the PTO tuning shaft.

Remove the 2 screws holding the strap to the PTO housing. It is not as easy as it looks due to the bracket being located directly above the screws which holds the PTO body to the mounting assy. Be sure not to loose the small screws and their lock washers.

Using De-Oxit or Flux-Wash, thoroughly clean the curved end of the strap where it touches the PTO shaft. Work you way slightly up the sides of the strap to accomodate the sides of the groove. Next, use a toothbrush with DeOxit and clean the spot on the PTO housing where the strap attaches. Finally, clean first the side of the strap where it mates to the PTO housing then clean the other where the two mounting screws seat.

Turing you attention to the PTO tuning shaft, clean area or groove where the strap ridest. Do NOT TURN THE PTO SHAFT or you will be realigning the radio due to the cam positions v/s the PTO frequency being changed. Be very careful not to get any DeOxit or Flux Wash into the front bearing. To best do this, put some of the cleaner on a iQî tip or small toothbrush first then clean the contact/groove area throughly. DO NOT GREASE OR OIL THE CONTACT POINT.

Reinstall the ground return strap on the PTO. Be careful to insure that the turning shaft end is riding in the groove machined into the tuning shaft.

Reinstall the PTO in the radio chassis, grease and install the Oldham coupler and reconnect the 2 plugs which were unplugged to remove the PTO. Make sure the PTO is mechanically aligned to the tuning shaft then tighten the 3 green captive mounting screws then finally, the 2 loose screws on the PTO rear chassis bracket. Install the anti-backlash spring on the Oldham coupler. Reinstall V-701 after first tightening the screws in the tube socket and giving the tube pins a shot of DeOxit.

Turn the radio on. As it is warming up, put a single drop of (do NOT spray) DeOxit onto the PTO shaft where the ground return strap engages. Work the iKilocycle Changeî control back and forth about 50KCís to seat the strap against the shaft.

Repeat the turning test above. The radio should now tune without instability.

Should it not, you may have a Collins, Motorola or other PTO which has an internal cam stack/follower assy that may be sticking. Repair of this is beyond any explanation here and should be only attempted by someone comfortable with doing surgery on that PTO.

Future maintenance should simply require to annually re-apply the single drop of DX-Oxit to the shaft/ground-strap contact point and rock the frequency back and forth as above.

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Date: Fri, 7 Nov 1997 21:18:02 -0800  
From: Reid Wheeler <reid@...>  
Subject: RE: [R-390] Oven concerns

...>using the heaters causes permanent damage to the PTOs in the form of  
>accelerated end-point drift and mechanical distortion. The described damage  
>sounded to me like a paradigm case of a stuck heater thermostat. <snip>

Some of you may be aware of the large body of work concerning R-390A's done by long time and experienced user/repairer, Walter (Wally) Chambers. He has worked on and aligned more PTO's than most of us could count. Wally has occasionally contributed to HSN and in #37 strongly suggests that the heater switch wires for the PTO be cut and taped! Over time, the heater can distort the PTO coil and vaporize the grease and oil in the two bearings. It is also not a rare occurrence for the heater thermostat to stick and send the PTO temp right through the roof. Unless you are operating in Arctic or Antarctic conditions, you don't need the heater.

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From: "Tom Bridgers" <Tarheel6@...>  
Date: Wed Dec 31, 1969 7:59 am  
Subject: [R-390] Lubricating the PTO?

One of my PTO's, a Dubrow (model 798, DM 101), was so hard to turn that I decided to take it apart this afternoon and take a looksee. This PTO had been overhauled by Tobyhanna sometime in its life, so I figured something dramatic must have occurred since then to make it feel like it was binding. Once inside and looking at the guts of it, everything except the stainless steel shaft and bearing were corroded. What a mess. I guess the ovens had been left on for an eternity, and the thing had cooked itself way beyond well done. The two "wings", one with metal roller, the other with a plastic roller, on either side of the slider (located just in front of the iron core) were so corroded that they did not engage as they should. After a little lubing, the rollers began to engage pretty well. After lubing the stainless steel screw over which the PTO iron core (and slider) travels, as I turned the PTO shaft through its course several times, it began to loosen ... but not all the way. And that is the reason for this email. Here's the weird part:

o Now when the shaft is turned causing the core to travel from rear to front, the action is smooth and silky. When I say, from rear to front, I mean that the iron core

goes from being largely exposed ... to being fully inserted into the assembly chamber.

o When the shaft is turned (in the other direction) causing the core to travel from front to rear (emerging from the chamber as this happens),

a) for the first 1/2 of the distance, the action is rather tight causing the metal wing to lift from the cams until you stop turning. Then, it drops to the surface of the cams ...and

b) for the remainder of the distance, the action is smooth and silky (and the metal wing does not lift from the cams).

With all manner of lubing tried, I still cannot get the smooth action in the first 1/2 of the distance (as described above in a). Has anyone dealt with this situation, and solved it? Would appreciate any help or suggestions, you might have. (Incidentally, after reassembling the PTO, it works just fine. And it appears to be stable. So one side of me says, forget it. But the perfectionist side of me, says hey, there has to be a way to fix this problem .....

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From: hinec@... (Cory Hine)  
Date: Mon Nov 24, 1997 5:31 am  
Subject: Re: [R-390] Lubricatiing the PTO?

Fair Radio has Tobyhanna (thats an Army electronics base in Pennsylvania) reconditioned PTOs for \$45. I got one and it works quite well.....

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From: Don Reaves <dr@...>  
Date: Tue Jan 13, 1998 8:01 pm  
Subject: [R-390] PTO Instability

Ever tune your R390A through a carrier with the BFO on and get a "warble?" PTO seem un-stable while tuning? If the answer is yes, this fix may apply:

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Here is the fix:

---> Unplug the radio <---

Remove the PTO by first removing the shielded cable (center plug next to J-208 on the left rear of the RF deck) . Turn the receiver upside down and unplug P109 on the back of the PTO. Loosen the two screws holding the rear PTO bracket. Do not completely remove them. Loosen the 3 captive, green headed screws which hold the PTO to the chassis. Carefully remove the spring on the Oldham coupler and set it in a safe place. Carefully maneuver the PTO from the main chassis being careful to guide the shielded cable which was attached to the RF deck past the antenna cables and through the hold in the main chassis. Place the now completely free PTO assy in a clean, well lighted place so it can be worked on.

Its a good time to clean out the PTO cavity in the main chassis with some WD-40 on a rag and apply a few drops of oil to the tuning shaft at the bearing in the main chassis located in front of the PTO. I use synthetic Mobil-1 90W rear end lube.

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Remove the 2 screws holding the strap to the PTO housing. It is not as easy as it looks due to the bracket being located directly above the screws which holds the PTO body to the mounting assy. Be sure not to loose the small screws and their lock washers.

Using De-Oxit or Flux-Wash, thoroughly clean the curved end of the strap where it touches the PTO shaft. Work you way slightly up the sides of the strap to accomodate the sides of the groove. Next, use a toothbrush with DeOxit and clean the spot on the PTO housing where the strap attaches. Finally, clean first the side of the strap where it mates to the PTO housing then clean the other where the two mounting screws seat.

Turing you attention to the PTO tuning shaft, clean area or groove where the strap ridest. Do NOT TURN THE PTO SHAFT or you will be realigning the radio due to the cam positions v/s the PTO frequency being changed. Be --> very <-- careful not to get any DeOxit or Flux Wash into the front bearing. To best do this, put some of the cleaner on a "Q" tip or small toothbrush first then clean the contact/groove area throughly. DO NOT GREASE OR OIL THE CONTACT POINT.

Reinstall the ground return strap on the PTO. Be careful to insure that the turning shaft end is riding in the groove machined into the tuning shaft.

Reinstall the PTO in the radio chassis, grease and install the Oldham coupler and reconnect the 2 plugs which were unplugged to remove the PTO. Make sure the PTO is mechanically aligned to the tuning shaft then tighten the 3 green captive mounting screws then finally, the 2 loose screws on the PTO rear chassis bracket.

Install the anti-backlash spring on the Oldham coupler. Reinstall V-701 after first tightening the screws in the tube socket and giving the tube pins a shot of DeOxit.

Turn the radio on. As it is warming up, put a single drop of (do NOT spray) DeOxit onto the PTO shaft where the ground return strap engages. Work the "Kilocycle Change" control back and forth about 50KC's to seat the strap against the shaft.

Repeat the turning test above. The radio should now tune without instability.

Should it not, you may have a Collins, Motorola or other PTO which has an internal cam stack/follower assy which is sticking. Repair of this is beyond any explanation here and should be only attempted by someone comfortable with doing "surgery" on that PTO.

Future maintenance should simply require to annually re-apply the single drop of DX-Oxit to the shaft/ground-strap contact point and rock the frequency back and forth as above.

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From: "Mark Glusker" <glusk@...>  
Date: Fri Jan 30, 1998 9:10 am  
Subject: Re: [R-390] R390A Mechanical mayhem

<snip> - In my opinion, the best first step if you are removing the RF module is to remove the VFO. First of all, turn the KC knob until "+000" shows on the counter. From the top of the radio, undo the connector on the RF module for the VFO and feed the cable and connector through the hole in the chassis. Turn the radio over and remove the spring on the coupler at the front of the VFO shaft (may be missing - if so, don't worry). Remove the two frontmost green headed screws holding in the VFO. Instead of removing the single green headed screw at the back of the VFO, remove the two normal screws holding the VFO bracket to the chassis itself (you'll see what I mean when you get there). These screws are not captive, so be sure to catch them when they are fully unscrewed. Now you can slide the VFO directly towards the back of the radio without losing the synchronization with the RF module. The center disk of the shaft coupler will be loose at this point - be sure not to lose it! Don't turn the VFO shaft more than about 1/8 turn. If you leave it unturned, it will slide back in again when you are done without needing any special synchronization (except tuning the RF module to +000 on the counter). If you do turn the shaft, you can always reset it if you have a frequency counter. The +000 setting corresponds to a VFO frequency of 2455 kc. <snip> - To reinstall, reverse the procedure. Be careful not to damage the spring fingers on the chassis under the RF module. Reinstall the VFO with the counter on the RF module reading "+000", don't forget the Oldham coupler disk. <snip>

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Date: Sat, 21 Mar 1998 07:59:50 +0000  
From: "Chuck Rippel" <crippel@exis.net>  
Subject: R390A Alignment Note

**The following is probably the single most important alignment component** in the R390A receiver. It's relevance is not really spelled out in any of the technical

manuals I have seen but it is the real key to getting the receiver properly aligned. PTO tracking on the R390A is very important. Due to the tracking nature of the RF and IF circuitry, the PTO end points must be very carefully adjusted. If the PTO is "long" or "short," it will not tune in the designed 1 MHz segments that match the mechanical cam profiles which drive the slugs in the various coils. In as much as I restore R390A's, I find that PTO mis-tracking by a little as 10 kHz can noticeably degrade overall performance. Don't believe it? Loosen the PTO coupler then tune the radio on simple band noise. At this point, changing frequency with the KILOCYCLE CHANGE knob will only tracking the cam stacks and not the PTO. Observe that the band noise drops away at about (+-) 7 kc or so from your original frequency. That's is how tight the mechanical tracking on the '390A is. Here is a quick check for proper PTO tracking:

Let the radio warm up for about an hour.

Tune the radio down to (-) 000 and zero beat the calibrator. Next,tune the radio up and note the frequency where it zero beats. The dial should read close, say to plus or minus 3 kc's of (+) 000. If that is not the result, both the PTO end points AND the dial over run need to be reset. This is followed by setting (timing, actually) the various cams which now need to be mechanically realigned. Follow this by an an electrical alignment as outlined on top of the "Utah shaped" plate on top of the RF deck.

Successful completion will result in the mechanics of the receiver tracking with the electronics.

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Date: Tue, 20 Oct 1998 22:33:02 -0400  
From: John <jbharvie@erols.com>  
Subject: Re: [R-390] **A Cosmos PTO** success story

Well I guess the group encourages alternate points of view... so flush this if you don't want to read it.

Let me start by saying that the alignment of A COSMOS was for me a tough difficult and stress producing procedure. More than likely there are experts out in the group who will take exception to this "simple" posting. So do not take it as anything but my individual hands-on experience. Candidly speaking I suggest that anybody who is considering this closely assesses the performance of your PTO PRIOR to any opening up and set-screw adjusting, even though the performance might be off and you might be tempted to do so the as-is performance might just be as good or better than the following intervention you can likely make - You have been warned!

However For a learning experience, on a spare unit, or if you are bold GO FOR IT! Having said all that: I "tuned up" both a Collins and a COSMOS PTO on one of my R390A receivers about 9 years ago. Roughly this is what would be along the line of what I did .for the COSMOS unit. (not knowing any better this turned out to be a very interesting educational experience)

It was a real pain in the rear and took me a lot of time but in the end, (no pun

intended) performance was significantly improved. Today the receiver still operates no more than one tick (200 Hz) on all the calibration points.

Bottom line, with enough time and some care and some special tools you can work on the COSMOS PTO... Results are dependent on your overall setup, equipment, time and finesse.

Important ! You must have a good (stable and accurate) frequency counter or some other means of measuring the PTO output to say 10 Hz or so precision.

Some tips:

I found I could obtain better results by slightly loading the output of the PTO under alignment into a non inductive load. Raise and maintain (for 4 hours minimum prior to any sensitive work) the PTO to a warm temperature by placing it under a 75 watt light bulb, mounted overhead, adjust the distance from the bulb to the PTO so that the unit runs at about the (indoor) receiver in-use operating temperature. Try to keep the temperature stable while you are working on the unit. If you must stop mid-stream you may have to back track and do it again, keep the light (heat) on at all times while you are working on it. If you keep the door closed on an inner work room I found the temperature variations are within a couple of degrees. As you start to get into the PTO guts diagram everything you see as this is what will become your owner / operators and recovery manual for your PTO. TAKE YOUR TIME

Mcmaster Carr sells adequate precision 6" and 8" diameter dial face plates with reasonable precision index marks for around \$10.

Mount this dial to an Aluminum backing plate which has been drilled for the shaft diameter (0.185 inches) and secured (epoxy is OK) to some sort of a shaft clamp, mounting close to center (0.005") is somewhat important. Once your happy tighten up the clamp onto the PTO shaft, this gives you a good dial reference for making repeatable angular displacement measurements.

The 8 inch diameter dial, though bigger does a little better job to resolve, measure and enable a better than 400hz shaft angular result. If desired a 10 turn counter (with lock) can be added to the alignment mechanism (such as the 400 series from Kilo International - Digi-Key page 376 in catalogue Q983 for \$15.75 part number 412KL-ND)

#### PTO basics

PTO provides range of 3.455 to 2.455 mHz span.... therefore:

10 turns	=	3,600 degrees ( 1,000 kHz)
1 turn	=	360 degrees (100 kHz)
1/2 turn	=	180 degrees ( 50 kHz)
1/4 turn	=	90 degrees ( 25 kHz)
1/8 turn	=	45 degrees ( 12.5 kHz)
1/16 turn	=	22.5 degrees ( 6.25 kHz)



1/32 turn	=	11.25 degrees ( 3.125 kHz)
1/64 turn	=	5.625 degrees ( 1.5625 kHz)
1/128 turn	=	2.813 degrees ( 781.25 Hz)
1/256 turn	=	1.406 degrees ( 390.625 Hz)
1/512 turn	=	0.703 degrees ( 195.31 Hz)

- \* Operational Limit = 1.79 degrees ( 500 Hz)
- \* (Reasonable) = 1.00 degree ( 277.78 Hz)
- \* (Obtainable) = 0.50 degree ( 138.89 Hz)

Per TM 11-856A paragraph #150: ....Total End Point error on PTO not to exceed 500 Hz..... (or about 2 degrees of shaft rotation)

To proceed:

- Remove and open up the PTO
- Remove the outer PTO can, heater and insulation (without trashing the thermal insulation)
- Unsolder where necessary
- Be gentle
- Once it is opened up examine the PTO closely, look for damage or excessive lead screw wear. Lubricate the lead screw if absolutely necessary with an acceptable lubricant.
- Mount the PTO to a suitable stable test fixture, mount and insure that the dial face is securely mounted and rotates perpendicular to the PTO shaft. Verify the turn counter works (if used)
- Insure you can gain access to and rotate the set screws. I had to make my own set screw driver as the set screws are real small! One option is to obtain the smallest possible driver and stone it down.
- Mount and check that the reference pointer is secure and that the dial clears the sharp pointer by giving the dial a full turn.
- You can place a fixed magnifier lens and lamp to assist you in seeing the lines as needed but with a 8 inches dial a 1/2 degree spacing is quite readable.
- Connect up the power to the PTO,
- Connect the PTO output to a load resistor and the frequency counter.
- Bring up and maintain the (exposed) PTO to a "warm to the touch" condition with the lamp.
- Turn on the PTO
- Look for a frequency output.
- Check the output vs. shaft rotation and move the shaft to get to the high end
- Double check the output range (its still not to late to turn back :)
- As you rotate the PTO you will see how the 40 or so adjustment screws are mounted in a perimeter array and what they do. These screws act to set into a precise position a metal ring on which rotates a coil plunger. The plunger depth is "modulated", by the degree to which the set screws deflect the metal ring. These plungers are what "trims" the precise PTO output frequency. As you rotate the PTO shaft the 40 or so set screws are need to be "adjusted" to precisely establish and define the mechanical plunger depth (position) so that the desired precise frequency output is achieved.

- Keep track of which and how much you turn the set screws - make a diagram and keep good notes.
- If you mess up take a break and start over.
- Always check the end to end (10 turns) as well as the 1 turn performance.
- After you are completed, turn the PTO off, let it cool off overnight, maintain the lamp in position, turn the PTO back on, let it heat soak for another 4 hours and (re) measure the results.
- Settle for a reasonable performance level and call it good enough
- Reassemble with care

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### **THAT PESKY ENDPOINT.**

(Revised 6/6/99)

by Dave Medley

When I do this I use a jig to make the procedure more accurate.. This jig is a simple mounting for the PTO with a separate mechanical counter to measure the shaft rotation. I can provide more information to anyone interested. The following assumes that the reader does not have such a jig. It yields acceptable results if you are careful.. The only catch is you need to have access to a good frequency counter. Here is the procedure by the numbers:

1. Remove the PTO mini BNC from J217.
2. Turn the radio on its back and remove the anti-backlash spring from the Oldham coupler. Store this in a safe place.
3. Loosen the spline screw securing the front flange of the Oldham coupler to the gearbox and pull it back to release the center disc of the coupler. Store this in a safe place.
4. Now remove the PTO. You do not need to pull the front panel to do this. Just loosen the two screws fastening the rear bracket to the chassis and disengage the three green headed screws holding the PTO to the chassis. The PTO can now be withdrawn. Place it conveniently on the radio so the power connector can remain connected.
5. Connect your frequency counter to the PTO output connector. To do this you need a mini-bnc to bnc adaptor. If you don't have one of these just remove the one that is attached to the rear apron and use that.
6. Switch the radio to standby and allow the PTO to stabilize for about an hour. Be sure the ovens switch is OFF.
7. Manually rotate the PTO shaft until the counter reads 2.45500 MHz. Mark the position of the shaft on the mounting plate. I use the anti-backlash spring post as an index.
8. Now rotate the PTO shaft 10 turns until the index lines up again. The counter

should read 3.45500 MHz but of course it won't otherwise you would not be going to all this trouble!! So now turn the end point adjusting screw until the counter does read 3.45500 MHz. You need a thin screwdriver to do this. Be careful not to lose the access cover screw,

9. Check the index once more at 2.45500 MHz. If it does not line up then repeat steps 7,8,9 until the range of the PTO is exactly 1 MHz for ten turns of the shaft.

10. Before you replace the PTO check the setting of the 10 turn stop. In its fully counterclockwise position the dial should read between -963 and -972. If it is outside this range adjust the ten turn stop until it does. If the error is minimal the best way to do this is to loosen the small bevel gear on the counter and reset it. After doing this be sure to check the mechanical synchronization. The check point is 2.000 MHz for the R-390 and 7.000+ for the R-390A.

10 Now replace the PTO using the reverse procedure but do not tighten the spline screw on the Oldham coupler. Set the KHz readout to +000, rotate the PTO shaft until the counter reads 2.45500 MHz and then carefully tighten the spline screw and reconnect J217. That is all there is to it and it should not take more than 10-15 minutes. If the end point adjustment is out of range then you have a much more difficult problem. This involves dismantling the PTO and removing one turn from the appropriate coil. This is another subject. If you have such a problem let me know. I may be able to help.

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Date: Sat, 03 Jul 1999 09:44:00 -0700  
From: dma@islandnet.com  
Subject: Re: [R-390] problem with PTO

Disassembling the PTO is not difficult. Remove the outer can. Remove the fiberglass blanket (carefully so that you can reinstall it). Unsolder the (2) wires from the thermostat/heater that otherwise makes it impossible to remove the inner can. Remove inner can and clean away. The only trick in reassembly is getting the @#\$\$% fiberglass to fit in properly without tufts sticking out around the edges like a bad haircut. That said, there is likely more to your problem. I've seen PTOs with a lot of internal corrosion - probably lost their air tight seal years ago and have operated in a corrosive atmosphere. The elevated temperature would hasten this process. If this is your situation, a careful and thorough cleaning may be required. Also, as has been discussed on the list before, there are at least two different internal arrangements for the linearity adjustment. I had one PTO that had a similar problem to yours. Inside the PTO are little sacks of silica-gel. The sacks look to be some kind of clear plastic, which turns brownish and gets very brittle with age. The ones in mine had burst, spreading silica gel crystals throughout. Some had inevitably gotten into the lead screw, and resulted in a sandy, gritty feel when tuning - especially in one direction. Getting all this stuff out was a challenge. Mostly what's required is care and attention, and an obsessive concern for tracking down the grit! If I can advise further, just ask!

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From: Bill Riches <briches@jerseycape.com>

Subject: Re: [R-390] PTO query

Last winter I purchased 10 of the potluck ones from Fair Radio - mostly Cosmos - have used 4 so far and all have worked 2 were within 100 hz of each 100 khz and 2 had endpoints out 500 hz brought down to within 100 hz at each 100 khz. They seem ok. The other 6 are still in sealed boxes.

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Date: Mon, 13 Sep 1999 18:50:13 EDT  
From: DJED1@aol.com  
Subject: Re: [R-390] PTO query

I don't know about the Collins, but I bought one of the "refurbished" ones. It was a Cosmos and it worked well- smooth tuning. But, it had an endpoint error of several KHz, well outside the nominal limit of 1.5 KHz. I have heard of others who found the same situation. Mine did not have an end point adjustment, but the classic Cosmos linearity adjustment every 25 KHz. I finally figured out how to calibrate the unit and it's been very satisfactory, accurate to about 300-400 Hz over the band.

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Date: Mon, 13 Sep 1999 18:02:20 -0700 (PDT)  
From: Tom Marcotte <courir26@yahoo.com>  
Subject: Re: [R-390] PTO query

The COSMOS does have an endpoint adjustment. It operates similar to the Collins et al endpoint adjust. When you look down at the front of the PTO, it will be the adjustment behind the cap screw on the right (almost behind the transformer). The linearity is the one on the left (actually there are 40+ screws for linearity under the cap). I wrote an article about this in Electric Radio. If you contact Barry Wiseman at er@frontier.net, I'm sure he can get you a copy (he has copyright). I usually set up the PTO's with a little extra endpoint range as they "leak" range over time, just like a lawnmower that burns oil, you give it a bit of lagniappe. I give it one extra kc (1001 kcs in ten turns) and it burns off one kc in a year or so, and then it is right on without removal. This is a very predictable thing. It always drifts the same way.

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Date: Thu, 16 Sep 1999 17:38:36 -0700 (PDT)  
From: Tom Marcotte <courir26@yahoo.com>  
Subject: [R-390] Cosmos Cal Procedure (long)

If you were wondering how to calibrate that confounded Cosmos PTO, here is a procedure that I developed with some trial and much error. Note: One should refer to the R-390A service manual before attempting to service the PTO, and should be experienced with either R-390A or other Collins designs. Background: The Cosmos PTO does not use a compensating stack for linearization as the other makes do. There are 40+ screws that can be adjusted from the front of the PTO through a little window. If you open the screw cap cover on the left-front of the PTO, you will see a staggered row of tiny screws. As you turn the PTO, a new screw will appear with each quarter turn. Endpoint adjustment (under the cap screw on the right) is done just like a Collins PTO. So

stop slammin' the Cosmos PTO and get to work :-)

Procedure:

The two things needed to calibrate the Cosmos PTO at 25 Kcs points are

- 1) an accurate means of measuring frequency, and
- 2) an accurate means of turning the PTO shaft exactly 90 degree at a time.

I use a frequency counter to measure the PTO output, and the Veeder-Root counter in the radio to measure the turns of the PTO. When using the radio's Veeder-Root counter to measure turns, take the time to tape exposed 120 VAC power and fuse connections to prevent electrical shock whilst performing the more than 40 PTO remove/install maneuvers. The frequency counter may be connected directly to the output connector of the PTO. A handy crossover connector from the mini BNC fitting to BNC can be found on the back bulkhead of the radio. Simply borrow the adapter that is present at the IF output jack. There are many alternatives to using the radio frame to measure turns, including using a sacrificial R-392 frame and various schemes featuring calibrated knobs.

Setting the endpoint on a Cosmos PTO is similar to the Collins PTOs. Test the PTO to see how many turns it takes to achieve an output starting at 3455 Kcs and ending at 2455 Kcs. Most aged PTO's that have not been recalibrated will typically require an additional 1-15 Kcs past the ten turn mark to achieve the proper range. To bring it back to 1000 Kcs output in ten turns, adjust the endpoint screw (usually clockwise). The endpoint screw is under the screw cap that is behind the transformer (when looking at the front end of the PTO, it is on the right). If the proper output cannot be achieved within the adjustment range of the endpoint screw, one must open the PTO and remove one turn from the endpoint adjusting coil. This change in overall inductance of the coil will bring the endpoint back 7 Kcs or so. Once this is accomplished, setting the endpoint can usually be achieved with the endpoint adjustment screw. While the PTO is open, the lead screw and bearing can be lubricated. I usually take this opportunity to bake an open PTO in an oven at 150F for several hours to dry it out and regenerate the desiccant. Perform the calibration only after baking, and keep the PTO in a zip lock bag if you plan to leave the adjustment window screws open for an extended length of time.

The linearization screws are under the screw cap on the left of the PTO (when looking at the front). There are more than 40 adjustment screws, one for each 25 kcs of range. The adjustment screws pass in front of the little open window as the PTO shaft is turned. To enable linearization, I find it best to set the desired point on the Veeder-Root counter, make note of the error, and then physically uncouple the PTO from its coupler, tilting it up to access the adjustment screws. The screws are very small, and this technique will make insertion of the screwdriver onto the screw head true with minimal fuss. The steps for checking a calibration point are as follows:

- 1) set the Veeder-Root Counter to the desired calibration point (ex: 000).

2) note the frequency output and error, and record both on a calibration chart (ex: 3456 kcs, +1 kcs error). An example calibration chart will be developed below

3) uncouple the PTO and tilt it up to access the adjustment screw (note this may jostle the output reading a bit, don't worry about that, you just need to work the error out with this screw no matter if it is jostled or not, trust me on this).

4) adjust the screw to remove the error (ex: -1 kcs, regardless of present reading which may have been jostled due to PTO uncoupling maneuver).

5) re-couple the PTO, and go to step one, adding 25 kcs to the Veeder-Root counter reading. repeat until past 2445 kcs.

### IMPORTANT!

When setting the 25 Kcs calibration points, it is extremely important that the screw being adjusted is directly lined up behind the adjustment window. This need be checked only once, on the first screw being adjusted (the 25 kcs increments for the remaining screws will line them up automatically). To accomplish this proper starting point, set the PTO shaft such that the output is 3455 kcs. Then simply rotate the PTO shaft slightly (left or right in 5 kcs increments) until the screw nearest the window is lined up with the window. Note the indication on the frequency counter as a starting point for your calibration chart. The reason the initial starting point for the first screw is so important is that the cam follower which rides on the compensating cam is directly behind the window, and will thus be directly under this screw at this point. If this caveat is not followed, apparent adjustment can still be made, but there will be interaction between the point that one is attempting to adjust, and its two neighboring points. This will yield poor results and will be very frustrating. Be advised that if the screw being adjusted is directly behind the window, the PTO position will likely not be at an exact 25 Kcs calibration point on the Veeder-Root counter dial, e.g. 000, 025, 050, etc. This is not a real problem, but it will be necessary to shift the starting point of the 25 Kcs check points (and the calibration chart) by 5, 10, or 15 Kcs up or down. Simply remember that the PTO must have an output of 3455 Kcs at dial indication 000, and 2455 Kcs at dial indication +000. Armed with this information, one can make a spreadsheet calibration chart for all 40 (or 42 if you prefer some lagniappe on the ends) calibration points in 25 Kcs increments.

The above example is for a PTO that has the nearest linearity alignment screw falling at a frequency of 3465 Kcs on the frequency counter. This corresponds to a starting point on the Veeder-Root counter of -010. Note that this starting point is not on an even 25 Kcs point, but that is OK as it is most important to start with the nearest screw directly lined up with the adjustment slug at the center of the window. To complete the chart, subtract 25 Kcs from the frequency counter reading and add 25 units to the Veeder-Root counter for each point out to or past (less than) 2455 Kcs.

Each screw will have an adjustment range of about 5 Kcs +/- . Clockwise rotation

of the screws will reduce the PTO's frequency output at a given checkpoint. One should avoid adjusting the screws to near their full clockwise position as this will cause excessive drag in the PTO.

#### Advanced Procedure for the Stout Hearted

To remedy problems with excessive drag due to adjustment screws reaching their clockwise limits, back all of the adjustment screws out to their counter-clockwise stops, and then turn each screw one turn clockwise. This will give the adjusting cam an initial flat shape. Start PTO calibration at the point nearest 3455 Kcs as described above, moving up the dial (down in PTO output frequency) to 2455 Kcs (+000 on the Veeder-Root counter).

Remember to check each calibration point against the frequencies on the calibration check chart you made (it is not hard to get 5 Kcs off). Some check points may require a touch-up calibration after completion of the first pass. This will be especially true if the PTO calibration was re-started with the cam in the initial flat position as described above. Extreme adjustment changes (greater than 5 Kcs) at any given point may cause output changes at neighboring points. These can be worked out with multiple checks and further adjustments at problem checkpoints. With this linearization procedure, it is possible to obtain checkpoint accuracies of +/- .100 Kcs with an initial dial calibration at 000 using the crystal calibrator. This exceeds the specifications listed in MIL-R-13947B which require a +/- .300 Kcs with a dial calibration at the nearest 100 Kcs check point using the crystal calibrator. 73 Bonne Chance! Tom N5OFF

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Date: Tue, 19 Oct 1999 04:56:29 -0700 (PDT)  
From: Tom Marcotte <courir26@yahoo.com>  
Subject: Re: [R-390] Cosmos PTO chicken or egg?

You did the right thing by setting the endpoint first. The rest of the PTO should be adjustable by the linearity screws, but 4 kcs is a bit of a stretch for a single point. If the main inductor is wound true, more or less, then the single point adjustments will serve to flatten out the corrector cam, but if the main coil is flawed, then the corrector cam will have a steep bow in it at that extreme point. This may cause a bit of drag in the PTO at that point. Don't sweat it and give it a try.

To answer your question, there will be little if any interaction between the endpoint and your erroneous mid-point, but you will have the opportunity to correct any last minute-minor endpoint error with the last linearity screw (keep it small though by doing your best endpoint adjustment first).

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Date: Tue, 11 Jan 2000 11:30:43 -0700  
From: "jordana@nucleus.com" <jordana@nucleus.com>  
Subject: [R-390] Cosmos PTO help...!!??

Hi for those who have sent e-mail... yes I have tried other tubes... the Ovens are off... the rig has been on for over 36 hours and the PTO still has a slow drift...it does occasionally jump a few hundred kcs even after 36 hours... The tube and

socket have been cleaned and this made no difference ... it seems to have settled down somewhat, and the linearity is OK...but the drift is still present...

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Date: Tue, 11 Jan 2000 11:09:45 -0800 (PST)  
From: Tom Marcotte <courir26@yahoo.com>  
Subject: Re: [R-390] Cosmos PTO help...!!??

Sounds like classic bad cap in the PTO. You might also check the condition of the cores.

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Date: Wed, 12 Jan 2000 10:10:43 -0500  
From: km1h@juno.com  
Subject: Re: [R-390] Cosmos PTO help...!!??

I cant speak from experience with that particular unit but the symptom sounds similar to a known fault of the 75A4 PTO. The cure was to replace the dogbone style ceramic caps. I do not remember if it was with NPO disc or silver mica; its been 30 yrs since I went into my PTO. The other primary cause of 75A4 instability was the shaft grounding spring, they just plain wore down over time and finally lost solid contact. I had to make another one about 5 years ago. GL Carl KM1H

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Date: Fri, 17 Mar 2000 09:48:36 -0800 (PST)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] BFO Adjustment (n+1)

One of the tuneup details is to loosen the setscrew on the Oldham coupler and turn the shaft to peak the output, this aligns and centers the PTO to the rest of the radio.

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Date: Sun, 19 Mar 2000 10:23:11 EST  
From: DJED1@aol.com  
Subject: Re: [R-390] VRC runout and PTO alignment question

Some information on the mechanical alignment- You probably should set the PTO end points before aligning the RF. I don't have an exact reference but check the archives under PTO and you should find lots of information. I did find the reference to the RF mechanical alignment which will set the overrun on the counter: it's a post by Chuck Rippel dated 15 January, 1998. Very clear description.

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Date: Sun, 19 Mar 2000 08:46:44 -0800 (PST)  
From: Tom Marcotte <courir26@yahoo.com>  
Subject: Re: [R-390] VRC runout and PTO alignment question

This is important to the performance of your rig. You should run the RF deck out to it's stop (either side is OK) and give the VRC 35 kcs of overtravel (make sure your zero set gadget is about in the middle of its limited range). Then set the cams up at the prescribed frequency (7+000 or 7999 + 1 kcs I think the freq is). Then, set your PTO endpoints to 1000 kcs in ten turns. After all this is done, you can



proceed with alignment. If you skip the above steps your alignment will be sub-optimal.

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Date: Sun, 19 Mar 2000 18:40:08 -0800 (PST)  
From: Tom Marcotte <courir26@yahoo.com>  
Subject: RE: [R-390] VRC runout and PTO alignment question

OK Dale, that is a fair question. Perhaps I was typing too fast. To set the overtravel, you should disconnect or remove the PTO, and then run the KC's knob over to its clockwise stops. Your counter should now read something on the order of the high side of the band that the RF deck is tuned to. With the knob at the stop, use your Bristo wrench to loosen the screw on the VRC pinion gear, and make the counter read X+035. X is the band you are on. Example: If you are on the 7 Mcs band, make the counter read 7+035 (make sure your zero set adjustment is about at its center). Tighten the screw, and then never ever ever ever change this setting again. If you get confused setting the PTO up, adjust something else. Not this screw. See below. Then once this is set up, put the counter on 7+000 (i.e. 7 999 plus one more kcs) and set the cams up in line with their respective alignment marks for each of the six RF sections (see manual), and then never ever ever change these again. Adjust your PTO for 1000 kcs in ten turns (see the manual). When reinstalling the PTO, I find it safe to set the dial on 000, and then drop the PTO in place with about two turns from its own stop (or at 3455 kcs output if you have a counter or can listen to the PTO signal on another HF rig). Once the PTO is in, you can true it up with a local AM broadcast station.

Since the RF deck and counter are joined at the hip for life (see my orders above) the only adjustment you have available is on the PTO shaft. Loosen either end of this and correct the error (i.e make the broadcast station read properly on the counter holding the PTO shaft whilst turning the Kcs dial).

Piece of cake. Call me at 504-592-6181 if you have any questions.

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Date: Wed, 29 Mar 2000 08:23 -0800 (PST)  
From: rruszkowski@west.raytheon.com  
Subject: [R-390] Doing end point adjustment on PTO's

You read well. You will not find it in there or in the R390/A manuals. The goal is ten turns and exactly 1 million cycles. If low to high adjustment does not work, do high to low.

Pull the PTO out of the chassis so you can grab the coupler. Hang your favorite counter on the PTO. Roll the shaft to get 2,455,000 on the counter. Mark the coupler and case with a marker.

Spool off ten turns and line up your mark. Read a new number near 3,455,000 but not exact or you would not be doing this. Adjust the end point to get closer. spool back ten turns if you are not at 2,455,000

Then do this adjustment from high to low. One end should set still while the other end changes. Erase your marks. Roll the shaft to get 2,455,000 on the counter. Mark the coupler and case with a marker. Spool off ten turns and line up your mark.

Read a new number near 3,455,000 but not exact or you would not be doing this. Adjust the end point to get closer. Spool back ten turns you should be close. About 3 or 4 times and you can get a 1,000,000 change in exactly ten turns. with a good counter you can get within 20 hertz.

I have hit 2 or 3 hertz doing these on the bench in service.

You can stop along the way at one turn points and track your 100,000 cal points. This will give you a clue to the linearity. You may record these for reference.

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Date: Wed, 29 Mar 2000 13:34:14 -0500 (EST)  
From: "Paul H. Anderson" <pha@pdq.com>  
Subject: Re: [R-390] Doing end point adjustment on PTO's

Roger - that is a great summary! The key question I have is how do I actually adjust the end point? What pot, slug, trimmer, am I supposed to be tweaking?

The only obviously adjustable thing is the top of the transformer on the PTO - is that was I want to turn? The PTO I'm looking at is a Collins PTO for a R-392 (so it is different than the 390 and 390-A, I think). Over lunch, I went home and aligned the PTO shaft using my new RF signal generator (URM-25F), as well as the internal calibration crystal, and I think the end points are actually ok. There is some non-linearity over the whole range - maybe +/- 1.5 KC, but this is livable for me. I'm learning more (and enjoying it a lot)... thanks for writing, folks!

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Date: Wed, 29 Mar 2000 13:33:28 -0600  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: RE: [R-390] Doing end point adjustment on PTO's

Were you using a mechanical 10 turn stop when you did this? Twenty Hz in 1,000,000 in 10 turns is 20 in 100,000 for one turn or 1 in 5000, which is a little less than 1/10th of one degree mechanical rotation. If you drew a circle ten inches in diameter and used a pointer 5 inches long attached to the PTO coupler, you'd have to line the pointer up within 1/200 of an inch, or about 1/4 of 1/64 inch. I'd need a really steady hand and a magnifying glass, or maybe a microscope. What I did was to fasten the PTO to the bench, on top of a steel panel, and then bring a try-square up against the coupling ridges. You're not looking for absolute accuracy of the endpoints, but to get 1 MHz in exactly ten turns. So you line up the coupling at the low end and write down the counter reading, turn the coupling ten turns, line it up with the try-square to get exactly 10 turns, adjust it, go back ten turns, do it over again until you can't get any better. Then you set either endpoint mechanically when you put the PTO back in the set, by moving the RF deck coupling on its shaft AFTER the set has thoroughly warmed up. Even an R-392 warms up, with its sealed case. The ones I've done do not stay put at one end

when the other is adjusted. That's why you do it several times. For an R-389 PTO it's 50 turns out and 50 turns back. For a really good time, open up the PTO and use the corrector stack to improve the linearity. But don't open it if the air is humid. Minnesota in January is OK, when the dewpoint is well below freezing.

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Date: Wed, 29 Mar 2000 12:21 -0800 (PST)  
From: rlruskowski@west.raytheon.com  
Subject: [R-390] Locating the end point adjustment on PTO's

>The key question I have is how do I actually adjust the end point? What pot, slug, trimmer, am I supposed to be tweaking? The only obviously adjustable thing is the top of the transformer on the PTO - is that what I want to turn? The PTO I'm looking at is a Collins PTO for a R-392 (so it is different than the 390 and 390-A, I think).

Oops I forgot to mention, there are several flavors.

Collins. you are looking for a 3/8 or 7/16 screw cover cap behind the tube that covers the adjustment point. This cap looks like a big bolt top.

Cosmos. You have two covers. Behind one is a single adjustment, This one you want for the end point. Behind the other the adjustments will change as you turn the PTO shaft. DO not adjust those if you are not working on the linearity of the PTO.

You can do an end to end spread check real quick. Zero the cal at one end. Spin the ten turns to the other end and see where the zero is. 2Kc is field acceptable for mil use. There ain't no reason to get yours adjusted down under a 100 hertz. You can get that close with the cal oscillator and just taking the time. You run the KC know by hand and the PTO by hand and listen to the zero beat.

Once you get the span correct you reassemble the PTO and set the shaft adjustment to go with the dial counter, cal xtal and zero beat.

The only obviously adjustable thing is the top of the transformer on the PTO - is that what I want to turn?

You need a good RF meter or a scope or time to adjust the transformer on the PTO. Measure the PTO output. Adjust the transformer to give a best flat output level across the whole range of the PTO.

The PTO I'm looking at is a Collins PTO for a R-392 (so it is different than the 390 and 390-A, I think).

Only in some of the external mechanical forms. IE their not swappable off the shelf. But from the maintenance point of view they are equal.

You know tires come in all shapes and sizes these days. But the guy at the tire shop gets them all on and off the rims the same way. So it is with the R3xx family

of PTO's If you have studied one you can do them all.

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Date: Wed, 29 Mar 2000 13:13 -0800 (PST)  
From: rlruskowski@west.raytheon.com  
Subject: Re:RE: [R-390] Doing end point adjustment on PTO's

We were in service and had nothing else to do for the whole damn shift. So we played with things a lot. Once we got done with the adjustment we put them back in the receiver and did the mechanical alignment. You can roll from 000 to +000 and get a good repeatable results. We just used a felt pen marker and some care. Random shots in several thousand receiver alignment over 6 years and your amazed a few fell almost exact.

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Date: Wed, 29 Mar 2000 13:22 -0800 (PST)  
From: rlruskowski@west.raytheon.com  
Subject: [R-390] More Doing end point adjustment on PTO's

>The ones I've done do not stay put at one end when the other is adjusted.....

This is true. However as you do the adjustments, it seemed to work better from one end to the other. After 25 years I do not remember which end would set more still than the other end. I only found a few in six years that needing adjustment would not adjust. The depot said most of the ones we turned in were OK. We had just not let them warm up enough. Yea, like we believed that. The ones we did get from depot were real close in the span and we did not try to get them any better.

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Date: Tue, 25 Apr 2000 17:12:52 -0400  
From: "Randall C. Stout" <racs1@sprintmail.com>  
Subject: [R-390] PTO Alignment

Thanks to those who commented on my moaning PTO. I looked carefully at the Oldham coupler. As it rotates, the alignment between the disks changes a lot. Whenever the slot is vertical, so that the PTO side can slide in a vertical plane, the PTO coupler disk is about 30-40 thousands higher than the KC knob side. This is true in any 180 situation, so I don't think the KC shaft is bent, rather the PTO sits too far above the plane of the main frame in relationship to the KC shaft. Remember, I have the radio upside down, so if you flip it into operating position, then the PTO side of the oldham coupler is actually lower, than the KC shaft side. The 3 green screws are tight. I noticed there are three screws which hold the PTO can to the 'frame'. IF those are either slotted or have some vertical clearance, I would think I could pull the PTO, adjust those screws, so the PTO would align better in the vertical plane with the KC shaft. I think the moan I hear comes from the oldham coupler as it rotates off having a vertical slot, it forces the PTO shaft to bend to accomodate the vertical mismatch. Since the Oldham coupler doesn't have free movement in all axes, I think it torques on the PTO shaft when the slots aren't in a vertical axis.

Does any of that make sense? I stared at it for a while, and am ready to pull the PTO and have at the alignment issue. Just wanted any collective wisdom before I

get out the dial indicators and see if I can change its position.

This is a depot/St.Julians creek dog from Fair, and perhaps Dave had to throw a different PTO into it to get it to work. It is a Collins PTO, as is the rest of the rig.

Hey Nolan, I know you put a lot of effort into your PTO alignment, what do you think?

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Date: Tue, 25 Apr 2000 17:09:35 -0500  
From: "Scott, Barry (Clyde B)" <cbsscott@ingr.com>  
Subject: RE: [R-390] PTO Alignment

Makes me wonder why the Oldham coupler was used. If the two shaft axes aren't co-linear, then it would seem there is going to be binding at two places 180 degrees apart. If the coupler can't handle the misalignment, then what good are they?

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Date: Tue, 25 Apr 2000 19:13:08 -0400  
From: Barry Hauser <barry@hausernet.com>  
Subject: RE: [R-390] PTO Alignment

I haven't seen that problem on any of my R-390(x)'s. Did you clean and grease each side of the disk? Old lube may have become sticky. Also, it may be preferable to give the connection some "slack". Don't jam the couplings up against each other too tightly. Give the works some jiggle room, but not sloppy. I suspect they're smooth up to some maximum amount of misalignment of the shafts. I've observed one or two with quite a bit of side motion, yet with no discernable drag spots.

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Date: Tue, 25 Apr 2000 19:41:41 -0400  
From: "Randall C. Stout" <rsc1@sprintmail.com>  
Subject: Re: [R-390] PTO Alignment

Thanks for the input. After I posted, I went downstairs and stared some more at the coupler. I believe that Nolan did some incredibly complex alignment of his PTO, but after all, this is a blue striper, and I just wanted to stop it from moaning at me all the time. I thought of calling it Mona.

Anyway, I figured that if I could help the coupler align itself, based on the shafts, I would be better off. I removed the PTO and looked at the 3 screws that hold the PTO to the vertical mounting bracket. What I wanted was a way to allow just a little float in those screws, so that the rotation would self center the coupler. Problem was, once the PTO is back in the rig, you can't get to those screws, clearance is too tight.

So, I replaced the top screw with the appropriate bolt(hex head) which I could adjust with a wrench, plenty of clearance for that. I loosed the two lower screws so that you would be able to move the PTO as the shafts turned. Cleaned the coupler and disc, which was full of hardened grease, and one of the couplers had

some kind of cement or glue on one face. I suspect some genius glued the disc to one side of the coupler! That certainly helped it float as designed.

Put it back in the rig, tightened the green screws to normal tension, checked the misalignment again, just to be sure it was still there and not changed from removing the PTO(it wasn't) I loosened my bolt just a bit, got out a medium brass drift, and very gently tapped on the faces of the coupler where they misaligned. That quickly cured the vertical misalignment, but I had a bit of side to side. I used the same strategy for that, and had my total run out of the coupler down to ~5 thou. I will need to do some final setting of the overall clearance in the coupler, but, I am happy to say that Mona has left for greener pastures. Not a squeak, chirp or creak to be heard.

Took it out again, tightened the lower screws, replaced the bolt with the original screw, put it back together, and am pleased as punch. John, where did you find the clearance info for the coupler? I thought I looked everywhere, but missed it.

I have learned more about these rigs working on this blue striper, figuring I couldn't hurt it compared to its sitting out in the weather for who knows how long, then on my nicer rigs, which I don't feel so comfortable with ripping into. I know Nolan wouldn't understand such timidity, based on what he did to his mint EAC, but to each his own.

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Date: Tue, 25 Apr 2000 16:59:24 -0700 (PDT)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: RE: [R-390] PTO Alignment

The problem here is that the Oldham Coupler was only meant to account for "SMALL" misalignments. Everyone here knows that if Art Collins was going to be the only one to work on one of these he would have made the mount out of 1/4" thick plate with drilled and tapped holes in the carefully machined corners and bolted together with a solid shaft coupled to the knob on the front panel! Then someone would be whining about how their's would bind up if there was a fly's wing squashed under one corner. But he knew better. He knew that he'd get too many complaints if it was too hard to line up or if it was too expensive to build.

On the good side; look at how far off it can be and still work! It didn't just jam up and break.

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Date: Tue, 25 Apr 2000 16:42 -0700 (PDT)  
From: rlruskowski@west.raytheon.com  
Subject: Re:[R-390] PTO Alignment

>Thanks to those who commented on my moaning PTO. I looked carefully at >the Oldham coupler. As it rotates, the alignment between the disks changes a lot. >Whenever the slot is vertical, so that the PTO side can slide in a vertical plane, the >PTO coupler disk is about 30-40 thousandths higher than the KC knob side. This is >>true In any 180 situation, so I don't think the KC shaft is bent, rather the PTO sits >too far above the plane of the main frame in relationship to the KC

shaft. >Remember, I have the radio upside down, so if you flip it into operating position, >then the PTO side of the oldham coupler is actually lower, than the KC shaft side. >The 3 green screws are tight. I noticed there are three screws which hold the PTO >can to the 'frame'. IF those are either slotted or have some vertical clearance, I >would think I could pull the PTO, adjust those screws, so the PTO would align >better in the vertical plane with the KC shaft. I think the moan I hear comes from >the Oldham coupler as it rotates off having a vertical slot, it forces the PTO shaft >to bend to accomodate the vertical mismatch. Since the Oldham coupler doesn't >have free movement in all axes, I think it torques on the PTO shaft when the >slots aren't in a vertical axis. Does any of that make sense? I stared at it for a >while, and am ready to pull the PTO and have at the alignment issue. Just wanted >any collective wisdom before I get out the dial indicators and see if I can change >its position. This is a depot/St.Julians creek dog from Fair, and perhaps Dave had >to throw a different PTO into it to get it to work. It is a Collins PTO, as is the rest >of the rig. Hey Nolan, I know you put a lot of effort into your PTO alignment, >what do you think? Thanks Randy

- ----

The offset is why the coupler is in there. Your offset is not that much.

Pull the thing and spin it by hand.

Just keep track and spin both the PTO and the dial back the same.

Is the squeek in the chassis?

Is the squeek in the PTO?

Is the squeek now gone (coupler)?

Do you have a little gap in the coupler?

There should be some clearance so the knob shaft does not push on the PTO shaft. The spring keeps the back lash out for you.

Did you look at your dial lock yet?

When we give you guys a few dozen tips do tell us which ones you did check and did not solve the problem.

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Date: Tue, 25 Apr 2000 19:10:07 -0500

From: "Bill Hawkins" <bill@jaxs.net>

Subject: RE: [R-390] PTO Alignment

If your Oldham coupler is forcing the shaft to bend, something is wrong with the coupler. There should be a disk between the chassis end and the PTO end of the coupler. The disk should have on slot on each side, and the slots should be at right angles to each other. The disk will move from being centered on one shaft to being centered on the other shaft as the assembly rotates. It will take quite a lot of misalignment. But the more it is misaligned, the more non-linear the rotation gets, throwing off the counter/frequency linearity. I think there's nothing for it but to remove the PTO. Mark the couplings first so you can put it back in the same rotation. You did try Joe Foley's suggestion of the dial lock, right? My guess is that the PTO (and maybe the radio) was dropped hard enough to bend the lead screw that moves the core through the coil form. The core dragging on the coil form (linearly - the core doesn't rotate except for the linearity corrector) causes the moan like a bow on a violin string. If a bent lead screw is the cause, it would be pretty tricky to get it straight again.

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Date: Tue, 25 Apr 2000 19:19:01 -0500  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: Re:[R-390] PTO Alignment

>Hey Nolan, I know you put a lot of effort into your PTO alignment, what  
>do you think?

It shouldn't take an hour to set one up real close. Before you put a lot of effort into it, pull the PTO and throw a dial indicator on the drive and driven flanges and verify that they are true as are the shafts.

If so, it's just a question of changing the up and down, in and out, and side to side positioning of the PTO mounting brackets. It can be tedious with three planes to deal with. <grin>

To be honest with you though, I'd be half-assed tempted to go ahead and pull the covers off of the PTO while you have it out of the chassis and take a peek inside. You might want to see just how much force is required to rotate the shaft in the PTO. There's a chance that you might end up having to pull the thing apart for a lube job.

If nothing else, verify the endpoint adjustment before you remove it and see if you need to remove a coil turn to bring it back into specs. It's a lot easier to do it all while you've got it out of the chassis.

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Date: Tue, 25 Apr 2000 17:23:04 -0700 (PDT)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re:[R-390] PTO Alignment

Also, if the PTO is forced to wobble because of a bent shaft, or if the shaft coupler isn't free, the bolts holding the PTO will come loose! Like mine did, picture that falling out on the floor, but it didn't.

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Date: Wed, 26 Apr 2000 09:01:55 -0400  
From: "Tetrode" <tetrode@sprynet.com>  
Subject: Re: [R-390] PTO Alignment-Oldham coupler

Glad to hear that your mechanical re-alignment and coupler cleaning efforts paid off!

>John, where did you find the clearance info for the coupler? I thought I  
>looked everywhere, but missed it.

In TM 11-856A its Fig. 89, Oldham coupler details, page 157.  
In T.O. 31R1-2URR-452 (Army TM 11-5820-358-35) its Figure 70 on page 113.

They are both the same drawing and it is only mentioned briefly during VFO removal/replacement or synchronizing steps. It shows the Oldham coupler disk



pressed flush against one side of the coupler plate, while the other side of the disk has a 1/32 (.031) free space between it and the other coupler plate to allow it to move around.

The first time I set it I took a piece of #twenty-something buss wire that was close to the right size and flattened it a bit with a hammer taps until it measured the right amount on a micrometer, and then used it as a gauge to set the spacing. Now that I know what the spacing looks like I just eyeball it.

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Date: Wed, 26 Apr 2000 09:07:39 -0400  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] PTO Alignment

>...I could pull the PTO, adjust those screws, so the PTO would align better in the vertical plane >with the KC shaft.

The purpose of the Oldham coupler is to allow for exactly just such mis-alignment. That is, displacement perpendicular to the axis of the shafts. It will allow for modest angular mis-alignment. Just add a small drop of oil to the moving surfaces and see if the moan goes away.

> it forces the PTO shaft to bend to accomodate the vertical mismatch. Since the Oldham coupler >doesn't have free movement in all axes, I think it torques on the PTO shaft when the slots aren't >in a vertical axis.

It does have ( or SHOULD have) free movement in the plane perpendicular to the axis of the shafts. If by "torques on the PTO shaft" you mean applies forces perpendicular to the axis of the shafts, then it is not working right. The slots in the disk are binding, OR there is excess force between the driving and driven disks on the center disk. To correct this, just re-position the PTO a bit to the rear allowing a slight axial clearance.

To be really fussy, polish the tabs on the driving and driven disks and the inside edges of the center disk with some polishing compound, check for free movement of the tabs in the slots, apply a coat of automobile wax, then a bit of soft grease, and re-assemble. The thing should then operate with as much as a half inch of mis-alignment in the shafts. To be crude and do the wrong thing, give it a squirt of WD-40.

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Date: Sat, 9 Sep 2000 08:52:42 EDT  
From: Llqpt@aol.com  
Subject: Re: [R-390] R-390A Advice

<< How many manufacturers were there for the PTO <snip>

PTO's were manufactured by the following:

1. Collins Radio Company
2. Motorola

3. Dubrow Electronics
4. Progressitron Corp.

These listed above are conventional corrector stack PTO's.

5. Cosmos, these are the most common, and have a different method of linearizing the end points.

Since the PTO you has no markings, it's probably a Progressitron, their decals were delicate to say the least. Their pto's are considered my many, including myself to be the best manufactured.

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Date: Sat, 9 Sep 2000 15:51:58 EDT  
From: Llgpt@aol.com  
Subject: Re: [R-390] R-390A Advice

>A follow-up to the PTO. Is there a way to determine manufacturer by external >indicators or is it >really worthwhile knowing.

The four manufacturers of the conventional corrector stack PTO's, are identical in construction.

The Progressitron's are the newest of those types, and consequently seem to be the cream of the crop. That said, The Collins, Motorola's and Dubrow's are all fine PTO's also. I would have no hesitation to use any of those.

But, some of the most " Linear " PTO's I have owned are the Cosmos. " ya p[ays your money and ya takes your chances. But, not a real big chance when getting a PTO for a R-390A.

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Date: Sat, 09 Sep 2000 22:23:58 -0400  
From: John <jbharvie@erols.com>  
Subject: Re: [R-390] R-390A PTO electrical hookup delta

Agree with "identical" in construction (some small deltas) however PTOs are not identical in electrical hook-up. My COSMOS unit has only 4 wires out to the J709 connector. I took the coverplate off of it to see where they connected. One difference is an internal jumper wire was added which connects the terminal normally connected to the RF-IF B+ line (J709-A) and feeds this from the P709-B V701 Regulated +150v line inside the small electrical junction box on the PTO. This eliminated the need for a separate wire to the RF-IF B+ line. I do not think that this makes any substantive difference in the operation of the receiver however if you are tracing down the exact delta and where the 4 wires are landed (connector to component) it is something I have learned.

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Date: Mon, 18 Sep 2000 13:26:59 -0500  
From: "Dr. Gerald N. Johnson, electrical engineer" <geraldj@ames.net>  
Subject: Re: [R-390] PTO Failure modes..???

Tubes, paper capacitors, resistors, RF circuits (capacitors and coils) in that order. Tubes use sockets for a good reason. They are the most suspect of parts. Though bad coupling capacitor can kill tubes and shorted bypass capacitors can kill resistors.

Changing the oscillator tube can require realigning the PTO.

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Date: Mon, 18 Sep 2000 15:10:38 -0500  
From: "Dr. Gerald N. Johnson, electrical engineer" <geraldj@ames.net>  
Subject: Re: [R-390] PTO Failure modes..???

I've no thoughts on aging of those parts. Could be either slug or any capacitor, or resistor or wear on the screw or the moulded coil shrinking. Drift with aging is not a characteristic of good ceramic temperature compensating capacitors. I do have some of those Collins that are not encapsulated. Maybe it would be interesting to check their values on a good bridge someday. Still I can't conceive that a capacitor value changing should change the range of the oscillator. Maybe shift the range but not prevent meeting the end point spread. The endpoint spread adjustment is adjusting the ratio of the delta L in the main coil to the total L in the oscillator. My bet is on the slugs. 73, Jerry, K0CQ

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Date: Thu, 2 Nov 2000 11:24:59 -0500 (EST)  
From: Norman Ryan <nryan@duke.edu>  
Subject: Re: [R-390] PTOs

> However, I'm still experiencing some warble or electromechanical  
> instability in the unit's Collins PTO. As per suggestions from this group, I've  
> cleaned the spring on the PTO shaft, and have cleaned and treated the  
> leadscrew with both Stabilant-22 and also Caig's deOxit. Although it's much  
> better than what it was originally, I'd still love to have a smoothly running  
> PTO like the ones I remember when I serviced so many of these sets back in  
> my Signal Corps days of the mid-1960s (I was a US Army MOS-31E20 field  
> radio repairman, pulling component-level maintenance on <snip>

Does the Oldham coupler have its spring? Is the assembly aligned straight and true? Does the disk have ~ 1/64" spacing between it and the two coupler faces? Getting this right may be all you need to do to get your PTO to settle down. Cosmos made the best PTO, IMHO. 73... Norman

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Date: Thu, 2 Nov 2000 12:36:01 -0500  
From: "AI2Q Alex" <ai2q@ispchannel.com>  
Subject: FW: [R-390] PTOs

Thanks for your note Norman. Yes, the original spring is in place. I'll have to check the mechanical alignment and spacing later, and let you know what I find. Would the "alignment" be adjustable by slightly re-positioning the PTO when the captive screws are loosened, or are you referring to something else? Could you clarify what you mean about the spacing?

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(ed: Additional info in the RF tips section)

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Date: Wed, 15 Nov 2000 04:29:35 -0800 (PST)  
From: Tom Marcotte <courir26@yahoo.com>  
Subject: Re: [R-390] Cosmos PTO question

> ----- Original Message -----

> > What is the coil inside the Cosmos PTO that is beside the end-point adjust  
> > coil? It looks to be in series with the end-point adjust coil. It seems  
> > as if it could be used as a coarse-adjustment for the end point, but I have  
> > not heard anyone mention it before. I only have two turns on the end-point  
adjust coil, and hate to remove one of those which would normally be the  
recommended adjustment.

> >

> > The second coil is the same diameter as the end-point adjust coil, except  
> > that it has three turns on it. It is pictured here -  
> > <http://www.knology.net/~wewilson/images/CosmosPTO.jpg> .

The end point adjust coil is lower left, and the other coil sits above and to the  
right,

> > on the end of the metal sleeve that it fits into.

- --- Walter Wilson <wewilson@knology.net> wrote:

> After a few replies an re-reading Tom Marcotte's article on the Cosmos PTO,  
> I see that the "extra" coil is part of the Cosmos corrector stack design.  
> Now my only question is this: I have only two turns on the end-point >adjust  
coil, and the spread is about 990KC. Do I really remove a turn from >this coil and  
take it down to only 1 turn?

You would remove one turn from the end point coil. This will move the endpoint  
quite a bit, enabling you to then use the adjusting screw to nail it.

---

Date: Wed, 15 Nov 2000 07:49:32 -0800 (PST)  
From: Tom Marcotte <courir26@yahoo.com>  
Subject: Re: [R-390] Cosmos PTO question

Good question! The article says to try the screw first, and if you can't achieve the  
1000 kcs in ten turns, THEN remove the turn. Thanks for the heads up.

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Date: Wed, 15 Nov 2000 09:49:03 -0700  
From: Jordan Arndt <jordana@nucleus.com>  
Subject: Re: [R-390] Cosmos PTO question

Do NOT remove the entire turn.. unsolder about 1/2 of the turn and fold it back on  
itself... then resolder it... otherwise if you go the whole turn you won't get linearity  
over the entire range...

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Date: Fri, 17 Nov 2000 21:31:24 -0500  
From: "Walter Wilson" <wewilson@knology.net>

Subject: Re: [R-390] Cosmos PTO question

I finished the adjustments on my Cosmos PTO tonight. I couldn't get the end-point adjustment with the screw, so unsoldered and folded a turn back on itself. This moved the end-point too far. I finally added a bit of wire to allow me to "loosely" wrap the original turn back around the coil. This got me in range for an adjustment. After adjusting each of the linearization screws, it was within 100 Hz at each 25 KC point. It's in the oven baking now at 140 deg F prior to reassembly and final adjustment.

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Date: Fri, 17 Nov 2000 22:38:47 -0600  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: Re: [R-390] Cosmos PTO question

Walter, before you close it up, hit the windings with some coil dope to secure them. There's no telling for sure if the loose turns might cause any type of drift or instability but a quarter of a cent coil dope will make sure that it won't.

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Date: Fri, 24 Nov 2000 14:58:27 -0500  
From: "Ronald Reams" <wa4mjf@worldnet.att.net>  
Subject: [R-390] PTO Problem

Sorry to be sooo long getting back to all y'all, It was the 6BA6 in the PTO. Got back from my parents in VA today and changed the tube and radio works FB. The ole on went to ? in the tube checker and then fell almost to 0.

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Date: Sat, 9 Dec 2000 13:09:03 -0600  
From: "Darrel Nichols" <n0dbx@mindspring.com>  
Subject: [R-390] PTO Question

OK. Here's a dead list question to ponder. Put this on the shelf after having a near tragic event with the BFH I had grabbed in desperation. Collins PTO has the bearing slightly protruding from the front housing. Enough so that the E-clip broke when I removed it for the initial cleaning. Now the shaft slot is about half covered by the bearing inner bore. Pulling on the shaft will open up the slot, but the assembly binds with a clip installed. From the condition of the PTO, I would guess it had never been opened and therefore suspect the bearing is the correct one. Anybody have any hints on removal of the bearing, or seating it without damage? Or is it a normal condition and I'm missing something?

---

Date: Sat, 09 Dec 2000 15:50:58 -0600  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: Re: [R-390] PTO Question

The bearing is preloaded in the housing with a couple of bellville springs. A small arbor press and a tubular collar with a section cut out so you can access the retainer should work. A short length of PVC or CPCV pipe with a notch comes to mind as an easy one. Supporting the casting is a must. You may or may not have to fabricate a pair of arbor plates to match the casting.

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Date: Wed, 27 Dec 2000 20:06:24 -0600  
From: Dave Metz <metzd@cfw.com>  
Subject: [R-390] Cosmos PTO's--mechanical observations; long

At the risk of boring this esteemed group, I wanted to pass on some comments in the hope that someone might know the answer as to how to realign the Cosmos PTO mechanical adjustment.

It really started quite simple, the blue striper unit in question turned hard. So after a few tries to attempting to lube it smoother, I finally looked carefully at what remained and sort of came to the conclusion that there must be something under the cover between the front and rear bearings that support the shaft. As the Fair has replacements, I said go for it and really take this thing apart because I had a hard turner and the endpoint was off a bunch. Not much to lose in case I lose the patient.

Step 1: after taking off the back support plate I rotated the tuning slug off the shaft and then laid it aside. Then, it appeared that the shaft should push out from the front to back so after removing the necessary stuff, sure enough, with a bit of force, the shaft pushed out the back. Then, a quick unsolder job on the two pins that have the nylon inserts to the next cavity. Then, remove the 4 screws on the base plate and it pulled apart very easily. To my surprise, there was a pinion and gear assembly inside that moved the linearity screw ring. So far so good but it didn't last long. It dawned on me that there must be an initial alignment position similar to a cam in a motor but unfortunately ( or rather OOPS), I didn't know to mark the position or see a couple of marks that would give a clue as to initial alignment. However, while apart, I couldn't see anything that seemed frozen. The front and rear bearings worked very easy and smooth and thus the hard turning must be coming from this pinion gear assembly.

Reassembly: Putting it back together in reverse order seems logical but the critical problem of initial starting point remains elusive. Now I have a unit that is about a 9.5 turn PTO and cannot seem to get it right. Initially, I took the one turn off the endpoint coil but hedged my bet as to cutting it off and merely doubled it back. It didn't seem to make a particle of difference--5 turns or 6 turns. Then there is the problem that 2.455mhz and 3.455mhz are not equally spaced on the runout of the inductor. That is, it's about 1 turn to the stop on one end and over 5 turns to the stop on the other end. In other words, not centered on the lead screw travel.

Thoughts: I know the difference between the end point coil and the linearity coil but I was somewhat surprised that then both appear to have about 6 turns around the form. I have never seen any material on adjusting the slug on the linearity coil that is only accessible from the back of the PTO.

Questions:

1. What could I have done to cause this unit to go from about 10.25 turns to a 9.5 turn PTO?

2. Would anybody have advice as to the initial settings as to the gear assembly/linearity screws before one starts screwing in the inductor slug?

It's really not a big deal to just walk away from it, but it's been an interesting exercise that didn't yield any significant learning growth except to probably never do it again! Aside from the fact that the time here isn't really worth it, I'm still curious as to whether I can get it back together reasonably close to a 10 turn PTO.

---

Date: Fri, 29 Dec 2000 00:50:06 -0500  
From: "Barry Hauser" <barry@hausernet.com>  
Subject: Re: [R-390] Cosmos PTO's--mechanical observations

Actually, Al Tirevold has the working Acrobat master of the Y2K. I'm the editor of The Hollow State Newsletter, not ER. But, do copy me -- plus Al and Pete Wokoun on any details and photos. Most likely, Pete will do the annotation with arrows, etc. There is a writeup on someone's site about the Cosmos -- either Chuck R's or Dave Medley's. I also recall that someone did a long post on a full blown linearity adjustment. I don't know about that problem with the linkage/gearing thingus. Am I mistaken, or is the Cosmos the most prolific PTO?

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Date: Fri, 29 Dec 2000 05:37:01 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] R390A Teledyne PTO calibration

You can go to Chuck Rippel's 390A site, and there are instructions for the Cosmos over there. The Cosmos will have a screw cap to the left of the shaft when looking at the shaft from its end.

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Date: Fri, 29 Dec 2000 09:21:41 -0500  
From: "Walter Wilson" <wewilson@knology.net>  
Subject: Re: [R-390] Cosmos PTO's--mechanical observations

.....how to realign the Cosmos PTO mechanical adjustment.....

Tom Marcotte's article on the rebuild of the Cosmos PTO is a good resource. [http://www.avslvb.com/R390A/html/n5off\\_pto.html](http://www.avslvb.com/R390A/html/n5off_pto.html) A more in-depth set of articles with a few diagrams was published in Hollow State News, issues 45 and 46.

> As the Fair has replacements, .....

A man after my own heart. Dig in first, try to climb back out later.

> a unit that is about a 9.5 turn PTO and cannot seem to get it right.....

I also found that wrapping a half turn back on itself did not make much difference. I started out with only three or four turns instead of your six turns. I added a short piece of stiffer wire that I shaped to be about 1/4 inch away from the coil form, hence making the last turn a "loose" turn. That worked for me.

.....I have never seen any material on adjusting the slug .....

If you mess with the linearity coil adjustment by moving it "in and out" using the adjustment from the back of this coil, you'll move the resting position of the slug within this coil. This will move the endpoint spread AND will impact how much effect the linearity screws have as you move them through their full range. I played with this adjustment on mine, but set it back close to its original position.

> Questions:

>

> 1. What could I have done to cause this unit to go from about 10.25 turns  
> to a 9.5 turn PTO?

To move it that much, it may be that you didn't get the wires completely resoldered to make a good connection, thus you "removed" six turns from the coil. You can only see 6 turns externally, but there are more turns that are covered with a white cloth material. Tom's article suggests that one turn on the coils equals about 7 KCs, but I found it to be closer to 10 KCs on mine. Your 3/4 turn change is equal to about 75 KCs. So check the solder connections really well. If you removed any wire (or broke it off removing it from the coil), the end of the wire would still have an enamel coating. A common trick when soldering this coated wire is to first tin the wire by pressing the coated wire into an aspirin tablet with a hot soldering iron. This works much better than trying to scrape the enamel off the wire.

> 2. Would anybody have advice as to the initial settings as to the gear  
> assembly/linearity screws before one starts screwing in the inductor slug?

You've come this far. Read Tom's article, and consider his "advanced" procedure for the "stout-hearted." After tinkering with mine a while, I decided to take this "advanced" approach. This sets the linearity screws to a flat profile initially, with all screws backed all the way out, then turned in 1 full turn. After setting a flat profile, I measured the frequency of the PTO every full turn, and found that the error looked like a bowl turned upside down. With the endpoints set at 1000 KC, the frequency in between was always above the desired value, and was off by over 5KC in the middle of the range. Tom's article indicates that only about 5KC of linearity adjustment is possible, so I was going to need all the adjustment I could get near the middle of the range. So I backed out the screws near the two endpoints to about 1/4 turn (instead of the initial setting of 1 turn), and set the endpoints 1000 KC apart. Then I began adjusting the intermediate frequencies to get the flat profile. I had enough adjustment in the middle of the range, but just barely. Had I not first measured the frequency profile with a flat linearity adjustment, I might have needed to start all over. Plus, the further you turn in the adjustment screw, the harder the PTO is to rotate. End result: less than 200 Hz error at each 25 KC adjustment point.

But I wouldn't do this tedious task unless you can come up with a way to measure and set the frequency profile with the PTO out of the radio. I made a little scale that was divided into quarter turns, and mounted that to the PTO shaft. I had the



PTO connected to the radio to receive power, but sitting on a wooden platform for easy adjustment with it's output connected to a frequency counter. This makes the adjustment tolerably quick. If you had to keep taking the PTO out and putting it back in to make adjustments, you could be there for days.

.....I'm still curious as to whether I can get it back together reasonably close to a 10 turn PTO.

Your Cosmos PTO is not a problem, but rather an opportunity. You'll learn a lot, so start diggin in. If you dig your hole too deep and can't seem to climb back out, box it up and send it my way. ;-)

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Date: Fri, 29 Dec 2000 19:27:13 -0600  
From: Dave Metz <metzd@cfw.com>  
Subject: [R-390] Cosmos Pictures...mechanical questions

For those of you who asked, if you go to the following, you can see the gears in question:

<http://www.imagehosting.net/images/commo/Mvc001f.jpg>

<http://www.imagehosting.net/images/commo/Mvc006f.jpg>

I hope this helps someone to tell me how to synchronize these gears with the lead screw start point

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Date: Fri, 29 Dec 2000 23:21:32 -0600  
From: Dave Metz <metzd@cfw.com>  
Subject: Re: [R-390] Cosmos Mechanical--final report

After too many hours, I half way solved the problem. To begin, the now apparent 9.25 turn PTO, really is about a 10 if one puts the inner cover on FULLY. That extra 1/2 " makes a big difference. That's so obvious but sometimes my logic is really missing. The mechanical alignment will have to elude me this time as I have too many other projects so I cannibalized this unit to make another unit work.

Lessons learned:

Don't take it apart unless you are really bored.

I did find out the reason for the hard turning however and hopefully that doesn't make the time spent a total waste. Inside that center section disk that contains the linearity screws, there is a small gear held to the shaft with a pin. It seems as if that pin has worked itself out a bit too much and was coring the oilite bearing it was running in. Too much work to ever justify, just get another PTO! I still never got the alignment question solved. However, my suspicion is that one can repeatedly back the inductor off the back and add one turn to the lead screw and eventually line up the start of the linearity screws when the output is at the ends of 2.455 or 3.455 mhz . Further turning of the lead screw through it's journey will keep a full set of screws in the

access window. Logic seems to say that in 9 attempts, one should find the magic point.

Thanks to everyone for your support and I hope this and the pictures help someone else to avoid this exercise. There probably is a TM for rebuilding them somewhere, but until that surfaces or someone with a lot more patience than me figures this out, it shall remain a mystery.

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Date: Sun, 31 Dec 2000 16:44:40 -0500  
From: "Walter Wilson" <wewilson@knology.net>  
Subject: Re: [R-390] More R-390A Newbie Questions

First, the AGC that the rig develops determines the carrier meter level. If your AGC is not right yet, your carrier meter will also be low. Tune in the strongest signal on the band (local AM broadcast) with the BFO off, and measure the voltage at the AGC terminals on the back. Something close the -9 VDC would be about right. If AGC is correct, the meter is probably the problem. Dr. Johnson has given you some good recommendations on this.

> Also while troubleshooting the IF Module, I made resistance measurements on the large socket >J511 per the book. On pin 2 (B+) the book says I should > get infinity for resistance. Instead I get about 50K. I checked the > schematic and indeed there is a combination of resistors attached to the B+ > rail that present about 50K to ground, so I think that is normal. What > gives with the depot manual saying infinity? Were there older/newer > versions of IF module that could give different readings?

Can I assume you meant J512? My book(s) shows 50K or 54K, depending on which book I use. It looks like you have two circuits both with 27K plus 82K in series to ground. 109K each, two of these in parallel, gives about 54K. Sounds good to me if you meant J512. Look again, or find another book. ;-)

> Second---The tuning calibration seems to be off by 15 khz everywhere, i.e. WWV tunes at >10.015, 15.015 and the cal signals are all reading out 15 kc higher. Fortunately, the error seems >constant from one end of the PTO range to the other, so it appears I need to adjust some >mechanical offset. Any suggestions? (I do have the depot manual and Rippel's on-line manual >so eventually I will go through all the alignment steps methodically.)

I'd normally guess that you've done the "zero adjust" to try and calibrate the dial, but since you said "newbie," I won't make that assumption. To do this, you'd set the dial at one of the 100 KC marks, tighten the Zero Adj knob until the dial no longer moves, put the BRO on and the Function switch in CAL mode, and spin the KC knob until you hear the CAL signal. There is only about 35 KC of adjustment + or - when the rig was last properly "calibrated." If the PTO coupler gets removed and is put back in half a turn off, you would shift the adjustment by 50KC, which would lead to a 15 KC error even after you had made the maximum dial adjustment. But this would also throw off the calibration of the RF deck. Quick check: Set the dial to 7+000 KC (1 KC above 7 000 KC), and see if all the cams

at the front of the RF deck line up with their black alignment marks, especially the cams toward the right hand side of the deck. If they do not, there's a good chance that the PTO coupler is off by half a turn.

> Third - Occasionally with the BFO on and tuning through a carrier, I notice a bit of jumpiness in the tuning and the change in tone as I tune through the carrier, >perhaps something jumping in the PTO or gear train. What's the prognosis? It's a Cosmos PTO.

The KC knob is coupled directly to the PTO shaft through the Oldham coupler. If there's much mechanical drag causing this, I'd think you could feel it as you turn. Does the PTO warble any when you stop spinning the knob? There is a grounding strip that contact the PTO shaft to keep it grounded that may be making an intermittent connection.

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Date: Thu, 4 Jan 2001 12:07:24 EST  
From: Llgpt@aol.com  
Subject: Re: [R-390] Motorola PTO's

>Did Motorola make PTO's and if so where do they stand as far as quality and ease of alignment...Ben

Yes, they did.....below is the list of PTO manufacturers:

1. Collins Radio Co.
2. Motorola
3. Dubrow Electronics
4. Progressitron Corp.
5. Cosmos

The first four are conventional PTO's, ie: corrector stack type. The last is totally different. For information go here. <http://www.avslvb.com/R390A/>>R390A Receiver Home on the WWW. There are quite a few PTO's with a Raytheon sticker on them, the were rebuilds under a government contract. Les Locklear

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Date: Thu, 4 Jan 2001 12:12:13 EST  
From: Llgpt@aol.com  
Subject: Re: [R-390] Motorola PTO's

Sorry I forgot to answer your other question....many regard the Motorola PTO's to be the best. They end points usually come right in without any problems. The only problems i have seen with the Motorola's is the end bearing is sometimes bad.

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Date: Thu, 04 Jan 2001 21:05:07 -0600  
From: Dallas Lankford <dallas@bayou.com>  
Subject: [R-390] Jumpy Motorola PTOs

I have had two Motorola PTOs, and Mr. R-390A has had more. These Motorola PTOs have all been jumpy in the sense that when you tuned across a carrier with the BFO turned on, the BFO pitch did not vary smoothly, but jumped in frequency.

And when the Oldham coupler was disconnected and the PTO shaft rotated (slightly), the shaft did not rotate smoothly, but rotated roughly or jumpily, as if a bearing were out of round or broken. When the PTOs were removed from their R-390As and disassembled, it was found that the "tension spring" (a hemispherical disc with a hole through it if I recall correctly... it has been 15 years) was applying too much tension to the "race," a flat disc that the balls of the ball bearing assembly ran on. The tension was so great that the ball bearings had worn a circular path (irregular in depth) into the flat disc. Or was it discs (2)? I don't remember. Fortunately, the disc was symmetric and could be turned over so that a new flat surface was made available to the ball bearings. Tension was reduced by removing one (I think it was one) spacer from the PTO shaft. If you remove too many spacers, you will again get a jumpy PTO. Be sure to clean the discs and ball bearings, and lubricate them with a good quality grease before reassembly. I don't know if all Motorola PTOs are like this. Other than this problem, which is fixable, I have found Motorola PTOs to have the best linearity and to have the least end point spreading.

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Date: Fri, 5 Jan 2001 13:02:30 EST  
From: Llgpt@aol.com  
Subject: [R-390] PTO's and missing decals etc.

In response to several inquiries about pto's with no decals, or bits and pieces left, not enough to identify it. If it is a conventional pto ( all but Cosmos ) and the decal is missing, or a little bit of blue is left, it is a Progressitron PTO. Also, look at the mounting ( end plate ) if it is marked with an Amelco stamp, it is a Progressitron PTO. Thankfully, the Progressitron PTO's were much better than their decals. Many, ( myself included ) believe the Progressitron Corp. PTO's one of the best. Very linear and smooth. Incidentally, the Progressitron's were built by American Trans Coil Corp.

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Date: Sat, 06 Jan 2001 17:30:38 -0600  
From: Dallas Lankford <dallas@bayou.com>  
Subject: Re: [R-390] jumpy PTO

> This PTO is a Collins and it feels jumpy.....

The answer is: I am not sure. I finally tracked down Mr. R-390A because he has done lots more PTOs than I have, and I could not remember some of the details. Well, he can't either. I did my PTO rebuilding before I started writing notes, and he doesn't write notes. So there we are. I will tell you what I can remember, and what I think I remember, and hope that is enough for you to take the shaft apart.

You have, I believe, already removed the outer can, insulation, middle can, and inner can, and saved the cable lacing to use to retie the insulation when you put it back together. (I have a big "bobbin" of mil-spec black lacing, waxed, fungicide impregnated, et al. that I use to retie the insulation.) It is sometimes possible to remove the thermostat and/or middle can without unsoldering the thermostat leads. If I remember correctly, I unsoldered leads so as not to stress things tugging around on them.

Next, I would disconnect the rear mounting bracket from the outer can (two Phillips screws). Then I would disconnect the nylon wiring "cable tie" on the side of the front bracket (if you haven't already done that as part of removing the outer case).

Then remove the front mounting bracket (three Phillips screws), and the hex spacer associated with the top mounting screw. And remove the right angle shaft doodad, with two small Phillips screws and internal tooth (?) lock washers. Looking at my Collins PTO, I see some green on one of these 2-56 screws. That may be Loc-Tite. If so, you should run your hair drier on the screws and surrounding area for several minutes to soften of the Loc-Tite before you try to loosen the screws. I believe I have seen it said that sometimes this right angle doodad can be associated with PTO frequency jumping, but I am unfamiliar with that situation. Perhaps someone who knows about that will post an update.

You might try removing that little right angle shaft doodad, cleaning it, cleaning the shaft where its "business end" sits, and put it back together before you do anything else. That is a lot less work than removing internal bearings and races, cleaning them, and adjusting the shaft tension.

O.K. Now we are ready to get down to business. Remove the rear bracket (three Phillips screws, I think) that supports the PTO shaft at its rear end. According to Mr. R-390A, the Collins and Dubro PTOs are the only PTOs with ball bearing shaft supports at the rear ends. The others merely have a hole in the bakelite which the shaft end fits into. I have seen both ways of mounting the end of the shaft, but I don't remember which method was used by which manufacturer.

Now look at the front of the shaft where it exits the metal housing. You should see a C-ring. When the C-ring is removed (I used a small screw driver blade), the shaft, powdered iron core, two flat "races," and ball bearing assembly should slide out the rear on the shaft. Buuuttt... this is the part I cannot remember clearly. Mr. R-390A thinks everything will slide out the back; I am not so sure. In my feeble memory (remember, this is almost 20 years ago), I seem to recall that the "races" (flat metal discs) were too large to slide through the inside of the coil form. I hope I am wrong.

I don't remember and difficulty in overhauling the two Motorola PTOs, so maybe the coil does not have to be removed. If the coil has to be removed, you may wish you had never started this project. I'll just briefly tell you what could be involved. To remove the coil form (with coil), you will have to unsolder 2 (?) wires and move them at least slightly. I mean move them no more than they absolutely have to be moved to get the coil out. Because if you don't get those wires back exactly as they were when you put it back together, your PTO will have been "de-linearized," and you will have to do a corrector stack alignment. I don't even want to talk about that. I did one, and one was enough for me. Mr. R-390A has a special test fixture that he uses to do corrector stack alignments. I would send him any PTO I had that needed a corrector stack alignment. In Cosmos PTO the corrector stack was finally replaced by a "corrector inductor" which is much easier to align.

I don't remember how I removed the races and ball bearings. It seems like there is another C-ring that holds the tension spring in place. Or maybe I slid the races and ball bearing off the front of the shaft. Assuming everything slides out O.K., clean the flat discs and ball bearings. I use NAPA Break And Electric Motor Cleaner for these kinds of jobs, or throw them in a small jar of Lacquer Thinner. If the front ball bearing assembly will come out easily, clean it too. Otherwise, try to clean and regrease it in place. Examine the discs surfaces. If you see a "bumpy" circle worn into the discs, then your jumpiness is probably caused by too much tension from the tension spring, a small hemisphere shaped piece of bronze colored metal. Too much tension from the tension spring in turn caused the "bumpy" circle to be worn into the discs. The cure is simple. Turn over both "races" (discs) so that they both present new surfaces to the ball bearings, regrease the surfaces and ball bearings, remove one spacer (there will be a bunch of thin copper (?) spacers somewhere on the shaft which determine the tension), and check the "feel" of the PTO shaft rotation. (To put the shaft back together, Mr. R-390A uses a vise; I did it by hand, pressing the rear of the shaft onto a piece of hardwood while I pushed the front C-ring back onto the shaft at the front with a small screw driver blade.) If you are not happy with the "feel" of the shaft rotation, you may decide to remove another spacer. But removing too many spacers will again result in "jumping" because of not enough tension.

If there is not a "bumpy" circle worn into the discs, I would not remove any spacers.

When you took the PTO apart, hopefully you made a note of the frequency to which it was set, and hopefully you did not move the powdered iron core. Generally, the best way to synchronize the PTO when you put it back into the R-390A is to leave the middle piece of the oldham coupler off, and use the R-390A tuning (antenna connected, on a low band with lots of noise and signals) to bring the tuning approximately in line. I would not rotate the PTO shaft to synchronize it because you might accidentally cause the powdered iron core "guide" to push through the rear bakelite shaft support, breaking it (gasp!).

I hope that this helps and that I haven't forgotten anything. Best regards, Dallas

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Date: Sat, 6 Jan 2001 22:52:00 -0600  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: RE: [R-390] jumpy PTO

If the ground 'brush' that rubs on the shaft outside the housing is not making good contact, the frequency may jump. De-oxid is the recommended cure. As to removing the shaft, beware . . .

I have disassembled two R-389 Collins PTOs. The setup is as follows: The front casting contains two bearings that are rated for thrust as well as radial loads. The rear bearing keeps the shaft from coming out the front. The front bearing takes the load of the spring (Belleville) washers against the 'C' ring. Together, they keep the shaft from moving in and out with temperature changes. Moving the shaft would

move the core, which would change the frequency. Then there is another bearing at the rear plate of the PTO, but this just keeps the shaft end from waving in the breeze. The spring washers are intended to keep the shaft from moving over a wide temperature change (mil spec, don't'cha know). I think the loading is excessive. Once you have popped the 'C' ring, it will be very difficult to put it back. If you remove one of the many washers, be careful of what the end washers press against. Removing a pair of them would eliminate that problem, but that will leave too much slack, and the shaft will be able to move in and out. This causes hysteresis in the frequency, and other things. There will be a dead spot of no frequency change when you reverse direction of the KC knob. The heavy axial (thrust) load on the bearings could certainly cause some of them to fail. But I wouldn't mess with that assembly until every other possibility has been eliminated. The R-389 PTOs are 50 turns, not 10, so some of the details may be different. I'm sure the corrector stack is different. One final word, while you have the PTO open, resist the urge to replace those funny looking temperature compensation caps with Orange Drops - or anything else.

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Date: Sat, 6 Jan 2001 23:18:43 -0600  
From: "Bill Hawkins" <bill@jaxs.net>  
Subject: RE: [R-390] jumpy PTO

It just occurred to me that these days it is entirely possible that the PTO passed through the hands of someone who did not know a Belleville washer from a car wash. Then two or more of them could have been removed to make it possible to replace the 'C' ring. If the shaft can be moved in or out \*at all\*, this is the problem. Look in McMaster-Carr under Belleville Washers for something similar. If there's one pair of them left, you might get by with flat washers. Build then up until you have to compress the spring washers somewhat in order to get the 'C' ring back on.

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Date: Mon, 8 Jan 2001 09:14:22 -0600  
From: "Steve Goode" <goode@tribeam.com>  
Subject: Re: [R-390] jumpy PTO and what lubricant to use for PTO?

I sure am grateful that Dallas replied to the reflector on Jeff's jumpy PTO question. Over the weekend I finally decided to test where the backlash was coming from in my Imperial 390A. I pulled the RF deck off expecting the backlash to stay with it as several gear loading springs are missing in the RF gear train. Much to my surprise the backlash was not evident in the RF deck and as soon as I turned the PTO it was obvious that the problem was there. After some time trying to document where the PTO and RF deck were set relative to each other, I got up enough courage to take the outer can, middle can and inner can of the PTO off. At that point I could see the problem. When the PTO was turned clockwise the cam follower that rides on the corrector stack is a metal arm off of the iron core bearing and shows no backlash. However, the cam follower in the counterclockwise direction is spring loaded and you could see the spring engage and cause the backlash. I do not know who made this PTO as the label is missing. All that is left is some orange remains. Since the backplate of the PTO has a ball bearing I am guessing it is a Collins.

Since the PTO was hard turning and your email had just come out I figured I may as well take it apart further and see if the front bearings were the problem. To answer your main concern, the shaft just pulls out the back when you take the C-ring off the front. I was betting on this as I did not want to take the coil out. I figured that pros had design this and they had to build it. Also, I thought I had a newer unit so if they did not initially design it to take apart without removing the coil, they would have discovered their error and fixed it by my unit. After the shaft pulls out the back the races, ball bearing and tension spring just slide off the front of the shaft.

In my case the front bearings were not the problem. The core on the lead screw shaft is the problem. It is hard turning and needs to be removed and lubricated. My question is what is the recommended lubrication for the lead screw? Also, what is the procedure? The core has two felt washers on each end. What is their purpose? Are these suppose to be an oil reservoir or should you load grease into the core and these felt washers somehow keep it in?? After lubing what is the procedure to put it back together? The inner cover seems to engage two o-rings at the front and back, should these somehow be revitalized? Should I bake the unit with the middle and outer covers off? At what temp? Any guidance is greatly appreciated,  
Best Regards, Steve, K9NG

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Date: Mon, 08 Jan 2001 21:05:09 -0600

From: Dallas Lankford <dallas@bayou.com>

Subject: Re: [R-390] jumpy PTO and what lubricant to use for PTO?

> when you take the C-ring off the front <cut> After the shaft pulls out the back  
>the races, ball bearing and tension spring just slide off the front of the shaft.

That's great. So you don't have to remove the coil to remove the races, bearings, tension spring, and threaded core. Where are the spacers, just for the record?

> In my case the front bearings were not the problem. The core on the lead  
> screw shaft is the problem. It is hard turning and needs to be removed and  
> lubricated. My question is what is the recommended lubrication for the lead  
screw?

Mr. R-390A uses Mobile gear lube, like a 70 - 90 weight oil. If you take a small glass jar to your local service station, they should give you some. Even a 40 or 50 weight synthetic oil should suffice. I don't remember what I used on my shafts. It is likely that your R-390A was run for long periods of time with the ovens turned on. The PTO oven dried out the PTO screw oil and made the shaft difficult to turn. Take off the crystals cover of the crystal oscillator and see if it also shows indications of the xtal osc oven having been on for long periods of time. If the ovens are still on, turn them off.

> Also, what is the procedure?

First, clean the screw and the threads inside the core. You will, of course, have to



remove the core. Make a sketch and measurements so you can put the threaded core back on the shaft in about the same place it was when you removed it. Mr. R-390A likes diesel fuel for cleaning off hardened grease. I like lacquer thinner. In either case, you will probably have to use something like a pipe cleaner soaked in the solvent you use to get the baked grease off (if it is baked grease). I would not use an ultrasonic cleaner on the threaded core because it might change its chemical or mechanical composition. Grease the shaft, and thread it back on with the felt washers on each end. Wipe off any excess grease.

> The core has two felt washers on each end. What is their purpose?

Your guess is as good as ours. Perhaps they are to keep the grease spread evenly along the shaft as the threaded core moves back and forth.

> Are these suppose to be an oil reservoir or should you load grease into the core and these felt washers somehow keep it in??

We didn't.

> After lubing what is the procedure to put it back together?

I don't understand. Put what back together? The shaft? I discussed this in the previous posting. If you need more details, e-mail me and I will try.

> The inner cover seems to engage two o-rings at the front and back, should these somehow be revitalized?

No. Only the front is an O ring. The rear is a rubber "grommet" which fits over the rear metal plate, probably to prevent electrical contact with the inner most can when it is installed.

> Should I bake the unit with the middle and outer covers off? At what temp?

Bake the unit? Don't bake the unit. The only things you bake are the indicating silica gel cylinders. I think I used around 225 degrees and baked them for about an hour. Mr. R-390A uses 135 to 150, and bakes them for 24 hours or so.

Both of use a small pie tin to hold the indicating silica gel cylinders. While you have the shaft out, clean and relubricate the bearings and races. If I missed something, let me know.

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Date: Tue, 9 Jan 2001 12:24:27 -0600

From: "Steve Goode" <goode@tribeam.com>

Subject: Re: [R-390] jumpy PTO and what lubricant to use for PTO?

Many many thanks for the reply. This really is a help to me. To answer your questions:

> Where are the spacers, just for the record?

I don't have the unit here at work and will check this tonight, but I believe the front ball bearing is housed in a cavity in the PTO housing. The order from front to back is the C-ring followed by the bearing in its cavity followed by the spring washer followed by in my case one copper spacer followed by one bearing washer followed by a ball bearing thrust race followed by one bearing washer followed by another C-ring on the shaft. So the shaft is basically held between the two C-rings with the spring washer against the PTO bearing cavity taking out any end play. I hope my description makes sense. I have a Gravely tractor that uses 90 weight gear oil so I will just move to synthetic for it as I was thinking of anyway.

>.....If the ovens are still on, turn them off.

When I got the R390 I saw the recommendation not to use the ovens. When I went to switch them off I found the switch was broken. I was going to remove the wire to the switch to make sure they are off. I figure I can measure where the core is relative to the end of the shaft and put it back at that measurement when I am done. Hopefully getting back within 10 kHz of original setting. Then use an RF generator to find it and bring it in. My main concern would be as you said in your first email of running the core against the back or front damaging something.

I think the silica gels are in two cylinders taped on the side of the PTO housing. I guess I should remove these, open the cylinders and spread out the gel on a pan and bake, or do I just bake the cylinders? Right now I think these are black. Should these get to a nice pink when baked out?

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Date: Sun, 18 Feb 2001 01:43:41 -0500  
From: Jim Miller <jmiller@iu.net>  
Subject: [R-390] Cosmos Linearity Adjustment

I have the end point spread set nicely for 10 turns, after having to remove a turn from the end point adj coil, but now the linearity in-band is not good. I see the 40 or so little screws that do this. So I am going to give it a try. Problem is, these 40 little screws look like the world's smallest spline set screw. Not a normal screw head, but a microscopic hole or opening in the end of each screw shaft. I've tried filing away at a small screw driver, but fit isn't good enough to turn the screws. Do these screws require a special ultra-small Bristol or other tool? Any help with ideas on how to fashion a tool to adjust these would be appreciated.

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Date: Sun, 18 Feb 2001 13:13:53 -0500  
From: Jim Miller <jmiller@iu.net>  
Subject: [R-390] Cosmos PTO - Deep Waters

I'm in deep water now. Cosmos PTO completely disassembled here on the desk. I mean down to the point where I am holding the little disk with the 40-some linearity screws in my hand here. Not sure where this is heading, but maybe I'll take pictures and make them available just in case (lessons learned). Found why the lead screw could be moved in and out lengthwise ... A concentric gear collar inside the cavity that holds the linearity disk had come loose. During manufacture,

it looks like they slip it on the shaft and then spot weld it somehow. I guess sometime in its life the shaft had been over stressed and the weld broke. The gear sleeve was what was supposed to be holding the PTO shaft from sliding out the front. Not only was the PTO shaft free to move in and out, but the linearity disk wasn't even turning consistently. Well I was able to secure it again by creating a little "friction fit" rough spot on the shaft and tapping the sleeve back on, so the linearity disk now turns ok, and the shaft doesn't move, and the rear of the shaft mates with the bearing pad in the rear. Will it all go back together again and work? Who knows! I have faith. But if not, dust off any spare PTOs (working and linear ones only please) you may want to sell in a few weeks. Also, on the linearity disk, I seem to have an oddball Cosmos, as the 40-some screw heads look like super small spline heads, about half the size of my smallest .048 bristol. I need to craft up a tool to adjust these, or find an original (any ideas?).

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Date: Sun, 18 Feb 2001 13:20:28 -0600  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: Re: [R-390] Cosmos PTO - Deep Waters

I'd be a bit worried about the long term viability of a friction fit for this application. TIG would be better. If you don't have access to that, I'd score a little bottle of top of the line stud and bearing locking compound and coat the junction with that than then press it back together. You'd have to heat the area to 400+ degrees to break the bond if you ever wanted to take it apart again but it should last longer than any non welded repair short of knurling the shaft.

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Date: Thu, 22 Feb 2001 23:27:30 -0500  
From: Jim Miller <jmiller@iu.net>  
Subject: [R-390] Head Above Waters Again - Cosmos PTO

Well for those who have been following the trials and tribulations of this R-390A newbie, I am proud to say that I can now claim some success, or pretty darn close, with this Cosmos PTO. At one time it was over 10 khz nonlinear within the band, and the PTO shaft was loose, so it ultimately found itself in pieces on the desk. Some radical surgery revealed a slipped gear sleeve that was supposed to be spot welded to the PTO shaft deep inside its bowels (this gear is supposed to drive the linearity adjustment disk with the 40 screws, but in my case it was doing nothing, just slipping). That has been repaired, its back together, tuning shaft is secure and smooth, (yes it still works!) and I just finished my first pass at end point setting (getting 10 turns exactly), and a first pass at pulling in the frequency every 25 khz on every one of those 40 dastardly little screws. I rigged up a little jig using a 360 degree plastic protractor and some PVC tubing clamped to the PTO shaft to count degrees and turns. What a pain, (3 hours worth) but I now seem to be well within 100 hz at each of the 25 khz points, except one spot near the low end where one screw is stuck, and won't turn! My eyes are tied in knots. What a strange hobby we have.

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Date: Sat, 24 Feb 2001 12:21:54 -0500  
From: Jim Miller <jmiller@iu.net>

Subject: [R-390] Journey Through The Cosmos

If anyone wants to see photos and the story of my recent (successful) adventure into my Cosmos PTO, you can see it all at: <http://home.iu.net/~jmiller/cosmos.htm>

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Date: Sat, 24 Feb 2001 15:07:12 -0500  
From: antipode <antipode@ne.mediaone.net>  
Subject: Re: [R-390] Journey Through The Cosmos

Man! Jim, those photos are excellent and a valuable source of information for future Cosmos teardowns. I hope these get archived in a stable site so we can refer to them in the future.

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Date: Sat, 24 Feb 2001 16:36:57 -0500  
From: "Tetrode" <tetrode@sprynet.com>  
Subject: Re: [R-390] Journey Through The Cosmos

That's a great page, thanks! You are a great example of someone posting a request for help to the group, and then later contributing several times as much info back. I've never seen the innards of a Cosmos before, so that was a treat. The handful of PTOs I've seen have all been Collins, Motorola, and Progressitron, yet a friend of mine has 3 390As, and they all have Cosmos in them. Guess it's the luck of the draw. FYI, For those who want to make a permanent local copy of an interesting interesting page to your hard drive it's very easy. Create an appropriately named directory (don't really have to do this but it helps to keep things organized and identified), and copy ALL the page elements to it. The browsers File/"save as" command will copy all the text/html stuff under whatever the native file extension is, such as .html or .htm. Then, save each and every graphic on that page (.jpg, .gif, etc) without altering the file name, to that same directory.

That's all there is to it. To view, use the browser's Open/browse file commands to open the local .html (or whatever) page that was saved in the previously created directory, and the browser will open it just like a regular web page with all the pictures and text in the right places.

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Date: Sun, 25 Feb 2001 08:26:36 -0500  
From: Jim Miller <jmiller@iu.net>  
Subject: Re: [R-390] Journey Through The Cosmos

I went through and added a sentence or two, and corrected some minor typos I found last night. If anyone saved it before then, you might want to grab it again (be sure to reload or refresh on the browser) to get the corrections. They're minor (like the disk really has 48 screws, not 40 as originally stated...) <http://home.iu.net/~jmiller/cosmos.htm>

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Date: Sun, 25 Feb 2001 11:39:11 -0500  
From: "Barry Hauser" <barry@hausernet.com>  
Subject: Re: [R-390] Journey Through The Cosmos

Wow! Super job! Maximum kudos with oak leaf cluster. While much has been written about the Cosmos PTO, this takes the documentation to new levels of excellence. Makes it possible to follow the path you've beaten through the jungle and proceed with confidence if the need arises -- or to savor vicariously even if we never open the thing. There ought to be an award for stuff like this. Maybe the large R-390A mug with personalization in gold leaf, or a wall plaque with bombastic compliments and some appropriate words in latin. Well, for now, many thanks will have to do ...

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Date: Sun, 25 Feb 2001 12:46:40 -0500  
From: "Jim Miller" <jmiller@iu.net>  
Subject: Re: [R-390] Journey Through The Cosmos

Thanks to all for the good feedback on the article. The reward of having it work again is enough for me: having a 390a that now seems to perform (tuning wise) as it was originally designed. Some have asked about camera, software etc. The camera is a Nikon Coolpix 990. Just aim and shoot...a no brainer. The software was Paintshop Pro, but all I used it for was to reduce image sizes to be web compatible, and add annotations,... any paint program can do that. It wasn't as hard as it looks. As I said before anyone wanting to add a link to this site (I believe it will be stable for a while), or download it in full on their own site, and reproduce it there, or as a pdf file, or whatever, or print it for personal use, or to give away free, is welcome to. The operative word is FREE. Or if you want to make it better, go ahead. Someone needs to write a compendium of PTO information covering all the models. Perhaps some PTOs that have been previously considered hopeless wrecks could be brought back to life like new. After all, they aren't making them anymore.

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Date: Mon, 26 Feb 2001 12:07:05 -0500  
From: Gene Beckwith <jtone@sssnet.com>  
Subject: Re: [R-390] Journey Through The Cosmos

Excellent work...even if I don't try this, it's a great insight as to the workings of the Cosmos...and a commentary on high skills... Thanks for letting us ride along with you!

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Date: Mon, 26 Feb 2001 12:11:03 -0500  
From: Gene Beckwith <jtone@sssnet.com>  
Subject: Re: [R-390] Journey Through The Cosmos

I wasn't quite so skillfull...but did a simple "page print" to an HP 932C...took a few minutes, but I too am adding the hard copy to my growing collection of R390X references....

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Date: Mon, 26 Feb 2001 11:57:21 -0600  
From: "Scott, Barry (Clyde B)" <cbscott@ingr.com>  
Subject: RE: [R-390] Journey Through The Cosmos

If you go to that trouble, it seems you could just store them all in a big document with a table of contents and print only what you need. Quick reference, no stale URLs, and it sure would save on the printer...

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Date: Sun, 04 Mar 2001 19:46:18 -0600  
From: David Medley <d.j.medley@att.net>  
Subject: [R-390] Cosmos PTO article

I have just published Jim Miller's article on my web page in case anyone would need to refer to it. Jim's ISP is down right now and this is the only way you can access it. This is great material and a welcome addition to my page.

For parts and information re R-390 radios please check my Web Page at:  
<<http://home.att.net/~d.j.medley>>

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Date: Thu, 08 Mar 2001 21:03:56 -0500  
From: "Jim M." <jmiller@iu.net>  
Subject: [R-390] Tuning Nonlinear at 75khz points

OK here's one for you. I've been fine tuning this Cosmos PTO. Built up a test jig with an 8 inch graduated plexiglass disk (I used John Harvie's 360 degree calibration sticker perfectly centered on the disk). Mounted the PTO in the jig, used a 3/16 inch brass shaft and plastic couplers to couple between the PTO shaft and this disk, with nice wooden frame to hold it all securely. Went through a lengthy alignment using a counter reading the PTO output. Tweaked all 40 corrector screws, until it was reading within 80 hz of expected output frequency at each 25 khz point, and was giving exactly 10 turns from low to high end (2455-3455 khz). The graph I plotted of the linearity (using an Excel spreadsheet) looked perfect. So I put it back in the receiver, lined it up to the odometer counter, and the tuning is dead on at each 0, 25, and 50khz point, but exactly 635 hz off at every 75 khz point, i.e. 7.000, 7.025, 7.050, 7.100 etc. are right on, but 7.075, 7.175, 7.275, etc. is off by about 640 hz! Looks like it is off at just around the .075 points. I checked the test jig again, checked the markings on the calibration wheel, they seemed to be right on. Either my calibration scale would have to be distorted, or my eyeballs would have to be repeatedly off about 2.5 degrees at each 75 khz spot to have miscalibrated the PTO in the jig, but the mechanism looked correct, double checked the angular markings with a draftman's protractor and it looked good. If it's not the test jig, or a dumb operator error (again, I would have to be repeatedly injecting almost the exact same error at every xxx.x75 point, but not at the others!), then could it be the odometer counter or a gear train anomaly? Before I take it out and try again, has anyone heard of such an anomaly in the odometer or its associated gearing?

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Date: Thu, 08 Mar 2001 22:47:48 -0500  
From: "Jim M." <jmiller@iu.net>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

Well no sooner than I ask, that I discover.... The Oldham coupler was pressed together too tightly. There was also a slight misalignment of the PTO on its

brackets, meaning the halves of the Oldham coupler were slightly askew, and the same spot of every rotation, the coupler was pressing more on the PTO shaft than other parts of the rotation. Also, a locking collar on the outside of the PTO shaft wasn't snug up against its shims allowing some undesirable free play. The coupler pressing in on the PTO shaft at the same point each rotation shifted its frequency slightly, each time, and that just happened to be at the 75 khz marks. Reading the manual I see that there should be a slight gap (1/32 inch I believe) between the oldham coupler and that slip disk within it to prevent too much pressure on the PTO shaft...now I think we know why. Likewise the retaining collars need to be snugged up on the PTO shaft, and the PTO must be physically aligned properly with the coupler to prevent binding, etc. Failure to do these things could result in this cause for poor tracking. Should have known! It doesn't help if you skip even the simplest instructions in the manual!

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Date: Thu, 8 Mar 2001 23:37:42 -0500  
From: "Barry Hauser" <barry@hausernet.com>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

> The Oldham coupler was pressed together too tightly.

All of mine are nice and snug .. uh-oh.

> There was also a slight misalignment of the PTO on its brackets, .....

Nolan has posted on this in detail, as I recall, including the need to use shims if necessary. The tendency is to think the Oldham couplers compensate for all ills.

> Also, a locking collar on the outside of the PTO shaft .....

Uh-oh #2. Somehow in umpty-up readings I missed this part. Now, where'd I put that feeler gauge? I suppose a worn coupler could also cause a consistent offset. Might compensate with heavier grease, like the old sawdust-in-the-differential trick.

> Likewise the retaining collars need to be snugged .....

Yup .... <sigh>. However, you do realize by fixing that up you've destroyed the 635 HZ Consistent Offset Mechanism you accidentally created. Now it's lost to antiquity. Well, thanks a lot, Jim. Now I hafta go pull all my radios and turn 'em upside down .... How much do you think they'd charge to MRI an R-390A? A hundred or so cross sections might .. nevermind.

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Date: Fri, 09 Mar 2001 00:53:43 -0500  
From: "Jim M." <jmiller@iu.net>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

Well other PTOs may not have this sensitivity to pressure on the shaft. A locking collar that was supposed to be flush with some shims on the shaft wasn't secure either so it allowed linear motion of the shaft, maybe a microscopic amount but

enough to pull the frequency. And most know my Cosmos PTO has been through quite a lot of rebuilding so it is probably more sensitive than others. Having secured the collar better on the shaft and relieved some pressure on the coupler, the anomaly has disappeared and the PTO is happily tracking at all of the 25 khz marks again. This obsession I seem to have with the accuracy of this old beast is killing me! But, yea indeed it is true that a Cosmos PTO can be made to track pretty dang good across the entire range. If you want, check your own PTO, but not at just the 100 khz calibrator points, but at each 25 khz. But watch out for that obsession with accuracy, it will bite you.

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Date: Fri, 9 Mar 2001 07:47:03 -0500  
From: "Warren, W. Thomas" <wtw@rti.org>  
Subject: RE: [R-390] Tuning Nonlinear at 75khz points

A very public thanks to you Jim for publishing your experiences with the Cosmos PTO. Some of the old timers likely will be nodding their heads and thinking "been there, done that." But for many of the rest of us, we're glad to hear the whole story of getting a Cosmos back in service. Many, many thanks. NOW, DOES ANYONE HAVE DETAILED EXPERIENCE WITH A MOTOROLA PTO? My understanding thus far is that it's not like the Cosmos with the 48 little tuning screws, but has some other mechanism (not easily accessible) for linearizing the 25kHz points. Any help out there?

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Date: Fri, 09 Mar 2001 13:41:29 -0500  
From: Gene Beckwith <jtone@sssnet.com>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

Interesting...I too have had trouble getting the PTO to line up on its brackets so the shafts are 'perpendicular' and with minimum off-set...seems like two possibilities... even though finally they look pretty good and seem to operate ok...I was never satisfied that there was perfect alignment. This surprises me, due to the mostly precision alignment of the main frame and the brackets. But, maybe that's why there is an Oldham coupler in there...maybe there was an anticipated alignment problem...but, either way, even with shimming slightly, I could never get the alignment to "look" right...even though the gearing finally does run smoothly...??

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Date: Fri, 09 Mar 2001 14:24:19 -0600  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

The purpose of the Oldham coupler is to permit displacement perpendicular to the axis of the two shafts.. that is "mis alignment", "offset". Try it.. if you can manage to get your shaft and PTO mis aligned by a BUNCH it will work anyway. That's why the coupler is there. It will also take care of some angular mis-alignment of the shafts, but that's harder to try out, unless you raise the rear end of the PTO a bit and move it back some.. Just allow for the right amount of clearance in the direction of the shaft ( between the disks) and add a bit of grease and see what happens.

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Date: Fri, 09 Mar 2001 14:37:14 -0500  
From: Jim Miller <jmiller@iu.net>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

Yes I think that's what the coupler is for. It looks like it can "absorb" a certain amount of mechanical misalignment and still couple the shafts reliably. But it needs room to "breathe" and coupling it too snugly, at least in my case, resulted in binding that pulled the PTO frequency off slightly (600 hz) at one spot of every rotation. When you think about the foresight of the designers was excellent.

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Date: Fri, 9 Mar 2001 17:36:13 -0500 (EST)  
From: Norman Ryan <nryan@duke.edu>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

You should be able to align the PTO shaft in all three directions, including adding enough play for the Oldham disk to jiggle (about 1/32"). The PTO mounting brackets have slotted holes for the purpose. I believe getting it right adds a little more silkiness to the KC CHANGE knob action. Besides, it's a nice way to spend an evening. :-) Make sure there's an anti-backlash spring present on the Oldham coupler. It need not be too stretchy-- just enough tension to do the job. (Do the above adjustments with the spring removed.)

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Date: Fri, 09 Mar 2001 17:39:13 -0600  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: [R-390] Oldham alignment in R-390A

>The purpose of the Oldham coupler is to permit displacement perpendicular  
>to the axis of the two shafts.. that is "mis alignment", "offset".

Correct. The maximum error that they can handle of the drive and driven flanges not being parallel to each other is 1 degree. First, I'm not an ME. I do know that if we take a shaft with an "cross type" universal in it and place it on pillar blocks and position the blocks so that the universal joint in the shaft has a 5 degree angle to it that when you rotate one end of the shaft at a constant speed of say 100 rpm, the rotational speed of the other end is not exactly 100 rpm except at two points in the rotation. It will average 100 rpm, but the speed will constantly vary. The other end speeds up and slows down. Maybe from 98 rpm to 102 rpm or whatever the calculations would say depending on the shaft size, joint diameter, and joint angle. I know of this from tweaking pinion angles in vehicles to reduce vibration. If say the angle of the front joint is 5 degrees and the angle of the rear joint is 0 degrees, vibration and roughness will occur.

I don't remember what this effect is called. Do any of you know?

Like I said, I'm not an engineer but to me it seems that it might be possible that a "positional error" could exist due to shaft plane misalignment of the PTO and the main frame of the receiver. Lets say that the drive and driven shafts are in sync at 000 KHz, 100 KHz, 200 KHz, 300 KHz, etc. that when rotated 180 degrees to the 50 KHz, 150 KHz, 250 KHz, 350 KHz, etc. that this error might cause the PTO to

be setting at 50.5 KHz, 150.5 KHz, 250.5 KHz, 350.5 KHz etc.internally? Maybe more, maybe less?

My attempt to prevent this possible occurrence from happening is why I spent hours physically aligning the PTO in the EAC when I put it together. Was this a wasted effort, or does this "positional error" occur with two shafts and a misaligned coupling? What about two oldham coupling flanges that are parallel but have a .010 difference in the height that they set above the chassis. What kind of error results from that?

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Date: Fri, 9 Mar 2001 16:01:25 -0800 (PST)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

What's a good technique to achieve this? Should I use feeler gauges to check the gap between the disks at four points around its circumference? Not easy to do in the confined space available. A jig to clamp to the two shafts with a gap to clear the coupler? That sounds expensive to make. What do you use?

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Date: Fri, 9 Mar 2001 19:11:16 EST  
From: Llgpt@aol.com  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

Try out a good old fashioned eyeball.....it works!!!

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Date: Fri, 09 Mar 2001 20:46:18 -0500  
From: "Jim M." <jmiller@iu.net>  
Subject: Re: [R-390] oldham alignment in R-390A

In my case it was not an angular error. It was having the coupler too tight, combined with a misalignment of the two shafts (because I didn't spend time shimming the PTO properly) causing pressure on the PTO shaft at each revolution. If you push in on the PTO shaft, it will change frequency slightly, at least mine does. So I don't want the coupler so snug that there is any possibility of pressure being applied to the PTO shaft anywhere in the rotation. Right now I have about 1/32 inch visible gap between that slotted disk and the couplers, and I didn't try to perfectly align the PTO orientation. It seems to be tracking just fine now, and tuning smoothly. I personally don't expect that planar misalignment would cause much error from a purely geometric viewpoint. Look at a universal joint in your car. The two shafts aren't perfectly colinear with each other, yet the total mechanism rotates at exactly the same rate and proportion. Isn't the Oldham coupler a form of universal joint? Jim N4BE

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Date: Fri, 09 Mar 2001 20:09:55 -0600  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

>What's a good technique to achieve this?.....

How about a bent piece of stiff wire that you know the diameter of. Easy enough to bend to whatever shape you need to fit into tight areas. MIG wire comes to mind if you need .023, .035, 040. etc.

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Date: Fri, 09 Mar 2001 20:20:14 -0600  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: Re: [R-390] oldham alignment in R-390A

>.....It was having the coupler too tight, combined with a misalignment of the  
>two shafts (because I didn't spend time shimming the PTO properly) ....

I spent hours setting mine up. It's a pain. ;-( Make sure that the two Oldham flanges are true. I measured a bunch of the center sections and they were all exact. It's the aluminum flanges that I had a problem with.

>I personally don't expect that planar misalignment .....

Actually, the AVERAGE speed is the same. The speed on the input end is different than the rate on the output end in proportion to the angle. The output side doesn't run at a constant speed like the drive side. The driven side constantly slows down and speeds up depending on the angle of the joint or joints. I ain't no engineer but I know that it happens. Maybe one of the guys in the list can explain it better. I just remembered what this is called, it's called "cycle error".

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Date: Fri, 9 Mar 2001 21:41:10 -0500  
From: "Howard Rawls" <howard@cconnect.net>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

Any mis-alignment of the shafts should show up as "run-out" of the center disc, so.... Remove the center disc from the Oldham coupler. Use a machinist's dial caliper to verify the central location of the interlocking surfaces. Reinstall the disc, then use a machinist's "last word" dial indicator on the circumference of the disc to check for run-out. Check at 3 equal points around the circumference. When you get it down to .0000025" true indicator reading, STOP. That's close enuff!!!

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Date: Fri, 9 Mar 2001 19:19:19 -0800 (PST)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] oldham alignment in R-390A

The characteristic that Nolan's talking about is true for a drive shaft where there is a rigid component like the spider in the center. But I don't think that is happening with the Oldham coupler because the center disk isn't rigidly mounted to either shaft, the center of the universal joint is solid to both shafts. Also, the universal joint is almost always used in pairs, which affects the final average speed at any point in its rotation. Especially if they aren't attached properly with respect to each other. What I want to know is how do we get this procedure down to something simple? Do we start with a guage block between shaft and radio frame to set both shafts to the same "height" then, once that's set, shim the back of the PTO to match that by checking the gap between disks with a piece of welding wire, for a

feeler gauge, and at the same time check for angular alignment of the shafts? The guage block would also be a quick way of checking the shaft for straightness, which I need to do on mine. That will give a good starting place for aligning the PTO shaft.

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Date: Fri, 09 Mar 2001 21:38:38 -0600  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: [R-390] PTO/Oldham alignment...

I've had several requests for my post on the "PTO" section of the overhaul report on my EAC that I posted to the list back in October of 1998. Damn, time sure flies. ;-( It follows below:

- -----<snip>-----

PTO: Why bother? Chunked it in the R390A parts pile and installed an Army rebuilt Cosmos that I've been sitting on for about ten years, sealed in the box, to replace the Cosmos that was in there. It turned out that the endpoint was out a little less than 2 KHz, and linear within a little less than 200 Hz across the spectrum. I don't know what the specs on it were when it left their hands in Feb. of 1984 but it sure aged well. :-) I guess that I'll let it run a few weeks and then adjust the endpoint. I did power up the oven and verified that the thermostat worked, measured the resistance of the transformer, and tested the tube. I like the Cosmos PTO's. That blue label sure is pretty, bubba!

On a side note, I probably use a bit more complicated method than most people do when fitting a PTO to a receiver. If you're going to do it right, it might as well be done right the first time. Both halves of the Oldham coupler should be perfectly parallel to each other and the centerline of both shafts should be perfectly in line with each other on both planes. I only spent about an hour adjusting the position and height of the PTO in the chassis, but spent several hours measuring the components and setting up the fixtures to measure other aspects of the components.

I first measured the run out of each half of the couplings while installed on their shafts. The one on the PTO was true within .001. The one on the KHz shaft of the RF deck was machined improperly. the rib was .003 off to one side and wasn't square with the bore either. I tossed it and pulled a few others out of spares. It took several before I found one that was square with the bore and only had a little more than 0.001 run out.

The next step was to check the center section. The width of the two grooves seems pretty consistent, but I was curious if the two grooves were machined at exactly 90 degree angles to each other. The grooves were of a dimension that I didn't have any key stock for so I used two 12" long pieces of 1/4" ground steel rod. I centered the two pieces of rod, lengthwise, one in each of the two grooves, clamped the three pieces together. Then by measuring and comparing the distances between the four rod ends, I could determine the exact angle that the grooves were from each other. This part of the process was a wasted effort, the coupling center piece from the EAC was 90 degrees like it should be and so were the ones in spares that I checked.

When I finally assembled the receiver and physically aligned the PTO to the chassis, mechanically and electrically, the dial indicator measured a total movement in the center section of the oldham coupling of .003 when the KHz knob is turned. Close enough! Put that spring on! Oh, I used a little dab of Penzoil wheel bearing grease to lube the coupling. It's red and contrasts, in a pleasing fashion, the blue label of the Cosmos PTO. :-)

---<snip>----

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Date: Fri, 09 Mar 2001 22:15:52 -0500  
From: "Jim M." <jmiller@iu.net>  
Subject: Re: [R-390] Tuning Nonlinear at 75khz points

How about a spark plug gapping tool? It has a variety of blades of various precise diameters.

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Date: Fri, 9 Mar 2001 23:00:54 -0500  
From: "Tetrode" <tetrode@sprynet.com>  
Subject: [R-390] Oldham coupler alignment epiphany

I just put the PTO back in a couple of weeks ago in the Fair Radio nonA I've been working on, and was wondering the same thing. The idea of using measuring devices was initially interesting, but that's a pretty cramped area to work in. So I decided to use the old eyeball method, and came up with an added twist to enhance the accuracy. Here's my logic.....

- 1) The Oldham coupler uses a disc which slides in two directions to absorb the shaft to shaft misalignment.
- 2) During normal operation, the disc will move in proportion to the misalignments as the shaft is rotated.
- 3) If there is no misalignment, the disc will not need to move during shaft rotation.
- 4) It's easy to observe the disc while rotating the shaft.

So there you have it, a visual indication of misalignments observable as the shaft is rotated.

After I put the PTO/Oldham assembly back in the radio I used a carpenters square held to the X frame to make a straight-edge alongside the PTO can body so that I could make a rough alignment to start with. I set the gap on one side of the coupler disk to be very small, so that any changes in gap spacing would be easily noticeable, and so that I could observe all the edges of the disc and coupler body. I also put the knob back on the tuning shaft so that I could spin it back and forth easier. (It's a good idea to have the PTO set at least a few turns away from either of its endpoint while doing this). With the initial misalignment present, I could see one side of one of the "grooves" of the disc protrude \*past\* the coupler body by a small amount, which represented an amount of error. When I gave the shaft a half a turn, I could see the opposite end of the "groove" protruding \*into\* the coupler

by the same amount. The other "groove" that's 90 degrees off does the same thing with the error that it is absorbing.

So basically my alignment method consisted of moving the PTO side to side while turning the KC shaft and watching the groove/disc movements until they were all minimized and symmetrical as possible. Then I would try adjusting the angle of the PTO body while repeating the above exercise in order to align it on that axis. Come to think of it I probably kept an eye on the gap symmetry while doing all this as well. After this was done I tightened down the PTO mounting hardware, checked for errors again, and then set the coupler gap to 1/32 as shown in the manual.

When I was done things looked pretty good. Had there been a big error in the Y axis I guess I would have had to try some shimming, but such was not the case here.

As an alternative to watching just the grooves, I also watched how the outside edge of the disc lined up with the outside edges of the coupler plates as the whole thing was rotated; this might be easier to see, and still shows any misalignment error. I also have an illuminated magnifier lens that I like to use for any inspection or detail work such as this.

So far I've only tried this method once, and there might be some errors introduced if the Oldham parts were machined way off center, but I figure that by watching for relative movements and symmetry of movements rather than absolute measurements, this technique might be useful.

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Date: Fri, 09 Mar 2001 22:26:03 -0600  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: Re: [R-390] Oldham alignment in R-390A

I don't know the cycle error specs on the Oldham coupling. I do know that when it's installed, the angular error between the two shafts must be 1% or less and the error in the centerline of the two shafts must be .010 or less. It's very possible that errors worse than these may create such a problem. I ain't no engineer. <grin>

>Also, the universal joint is almost always used in pairs, which affects the final >average speed at any point in its rotation.

Correct. The old double carden <sp?> joints with the ball between the two universal joints that GM used in it's full size products in the 70's and 80's were supposed to either totally eliminate or greatly minimize this problem.

>Especially if they aren't attached properly with respect to each other.

I fought a drive shaft vibration for a half a day one time in 2WD full size Jimmy. The joint angle at the slip yoke and the pinion were well within spec and the joints themselves were smooth. I probably drove 50 miles road testing the thing and stopping every half a mile or so to reposition the hose clamps I was using for

weights to see if it was an out of balance problem. As it turned out, the two universal joints were a few degrees out of phase with each other. I've only seen this a couple of times but the second time was a hell of a lot easier to diagnose. The way I found it was by turning my drive shaft angle indicator 90 degrees. Simple as hell....once I thought of it. ;-)

>What I want to know is how do we get this procedure down to something  
>simple?

Nah, everything pertaining to the R-390A has to be complicated or it isn't "right".  
<grin>

>Do we start with a guage block between shaft and radio frame to set both shafts  
>to the same "height" then,

Calipers or snap gauges are more than enough for setting the height.

>once that's set, shim the back of the PTO to match that by checking the gap  
>between disks with >a piece of welding wire, for a feeler gauge, and at the same  
>ime check for angular alignment of the shafts?

That will allow you to correct for the ass end of the PTO being higher or lower than the end with the coupling, yes. Ditto for side to side being out.

>The guage block would also be a quick way of checking the shaft for  
straightness, >which I need to do on mine.

I used a dial indicator.

>That will give a good starting place for aligning the PTO shaft.

Yep. After you rough it in. Throw a dial indicator on the center section of the coupling. Then you can tweak the exact positioning to give the least movement of the center section when the shaft is rotated. check it for both up and down movement and side to side movement. Something to check before you start is that the two aluminum halves of the coupling are square and true in relationship to their respective shafts.

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Date: Fri, 09 Mar 2001 22:41:19 -0600  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: Re: [R-390] Oldham coupler alignment epiphany

>..... but that's a pretty cramped area to work in.

Yes. You'll need a mirror on a stick and a lever type extension for the dial indicator.

>.....the disc will move in proportion to the misalignments as the shaft is rotated.

Correct. It was seeing this movement in the center section that caught my attention in the first place.

>3) If there is no misalignment, the disc will not need to move during shaft  
>rotation.

Up and down or side to side errors in the position of the PTO will cause the center section to move. Angular alignment between the two shafts won't cause the center section to move. But, you can check this easy enough by comparing the difference in the gap from side to side between the center section and one of the end sections. This will spot side to side angular error. For up and down angular error, you'll need a mirror on a stick.

>4) It's easy to observe the disc while rotating the shaft.  
>So there you have it, a visual indication of misalignments observable as the  
>shaft is rotated.

And more if you want to use a dial indicator.

>After I put the PTO/Oldham assembly back in the radio I used a carpenter's  
>square held to the X frame to make a straight-edge alongside the PTO can  
>body so that I could make a rough alignment to start with.

Excellent idea, thanks!

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Date: Sat, 10 Mar 2001 00:17:39 -0600  
From: "Bill Hawkins" <bill@iargs.net>  
Subject: RE: [R-390] oldham alignment in R-390A

For data on the Oldham coupler as a mechanical device, see:

[http://www.allaboutmotion.com/couplings/huco\\_oldham.htm](http://www.allaboutmotion.com/couplings/huco_oldham.htm)

Google could not find any pages that gave the rotation error as a function of alignment error. Oldhams are also used in the drives that keep a telescope pointed at a star while a camera takes a time exposure of several minutes.

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Date: Sat, 10 Mar 2001 08:40:28 -0500  
From: Jim Miller <jmiller@iu.net>  
Subject: Re: [R-390] Oldham coupler alignment epiphany

Has anyone noticed the maintenance access holes machined into the subpanels behind the front panel? And also the four holes machined into the large silver kc dial brake and drive gear? In my SW 390a, three of these holes appear to align with the three front mounting screws of the PTO. It appears that if you drop the front panel and line up the dial brake disk with the various holes, you can access the three front PTO screws with a long screwdriver, allowing some adjustments in that manner, without removing the PTO.



Likewise, another set of holes machined into the sub panels appear to allow access to the PTO endpoint adjustments while the PTO is in the radio! Again, it looks like if you line up one of the four holes in the dial brake disk with this other larger access hole, a long tuning tool will reach the end point adjustment port. This may allow you to set end point with the PTO securely in the radio using the odometer. For the Cosmos PTO, the corrector screws appear to also be accessible this way, if one can find a long enough and small enough screwdriver. There are 4 holes pre-drilled in the dial brake which should let you turn the dial the necessary 1/4 turn to access each 25 khz tuning screw. I haven't actually tried this yet, just an observation. I'm a newbie so this discovery may be old news to others, but it looks interesting. Sure wish I had my hands on whatever custom tuning drivers they must have used in the factory to tweak these PTOs. Jim N4BE

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Date: Sat, 10 Mar 2001 10:34:41 -0500  
From: Al Solway <beral@videotron.ca>  
Subject: Re: [R-390] Oldham coupler alignment epiphany

I used the three holes you mention along with a a mechanical alignment tool I made. A No. 2 Phillips screw driver tip 2 inches long from my electric screwdriver was used to gain access to three screws on the PTO. This made mechanical alignment much easier and repeatable. I mean that when the PTO is removed and reinstalled it is very easy to achieve acceptable alignment.

This method was developed as result of Nolan,s "R-390A Overhaul Report". His description of the measurements made a lot of sense and is very well written. the only problem was the equipment to make the measurements. I have some of the equipment but not all. So something had to be done. The results was the tool. I don't have the time today to describe the method and the tool used.

But within the next day or two I will. I bought some BA equipment (Drake) and have to make major change to the shack to get it installed. And Nolan, engineer or not, bask in the glory of making like one. Results are what counts.

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Date: Sat, 10 Mar 2001 17:25:58 -0500  
From: Jim Miller <jmiller@iu.net>  
Subject: Re: [R-390] Oldham coupler alignment epiphany

I once straightened a bent shaft on a Smith & Wesson 38 revolver by tapping gently on the shaft with a wooden mallet (or using a small wood block and a regular hammer, to "eyeball" it back straight again. The revolver eventually worked OK but there was still a very minute deviation in the shaft rotation. For a PTO to work well after such a procedure would require a great deal of precision, patience and luck I believe.

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Date: Sat, 10 Mar 2001 17:25:06 EST  
From: DJED1@aol.com  
Subject: Re: [R-390] Oldham coupler alignment epiphany

I know the holes work, although I've used them without removing the front panel.

I adjusted a Cosmos using a cut-down jeweler's screwdriver and a small mirror. I undertook this after I found I couldn't get good enough settability by taking the VFO in and out, and I didn't want to go to the trouble of building a jig.

By having the calibration done using the odometer, I knew it would be OK in the radio. However, it sure was tedious. I like the idea of dropping the front panel, that might make things go a lot faster. I did get the Cosmos to read within 300 cycles at all 25KHz check points.

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Date: Mon, 12 Mar 2001 08:23:16 -0800  
From: "Roger L Ruszkowski" <rlruszkowski@west.raytheon.com>  
Subject: Re: [R-390] Bent Shafts

>.....have any suggestions for straightening an obviously bent PTO shaft? .....

Hang a box end wrench over the shaft and lean on it. If you can get two wrenches on the shaft then you can work them against each other. Then you do not use the bearing, bushings, and ect attached to the shaft as a lever. Different size holes will change the angle and force points you have to work with. Drill small holes in some good bar stock and use the bar as a lever. Slide the shaft through the hole in the bar. This will get a close fit where working angle is an issue. You want to get one force point at the bend and the second force point some distance away. Use heavy tubing, slip it down over the shaft and use it as a lever.

Once you get it as close as you can, you may then want to take the can apart and work the shaft on a flat surface to get the last of the bend out. You may want to sand or polish the shaft at the bend point prior to disassembly of the shaft through a bushing or bearing. Sand and polish until it slides apart with out force. Pull the extra stuff off the front of the PTO as needed to get room to work on the shaft. You should be able to get back real close by eye ball. And good enough to get the PTO back in service.

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Date: Mon, 12 Mar 2001 12:13:33 -0500  
From: Al Solway <beral@videotron.ca>  
Subject: Re: [R-390] Old Ham-- PTO

In my opinion you are most likely correct in your observations. There is an explanation for the stated problem. The situations you refer to are most likely those where a PTO is removed to adjust endpoints or replace the tube.

In the situations that are referred to, the PTO was completely dismantled to make internal repairs and linearity adjustments. To do this the mounting bracket (3) were removed.

Doing this results in loss of all mechanical alignment. The brackets are mounted to the PTO. The screw holes in the brackets are enlarged. This provides the ability to make adjustments in relative position of each bracket to each other and to the R-390A KHz shaft. Once these adjustments are made they should hold. The green headed PTO mounting screws (3) should then be sufficient to maintain

mechanical alignment when the PTO is installed after routine maintenance.

That is my understanding of the PTO mechanical alignment. There other techs/ engineers on this reflector who may explain this in more elegant or technically correct way.

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Date: Tue, 13 Mar 2001 16:34:05 -0700  
From: "Kurt" <radiouser@uswest.net>  
Subject: [R-390] Cosmos PTO Types

While attempting to get brave and check end spread on a couple of Cosmos PTO's I found two different types. On one there are the very small slotted screw heads to linearize at the 25 Khz points and all of the wires come out of the front section of the PTO. This PTO does have a Cosmos label on it. The second type does not have slotted screws but some type of hex or spline head for the 25 KHz point adjustment. There is a series of these that rotate into position just as the other PTO. Also some of the wire bundle comes out of cylindrical cover. The cover is not slotted so some wires must be disconnected to remove the cover. Unfortunately this PTO does not have a label on it. A couple of questions. Has anyone seen this second type of PTO before? Nothing I have will fit in the heads of the linearizing screw heads. Anyone have any ideas was to use? I have tried a .050 Allen wrench and a Xcelite 99-61 (the smallest) Bristol. Both of these are way too big. Any suggestions and comments appreciated. Kurt Holbrook

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Date: Tue, 13 Mar 2001 20:10:55 -0700  
From: "Kurt" <radiouser@uswest.net>  
Subject: Re: [R-390] Cosmos PTO Types

I have studied your work and greatly appreciate your effort. Have you seen a Cosmos or any other for that matter, PTO that has some of the wires coming out of the cover? This makes it more difficult to get the cover off because you have to take the connector apart to undo the wires.

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Date: Sat, 31 Mar 2001 12:27:58 -0500  
From: Jim Miller <jmiller@iu.net>  
Subject: [R-390] Re: [Fwd: thanks for cosmos photos]

Normally the gears behind the linearity adjust opening shouldnt need a lot of lube, or any at all. I did put a tiny touch of oil on my gears when I had it open, but actually I don't think Cosmos had that in mind. I dont believe it was not meant to be opened to that degree in normal practice. I dont think it would hurt anything, but just dont overdo it. You definitely do not want to pour a lot of oil in there...not a good idea. There is the risk that oil or grease could get into the little plunger actuated coil and affect the coil form or the core. I did put a tiny drop of light oil in the bearing where the shaft exits the PTO in the front. There are a couple of bearings there.

In terms of lubing the Cosmos PTO at all, I'm not sure what is appropriate, or what Cosmos or Collins would recommend as regular maintenance. Maybe someone

on the list could comment. I went from my experience with the S-Line 70K2 PTO where you have to clean the threads of the lead screw (the long shaft) and the core, and then coat it lightly with white grease. And also the bearing collars, etc. I did that with my Cosmos since I had it open anyway. But if you are not experiencing a lot of drag with your Cosmos, then it may not be necessary to do that.

On that bracket, it is supposed to be there. It does offer some bracing to the shaft. In the R390 video, it was mentioned that there was a groove in the shaft that this bracket rides in, but mine had no such groove. I believe it is primarily for grounding of the shaft to prevent slight frequency changes when the operator touches the tuning knob or other causes. So don't take it off (I did and it took forever to get those tiny screws back in). Also it has been discussed elsewhere that if you get lubricant on this that it could affect the electrical contact and cause some jumpiness or warbling of the frequency as you tune. DeOxit has been recommended at this point.

Hope this helps. If others have comments about PTO lubing please let us hear.

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Date: Mon, 02 Apr 2001 17:26:46 -0400  
From: Jim Miller <jmiller@iu.net>  
Subject: Re: [R-390] Out in the Cosmos

I had the same problem Norman did with removing too much from the coil. I found that the small wirewrap wire from Radio Shack worked OK to repair the coil. It seems to be the right diameter and has a very thin, blue insulation that is easy to remove. On the adjustment screws, I was as frustrated as the others who have these strange looking heads. I used a filed down jewelers driver but it wasn't very reliable. the idea of a very small socket type driver may make sense. You might also look in Technitools or Jensen. If anyone figures this out please let the list know. Jim N4BE

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Date: Thu, 05 Apr 2001 21:45:42 -0500  
From: Nolan Lee <nlee@gs.verio.net>  
Subject: Re: [R-390] Out in the Cosmos

Snap-on did or still does offer a .015 Allen wrench. I've got one. I've also got one .010 one but do not know who the manufacturer was. 010 is the smallest I've seen. It's easy enough to cut down an Allen wrench to the size you need using a Dremel or just plain sandpaper and a micrometer.

>smaller. After looking far too long at the adjustment screw I don't think it  
>is a spline, torque or Allen. Looking at the outside edge of the screw  
>reveals what appears to me to be a super small nut that a suitably sized nut

After I finished the EAC, I took the Cosmos PTO that I had removed from it originally and went through it. The adjustments in mine were 4 spline Bristol type. I had a wench to fit them but it wasn't long enough to extend out far enough for me to turn. Rather than cut it down and mount it in a handle, I used a jewelers

screwdriver to make the adjustments. I cut down on the width and thickness of the blade until it fit diagonally across the head from one spline to the other. It worked like a champ.

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Date: Fri, 27 Apr 2001 17:14:23 EDT  
From: Llgpt@aol.com  
Subject: Re: [R-390] Interesting Crystals

Check the thermostat..when they fail open it gets pretty warm. I have seen PTO's literally cooked and grease burned when the PTO thermostat failed open.

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Date: Fri, 29 Jun 2001 22:31:53 -0700  
From: Dan Merz <djmerz@3-cities.com>  
Subject: Re: [R-390] PTO

Paul, when I think about your statement concerning +/- 3 Khz on pto tracking, I start wondering whether the dog is chasing its tail. I recently obtained a 390a EAC in pretty nice condition (missing the oldham coupler but worked ok otherwise once I found a coupler by good luck). The Cosmos pto wouldn't put out the 1 Mhz range so I followed Marcotte's instructions for taking a turn off the deeply hidden end point adjustment coil and this did the trick. However, I began to wonder why this might or might not solve an apparent problem. What about all those other coils that must have aged also and how do they track if the inductances also changed. A change in core permeability worries me most. Without some real data on this issue - I'm guessing for instance that the aging of the pto coil had more to do with aging of the core material than with coil dimension changes - it's hard to know what's happened to the other coils. Has anyone addressed this issue and really established that tweaking the pto to track linearly and over the original range really helps overall tracking or does it just put the received frequency on the correct spot on the dial? What I wonder is, "did I do the "right" thing by bringing the pto into line or did I just adjust the frequency indication to be more accurate?" Of course, knowing the frequency of a signal being detected is pretty valuable, tracking considerations aside. I haven't yet tried tweaking any of the cam driven tuning coils according to manual procedures so I speak from little experience and I'm a beginner as far as this radio goes. However, I would guess that if the core materials of all those moving coils have also aged, it may be difficult to get original tracking specs back, though tracking may be optimized in some sense. Moreover, I'd be surprised if +/- 3khz would be significant in the tracking scheme of all the bands, maybe for the lower bands?? I would again guess that tracking is only right at some selection of intermediate points, was pretty darned good with the cams designed to match the core material/coil combinations, but may be not as good as the set gets older and the coil/material age because the cam shape must have been experimentally determined to do just that for the materials at that date. Without knowing the answer to the question about aging of all the coils in a 390a, it's hard to be convinced that +/- 3 khz on the pto will make a difference, or more to the point, that eliminating the +/- 3 khz would really be significantly beneficial other than frequency indication. Maybe I'm puffing wind about something that has already been explored and put to rest. If so, I hope somebody might set me straight or

lead me to the watering trough on the subject.

As an aside, the only parts I've replaced so far are the caps leading to the mechanical filters, which actually seemed ok but the risk was not worth taking in light of advice given by others on this subject, and the very small 8 mfd cathode bypass cap on an audio stage tube, which was actually failed. I'm very happy with this radio and it's performing very well compared to the only other receiver that I've compared it directly to - a JRC 525, , especially with the diode load output taken to an external audio amp. I'd like to do something about the ssb reception but am balking at \$200 for an external ssb detector and would just as soon leave the 390a pretty much original inside, at least for the nice example that I have. Has anyone published the circuit for an external ssb detector that I could throw together, thanks, Dan Merz

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Date: Sat, 30 Jun 2001 10:37:43 -0400  
From: Bob Camp <bob@cq.nu>  
Subject: Re: [R-390] reporting in (PTO)

There has been quite a bit published in the various magazines over the years on the PTO and what it's design parameters. There is also a surprising lot of data on the various core materials out there. Based on all that here's my \*guess\* on what is going on.

One reason the PTO's range drifts upwards is that the coil body is shrinking with time. A lot of materials do this and phenolic is one of them. As the coil body shrinks the turns get closer to the tuning core and the range of the coil increases. In order to make wider tuning PTO's Collins later came up with a different construction technique to put the coil windings much closer to the core than they are in the R-390. There are a whole series of Electric Radio articles on what they did.

Collins and several other companies did a bunch of testing on core materials back in the 50's and 60's worrying about just the kind of drift you are talking about. The conclusion was that some of the high permeability ferrite materials drift with time, but that powdered iron cores do not do so. All the stuff in the RF and IF deck racks is powdered iron as far as I can tell so they should go on forever. The PTO core is a ferrite material so it may drift a bit. If anybody out there has a copy of one of the old engineering reports on ferrite drift it might help out. I never saved a copy :(

Both of these effects are accelerated by heat. A good bet is that they follow a normal "doubles for every 10C" type rate law past some activation temperature. A PTO with the ovens on would be at > 80C. In a normal radio with the ovens off it probably runs at 40C. Assuming a 40C to 50C difference and an activation temperature below 40C you would get an acceleration factor of 16 to 32. A year with the ovens on would equal 16 to 32 years with the ovens off. Sounds like a good reason to turn off the ovens :) It is also a good argument why a lot of PTO's got junked. Five or ten years of normal service with the ovens on probably nuked them pretty good.

If you did have a problem with RF or IF deck tracking it should show up in the standard alignment procedure. Assuming you re-check the standard points for peak sensitivity after you are done you should spot the problem. If you want to be absolutely sure you would check a point half way in between the two standard alignment points and see if the sensitivity was the same there.

The guys who designed this radio where pretty darn good at what they did. They had at least some of the data on these effects. Certainly much more data was collected after the radio was designed. I suspect that even they would be amazed that the darn things work as well as they do 30, 40 or even 50 years later. Notice I didn't even mention the DMRO's efforts in there ...

Don't know if that helps or not ...

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Date: Sat, 30 Jun 2001 11:43:17 EDT

From: DJED1@aol.com

Subject: Re: [R-390] reporting in

Re: Cosmos PTO tracking I can't really answer the question about aging components, but I did align one of these PTOs, and found some items of interest. I didn't know about trimming the coil, so I tried to linearize the PTO by tweaking the calibration screws. I found I could get a combination of settings which corrected for the 3 Kc end point error, but I then had to adjust all the screws. I found that setting at the 100 Kc points was inadequate, and that the 25 Kc points could be 1-2 Kc off unless they also were adjusted. I finally got it within 300 c at all 25 Kc points, but didn't check in between to see how good it was. I now find that the end points have drifted about 1 Kc apart, but I have trouble working up the enthusiasm to take it all apart and do it again. The PTO, incidentally, was one of the G0v't refurbished ones that Fair was selling a couple of years ago. My guess is that the PTO will be within 1/2 Kc if aligned at the 25 Kc points.

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Date: Sat, 30 Jun 2001 14:26:30 -0700

From: Dan Merz <djmerz@3-cities.com>

Subject: Re: [R-390] reporting in

Bob, thanks for getting to the point I was concerned about, mostly what was known about the aging of the other coils. I didn't realize iron powder in rack coils vs ferrite in the pto - must be more stable oxidation state in the powdered iron cores -so it's encouraging that things would be expected to better in these coils. I'm a retired materials scientist so this kind of info interests me a lot. Your comment about 10C doubling the rate is one of those rules of thumb that flew around in a lot of meeting during my career. Your idea about checking the mid band sensitivity after alignment at the ends was what I was starting to think about and this is the essence of whether tracking is maintained. One can always adjust two points on a given band to be right on, but what happens over the rest of the band and how well all the coils being simultaneously tuned match up is the challenge of the design and I think the measure of how well the coils held up over time. Why did I buy this creature in the first place? - mostly because I knew there

were a lot of guys that have put a lot of time into appreciating it, willing to pass info on and I wanted to see what it is all about firsthand. And I've known guys who loved it, one good friend who takes on just about any radio that comes along that wouldn't own one again if I gave it to him and a couple of collector friends who have a 390a but just let them sit there waiting in line as another project. Your comments are much appreciated, thanks. I'll be getting around to the alignment task before too long, Dan.

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Date: Sat, 30 Jun 2001 19:12:52 -0400  
From: twleiper@juno.com  
Subject: Re: [R-390] reporting in

> What I wonder is, "did I do the "right" thing by bringing.....

They are not mutually exclusive. You did right on both. Variation in crystal frequency will still require you to zero when changing bands, but any other coil variation in the RF sections will only affect the linearity of sensitivity in certain areas, and that depends upon how you tune. On the other hand, a radio like an SP-600 with a variable HFO WILL suffer dial inaccuracy due to such degradation, but it is usually minimal, and you have the option of deciding WHERE it is most important for the dial to be accurate.

> I'd like to do something about the ssb reception but am balking at \$200 for an external ssb.....

*A poor man's SSB improvement is to use a baby monitor.* I discovered this quite by accident when I wired a baby monitor transmitter to a 390 so I could listen remotely. The automatic volume control has such range that you can set your RF gain well down (to avoid distortion on strong signals) and still copy the weak signals easily. The fast attach/slow decay of these units is perfect, and with the low noise level in these radios it works extremely well. Mine is a Radio Shack, and I just disconnected the internal mic and wired the input to a 50K pot across the "line" output. I've often thought of making a little AVC amplifier to drive conventional speakers from the "line" output on these radios with about 10-20 watts. Maybe I should...I could even add reverb and disco light control.

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Date: Tue, 17 Jul 2001 09:24:51 -0700  
From: David Wise <David\_Wise@phoenix.com>  
Subject: RE: [R-390] Restoration Bulletin 2: Gear Train again

And I reply to both: Certain. I have the radio all apart. Metaphorically speaking, I have the PTO in my hands as I write this. It takes a lot of torque to turn it, but it's smooth and uniform, no gritty spots or bumps. Like the bearings are ok but just super-tight. Roger's got the idea, but I was fishing for advice on getting the unit apart and back together. My neighbor has a press. I'm looking for tips like What size EMT (or whatever) makes the perfect jig?

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Date: Thu, 19 Jul 2001 17:04:22 -0400  
From: "Walter Wilson" <wewilson@knology.net>



Subject: Re: [R-390] Zippo lighter/tube heaters commit

> Say, what numbers should be showing on the Veeder-Root?

03 885, of course. And make sure the BFO is in the OFF position, Bandwidth 8KC.

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Date: Fri, 03 Aug 2001 10:06:20 -0400  
From: Bob Camp <bob@cq.nu>  
Subject: Re: [R-390] Ovens stay on with switch in off??

Based on talking to the guy who designed that part of the radio (for real, I ran into him at Collins ..) here's the problem. On the PTO the temperature is as stable in a normal room as it is with the heaters on. On the crystals the temperature is roughly ten times more stable with the heaters off in a normal room than with the heaters on. They had to make some compromises in the design of the crystal "oven" and it did not wind up quite as good as it could have been. They did a \*lot\* better on later designs.

The ovens do a very nice job if you are running way below freezing and the temperature in your tent is swinging every time the wind blows. The angle of crystal they used gets more sensitive to temperature swings as it gets real cold so that can be a factor as well.

Since there is no advantage to running the ovens you leave them off since the parts will die faster at higher temperatures. It's not just the stuff in the ovens that gets hot. Anything that puts more power into the radio will heat up a lot of stuff.

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Date: Fri, 3 Aug 2001 22:05:03 -0500  
From: "Richard Biddle" <theprof@texoma.net>  
Subject: Re: [R-390] Ovens stay on with switch in off??

I am paranoid about excessive heat on components. I suppose that comes from playing with mil-grade silicon - nasty little boogers to keep running for a long time at 125C :) Like the MILSTAR guy told me, it's not the repair cost that kills you, it's the service call.

I run ovens switch off and have disconnected the heaters from the plug in oscillator on the RF deck. I use a 4" fan in a custom designed oak cabinet for the R-390A. I don't see enough drift to be worth wondering about.

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Date: Mon, 6 Aug 2001 23:36:25 -0400  
From: "Walter Wilson" <wewilson@knology.net>  
Subject: Re: [R-390] R-391 questions

That's an acceptable sub, but most folks avoid putting a new tube in the PTO. Put a good 5749/6BA6 from another location in the PTO. One of the Collins engineering reports goes into some detail about the benefits of using an aged PTO tube.

> The receiver came to life, but suffers from a bad hum on both the local.....

I guess you're using either a 600 ohm speaker or some kind of audio transformer if you're driving an 8 ohm speaker. You also may want to check the DC voltage level at E206 and E207. You should have negative DC voltage here on strong signals. If either of these is close to zero, the AGC would not be working for that stage and you'd get some distortion and blocking on stronger signals.

> I have checked the B+ and have 180 VDC at the test point, .....

How large was the AC you measured when you dipped AC level with the hum balance adjustment? Is the rig grounded? If it is fed with coax, are you using the balanced antenna input and tying one side to ground?

> The carrier meter seems to be somewhat stingy,

Switch the AGC between Fast and Slow and see if the resting carrier meter level on a local AM station is the same either way. If it's lower on Slow, you may have a leaky AGC capacitor. Is the carrier meter an original meter? If not, that would explain why it's stingy.

> or slow to respond as well.

> I am thinking this receiver could benefit from a complete alignment.

The R390/391 seems to me a bit slower than the R390A, especially with AGC in the Slow position.

> Fortunately, it came with an original of the 1953 Collins TM, but is there a better alignment procedure than the one in this manual? Besides testing the tubes and cleaning switches, should anything else be done before an alignment?

If you have the green gear, set the frequency to 2.000 MC, install the green gear, pull the RF deck, and check the cams for proper mechanical alignment. (Don't try this without the green gear, or else you'll have a messed up mechanical alignment for sure)

>Also, one of my R390 manuals does not talk about checking the PTO endpoints.

This is always a good idea, as the cams are cut expecting exactly ten turns of the KC knob to equal 1000 KC. This is easy to check using the CAL position. If it's more than a couple of KC off, it's worth setting the endpoint before proceeding with the alignment.

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Date: Wed, 15 Aug 2001 22:18:26 -0400

From: "AI2Q Alex" <ai2q@adelphia.net>

Subject: [R-390] "Warning, Sealed Unit, Do Not Remove This Cover"

"Warning, Sealed Unit, Do Not Remove This Cover" Over the years I've often

looked at that message on the label of various PTOs. When I restored a Motorola R-390A (Order No. 363-PH-54, SN 1857) last October I disregarded that ominous-sounding label and opened the PTO. The reason was that although the set's Collins PTO didn't drift, and was reasonably linear, it had an annoying warble at some points on the dial. It made it tough to tune SSB, and CW at narrow filter settings. In short, it was bad news. Anyway, I noticed last October that someone had been in there before me, as the PTO's seal was broken and I could see the telltale re-soldered wire on its heater element as I took it apart further. At that time I tried cleaning and lightly lubricating the internal dual linearization racks, to no avail. The warbling persisted. I also meticulously cleaned the internal rack screw, but that didn't cure the mechanical instability problem either. Having just installed a new Cosmos PTO (courtesy of a real gentleman, W5BVB, Phil), I finally got a chance to dig into the original Collins unit.

What I did was set it up on the bench with 6.3-V ac for the filaments, and about 150 volts dc fed to pins A (feeding V701's plate) and B (the screen) of the power connector. By the way, for the purpose of testing, this voltage isn't critical; it can be anywhere from about 80-V to 200-V or so. I have an old Heathkit variable bench supply that I use for these types of things. I also used a 51J-4 that's on the bench right now, with its BFO on, to listen to the oscillator, and I simultaneously monitored the PTO output-frequency using a frequency counter while I poked around trying to discover the source of the mechanical instability that was causing the warbling inside the PTO.

Taking the bull by the proverbial horns, I removed the two large Philips screws holding the rear bearing plate, and then the smaller Philips screw that holds the plate to the linearization rack. With the plate and bearing assembly out of the way, I could unscrew the small brass stop-slug by holding it with a pair of pliers while I manually rotated the lead screw by rotating the PTO's Oldham coupler. Removing this small brass component permit me to rotate the Oldham coupler and run the core assembly up to the highest frequency end of its travel. Carefully holding back the spring-loaded dual track-bearings, I further unscrewed the core until it was free of the lead screw. I took the whole core assembly entirely off the PTO. This exposes the threads at the opposite end, and inside the core. They can then be inspected with a small magnifier. I could see some crud in there, likely from year's of wear, so I poked some dish detergent in there and washed the core thoroughly with very hot water, getting the flow inside the critter. After drying it with a hairdryer, I put a small squirt of DeOxit on the core's threads. Next I stood the PTO assembly vertically with the Oldham coupler end face-down, and applied a squirt of DeOxit to the lower internal CirClip that can be seen with the core out. It's located down inside the coil form. I also checked the tightness of all the coil assembly's Philips head screws. They were all okay.

I also removed the rear bearing assembly and cleaned it, and applied a drop of DeOxit there as well. Next I used a mini-oiler to apply one drop of light oil to the pivot point of the miniature spring-loaded tracking arm. I also loosened the three small slotted screws that hold the three tiny flat copper leaf springs at 120-degree intervals. These are located at the metal plate affixed to the actual core material (can anyone tell me what these are for?) I also burnished both linearization rack

surfaces, and moved the fiber bearing 180 degrees in order to expose a new surface to the linearization fingers. After re-assembling the core and installing the rear bearing, with a tiny drop of oil on the rear bearing surface, I positioned the three tiny springs so that they now bear on the leadscrew (again, does anyone know what these were for originally, or what position they were originally in on the shaft assembly?) Anyway, while open on the bench, I powered it up again and ran the core up and down its range, proving conclusively that TLC is a good thing. There's no more warbling, and the linearity is still good. I now have a spare PTO for...who knows? Another R-390A in the future? Vy 73, AI2Q, Alex in Kennebunk, Maine .-.-.

PS - I'll try to take a photo of the disassembled PTO for possible posting here at some point.

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Date: Wed, 19 Sep 2001 15:08:04 -0700  
From: David Wise <David\_Wise@phoenix.com>  
Subject: [R-390] R-390A Restoration Bulletin 7: Smoke Test/Collins PTO/Killer Sock et

...it worked. Whew. Did a really brief cal/carrier meter-only alignment, and picked up stuff on all bands. Noticed that the 8kHz filter is about 20dB down (as I mentioned in another post), and that the PTO was a couple of kHz long. I have one short diddle stick with a metal blade, with which I can set the endpoints without pulling the front panel. Once I did that I did a frequency counter sweep and found that the linearity was off, by up to 600Hz in some places, but always off in a systematic way. The PTO runs high except at the endpoints. I decided to see for myself what a Collins corrector stack looks like.

Removal of the outer can, the insulation, and the oven was uneventful. Don't breathe that crap! I did this part outdoors in a breeze. Went back in and pulled off the inner can. Ah-hah! I had never made sense of other peoples' descriptions, so unless someone asks me, I won't try either, except to point out what I don't remember hearing: there's a long thin screw that goes through the stack, which is normally tight. To move the disks around, you loosen it. Don't loosen it unless the follower is parked at an end, or it will move some disks. Each disk is separated from its neighbor by a thin shim. All the shims stay exactly in place due to their shape (which grips the backbone), so you can move each disk independently of the others. The disks are not exactly 25kHz each! Ten turns is actually 38 or 39 disks not 40. What were they thinking?

The stack was bowed to one side. To bring the PTO back linear it would have to bow a good deal further. This procedure took a lot of patience, because I didn't dare change things too much at a time. I'd take a reading, note areas that had to move and (relatively) how much, remove the PTO, pull the cover off, massage the stack, put the cover back on, replace the PTO, and take another reading. After about five cycles, I had it as good as it was going to get, only about 200Hz off at the worst point, and no more than about 100Hz off from the nearest cal point.

Then I realized I hadn't baked it. Put it in the oven at 170 (the lowest temperature

it will go), and left it overnight. Put it back in next day and took a reading. Way off! Not only was it about 5kHz long, I was going to have to undo most of yesterday's stack work, because the main coil had become more linear. Another couple nights of patient twiddling and I had it pretty good again.

Baked it again. Next day: way off! Again. In the same direction: long, and straighter. Now my corrector stack is almost a straight line, just a few little wiggles. Should I bake this thing again? I'm afraid I'm pushing it towards a state that won't last.

On a related note: something is wrong with V701's socket or shield. It has killed two 5749Ws in three days. I come by and find that the base is cracked. Anybody seen this before? By the way, it's the crummy shiny shield, but I don't know if the problem is heat or mechanical. There's certainly nothing obvious. Now I'm running without a shield and the latest tube is holding up. Eh?

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Date: Tue, 23 Oct 2001 11:46:08 -0700  
From: "Roger L Ruszkowski" <rlruszkowski@west.raytheon.com>  
Subject: Re: [R-390] PTO tuning tool, R-390A

..... try to locate a suitable nonmetallic tuning tool.....

Use what ever fits.  
File the tool to fit if needed.  
Read the output indicator.  
Poke it.  
Stop poking it.  
Read the output indicator.  
Evaluate results of poking.  
Repeat until satisfied.

Just use a good metal screw driver for the flat screws. Finding the very small Allen wrench for some of the models is hard to do. You may have to grind one to fit if you need it. The tool will impact the setting. You let the thing settle and then reach in and make a small adjustment. Then let it settle again and see what happened. You just do not try to do a reading while tweaking. In fact just tweaking is not real good. You want to run the shaft off and back to the point a time or two to see how it will settle.

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Date: Thu, 25 Oct 2001 09:17:11 -0700  
From: David Wise <David\_Wise@phoenix.com>  
Subject: RE: [R-390] PTO tuning tool, R-390A

> Since the PTO on one of my R-390As stops oscillating at about 70 KHz from the bottom .....

Like many techs, I have a collection of diddle sticks. One very old one has a metal blade at the end. I accidentally broke it years ago. One piece happens to be exactly the right length (about three inches) for in-situ endpoint adjustment. It's

short enough to slip into place without taking off the front panel, but long enough to turn between thumb and forefinger. The metal blade turns that sticky little screw without warping. It's a file-to-fit situation. I do have to use a real screwdriver to remove the access plug. If I go in at an angle with a thin one, there's just enough leverage to break it loose. That said, IMO endpoint adjustment won't help you. It stopped oscillating because the loop gain fell below 1. You have:

1. A weak tube.
2. An off-tolerance resistor.
3. A bad solder joint.
4. A lossy deposit on the coil.
5. A bad cap.

If your VFO has FC-7 installed (screen resistor 220k instead of 56k), it's already near the edge and will not tolerate further losses. If you go inside Z701, do NOT damage the funny-looking ceramic caps. They were selected with exquisite regard to their temperature characteristics; if you have to replace them it will never be the same.

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Date: Thu, 25 Oct 2001 09:35:30 -0700  
From: David Wise <David\_Wise@phoenix.com>  
Subject: RE: [R-390] PTO tuning tool, R-390A

Somebody wondered a while back which end to adjust at. It's the 3.455 end. The 2.455 end will be affected too, but (observation) only about half as much. I haven't done the algebra, but this suggests that if you want to change the spread a certain amount, moving the 3.455 end by some multiple of that amount will make the procedure converge faster. I've had good results with a multiplier of 2. Why 3.455? For the same reason you set trimmer capacitors at the high end. L701 (the adjustment) and L702 (the main) are in series, so their inductances add, like trimmer capacitance and main capacitance. In fact, you can think of L701 as a "trimmer coil", if that doesn't insult your sensibilities :-). How much does L701 affect the total? Depends on L702. L701 is a larger percentage when L702 is small (3.455) than when L702 is large (2.455). QED.

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Date: Mon, 12 Nov 2001 10:23:49 +0200  
From: "Bryce Ringwood" <BRingwoo@csir.co.za>  
Subject: [R-390] R390-A VFO Jitter

I notice when tuning AM stations for listening on USB that my 390-A VFO has a slight jitter which is a bit annoying. I'm not sure if it's just amplitude noise or jittering around the frequency I'm trying to tune. Otherwise, I have no problem tuning SSB, and the VFO seems very stable.

Any suggestions? - Perhaps someone could tell me how the VFO works. Is it a permeability tuned thing, or does it work on the same lines as a ten-turn pot? Taking it apart is something I'd rather avoid. Also - is there any way of pulling the crystals to be 100% the correct frequency - or do we just buy new ones?

I see the photos of the 390-A on Dutch's web site appear to show a flywheel on the tuning shaft. If so, mine has gone AWOL, I think (Haven't taken the front panel off YET, but I don't see one from underneath and the kHz tuning doesn't feel like it has a flywheel. ).

BTW, Phase-locked loops were certainly around in the valve era. I have a TRT PLL "Master Oscillator" which I use as a frequency standard. It contains 16 valves ,is a beast to align and requires an unreasonable degree of mental agility to work out what frequency will be produced.

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Date: Mon, 12 Nov 2001 07:49:16 -0500  
From: Bob Camp <bob@cq.nu>  
Subject: Re: [R-390] R390-A VFO Jitter

Unfortunately there is no way to pull the crystals back on frequency. The only explanation I have ever gotten on this is "it wasn't in the Army specification". With an enormous amount of work and a lot of crystals you can get them pretty darn close. I would say that anything under 300 Hz total spread is worth bragging about.

I have never seen a flywheel on the tuning shaft of a 390A. I think the gizmo you are looking at is the locking plate for the kilocycle tuning shaft. The PTO should not hop as you tune it. If it is slipping you should see it first on SSB or CW signals. If you only notice it on AM then it's not the PTO. The PTO is an inductively tuned oscillator and it is kind of a pain to take apart. One of Chuck's video's shows how to do it if you need to. Check the AGC voltage(s) and see if they relate to your AM problem.

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Date: Mon, 12 Nov 2001 09:46:55 -0800  
From: "Roger L Ruszkowski" <rlruszkowski@west.raytheon.com>  
Subject: [R-390] R390-A VFO Jitter

One place to look is the mechanical filter in the IF deck.

Try a different bandwidth, (another filter) and see if the problem is present. If the problem is only one or two filters then you have filter problems. (Do a IF deck swap with some one who is not worried about the filter band edge as much as the SSB users are.) The filters can have microphonics on the filter skirts. One side may have them while the other filter side may not have them. More than one filter in a receiver may have the problem and you can spend weeks looking for a common failure that is in fact two problems. A real good sweep generator and proper setup will also show the notches and anomalies in the filter skirts. It is a fairly common problem. Most times the problem is not annoying and gets lived with. More filters get changed for this reason than the fact that they flat out fail either shorted (wide band) or open (no signal). Filter failure need not change the input and output impedance of the filter. A meter check need not be a clue. It's a mechanical problem in the filter "stack" and "funny" thing happen on the skirts.

.....how the VFO works .....

The VFO is a slug tuned thing. The slug travels on a threaded rod inside the can. The coil is not a tight wound limier coil. It is spaced to give a linear output as the slug moves liner through the coil form. One model uses a comb like slide rail for small liner adjustments. as the slug is moved in and out the rail varies the stop rotation and changes the linear thread motion small amounts by using variations in the resting stop. Another model uses small bolts to change the pressure plate in the end shaft thrust bearing. as the shaft and plate rotate different displacement is applied to the shaft end to effect small changes in the linearity of the VFO to smooth out variations.

These things are very good.

Check yours from end to end. If its less than 3KC its in mil speck and can be left alone. You can first adjust the band spread to get the 3KC down to real good. ( a few hertz with a counter) Less than 500 hertz with a zero beat and effort. Then you can measure the linearity and go into those adjustments if you are so inclined.

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Date: Mon, 12 Nov 2001 11:51:54 -0800 (PST)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] R390-A VFO Jitter

The first thing to do here, is to clean the ground contact on the shaft of the PTO. Its a small tab that runs in a groove on the shaft. This has to be CLEAN! And don't oil it.

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Date: Mon, 12 Nov 2001 16:59:08 -0800  
From: "Roger L Ruszkowski" <rlruszkowski@west.raytheon.com>  
Subject: RE: [R-390] R390-A VFO Jitter

.....Is 3kc the endpoint milspec, or the linearity spec?

If it's endpoint, then what's the spec for linearity? In other words, if I have zero at zero and 1000 at 1000, but 510 at 500, is this still in spec? (I doubt it is, but I wonder what the linearity spec is.). Back when I was teaching this stuff in school to receiver repairmen, 3KC was the spread. 2.455 to 3.458 or 2.455 to 2.452 If the semi bench test fit this number. Test is done go to next test. If test did not fit these numbers you could try three time on the bench to get the critter into conformance. If three tries did not get it you passed it to depot for fix. It would always come back from depot as dead on and reported as no trouble found.

Define three tries as  
Once by a nug.  
Once by a Elmer (short timer experienced)  
Once by the trick chief.

We never worried about the linearity.  
We never had the time or way to test it.



If you did log it with a freq. counter you had no way to adjust it.

We only taught the Collins VFO with the rack if washers inside.

This was 1968 -1974, when R390's were new. We were doing field maintenance.

Do all this to a receiver,  
load it into your 2 1/2 6x6  
drive 4 hours cross country  
drink a warm beer  
ponder if work back on bench was still relevant to equipment.

I do not know what the spec is.  
But some fellows have some real dead on no BS units glowing in their shacks.  
With time and effort you can get the units to operate real close.  
As in better than your freq counter and dial indicater can replicate in 100 or so  
test events.  
How good is your back lash?  
How good is your counter?  
How close can you read that dial?

Your PTO can do better.  
Is your PTO better? (very likely)

If your PTO goes bump then it has a real problem. (some do) and it could be that  
some one not knowing tweeked just one or more of those little bolts not knowing  
what was happening. So you could have a PTO that needs some very tender  
care. Then again your receiver may have gone cross country and have shook a  
bolt or two loose.

When PTO are good they're real good.  
When their bad they can likely be fixed.

There are several problems that all exhibit exact symptoms.  
Each set of symptoms has an exact fix.  
Do not shot gun tour PTO.

Read the archives.  
Post your problem here.  
Wait for all the E-mail to settle in.  
Proceed with care.

Without offense to Les or Nolan, save the beer for after PTO work.  
Beer is best enjoyed while in the operate mode.

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Date: Mon, 12 Nov 2001 22:49:46 EST  
From: DJED1@aol.com  
Subject: Re: [R-390] R390-A VFO Jitter

If I look up MIL-R-13947, I find the following spec for the PTO. When calibrated at the nearest 100 Kc point, the frequency readout shall be accurate within 300 cps. When the PTO is accurately set at the low end of the range, the high end reading shall be within -1500 to +200 cps. So you might say end point adjustment is within 1500 cps, and linearity is within 300 cps. also, the variation from band to band is spec'd at 4 Kc. Ed

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Date: Tue, 13 Nov 2001 09:36:53 +0200  
From: "Bryce Ringwood" <BRingwoo@csir.co.za>  
Subject: Re: [R-390] R390-A VFO Jitter

Thanks for the swift and very helpful replies and links. I should be able to fix it now - I notice its only bad with strong stations 80db on the carrier meter and not really noticeable on stations with 40db or less. (Whatever S points that is - I'll have to look at the graph). The label on my VFO/PTO has been scratched, so I don't know who made it. (Its a Capehart Rx). The PTO is about 3Kc out on end points - maybe a touch less. I was going to adjust it, but now - probably not. Now I put my glasses on, I see I do have a locking disk and its not a flywheel. Touch of Eddystonitis there. Re: cleaning - One problem I have concerns cleaning fluids, since we don't have the same ones you use here - with the exception of WD- 40. I use 'Servisol' for contacts and potentiometers (Very sparingly indeed-this stuff has a bad reputation). Wynn's 'Clean Green' for general dirt removal. Some pink stuff called 'Prepsol' for de-greasing and sprays based on trichloroethane on contacts when I just want to clean away dirt. I sometimes use 300 thinners if I feel sure its not going to dissolve away anything nearby. Also air-duster and elbow-grease. Your De-Oxit sounds like good stuff.

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Date: Tue, 13 Nov 2001 08:40:35 -0800  
From: "Roger L Ruszkowski" <rlruszkowski@west.raytheon.com>  
Subject: Re: [R-390] R390-A VFO Jitter

".....If I look up MIL-R-13947, I find the following spec for the PTO. "When calibrated at the nearest 100 Kc point, the frequency readout shall be accurate within 300 cps. When the PTO is accurately set at the low end of the range, the high end reading shall be within -1500 to +200 cps. So you might say end point adjustment is within 1500 cps, and linearity is within 300 cps. also, the variation from band to band is spec'd at 4 Kc." Ed"

The variation from band to band is spec'd at 4 Kc. This is a function of the crystals in the Crystal osc deck. You use this value to decide if the crystals need swapping. The crystals are functioning OK or you have a dead band. Practice here was to pull about 4 sets of crystals and then by test sort them into back into 4 sets.

For each frequency / crystal.

- put all the low value in one receiver
- put all the high value in one receiver
- put all the center values in one receiver
- put set four back in the spare box.

Some real off center ones got replaced.  
It would be a 17 priority not an 05 or 02 dead line on part.  
Being more than 4KC off was just annoying not a mission stopper.

There were a lot of crystals pulled and worked good.  
They just would not put to frequency in the circuit.  
We always peaked the osc deck for Max output.  
We never tried to tweak for frequency.  
If the frequency and the peak were not the same point.  
(the crystal was off frequency a few hertz) the max output won.

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Date: Tue, 13 Nov 2001 11:56:46 -0800  
From: "Roger L Ruskowski" <rlruszkowski@west.raytheon.com>  
Subject: RE: [R-390] R390-A VFO Jitter

Can you plug in a pair of 12BA6 for us? One in the BFO, one in the PTO and put a jumper in the ballast socket. How badly will this drift? This would be the zero control standard. Then we can gauge what the ballast tube adds to the mix. This could be a surprise. If room temp and tube temp are causing more drift than filament variation we could be chasing the wrong dog here. If line voltage is causing drift, then all hell is loose. The B+ is regulated. The filament is regulated. Those two circuits should provide a stable operation. Not an exact value, but stable where it is. If your local line varies (lights blink) enough to produce PTO shift, I do not know what you can do. Steady state high or low voltage can be adjusted with a line auto transformer. Even good UPS will not filter out dips and surges.

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Date: Tue, 13 Nov 2001 14:11:28 -0800  
From: David Wise <David\_Wise@phoenix.com>  
Subject: RE: [R-390] R390-A VFO Jitter

I'm replying to two Roger R. posts. It's long, sorry.

> Can you plug in a pair of 12BA6 for us?

I figure the series resistor version will give the same performance, so I'll report on that when I get to it. I'll include the with-ballast figure so you don't have to compare three old emails. Remember I only have this one radio, so YMMV.

>If room temp and tube temp are causing more drift than filament variation we  
>could be chasing the wrong dog here.

I'm going to ignore tube temp per se and just concentrate on filament and Z701.  
Stick to stuff I can control or at least measure.

> If line voltage is causing drift, then all hell is loose.  
> The B+ is regulated. The filament is regulated.  
> Those two circuits should provide a stable operation.

> Not an exact value, but stable where it is.

It's immune to B+ changes. As long as the filament is steady, you can swing the line all over the place. It'll stay on zero-beat. The two sensitivities are cathode temp (i.e. emission) and Z701 temp (coil/cap). During the day, my line slowly drifts about a volt, which is why I based my measurements on 1V. Of course I don't wait for it to drift, I use a variac :-). This lets me separate line voltage from temperature. For temp I open the back door and start a fan. I didn't have a thermometer handy but rough guess maybe 10 degrees plus wind chill from the fan. Who knows? Anyway, that was good for about 200Hz. The TC is positive, i.e. cold is lower frequency than hot. My DVM is measuring filament voltage (even though I have the 7805 wired as a current regulator). A couple hundredths of a volt is worth a few Hz. The TC is negative. More emission => lower freq. I'm going to try to make the current regulator have a positive TC, with a sensing diode or thermistor taped to the VFO can. If the curves are congruent enough, I'll be able to get partial cancellation over the interesting range. Remember, I'm just playing a game here, let's see how good we can get it on the smallest budget possible. See if I can zero-beat, turn it off, turn it on next morning and be zero-beat ASAP. Or stay zero-beat all day. Unless you listen to music on SSB, none of this means a thing. Also remember. BIG CAVEAT. There's nothing special about a VFO that says it has to have a positive TC. That's just the way mine shook out at the factory, based on the temp-compensating caps the guy put in it. I would not be the slightest bit surprised to hear of other VFOs with zero (you should be so lucky) or negative TC. Even if my design works, it might not be applicable to anybody else's VFO. It might make a decent base for tweaking, and a slight variation can give a negative TC instead of positive.

> If your local line varies (lights blink) enough to produce  
> PTO shift, I do not know what you can do. Steady state

No, see above, only about 1V. I'd never notice it without the DVM.

> Would you be open to a sand state solution?  
> Could we do a 7 pin plug in replacement for the 5749 tube.

Where's Dr. Jerry when we need him? That's more along his line. I'm going to be exhausted by just the filament regulator.

> If the Can L and C are suppose to set the frequency,  
> How come such a small change if B+ or filament produce so much drift?

It's the filament, not the B+. I think there's a discussion in the RCA Radiotron Designers Handbook. Here's one cause: hotter cathode => more electrons => more charge near the grid => more grid-cathode capacitance. There's also something about space-charge-limited operation vs temperature-limited operation, I don't remember more than that, except that it gets wierd fast. "Frequency-dependent negative capacitance". That book's an eye-opener. Here's another factor: cathode-grid-plate geometry changes slightly with temp, which changes the gain. Maybe the VFO frequency is sensitive to gain.

- > What is, is But why? Do we need to mod the can oven and hold a
- > temperature stability on the L and C? Do we need to move some of the C
- inside the can? Do we need to strap a Zener on the B+ at the tube?
- > Do we need to replace some of the C with more modern temp stable devices?
- > The solid state regulator will hold the filament voltage constant.
- > but we can get drift from other changes (B+, Temp).

I'd rather keep the intrusion level below that. Nobody wants to rewire stuff inside the can, yecch. Remember, if you listen to AM, you don't even care. If you listen to voice over SSB, you care only a little. The stock R-390A is an excellent receiver.

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Date: Thu, 29 Nov 2001 15:12:06 -0800  
From: David Wise <David\_Wise@phoenix.com>  
Subject: RE: [R-390] PTO non-linearity

- > .....trying to get another pto? Any better pto's out there?.....

It's no good. Give it to me :-). Ok, I'll be serious. Nobody else has answered. 13kHz is larger than normal, but not drastic enough to shout "broken". Try the adjustment. If you run out of adjustment range before you get 1MHz in ten turns, you may still be able to save it by going inside and changing the number of turns on the endpoint coil. Couple of other things to ponder. Is it extremely temperature-sensitive? If one of the compensating caps is bad, it would affect the base frequency, the range, and the TC all at the same time. Once you're inside, the shape of the corrector stack should suggest where the ten turns originally started and ended. Is it near that now? Is crud deposited on the coil? That will change its inductance. Is it nonlinear as your subject line suggests? Or merely not quite 10:1 scale? The corrector stack linearity adjustment, while doable, requires much more patience than the Cosmos design.

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Date: Sun, 23 Dec 2001 15:07:27 -0500  
From: James Miller <JamesMiller20@worldnet.att.net>  
Subject: [R-390] MECO?

On the bottom cover of this 390a someone has written in pencil: "PTO Cal 11/5 1986" and the letters "MECO" inside a hand drawn triangle. What/who is MECO? Was that a PTO manufacturer? (The PTO label is missing).

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Date: Tue, 15 Jan 2002 05:01:38 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] R-390 end-point adjustment

- > Hi, have a R-390 non-a with a Collins 70H-2 PTO, with mod.
- >
- > This one is out a bit, and I have attempted to adjust the end point. I have
- > removed the cover from S701. Inside is a hollow, threaded cylinder. The
- > cylinder seems to be threaded inside and out. Slots are cut in the end of
- > the cylinder presumably for screwdriver adjustment.

>  
> I have attempted to rotate this adjustment, but it appears to be locked in  
> position. I used a small mirror to see if there was any other adjustment  
> inside the cylinder or a locking nut. None found.  
>  
> The low point of the PTO (at 000) can be set to 3.455 KHz. The upper end  
> then measures 2.467 KHz.  
>  
> Any ideas? I'd hate to force the adjustment any further without knowing I  
> won't break anything!

If I have the picture right you are messing with the oven adjustment. To adjust the endpoint, one does not remove the cover. The endpoint adjustment is under a screw cap on the upper right hand side of the front of the PTO as you look at the drive shaft. Is this what you are looking at?

---

From: "Bill Smith" <billsmith@ispwest.com>  
Subject: Re: [R-390] R-390 end-point adjustment  
Date: Tue, 15 Jan 2002 08:59:04 -0800

Apparently I was trying to tweak the temperature compensation. Glad I asked first! I have put the set back together, and will find another mini-moment to take a look at it. Along with miniature gear, time seems to have shrunk also. Thanks for the notes, will carefully file them away for the next attack. Noticed also, in tuning around that a couple of spurs have appeared, one near 910 KHz and another at 610 KHz. They are not loud, but doubt they should be there. Thanks again. It is great to work on equipment this complex with an expert eye or two watching over one's shoulder.

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From: "Mike Melland" <w9wis@charter.net>  
Date: Mon, 28 Jan 2002 16:13:14 -0500  
Subject: [R-390] More R-390A Questions...

I've been ringing my "new to me" R-390A out all weekend. I received it last Wednesday.... It's a Motorola, serial number 714 from the 1956 contract.... parts inside have 1955/56 date stamps on them. I noticed that the PTO is a Collins. I have checked over most of the things all of you told me to check and find that the radio works very well indeed. It is very clean inside and the front is also in nice shape.... has all internal covers plus top and bottom as well as tube shields (silver ones) and has what appear to be the original meters. It does not appear to have any modifications at all. Everything appears to work pretty much as it should. I do have a couple of questions that perhaps some of you could answer for me.

How linear is a Collins PTO ? If I calibrate against the calibrator at for example 6.000 MHz and then turn up to 6.900 MHz and re-check against the calibrator It's off about 1.0 to 1.2 kHz high.

If I listen to my local AM station at 1.490 MHz and have the radio set up medium AGC, RF gain up all the way at 10 I read about 80 dB of carrier level and the

audio sounds fine. However if I leave the radio on for several hours and return I notice the audio is distorted. If I then reduce RF gain a bit I hit a point where the audio clears up and is fine. I can then turn up the gain again after a bit and the audio remains fine.... but will eventually distort again. This seems to happen only on this very strong very local signal and in the 4,8 and 16 kHz filter positions. MGC appears to work normally. Is this overload when in AGC ? Is it normal ? What would be likely to fix this if it's a problem ? BTW.... I was checking Chuck's procedure for adjusting IF gain. What is meant by "terminate antenna" ? If I put it into a 50 ohm Bird load I hear nor see any receiver noise.... perhaps it means tune to 15.2 MHz with the antenna hooked up to hear background noise ? At any rate, the carrier needle on mine using the antenna hooked to a dead spot around 15.2 pins to the right when using the procedure to check the IF gain.... could that be part of the cause of the distortion when listening to a very strong signal in AGC if the gain is in fact set too high ?

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Date: Mon, 28 Jan 2002 17:23:24 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] More R-390A Questions...

There are two main modes of PTO error.

- A) non-linear error
- B) endpoint error

If a PTO is non-linear (it can happen) a graph of the output vs dial reading would not be a straight line (within 200 hz at ea 100 kcs checkpoint). If the PTO endpoint is off (very common to be "long") it has an output of other than the proper 1000 kcs in ten turns of the pto shaft. The PTO should have an output of 3.455 kcs at 000 on the dial and 2.455 kcs tens turns higher than 000. Yours is requiring more than ten turns to achieve the 1000 kcs of full output. While not a major problem, it can harm sensitivity on the low bands as this can be a significant percentage out of tune when it is supposed to be joined at the hip with the RF deck and the variable IF's (less of a problem on the higher bands). It can also be a tuning hassle, and after all if you fiddle with 390's at all this has to be right!

The endpoint adjustment is under a screw behind the transformer on the PTO. Turn it to the right to get more output is ten turns. It may also be nonlinear, but fix the endpoint first and then regroup. You should have a manual handy when attempting this.

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Date: Sun, 7 Apr 2002 07:54:14 -0700 (PDT)  
From: "Tom M." <courir26@yahoo.com>  
Subject: [R-390] 51J-3 PTO AGC Audio Fun

Gentlemen? I went back in to the 51J-3 PTO this weekend after setting it properly in 1996. It was 4 kcs in the usual direction (I've been admonished for calling it "long" so I'll refer to it as the "usual direction" from now on to avoid confusion). This was on 120V supply. One turn of the endpoint screw remedied the 4kcs endpoint problem exactly (I'll tell you tomorrow what the new endpoint error is

after it drifts overnight).

This radio exhibits endpoint deltas with differing supply voltages. The OA2 regulator is regulating, so I'm not sure if this is just my radio, or a 51J-3 thing. I also slowed down the AGC (thanks group for the tips) by jumping the 0.1 uF C205B with an additional 0.5 uF to ground. This slowed the AGC down, and the S meter no longer pegs upon switch-on (but when going from stand by to on, I get an alarming arc in the on/off switch!! Yikes, what is that? Charging of the new caps?). Also did an audio mod by uping coupling caps C209 and C211 from 0.01 to 0.1 uF. C209 is behind the front panel, which I had access to from the PTO work, but otherwise this would be a P.I.T.A. to change. Audio is a little better. In all, fun work on the 390's light weight brother. The 51J is a fine receiver IMHO.

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Date: Sun, 07 Apr 2002 19:41:31 -0500  
From: Francesco Ledda <frledda@attbi.com>  
Subject: [R-390] R-392 Dubrow PTO endpoint

All, I am struggling with a Dubrow PTO for my 392. The endpoint is about 3 kHz off, and I am at the limit with the coil adjustment. Any suggestions?

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Date: Mon, 8 Apr 2002 05:56:43 -0700 (PDT)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] R-392 Dubrow PTO endpoint

I've never worked on a Dubrow, but I think it is the same as a Collins. This is a very common problem. One author wrote that this mod is not worth doing, but I can't disagree more. What you'll need to do is remove the cover, find the PTO endpoint adjusting coil, and remove one turn from it, and then start over. I find on some PTO's that it is easier to make a new coil than to trim the old (Cosmos in particular), but that will be your call. This will keep you in business for the news 30 years or so.

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From: David Wise <David\_Wise@Phoenix.com>  
Subject: RE: [R-390] R-392 Dubrow PTO endpoint  
Date: Mon, 8 Apr 2002 10:38:05 -0700

> What you'll need to do is remove the cover, find the PTO endpoint adjusting  
> coil, and remove one turn from it, and then start over. The endpoint is about 3  
>kHz off, and I am at the limit with the coil adjustment.

Unlike most of the tuning slugs I've turned over the years, the R-390A's PTO slug seems to lose permeability over time. (Usually I see them gain.) When you tune a PTO down in oscillator frequency, you are changing the coil from an air-core coil to an iron-core one. With a slug that's less permeable than it's supposed to be, this changes the coil inductance less than it should, giving you a smaller than expected frequency spread\*.

The spread is trimmed by the endpoint coil, which is in series with the main one. Their inductances add. The endpoint coil has the largest effect when its



inductance is the largest-possible fraction of the total. When is this? At 3455 (i.e. dial 0), because the main coil is at minimum. (This is analogous to the more common capacitive tuning scheme, with a trimmer in parallel with the main cap.) The subnormal inductance spread of the main coil dictates a small endpoint inductance. That's why you remove a turn instead of adding one.

It might also be possible to restore the spread by changing the size of the tank capacitor. To get a 3.455:2.455 frequency spread, the inductance has to change over a 1.9806 ratio ( $3.455/2.455$ , squared). For any given frequency, a larger capacitance dictates a smaller inductance, which is achieved by translating the slug's 10-turn range in a direction away from the coil. With the inductance tending towards smaller values, the max/min ratio would be larger and you'd get a larger frequency spread, which is what you want.

I HAVE NOT TRIED THIS. The straight-line-frequency variable pitch of the R-390\* PTO coil may throw my reasoning out the window. But since you're already hacking, it's less intrusive to tack on a cap than to chop a coil. Note that with the main slug in a different relation to its coil, you will have to do the dreaded linearity calibration. But the slug has already changed (that's why you ran out of endpoint), so you might need to anyway. Take a linearity reading, add a cap, read again.

Note also that the Temperature Coefficient of the added cap is important, but don't freak out. My PTO turned out to pretty far off, which means that yours might be too. It's not surprising; if a slug changes permeability, why not TC? Experiment with different TCs until you get satisfactory overall stability.

\* It seems to be accepted jargon here to call this "long", but as I mentioned to Tom, it makes me flinch, because I've always compared the electrical spread to a 10-turn mechanical baseline. The electrical spread is "short". If instead you take 1000KC as the baseline, you have to turn the dial "long"er than 10 turns. Say what you like; I'm going to footnote my usage from now on

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From: David Wise <David\_Wise@Phoenix.com>  
Subject: RE: [R-390] 51J-3 PTO AGC Audio Fun  
Date: Mon, 8 Apr 2002 12:13:46 -0700

I hope I didn't come across as the Endpoint Terminology Police. I only meant to express a preference, and I understand that everyone's used to what they're used to. I chuckled at your coinage of "usual direction". If we had a FAQ, that would fit in just fine. Maybe it should be capitalized, like the Usual Suspects.

> This radio exhibits endpoint deltas with differing supply voltages. The OA2  
> regulator is regulating, so I'm not sure if this is just my radio, or a 51J-3  
> thing.

It's probably related to oscillator heater temperature. We all know that the freq can drift if the temperature changes. It never occurred to me that the \*spread\* could change, but it makes as much sense. That puts the last nail in the coffin of my

attempt to linearize PTO warmup by controlling heater current. Speaking of which, I suppose you could rig a filament regulator a la R-390A Solid-State Ballast.

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From: David Wise <David\_Wise@Phoenix.com>  
Subject: RE: [R-390] 390A help...  
Date: Mon, 15 Apr 2002 13:36:38 -0700

<snip>.....it doesn't work on the first part of ANY MHz, say about the first 80/120 KHz, then when you go over this point it start to work... If we increase a bit the AC voltage power on the Variac, this receiver starts to work after the first 60 KHz (instead of first 80/120 KHz).....

My main guess is the VFO. First, here is a simple test. This will tell whether it is the VFO, or something else.

1. Put a second shortwave radio with antenna near V701.
2. Tune the second radio to 2455.
3. Tune the R-390A KC dial to +000.  
The second radio should "hear" the R-390A's VFO.
4. Tune the second radio to 3455.
5. Tune the R-390A KC to 000. The second radio should hear the R-390A again.  
If it does not, the troubles definitely the VFO, and you can concentrate on it.

You could also do the Oscillator Injection Voltage tests from the R-390A manual, section 5.5.3 . If you have found that the VFO is bad, test V701. If it's ok, measure the voltages on V701. If RT510 is a 3TF7 as it should be, V701 heater should be 6.3VAC. Plate should be around 200, and screen grid should be around 60. Let us know how it goes, Dave Wise

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From: G4GJL@aol.com  
Date: Tue, 16 Apr 2002 17:35:58 EDT  
Subject: Re: [R-390] 390A help...

I had the same problem...the key is that the fault is on every band. The most likely cause is the PTO running out of sufficient feedback to maintain oscillation. In my case the problem was cured simply by changing the PTO tube for a newer one with higher emission. Dont use brand new / NOS as these tend to drift more. Swap with one from the IF strip, and put the newer bottle in the IF. An alternative problem could be a capacitor in the PTO feedback circuit, but as I dont have the precise circuit schema to hand I will leave it to others to pick up on this part. Try the tube first, its 95% odds on that!

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Date: Tue, 21 May 2002 12:44:28 -0700 (PDT)  
From: "KC8OPP Roger S." <kc8opp@yahoo.com>  
Subject: [R-390] PTO....Coming and Going

Hope that one of the learned masses can help with this PTO. I have a Collins 70H-2 PTO in an R-390 (real radio). It stopped working last week, so out of the

rack and on the bench it went. New tube and it is back in operation, so decided to check the end points. With just a bit of tweaking I was able to get 3455.247KHz at 000, and 2455.009 at +000. When I checked the 100KHz points from 000 to +000 the values were all over the place, as much as 1.998KHz high but when I checked it starting at +000 and going to 000 the freq was never more that 243 Hz out of bounds. The problem seems to be connected to the corrector stack and cam follower some how catching and hanging up when going from 000 to +000. Maybe I should just sneak up on all of the frequencies from the top down. Anyone have any words of wisdom? Any cautions about adjusting the corrector stack? What lubricant (if any) should I use on the lead screw and corrector stack? And finally, how do you get all of that fiberglass insulation back in the can?!!! Thanks for your comments in advance. Roger

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Date: Tue, 21 May 2002 16:39:46 -0400  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] PTO....Coming and Going

Disassemble your PTO and lubricate it.

>Any cautions about adjusting the corrector stack?

Before you adjust the corrector stack, you should find or make a jig to do the job. I know of only one person on the planet who has one. That is Howard Mills. You may not have to adjust the corrector stack if you get good linearity in one direction. You need lubrication first, I think.

> What lubricant (if any) should I use on the lead screw and corrector stack?

See any of the articles that have been written on the topic.. The little roller is important I suggest you clean that, then add lubrication. Molybdenum Disulfide grease may be best.

> And finally, how do you get all of that fiberglass insulation back in the can?!!!

Wrap the inner can and the insulation with a piece of plastic, such as an overhead projector slide, or clear notebook cover from the office supply store.. squeeze the insulation down flat.. use rubber bands to hold it tight. then slip the cans together and then withdraw the plastic. Slits lengthwise in the plastic may help get it out around the tubes and framework.

Check your OVENS switch is OFF.

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From: "Jim Temple" <jetemp@insightbb.com>  
Date: Sun, 23 Jun 2002 14:29:44 -0400  
Subject: [R-390] R-390-A fix summary

Recently, the bottom 350khz of ALL bands were found to be dead. Tuning to a point below 350khz produced an abrupt loss of signal. I confirmed that the symptoms were present above and below 8mhz, and within all the band groups

defined from the coil and RF deck positions. The likely suspect seemed to be the PTO, so I put the frequency counter on the output and confirmed that the frequency abruptly disappeared below about 350khz. I replaced the PTO tube, the symptoms disappeared, and the unit now works perfectly. Of course I will recheck the alignment after the tube burns in for awhile. For the newbies on the list, I hope this might be helpful in the future.

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From: krk@ix.netcom.com  
Date: Sun, 23 Jun 2002 11:44:30 -0700  
Subject: [R-390] Re: R-390-A fix summary

Hi Jim, Thanks for your post on this topic. I'm curious about why you replaced the tube. Did you test the PTO tube and find it bad? Or does it test good but fail in the receiver (I hate those kinds of problems)? I ask because I have a URM25F signal generator that behaves similar to your 390. n

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From: "Jim Temple" <jetemp@insightbb.com>  
Date: Sun, 23 Jun 2002 15:39:39 -0400  
Subject: [R-390] Re: R-390-A fix summary

I received a couple of very insightful questions.

1. Did I test the tube prior to replacement?

No, but I just tested the first tube on my Hickok 600A. The chart recommended 3300Gm. The first tube measured 2300Gm. The replacement tube measured well above 3300Gm.

2. Did I try to adjust Z-702 prior to replacement? (Suggesting that Z-702 will shift the effective distribution of the tube output in the center of the proper range, if it was originally out of range).

No I did not attempt to adjust Z-702. Perhaps the tube did not actually need replacing if the Z-702 range was off center?? I intended, but forgot, to ask the list what the purpose of Z-702 is, since I can not find an explanation in any of the pertinent manuals.

Question... The above response to my original post suggests that Z-702 shifts the effective range of the PTO 5749 tube to a position that is more centered, if it was off center in the first place. Is this a correct assumption of the purpose of Z-702??

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From: "scott" <polaraligned@earthlink.net>  
Date: Mon, 26 Aug 2002 20:33:39 -0400  
Subject: [R-390] PTO

I dropped the front panel and set the endpoints through the access hole to within 50 HZ. The linearity is not so close. It is 530 Hz off at 250 on the KHZ dial, 600 off at 500 on the KHZ dial and 60 HZ off at 750 Khz on the dial. Is it worth messing with the linearity?? or is this pretty good. It is a Dubrow PTO.

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From: "Al Parker" <anchor@ec.rr.com>  
Subject: Re: [R-390] PTO  
Date: Mon, 26 Aug 2002 21:10:34 -0400

If I got one that close, I sure wouldn't mess with the linearity stuff, I'd probably make it worse, and get real frustrated in the process. I think one of the guys I pal with at Shelby 'fest, who's into 390's real deep, had tried it once upon a time, I don't remember now what he said about it. I've been into a coupla the smaller, R-388 PTO's, I wouldn't try it there. I know there's a coupla systems.

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Date: Sat, 31 Aug 2002 15:48:59 +0000  
From: Philip B Atchley <ko6bb@juno.com>  
Subject: [R-390] Collins PTO Set.

After advice from a couple folks I decided to leave the Collins PTO in this 67EAC that I'm fixing up. I was a little concerned about it because the end point was so far off (over 6kHz). However, it came in nicely. The hardest part of the entire job was getting that cap screw back into place! It kept wanting to land "upside down" and there wasn't enough room to hold it with my small seizers while starting it.

1. End point adjusted to less than 50Hz error end to end (I had a long skinny screwdriver that let me adjust it without removing front panel).
2. Linearity "worst case" is about 600Hz in the 600kHz area. I think the book says it should be under 500Hz. IS THIS TYPICAL FOR A COLLINS PTO? I can (will have to) live with it in any case.

Next step is to "Select in test" Crystals between the two sets to try to get a "closest match" band to band(Don said I could). THEN I'll start on the slug rack alignment!

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From: Llqpt@aol.com  
Date: Sat, 31 Aug 2002 13:12:47 EDT  
Subject: Re: [R-390] Collins PTO Set.

> 2. Linearity "worst case" is about 600Hz in the 600kHz area. I think  
>the book says it should be under 500Hz. IS THIS TYPICAL FOR A COLLINS  
>PTO? I can (will have to) live with it in any case. >>

Specifications say 300 hz..... but, close enough I'd say. If it is 50 hz end to end, the problem is more than likely a x-tal Phil.

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From: DJED1@aol.com  
Date: Sun, 1 Sep 2002 10:54:21 EDT  
Subject: [R-390] R-390 PTO calibration

The recent mail on adjusting end points reminded me of the specifications I've got, which give some insight into how the radio should perform: The original specs (for the R-390 circa August 1950) called for a readout accuracy of 500

cycles over the whole tuning range, and 200 cps after calibration at the nearest 100 Kc point. This was astounding for that day, and apparently too ambitious. A later spec, presumably done after they had built a few radios, called for 300 cps accuracy after calibration at the nearest 100 Kc point. Interestingly, the end points were allowed to be -1400 cps or +200 cps at the top of the readout, after setting the bottom at zero. Also, a separate tolerance for band change (4 Kc) was included. So if you're getting linearity of a few hundred cps across the entire range, you're doing good. I don't know how well the units with the calibrator stacks hold up. I did adjust one of the Cosmos units to be good to 300 cps over the entire range. I recall I had to allow the end points to be off in order to get no more than 300 cps error over all 42 measurements at 25 Kc spacing. Ed

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Date: Wed, 4 Sep 2002 18:18:52 +0000  
From: Philip B Atchley <ko6bb@juno.com>  
Subject: [R-390] Cosmos PTO question

Well, I still have Dons R-390A on the test bench being worked on. This is the receiver that has the Cosmos PTO. As it turns out this sucker has the endpoint out by about 11kHz, and I thought the 6kHz on my Collins PTO was terrible before I corrected it! Anyway, I read through the Cosmos setup that I downloaded and it looks like a REAL pain in the rump to align. I 'thought' that there might be an endpoint adjustment separate from the linearity adjustments and so removed the cap screw. Apparently this is NOT the case. But I'll ask anyway. QUESTION: Is there a way to set up the endpoints separate from the linearity adjustments?

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Date: Wed, 04 Sep 2002 17:33:38 -0400  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] Cosmos PTO question

Below is an earlier post from Tom Marcotte which indicates that changing the turns on the corrector inductor, or making a new inductor is the thing to do. I suspect that getting the thing out of the case and locating some wire the right size is the hardest part of this procedure. (Apparently the corrector disk runs the slug of the corrector inductor in and out as the thing goes through its range.)

Tom may well have a response.

If you are loathe to take the thing apart, email me. I might be talked into working on it for you. Roy Who recently got an unused Cosmos.

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Date: Wed, 4 Sep 2002 14:39:06 -0700 (PDT)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] Cosmos PTO question

Yes, the Cosmos has two caps, one for linearity and one for endpoint. When looking at the front of the PTO, the cap to the left gives access to linearity. Behind the transformer you'll find the cap on the right. Under this cap will be a screw that adjusts endpoint. You do this one first, however 11 kcs will require removal of a turn from the endpoint adjustment coil. This will require opening of the PTO to get

at the coil. Last time I did this I just made a new coil with one less turn and replaced the old one with the new. After removing a turn, the PTO should have new life and you'll be able to get 1000 kcs in ten turns. The thing will drift in a predictable direction (I'll avoid the use of words like "long" and "short" because this list has long and short word police, equally rabid about "their word" :-)

What I do is give the thing about 1000.5 to 1001 kcs in ten turns to avoid having to go back in there within the next 12 months. One extra kcs should last you a few years, after which the thing should be right on the money (like a stopped watch I guess!).

Linearity adjustment is a whole other project. You can pull down some instructions from Chuck Rippel's website.

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Date: Wed, 04 Sep 2002 16:12:37 -0700  
From: Dan Merz <djmerz@3-cities.com>  
Subject: Re: [R-390] Cosmos PTO question

Phil, I did the "remove a turn" thing on my Cosmos pto per the description by Tom. Getting into the unit was pretty straightforward after looking at the nice pics that were posted by Jim Miller N4BE of the innards. I removed 1 turn and brought a 10 khz error down to within 1 or 2 khz, which was good enough for me. I haven't had any problems with the pto, though I haven't really checked it carefully since, Dan.

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Date: Thu, 5 Sep 2002 00:59:44 +0000  
From: Philip B Atchley <ko6bb@juno.com>  
Subject: [R-390] Thanks all (Cosmos PTO).

A big thank you to all who had suggestions for the Cosmos setup. There is a lot of knowledge on this list.

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Date: Thu, 5 Sep 2002 00:57:23 +0000  
From: Philip B Atchley <ko6bb@juno.com>  
Subject: [R-390] I'm a lucky fellow! (Cosmos PTO)

Earlier I posted a question about a Cosmos PTO that is in a receiver I'm fixing up for another ham (couldn't find the end point screw). Any-hoo.... After posting the question and before any answers came in I did finally find a reference to said adjustment. These old eyes aren't what they used to be and I missed it when I examined the PTO (and the cap screw was missing too). This PTO was over 11kHz "wide" and general consensus was that I'd probably have to remove a turn of wire. Having to "remove" the PTO to get to the end point adjustment with anything that I had (Jewelers screwdriver) I decided to give it a shot anyway. I turned the screw 3/4 turn anticlockwise (same direction I had to turn the one on my Collins PTO). That made things worse, so I pulled the PTO, gave the screw about 2 3/4 turns clockwise, slapped the unit in and it's GOOD TO GO!! Yes, linearity could be a little better but "what the hey"?

Here are the readings I got when I "Zeroed" the PTO at 10000 kHz.

10000.0  
10099.4  
10200.5  
10300.0  
10400.0  
10500.2  
10600.4  
10700.5  
10800.4  
10900.5  
10000.4

Needless to say I didn't pull it out again. As I said, I'M A LUCKY FELLOW

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Date: Mon, 4 Nov 2002 05:08:00 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: [R-390] PTO Doesn't "O"

The PTO on my 51J-3 has gone kaput. I've checked the tubes, its getting filament and good B+ from the OA2 but still no output. I get nothing on the freq counter at the PTO output where I ustacould. The radio makes all the proper noises other than those you would associate with PTO operation (like zero beat with cal). Before I dive into the innards, does anyone has a list of common failures in these PTO's?

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From: "Dan Martin" <dmartin@visuallink.com>  
Subject: Re: [R-390] PTO Doesn't "O"  
Date: Mon, 4 Nov 2002 19:20:31 -0500

Tom: I seem to remember Howard Mills >always< preemptively replaces some component (a cap or two?) inside J-series PTO's whenever he does his famous rebuilds, likely to avoid the very thing that has happened to you. I cannot recall details but I've cc'd him on this message in hopes he might respond.

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Date: Sun, 17 Nov 2002 14:33:09 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: [R-390] More 51J-3 PTO Fun

Gentlemen? Last week I reported that my PTO doesn't "O." I found that the PTO was missing its bypass caps (I went in to replace them and they were gone)." The unit actually had a crude solder job done on the cover so I smelled a rat. When it worked, it also had the freq vary with operating voltage, so I figured a kluge was in there somewhere. Still not sure what is wrong with it, but since it acted funny all along and now did not work at all, I went to the parts bin for a spare.

The spare had a s.n. of > 9000, and the circuit cover was screwed down instead



of soldered down, a great improvement. I went into the spare and replaced the bypass caps (which were set up differently than the schematic, not sure why) and then powered it up. The endpoint was 15 kcs long (or is it short?), anyway, in the usual direction.

I tried the one turn removal trick and this did not do the job. Still 9 Kcs out. For the first time I had to remove two turns to bring it in. This worked, but of course the adjustment range is very skinny (since the adjustment coil is almost gone). Anyway, the PTO is in the oven right now getting Hurricane Lili baked out of it (eat cereal for supper, this is important!).

This is all very difficult to explain to the neighbor why I'm doing this for a radio to listen to in the shop.

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Date: Thu, 26 Dec 2002 22:27:00 -0500  
From: "Jim M." <jamesmiller20@worldnet.att.net>  
Subject: [R-390] Adjusting Linearity Stack Collins PTO

I am looking for instructions for adjusting the linearity stack in a Collins PTO. I have the PTO in an external jog now with a frequency counter and a calibrated scale and have the end points pretty close, but there is still 1-2 khz error midpoint. I suspect the stack needs adjusting. It seems to be connected to a large screw that is accessible from the rear of the PTO (after opening it. Any info out there?

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From: "Jerry Kincade" <w5kp@direcway.com>  
Subject: Re: [R-390] Adjusting Linearity Stack Collins PTO  
Date: Fri, 27 Dec 2002 06:16:22 -0600

Start here <http://www.r390a.com/> and branch out from there. More info than most brains can absorb is available on this subject, including in the list archives.

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Subject: RE: [R-390] Adjusting Linearity Stack Collins PTO  
Date: Fri, 27 Dec 2002 12:09:46 -0800  
From: "David Wise" <David\_Wise@Phoenix.com>

I've done one. Start by taking data points, expected vs actual every 25kHz. If you have enough visual acuity (or a good lighted magnifier), pick a starting point that puts the rider exactly on top of one stack element (I call them "chips"). Turn these data points into a graph of actual freq divided by expected freq. If you have the endpoints set, the graph will intersect 1.0 at each end. Ideally, it will be a horizontal line. It won't be!

However, if it's a smooth curve, you may be able to avoid the tedium of adjusting the stack. Trimming the shunt capacitors will bow the curve up or down. Sorry, I can't remember which is which, just try it both ways. Each time, you'll have to redo the endpoints, but for the first few tries the only other data you need will be at midpoint. When it's close to 1.0, do a full run to see the residual error. If it's small enough, smile! Then get ready to fix up the temperature coefficient you changed when you added or subtracted capacitance. By the way, the originals may not be

all that good today even if they were spot-on in 1954. It's possible to calculate the required tempco based on the percent change in capacitance you've perpetrated, but I found that it doesn't match experimental results very well. Cut and try. Don't forget that low VFO tempco isn't the goal, it's low overall tempco. Your crystals have tempcos too.

All this doesn't matter much if you're one of those hardheads who run 24x7, but if you aren't, warmup drift is just another annoyance you can do something about. I wound up removing the small caps entirely and substituting a pair of trimmers, one NPO, the other N750. By adjusting them suitably, you can get any capacitance at any tempco. (Within physical possibility, of course. Darn language lawyers!) To check system tempco, I focused a tv camera on a frequency meter, and fed the video to a VCR with a six-hour tape. After the run, I'd fast-forward through the tape writing down readings. Frequent readings at the beginning, spacing further and further apart as the radio stabilized. I got it down to around 100Hz total (down from around 800Hz), but I suspect that this could only be maintained if you ran the radio on a schedule. If you leave it for a week or so, it's off until it's been run a few times again.

Assuming you've read this far :- ) the actual stack adjustment is simple in concept but IMHO one of those skills you have to apprentice for. The nuances can't be described. The basic motion is to loosen the hold-down screw which compresses the stack. With the pressure released, the chips can be slid up and down. You move the appropriate chips what you think are the appropriate amounts, close her up, and take your 40 data points again. Adjacent chips interact, and there's a mechanical limit to the amount of change possible between them. If you set a couple on a steep slope or try to move one without moving the others, you'll see what I mean. It reminds me a lot of adjusting the delay line on a 53x-54x series Tektronix oscilloscope.

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Date: Fri, 27 Dec 2002 18:00:45 -0500  
From: Dave or Debbie Metz <metzd@intelos.net>  
Subject: Re: [R-390] Adjusting Linearity Stack Collins PTO

Right you are on the difference between Collins and Cosmos.

A long time ago, I tried it and had limited success on a PTO that was out 6-8 kc with a procedure that went something like this:

Take a junker PTO and cut a slit in the inner can above the camstack about a 1/4" wide to allow you to insert a piece of insulated something to push on the cam stack just above the roller. Then, adjust the tightening screw so that you can move the stack. First, you need to find the worst offset from end to end such that you are only going to push the stack down to either increase or decrease the freq. ( could never quite figure out the way to pull the stack up to go the opposite direction in frequency.) Then mount the pto into the receiver with only the inner slotted can and push down at each 25khz increment to either raise (or lower, I cannot remember). the freq to the desired freq. I only used the inner can with the slit. This creates a bit of a problem because you have no rear mount so you have

to brace it somehow. You should "T" in a counter to measure the freq with a counter. Remembering the PTO goes from 2.455--3.455 inversely as the freq is ascending you need to set up a chart to know what is the desired PTO freq @ each 25khz indicated.

I am sorry for the lack of detail but it's been a few years and I forgot the details. I am sure there must be a better way. However, I was not able to figure a way to adjust the camstack short of pulling the PTO hundreds of times with a trial and error method. I seriously doubt that Collins did anything trial and error. I am so in awe of the engineering of this setup. What a sophisticated way to linearize a very delicate oscillator.

I know that there has been a lot of talk about the PTO manufacturers here on the list but a long time ago I had a conversation with Paul Zechinno at Mil Spec Communications, (Not Rick Mish) and he was less than complimentary on Cosmos compared to the Collins PTO's. He had years of experience with these and felt that the Cosmos was probably fine when it left the factory but would not weather the years like the Collins units in the non A 390's.

However, bottom line: Don't do it! If you have a PTO within one or two KC, you have NO problem. It never was perfect and I doubt seriously that you can achieve anything better.

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Date: Fri, 27 Dec 2002 23:05:11 -0500  
From: "Jim M." <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Adjusting Linearity Stack Collins PTO

Thanks much to all for the discussion of corrector stack adjustment on the Collins PTO. It sounds formidable, but worth a try. I wonder what would be the effect of just leaving the can off the PTO during adjustment. Does the proximity of the can change the adjustment enough to worry about? I have linearized a Cosmos PTO quite nicely before...it's adjustment concept is a good one, it can all be done with the unit sealed, and it comes out very linear indeed. Cosmos seems to have taken a bad rap, but it does work well in my opinion. This Collins PTO looks like a chore, but I want to keep my latest "Collins" 390a "all Collins", so I will go for it and see what happens!

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From: "Bill Smith" <billsmith@ispwest.com>  
Subject: Re: [R-390] Adjusting Linearity Stack Collins PTO  
Date: Sat, 28 Dec 2002 12:09:31 -0800

Has anyone tried this?

1. Set up a spread sheet with a list of frequency entries every 50 kHz.  
(nominal) from 3.455-2.455 mHz
2. Rotate the PTO from one frequency end to the other. At mechanical 50 kHz intervals, using a counter, document the measured PTO frequency.

3. Remove the cover.
4. Repeat step 2, above with the cover off.
5. Subtract the frequency differences steps 2 and 4 for each measurement in the list. The result should be the error due to capacitance contributed by the cover if this scheme is to have any merit.
6. Add (subtract) each result obtained in step 5 to each frequency in step  
This list becomes the calibration standard for the PTO.
7. Calibrate (adjust) the PTO at each mechanical 50kHz stop to the frequencies obtained in step This is a predicted error + frequency so that when the cover is replaced, the error will be compensated by the cover.
8. Replace the cover. If the calculated error values are correct, the PTO should now be linear. Hopefully you won't have to go through a second calibration cycle.

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Date: Sat, 28 Dec 2002 16:00:28 -0500  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] Adjusting Linearity Stack Collins PTO

Having spent most of the last 20 years doing this sort of thing there is one other item to worry about. The inductance of the coil will change when you put the cover on it. It doesn't change a lot but it will change enough to notice. I doubt that it will have a major affect but you will see it throw things off a bit. The bottom line is that there is no easy way to set up a PTO. The people who built the radios still remembered that as being the worst job on the entire line 20 years after the last radio shipped .....

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Date: Sat, 28 Dec 2002 16:53:31 -0500  
From: "Jim M." <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Adjusting Linearity Stack Collins PTO

I like this spreadsheet idea! I already have an Excel spreadsheet from when I did my Cosmos PTO last year. It shows the expected frequency output at each quarter revolution. Think I will do this for the Collins, once I muster enough umph to get started. I also have a wooden test jig I made where the PTO mounts and a large calibrated wheel (a circular scale from a PDF file I downloaded from another site). This is how I know how much it is off. I will try to take some digital pics. and post them as I go. Thanks to all the replies here I think I can get started. We'll see how it goes. Stay tuned. 73 Jim N4BE

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From: DJED1@aol.com  
Date: Mon, 30 Dec 2002 10:18:47 EST  
Subject: [R-390] Cosmos PTO

That last thread on PTOs got me going on mine. A couple of years ago I replaced the Progressitron with a rebuilt Cosmos, and aligned the Cosmos at that time.

Over the years it had been gradually shifting, to where some points were a Kc off. I pulled the radio and went through the alignment again and was very happy with the results. I haven't set up a jig for alignment, so I use a small screwdriver to adjust the 42 little screws with the PTO in place. I found this time that I could set each 25 Kc point to within 200 cycles, and that they didn't interact significantly. I set the end points, then did the fine adjustment. The result is that I got the PTO to track to 2-300 cycles over the entire range. I just need to calibrate once for each band now. The ability to "easily" align the PTO is a significant advantage for the Cosmos PTO. It took about 5 hours to do the adjustment, with most of the time being spent getting the little screwdriver into the appropriate screw slot!

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Date: Mon, 30 Dec 2002 08:22:57 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] Cosmos PTO

I find that the most important thing to do to avoid interaction between the points is to insure that the screw being adjusted is directly above the coil/plunger. This will not necessarily be at an even 25kcs point (unless you start from scratch and make it so with numerous iterations).

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From: "Tom Warren" <wwarren1@nc.rr.com>  
Date: Thu, 2 Jan 2003 07:12:10 -0500  
Subject: [R-390] Field Change No. 7, R390A

Anybody got clues to the intended and non-intended effects of Field Change No. 7 to the R390A? This is the change where R702 (screen resistor on the PTO) and R210 (screen resistor on the 1st crystal oscillator) are changed from 56K to 220K, presumably to reduce radiation to the outside world (so the enemy can't listen for your PTO freq or your 1st oscillator freq and then bomb in that direction). My guess is that the first consequence is to reduce the output level of each of those oscillators. Secondly, there may be some harmonic reduction from each of those oscillators. However, what else happens? That is, is the sensitivity of the receiver or the intermod performance reduced by the modifications? Also is the birdy response affected by the modifications (e.g., less harmonic output from those oscillators leads to fewer internal mixer products). Any other effects that folks have definitely found?

My reason for asking is that I'm working on a Motorola PTO with the 56K screen resistor and a later Cosmos PTO with the 220K screen resistor and wondering if I ought not to "re-convert" the Cosmos PTO to have a 56K screen resistor. R701, R702, and R703 are out of spec on the Cosmos anyhow, so I will probably change them out, but if a better choice for R702 is 56K considering that I'm not worried about the enemy direction finding on my oscillator outputs, then maybe that's what I ought to do. For Tom Bridgers and Al Parker, yes, the Motorola PTO is from the Charlie Taylor (hello Charlie, if you're out there) 390A. AND I'VE GOT THE CHARLIE R390A MOSTLY WORKING. HOORAY AFTER ABOUT TWO YEARS.

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Date: Thu, 02 Jan 2003 10:26:39 -0500

From: "Jim M." <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Field Change No. 7, R390A

I installed the mod. to my R-390a last year to see what would happen. I found that it decreased the sensitivity noticeably. By that I mean that a 40 dB test signal now read 30 dB on the carrier meter. Not an exact test but it was enough to convince me to remove the mod. I did not look at the more esoteric effects such as harmonics or spurs. I like a "hot" receiver. If it were me, I would remove the mod and go back to the original values. Jim N4BE

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Date: Thu, 02 Jan 2003 11:39:46 -0500  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] Field Change No. 7, R390A

Did you try adjusting the IF gain after you put in the mod ? On most 390's the IF gain adjust has far more range than you would ever need. The most sensitive point on the IF gain is not the full gain position on the pot. It took me quite a while to prove that to myself ....

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Subject: RE: [R-390] Field Change No. 7, R390A  
Date: Thu, 2 Jan 2003 09:49:19 -0800  
From: "David Wise" <David\_Wise@Phoenix.com>

I also installed FC7, and like Jim found that it decreased the sensitivity, even after adjustment of the IF gain for maximum S/N. I removed it. If I acquired a radio or module that had it, I would remove it. We've never found the original documentation explaining the reason for FC7. After some thought about the target ("radios in supplemental spaces"), I believe it was meant for less-important R-390As so they wouldn't interfere with more-important ones. It obviously does not apply :-)

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From: "Al Parker" <anchor@ec.rr.com>  
Subject: Re: [R-390] Field Change No. 7, R390A  
Date: Thu, 2 Jan 2003 13:13:07 -0500

Well, I'm glad it's "mostly working." I know you've been at it for a long time. My Motorola 390A is also mostly working, sitting up on end on the bench, being listened to some, awaiting some real attention. I guess, being Motorola, the PTO probably doesn't have FC7, a good thing, from others' comments. Will be waiting for some more pix of yours, completed, at Shelby. I've been working on SP-600's lately, just finished one for a friend, got another for myself in payment.

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Date: Thu, 02 Jan 2003 14:46:30 -0500  
From: "Jim M." <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Field Change No. 7, R390A

"Radios in supplemental spaces" is probably spook-speak for classified listening posts. They (whoever "they" are) would want to reduce any local oscillator or PTO signal emissions that could be intercepted by an enemy in order to deduce

the frequencies being monitored. I suspect the screen resistor changes helped reduce oscillator output. Alternatively, it was to reduce their output to prevent interference with other receivers.

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Date: Thu, 02 Jan 2003 17:35:16 -0500  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] Field Change No. 7, R390A

On the last go around on this one the "supplemental spaces" came out to operating next to VHF / UHF radios. Apparently the R-390's would take off and knock out the WSC-3's or some such thing.

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From: "Larry and Jody Cogan" <woodrat@citynet.net>  
Date: Mon, 6 Jan 2003 18:48:09 -0500  
Subject: [R-390] Installing replacement PTO

I have just acquired a replacement Cosmos PTO. I have no real information about it, other than it "was removed from a working receiver". Is there a mechanical way to determine if it is set at (or near) 2455 khz? The oldham coupler on the PTO was "unrestrained", i.e., not taped to prevent rotation, etc.

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From: "polaraligned" <polaraligned@earthlink.net>  
Subject: Re: [R-390] Installing replacement PTO  
Date: Mon, 6 Jan 2003 19:06:07 -0500

Forget it. You are going to have to put it in the radio and set it. Even if I set my PTO at a certain value and shipped it to you it would not be aligned to your set. It is very easy to do with a frequency counter, but in a bind you can set the PTO by shooting for maximum output when tuned to a local station. See the Y2K manual for setup instructions.

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Date: Mon, 6 Jan 2003 16:15:54 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] Installing replacement PTO

You are wise to be cautious. The PTO can be damaged if it installed improperly. The PTO has a end to end range of about 16 turns if I recall. The "ten turn" stop has a range of 10.7 turns. So as long as you set the PTO up reasonably close to the logical starting point, +/- one turn you will be safe. If you have another receiver you can listen for the PTO signal.

Hookup the electrical connector and turn on your 390A. Set your second receiver to 3455 kcs (BFO ON) and listen for your PTO signal as you turn the PTO dial a little left or right. 3455 will be about three turns clockwise from the counterclockwise stop (don't be too rough with the stops). 3455 corresponds to the low end of the range, 2455 is the high end (it goes down as you tune up, in other words). Tune around and listen and you should hear the signal. If you don't hear it you can rig a "transmit antenna" onto the MB connector on the PTO for more signal.

Of course you could read it with a freq counter if you have one. Once you have the PTO set to 3455, set the 390A dial to 000 (i.e. the low end) and hook up your PTO as best the coupler allows you to.

You can then tune to a local AM station of known frequency and check to make sure it is set up properly. If you don't want to mess with the second receiver, you can use the local AM station but you'd need to be reasonably close in the initial setup so that the RF deck is cooperating with the PTO. Again, set it up about three turns from the counterclockwise stop (so when you tune up you know you won't be hitting a stop in the PTO), install it in the 390A with the dial at 000, and then check it all against a local AMer.

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Date: Tue, 07 Jan 2003 08:09:40 -0500  
From: Jim Brannigan <jbrannig@optonline.net>  
Subject: [R-390] PTO endpoints

My COSMOS PTO endpoints were long by 6.5 Kc. I attempted to reset them "by the book". It quickly became an exercise in futility. Trying to thread a tuning tool through the gears and into the hole behind the coil can was not going to work....

Finally, I pulled the PTO, set up a quick jig and connected it to a frequency counter. Many iterations later I got the endpoints down to 1.5 Kc. long. I may have to live with the 1.5 Kc. for a while. The top of the core seems to be broken. (I really can't get a good look at it through the front) The "junkte box" has some cores that may fit the coil, but they are of unknown permeability. Has anyone else run into this problem?

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From: "Bill Riches" <bill.riches@verizon.net>  
Subject: RE: [R-390] PTO endpoints  
Date: Tue, 7 Jan 2003 09:31:59 -0500

> I may have to live with the 1.5 Kc. for a while. The top of the core seems to be broken. ....

Hi Jim - If you are adventurous you can remove one turn or less from the coil - (the small one!!!) that will reduce the tuning range. I believe the procedure is on Chuck's website.

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Date: Tue, 07 Jan 2003 10:19:26 -0500  
From: "Jim M." <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] PTO endpoints

I just repaired a end point adj coil with similar broken screw slot. Open the PTO and remove the coil (help to the front by two screws). Use a Dremmel with the smallest cutoff disc available to cut a new "slot" in the end of the tuning shaft, then clip off the remaining old burr. At the same time you can remove a turn if you need to. Chances are someone tried to crank the coil all the way in, but couldn't get enough adjustment range, and broke the screwdriver slot.



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Date: Tue, 07 Jan 2003 08:05:32 -0800  
From: Dan Merz <djmerz@3-cities.com>  
Subject: Re: [R-390] PTO endpoints

Jim, I did about the same things you've done when I got my 390a and Cosmos. I ended up opening the PTO and taking a turn off the coil - mine was about 8 khz long before I opened it. I don't know if I would have done it for 1.5 khz. George Rancourt convinced me to go ahead and dig into the pto and I never regretted doing it. This gadget is worth exploring if that's your cup of tea. There were detailed photos online of the insides of the unit which were very helpful. It's worked well for me since, Dan.

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Date: Tue, 07 Jan 2003 11:12:34 -0500  
From: Jim Brannigan <jbrannig@optonline.net>  
Subject: Re: [R-390] PTO endpoints

Interesting idea. I just hope that the slug isn't fractured

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Subject: RE: [R-390] PTO endpoints  
Date: Tue, 7 Jan 2003 12:58:07 -0800  
From: "David Wise" <David\_Wise@Phoenix.com>

Since it's the endpoint coil and not the main one, linearity isn't important. You can use any slug that fits, and add or subtract turns to get the right adjustment range. You might even get away with this on the compensator coil, if it were damaged.

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Date: Tue, 07 Jan 2003 17:10:46 -0500  
From: Jim Brannigan <jbrannig@optonline.net>  
Subject: [R-390] RE: PTO endpoints

Thanks Roy, The notes will be helpful. I've repaired S-line PTO's, so I'm over the nervous part. Dave Wise's note on the slug is good news. The PTO will go on the back burner for now. The 3rd mixer on my deck was changed to a 6BE6, I'm going to put the 6C4 back in.

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From: K2CBY@aol.com  
Date: Tue, 7 Jan 2003 18:04:48 EST  
Subject: Re: [R-390] PTO endpoints

I agree that adjusting the PTO endpoint trimmer coil is a pain in the neck using the manual procedure. There is an easier way to make the adjustment with the VFO in place and without removing the receiver front panel. (1) Remove the VFO subchassis. (2) Remove the screw cap covering the end point adjustment. (3) Reinstall the VFO subchassis. (4) With the entire receiver upside down on the bench, rest your longest, thinnest screwdriver against the outer edge of the gearbox plate and poke it through the access port from which you removed the screw. (Don't even try to thread it through the holes cut in the gearbox plates for this purpose.) It should just make it to the end of the slug screw. (5) Make the

endpoint adjustment. (6) Remove the VFO subchassis. (7) Replace the cap covering the end point adjustment access. (8) Replace the VFO subassembly in the receiver. In making the adjustment I use a 3/16" screwdriver 8" long sold by True Value Hardware under the Master Mechanic label bearing stock nos 127-399 TS322. (If you have exceptional dexterity -- or luck -- and some means of holding the plug onto the end of the screwdriver, it may be possible to remove and replace the cover plug while leaving the VFO subchassis in situ, thus eliminating steps 1, 3 6 and 8 above.)

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From: K2CBY@aol.com  
Date: Tue, 7 Jan 2003 18:10:06 EST  
Subject: [R-390] [R390] PTO Endpoints

There is an error in my last note, the spec on the screwdriver is 3/32 x 8 inches NOT 3/16 x 8"

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Date: Tue, 07 Jan 2003 18:46:57 -0500  
From: Jim Brannigan <jbrannig@optonline.net>  
Subject: Re: [R-390] PTO endpoints

It was a lot easier to pull the VFO, and attach a frequency counter. I put pencil marks on the Oldham coupler and PTO body as reference points. wrote down the low frequency, counted ten turns, wrote down the high frequency, count down ten turns, set to marks, adjust coil. Repeat and adjust as necessary. When I was done, I set the counter dial to the calculated PTO frequency and reassembled. Final calibration can be done with the "ZERO SET"

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Subject: RE: [R-390] PTO endpoints  
Date: Tue, 7 Jan 2003 16:23:38 -0800  
From: "David Wise" <David\_Wise@Phoenix.com>

I can do the endpoints in situ, using a \*very\* short screwdriver which is actually the broken-off end of an old metal-tipped diddle stick. It was about two inches long and 1/4 inch diameter. The length has to be just right. Too long and you can't get it into position, too short and you can't grip it to turn. There's not much leverage, so it's important that it has good grip and you have squeaky-clean, average- or small-sized fingers.

1. Tip the receiver onto its back.
2. Maneuver the screwdriver through the holes.
3. Loosen the cover screw. Use pliers on the screwdriver for leverage if necessary. You can also  
    come in at an angle with a small, long, skinny screwdriver, but again, torque is limited.
4. Finagle it out of the way using another small, skinny screwdriver.

5. Adjust.
6. Fiddle the cover screw back into position.
7. Tighten. Yer done.

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Date: Sun, 26 Jan 2003 17:30:26 +0100  
From: "Clemens S.Ostergaard" <clemens@it.dk>  
Subject: [R-390] PTO 70H-12 problem

A "new" EAC R-390A being renovated (recapped, etc.) has turned out to have a problem preventing calibration. The PTO variation is insufficient, with the end-point adjustment screw all CCW it covers 977.13 kcs, all CW 983.55 kcs. A friend of mine, who has the sufficient skill and learning, took it apart and it proves to have been tampered with: windings off the adjustment coil and the linearity-coil also seems to have been maltreated. White salt-like deposit all over the insides, but this is perhaps not so grave. I have (large) digital pictures if anyone wants. Mechanically it seems OK and it was functional, though sometimes with a kind of slight wobbling when tuning through a heterodyne.

Here in Europe, spares are not thick on the ground, so I reckon my best chance is to ask the list if anyone has a spare PTO to sell. Payment in unmarked dollarbills, hi. Alternatively, does anyone have positive/negative experiences with PTO's from Fair Radio?

And while I am asking questions: why not put either the training manual TM-4000 or the STP called "Troubleshoot the radio receiver R390A/URR to the faulty component" on the phenomenal R390A website?

Best, (and hope to hear from you)  
Clemens S.Ostergaard  
Aarhus, Denmark

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From: "Steve Hobensack" <stevehobensack@hotmail.com>  
Subject: Re: [R-390] PTO 70H-12 problem  
Date: Sun, 26 Jan 2003 11:41:59 -0500

Hello Clemens, I had that problem a while back. I found a small solder glob shorting the turns at the terminal point on one of the compensator coils (cosmos pto). You need a magnifying glass. There were only 3 or 4 turns. Be sure they are not shorted together. Hope this helps,

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From: ToddRoberts2001@aol.com  
Date: Sun, 26 Jan 2003 13:32:31 EST  
Subject: [R-390] Honey I Shrunk the VFO (tuning range)

<PRE>I have read discussions of the R-390 and other Collins VFO end-point-adjustment. I wonder if we could all settle on what happens with the tuning range? Some people say adding inductance "shrinks" the tuning range, others

say it "expands" the tuning range. To be correct wouldn't adding inductance "shrink" the actual tuning range? If you have a VFO that starts out at 0000 and you have to crank it up to +0009 to get exactly 1 MHz of change, the VFO tuning range has actually "shrunk". That means with exactly 10-turns of the tuning knob, the VFO RANGE of coverage was only 991 KHz. You will have to "expand" the tuning range so that 10-turns of the VFO will cover a full 1 MHz. It sounds counter-intuitive from the numbers on the counter dial. When you turn the endpoint adjustment slug clockwise you are LOWERING the inductance - thus "expanding" the range of the VFO = it will cover more frequency range in the same 10-turns of rotation. Likewise if someone has to resort to removing 1-turn or more from the End-Point adjustment slug you are lowering the inductance = expanding the tuning range of the VFO. Hope I have this right! 73 Todd Roberts WD4NGG.

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From: "Steve Hobensack" <stevehobensack@hotmail.com>  
Subject: Re: [R-390] Honey I Shrunk the VFO (tuning range)  
Date: Sun, 26 Jan 2003 14:29:40 -0500

Here's my way of reasoning on this; On the Cosmos pto, there are two little compensating coils. If the coil has four turns, and you remove one turn, the screwdriver adjusting slug will not have as much coil to act upon. If you want more "action" with the iron slug, there needs to be more turns. In my case , the compensator coil had little range of adjustment. I found the solder terminal had enough solder to short out the four turns. There's very little room there and its easy for that malfunction to happen. I can see where a huge number of pto's could have been made with this weakness.

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Date: Tue, 4 Mar 2003 10:03:36 +0200  
From: <antero.nordlund@nokia.com>  
Subject: [R-390] alignment assistance for an R-390A beginner

This is the first, but probably not the last time I write to you. I have just recently acquired an R-390A receiver from Fair Radio. Having my background in humanities (linguistics), I chose the "checked" option in hope of a working unit. After having paid almost another USD 550 for shipping, value added tax and customs duties, I finally have my radio on my desk here in my hometown of Nurmijarvi, Finland. I think I got a nice receiver: it has an engraved front panel (without a manufacturer's tag), one fuse, the PTO is a Collins, power transformer from EAC, AF subchassis from Capehart... well, all in all, a nice example of the modular construction principle! These all are from the 1960-1961, or thereabouts, contracts.

I resisted the temptation to apply power to it before I had changed the critical capacitors in the IF subchassis (C-531, 547, 549, 553). Obviously, I also had to make the necessary changes in the power supply for our 230 VAC. Further, I have now changed all the capacitors in the AF subchassis listed on KK4DF's homepage.

At this point, the receiver is working surprisingly well, taken into account the little work I have done so far. Signals are present on all bands, random checks into

tube sockets show approximately the correct resistance and voltage values, and test point E607 provides exactly 150 VDC. In fact, my R-390A receives just about every signal my other receiver, a Drake R8B, receives. Not bad, although I do notice that the Drake is more sensitive on the medium wave band, at least so far... Of course, my R-390A probably has who knows how old tubes and it probably is not perfectly aligned, which brings me to, yes, alignment issues:

I can at the moment adjust the frequency display to indicate the correct frequency as described in the Operator's manual, but I notice that, using the "zero adj", I end up at the very limit of the KC knob's range of movement without the last three digits of the display changing. More specifically, I can't move the KC knob to the right (higher frequencies). =20

Further, the mechanical alignment at the frequency reading of 07+000 is slightly off, with the cam plates (all of them) better in place at frequency reading 07 990. Now, in such a case, the manual suggests the remedy is to set the cam plates to their correct position, and then manually change the frequency reading to 07+000. In my case, then, I would have to add 10 kHz to the reading. But here's where my confusion already starts: if I add 10 kHz to the frequency reading, I can't correct that using the "zero adj." as I'm already at the limit of its range. Further, the nice balance of approximately 35 kHz above and below a "XX 000" reading on the frequency indicator will be gone, right?

So, as you notice, I'm a bit confused as to what setting affects what other settings and what the correct order of doing things is. Is there a procedure described somewhere that corrects the frequency error, centers the "zero adj." to the middle of its 15 kHz range, and restores the 35 kHz on both sides of a "XX 000" reading? Of course, what I'm after is a non-technical description using layman's terminology and definitely not using signal generators, oscilloscopes and other equipment that I don't happen to own! I have downloaded TM 11-5820-358-10 and -35, and the 21st century technical reference, but can't seem to be able to extract the information I'm after.

Any help you can provide is received with gratitude!  
Greetings from Finland, Antero Nordlund

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From: "Walter Wilson" <wewilson@knology.net>  
Subject: Re: [R-390] alignment assistance for an R-390A beginner  
Date: Tue, 4 Mar 2003 06:04:05 -0500

Antero, It sounds like your PTO is not outputting 2445 KC when your KC knob is at 7+000 with the cams aligned at the marks. Here's what I would do:

1. Set the zero adjust mechanism in the center of it's range by tightening down the ZERO ADJ knob, spinning the KC knob one way and then the other until it stops, setting the KC knob near the center of that range between the stops, and then loosening the ZERO ADJ knob. The zero adjust mechanism is now near the center of its range.

2. Set the camshafts at their alignment marks. Don't worry about whether the dial reads 7+000 or some other value.
3. Loosen the clamp that connects from the KC shaft to the oldham coupler, which ties the KC shaft to the PTO. This will decouple the KC shaft from the PTO.
4. Rotate the PTO shaft by spinning the oldham coupler until the PTO is outputting 2445 KC. If you don't have a frequency counter, you can just use the CAL function to find the carrier (at 8.0 MC). You now have the camshafts aligned with the zero adjust near the center of its range and the PTO putting out 2445 KC.
5. Retighten the clamp connecting the KC shaft to the oldham coupler.
6. Look at the frequency readout. If it is very far from 7+000, you will have to remove the front panel and adjust the veeder root (frequency readout) by loosening the gear clamp and rotating the gear on the right side of the veeder root mechanism. If it's close to the correct reading, you should be able to adjust it with the ZERO ADJ method.

This will get the camshafts aligned at their marks when the PTO is at 2445 KC with the zero adjust range near center and the dial readout at 7+000. That's your starting point. If the radio was aligned when the camshafts were in their misaligned positions, the radio will now be in need of a good alignment.

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From: Buzz <buzz@softcom.net>  
Date: Sat, 22 Mar 2003 15:43:53 -0800  
Subject: [R-390] PTO to gear train alignment question

I have a R-392 that has had the KHz knob and PTO shaft rotated while the PTO was removed. How do you realign the two ??? Thanks in advance,

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Date: Sat, 22 Mar 2003 16:30:07 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] PTO to gear train alignment question

If it is working, set the rig dial to a known local station, and turn the PTO shaft until you hear the desired station. There are a lot fancier ways to do it, but this will get it for you. The tuning of the racks will hardly allow any reception until you get real close, and then you'll hear it.

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From: "Dave Faria" <Dave\_Faria@hotmail.com>  
Date: Tue, 22 Apr 2003 20:23:53 -0700  
Subject: [R-390] Question for Historians

GE List. I'm working on a very nice Capehart 1961 contract. All modules are Capehart except the P.S.(Stewart-Warner) and the PTO(Progestron). Did Capehart ever make its own P.S. or PTO? A technical question - the PTO seems to be very sensitive to vibration. I know this PTO is built like the Collins but, don't recall a Collins PTO being this sensitive. I swapped out the 6BA6 and it helped

some but, the sensitivity to vibration is still there. Its like the grids in the tube are vibrating or a bad ground(I hope not).

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From: R274C@aol.com  
Date: Tue, 22 Apr 2003 21:38:35 EDT  
Subject: Re: [R-390] Question for Historians

No, they did not make their own PTO's. The only PTO manufacturers were.... Collins, Motorola, Progressitron, Dubrow Electronics and Cosmos. The vibration probably is likely a bad solder joint on one of the minicaps (forget the capacitance) I have had three Progressitron PTO's and all three had the same problem. A slight jarring would make it change frequency. Took it apart and lo and behold, a solder joint was making intermittent contact. A quick reflow and it was working like new. ymmv. Les Locklear

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Date: Tue, 22 Apr 2003 19:52:20 -0700 (PDT)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] Question for Historians

That'd be very likely, check the ground strap on the PTO shaft.

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Fri, 27 Jun 2003 00:14:03 -0000  
Subject: [R-390] Will it ever be the same?

Hi. Well, today I replaced the deadly capacitors in the IF strip as I wanted to check out the PTO thoroughly and didn't want to risk taking out a mechanical filter. I'm going to have to wait till the first of the month to order all the parts needed to re-cap this set properly, though I had enough to do "most" of the IF strip. (I've been working to too many BA's lately and ran out of new parts).

Anyway, to make a short story long, the endpoint of this Cosmos was off by about 6KHz. I thought, aha! I should be able to pull it that far. WRONG!!! got it to where the error is about 3 KHz and I think the slug dropped down into the PTO 8^(( At least that is the way it appears and the unit "rattles" when I shake it. SO, now I have pulled the PTO, removed the outer cover and am faced with having to pull the entire unit apart.

I had previously downloaded a LOT (250 MB worth) of R-390 information and found the two files on calibrating the Cosmos PTO. I remember reading about removing a turn from the coil, I just haven't found that "page" yet. "thought" I had complete teardown/service information on this too but haven't found it yet. Anybody know where that info might be located?

QUESTION; Will this poor thing ever be the same again? I was sorry to see a Cosmos PTO in this receiver and it looks like I wasn't far wrong. All my personal R-390A's to date had Collins PTO's, set the end point and forget it, they worked fine and were well within specs on linearity.

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Will it ever be the same?  
Date: Thu, 26 Jun 2003 21:19:05 -0400

Yes, and better! I have done that service on a Comos, it's not that bad once you get the can taken off. The slug can be screwed back into the coil when you open it. I have an article on Dave Medley's page <http://www.davemed.com/> showing how I had to completely rebuild a Cosmos.

You arent faced with that much however just to remove a turn from the adjustment coil. However if the linearity or tracking is off, adjusting all the little screws can be a daunting task. However, adjusting Cosmos linearity with those screws is far easier (to me) than the linearity stack in a Collins PTO (I have done both). There is some PTO information on this page:

<http://www.r-390a.net/Pearls/>

Also try <http://www.r390a.com/>

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Fri, 27 Jun 2003 04:26:04 -0000  
Subject: [R-390] Cosmos PTO end point coil

Hi. Earlier I tried to set the end points on this unit. I got it within 3 KC at which point the slug dropped into the PTO. SO, I bravely pulled the PTO and carefully opened it up. I didn't observe any unusual escape of nitrogen gas as I pulled the inner shield!) Anyway, I reinserted the slug, removed 1 turn from the end point coil (it had 3 turns) and reassembled the PTO. NOW IT'S WORSE THAN EVER. Best I get is within about 10KHz, that with the slug turned fully anti-clockwise. The 100 KHz markers are 1000 and 1990 KHz at the ends indicating that exactly 10 turns of the tuning dial are tuning further than 1MHz. I only removed one turn but that appears to have been too much. HOW MANY TURNS DOES THIS COIL TYPICALLY HAVE IN A CORRECTLY SET-UP UNIT? I wonder of someone previously removed turns? Stoopid Cosmos PTO's!

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Cosmos PTO end point coil  
Date: Fri, 27 Jun 2003 09:14:37 -0400

If you have the slug fully counter clockwise, you may need to run it in clockwise more. The adjustment is an iterative process. See Dave Medley's procedure at <http://www.davemed.com/pto.html>

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Cosmos PTO end point coil  
Date: Fri, 27 Jun 2003 09:22:14 -0400

One more nit... just be sure you put the inner can cover back on the PTO. If the cover is off it will be way off. The proximity of metal can does affect the



tracking.

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From: "Scott, Barry (Clyde B)" <cbsscott@ingr.com>  
Subject: RE: [R-390] Cosmos PTO SUCCESS!!  
Date: Fri, 27 Jun 2003 11:03:20 -0500

Phil, The radio was simply reminding you who is in charge. "HmMMM, sensors indicate the human is attempting to enjoy the radio without having produced any angst. Expectations of being able to place the radio in the rack and "plug-and-play" must be quashed immediately." MSG: R390A-TO-PTO. Change endpoint setting +3kc. If attempts are made to modify, change endpoint setting to +4.1kc regardless of slug settings. Hold setting for 36hrs. Revert to original setting. EOT Barry(III)-nonHW - N4BUQ

Good morning folks. Well, after sleeping on it all night (figuratively speaking ;-) I jerked this PTO out first thing this morning having decided to rewind the coil This coil originally had three turns when I first opened it, though it appeared to have been "violated" before. I dug through my junk coil tray and found a slug tuned coil that looked like it had the same gauge wire on it (close as I can determine via eyeball). I stripped a few inches off it and tinned one end. I then re-wound the end point coil (Yes, it was the end point coil, somebody inquired if I had the correct coil). I put three turns on it, just like it had when I started. Close wound and nice snug turns. I then gave it a light coat of clear nail polish to hold the turns in place and "cooked" it under a light bulb for a short time. Upon re-installing it and setting the starting point to 1000 KHz I checked the upper end. With the slug all the way counterclockwise it was 2.5KHz off end to end. (BEST I could get (before I dropped the slug in) was about 3 KHz. A couple clockwise turns of the slug brought it dead on to 1000 to 2000 KHz, Plus/minus 100 Hz! Time will tell if it stays good! I really don't know why it wouldn't tune up with the original coil (also 3 turns) but it wouldn't! The only thing I can think of is that the coil was rather loosely wound and sloppy, perhaps by a previous "tweaker". NOW FOR LINEARITY: In checking across the 100KC points I see about 2KC worst case. I don't have a frequency counter but I intend to use my Yaesu digital radio in SSB mode and tune each of the screws for "zero beat". Should be good for getting it within 100 CPS.

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Sat, 28 Jun 2003 00:43:43 -0000  
Subject: [R-390] Stinkin' PTO !!

Good afternoon all. well, the odyssey of the Cosmos PTO lives on. I repaired the end point coil this morning and was able to set the end points F.B. However, earlier when I checked the linearity at the 100KC points it looked 'pretty good, running typically 200 CPS to 1 KC off. However, the 600 KC point was OVER 2 KC out and I figured I could correct this with the correction adjustments. WRONG! Taking my time and after tuning on this thing for perhaps 3 hours in a radio room with an ambient temperature of 95 degrees (WITH the Air Conditioner on full bore) I got up to the frequency of +570 KC (that is with adjustment screws centered in the window). Up to this time the tuning had gone pretty good with

most adjustment screws only requiring a turn or two in one direction or the other.

At this point the PTO tuning became very stiff and the adjustment screw had NO affect on frequency when tuned either way. I even backed the adjacent screws off to make sure they weren't binding or dragging. So I checked the next frequency, same way for the next couple steps. Stiff tuning and the corrector has NO affect! At this point I stopped and threw in the towel. (The screws adjusted earlier were rechecked and are still good).

As I said before, though it looked nice on the outside, this PTO was no virgin, at least around the end point coil. I suspect that either the Teflon disk or the "screw disk" is damaged. That or there is another problem in that area. I have no intention of going that deep into the PTO. The man I got the R-390A from said he has another PTO and I'm going to give that one a try. In the meantime, I have the time to pull the RF deck and check it out thoroughly.

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Sat, 28 Jun 2003 04:22:55 -0000  
Subject: [R-390] Autopsy of a bad PTO.

Since there is another PTO coming I went ahead and took this one apart all the way down to the corrector disk to see if I could determine the failure mode (not sure I can get it back together correctly!) Anyway, I was right. The 48 tuning screws are rotated one by one past a round spring loaded thingy made of spring steel that has a small piece of steel that looks kind of like a "footbridge" spot welded to it. As the screw for a particular segment of the frequency range (25 KHz steps) walks over the "footbridge" it presses down on it and pushes the slug under it further into the coil. The "footbridge" was damaged in two ways. First it had a BIG dent in it on one side that would make screws riding on that side of the bridge (they're staggered) not press down as hard on the bridge. Secondly, the spot weld that holds one end of the bridge is broken loose so that it has lost some of its "stiffness" and positive action. In trying to fix the "dent" in the bridge I'm afraid that I also weakened it some more as spring steel doesn't take kindly to dents and trying to straighten them out. The third problem I found was that some of the screws had apparently been turned CCW "counterclockwise" too hard, spreading the slot and screw too wide to thread down into the disk far enough to reach the damaged bridge. These are the culprits that probably had no adjustment affect as they wouldn't reach the "footbridge". These are very tiny screws that are really only a screw shaft with a "slot" in the end and a flat head on the backside to "walk across the bridge". NOTE: A couple articles that I read said that there was a flexible Teflon ring that these screws rode on forming kind of a cam. This one had no such ring, only the spring steel thingy that the screw heads walked across.

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Date: Fri, 27 Jun 2003 21:39:05 -0700 (PDT)  
From: John Kolb <jlkolb@cts.com>  
Subject: Re: [R-390] Stinkin' PTO !!

I should repeat a tale I've relayed once or twice before - I once had a National HRO-500 which was rather beat up. Some previous owner had adjusted the

tuning linearity until it was perfect NOT. Indeed it was on on the 100 kHz calibrator points and 25? 50 kHz? However between calibration points it was as much as 5 kHz out. Looking at the slotted end plate of the tuning cap, it was bent up to look like a saw blade  $\Lambda$ . To tweek it back into shape, I built a neat little crystal calibrator box. Starting with a 4 MHz crystal oscillator, I went through a chain of divide by 10 digital dividers, with a switch to select a tap on the chain, and then a chain of divide by 2's, also switch selectable. Thus I could select 4 MHz, 400, 40, 4 kHz, or selecting 400 kHz switch in divide by 2's to get 200, 100, 50, 25, 12.5 kHz or selecting 40 kHz, get 20, 10 5, etc. This gave me a real multitude of spot frequencies to check the dial at. A perfect square wave would have only odd harmonics in the output. If you instead of a square wave out of a crystal calibrator, generate a very narrow pulse, the odd and even harmonics will be almost even in amplitude. The narrower the pulse, the higher higher frequency output/ Using 74S logic, the output went to almost 100 MHz before starting to fall off. With as many adjustment screws as the Cosmos PTO has, it's necessary to check at freqs other than the 100 kHz xtal calibrator spots. Such a unit as I've described would be ideal. With the high speed digital logic available nowadays, it could be made flat to very high freqs indeed.

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From: "Barry Hauser" <barry@hausernet.com>  
Subject: Re: [R-390] Autopsy of a bad PTO.  
Date: Sat, 28 Jun 2003 07:28:18 -0400

I dunno, there was a time there would have been several posts with detailed "been-there-done-that" posts to assist you. I've held back on replying simply because I've never been that deep into a Cosmos. Soooo.. in the absence of any experienced replies .... (maybe some were off-list?) Somehow, I'd also assumed that with all the downloading you mentioned you had certainly come across Dave Medley's pages or another site with Jim Miller's "A JOURNEY THROUGH THE COSMOS (PTO)". The direct URL on Dave M's site is <http://www.davemed.com/cosmos.html>

This includes detailed photos, though there's something wrong with one or two of the photos. Gonna try to shed some light on this, but again, bear in mind that I have no hands-on, so take it for what it's worth.

.....took this one apart all the way down .....

Somehow, I'm not surprised. I always take your "quit" and "throw in the towel" declarations with a grain of salt. (about the size of a football ;-). While you were tearing into that PTO, I was probably searching for that web article (or copping some Z's).

.....The 48 tuning screws are rotated one by one .....

The web site photo shows this. The spot welded piece looks more like a triangle, so I'm not sure what you mean by a footbridge. (Maybe like the ones in Japanese gardens and Central Park?) Check out the photo for what the shape of it should be.

....."footbridge" was damaged .....

From the photo, it would seem that bridge is supposed to be rigid, not flexible, even if it's made of the same spring steel as the ring. (Just a manufacturing convenience, vs. a solid piece of something, also avoidance of dissimilar metals. Also, spring steel is fairly hard and less prone to wear.) Wouldn't it be solid if that other weld weren't broken?

.....some of the screws had apparently been turned "counterclockwise" ....

Can't you turn them back down again while it's apart, to make sure they'll make it through? Sounds like what you are describing is a false bottoming out of the adjustment screws. The "no adjustment" effect might also be due to the "bridge" being out of shape, partly flattened and flexing flatter due to the broken weld on one end and/or the dent. Actually, if that bridge or arch was flexing, that would have messed up your linearity adjustments and may have contributed to the other problem.

.....flexible Teflon ring.....

Was that a Cosmos PTO in the articles? May have been a different mfr. Again, keeping in mind the nature of the source, (not been-there-done-that) -- here's some partially lame advice: From the photo, it looks like the bridge should be solid, not flexible. I imagine the screws should just catch the bridge on the rise, not at the base near the spot welds. If so, then you should be able to repair the thing with epoxy, or perhaps a solder repair, if the spring steel will take soldering. One way would be to fill the void in the bridge -- basically an "arch support". Reshape the arch as best as possible, using the photo or another unit as a guide. Cut the corner off a piece of sheet metal -- aluminum -- to make a small triangle support with a slightly rounded apex to fit the underside of the bridge and secure the whole business with epoxy, using a small clamp to hold in place until it sets. Basically -- an orthotic shoe insert. Then fix the screws somehow, if they actually need fixing. The photo on the website shows that quite a few screws are either not present or in the fully backed out position. There's another thing. I was a bit confused as to how this setup could work if the screws are riding up and down the arch, with gaps in between, causing reciprocating action. That would mean that it would be nearly impossible to have smooth action in terms of degrees rotation to frequency. The key is that the adjacent screws are straddled so that the tip of the bridge/arch is always riding on a screw or none at all. But -- what that means is that the screw setting should end up with reasonably smooth transition from one to the next. If there were too much of a differential from one (or a pair) to the next, it could jam or cause roughness. I would think that extreme differences between adjacent screws might be indicative of a problem elsewhere -- worn lead screw or something. Also -- does it seem possible to run a screw down far enough to actually crush the bridge piece (or snap a weld)? The photos on that site are of fairly high resolution. I blew up the side view of the "bridge" and it certainly appears to me that it should be fairly or completely rigid, not flexible, if both welds are intact. It's basically triangular in shape, but with a smooth bend at the apex.

With one weld broken, it will flatten under pressure and you won't get a reliable adjustment. That's my theory anyhow. Of course, as I'm typing the last of this speculative tract, Phil is waiting for the epoxy to cure or soldered the thing, or maybe hand carved a new ring and "footbridge" out of some spring steel in his junk drawer. "Throw in the towel" -- yeah, right. We know you better than that. ;-)

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From: "Barry Hauser" <barry@hausernet.com>  
Subject: Re: [R-390] Autopsy of a bad PTO.  
Date: Sat, 28 Jun 2003 07:39:57 -0400

There is also a fine article on the Cosmos by John Harvie on Chuck R's website:  
<http://www.r390a.com/html/PTOS.htm>  
Speaking of the "role call" -- anyone hear from John lately. YO! John!

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Autopsy of a bad PTO.  
Date: Sat, 28 Jun 2003 08:38:23 -0400

I just noticed some of the photos in my Cosmos PTO article on Dave's page have become corrupted. If anyone's interested, the original article is at the following url. Copy anything you want.

<http://home.att.net/~jamesmiller20/cosmos.htm>

I tried emailing Dave but his email bounces. I guess I like the Cosmos over the Colling PTO because it appears to be relatively easier to linearize despite Phil's nightmare. I spent over a week (couple of hours a day) going through the stack (trial and error) in a Collins PTO, taking the cover off, tweaking, putting the cover back on, over and over. I can see why the inventor of the Cosmos approach thought he had a better idea. Sounds like someone in a past life got heavy handed with a screwdriver and jammed some of the little screws.

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Autopsy of a bad PTO.  
Date: Sat, 28 Jun 2003 08:58:15 -0400

By the way Phil's experience and Barry's theory with the PTO getting tough to turn at one point jog's my memory. This happened to me whenever I accidentally ran one of the screws too far in or out. A sudden jump in the height of adjacent screws did cause some jamming as I recall now. The transitions should be fairly smooth from point to point. If a screw is run too far in, it can also depress the flexible ring into the body and possibly crimp it. Also found that some of the screws tend to get very tight and won't always turn easily without some effort. They sit in a threaded teflon or plastic ring. I never saw any stripped threads in the one I worked on, but I suppose this could happen leaving some screws in permanently high or low positions...thus the binding effect. Maybe better luck with the "new" one!

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From: "Barry Hauser" <barry@hausernet.com>  
Subject: Re: [R-390] Autopsy of a bad PTO.

Date: Sat, 28 Jun 2003 09:28:06 -0400

Hi Jim: Sorry ... I didn't notice your earlier post(s) in reply to Phil. Thanks for the new URL. Those missing photos help make it clearer about the action with the "footbridge" riding and straddling adjacent screws. The overlap/staggering of the linearity screws is intended to avoid jumping which could otherwise cause up-down variations in frequency as the unit rotates. (and how an abrupt jump from one screw to the next could cause problems.) The photos on your site seem to be clearer and larger as well. Even clearer to me that the little ramp or bridge should be rigid, not flexible. If the metal will take to soldering, Phil could solder the broken weld and perhaps fill the void under the bridge (no boat traffic) with more solder. Of course, it would have to be reshaped as well as possible first and the final result deburred and lubricated with a small amount of non-running grease.

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Autopsy of a bad PTO.  
Date: Sat, 28 Jun 2003 09:56:40 -0400

I don't want to sound too negative, but if that bridge is broken, I'm afraid it's time for plan B (new PTO). That is spring steel which won't solder well at all. Even if repaired, it may never be as smooth and repeatable as an undamaged one.

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From: "Barry Hauser" <barry@hausernet.com>  
Subject: Re: [R-390] Autopsy of a bad PTO.  
Date: Sat, 28 Jun 2003 10:19:20 -0400

You're probably right about Plan B, and a replacement is on the way. Since the present one would be a goner anyway, it might be worth experimenting with epoxy as I first suggested. The entire space under the bridge would have to be filled to increase the surface area of the bond. The surfaces getting the epoxy - top of ring under the bridge and underside of bridge would have to be roughened up to provide grab. Most epoxies are fairly heat resistant. Wouldn't take much to try it. If you are going to try to fix that one, Phil, I would suggest pre-setting any of the 48 linearity screws to remove any "cliffs". A key question has to do with how well you were able to reshape that bridge. The flex would be fixed with the epoxy. I suppose you could dress up the surface of the bridge if there are some bumps and ruts in it. You could try re-spot welding it -- maybe with a high current battery and a couple of makeshift electrodes. Or maybe not. ;-) There's always Plan B. Barry

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From: "Phil Atchley" <k06bb@elite.net>  
Subject: RE: [R-390] Autopsy of a bad PTO.  
Date: Sat, 28 Jun 2003 15:31:20 -0000

Hi Jim, Barry et al... I'll try answering all the messages posted here at once. First, thanks Jim for providing the alternate URL for the file download. Yes, I had previously downloaded that one along with a gazillion files on the R-390A and the Cosmos in particular. That "Journey" was one of the factors that motivated me to dig deeper into the Cosmos at hand. However, as you discovered, the picture I

really needed of the "footbridge", perhaps more correctly called an "arch" was corrupted and unusable here. (I still think that "footbridge is a better description as the screws march across it in succession). NOW, the bad news. As I mentioned, this unit's "arch" had been "crushed", probably by some ham handed "mechanic" who thought everything needed to be torqued to 50 ft/lbs 8^(( Why else would some of those screws been spread out like they were? Instead of a nice arch or ramp, what I have here is a ramp that has been crushed, with a severe "crink" on either side of the peak, a rather flattened peak with a deep dimple (comparatively speaking) on the inner half closest to the shaft. All this plus the broken spot welds on one side makes for a very rough and unreliable ride for the screw heads. Now, if the ramp was intact and just had broken spot welds I could probably fill the entire area under the "bridge" with JB Weld or similar and it'd be rigid and good forever! The only way to fix this one would be to fill said void with JB Weld or similar and then rebuild the ramp and shape it with some more JB weld. However, I don't think that would be a very reliable long term "fix" as the JB is an adhesive, not designed to use as a "bearing". The constant (and I do mean constant) friction with the screw heads would wear it down quickly making for a continuous change in linearity!! No, I'm afraid this one is destined to be an "organ donor" unless I can eventually find a replacement for the spring steel ring. ONE ADDITIONAL NOTE: This also explains the Frequency "jumpiness" that I experienced while trying to set the linearity screws. I didn't mention it but I kept seeing the frequency "jump" back and forth erratically while setting the various screws. This got worse as I progressed up the band though I'm not sure why that would be except that perhaps the linearity coil has more affect at one end of the band than the other (makes sense to me). I really thought maybe it was the "shaft grounding" though I had cleaned it.

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Date: Sat, 28 Jun 2003 11:15:11 -0700 (PDT)  
From: John Kolb <jlkolb@cts.com>  
Subject: RE: [R-390] Stinkin' PTO !!

> However, to align a PTO it is much easier to use a counter (best).....

Indeed you are right - the counter is easier. I did the HRO-500 about 20 years ago, when counters were rare and expensive beasts :) Even today, not everyone has one.

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Autopsy of a bad PTO.  
Date: Sat, 28 Jun 2003 22:51:40 -0400

What Barry said about presetting the screws woke up another brain cell in my fading memory. I recall reading in one of the other articles (Harvie's maybe) that the first thing you want to do before starting the linearity alignment is to preset the 48 screws equally about half way in or maybe a little less. There is a reason for this... If the screws are already pretty well cranked in before you start aligning, then at some point you may run out of adjustment range on the "upper" screws, which will bottom them out and start them grinding into the "bridge"..

The hard part to me is presetting them all the same, you have to turn them fully in and than back off about half the turns (or is it fully out?). I don't recall the exact number of turns. While you have that bad PTO open with access to the disc you might use it as a learning aid to see how many turns can be expected on each screw to get a feel for the range of adjustment possible and how far to back them out to preset them.

This is a real hard introduction for a new 390a owner, but once you have accomplished the PTO initiation, you will be a true member of the fraternity. Good luck!

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From: "Phil Atchley" <k06bb@elite.net>  
Subject: RE: [R-390] Autopsy of a bad PTO.  
Date: Sun, 29 Jun 2003 03:11:36 -0000

Well, this is R-390A number either 5 or 6 (you tend to lose count as you get older) that I have had and overhauled here (one belonged to a friend). In fact, come to think of it, over the years this one may actually be number 7 overall. That doesn't include one Junker that was parted out and an R-391 autotune unit that I obtained and sold without repairing it. I just can't stay away from the things!! When one arrives at the house one way or another and I show it to my wife, she just looks at it and says, "Yep, another big gray radio". This is just the first one that I EVER had this many problems with the PTO. All the others except one had Collins PTO's. The lone exception was an EAC belonging to a friend. That one had a Cosmos PTO which, after a little tweaking lined up on the end points and the 100 KHz calibration spots were in tolerance (didn't check the 25 KHz points). So, I've done a few of these critters.

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] Autopsy of a bad PTO.  
Date: Sat, 28 Jun 2003 23:18:22 -0400

Sorry. I assumed incorrectly you were new to this addiction. Yeah 5-6 or so is a good go at it. I have 3 here, one basket case, one "nea"r Collins, one Stewart Warner, 2 more than I really needed. I always dread the PTO work.

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Mon, 7 Jul 2003 17:50:02 -0000  
Subject: [R-390] Replacement pto arrived.

This morning I picked the replacement PTO up at the post office. Examination disclosed the following.

1. No label but it is obviously a Cosmos PTO from the fact that it has the 25KHz linearizing screws that only the Cosmos units have.
2. It's an older unit, the coax shield and outer covering (green instead of white) around where the coax exits the PTO is cracked all the way around, with the shield basically non-existent. Some light corrosion on the housing and around



where the power cable exits the can.

3. Bent slug shaft on the output transformer (the small can).
4. The linearity adjust screws has those itty bitty hex or fluted screw holes instead of the slots, the size nobody can find a tool to fit 8^ (I 'might' have a itty bitty fluted wrench that will do the job)

An electrical check of the unit showed that it's working but the end points are out by over 12 KHz, which means that I'll have to go into the unit and tweak the end point coil and check other things. While I'm inside it I'm going to do a thorough examination for overall condition etc. It may behoove me to use the flexible linearity ring to repair the other unit since it's in otherwise pretty nice condition. A little more work but I want the best possible PTO in this radio!

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Wed, 9 Jul 2003 02:55:42 -0000  
Subject: [R-390] PTO SUCCESS!!

Hi. Well, I finally met with success in getting a PTO set up for this '67 EAC. If you recall this Cosmos PTO had a linearity ring with a crushed "footbridge". It's not perfect, but it is much, much better than when it arrived here. Smooth tuning and no minor frequency jumps when tuning either!

Well, the PTO that arrived in the mail was also a Cosmos. It worked but had a number of "issues" with it also. Notably the damaged Coax cable, the damaged slug screw for the output transformer etc. BUT, the one thing it did have was a good linearity ring. So, I decided to rebuilt the one that came with the receiver as it was otherwise in pretty nice condition. First order of the day was to tear both PTO's all the way down to the inner sanctum where the linearizing hardware resides. I then swapped the linearizing rings, backed all the linearizing screws counterclockwise and then one turn clockwise. Reassembling the unit it took about 4 tries before I got the disk in the right position so that I had screws at both ends of the tuning range. I had previously marked the tuning slug position for 3455KHz to make it easier. I quickly discovered that I could pull the assembly far enough apart to reposition the disk without having to take the lead screw all the way out of the tuning slug. This helps keep things in position. While reassembling the unit one other problem reared it's ugly head. I had previously mentioned this PTO was not "virgin". Somebody had worked on the coil tap for the main tuning coil. In the process of taking the wire off the feedthru this same wire pulled loose from the coil, breaking the winding in two (previously repaired). So, my fix was to solder a heavier piece of hookup wire to the feedthru, carefully position this over the two ends of the broken wire and solder them. Some clear fingernail polish then secured the fine wires to the coil form and the hookup wire. I was very careful how I positioned this wire, even so I was afraid that it might affect the tuning range of the coil. However, I was pleasantly surprised that upon re-assembly the PTO tuned just fine, the 3455 position being just about where it was when I removed it (A little difference but I attribute that to the fact that I backed the linearizing screws out).

You might ask, if I had two PTO's here and was using one for parts, why didn't I rob the tuning coil out of the parts unit? Good question! The answer is simple. While both were Cosmos units there were significant differences in the two units, particularly around the tuning coil. I'm sure the coils were electrically the same, however the hook-ups were somewhat different, the older unit having three feedthru wires to the oscillator, two of which were from the coil. The other unit (one I used) had only two feedthru wires.

All the above was THE EASY PART!! It took me a good 10-12 hours of work to set the end points AND all the linearizing screws. I had no test jig so I did it in the set, using the Veeder Root counter and lifting PTO out of the set for each adjustment. I quickly found out that if I left the back bracket on but not screwed to the chassis and left the front screws unscrewed from the chassis I could hold it in position, tune up to the next point, lift PTO out and tweak it and re-insert the PTO without knocking the PTO shaft out of position (I have a fine touch ;-). It also took several trips through the routine as I found that the first setting I did for end points was not optimum for having sufficient range on all the linearizing screws. The final results are that I have a couple screws that are backed all the way out, MOST in the mid-range and a couple in as far as I could go without getting any binding on the PTO tuning. Where there was any problem there I backed them out a little more than the optimum point as I figured a couple hundred Hz non-linearity was better than getting the screws too tight.

No, this is NOT a PERFECT PTO, worst case non-linearity is at 025 KHz where it actually reads 025.7 on the counter (000 and 050.1 on 25KHz points either side). AVERAGE non-linearity is probably better than 300 Hz, this with the end points at 000 and +000 being dead on the money. I think some of the non-linearity may be due to the repairs that have had to be made to the tuning coil etc. That and if I had a test jig where I could EASILY adjust the critter it may have made a difference. Not having a frequency counter I used my Yaesu VR-5000 in LSB mode to Zero Beat the PTO when the Yaesu receiver was tuned to the desired frequency. However, I DO feel pretty good about rescuing what was otherwise a "Sows Ear" and which was useful only for parts! BESIDES, THEY DON'T MAKE PTO'S LIKE THEY USED TO!)

#### NOTES:

DIFFERENCES BETWEEN THE TWO COSMOS PTO'S (#1 came in my receiver). It appears that unit #1 is a much newer PTO than unit #2.

1. PTO#1 had two feedthru wires from coil to oscillator.  
PTO#2 had three feedthru wires from coil to oscillator.
2. PTO#1 had new style coax with clear jacket, good condition.  
PTO#2 had old green coax with cover and shield broken at body.
3. PTO#1 had slotted linearizing screw shafts for screwdriver.  
PTO#2 had some sort of hex or fluted linearizing screw shafts.

4. PTO#1 Disk had a number of missing linearizing screws.  
PTO#2 Disk had linearizing screws in all holes.
5. PTO#1 Heater wires entered through front of PTO unit.  
PTO#2 Heater wires entered through side of outer can. =20

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From: "Bill Smith" <billsmith@ispwest.com>  
To: "Phil Atchley" <k06bb@elite.net>, <r-390@mailman.qth.net>  
Subject: Re: [R-390] PTO SUCCESS!!

Congratulations! Have been following your story with great interest. Goodwork.

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Sat, 12 Jul 2003 00:51:17 -0000  
Subject: [R-390] 3rd Mixer noise, STINKIN' COSMOS PTO's!

Well, I located the source of the warm-up noise in my '67 EAC. When it was first turned on it would snap, crackle and pop and just generally be noisy. I'd traced it to the 3rd mixer stage. So, I pulled the RF deck and replaced all the resistors/capacitors in the 2nd and 3rd mixers as well as a "bulged" 2.2K resistor in the plate coil circuit of the RF amplifier. That resistor had measured 5.5K ( I had checked the PTO by listening to its signal on another receiver. It appeared to be nice and quiet with no drift or noise. After re-assembling the unit (I'm getting to be a whiz at the RF deck removal/installation) I again checked it with no apparent change in status. Still noisy at turn-on. On a whim I disconnected the receivers PTO and patched in the "parts" PTO, not bothering to mount it in the frame. This PTO while operational is really only good for parts as I've swapped out the spring loaded linearizing disk, the heater wires are disconnected and the output coil slug damaged. After tuning the PTO to roughly the same frequency as the receiver was tuned to (as evidenced by the local station on 1480KHz) I listened carefully. EUREKA!! Just the normal white noise or hiss of a normally functioning R-390A. To be sure I patched in the original, SNAP, CRACKLE POP! On a hunch I pulled the 6BA6 tube out of the parts unit and put it in the original PTO. EUREKA AGAIN! No more snap crackle pop! Now, you can ask, why didn't I test the tube earlier? I DID, before doing an alignment of the PTO and it tested good. Checking it now shows a shorted tube with VERY low transconductance! THE SICKENING THING IS I AM PROBABLY NOW GOING TO HAVE TO GO THROUGH A SEVERAL HOUR PROCEDURE TO SET ALL THOSE 48 LINEARITY SCREWS again. . . =

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From: "Barry Hauser" <barry@hausernet.com>  
Subject: Re: [R-390] 3rd Mixer noise, STINKIN' COSMOS PTO 8^)  
Date: Sat, 12 Jul 2003 05:41:31 -0400

.....why didn't I test the tube earlier? .....

I was going to suggest a bad tube as most likely, but you said that you tested them all. What probably happened is that the tube was good or perhaps becoming borderline with no initial shorts indication. But then, you were

repeatedly installing, removing, fussing with, reinstalling, etc. that PTO. Tubes sometimes don't tolerate shock very well and they're most prone when plugged into a chassis that's being moved around -- especially if the tube is still hot -- which I suspect happened as you were working on the PTO from the way you described it at the time. BTW-- how do you know the transconductance/quality was low? If you get a shorts indication on a tube tester, as a rule you should never go to the quality test, as you risk damage to the tube tester. An exception might be if you can clear the short while in the shorts test by allowing the tube to warm up and tapping on it. However, that kind of fiddling is basically pointless, as the tube should be discarded. (The purpose of tapping on a tube is to check for an intermittent short in a suspect tube -- i.e. to force a short, not temporarily finesse it away.)

>THE SICKENING THING IS I AM PROBABLY NOW GOING TO HAVE TO GO THROUGH A SEVERAL HOUR PROCEDURE TO SET ALL THOSE 48 LINEARITY SCREWS again. . .

Go easy on the PTO as you do this and periodically check the tube if you are going to be repeatedly removing/installing the unit. Put a piece of foam down on the table where you are going to set the PTO. When re-installing, avoid bumping it. Another consideration -- short-proneness and other latent defects tend to run in families -- production runs. So, if your supply of 6BA6's all came from the same lot, it may well happen again.

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From: "Don Reaves W5OR" <w5or@comcast.net>  
Subject: RE: [R-390] 3rd Mixer noise, STINKIN' COSMOS PTO!)  
Date: Sat, 12 Jul 2003 09:14:31 -0500

Let me comment about Phil's adventure with his 'new' EAC. It is precisely this kind of narrative that makes this list unique and useful. Phil's story, which we all know is going to end with his success because he is going beyond the call of duty with a Cosmos PTO, gives us all a bit of inspiration to do battle with our own tough nuts. So, on behalf of the list, Phil, thanks for sharing your trials and tribulations with us - you have 600 interested onlookers in your workshop, looking over your shoulder, double checking your work, nodding our heads in approval. It does get a bit crowded, doesn't it? OOPS, 1 percent of us stray for some unknown reason, and start babbling about off the wall subjects, distracting the rest of us from the task at hand. Those people will be shown the door! Don't worry about running out of 6BA6 tubes - there are plenty of those available. So, good job, Phil. Don

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Sat, 12 Jul 2003 18:32:01 -0000  
Subject: [R-390] COSMOS PTO, starting over again.

Hi. Y'all are gonna to get tired of all these Cosmos PTO's. But! Let me tell you, you're not as tired of them as I am of working on the blasted thing. In trying to adjust the linearity of it after having changed out the bad 6BA6 tube I noticed that I wasn't getting "repeatability" on the linearity screws. I could tweak one, tune

away and come back and it'd be off. In the most severe cases by a couple KHz, most of the time a couple hundred or so. What was maddening is that it demonstrated no discernable pattern as to when or where. . . So, I've stripped the PTO down completely AGAIN. All the way down to the inner sanctum where the linearity "guts" lie. Upon pulling the "spring ring thingy" and checking the plunger of the linearity coil I noticed just the tiniest bit of roughness or grittiness in its action. Very minute, but possibly enough to prevent repeatability of the core position. So, I unsoldered the wires of the coil and removed it thinking that would allow me to remove the Plunger and clean/lube it. WRONG!! It is a sealed assembly with the coil. So I did the next best thing. I used some semi-synthetic grease and applied it to the part of the plunger that was visible (after wiping that part clean). I did this a couple times, each time working the plunger in as far as it'd go to spread it around. NOTE: DON'T use oil as it may run down the plunger and contaminate the coil core. The plunger now is smooth and silky. Don't know how many years it'll last before the grease hardens some but I've had good luck with this Valvoline DuraBlend on many items. It "seems" to stay "greasy" and not harden any. Next, I am backing all the linearity screws out again and pre-setting them one turn clockwise to give me a good starting point and the BIG job of tuning will start again. Luckily I have that down rather pat. As I mentioned before, I tune it IN the receiver. I leave the rear mount attached to the PTO (but not screwed to the receiver frame), leave the front screws unscrewed and that allows me to hold it in place against the Oldham coupler for tuning and EASILY lift it out for tweaking. NOTE to Barry: This doesn't put any undue shock on the PTO as I lift it out very easily and tilt it back for adjustment. I HAVE to be gentle so as to not knock the tuning shaft position out of place. HEATER NOTE: This time upon disassembly I completely removed the thermostat and the heaters from inside the PTO. I NEVER use them anyway and they just complicate the teardown-rebuild of the unit. Yes, I'll keep the insulation intact as I'm sure it adds to the thermal stability. One FINAL note. IF this doesn't get it this time I'll be giving up on this PTO and will be looking for a Collins or other unit ;-)

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From: "Bob Tetrault" <r.tetrault@comcast.net>  
Subject: RE: [R-390] COSMOS PTO, starting over again.  
Date: Sat, 12 Jul 2003 12:31:02 -0700

Pretty soon you'll be able to write THE book on Cosmos...

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From: ToddRoberts2001@aol.com  
Date: Sat, 12 Jul 2003 16:33:31 EDT  
Subject: Re: [R-390] COSMOS PTO, starting over again.

Phil, good luck with the (ugh) Cosmos PTO! I know perseverance is a good thing but how many hours have you spent on this thing already? Let's see, at \$30/HR labor minimum do you figure this PTO is worth about \$500 bucks by now? Oh well, keep up the good work - you will be THE expert on Cosmos PTO's! Maybe someone will send you a Collins or Motorola PTO out of the goodness of their heart! I bet you are longing to see a corrector-stack again! 73

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Date: Sat, 12 Jul 2003 16:36:42 -0400

From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] 3rd Mixer noise, STINKIN' COSMOS PTO 8^)

I second this! I'm restoring a '52 Collins 390A. The ONLY non Collins component is - you guessed it - a Cosmos PTO. I'm saving ALL this traffic for my close future endeavor. It looks like THIS could be INTERESTING.

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] COSMOS PTO, starting over again.  
Date: Sat, 12 Jul 2003 19:22:23 -0400

Check to be sure the linearity disk isn't slipping on the shaft. That was the cause of the problem with the one in my Cosmos article on the web. The disk would slip and cause all kinds of problems with repeatability. It appears to be welded to the shaft with some kind of tiny electronic weld that can break loose. It can be repaired if this has happened. Also you would be wise to build a little test jig for the PTO. It will save you a lot of time in the long run. I built one with some cheap lumber, some metal brackets with holes threaded to match the PTO mounting screws, a few plastic couplings, a foot of brass stock shaft, and John Harvie's PTO calibration sale attached to a plastic disk. I will take a picture and post it on the web for any who want to do the same. I used a counter attached to the PTO, and a laptop with an Excel spreadsheet that plots the tuning curve (I type in the counter measurements at each quarter turn). The little test jig eliminates the need to swap the PTO in and out of the receiver, and provides relatively easy access to the tuning screws.. You will soon go bonkers if you keep doing that. I'll see if I can get that on the web also. It took me a few hours to build it, but saved a lot of hours in return. It's nice with the spreadsheet to be able to "see" the linearity error on the screen and know what areas need tweaking. Before you decide that the Collins PTO is better, keep in mind that it's stack of linearity "discs" inside the PTO are horrible to work with, and you have to keep taking the shield can off and back on again. I can linearize a Cosmos in an afternoon if it is working. Took me a week to do a Collins (a few hours a day). Jim N4BE

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From: ToddRoberts2001@aol.com  
Date: Sat, 12 Jul 2003 20:45:39 EDT  
Subject: Re: [R-390] COSMOS PTO, starting over again.

Thanks for all the info, Jim. Not sure why a corrector stack was seemingly hard for you to work on. I linearized a Collins PTO in an afternoon - got it to within 200Hz every 100KHz checkpoint. I did it outside of the R-390A using a degree wheel on the shaft. Just write down where it is off then you can return to each spot with the shield cover off. Just slip the cover on-and-off when you reach inside and then check linearity. You can get a "feel" for how much to change the corrector stack for the desired change.

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Sun, 13 Jul 2003 02:53:21 -0000  
Subject: [R-390] Cosmos, I broke it :.((

Well, I guess with all the taking it apart and putting it back together it was bound to happen. After this last surgery the poor thing is deader than a doornail! I've since pulled it apart twice and can find absolutely NOTHING wrong.

All coils have continuity, I have both B+ and screen Voltages on the tube, tube lights up, tube is good but "she no worky". I replaced the 2.2K resistor in the B+ supply as the original was somewhat burned and while I was at it replaced the capacitor that bypasses it to ground (as it was the only thing I could think of that would overheat that resistor).

I've had it open twice to try to figure out why it doesn't work. It is a SIMPLE one tube circuit and with 45+ years of tube experience it shouldn't be a challenge for me. But then engineers have a saying that the two most maddening things in engineering are "Oscillators that don't and amplifiers that do" (oscillate). Anyway, I've put it aside for the evening. I'm going to pick up the guitar and just have some "fun time" for a couple hours. Maybe tomorrow after church I'll look at it one more time and if I can't resurrect it I'll resurrect the parts unit I have here.

But I'll have to take the "spring thingy" and linearity disk out of the original PTO as I don't have the tiny tools needed to tune the disk in the parts unit. Also I don't like the looks of the coax cable or the output transformer on that unit (but it does work).

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Date: Sun, 13 Jul 2003 01:52:52 -0400  
Subject: [R-390] PTO Test Jig

These are photos of the test jig I use to align PTO's. It is made of pieces of stock lumber. As you can see it is rough but it works. The tuning circle is cut from plastic sheet stock with a PTO calibration template glued to it. I found this template as a printable download from the web, created by John (Harvie?) N3JKE. I can't seem to find that web page now however.. It ain't pretty but it works. <http://home.att.net/~jamesmiller20/ptojig.htm>

Also my original Cosmos adventure story is at:  
<http://home.att.net/~jamesmiller20/cosmos.htm>

Hope these are useful to anyone interested.

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] COSMOS PTO, starting over again.  
Date: Sun, 13 Jul 2003 01:58:30 -0400

Well maybe I was doing it wrong. You have to take the can off, then loosen that clamp screw in the back and then nudge the one slice of the stack you need to adjust, then tighten the screw again, then put the can back on, then check your frequency, and repeat those steps every 25 khz... seemed like the stack would squirm around whenever I loosened that clamp screw throwing a bunch of them back out of alignment, and I'd have to repeat it all again... or if I tweaked one slice,

it would mess up those either side. If there's a better way I sure would like to know. I have heard the rumor that Collins had a few very unique people locked away who did nothing but PTO calibration.

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From: Al Tirevold <tirevold@mindspring.com>  
Subject: Re: [R-390] PTO Test Jig  
Date: Sun, 13 Jul 2003 07:43:04 -0400

John Harvie's PTO calibration label is at:  
<http://r-390a.net/R-390A-PTO-label.PDF>

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From: ToddRoberts2001@aol.com  
Date: Sun, 13 Jul 2003 08:49:56 EDT  
Subject: Re: [R-390] COSMOS PTO, starting over again.

Jim, thanks for all the info AND PICTURES you posted on your web pages on repair and calibration of the Cosmos PTO. Now I have a much better understanding of the inner workings of the Cosmos! When I recalibrated the Collins PTO with the corrector stack, what I did was loosen the corrector stack holding screw just enough so that with some force I could slide the adjustment disks but not so loose that the corrector stack would lose its shape.

Instead of trying to slide one disc at a time I would gently curve the outline of the discs at the correction point. I checked mine every 100 KHz but I'm sure it would take more time and be more tedious if someone wanted to check every 25 KHz. The linearity seemed very good so I didn't bother to check every 25 KHz. Mine was off a half a KHz or so between about 3 or 4 100KHz checkpoints in a row so it was not a real tedious job. I can see the benefits of the Cosmos design - as long as it has not been abused or the ring damaged along the way.

I can see how someone not familiar with the Cosmos might try to screw those linearity adjustment screws in by mistake thinking it was the end-point adjustment. I bet that is how some of them got broken or damaged in the past. Thanks to Al for posting the address for getting a copy of the degree wheel - a handy item!

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From: "Jim Miller" <jamesmiller20@worldnet.att.net>  
Subject: Re: [R-390] PTO Test Jig  
Date: Sun, 13 Jul 2003 09:34:18 -0400

Someone asked me about the equations for the little spreadsheet I used to graph the PTO error. I lost your email. Send to me again and I will email an attachment back to you. Or go back to the web page and click on the link I added to a sample .xls file (scroll down to the bottom). It calculates expected frequencies at each quarter turn. Then you have to manually enter the actual measured frequencies, and it uses the Excel chart function to plot the differences, Pretty simple really.

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From: K6LQI@aol.com



Date: Sun, 13 Jul 2003 14:17:25 EDT  
Subject: [R-390] Setting end points on Cosmos PTO

I'm aligning my first R390. I pulled the PTO to correct the 14 khz error it had in it's 1 mhz travel. I turned the screw several times but it had no effect on either end point. I removed the outer cover on the PTO and saw what I was turning was a brass screw with a fine thread on it's OD and a 1/8" diameter hole through it. Any ideas? Is this screw supposed to move a slug in the coil like the schmatic shows or is this a variable cap? Thanks and 73 Tom k6lqi

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From: "Phil Atchley" <k06bb@elite.net>  
Subject: RE: [R-390] Setting end points on Cosmos PTO  
Date: Sun, 13 Jul 2003 23:59:29 -0000

It sounds to me like you're adjusting the thermostat instead of the end points. The thermostat is the far LEFT screw (left side of the tube) as you look at the front of the PTO with tube UPRIGHT. The End point is on the far RIGHT when looking the same way. The one in the middle is the linearizing window to access those 48 screws! (BOY DO I KNOW ABOUT THOSE 48 SCREWS!)

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From: "Phil Atchley" <k06bb@elite.net>  
Subject: RE: [R-390] 3rd Mixer noise, STINKIN' COSMOS PTO 8^)  
Date: Mon, 14 Jul 2003 04:53:26 -0000

Well, I won't say that ALL Cosmos PTO's will give you as much trouble as I had. Remember, the first PTO I had contained some damaged components ("Springy thingy") and a couple other problems and the 2nd unit had some other "multiple issues" with it. However, as evidenced by the relative ease I had after overhauling the second unit I will have to say that if your PTO is otherwise in good condition you may have little or no problems at all tuning it up. One thing that IS worth noting is that neither of my units needed to have a turn removed from the end point coil though I did that to the first unit and ended up having to rewind the coil with the proper 3 turns. It appears, at least in the case of these units that cleaning and lubing them seemed to bring the end points in to where they could be adjusted with the end point coil. Good luck with your Cosmos.

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Date: Mon, 14 Jul 2003 15:05:47 -0400 (EDT)  
From: "Paul H. Anderson" <pha@pdq.com>  
Subject: Re: [R-390] COSMOS PTO, starting over again.

> HEATER NOTE: This time upon disassembly I completely removed the  
> thermostat and the heaters from inside the PTO. I NEVER use them anyway  
and they just >complicate the teardown-rebuild of the unit. Yes, I'll keep the  
insulation intact as I'm sure it >adds to the thermal stability.

Phil - it has been great reading all your notes about your rebuild experience. I've got only Cosmos PTO's for my R-390A's, plus one spare that I have taken partway apart. Regarding the fiberglass insulation... it must be there to keep heat IN the PTO with the heater running. If the heater is off, or left out, the blanket slows the

absorption of heat from the radio. Stability is reached when the temp is the same over time. Therefore, I suspect that it would be better to leave the blanket off, since you'd reach thermal soak more quickly (i.e. the radio heats the PTO to the same temp).

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Date: Wed, 16 Jul 2003 07:56:47 +1000  
From: Lionel Sharp <vk4ns599@optusnet.com.au>  
Subject: [R-390] Re: (R-390) PTO Test jigs

There is an article titled "New life for the Collins 51J receiver VFO" by William Orr, W6SAI (now a SK) in the December 1969 issue of Ham Radio magazine which features a "test jig" to operate on the PTO. The PTO is a 70E - 15 which covers 2 to 3 Mhz with 10 turns of the tuning shaft. This PTO does not appear to be as complex as the ones used in the R390 & R390A receivers whose PTOs cover the range 2.455 to 3.455 Mhz..

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From: "Merle" <lal@cyberwc.net>  
Date: Thu, 17 Jul 2003 18:34:56 -0400  
Subject: [R-390] Collins PTO Identification Guide

You might find this site helpful when working on PTO's I use it often ! Good luck..  
Merle W1GZS <http://www.militaryradio.com/pto.html>

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From: "Phil Atchley" <k06bb@elite.net>  
Date: Wed, 23 Jul 2003 20:45:33 -0000  
Subject: [R-390] Today I Tweaked my PTO endpoint and lubed gear train.

Hi After having used it for a week or so the end point had changed about 1KHz. This gradually occurred during the first couple days of use after the set was put into full operation at the primary operating position and hadn't changed since. So today I removed the PTO and tweaked it back to where it was. Linearity was still good after putting it back. This doesn't surprise me any as I kind of figured it might change a little after the set was run many hours in its cabinet. It is probably the nail polish I used on the coils etc curing. It was baked for a short period but doubt that took care of all curing. I suspect it won't happen again, at least not for quite a long time. <snip>

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From: "John Page" <k4kwm@hotmail.com>  
Date: Wed, 30 Jul 2003 02:00:27 +0000  
Subject: [R-390] bottom 200 kc dead

My Collins R390A just suddenly developed an odd ,to me, problem. It suddenly decided it would not receive anything from X.200kc down. This on ALL bands. Really didnt have a clue as where to start as signals from 200kc up were great. It was as though you flipped a switch when you tuned below 200kc on any band. I did check all tubes. Just to try something. All checked good. Thought a cam had slipped so I compared it with my Stewart Warner which works great.

All seemed ok. Had a occasion to be talking to Jim Garland W8ZR this evening

and he thought I should **check out the PTO**. Jim knows his stuff so I went home and decided the easiest check was a new PTO tube. WOW it works. Old tube still checks good and returning it to the PTO brings back the problem So Thanks Jim, you fixed it. Not sure why that happens but at this point, who cares. Just wanted to share this with the group. Might be some newbys to 390's like me on here.

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From: "g4gjl" <g4gjl@btopenworld.com>  
Subject: Re: [R-390] bottom 200 kc dead  
Date: Wed, 30 Jul 2003 09:17:02 +0100

I had the same problem, and it turned out to be the 6BA6 in the PTO had gone low emission. Change it before you look any further.....could save a lot of time!

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From: <Tarheel6@msn.com>  
Subject: Re: [R-390] bottom 200 kc dead  
Date: Wed, 30 Jul 2003 09:01:51 -0400

Check the mixer rack and slugs to the right, rear of the rf deck. Usually when something like you experienced happens to me, I find that the rack is sticking. It may be a subtle binding, so look very carefully at whether the rack is moving through its entire range.

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Date: Wed, 30 Jul 2003 09:59:07 -0400  
From: tbigelow@pop.state.vt.us (Todd Bigelow - PS)  
Subject: Re: [R-390] bottom 200 kc dead

Thanks for posting this, John - these are the kinds of things you'd (we'd?) not normally associate with this behavior (I was thinking something along the lines of a crystal problem).

Just goes to show, you can never trust a tube even if it checks 'good'. There's a reason why they list "substitution with a known-good substitute" as being the best method for testing a tube or given circuit.

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Subject: RE: [R-390] bottom 200 kc dead  
Date: Wed, 30 Jul 2003 12:26:05 -0700  
From: "David Wise" <David\_Wise@Phoenix.com>

I bet that PTO has FC-7 installed.

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From: "Drew Papanek" <drewmaster813@hotmail.com>  
Date: Thu, 31 Jul 2003 14:01:27 -0400  
Subject: [R-390] Bottom 200Kc Dead

<snip> it would not receive anything from X.200kc down. T.....

As Dave Wise (he truly is) pointed out, your PTO may have Field Change 7 installed. That changes the value of the screen resistor with the intent of reducing radiated signal. Low(er) screen voltage may cause the problem you described.

Someone else had the same problem a while back. The cause turned out to be low PTO tube heater voltage caused by a defective BallasTube. Replacement of the 6BA6 was the temporary solution. Verify correct heater voltage at PTO tube with tube in socket. Those BallasTubes can fail in ways other than going open, and some were out of spec to begin with.

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From: Doug McRae <d.mcrae@telus.net>  
Date: Sun, 30 Nov 2003 19:40:39 -0800  
Subject: [R-390] r-390a pto output voltage

Does anyone know what the correct output voltage is for R390a PTO? As well, where does it peak and what the correct adjustment procedure for transformer Z-702? I have checked one with a HP3400A and it had a peak of 7.75 volts at 0 000 and 2.25 v at 0 500 and 0+000. I can't find anything in the manual or on-line.

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From: "Ronnie Davis" <rdavis24@carolina.rr.com>  
Date: Fri, 19 Dec 2003 17:48:25 -0500  
Subject: [R-390] Big Mistake Please Help

Well all was going well with the Capehart R-390A until last night. I pulled the RF Deck out to start working on it, and after cleaning for sometime, I remembered that I did not set the PTO to 8 Mhz before pulling the deck! After I remembered that I just thought about messing up big time! I had already been turning the Mhz change knob to clean the deck, and the kilocycle change knob has also been turned for cleaning.

So the problem is, that I have no idea where the PTO was at when I pulled the RF Deck? I knew better than this, I knew from the manuals and the videos that I should have put the PTO on 8 Mhz but while in the heat of working on it I just slam forgot. Please tell me there is a way to find out where the PTO is so I can install the RF Deck when I finished with it. Sure hope I did not mess up to bad? Again a Stupid Beginners Mistake

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From: "Steve Goode" <goode@tribeam.com>  
Subject: Re: [R-390] Big Mistake Please Help  
Date: Fri, 19 Dec 2003 17:35:13 -0600

If it is any consolation, I made careful measurements of my PTO before I took it apart. I took digital pictures of it. I made marks on the shaft and housing. Everything was done at 8 MHz. After I put it all together, IT WAS STILL WAY OFF! So don't feel bad. If I remember correctly, the way I got it back on was to take my signal generator and find where the receiver was with the generator set very high. Then I walked the PTO back to where it should be. Sure made a big difference in sensitivity! I guess you could also count the PTO with a freq counter to get it back on.

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From: David Hallam <dhallam@RapidSys.com>  
Subject: RE: [R-390] Big Mistake Please Help  
Date: Fri, 19 Dec 2003 19:32:08 -0500

Don't know about the 390A but on the 390 the end points of the PTO are 3.455 and 2.455 MHz. If you use your frequency counter to set the PTO to 2.955 MHz and set the counter to 500, you can lock the shaft to your tuning knob.

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From: "JamesMiller" <jmiller1706@cfl.rr.com>  
Subject: Re: [R-390] Big Mistake Please Help  
Date: Fri, 19 Dec 2003 19:26:31 -0500

Set the band and the tune digits to your favorite AM stations frequency (say 1240 or whatever). Turn the PTO shaft by hand until you hear your station. If you get all the way to one end with nothing heard, go the other direction. You will also hear the noise level peak up when you're more or less synchronized. Be careful not to turn it past its stops however. It's no big deal, I have to do this every time I open mine up.

---

Date: Fri, 19 Dec 2003 17:19:16 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: RE: [R-390] Big Mistake Please Help

You did the right thing by asking for help, but this is not really a big deal (unless you proceed without help then it can become a big deal). The methods mentioned herein all can work. You can do an initial setup by knowing this:

- the 10 turn stop on the RF deck has a range of 10.7 turns (what the? I thought it was 10!).
- the PTO has a greater range, about 15 turns from its stop-stop (give or take for different makers).
- So just set your RF deck on a known spot (like 000) and then install the PTO about 2.5 turns from its stop (from the proper end of course).
- now you can listen for your local AM stations and check for the amount of KC error and correct it.

The 390 and 390A have the same output in frequency on the PTO, that is on 000 the PTO will generate 3455KC, at the top end of its range it generates 2455 KC. If you have a frequency counter, this is the safest way to set it up.

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From: "Dennis L. Wade" <dwade@pacbell.net>  
Date: Fri, 19 Dec 2003 20:43:58 -0800  
Subject: Re: [R-390] Big Mistake Please Help

I am in the almost exact same position...I have my RF deck out for cleaning and recapping and I'm sure the PTO isn't where I left it. I've been looking at the manual anticipating doing just what's been suggested...lining it up with a broadcast station or using the freq counter. Unless you've cranked the PTO way too far either way I'm sure you haven't ruined anything. I really don't know how

you could avoid re syncing the PTO after removing the RF deck. Good work...and good question! You beat me to it.

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Date: Sat, 20 Dec 2003 01:44:44 -0500  
From: "Steve Modena, AB4EL" <AB4EL@MindSpring.com>  
Subject: Re: [R-390] Big Mistake Please Help

I showed the question from Ronnie to an R-390 fiend. The answer is:

"The R390 RF deck is set to 8MHz or 07+000 .  
"The PTO should be set to 2455kc with a freq. counter or another receiver.  
"When the RF deck is on freq. 8MHz./07+000 all the cams should be on target."

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Date: Sat, 20 Dec 2003 08:18:27 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: [R-390] Cams and/vs PTO

The cam issue is a separate problem from the PTO issue.

The cams must be set at 7+000. The PTO can be set on either end or anywhere one can track down a reference.

The point is, the RF deck does not have to be at 7+000 to set the PTO.

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Date: Mon, 22 Dec 2003 15:52:39 -0500  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: RE: [R-390] Big Mistake Please Help

>Don't know about the 390A but on the 390 the end points of the PTO are 3.455  
>and 2.455 MHz. If you use your frequency counter to set the PTO to 2.955  
>MHz and set the counter to 500, you can lock the shaft to your tuning knob.

CAREFUL! Note Tom M's later post. (the PTO frequency in the opposite direction from dial frequency):

>The 390 and 390A have the same output in frequency on the PTO, that is on 000  
>the PTO will generate 3455 kcs, at the top end of its range it generates 2455  
>KCS. If you have a frequency counter, this is the safest way to set it up.

---

From: "Ronnie Davis" <rdavis24@carolina.rr.com>  
Date: Mon, 22 Dec 2003 21:20:40 -0500  
Subject: [R-390] Big Mistake Update

First I want to say a BIG THANK YOU to all on the list who offered me help with my latest problem. I have found out what im going to do, after listening to several solutions from the members of this list. I have been cleaning, re-cleaning and cleaning again the entire RF Deck. I have all the slug racks done, but ended up breaking two slugs by dropping the last rack. I have a few spares and I'm glad I do

now hi. I have been working on the gear train for several days on and off. I was afraid to dis-assemble the gear train since this is my first one, but I have all the gears clean now. I have lined up all the cams at 7+000 and set the over travel on the dial to 7+035. I still have to do a little more cleaning and then im going to recap the RF Deck. Hopefully by this weekend I will have it ready to try and line up the PTO to the RF Deck. What I am going to do is set the radio to 7+000 then im going to set the PTO to 2,455 with a frequency counter and hook everything back up. I hope all is well, cause I have spent a lot of time cleaning and working on this Capehart R-390A. I think I may have been bitten by some bug? I never in my life would have thought that I would enjoy working on a radio as much as I have this one. Its been a great stress relief, and it keeps the old radios glowing. Its great being able to stop when you want to and go back when you want to. Although my XYL thinks im crazy working on the ole radio so much, it sure does make me happy. Again thanks for all the help and maybe by Sunday I will have a better update. Thanks Ronnie

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Date: Sun, 4 Jan 2004 18:50:47 -0500 (EST)  
From: "Paul H. Anderson" <paul@pdq.com>  
Subject: [R-390] R-392 PTO output level?

What is the output level of the R-392 PTO supposed to be, and is it about the same as the R-390/391/390-A PTO? I'm aligning a 392, and found that the PTO is drifting, so when I put a scope on the output, the signal looks noisy and weak (<10mv or so).

---

> Paul,  
>  
> Data I have indicate 1.5 to 2.2 volts. (I assume this is RMS RF voltage.)  
> >I'm aligning a 392, and found that the PTO is drifting, so when I put a  
> >scope on the output, the signal looks noisy and weak (<10mv or so).  
>> Way too low. You have something to fix and you know where to start.  
>> - Roy Morgan, K1LKY since 1959 - Keep 'em Glowing!

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Date: Fri, 06 Feb 2004 11:48:17 -0500  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] R-388 Info

One point that may not have been mentioned yet: the R-388 PTO's. The R-388 PTO's can be divided into two groups: those which do not drift and those which do, always have and always will. By "drift", I mean the "endpoint spread" increases slowly over time. That means that it takes more than 10 turns of the shaft to change the PTO frequency the one megacycle it is intended to change.

Here are significant points about this situation:

- The only way you can know which you have is to get the radio and try it out. -
- Non-drifting PTO's are not rare but you don't know which you have till you have it. Do not rely on any seller to tell you the truth. They may not know what -

you are talking about.

- There is no cure for a drifting PTO. You can re-align it to bring the spread back to correct, but it will continue to drift. (Some folks overcompensate about 2 to 3 years worth of drift and then count on doing it again after 4-6 years.)
- Careful overhaul of a PTO and correction of drift is not for the novice, but is certainly doable if you are a capable technician and take advice well.
- This situation of a drifting PTO only bothers some people, not all.
- The receiver is still very useful, and normal operating procedure compensates for the errors.

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From: "Bernie Nicholson" <vk2abn@batemansbay.com>  
Date: Sun, 11 Apr 2004 16:12:25 +1000  
Subject: [R-390] 4KHZ filters

<snip> on a different subject I have just linearized a PTO by making a little jig and using the dial from a ten turn pot to draw graphs until I got a straight line response. It took about 5 hours and when I put the cover on I only had to make a slight adjustment to the end stop and it is within 300 hz from one end of the dial to the other, A win for me anyway.

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Date: Sun, 11 Apr 2004 11:10:47 -0400  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] 4kc filter

This is turning into two different threads ..... <snip> The PTO issue .... There is a well documented issue with the main coil in the R-390 PTO's. Collins figured out the problem and changed the design on the next generation of radios. All of the subsequent Collins designs used the newer coil rather than the R-390 one. It's not at all clear why somebody didn't put the newer coil into a 390 PTO ... I suspect that Collins kept quiet about what the fix was for competitive reasons. The guys that figured it out still treated as a big secret thirty or forty years later. A couple of things happen to the coil over time: First the core material that tunes the coil changes value over time. Depending on the material this could go either way in terms of inductance. Second the coil form it's self shrinks very slightly. This puts the windings of the coil closer to the core. The change in length is insignificant. When the turns get closer to the core the inductance goes up. The net result is that the tune range of the coil changes as it ages. Since no manufacturing process is perfect the coil turns are not quite spaced evenly over the length of the coil. As the value of the coil changes the relationship between the non linearity and the tune setting changes.

The nice thing about the gear train is that until you lose a tooth off of a gear it keeps doing about what it always has done. The play goes up a little on the counter as things wear with time but the rest of the system stays pretty tight. I have no problem at all with doing a linearity fix on a PTO. It takes a lot more



patience than most of us have. The thing that puts most of my 390's off frequency is the crystals. Getting to the point that they are not a problem also takes a lot of patience and a very big bucket of crystals. If you wanted a radio that you could simply tune to frequency that would be the way to go. No calibrate each time you switch the MHz knob. Of course you could revive one of the Manson Labs.  
=46rom talking to the tech's who built them that would be a bit of a chore though.

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Date: Tue, 13 Apr 2004 03:09:35 -0700 (PDT)  
From: "KC8OPP Roger S." <kc8opp@yahoo.com>  
Subject: Re: [R-390] PTO

I have a COSMOS built for the 390A that is now in one of my R390's. You will have to fabricate a new rear mounting bracket. I was able to pull the green screw and barrel out of the old bracket and press it into the new bracket. Rewire the the power connector to match and replace the signal output cable with some RG58 and a normal BNC. Good luck and let us know how it works.

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From: "Jim Temple" <jetemp@insightbb.com>  
Subject: Re: [R-390] PTO  
Date: Tue, 13 Apr 2004 11:37:50 -0400

I have four Cosmos PTO's in my R-390A's and spares. All have the "type" 136-1 printed on the case. I own a R-390 that also has a Cosmos PTO. This PTO appears to have original wiring. The "type" printed on this PTO is 136/283. Perhaps there was a contract let for replacement PTO's manufactured by the Cosmos people for the R-390?? Any thoughts?

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Date: Tue, 13 Apr 2004 10:55:41 -0700 (PDT)  
From: David Medley <davidmed82@yahoo.com>  
Subject: Re: [R-390] PTO

There are 3 things you have to do to convert and R-390A PTO to an R-390.

- 1. Shorten the output cable and replace the mini BNC with a regular BNC, This is not as easy as it sounds as the cable in the R-390A is a mini coax and it is not easy to attach a full size BNC. If I had to do this I would replace the whole cable assembly.
  - 2. The pinout in the power plug is different and has to be rewired. This should not be difficult.but be careful. It is easy to damage these connectors with too much heat.
    - - 3 You will have to replace the rear mounting plate.

If you decide to go ahead with this I have some junk PTOs here and can probably come up with a rear mounting plate and an output cable.

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From: "Jim Temple" <jetemp@insightbb.com>

Subject: Fw: [R-390] PTO  
Date: Sat, 17 Apr 2004 09:19:39 -0400

I have been thinking (oh-oh). The cable that outputs the frequency for the R-390A is tagged P717. The Cosmos PTO that is installed in my R-390 has the frequency cable tagged as P723. Is this more proof that, perhaps, Cosmos had a contract to provide replacement PTO's for R-390's??

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Date: Wed, 16 Jun 2004 18:57:30 -0400  
From: "Forrest Myers" <femyers@attglobal.net>  
Subject: [R-390] Re chirping CW and low audio plus strange PTO problem.

<snip> Now, I have a strange problem with the PTO. If I tune up from 0 to 1000, it is very linear, within a couple hundred hertz all the way. If I tune down from 1000 to 0, it is very linear, within a couple hundred hertz except at 100khz where it is suddenly about a kHz off. Going on down to 0 it is back on. If I approach the 100khz mark from about 10 kHz below, it's right on the money. If I approach it from about 10 kHz above, it's about a kHz off, low. Scratching my head for a while, I figure there must be some mechanical problem inside the PTO but can't imagine what it is unless the core is dragging on the coil and causing it to move at around the 100 kHz mark. There is no play in the gear train or the PTO shaft coupling. When tuning at the 100 kHz mark, any slight movement of the tuning knob will cause a change in the frequency of the PTO. Any ideas? Should I just live with it?

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Date: Wed, 16 Jun 2004 21:43:26 -0400  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] Re chirping CW and low audio plus strange PTO problem.

You don't mention whose PTO you have so this may not be exactly right for the PTO you have. The simple answer is that yes you have a simple mechanical problem with the PTO. With the original design the PTO is linearized by a bunch of little sliders that make up a zig zag track that runs the length of the coil. There is a follower that runs along this track and it drives the compensation process. If you have a steep spot on the track around the 100 KHz point and a weak follower spring then it will run "up hill" just fine. When you come back and try to go "down hill" the compensation will not be repeatable. On a totally unrelated note the set up of the sliders on the track was still remembered twenty years later as "the worst job they ever made me do here" by the line workers who built the Motorola PTO's .... Talk about hard to explain your hobby to somebody ....

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Date: Thu, 17 Jun 2004 09:34:31 -0400  
From: "Forrest Myers" <femyers@attglobal.net>  
Subject: Re: [...plus strange PTO problem.

Thanks for the PTO information. My PTO is a Progressitron and is extremely linear except when going up hill at around the 100 khz point. I did some more testing last night and found that it is worse than I'd thought. The worst point is at 105 khz where it is 2 khz low! Going uphill, the non linearity starts at 80 khz and gets worse up to 105 khz where it is 2 khz low. Then, at 110 khz it is fine at only 200 hz low.

Remember, when tuning downhill, the linearity is just fine from 1000 to 0. Do you know if the Progressitron PTO works the same as the Motorola? I'm seriously thinking about taking the thing apart and looking at it. If the spring is weak, is it repairable?

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Date: Thu, 17 Jun 2004 07:47:38 -0600  
From: Jordan Arndt <jordana@nucleus.com>  
Subject: Re: [...strange PTO problem.

It's entirely possible that the spring is weak, but it could also be that the pivot is gummed up with dried lubricant...if the 'bend' of the wafers in the corrector stack is steep, it can cause the pinch rollers to 'open' and stay that way until some other contact cause it to close back up again and continue normally....whatever you do, don't change any of the corrector stack settings...! 73 de Jordan...

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Date: Thu, 17 Jun 2004 19:11:11 -0400  
From: Bob Camp <ham@cq.nu>  
Subject: Re: ....strange PTO problem.

The PTO's are all repairable regardless of who made them. Since it's a mechanical problem it should be pretty easy to figure out. You may find a bunch of what used to be grease or you may find a spring that's past it's prime. I doubt you will find anything more complex than that. Make sure you do a read through one of the manuals before you pull the PTO from the radio. It's not real hard but if you do it right it's a lot easier to get everything running after you drop it back in.

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Date: Thu, 17 Jun 2004 19:57:57 -0400  
From: "Forrest Myers" <femyers@attglobal.net>  
Subject: Re: ....strange PTO problem.

Well, today I took the PTO apart. Inside it looked like a new one. All the lubricant was still very moist and the spring on the stack follower was nice and strong. I figured out the problem but didn't fix it. It appears that the PTO was defective when manufactured and when it was linearized, it was done only while tuning uphill.

The correction stack has a very sharp bend right around the 100khz point. I checked both rollers as they passed the sharp bend and they both followed just fine. Looking closer, I noticed that there was a slight gap between the wafers in the stack. Looking even closer, I noticed that, when tuning uphill, there was so much pressure on the wafer at the peak of the bend that the wafer actually bent under the load and straightened out after the roller passed it. When tuning down hill, the wafer wasn't under much pressure at all and didn't bend at all, thus the difference in the linearity between tuning up and tuning down.

I didn't see any easy way to fix it so just put it all back together. One nice thing is that the rig still works and the linearity didn't change, whew! Guess I'll just live with it unless anyone on the list has a way to fix the problem.

I suppose, I could change the wafers such that it tuned correctly going downhill and

then fill the gaps between the disks with epoxy or something so that they wouldn't bend while tuning uphill. Sounds like a lot of tedious work to me.

---

Date: Thu, 17 Jun 2004 19:12:13 -0500  
From: mikea <mikea@mikea.ath.cx>  
Subject: Re: .....strange PTO problem.

Well, the easiest way to fix the problem would be to get a "new" (to you, at least) PTO, from Fair or someone who's parting them out, or from one of the R-390/R-390A fixers. Good luck, whatever you choose to do.

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Date: Thu, 17 Jun 2004 22:14:31 -0500  
From: Tom Norris <r390a@bellsouth.net>  
Subject: Re: ....strange PTO problem.

>It's entirely possible that the spring is weak,

The spirit is willing, but the spring is weak???? Had the same problem with one of my spare PTOs a couple years ago, it was indeed the spring on mine.

---

Date: Fri, 25 Jun 2004 13:30:35 -0400  
From: "Forrest Myers" <femyers01@bellsouth.net>  
Subject: [R-390] Non-Linear PTO

I had a problem with my Progressitron PTO where it had a bad spot right around 100khz Where it was suddenly almost 2khz off, depending on the direction of tuning. Tuning uphill, it was fine. Tuning downhill, it went bad at about 105khz and got back on track at about 80khz. Took the PTO apart and found it to be unrepairable due to the sharpness of the change in the stack at that point. Decided to get another PTO.

Bought a junker from Fair Radio. When it arrived, I took a look at it and didn't have much hope. It was very beat up, dented and dirty. Took the outer can off to see if the dents reached the inner can and found that they didn't. The shield on Z702 was badly dented and leaning at about a 10 degree list to port. I took the cans and brackets off and gave them a good washing. Decided to to some body work on the Z702 can and got it back into fair shape. Bent the works inside the Z702 can to where they stood straight up again. Noticed that T701 had never been soldered in! Wonder how it ever worked reliably. Probably never did. Soldered T701 in. The output co-ax was in bad shape and was almost cut in two in a few places. Replaced the co-ax. Made up a test jumper cable and hooked the PTO up to power to see what would happen. Hooked a frequency counter to the output and fired it up. The PTO came up without any smoke and was on a reasonable frequency. Turned the shaft and it seemed to be very stable. Maybe it was going to work! Adjusted the PTO to put out 3.4550 mhz and powered it down. Installed the PTO in R-390 a Capehart SN #557, did the end point adjustments and it's just fine! The linearity is within spec and seems very stable. Hope it keeps working! I'm keeping the old Progressitron for a backup but will probably never use it because of the bad spot in its tuning range.

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Date: Fri, 3 Sep 2004 22:41:35 +1000  
From: "Bernie Nicholson" <vk2abn@batemansbay.com>  
Subject: [R-390] 390a frequency readout

The cosmos PTO on one of my receivers has 4 linearity adjustments /turn I made a jig using the dial from a ten turn pot and using a HP5245 counter and a couple of sheets of graph paper; and after a few adjustment runs my receiver after I calibrate it on any particular band the frequency read out is within 100hz , I have also checked it against my Racal/Dana synthesized sig gen, and that also supports the same conclusion Who needs better accuracy than this?

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Date: Sat, 18 Sep 2004 09:35:54 -0400  
From: "James Miller" <JMILLER1706@cfl.rr.com>  
Subject: [R-390] COSMOS PTO Article

For use in Dave Medley's page re-hosting, the full COSMOS PTO article is on my web account at: <http://home.cfl.rr.com/jmiller1706/cosmos.htm> The two corrupted images can be restored from there.

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Date: Mon, 22 Nov 2004 15:29:15 -0500  
From: Bill Abate <wabate@dandy.net>  
Subject: [R-390] Cosmos PTO adjustment

I'm tackling the Cosmos PTO for linearity adjustment. I have Dave's article on how to do it but I'm having problems in finding out what tool to use. Those darn small screws are hard to see especially at my age!! I was able to determine (with an 8X magnifying glass!)that the cap screw is an Allen head cap screw. The smallest allen wrench I have is .028" and it fits but jumps when I try to turn the screw. I have no idea what standard sizes allen wrenches come in. 1/16" is way to big. 1/32" is .032" but that does not seem like too much of a difference from the .028 that I have. Anybody know what size wrench I should be looking for?

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Date: Mon, 22 Nov 2004 17:16:48 -0500  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] Cosmos PTO adjustment

I think the Cosmos PTO's I have here use screwdriver-slotted screws for the linearity adjustment. I have no idea what standard sizes allen wrenches come in.

Check <http://www.engineeringfindings.com/cat22/cat22pg364.pdf> (Small Parts, Inc,) they seem to come in 28, 35 and 50 thousandths.

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Date: Mon, 22 Nov 2004 17:54:22 -0500  
From: Bill Abate <wabate@dandy.net>  
Subject: Re: [R-390] Cosmos PTO adjustment

Thanks for the info. It looks like I need the .035, unless it is a non-standard size which I doubt. I have a friend checking for one. Hope he can come through. Also, it

is my understanding that the Cosmos PTO used allen, slotted head and bristo head cap screws for the linearity adjustment. Go figure! At least they didn't use them all on the same PTO! HI HI..

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Date: Tue, 23 Nov 2004 05:56:20 -0800 (PST)  
From: "KC8OPP Roger S." <kc8opp@yahoo.com>  
Subject: Re: [R-390] Cosmos PTO adjustment

Here is what I found and it fits a couple of the PTO's that I have been into. Some of them have slots for a tiny jewel screwdriver bit, but then there is the allen type. Contact your Snap-On dealer and order up "MS2A". this is a multi spline L-shaped wrench. Four flutes at 0.033 inches. When it comes in take your magnifier with, it is very small. Good luck and let me know what you find.

---

Date: Sun, 28 Nov 2004 15:01:05 +0000  
From: "Gene Dathe" <dathegene@hotmail.com>  
Subject: [R-390] PTO connector

I have a damaged Cosmos PTO. I need J709, the blue 9 pin connector and associated hardware. You can sell me the connector alone or a complete junked pto of any vintage... Thanks!

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Date: Sun, 28 Nov 2004 12:15:43 -0500  
From: "David C. Hallam" <dhallam@rapidsys.com>  
Subject: RE: [R-390] PTO connector

Try Bill Perry at William Perry Co. 502 893-8724 He has all kind so surplus connectors.

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Date: Sun, 28 Nov 2004 21:25:12 +0000  
From: "Gene Dathe" <dathegene@hotmail.com>  
Subject: [R-390] PTO connector

A connector has been located. A big THANKS to Dave and all the others who responded off list. Gene, NA0G

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Date: Fri, 17 Dec 2004 08:15:08 -0500  
From: joe.fallon@philips.com  
Subject: [R-390] Comsos PTO

I have been trying to do an end point adjustment on my R390a 's Comsos PTO. Turning the endpoint adjustment screw has no effect on the PTO's output frequency although the adjustment screw appears to be moving in and out . Anyone got an idea as to what may be going on? I was thinking off removing the cover but the PTO's power cable splits into two with one half going though a access hole in the cover. It looks like I will have to undo the connections to the Cinch connector and split the cable harness so that cover can be removed..... Thanks in advance for any comments or suggestions,

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Date: Fri, 17 Dec 2004 07:48:24 -0600  
From: Jerry K <w5kp@direcway.com>  
Subject: RE: [R-390] Comsos PTO

[http://www.r390a.com/html/n5off\\_pto.html](http://www.r390a.com/html/n5off_pto.html)  
should be a good starting point, Joe. A google on "cosmos pto" will turn up a ton of helpful info.

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Date: Sat, 22 Jan 2005 11:42:20 -0600  
From: Tom Norris <r390a@bellsouth.net>  
Subject: [R-390] Raytheon PTO?

I recently came across a Raytheon PTO for the 390A. Anything special about it? I will assume this is a rework by Raytheon. Date is 1977. Pix here --  
<http://www.hezbollah.org/390A/ray1.jpg>  
<http://www.hezbollah.org/390A/ray2.jpg>

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Date: Sat, 22 Jan 2005 12:56:32 EST  
From: Llgpt@aol.com  
Subject: Re: [R-390] Raytheon PTO?

Raytheon "NEVER" manufactured PTO's, it was a rebuild contract.

The Manufacturers of PTO's are:

1. Collins
2. Motorola
3. Dubrow
4. Progressitron
5. Cosmos

Les Locklear

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Date: Sat, 22 Jan 2005 13:57:14 -0500  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] Raytheon PTO?

The main problem with "Raytheon" PTO's is that you next have to find out who \*really\* made the poor thing. The military went through a \*lot\* of PTO's. They set up Raytheon to rebuild a bunch of them to keep the radios in service.

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Date: Sat, 22 Jan 2005 14:50:11 -0600  
From: Tom Norris <r390a@bellsouth.net>  
Subject: [R-390] Raytheon Rebuild Riddle Resolved

The Raytheon rebuilt PTO is a Cosmos. The cal label was over the linearity adjustment cover screw.

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Date: Sat, 22 Jan 2005 19:40:46 -0500

From: Llgpt@aol.com  
Subject: Re: [R-390] Raytheon Rebuild Riddle Resolved

The majority that I have seen are Cosmos, of course, the Cosmos PTO's are much more abundant than the others. I have seen a couple of Dubrows and one Progressitron. Les Locklear

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Date: Sun, 27 Feb 2005 11:33:20 -0800  
From: "Dennis L. Wade" <dwade@pacbell.net>  
Subject: [R-390] PTO Woes

I think I killed my PTO. Probable cause of death was excessive pressure on the shaft while attempting to re-install the RF deck after cleaning and recapping. Apparently the Oldham coupler wasn't aligned as I had thought, and after the deck was installed, I turned the Kc/s knob and noted an excessive amount of drag. Upon inspection, the mis-aligned disk was \*tightly\* up against the VFO shaft. Next time I have to take out the RF deck, the PTO is coming out first. Ah, the wisdom of hindsight.

Looking at the output on a counter, it wasn't near 2.45500 Mc/s. (It was over 3). Turning the shaft clockwise brought the frequency \*up\*! Running the shaft the other direction brought it down to around 3..then back up..then down consistently in the manner it should. My layman's hunch says the corrector stack and/or the core itself it toast. I've never done it that I know of, but it almost acts like it was run out beyond its 10 turn stop given its symptoms. If I set it now at 2.455, and call that turn 0, it behaves ok till about turn 6 or 7 when the frequency goes amuck, jumping around hitting almost 6 mc and then, around turn 8 settles back approximately the right frequency. However, it reaches 3.455 mc/s in about 9.5 to 9.75 turns.

I'm not up to rebuilding a PTO (See what happened when I took out the RF deck?). Unless I decide to do an autopsy, I have available a Motorola for someone who would like one to rebuild. :/

Maybe someone would like to rebuild mine? :D

Anybody have a good PTO available? I'd like one with linearity screws (as in the Cosmos) if possible. I'd like to find one here, but failing that...anyone have any experience with the "as-is" PTOs from Fair? Also, please advise appropriate penance for killing a PTO.

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Date: Sun, 27 Feb 2005 14:39:56 -0500  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] PTO Woes

I don't know if they still have them, but for a lot of years Fair Radio would sell you a replacement PTO pretty darn cheap. It was a "pot luck" sort of deal so you might have to buy more than one. I seem to remember them being less than \$30

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Date: Sun, 3 Apr 2005 22:20:08 EDT



From: Llgpt@aol.com  
Subject: Re: [R-390] Cap leakage

>the original Progressitron failed PTO (it developed a warble).

There is an easy fix for that. The tiny caps (10 picofarads I think) inside the can break loose from the solder connection, just reflow it and it will be fine. Seen it on 7 different Progressitrons.

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Date: Sun, 3 Apr 2005 22:18:18 -0500  
From: "Barry" <N4BUQ@aol.com>  
Subject: Re: [R-390] Cap leakage

Isn't a dirty ground strap also one cause of PTO warble?

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Date: Sun, 3 Apr 2005 23:25:12 EDT  
From: Llgpt@aol.com  
Subject: Re: [R-390] Cap leakage

Yes. But in the Progressitron's case, I believe it was a quality control problem. I've owned R-390A's with 8 Progressitron PTO's, 7 of them had the bad solder joint on the caps. And, they all warbeled.

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Date: Mon, 4 Apr 2005 10:26:55 EDT  
From: DJED1@aol.com  
Subject: Re: [R-390] Cap leakage

Yes it is, but I tried removing and cleaning the strap without solving the problem. Always a good thing to try before disassembling the PTO.

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Date: Mon, 4 Apr 2005 12:43:07 -0400  
From: Walter Wilson <wewilsonjr@gmail.com>  
Subject: Re: [R-390] PTO extender cables

If you flip the R-390A up on it's side and get a small box about 10 inches or so high, you remove the PTO from the R-390A and set it right there on the box. Works for me, without extender cables.

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Date: Mon, 4 Apr 2005 13:09:07 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Adjusting Z702 Tools

>Is there a tool made to adjust the slug on Z702 (the can on the PTO)?

All the tools I have seen for Z702 were from the teletype side of the shop. We had a round soft iron rod that had a slot sawed into the end of it. The slot was wide enough to fit the flats. Most guys had a wrap of tape (heat shrink sleeve) around the end of the rod over the slot to keep the tool from slipping off it nut. The best one I seen was an El Cheepo screwdriver shaft cut off and slotted. I had been slotted

with a Demerol tool grinding wheel because even cheap screwdriver shafts are fairly hard to saw. Roger KC6TRU

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Date: Mon, 4 Apr 2005 13:35:02 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO extender cable

Thousands of old ASA 33's worked on these R390 and R390/A for years all over the world for years and never even seen an extender cable. Not one Nota. Old school knowledge was the extender cables introduced more problems in feedback, loss of shielding, flaky connections than was gained by the extra working space.

Stand the receiver on it end. Use a 2x4 to level the back of the receiver with its front panel. Pull the PTO connector bracket loose from the chassis so you have some wire harness freedom. It is still a short leash. Set the PTO on a small cardboard box so it does not have to hang on its wire harness. This setup was used to set the 10 turn end point adjustment.

If you just need to run the linear deviation, pull the Standard BNC to Mini BNC adapter off the 455 output on the rear panel and use it on the end of the R390/A PTO. The R390 is a bit more creative as it has the B+ on the coax. You need to isolate the frequency counter from the B+ on the R390. Leave the PTO in place and use the dial read out to count PTO shaft turns. Set one end at 455 and zero the dial. Start rolling off turns. At each 100 on the dial counter record the frequency counter reading.

Just hanging the PTO out the up ended receiver and using a pencil mark to index to, we would get the end points to within 10 cycles or so. Considering the counters and power company (VietNam, Korea, 69-75) we knew we were kidding out selves with those numbers. But you can do it.

If you were really going to go into a PTO and try to adjust the bank of little shins all stacked up along the PTO guide assembly, spring for the connectors from Fair for the PTO harness. You likely have the coax BNC adapter and can extend that cable to the counter with no problem.

I have seen PTO that would not make end point spread and needed work. I have not seen one that was considered so non-linear as to warrant an adjustment of the shim stack. However, these items are much older now and who knows what would do them some good. Good Luck with this, Roger

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Date: Mon, 4 Apr 2005 13:45:13 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO warble

Chances are good your not running a ballast tube. So consider the BFO and PTO tubes. The filaments may be doing this to you. Just a hopeful idea. Like Les said there are those little caps inside that come loose. Not wanting to upset you with scary feeling I will not go into the subject of PTO that have all the caps waxed

together into a block like Zenith did in TV sets. Clean the strap, swap the tubes, stock the beer, clear the calendar, clear the bench. Prepare to enjoy you hobby to the fullest extent. Life has dealt you a real puzzle and you need to savor solving it to the fullest extent possible. Roger KC6TRU

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Date: Mon, 04 Apr 2005 19:49:06 +0000  
From: eldim@att.net  
Subject: Re: [R-390] Adjusting Z702 Tools for R-390 PTO'S

I'll have to dig into and check all my alignment tools to see if I still have a tool that fits this description. I vaguely remember a tool approximately 5-6 inches long that was made of dark brown fiber with a small metal slotted slit. Since I have not worked on a 390 in detail for over forty years, and don't recall if I ever did any PTO re-work, I'm wondering if there is a list of "Required Tools" for FIELD or DEPOT rework listed in any of the service manuals for the R-389, R-390, R-390A, and R-391. Better yet, is there a picture of this tool, Part Number, Stock Number available? Perhaps, one of the group members has fabricated a similiar tool that passes the test. Personally, I think that inserting any metallic object into the innerds of the PTO may possibly upset the reactance of the circuit.

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Date: Mon, 4 Apr 2005 20:56:36 -0400  
From: "Jim Miller" <jmiller1706@cfl.rr.com>  
Subject: Re: [R-390] PTO Rebuild?

<http://home.cfl.rr.com/jmiller1706/cosmos.htm>

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Date: Mon, 4 Apr 2005 23:23:17 EDT  
From: Llgpt@aol.com  
Subject: Re: [R-390] PTO Rebuild?

If the decal is missing, chances are it is a Progressitron, good PTO's bad decals. Look on the back cover, if it has an Amelco stamp, it is a Progressitron.

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Date: Tue, 5 Apr 2005 13:45:07 EDT  
From: Llgpt@aol.com  
Subject: Re: [R-390] PTO Rebuild?

Inside, it would look the same as a Collins, Motorola or Dubrow. AFAIK, the Progressitrons were used in the 1962 Amelco contract, whether or not Teledyne Systems continued to use them for the remainder of the 1962 contract or not.. Perhaps someone who owns a Teledyne R-390A with the 35064-PC-62 contract could tell me/us? The ones I have seen had bits and pieces of a blue decal left on the can and an Amelco stamp on the rear of the pto can. Trying to gather the history on the different contracts was a challenge as was the information on the different suffix numbers on the Hammarlund SP-600 series. Whenever I think I have "ALL" the information, I am proven wrong.....and continue to learn, even though my grown children have officially declared I am an "old fart." Les Locklear

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Date: Tue, 5 Apr 2005 22:21:17 EDT

From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO Linearity

>Just out of curiosity, Roger, what was considered acceptable linearity for  
>working radios, considering that the factory spec was 300 cycles

Ed, We would not even try to tweak the end points if it was off less than 3 Khz. As far as linearity went, if you could get a cal tone to zero on the 100 KC within reach of the zero adjust it was good enough. Hay we were fighting a war abeit a cold one. We only checked the total spread end to end. If we could not get a fair end point adjustment, we sent the critter to depot exchange. We never tried to get inside one. You could still get brand new units from the depot, who would ever want to fix one?

Most of them were pretty good within the 300 Hertz factory spec. We just expected them to be linear and that was that nothing to inspect or test. The flip side was every shop did have a budget. We were putting hours on tubes 24 7 and needed lots of them. The teletype guys were also eating motor brushes, printer ribbons and paper. We would not go looking for items to change. We had a fairly loose 10 : 1 signal to noise ratio and did not work over time eeking the extra out of receiver. We hated to give the operators real great receivers, they expected them to all work that well. We could spend time doing cleaning and alignment, theses were just time consuming and did not cost extra for parts. We were going to be on the bench for the hours so we did what we could with the time and tools to give the best we could for the operators. PTO were pretty linear and not worth the effort and cost over head to swap out.

You just were not going to tell the Warrant Officer you were dead lining a R390/A and wanted a PTO because the operator would have to zero it every 200 kHz.  
Roger KC6TRU

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Date: Tue, 5 Apr 2005 23:08:12 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO Tenny Bolts and war stories

Seen a dozen examples of how to adjust the linearity ring, none tell the wrench size for that tiny screw that I've been able to find. Most likely I missed that part of the instructions. Best 73 Tom NU4G

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Tom, this is another one of the do it your self tool making adventures. A small slot in the end of a shaft.

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Personally, I think that inserting any metallic object into the innards of the PTO may possibly upset the reactance of the circuit. 73, Glen Galati, KA7BOJ

Glen, the PTO assembly has a transformer on it. The can has an adjustable slug like the one on the top of the Crystal Osc deck. Some of the models have a round "nut" on the shaft with two flats. You need a slotted tool to fit the flats, or you turn the shaft with a pair of pliers. A good home made slotted tool is better. So you are not

really going into the PTO to do an adjustment. Strange but some times running the PTO for maximum signal will not give the best signal to noise. Mostly some where in the alignment process, you peaked the PTO transformer for maximum signal through the receiver. Usually some where above 8 MHz so the first mixer was not in the signal path mix. Do it this way until you have a week or so and want to play with your receiver. You can then try varying the coil adjustments and checking the signal to noise. Tweak and measure and tweak and measure and find the real good settings.

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I don't have any B+ on the output cables of any of the 390's I currently have on the bench. Once upon a time in Nam I had an R390 on the bench. I thought I had an adapter cube from an AN/URM 25 that had a cap inside it. It in fact had been rewired straight through as a barrel connector. I did not know this and it was the only reason I was not shot. Plugged that critter in between the receiver and the only frequency counter in the whole shop. Smoked the front end resistors out of the frequency counter. It was dead lined for almost 60 days until the parts come in.

That shop had no counter and there were 200 plus 33's that knew just who it was that killed the important item of test equipment. We ran the PTO cabled up in circuit with a Tee and cap. We had no idea how the load changed and just did it that way. It was so much nicer to use the frequency counter and not count cycles on the oscilloscope display.

Sorry I do not have an R390 schematic to detail the exact reason the frequency counter will go up in smoke if not isolated. But I sure as hell barely lived through one experience with an R390 PTO that did smoke a frequency counter.

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Date: Wed, 06 Apr 2005 10:46:17 -0400  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] PTO Rebuild?

May I clarify a bit? The Cosmos PTO uses a flexible disk with a series of adjustment screws to make the frequency correction. These screws are adjusted from the outside of the PTO case. The other, "standard" design uses a stack of corrector plates and a corrector follower bearing to make the frequency correction. These plates are adjusted inside the PTO case by loosening the clamp screw and moving the plate "up or down" with respect to the frame. The clamp screw holds all the plates in position. Provision is made so that adjustments to one plate do not move the ones on either side of it.

Congratulations on having a stout heart. No doubt you'll have a success. As I understand it, adjusting the linearity a normal-design, corrector stack PTO involves the following points:

- The PTO cover must be removed, either once being replaced by a cover with an access slit cut in it, and a hole to get at the locking screw, or removed and replaced each time a correction or series of corrections is made to a plate or plates.

- a jig is very useful so the PTO does not need to be re-installed in a radio each time adjustments are made. The jig would allow setting the shaft to close rotational tolerances, supply power to the PTO, and perhaps provide a proper load for the oscillator output.

- A frequency meter is extremely useful

- mechanical means of moving each plate, and only one plate, a known amount is very useful.

- likely a computer spreadsheet or paper table would be most useful to correlate changes in set point frequencies with the mechanical movement made to each plate, in thousandths of an inch or millimeters or whatever.

Likely, all this was done at the factory with the PTO brought up to oven temperature.  
Roy

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Date: Wed, 6 Apr 2005 10:33:51 -0500

From: "Laird Tom N" <LairdThomasN@JohnDeere.com>

Subject: [R-390] RE: COSMOS PTO

>From the WC9M archives: Hope this helps, Tom Laird WC9M

The following is an old post from JB Harvie.....

Let me start by saying that the alignment of A COSMOS was for me a tough difficult and stress producing procedure. More than likely there are experts out in the group who will take exception to this "simple" posting. Candidly speaking I suggest that anybody who is considering this closely assesses the performance of your PTO PRIOR to any opening up and set-screw adjusting, even though the performance might be off and you might be tempted to do so the as-is performance might just be as good or better than the following intervention you can likely make. For a learning experience, on a spare unit, or if you are bold GO FOR IT! I "tuned up" both a Collins and a COSMOS PTO on one of my R-390A receivers about 9 years ago. This is what would be along the line of what I did for the COSMOS unit. It was a real pain in the rear and took me a lot of time but in the end, (no pun intended) performance was significantly improved. Today the receiver still operates no more than one tick (200 Hz) on all the calibration points. With enough time and some care and some special tools you can work on the COSMOS PTO, results are dependent on your overall setup, equipment, time and finesse. You must have a good stable and accurate frequency counter or some other means of measuring the PTO output to say 10Hz precision.

Some tips:

I found I could obtain better results by slightly loading the output of the PTO under alignment into a non inductive load. Raise and maintain (for 4 hours minimum prior to any sensitive work) the PTO to a warm temperature by placing it under a 75 watt light bulb, mounted overhead, adjust the distance from the bulb to the PTO so that

the unit runs at about the (indoor) receiver in-use operating temperature. Try to keep the temperature stable while you are working on the unit. If you must stop mid-stream you may have to back track and do it again, keep the light (heat) on at all times while you are working on it. If you keep the door closed on an inner work room I found the temperature variations are within a couple of degrees. As you start to get into the PTO guts diagram everything you see as this is what will become your owner / operators and recovery manual for your PTO.

## TAKE YOUR TIME

McMaster Carr sells adequate precision 6" and 8" diameter dial face plates with reasonable precision index marks for around \$10. Mount this dial to an Aluminum backing plate which has been drilled for the shaft diameter (0.185 inches) and secured (epoxy is OK) to some sort of a shaft clamp, mounting close to center (0.005") is somewhat important. Once your happy tighten up the clamp onto the PTO shaft, this gives you a good dial reference for making repeatable angular displacement measurements. The 8 inch diameter dial, though bigger does a little better job to resolve, measure and enable a better than 400hz shaft angular result. If desired a 10 turn counter (with lock) can be added to the alignment mechanism (such as the 400 series from Kilo International - Digi-Key page 376 in catalogue Q983 for \$15.75 part number 412KL-ND)

## PTO basics

PTO provides range of 3.455 to 2.455 MHz span therefore:

|                   |                 |               |
|-------------------|-----------------|---------------|
| 10 shaft rotation | = 3,600 degrees | = 1,000 kHz   |
| 1 shaft rotation  | = 360 degrees   | = 100 kHz     |
| 1/2 turn          | = 180 degrees   | = 50 kHz      |
| 1/4 turn          | = 90 degrees    | = 25 kHz      |
| 1/8 turn          | = 45 degrees    | = 12.5 kHz    |
| 1/16 turn         | = 22.5 degrees  | = 6.25 kHz    |
| 1/32 turn         | = 11.25 degrees | = 3.125 kHz   |
| 1/64 turn         | = 5.625 degrees | = 1,562.50 Hz |
| 1/128 turn        | = 2.813 degrees | = 781.25 Hz   |
| 1/256 turn        | = 1.406 degrees | = 390.625 Hz  |
| 1/512 turn        | = 0.703 degrees | = 195.31 Hz   |

\* Operational Limit = 1.79 degrees = 500 Hz

\* (Reasonable) = 1 degree = 277.78 Hz

\* (Obtainable) = 1/2 degree = 138.89 Hz

Per TM 11-856A paragraph #150: ..Total End Point error on PTO not to exceed 500 Hz....(or about 2 degrees of shaft rotation)

To proceed:

Remove and open up the PTO

Remove the outer PTO can, heater and insulation (without trashing the thermal insulation)

Unsolder where necessary

Be gentle

Once it is opened up examine the PTO closely, look for damage or excessive lead screw wear. Lubricate the lead screw if absolutely necessary with an acceptable lubricant.

Mount the PTO to a suitable stable test fixture, mount and insure that the dial face is securely mounted and rotates perpendicular to the PTO shaft. Verify the turn counter works (if used) Insure you can gain access to and rotate the set screws. I had to make my own set screw driver as the set screws are real small! One option is to obtain the smallest possible driver and stone it down.

Mount and check that the reference pointer is secure and that the dial clears the sharp pointer by giving the dial a full turn.

You can place a fixed magnifier lens and lamp to assist you in seeing the lines as needed but with a 8 inches dial a 1/2 degree spacing is quite readable.

Connect up the power to the PTO,

Connect the PTO output to a load resistor and the frequency counter.

Bring up and maintain the (exposed) PTO to a "warm to the touch" condition with the lamp.

Turn on the PTO

Look for a frequency output.

Check the output vs. shaft rotation and move the shaft to get to the high end

Double check the output range (its still not to late to turn back :)

As you rotate the PTO you will see how the 40 or so adjustment screws are mounted in an perimeter array and what they do. These screws act to set into a precise position a metal ring on which rotates a coil plunger. The plunger depth is "modulated", by the degree to which the set screws deflect the metal ring. These plungers are what "trims" the precise PTO output frequency.

As you rotate the PTO shaft the 40 or so set screws are need to be "adjusted" to precisely establish and define the mechanical plunger depth (position) so that the desired precise frequency output is achieved.

Keep track of which and how much you turn the set screws - make a diagram and keep good notes.

If you mess up take a break and start over. Always check the end to end (10 turns) as well as the 1 turn performance. After you are completed, turn the PTO off, let it



cool off overnight, maintain the lamp in position, turn the PTO back on, let it heat soak for another 4 hours and (re) measure the results.

Settle for a reasonable performance level and call it good enough  
Reassemble with care

Bottom line is: You will need to have a lot of time and patience however you can obtain extremely good performance with the COSMOS PTO.

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Date: Wed, 06 Apr 2005 21:20:16 -0400  
From: "Miles B. Anderson" <mbalaw@optonline.net>  
Subject: [R-390] PTO Rebuild

I'd like to caution against jumping to the conclusion that the corrector stack needs adjustment whenever the PTO can't be made to track at the intermediate points. I tried once to adjust the corrector stack on a Collins PTO and made such a hash of it that the whole assembly wound up in my junk box. I later discovered that the real problem is often much easier to solve. The problem in my case was that one or more of the little unencapsulated mica capacitors went west. There is no way to adjust the shunt capacitance of a Collins PTO. All you can do is adjust the start point of the tuning slug and the little series inductor that is used to trim the end point. This means that there is a unique shunt capacitance which will make the tuning equation come out right at both ends and the middle. If that shunt capacitance changes because of aged components, no amount of fiddling the inductances will make the tuning linear anywhere except at the end points.

The procedure I followed was to adjust the start point and the end point as per the manual. Then tune the PTO to the midpoint (500). If the oscillator is high at the midpoint, add more shunt capacitance. If it is low, remove shunt capacitance. Adjust both end points again per the manual and check the error at the middle. If it is still off, repeat the process. We are only talking about 10 to 30 pf difference, but that small capacitance difference can knock the daylights out of the linearity by putting an "error bulge" in the middle. When you think you have the middle and both endpoints "spot on," check the tuning error every 100 kHz. If there are two "error bumps" (at, say, 300 and 700) these can be washed out by simply over-compensating the middle so the error runs in the other direction. By the way, I replaced the inner shield cover before each measurement. The main thing to bear in mind is that the corrector stack was set properly at the factory. The main coil is heavily doped and is not likely to move or change. What IS likely to happen is a change in the shunt capacitance. The shunt capacitors are intended to be temperature compensating, but this never bothered me much. Ordinary NPO ceramics seem to work fine.

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Date: Thu, 7 Apr 2005 10:35:20 -0500  
From: "Barry" <n4buq@aol.com>  
Subject: Re: [R-390] PTO Rebuild

Hmmm. I'm familiar with setting the endpoint, but don't remember anything about setting the start point. I simply crank the shaft until I get the lower frequency, crank

it 10 turns and adjust the endpoint to get 1Mc. Rethinking this, I may have been doing this backwards as well. Perhaps I'm supposed to be setting the endpoint at the lower end, not the upper end. Maybe it doesn't make any difference? At any rate, I'd like to read more about setting the start point. Can someone point me to the document for this?

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From: JMILLER1706@cfl.rr.com  
Subject: Re: [R-390] PTO Rebuild  
To: "Miles B. Anderson" <mbalaw@optonline.net>

I went through a corrector stack adjustment last year and it took an entire weekend and some. It had to be changed quite a bit from factory setting. I suspect you have described the real cause of the change in linearity here. My corrector stack now looks like a "sine wave" almost, big hump near one end. Does anyone have an idea of what an ideal stack should "look like", or is it too hard to predict?

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Date: Thu, 07 Apr 2005 20:31:11 -0400  
From: "Miles B. Anderson" <mbalaw@optonline.net>  
Subject: [R-390] PTO Rebuild

A couple of clarifications: The PTO "tunes backward." That is, the PTO frequency is lowest (2.455 MHz) at the high end of the counter dial (999 or +000) and highest (3.455 MHz) at the low end of the counter dial (001 or -000). I used the terms "startpoint" and "endpoint" in my original post with reference to the alignment procedure in Paragraph 81 of TM 11-5820-358-35.

You can tweak the "startpoint" at 07+000 by slipping the Oldham coupler with respect to the PTO shaft. This sets the low frequency end to 2.455 MHz with the slug pushed most of the way into the main tuning coil L702. As you tune lower in frequency (per the counter dial), the slug is gradually withdrawn from L702; and the PTO frequency increases. You adjust the "endpoint" at 07-000 by tweaking L701 so that the PTO frequency is 3.455 MHz. L701 is in series with L702. Since the tuning slug is most of the way out of L702 at the "low end" of the dial, its inductance is smaller and L701 has a proportionally greater effect on the frequency. To use a mechanical analogy, the "startpoint" (how far into L702 the slug starts its travel) is the point where you put the end of your "ruler." The "endpoint" (the setting of L701) establishes the "length of the ruler." The shunt capacitors C701 (370 pF), C702 and C703 (10 pF each) affect the frequency at all points. The little 10 pF capacitors are naked mica squares with silver plates deposited on each side and very thin wire leads. They corrode easily and in my case they failed. The result was to create an "error bulge" midway down the dial after both 07+000 and 07-000 were set dead on.

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Date: Fri, 8 Apr 2005 18:38:04 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO Rebuild

>Does anyone have an idea of what an ideal stack should "look like", or is it  
>too hard to predict?

The ones I looked at were fairly straight. Mostly even. The whole blog on setting the end spread, (Hi to low of Low to Hi depends on which way you want to spin the shaft first) and adjusting the caps to get the mid point correct is the way to go. Then you can try to adjust the stack to get closer at the other points. You would expect the stack to take on a sine shape. You are just looking to get every thing else as close to expectations and then get real close with the stack adjustment. The stack is the last thing to adjust not the first. Roger KC6TRU

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Date: Fri, 8 Apr 2005 20:09:56 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO Massive Deaths

>The 390A's have been "eating" PTO's since the mid 60's. There are documented stories of >mountains of dead PTO's piling up out behind various depot locations. Strange

Yup, The PTO was an exchange item not fixed at the organization level. New ones were to be had for exchange. So we just shipped one in and got a brand new one back if it even looked dusty. Prior to the 70's most units did not have a frequency counter. So the unit had no way to do an end point adjustment. If the spread got to far off, (300 Hertz) the tech just did the paper work for a replacement. The PTO wound up in a stack at some Depot. Get a thousand stacked up and you consider a contract to refurbish. Until they went out of production, why bother just build me a new one please. Until the late 60's we did not understand how the crystal ovens were cooking the receivers. It was common practice to run the receivers with the ovens on thinking it added something useful to crystal stability. Buy 1972 even sites on the DMZ in Korea were well heated enough that the receivers were run with the ovens off. If you had a Van full of receivers you just turned every thing on and let the shelter heat up until it was warm enough to work in. We had a MLQ24 van in Korea. It was a 3/4 ton truck and shelter. Some nights the Van was the warmest place on the site and all the off duty guys would sleep on the floor. Yup it was warmer in a Van full of tubes than in a block building with space heater glowing as red as the filaments in the vacuum tubes. I digress, back to PTO's.

PTO's were going to depot for all kinds of reasons. Lack of counters to adjust them. Killed from ovens being on in summer heat. Bounced down roads in Vans until something broke. Pulled coax connectors. The fair number of cold solder joints that would not be explored because the unit was an exchange item. You just trouble shot your problem down to the PTO and exchanged it. If a tube swap did not cure a PTO problem, it went to the big pile at the depot. Once the depot sent big bunches off to a contractor to refurbish because new ones were not coming off the assembly line any more, the problems found were a variety of simple problems. Lucky for us so many got swapped out, there are lots spare units around today. Do you have any idea how many PTO's have been built into home brew VFO's? The contractor bitched that more problems were from the poor handling than actual problems with the PTO's. The issue became a good hour lecture on the handling of PTOs in the R390/A class room by 1968. Most were just needing end-point adjustment. The little wiper was dirty and PTOs warbled. Some were cooked from their own oven

heaters. A few had broken cores from bad G's. Some had broken pins on the wire harness. There were a number of cold solder joints. The upshot was, techs started to inspect PTO's when problems occurred, and frequency counters were added to the R390 service bench.

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Date: Wed, 27 Apr 2005 09:59:47 -0700  
From: "Craig C. Heaton" <wd8kdg@worldnet.att.net>  
Subject: [R-390] Variable-Frequency Oscillator End-Point Adjustment

The other day while performing an end-point adjustment I realized there is a better way. For those who would like to add a new tool to their collection; add a Snap-On SSM5A. It is nothing more than a screw starter. Used one years ago (about 30 years) for those hard to reach places on motorcycles.

No need to remove the VFO subchassis just to remove the end-point-adjustment cover nut, reinstall VFO; then, repeat the same process all over again when you are done with the end-point adjustment!

You still have to remove the front panel. Rotate the riveted locking plate by hand until the holes line up through the front of the receiver and allow access to the cover nut. I then used a screw driver long enough to just loosen the VFO cover nut. Leave the cover nut partially threaded into the VFO. The SSM5A is about 5 1/4 inches long. Long enough to reach the cover nut. If you have a screw starter or purchase one the next sentence will make sense. Cock the screw starter and place it through the riveted locking plate hole and lower it until it reaches the cover nut. Line the screw starter up with the notch in the cover nut and push. Rotate the cover nut until loose. Righty tightie, lefty loosie. The screw starter can now be raised with the cover nut attached. The cover nut will NOT pass through the hole in the riveted locking plate! You will have to grab on to the cover nut with your fingers.

Access to the adjusting screw is now possible. Reverse the process when the end-point adjustment is complete. This should give R-390A owners more time to play Radio.

And of course you have my standard tail light guaranty this will work on your R-390A, it has been tested on a 56 Motorola.

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Date: Wed, 27 Apr 2005 13:33:42 -0700  
From: "David Wise" <David\_Wise@Phoenix.com>  
Subject: RE: [R-390] Variable-Frequency Oscillator End-Point Adjustment

I don't even remove the front panel. I broke an old metal-tip alignment stick into two pieces. The short half is just short enough to maneuver into place. It's also just long enough to turn between thumb and forefinger. I can't remember how I initially broke the cover nut loose; I probably took out the VFO. If you get lucky, your right-angle screwdriver will have the right orientation to catch. I put it back on with the above alignment stick, which keeps it loose enough to get it back off the same way. I rock the radio onto its face to drop it out, and put it on its back to put it back in. Takes some poking around, but it still beats (with a stick!) pulling the front panel,

unless you're rack-mounted.

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Date: Wed, 27 Apr 2005 14:11:08 -0700  
From: "Craig C. Heaton" <wd8kdg@worldnet.att.net>  
Subject: RE: [R-390] Variable-Frequency Oscillator End-Point Adjustment

Talk about working in tight spaces. I needed to slip the veeder root counter after tweaking the VFO, so the front panel had to move a few inches. There is more than likely a better way, but I tweaked the VFO, slipped the counter, and then checked to see how far off the VFO was end to end. After finding the correct direction to turn the adjustment, it wasn't too bad.

Got a question for the group. I made my end-point adjustment with the receiver standing up on its back panel. In this position it was easier to get the cover nut out of the way and see what I was doing. Would there be any difference with the receiver in its normal top side up vs. panel side up while performing the end-point adjustment. Or I'm I picking belly button lint, almost like discussing the replacement of capacitors.

I did notice some backlash with the R-390A front panel side up. In other words, checking 100KHz markers counting up vs. checking the markers counting down was different. Always had to start at 000, calibrate, and check every 100KHz up to +000, counting up. Once the end-point was as close as I could get it, I put the receiver front panel on. Today, checking the 100KHz markers, and the receiver in normal position markers are repeatable going in either direction.

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Date: Fri, 29 Apr 2005 12:27:46 -0400 (EDT)  
From: "William A Kulze" <wak9@cornell.edu>  
Subject: Re: [R-390] Rats - There goes a pair of 26Z5W's

> As I was sticking the screwdriver into the PTO to adjust it, I heard the  
> sound like something was drawing excessive current.

I know this post was awhile ago, but I haven't seen this in the replies. I recently did my PTO and noticed that the end point cap is hot. If you touched the frame at all, it's shorted to ground. The procedure says to use an insulated screwdriver. A metallic tool doesn't seem to throw the freq off much, so I imagine that they tell you this to prevent shorting the circuit to ground. I didn't have a non-ferrous tool so I used a standard tweaker. I noticed it sparked a little if I hit the frame while adjusting. A little heatshrink on the shaft should do the trick.

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Date: Fri, 15 Jul 2005 17:41:51 -0700 (PDT)  
From: "KC8OPP Roger S." <kc8opp@yahoo.com>  
Subject: [R-390] PTO Desicant

I have finally dug into the PTO on a R-390 that has been here in the shack for about 20 years. It has never indicated the right freq and I am tired of remembering the offset. Overall the radio is in good shape but the PTO has been off for a long time. I

measured 6.3KHz non-linearity end to end so it is time. When I opened up the inner can I was surprised that there was not a desiccant pack. Not too bad on the inside, a bit of dirt laying around and an ugly dark grease smeared all over the corrector stack, but it should clean up nice. What does the group think, should I put a desiccant pack inside when I put it back together? I have a few laying around that I have collected over the years and could dry them out and tie them to one of the support rods. Thanks for any thoughts and wish me luck with the corrector stack. Done a few "A" PTO's with the screws out the front, but this is the first corrector stack adjustment. Thanks for the thoughts

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Date: Sat, 16 Jul 2005 12:34:20 +0100  
From: "Peter Worrall, G4GJL" <g4gjl@btopenworld.com>  
Subject: Re: [R-390] PTO Desicant

Do it! The PTOs were originally built with dessicator packs included. I've seen some with three packs. I presume you know the stuff can be re-activated by bakink in the oven. Watch out for the more modern bags, as they are plastic based and melt at the reactivation stage. The older paper or cloth ones are the best in this respect, however they let dust particles out from chipped dessicant granules. You choose!

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Date: Sun, 17 Jul 2005 17:02:57 +1000  
From: "pete williams" <jupete@bigpond.net.au>  
Subject: [R-390] R-392 PTO end point

The Collins PTO in the R-392 appears not to be as sophisticated as those in the other R-390-Xseries. no ovens for one. The manual does not tell anything about making an end point adjustment for linearity, and haven't taken the PTO out or apart to have a look. Anyone been this way before and can tell a story ? Incidentally those small red micas EL Menco - 50, 100 etc pf are trouble.. found a few leaky in the cal. osc. to the extent it wouldn't.

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Date: Tue, 26 Jul 2005 13:50:14 -0500  
From: "Barry" <n4buq@aol.com>  
Subject: [R-390] OT: R-388 questions

I'm pretty sure a lot of you guys have R-388's. I'm thinking of buying one and was wondering what to ask about. I understand the PTO endpoints are an issue. From what I've read, it takes surgery to fix this in an R-388 PTO. Any other known failure points I should be concerned about?

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Date: Tue, 26 Jul 2005 15:16:48 EDT  
From: Llgpt@aol.com  
Subject: Re: [R-390] OT: R-388 questions

There are only two kinds of R-388 PTO's, good ones and bad ones. Check before buying if possible. If it is out over 8 khz, it is probably a bad one. No way to tell by serial numbers either.

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Date: Tue, 26 Jul 2005 16:50:58 -0400

From: "Al Parker" <anchor@ec.rr.com>  
Subject: Re: [R-390] OT: R-388 questions

Don't apologize for R-388's being off topic, with all the other crap that goes on here ;-). Yes, the PTO's almost always need help, but it's not a difficult or life threatening surgery, there's info on it on my webpages, ref. below. I really like working on R-388's. Let me quote from a msg I just sent about 30 min. ago to almost the same question:

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The R-388's are very nice rcvrs, tho' not as easy to cruise with as an SP-600, but at least you do know just where you are. I've "done" 2 of them in the last 6 mo.s or so, one of mine and one for a friend. The only capacitors that I've found to be worrisome are the HV filters (plug-in), some of the bathtubs, and a mica, C-204, the coupling cap from V-110 to the AGC ckt.

2 other guys have had problems with it also, so take a look. It may be the sensitivity problem. I've been into several Collins PTO's, usually they've had "vitamin Q's" (or is it D?) as bypasses, and didn't really need replacement, but I did anyway. The span fix isn't hard, and the feedback cap should be replaced. (Your 500kc xtal in the phasing can is probably bad, mine was, and I'm still looking for a replacement, as I borrowed one from another rcvr.) - that was in response to a particular question, it's not always bad. You can take a look at the ones I've done, start at:

<http://www.thecompendium.net/radio/R388sn58.htm>

I sold this rcvr a week ago to a collector who really only wanted the cabinet, and the rcvr then showed up on ebay.

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Date: Wed, 24 Aug 2005 19:56:15 -0700 (PDT)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] Pto Question

>....My PTO is lost, I did not note the frequency .....

Nope, you're making it too difficult! Just loosen the Oldham coupler set screw and turn the shaft until the frequency comes in. Loosen the screw on the shaft going out to the knob so you can get a hold on the coupler itself.

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Date: Tue, 30 Aug 2005 21:39:09 -0700 (PDT)  
From: Mike Castellana <rocket\_no9@yahoo.com>  
Subject: [R-390] Cosmos PTO and compensator stack ...

Had an interesting (and fun) afternoon today... The Cosmos PTO on my R-390A was binding slightly. Symptoms were squeaks coming from inside PTO and more effort needed to adjust KC knob. This was the first time I've attempted this procedure. I read everything I could find on PTO's including Jim Miller's excellent overview. (Thank you sir) I tore PTO down to it's two separate halves. I made notes as to number of threads visible on main shaft before further disassembly. I tightened and lubricated where needed. With PTO back in, binding and noise is

gone and it's easier than ever to twist KC dial...

This brings me to my question. When I had the PTO in two halves I stupidly <REMOVED> compensator stack without taking note of it's exact orientation on the shaft. This stack has 48 adjustment screws and 12 empty holes (no screws) Before I tackle adjusting PTO's linearity, how do I know compensator stack is installed properly? I followed Mr Millers suggestion of locating 15th set screw (from clockwise "end" on stack) in adjustment window. Radio is running fine tho' readout accuracy is maybe 2kc +/- MORE off than I'm accustomed to. Please pardon my long-winded-ness and the fact that I'm not so clear here, I'm really on the curve! Thanks in advance for any help.

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Date: Wed, 28 Sep 2005 20:33:03 -0400  
From: "John Bunting" <john@gumlog.net>  
Subject: [R-390] R-392 VFO End Point?

My R-392 VFO is almost 7Kc long between 000 & +000. Anybody remember a thread about setting the end point of one of these critters? TIA for any info you can supply. I've searched my manuals from cover to cover and can't find any reference to the end point correction.

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Date: Wed, 28 Sep 2005 21:47:24 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] R-392 VFO End Point?

For luck the R390/URR R390A/URR and your R392 all share the same PTO.

I think 7 KC is still well within adjustment range. If you are 7 KC long you may be needing to open the can, undo the heater wires, open the inner can and change the winding on a very small coil. Or add / subtract some small (2PF) caps. Watch the mail here, someone is already looking for the archive thread and will post that for you also. On the front of the PTO there are two cover caps. You want the inner one on the right between Z702 and the shaft. Behind cover cap 1 is an end point adjustment. Like Alice, one way will make you longer (taller) and the other way will make you shorter (smaller). Can you screw 7 KC out of that adjustment? Try it before you go opening cans of wires. If you have a frequency counter you are better off. You can make adjustments with the PTO hanging out of the receiver. If not then you have to

- 1.) remember where you are.
- 2.) Pull the PTO
- 3.) make and adjustment.
4. Remember if you went left or right
- 5.) put in the PTO
- 6.) set the PTO on one end
- 7.) dial off to the other end
- 8.) determine if this is better or not
- 9.) consider if next adjustment will be left or right
- 10.) consider how much to adjust



11.) repeat until perfect.

If you have a counter it just goes faster.

Dial the PTO to X.455 and draw a mark across the coupler and the frame. Carefully rotate dial If you go the wrong way you will hit the stop before you get 10 turns. So having learned which way to go, start over and dial it off in the correct direction We think clock-wise is down in frequency and counter-clock- wise is up in frequency. Think about the KC knob and the way the frequency conversion is done.

Rotate off 10 turns, line up your mark and see what the counter reads.

Every time you change the end span adjustment, the points will move. So make an adjustment.

Line up for the counter at X.455  
Mark the dial to frame  
Roll off 10 turns  
Line up the mark  
Read the counter  
You will either be getting closer or further off the exact 1Mhz

If you hit the end of the adjustment before you get exact there are two options

- A.) accept what you get.
- B.) Read some more help from the archives and prepare for some PTO surgery.

It is not hard to open the outer and inner can and do repairs.

Good Luck with the fix.            Roger KC6TRU

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Date: Wed, 28 Sep 2005 21:56:10 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] R-392 VFO End Point?

R392 were considered tactical radios and got treated different from the R390 receivers. If your R392 did not work, it was sent away from you for repair. Your repair guy was likely a module swapper. If your PTO was out of spec, it was just swapper. For a long time PTOs just piled up out back of the Depot. Then someone invented a "portable" frequency counter and it was discovered that the PTO could be easily "refurbished". It is not amazing there is nothing in the TM about making what is a simple adjustment. We know there are several good things missing from the R390 TMs. Back when there items were new, you could get 10 plus years on a PTO and never need to adjust it. Once you get yours set, it may never need adjustment again. It likely has never been adjusted in its life or maybe once or twice.            Roger KC6TRU

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Date: Mon, 05 Dec 2005 14:08:13 -0700

From: DW Holtman <future212@comcast.net>  
Subject: [R-390] PTO

I stumbled on to an R-390 non A PTO. Are they the same as a R-390A PTO except for the BNC vis MB connector? Thank you for your help.

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Date: Mon, 05 Dec 2005 14:37:57 -0700 (MST)  
From: Richard Loken <richardlo@admin.athabascau.ca>  
Subject: Re: [R-390] PTO

No they aren't the same but they are less common so you stand a good chance of selling it or trading it for a 390A PTO. To me for for instance.

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Date: Mon, 5 Dec 2005 16:35:04 -0500  
From: "David C. Hallam" <dhallam@rapidsys.com>  
Subject: RE: [R-390] PTO

According to the information I have, the only differences are the RF connector and the power cable. I think the power connector itself is the same.

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Date: Mon, 05 Dec 2005 15:06:41 -0700 (MST)  
From: Richard Loken <richardlo@admin.athabascau.ca>  
Subject: RE: [R-390] PTO

That is useful information. This means that I can now look at certain R390A parts with much more (malevolent) interest than I used to. I always thought that they were different and I was encouraged in this belief by the 24V filament wiring more so than by the difference in RF connectors. I would still recommend selling it and getting a much more common 390A (and probably newer) 390A PTO.

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Date: Mon, 05 Dec 2005 17:25:03 -0500  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: RE: [R-390] PTO

Do be careful here: Radio        PTO  
                         R-390/URR: 70H-2  
                         R-390A/URR: 70H-12

The power plugs may be quite different: one having a different number of contacts than the other one, even though they are both the small hex shaped Winchester type. It's not clear to me but the B+ supply to the PTO may be though the output coax in the R-390/URR PTO (70H-2). The output voltage may be specified as different, but likely would work ok. The frequency span, plate voltage, heater voltage and current, filament voltage and number of turns are the same. I can't say about the physical size and mounting point dimensions. Any one with a 70H-1 PTO: It will \*not\* work in either of these radios, send it to me.

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Date: Mon, 5 Dec 2005 17:31:20 -0500  
From: "David C. Hallam" <dhallam@rapidsys.com>

Subject: RE: [R-390] PTO

The filament circuit for the VFO and BFO is identical in the R-390 and R-390A. The two tubes are in series with the ballast tube. IMO the R-390 is much the better of the two receivers. The mechanical filters in the R-390A do not make that module superior to the R-390. I set up a R-390A IF module for use in my R-390. After a few hours of use, I took it out and put the original back in. In general higher quality parts were used in the manufacture of the R-390. The R-390 does not normally need have wholesale replacement of capacitors (paper and electrolytic) as does the R-390A. The R-390A was designed to reduce cost. Longevity was not a consideration.

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Date: Mon, 5 Dec 2005 18:34:04 -0500  
From: "David C. Hallam" <dhallam@rapidsys.com>  
Subject: RE: [R-390] PTO

I guess I should review my notes before opening my mouth. It is not a plug and play interchange but is readily doable. The R-390 get screen voltages from a dropping resistor in the B+ line while the R-390A has a separate 150 VDC regulated supply. Since you will have to rewire the power cable anyway (the R-390A cable is too short), the changes are minor. The R-390A mounting bracket will take some changes to mount in the R-390. Bottom line for me is that I would not hesitate to make what I believe minor changes to use a R-390A VFO to use in a R-390 if I had to.

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Date: Mon, 05 Dec 2005 15:34:19 -0800  
From: "Kenneth G. Gordon" <kgordon@moscow.com>  
Subject: [R-390] 70-H1 PTO.

Roy is being too deferential: the 70-H1 PTO ONLY works in the R-389. His has been badly mauled, munched, and otherwise twisted into a pile of unrecoverable junk, and he really NEEDS one. If any of you people have one sitting around being useless, it would be an act of extreme kindness to give it to Roy. He will put it immediately to work. I've been watching for one for him for a couple of years now. I recently ALMOST had one for a mere pittance, but fell asleep before the auction ended. Ratz!

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Date: Mon, 5 Dec 2005 19:06:22 -0500 (EST)  
From: "Paul H. Anderson" <paul@pdq.com>  
Subject: Re: [R-390] 70-H1 PTO.

One went on eBay a few months ago for a few hundred bucks.

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Date: Mon, 5 Dec 2005 20:23:55 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] 70-H1 PTO.

David at Fair Radio Sales who has put most of the R390A out their doors over the last few years would also like one for his own R-389. Someone at Fair let his get

away one day thinking it was a R390 item. The customer never complained that his unit did not work so David has never had a chance to get it back. Do not ask David why his PTO was out of his R389 and just laying around. I do not need to know the bitter facts.

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Date: Tue, 6 Dec 2005 03:55:10 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] PTO

The output frequencies are the same but be cautious about the connector.

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Date: Tue, 6 Dec 2005 14:45:56 -0500  
From: "David C. Hallam" <dhallam@rapidsys.com>  
Subject: [R-390] PTO Stability

What PRACTICAL application does improving the PTO stability over the ballast tube design have other than perhaps participating in the ARRL frequency measuring contest? You notice I emphasize the word practical.

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Date: Tue, 6 Dec 2005 12:39:50 -0800  
From: "David Wise" <David\_Wise@Phoenix.com>  
Subject: RE: [R-390] PTO Stability

One day I wanted to listen to music on AFRTS SSB. Even a few Hz off, it goes out of key something fierce.

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Date: Thu, 8 Dec 2005 01:14:17 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Christmas Wish List

Fellows Craig mentioned cleaning the gear trains. Back when we would take them over to the teletype typewriter degreaser. We would hang the whole receiver over the edge of the degreaser. Likely setting on a cart. Pour degreaser fluid through the gears and elsewhere. Let it drip dry. Blow it out with the air line. Return the unit to service. I am sorry I did this to many receivers in the past. I just know some of you who own receivers that received this abusive treatment. But those knobs sure spun nice when we finished up and the front panels were clean. I had no idea how bad the degreaser fluid (K1 so not to smell and additives to dissolve things.) trashed wire harness over time. Hay they put the TTY stuff in there and closed the lid and spun it around. How much was I hurting the poor R390's with just a rinse job?

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Date: Thu, 15 Dec 2005 13:53:29 -0600  
From: Conard Murray <cmurray@tntech.edu>  
Subject: RE: [R-390] building new components (PTO)

Back when I was a young whippersnapper, my elmer was given a '390A from a batch that MARS was distributing without PTOs. This guy was a build-it-yourself

sort of ham and since PTOs weren't as available in 1978 as they are now, he built up a solid state VFO for it using a 10 turn pot as the tuning element. I especially remember this because we went through what seemed like thousands of 10 turn pots at hamfests looking for a non-wirewound one for the tuning element. This lashup actually worked out with fairly decent tracking, so it can be done.

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Date: Thu, 15 Dec 2005 19:39:16 -0500  
From: "Dave Maples" <dsmaples@comcast.net>  
Subject: RE: [R-390] building new components (PTO)

Conard is talking about Bill Hoehl, WB4MUZ, and he did indeed build a PTO replacement using a 10-turn pot and a diode linearizer. There's an article published in the 1983-84 timeframe (QEX? Not sure). Today I'd do it with a DDS and either two encoders (one fast to handle fractional kHz and another one to handle the higher steps with suitable gearing) or else revert to something simpler and just ADC the 10-turn pot and use it to drive a lookup table for the DDS. The only thing I didn't like about the 10-turn pot is that if you forgot and turned past 000 going low or 999 going high you were going to break the pot. A 15-turn pot would be the cat's meow.

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Date: Tue, 20 Dec 2005 07:33:07 -0600  
From: "tfrobase" <tfrobase@kitparts.com>  
Subject: RE: [R-390] Cosmos PTO label

Here you go ... Tom, N3LLL <http://www.kitparts.com/misc/cosmos.jpg>

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Date: Tue, 27 Dec 2005 22:07:11 -0500  
From: "Jim M." <jmiller1706@cfl.rr.com>  
Subject: Re: Re:[R-390] More Ideas

If anyone would like to add my "Cosmos PTO Adventures" article to the mix please feel free to do so.

The latest original is at: <http://home.cfl.rr.com/jmiller1706/cosmos.htm>

You should be able to download the files from <http://home.cfl.rr.com/jmiller1706/>

If not I can zip them and ftp or email them. It was also on Dave Medley's page but some of the image files were corrupted on Dave's copy.

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Date: Tue, 3 Jan 2006 08:29:12 -0500  
From: "Bob Young" <youngbob53@msn.com>  
Subject: [R-390] question on R390A

I asked a guy on ebay if the endpoints were off and this is what he replied: "I just checked it with the internal cal... and I didn't warm it up. 3 MHz (not that matters, it's mixed) and 4k IF, I set the zero on 3.00 and ran up to 4.00, I saw around 9 kc total difference from one end to the other." it's for this radio:

<http://cgi.ebay.com/ws/eBayISAPI.dll?>

ViewItem&item=5849372507&rd=1&sspagename=STRK%3AMEWA%3AIT&rd=1

Should I be concerned with this? I intend on having it done over eventually when I buy one anyway, I think they may be a little too complicated for me to tackle myself, thanks much,

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Date: Tue, 3 Jan 2006 05:54:58 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: [R-390] PTO question on R390A

Bob, 9 kcs is not abnormal for a radio that has not be aligned in a long time. This can be adjusted out, either by plan a) the endpoint adjustment screw, or plan 2) removing one turn from the endpoint adjusting coil. This should not prevent you from buying the radio.

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From: "bernie nicholson" <vk2abn@bigpond.net.au>  
Sent: Thursday, January 05, 2006 8:56 AM  
Subject: Re: [R-390] PTO identification

Ok Gary the progesteron PTO transfers are particularly delicate and come off very easily, the Cosmos can be identified by its having an extra hole in the front , if you don't have a Cosmos the other VFO s are very similar, the first thing to do is the endstop adjustment which just takes a few minutes you need to establish that you are getting 1Mhz coverage in 10turns exactly, if you can't achieve this you may have to remove a turn from the coil , its not as hard as it sounds but you do have to remove the covers and the oven assy. and unsolder a few wires, whilst inside you can check resistor values ect, it then needs to be reassembled powered up and the end point set again ,THEN you need to check the linearity, START at either end 1Mhz and check the 100khz CAL points they should be close, if not you need to draw a graph of the response across the 1MHz band to see where you are" out " . I use the dial of a 10 turn pot.for this and do it outside the set but with the VFO connected to the 390, when you take it apart you would have seen the corrector stack assembly , you need to look at the graph and see where its out sometimes its only necessary to alter 1 or 2 of the cams, when you put the covers back on things change a bit , you will need to set the end point again each time , Some times I have had to pull them apart and repeat the process 15 times and I can tell you that it would try the patience of a Jesus let alone a normal person , , But incrementally you see you are making progress , the linearity is stays put in my experience for at least another 15 years , the Cosmos is easily adjusted and doesn't even need to be removed from the set ,You just drop the front panel down, The guys who designed the Cosmos new a lot about VFO s they introduced a transceiver that predated the Collins Called the COSMAPHONE , you will see ads in QSTaround 1956.

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Date: Tue, 10 Jan 2006 15:41:32 -0600  
From: "Barry" <n4buq@aol.com>  
Subject: Re: [R-390] Amp 9 pin PTO connector R-390A, R-392 Needed

>Does anyone know of a source for the blue hexagon locking connector (male & female) used for the power connection to the R0390A and R-392 PTO's. I'm trying

to make up an extension cable so that I can work on the PTO on the bench.?

Following another "Barry's" suggestion, I made one from a spare harness by using two female connectors (there are two of the same type as used for the PTO in a single harness) and used pins to change the "sex" of one of the female sockets. It works. I believe you can contact Barry Hauser on this list to purchase a spare harness.

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Date: Sat, 14 Jan 2006 17:29:24 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Getting that winter project onto the front burner

To do PTO adjustments, you can just hang the PTO out of the receiver bottom. Turn the receiver up on one end. Use the mini BNC to BNC connector to get the PTO output coupled into the frequency counter. Use the Odham coupler on the PTO shaft for a knob. A simple pencil mark on the PTO and frame let you align the shaft rotation. Once around is 100 KC ten times and you get the meg. We did it on the bench that way back when and got very close. (within a few cycles). No real jigs or setup is really required. Mostly you just need the time to slowly go through the Cosmos adjustment points and do the service work.

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Date: Sat, 14 Jan 2006 16:50:30 -0600  
From: "tfrobase" <tfrobase@kitparts.com>  
Subject: RE: [R-390] What I did on my winter vacation

I use a jewelers saw to cut the can, but like your pipe cutter approach. I then heat the upper area severed aluminum can with a propane torch, just enough to soften the goo and then pull the bottom out with the pins attached. I make the cut just above the crimp to the octal socket. I have used this process numerous times with consistent results ... Tom, N3LLL

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Date: Sat, 14 Jan 2006 18:44:14 -0600  
From: "Cecil Acuff" <chacuff@cableone.net>  
Subject: Re: [R-390] What I did on my winter vacation

I got em unpacked with no problem but when I drilled out the aluminum pieces in the base the tap wouldn't cut threads because the aluminum was so soft....it just augured out. I ended up driving the pins out from the bottom and considered pressing the octal base pins in their place but was struck with the idea of just plugging the caps with the octal base pins into the socket and covering the whole thing with the cap shells.

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Date: Sat, 14 Jan 2006 22:11:54 -0500  
From: "Michael Murphy" <mjmurphy45@comcast.net>  
Subject: [R-390] Metal Paper Caps?

I had to change out one of those round metal triple-caps on a command set RX myself, last weekend. It was on the the B+ feed of the BFO. The BFO would run for a while, warble for a few minutes and then quit all together. Normal voltage on the

cap was supposed to be about 180 VDC. It turns out that the BFO had around 27 VDC when it was functioning "normally" and 14 VDC when it would warble. Below that it would finally quit. Now that is overdesign. With a new cap the voltage returned to the nominal 180 V. The command set was last weekend's project.

This weekend I brought a Sky Buddy back to life for a "buddy" at work. It had some bad caps of course and a little creative modification or two which had to be undone, but it came back and I was listening to AM and CW all afternoon on it. What a simple box! I think this was a 1938 design, but it is a late model S-19R with the more modern tube lineup. 6K8, 6SK7, 6SQ7 and a 41 in the PA. The BFO is a separate 76 tube. It has a "real" power supply with a type 80. I am keeping it long enough to use it at the end of the month in the AWA Linc Cundhall Memorial OT Contest which is CW only, pre-1946 only.

I see you are getting into HBR's. I have not done that yet, but I am on the lookout for a carcass to rebuild. My latest craze is re-discovering Q-Multipliers. I just built two, one for my TCS at 455kc using a single 6J5 which is a "peaker" and one for the 3-6 McCommand set for 1415 kc IFs using a 12AT7 which peaks and nulls. Wow! is all I can say; almost enough to make my R390A a little nervous.

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Date: Sun, 29 Jan 2006 15:38:20 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: [R-390] VFO endpoint adjustment - stumped!

OK, I'm stumped.

I'm putting my yellow striper back together. Right now the VFO covers a range of 2.500MHz to 3.6MHz. At the low end it hits some sort of apparent mechanical stop. Didn't hit anything at the high end because I don't need to turn it that far :-). It is supposed to cover 2.455 to 3.455 MHz (and with 25kHz of under-run it ought to go to 2.430 MHz) just as a reminder. Even though it doesn't span the right range, the linearity is pretty good, and in the first ten turns it is always within 0.5kHz of being on the money. I look in the Y2K manual, but the endpoint adjustment screw illustrated there does not match my unit physically. There is a plug-screw in mine, but it's on the left hand side, outside the triangle frame as seen from the front. The one in the Y2K manual is shown as being inside the triangle frame and a bit on the other side. Inside the plug-screw, I find some sort of slug that can be turned with a 3/8" screwdriver bit. The slug seems to be hollow and probably brass. Turning it does nothing, doesn't budge the frequency at all.

There is another access hole, inside the triangle frame, that has a bunch of little set screws in it that slowly scroll past as I turn the dial. I think these are obviously the linearization screws. I do not want to screw up the linearization of this PTO, I am very happy with it as is. Oh, and I pulled the metal rectangular cover from the box, and found some resistors. Hmm, that 2.2k resistor looks a little suspiciously brown, better check it out.... actually 8K!!! This makes the score on this radio for a total of seven 2.2K resistors that were too high in value by hundreds of percent! (Almost all of them in the plate lines). So I fixed that.



So how do I adjust the endpoint on this PTO? No maker's label on the outside, but there is a refurb sticker from Raytheon, indicating a service date of Feb 7, 1976. At one point I brought it up and I think the suggestion was that it was a Motorola? I could be recalling that incorrectly.

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Date: Sun, 29 Jan 2006 17:09:54 EST  
From: DJED1@aol.com  
Subject: Re: [R-390] VFO endpoint adjustment - stumped!

Sounds like you have a Cosmos PTO with the linearization adjustment. The end point adjustment is to the RIGHT of the linearity adjustment, hidden partly behind the transformer housing. However, you're only going to move the PTO tuning range a few KHz with the endpoint adjustment. If you're off 50 KHz you either have a problem with the mechanical stops or with the PTO capacitors. Is the mechanical stop you're hitting within the PTO itself or the 10-turn stops in the radio? You can change the relationship of the PTO and 10-turn stop simply by loosening the shaft clamp on the PTO and turning it without adjusting the radio's geartrain.

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Date: Sun, 29 Jan 2006 17:35:59 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] VFO endpoint adjustment - stumped!

Ed - it's something inside the PTO. The PTO has not been reattached to the Oldham coupler since the day I got this radio :-). But I will take your advice that it's gotta be something mechanical inside the PTO. The endpoint (I would call it the slope, but everyone else calls it the endpoint) and linearization are great, it's just that it doesn't go down to 2.455Mc but makes this mechanical scrape inside, most of a turn short. And a word to everyone: never ever trust a 2.2K 1/2W carbon resistor you see in a R-390A. I started investigating in my other radio (which had seen much better treatment over the years) and all of its 2.2K's were too high by a couple hundred percent too!

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Date: Sun, 29 Jan 2006 16:17:32 -0700  
From: DW Holtman <future212@comcast.net>  
Subject: Re: [R-390] VFO endpoint adjustment - stumped!

Take a look at this link, it will give you an idea of the inner workings of the Cosmos PTO. <http://www.davemed.com/cosmos.html> <snip>

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Date: Sun, 29 Jan 2006 16:57:40 -0800 (PST)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] VFO endpoint adjustment - stumped!

If you're sure the stoppage is inside the PTO then the best course of action is to open it up, no amount of guessing is going to verify what the problem is. You might check the run-out of the shaft just to see if there is anything to see. It may show a bend that will let you know what to expect when you get inside, maybe. Someone mentioned in the past needing to leave the rear mount loose to accommodate movement in the shaft due to being slightly bent.

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Date: Sun, 29 Jan 2006 22:57:26 -0500  
From: "Jim M." <jmiller1706@cfl.rr.com>  
Subject: Re: [R-390] VFO endpoint adjustment - stumped!

Probably a Cosmos PTO. The little coil you say doesn't change anything is the end point adjustment. Maybe a previous owner turned it too far in trying to set the end points and pushed it out of its threads. The old PTOs cores are notorious for changing permeability with age requiring more and more aggressive end point tweaking until the "tweak" coil bottoms out, then you have to go in and remove a turn from the end point adjust coil.

Is the tuning repeatable from end to end, even though you can't reach the one extreme? Or does it seem like there is a large amount (10's kilohertz worth) of hysteresis or backlash as you go up and down? If so, the little disk that holds the linearity screws could have broken loose from the shaft. Then you need to read my article posted on Medley's site (it has some bad images, I can provide originals if desired). One way or another it sounds like you are going to need to open it up and investigate. Or buy a replacement off of someone on this list. Goodluck.

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Date: Mon, 30 Jan 2006 05:31:29 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] VFO endpoint adjustment - stumped!

Thanks all - I have solved the PTO range issue!

First: that brass thing I was turning with the screwdriver was the oven thermostat. Little to nothing to do with endpoint etc.! Nobody here seems to care too much about the thermostat so I won't worry much either (after I make sure that whatever I set it to doesn't make the PTO cook itself!)

Second: the pictures of the disassembled VFO inspired me to take mine apart. Took out the VFO, took off the mounting brackets, took off the outer can, took off the oven (unsoldering 4 wires), then I finally get to see the works.

No apparent bending/etc. on the inside. The two "limits" I was feeling from turning the shaft came from the core hitting the end of its travel (this is the high end, at approx 3.7 MHz) and something else I never understood on the low side (which was stopping me at 2.5 MHz). Visual inspection showed that physically there was at least 2 and probably 3 more turns that the core could go in. So all I did was crank the core to its outer end (where it emerges from the mechanism if you remove the end), take it off, and put it back on one turn earlier. Now the PTO covers 2.4 MHz through about 3.6 MHz, which is great. Linearity is not as spot-on as it was before the intervention, but now that adjustment seems trivial with a frequency counter and whatever kind of tiny screwdriver fits those little screws.

Again, thanks everyone! Oh, and thanks for the confirmation that I am not insane regarding 2.2K plate resistors. I am still astonished that almost all of them in my radio were high by a few hundred percent, while very few of the other resistors are

out of tolerance.

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Date: Mon, 30 Jan 2006 18:57:50 -0500  
From: "Steve Hobensack" <stevehobensack@hotmail.com>  
Subject: Re: [R-390] VFO endpoint adjustment - stumped!

Don't confuse the brass thermostat adjustment as an end point adjustment! I've adjusted several Cosmos PTO's. I once found one end-point coil that did absolutely nothing when adjusted. Upon close examination under a lighted magnifier, the end leads on the small coil touched each other near the solder tabs. Actually one small copper wire crossed around a solder tap to get to the next solder tab. The varnish had given way to a short. It must have been a quality control defect.

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Date: Tue, 14 Feb 2006 20:36:55 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: [R-390] Squirrely PTO

OK, you guys may remember my dissected PTO. It's mostly back together, but now I notice something else: If I tune continuously in one direction, then the frequency is nice and smooth. If I reverse and tune continuously in the other direction, then the frequency is nice and smooth after a small fraction of a turn. But... for a small fraction of a turn (say a few hundred Hz which would be like a degree or so) if I wiggle it back and forth it sounds "squirrely". Seeing how this only happens when I reverse direction, I'm guessing this is some form of backlash. "Squirrely" means that if I'm tuning through a carrier it does not smoothly go up and down, but jumps around by like 100 Hz or so from smooth. In the "reversing zone" I can turn the knob a bit with no noticeable frequency change, and then it jumps a lot (maybe 100 Hz). After the reversing zone it seems to be nice and smooth. Pulling the covers off and looking inside I see no obvious anti-backlash spring. There is a ring holding tight the PTO slug to the threaded shaft, and maybe that's supposed to be under tension to make the assembly be anti-backlash? What is the "official" anti-backlash mechanism for this PTO? It's a Raytheon-refurbished Cosmos by my best reckoning. If I go to my other 390A (also a Cosmos PTO) the behavior is not nearly so squirrely. There may be a very small amount but it's possibly my wrist :-). Or is it not anti-backlash, but something that the right grease cures? I've rebuilt Ten-Tec PTO's and the usual cure for everything there is a few new plastic parts and magic grease. I didn't really understand what I was doing but I was just following Ten-Tec's directions. My feeling is that plastic pieces and grease is not the answer for my 390A's PTO, but I will appreciate corrections! Oh, as to overall PTO alignment, after I "jumped a turn" the range was correct and with a little tweaking of the endpoint and a couple of the setscrews it's nice and linear, to within a few hundred Hz end-to-end. I do seem to be at the very very end of the endpoint adjustment range: if I need more range, is the endpoint inductor the inductor that folks remove a turn from? I remember hearing about the procedure but didn't really relate to it, having never torn into the PTO when I was reading!

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Date: Tue, 14 Feb 2006 22:25:10 -0500  
From: "Jim M." <jmiller1706@cfl.rr.com>

Subject: Re: [R-390] Squirrely PTO

The Oldham coupler between the PTO shaft and the front gears should have a spring between the two posts. This is on the outside front of the PTO where it's shaft meets the front panel mechanisms. If you don't have a spring there, you will get backlash. The warble can be caused by either a loose, corroded or missing bracket on the front of the PTO that presses against the PTO shaft to ground it. It's a little right angle bracket and it needs tension to effectively ground the shaft.

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Date: Wed, 15 Feb 2006 03:14:43 -0800 (PST)  
From: "KC8OPP Roger S." <kc8opp@yahoo.com>  
Subject: Re: [R-390] Squirrely PTO

Just last week I had the same problem with a Cosmo PTO that I had disassembled for maintenance and cleaning. When I check a PTO I use an Excel spreadsheet to plot measured freq at each 100KHz point against desired freq, and problems like this really show up on the graph. I started with about 300Hz difference, after some fixing managed to get it to over 800Hz. After taking the PTO apart more times than I can count I think I have found the answer.

The lead screw is threaded into the tuning slug, at the end opposite the oldham coupler are two arms that reach out to the frame to keep the slug from turning. The bracket that holds the arms also has a washer with four tabs. The four tabs are for backlash tension. Riding on that washer and threaded on the lead screw is a castled nut that you can rotate to increase/decrease tension. You may have to remove the tuning slug to clean and free up the castled nut. I thought about removing the screws that hold this assembly to the slug, but now would recommend against doing that. I was able to clean things up and re-lube in place. With all covers off, I would move the PTO both ways to a pre-set point and measure the off-set. Each time I would rotate the castled nut a little to increase tension (decrease backlash). I stopped when the backlash was in the 50/100 Hz range. I did not want to put too much strain on the threads inside the tuning slug. You do need to look at the Oldham coupler also. I changed to a stiffer spring which helped remove some of the backlash there.

Hope this helps. I did take a few pictures but don't have anyplace on the web to put them.

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Funny how some of us seem to experience the same type things at about the same time.....at times. (confused yet?)

I have been fighting with my Cosmos PTO for the last week of available evenings. Same problems...got the jitters with reversing direction or even when fine tuning at times. Tap on the PTO cover with a small screwdriver handle and the het tone would bounce all over the place. (most noticeable with the bfo on and using a heterodyne tone for discernment) I've had the thing apart so many times it's crazy. I finally completely removed the heater and associated wiring with no intents in putting any of it back. We don't use them anyway and I see no need for them to remain. I even put the thing back in the radio with all covers removed so I could

move things around with a tuning tool with the radio tuned to a carrier and bfo on. All seemed to center around the rear connection of the tuning slug to the lead screw and anti rotation hardware.

I had remembered reading Rogers post but didn't remember the details. (went back and looked this morning) Here is what I did.

I considered fully removing the tuning slug but had concerns about getting the slug back in sync with the compensating ring and it's already pretty close adjustments. I pulled the rear end plate with the slug fully in that direction and removed the tiny screws (had to drop one on the carpeted floor), the top brass ring, the lead screw to slug tensioning nut and finally the inner brass ring. It appears that the slug is not actually threaded but probably has some type of threaded fixture on the opposite end as well. I cleaned and scuffed the brass rings and the lead screw tensioner fingers (for lack of a better description). I washed them with spray contact cleaner and scrubbed them with a scotch brite pad to remove any oxidation and re-washed. All was re-installed on the end of the tuning slug. There is a metal ring with a couple of arms that go to a piece of square stock that is used to keep the frictional forces from rotating the tuning slug. (it is attached to the slug) It has twice or three times the number of threaded holes needed to attach the brass rings. Pick a set that don't interfere with the tabs on the tensioner once set as tightly as desired. I torqued mine down a bit more than it was when I disassembled it to improve electrical contact with the lead screw. (with fingers, not tools) I have no fear of it damaging the core as it is springy and should prevent any damage. The top ring and screws lock everything in place and ground everything by virtue of the shaft ground on the front of the PTO...which was also removed and treated to the cleaning and scotch brite pad treatment....shaft included, re-tensioned and re-installed.

I feel no added friction in tuning but the thing is dead on now...no more jitters period! I washed all lubricant off the lead screw ( I had placed there)...it looked like stainless steel and the frictional components appear to be brass or copper so I consider it to be self lubricating....and obviously the RF ground at that point is very important.

I was watching the slug movement before disassembly and there was no perceivable backlash even under high magnification so I don't think that was too much of a contributing factor in mine. I could push slightly on the parts mounted on the end of the tuning slug and it would jump around in frequency like crazy but I couldn't see anything actually move so I attribute it to poor electrical contact....

It's all reassembled and back in the radio....minus the heater stuff! It is a joy to tune! Very smooth sounding.... Now to fine tune all those little screws at the 100cps points...while in the radio! Still planning that one! Right now this SJC survivor tunes and hears as well as any radio in the shack and that includes an Icom 756 Pro II and a hot rod Leary SP-600...all sharing the same antenna through a military active multicoupler. The Pro II needs preamp 1 on to keep up...the Leary is still the winner with best recovered audio and top notch sensitivity. (nice front panel IF gain control)

Improved audio is next.....more power, less distortion...then on to adapting look alike meters with 100 ohm inputs. Remember this is the "lets see what is possible within the scope of the technology" radio....never intended to be a museum piece! So far no extra holes...no modifications that would prevent module swaps beyond 12V tubes to eliminate the ballast tube and solid state stuff limited to rectifiers in the power supply and replacement of the selenium which had failed. All molded paper caps replaced. New filter caps and a few resistors replaced. Will need to go back and check more resistors now that some of them have been flagged by others. Am running a 6BZ6 in 1st RF amp. Can't measure any additional sensitivity but it sounds much cleaner, a bit quieter and is every bit as sensitive as original. Half turn removed from end point coil in PTO for end point adjustment. Stay tuned...more to come for those interested.....

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Date: Tue, 21 Feb 2006 13:23:36 -0500  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] Squirrely PTO & SJC update

I've been doing most of my testing with a receiver on the bench in CW mode to pick up the hetrodyne. It's a lot easier to hear the squirreliness than it is to see it on a frequency counter. That said, my squirrely PTO seems to have cured itself without me ever doing any of the dissection that Roger or Cecil suggested. I did do a little cleaning on the square rod that the spider arm rides on, and that may have been enough. It had some visible deposits (maybe grease turned into shellac?) that might have been hampering smooth action at some points on the dial. Looking inside the PTO I see some greasy/shellacy gunk elsewhere but not on the mechanics. After reading Cecil's success I am tempted to tear down and scrub-bright and wash the whole innards. Could the grease been intended to make the airtight/nitrogen-tight seal of the cans against the O-rings? Is there any purpose at all at this point to pump the PTO full of dry nitrogen again?

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Date: Tue, 21 Feb 2006 13:02:39 -0600  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: RE: [R-390] Squirrely PTO & SJC update

Well, you can get most of the way there by sending the PTO to me in Minneapolis, where the dewpoint is around -20 at night. I'll open it up, let it fill with almost 80% nitrogen, then lightly grease the seal and send it back to you.

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Date: Tue, 21 Feb 2006 16:16:06 -0600  
From: "Cecil Acuff" <chacuff@cableone.net>  
Subject: Re: [R-390] Squirrely PTO & SJC update

My 2 cents worth is no! I even cut the silica gel bags out of there because they couldn't have been contributing to reducing the moisture after all these years and I have read horror stories about them rupturing and spreading grit all over the inside of the PTO. These radio's are not operated in the environment they saw during the wars....cold or hot. (wars that is) Mine is in an air conditioned shop/shack and being in the south I heat it by vacuum tube when necessary... not unusual to be

running the A/C in December.... Be careful not to spray cleaners or lubricants on the main coil form....bad things could happen. I washed all my parts after removal and what cleaning I did with contact cleaner was done with Q-tips. I did flow some over the lead screw while running the core in and out. Just be careful...it wouldn't take much to reduce a perfectly good PTO to junk quickly!

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Date: Sun, 26 Feb 2006 13:12:40 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: [R-390] Cosmos PTO, spring-loaded core?

OK, my wife is sick, the kitchen is a mess, my three kids are running around the house screaming, and of course I've decided to pull apart my PTO. I've gotten roughly to where the pictures at <http://www.r-390.com/cosmos.htm>. But of course I've got some questions: I see the ring and ridge that ride the linearity adjustment screws. (Interestingly enough \*all\* the screws are present on mine. Looks like they take a 0.028" hex key but can't find mine at the moment.) I see the core that is supposed to ride the linearity adjustment core, and I find that it sits on the end of a threaded rod and presumably a black nub on mine (it's red in the pictures at the URL above) is supposed to ride the ring and move in and out with a spring pushing it. BUT... I don't feel any pressure when I press on the nub. Is it time for me to tear off the two screws holding the linearity adjusting coil and look for the springs under there? Or do I have to "press harder"?

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Date: Sun, 26 Feb 2006 19:52:49 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] Cosmos PTO, spring-loaded linearizing core?

OK, made that much progress :-). But now I have more time to write my real question: How the heck is the linearization screws/plate/core/inductor supposed to work in real life? "In principle" it's a spring loaded thing such that the core follows the 40-some linearizing screws through the rotation.

But this is what I find in my Cosmos:  
The linearizing inductor has a core in it.  
The core is on a leadscrew.  
The leadscrew goes through a threaded hole in the metal base of the inductor.  
On the other side of the leadscrew is a plastic nub that, I presume, is supposed to follow the 40- some screws. What I don't see: anyway for the nub to move the core in and out of the little linearizing inductor. There's no spring. Nothing slides.  
Maybe, just maybe, the nub compresses/flexes the metal base such that the tiny corrections are made. But it doesn't seem likely. Maybe, just maybe, the pressurized nitrogen in the PTO provides the restoring force and the sliding is just the screw wiggling in its threads. But that doesn't seem likely either. Obviously my knowledge of how the linearizing is supposed to work has a huge gap in it, because I don't see how the screws move the nub or how the nub moves the little core. Can anyone PLEASE correct my mistaken reasoning here?

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Date: Mon, 27 Feb 2006 01:32:31 -0000  
From: <fwbray@mminternet.com>

Subject: Re: [R-390] Cosmos PTO, spring-loaded linearizing core?

Hopefully, the following links will be of some value.

<http://web.webhost4life.com/barryhauser/index.asp?action=page&name=3>

Take a look at issues 45 and 46 of Hollow State News. Also look at:

[http://www.r390a.com/html/body\\_n5off\\_pto.html](http://www.r390a.com/html/body_n5off_pto.html)

I have a Cosmos PTO, but have not yet tried to align it. Good luck, Fred Bray

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Date: Sun, 26 Feb 2006 18:41:14 -0800

From: "Dan Merz" <mdmerz@verizon.net>

Subject: RE: [R-390] Cosmos PTO, spring-loaded linearizing core?

Tim, you might want to look at [www.davemed.com/cosmos.html](http://www.davemed.com/cosmos.html) if you haven't.

You can also find this by goggle search "cosmos pto miller 390a". Miller's pictures of the innards may be helpful. Dan.

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Date: Mon, 27 Feb 2006 00:25:21 -0500

From: "Jim M." <jmiller1706@cfl.rr.com>

Subject: Re: [R-390] Cosmos PTO, spring-loaded linearizing core?

If I recall correctly, and it has been a while, the core of the linearizing coil is spring loaded inside in some fashion so that it moves in and out as the adjustment screw heads push against the slide (I don't have better names for these parts). I don't recall if there was a lot of tension or not but when you push on the little "nub" the coil core should go in slightly, and then spring back when you release the pressure. The pressurization inside the can (if there ever was any) has nothing to do with it. What is going on that you think this coil may be the problem?

The only adjustable coil I know of with screw threads is the end point adjustment coil right next to the linearizing coil. There shouldn't be any wiggling threads. I have only opened one Cosmos PTO (the one on the URL) so I don't know what you may have there. If it doesn't look like what's pictured on the URL inside, then maybe it is something different or it has been modified sometime in its life.

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Date: Mon, 27 Feb 2006 08:42:29 -0500

From: "Tim Shoppa" <tshoppa@wmata.com>

Subject: Re: [R-390] Cosmos PTO, spring-loaded linearizing core?

<snip>....the core of the linearizing coil is spring loaded inside in some fashion...

That was my understanding too. What I do NOT understand is why there's no spring action and no spring and no slide inside this VFO's linearizing coil.

<snip>...> when you push on the little "nub" the coil core should go in slightly...

Again, no spring action. Disassembly of the linearizing coil shows no spring. In fact the core sits on a screw that is threaded through the base. It is VAGUELY



possible that the base is actually two pieces, and the threaded part is supposed to be sliding in and out. But pushing and tugging firmly on it shows no sliding. And it looks like it's just one solid piece. (And externally looks just like all the pictures). If someone told me that this cylinder was supposed to slide, I might start putting it in a vise hammering on it or something. But short of that it's not gonna move.

<snip>...> The only adjustable coil I know of with screw threads is the end point > adjustment coil right next to the linearizing coil.....

Yeah, I've got the end point adjustment coil and it is threaded. (Actually the threads are not on the coil but on a brass insert in the bulkhead that the coil attaches too.) BUT... my linearizing coil has a threaded base, and a core on the end of a threaded screw. No sign of any spring or slider at all. Thus my complete mystification as to how it ever worked. My pictures look just like those on the other websites of a Cosmos's innards, except that none of them ever got so far as unscrewing the linearizing core to look for how it was supposed to work. Oh, one difference: on mine the nub behind the ring isn't red, it's black. Don't know what that means. It looks original, it's a very snug fit into the bottom of the linearizing coil's base, but so snug that it never could've slid in and out. I'm tempted to tear down my other Cosmos PTO just to see what the heck is inside it.

<snip>...or it has been modified sometime in its life.....

Mine \*had\* been rebuilt by Raytheon (according to the maintenance sticker) sometime in the early 70's. But the coil base looks identical to the other Cosmos pictures I've seen around (of course they only show the outside of the base and not the threads or the slug on a threaded screw on the inside). The only obvious difference is that the nub that is supposed to ride the back of the ring is black plastic on mine. The reduction drive for turning the screw plate in mine was pretty grungy. Not as much shellac and grit as the RF deck geartrain, but pretty bad for a sealed unit!

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Date: Mon, 27 Feb 2006 09:45:39 -0500  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] Cosmos PTO, spring-loaded linearizing core?

<snip>..First let's be sure > you are looking at the right inductor.....

Oh, definitely.

<snip>...but I can't imagine the screws riding directly on the end of the shaft....

In my unit, the metal ring has a triangular "screw rider" that obviously is shaped so that it is riding at least one and usually two screws at any point in its travel. Then I guess the back of the ring pushes up against the "slug rider" that is supposed to slide the slug in and out (I guess, in my case it's not sliding!) As to the triangular screw rider: see how the screws zig-zag in and out? The backs of the screws look to be enlarged such that the triangular rider is always on at least one and usually

on two of the screw backs.

<snip>....watched the movement of the alignment tool through that process.....

Thanks Cecil, to verify that there is really supposed to be movement :-). Looking at how adjustable the screws are I would be surprised if there could be an eighth inch of travel, but that's a good upper limit. If you turned one in an eighth of an inch it would probably fall off inside :-(. But I'm getting no sliding. Maybe I should soak the metal inductor base in some kind of solvent to free up that so-far-hypothetical slider. I can sort of conceptually see that there's a cylinder in there, with internal threads that the core sits in, and that the cylinder and thus the slug are supposed to be sliding in and out. There's a lot of mechanisms with a lot of screw holes and I really don't understand how they kept all those holes closed to pressurize this thing with nitrogen.

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Date: Mon, 27 Feb 2006 10:03:02 -0500  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] Cosmos PTO, spring-loaded linearizing core?

One further thought: my PTO is evidently a Cosmos PTO that had been rebuilt by Raytheon in the 70's. I compare the innards of mine (covered with grease, goop, and shellac) to Jim's pictures at <http://www.r-390.com/cosmos.htm>.... and I'm stunned at how shiny his is. In mine the reducing gear was slopped in tan/grey grease, much of which was running all over the feed-through wires. Much of this grease was also on the screws/ screwplate etc. too. Some was leaking through into the back of the can and seeping out of where the inductors screw down to the baseplate. I've been able to clean up much of it. I think Raytheon royally screwed my PTO up 30 years ago. But, if I can get the slug to slide again I'll be home-free!

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Date: Mon, 27 Feb 2006 10:36:35 -0600  
From: "Bill Hawkins" <bill@jaxs.net>  
Subject: RE: [R-390] Cosmos PTO, spring-loaded linearizing core?

The innards pictures show enough details for some educated guesses. Most of my PTO work was on R389 PTOs with 50 ring corrector stacks. The solid ring that holds the slider that contacts the ends of the adjusting screws must be attached to the frame at some point, probably opposite the linearizing coil. It can't turn. That means it could be the spring that you are looking for. If it isn't springy, that could be the problem. Does the PTO look like it had been overheated? You can't put a spring in the end of the coil opposite the slider, or it would be detuned. Seems like you have to attach the screw from the slug to the ring with the slider, to get spring action. That means the relaxed spring must be well away from the frame (at the coil) when the frame is separated from the ring with the screws. You'd have to disassemble the PTO as shown in Jim's pictures. Once you've done that, you ought to be able to press gently on the slider, in the direction of the coil, closing the gap between the slider and the frame holding the coil. Can you do that? Do you feel spring action, so that the gap widens when you remove pressure on the slider? If the slider ring is acting like a spring, then the rod from the coil slug must be attached to the ring. Can you see if that's true? The detailed pictures don't show

that detail. If it isn't attached, can you see how it might have been before it broke away? The adjuster screws don't hold nitrogen pressure. The case is sealed with the big O-ring, the 2 feedthrus and the two screw caps for linearity and endpoint adjustment. Old silica gel packs have to be heated to dry them out before they may become useful again.

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Date: Mon, 27 Feb 2006 12:29:31 -0500  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: RE: [R-390] Cosmos PTO, spring-loaded linearizing core?

<snip>....The innards pictures show enough details.....

Yeah, your guesses are pretty good based on the pictures, but... :-).

<snip>.....must be attached to the frame at some point, probably  
> opposite the linearizing coil. It can't turn.....

You are correct, it is held on by two screws.

<snip>..... Does the PTO look like it had been overheated?.....

It is springy. But there's no way it can "pull" the slug out of the coil. Look at Jim's pictures of the ring and its riders: vacing the outside is the metal triangle that rides the screw, and on the inside you can see a red-with-white-cap thing that must ride the back. The PTO does not look overheated but it is way greased up compared to Jim's pictures. (He doesn't say if it looked that way when he opened it or if he cleaned it up to make it shiny).

<snip>.....Do you feel spring action, so that the gap widens when  
> you remove pressure on the slider?.....

My PTO is completely torn down. I've removed the linearizing coil (you see it in Jim's pictures - there a phenolic form on a long metal base, and there are two cheese-head screws that hold the base to the plate which you cannot see.) There is no spring action and no slide action either.

<snip>..... then the rod from the coil slug must be attached to the ring.....

It is not attached, and it does not slide. I don't think it was ever attached. There is a black plastic nub that must've ridden the back of the ring. The ring can push on the nub, but it cannot pull, so there must be a spring and slider to push the nub back out. My best theory (while I do not have the PTO in front of me!) is that the sliding component must be seized inside the base of the inductor. (You can see the base in Jim's pictures, it's the long metal thing on which the phenolic coil form sits. You also see the nub sticking out and contacting the ring.) The base is long enough that it must have the slide-spring mechanism in its base. My nub looks different than the one in Jim's picture (which now that I look at it again is RED with a WHITE tip). Mine is black. I don't think it's a "mismatched" part because it fits very snugly in the bottom of the metal inductor base. Although it is vaguely possible that the idiots at

Raytheon modified mine, I'm surely HOPING they did not.

<snip>.....> The adjuster screws don't hold nitrogen pressure. ....

OK, so the first time you do the endpoint adjustment the nitrogen poofs out. That's what it seemd like to me :-).

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Date: Mon, 27 Feb 2006 12:30:27 -0500  
From: JMILLER1706@cfl.rr.com  
Subject: Re: [R-390] Cosmos PTO, spring-loaded linearizing core?

I think there's your problem. With all that goop in there it could be that some found its way into the linearizing coil and has dried hard, keeping the coil from moving. Try a squirt of denatured alcohol to the insides of that little coil to see if it will start moving in and out better. BTW my PTO looked like that on first being opened. There is not supposed to be large amounts of grease in there. Just a dab on the main lead screw (that the large core runs on). I have also found dried grease in the main tuning shaft bearings and grease seals where the shaft exits the front. This caused stiff tuning and backlash. As long as you have that apart, you can clean the bearings and produce a much smoother tuning action.

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Date: Mon, 27 Feb 2006 12:10:35 -0600  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: RE: [R-390] Cosmos PTO, spring-loaded linearizing core?

OK, the ring is not the main spring. I do see the red part with the white dot in Jim's pictures. What I can't see is how to remove the coil assembly, with that long steel base that surely could contain a spring. The picture with "The two halves of the PTO being separated ..." shows what appears to be a wrench flat at the end of the "steel" (or some gray metal) base that is close to the frame. Have you disassembled it that far?

If you do have the coil assembly free of the PTO, can you see a way to look in the steel barrel? The spring has to push the rod all the way out, so the fixed end of the spring is near the coil. The other end pushes on the rod, probably using a circlip snapped onto the rod.

OTOH, Cosmos didn't machine anything that didn't have to be machined. Perhaps the red rod is hollow. The inside end pushes against the spring. The outside end pushes against something like a rivet head on the end of the inner rod that attaches to the coil slug. If that's the way it's built, I wouldn't expect the spring to be gunked up. More likely the rivet head broke off - but you can see something extending from the outer rod. You ought to be able to push the rod a little further into the coil, or go around and push on the core to get the rod to move out. The core is probably fragile.

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Date: Mon, 27 Feb 2006 13:25:56 -0500  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: RE: [R-390] Cosmos PTO, spring-loaded linearizing core?

It's easier than you see. There are two cheese-head screws (which you do not see in Jim's photos) that hold the linearizing core base onto the main plate. It's tight but not too hard to get to those screws. The material seems to be aluminum for most of the PTO innards that are not phenolic/ plastic.

<snip>...can you see a way to look in the steel barrel?.....<snip>

Yeah, I don't see a spring. I see a threaded hole in the base. The thread on the screw attached to the core threads through that hole. Current theory is that the threaded hole isn't part of the base but is part of a sliding cylinder that goes up and down in the base, and that the cylinder has somehow seized up in mine.

<snip>.....Perhaps the red rod is hollow. ....<snip>

That's a good theory, and it may indeed be what's in other Cosmos PTO's but that's not what I see in mine. I am tempted to tear down my other Cosmos PTO (it is actually in much bigger need of linearization) just to see if I can slide the core in that one! I looked at the Cosmos patent #3,098,989 and while the externals of the linearing inductor match mine, the innards of base #28 and core #31 do not look like mine. That's a really well-written patent BTW. Occasionally for work I have to look at more modern patents and they are written like crap in comparison.

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Date: Mon, 27 Feb 2006 14:04:11 -0500  
From: JMILLER1706@cfl.rr.com  
Subject: Re: RE: [R-390] Cosmos PTO, spring-loaded linearizing core?

Just to clarify my PTO was clean and shiny on first opening as in the photos, although the grease on the main inductor lead screw had blackened a bit. Sounds like somebody at Raytheon got a little heavy handed with the grease gun. Another thing: I wonder if some coil parts have absorbed grease and expanded? This happens to the material of the coil forms - they absorb lubricants, expand and then the slugs don't move in them too well any more. I don't recal what the coil form was made of for the linearizing coil, but if it is paper based or easily absorbs moisture, it could have expanded around the plunger and frozen it in place.

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Date: Mon, 27 Feb 2006 14:46:25 -0600  
From: "Bill Hawkins" <bill@jaxs.net>  
Subject: RE: [R-390] Cosmos PTO, spring-loaded linearizing core?

OK, no more guesses. When you say there is a threaded hole in the base, does that mean that the red/black rod is threaded on the outside? It looks smooth in the pictures. If it's smooth, it ought to slide.

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Date: Mon, 27 Feb 2006 15:53:53 -0500  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: RE: [R-390] Cosmos PTO, spring-loaded linearizing core?

Your guesses have been pretty good and quite helpful in fact :-). That red/black rod

in the picture isn't really present in mine. Mine has a black plastic nub sticking (friction fit but pretty tight!) into the bottom of the inductor base. The threaded rod goes into the threaded hole into the base, and has the slug on the other end at about the right height to stick into the winding area. If I screw it in far enough from the top, it eventually bumps into the black nub. Because I'm turning the slug at the top I stop turning at that point (rather not break that slug!) My belief (unconfirmed by fact yet) is that the threaded hole is part of a cylindrical "piston" that should slide up and down the base body. The bottom of the metallic piston has the black nub for riding the ring. And that the piston is seized in the body.

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Date: Mon, 27 Feb 2006 17:14:12 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: [R-390] Stuck linearity coil piston: SOLVED!

OK, I got home, gave the kids their snacks so I could have 5 minutes in the basement, stuck a nail into the top of the linearity coil and gave it a couple of whacks. Piston frees up and comes out the far end. It was coated by a layer of grease/shellac, some acetone and brake cleaner helped clean it up and now it works great. I do not NORMALLY use a hammer to solve my R-390A problems :

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Date: Wed, 01 Mar 2006 17:18:36 -0500  
From: Mark Huss <mhuss1@bellatlantic.net>  
Subject: Re: [R-390] original Collins PTO

According to a conversation I had many years ago with the son of one of the Engineers that worked on the R-390 and R-390A design, there was indeed something 'Special' about the Original 'Collins' PTO. From what I remember, we had an R-390A with a PTO that was out of adjustment range. It was a low serial number PTO made by Collins, the first time I had seen one. I had decided to try repairing it as the School was not exactly high on the priority list for spare parts. That is when this fellow told me about his history, and the solution to the problem. I.E., take a half turn off the small coil in the PTO. The cause, according to him, was the material used for the large coil form. It changed dimensions with age and heat, causing the inductance to change. He said his dad told him about it when he joined. Said that Collins discovered the problem in the 75A series, but it did not show up until about the middle of the first year Collins R-390A run since it took years to show up. They fixed the problem in the latter half of the Collins run, and all subsequent PTO's made by other manufacturers. So yea, it is 'Special' in that it is one of the worst PTO's you can have.

As for the bonifidies of this issue, I never met his father, just what he told me. However, the solution did work. And later I heard that PTO's on the 75A series Collins do have a problem with being out of adjustment range. And I never had the problem with any other PTO by other manufacturers. If the tale is true, then Motorola also made PTO's before 1957, so they may also have the same problem.

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Date: Wed, 01 Mar 2006 19:10:10 -0800  
From: "Dan Merz" <mdmerz@verizon.net>  
Subject: RE: [R-390] original Collins PTO's

Mark, can't be exactly as you say, or heard. My Cosmos in an EAC 390A required removal of a turn to get it back in the proper range. I have limited experience otherwise. Maybe because they're older, the Collins PTO's are more apt to show up with this ageing problem.

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Date: Wed, 01 Mar 2006 19:18:54 -0800  
From: "Dan Merz" <mdmerz@verizon.net>  
Subject: RE: [R-390] original Collins PTO's

Mark, I don't think the ageing of the PTO that you described is limited to Collins PTO's. The Cosmos PTO in my EAC 390a also required removal of a full turn to get it back in the proper range. Time/temperature may be the enemy. That's not to say that there may not have been some effort to cure the problem but 30 odd years is apparently enough to have another type of PTO (non-Collins) show the same symptom. Dan.

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Date: Thu, 2 Mar 2006 00:50:02 -0600  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: RE: [R-390] Collins PTO's

Well, I worked on two R-389 PTOs for linearity. Can't get much more Collins or much older than that. They were within 500 cps of linear without being touched. Maybe the "cost-reduced" (that is "cheaper") R-390A had that problem. They're gone now...

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Date: Thu, 02 Mar 2006 10:09:11 -0500  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: RE: [R-390] Another "Close to Perfect" R-390a

The R-389 PTO is type 70H-1 (not 70H-2 or 70H-12). It makes FIFTY turns not 10 turns end to end. It is rumored to have been the most difficult PTO Collins ever made. I assume that they were all made at Collins, not contracted out. I need one.

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Date: Thu, 2 Mar 2006 09:32:36 -0600  
From: "Les Locklear" <leslocklear@cableone.net>  
Subject: Re: [R-390] Another "Close to Perfect" R-390a

It was /is a known problem with the 51J series PTO's, but they had other problems, 12 kc off wasn't uncommon. Theory seemed to be, you either had a good one, or you didn't. I must have been lucky, had several 51J3's (R-388) and 2 51J4's, all were good.

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Date: Thu, 02 Mar 2006 10:58:23 -0500  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: [R-390] Corrector plate PTO's,

I just googled for "R-389" and PTO and found Don Reave's pictures of the internals of a 70H-1. Except for the corrector plate stack it looks a lot like the innards of my 390A Cosmos PTO's (some of the parts look to be identical or at least the same

series) and elements of the chassis look very similar too (including those dessicant packs even!) Silly questions about corrector plates (my very limited experience is with Cosmos-style PTO's):

What's the typical "range" of correction? It looks like a little less than 1/4 of a turn is max (although typical seems to be far less and obviously you can't go too far from one correction plate to the other.) Are the plates "slidable" to the correction, or is each correction plate machined to provide exactly that correction? If they're slidable it looks like it'd be tricky to slide one without disturbing others in the stack... If they're not slidable it would seem that re-linearizing would require either a machine shop or a large supply of assorted corrector plates.

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Date: Thu, 02 Mar 2006 11:23:31 -0500  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] Corrector plate PTO's

I found that at: <http://www.r-389.com/> What's the typical "range" of correction?

I have not done a corrector stack adjustment, but: Seems to me that the range of the stack plates is way less than one quarter turn, more like five or maybe 10 degrees of rotation. The change of rotational position of the threaded part of slug mechanism imparted by the corrector mechanism is not very much. Yes, the jump from one plate to the next cannot be too much, or the roller follower will not make the move. As I understand it: Each plate is separated from the next by a more or less fixed shim. Thus you can move each plate independently of it's two neighbors. The manufacturers had a jig with a PTO shield cut to allow entrance of a moveable set of jaws that could move one plate at a time. The stack of plates is locked by a bolt through the whole stack, or by some similar clamping mechanism. The operation was: Move PTO to next plate, unlock, make correction, lock, then repeat 40+times. Then do it all over again. If \*I\* were setting up the ladies with linearization adjustment stations, I would automate the stack lock/unlock thing with a foot switch, and provide a very easy to read center-zero meter readout for each 25 kc step, and likely an automated turn-a-quarter-turn mechanism.

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Date: Sun, 05 Mar 2006 13:29:06 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: [R-390] VFO squirreliness solved FOR GOOD

OK, I went one step further and think I've solved all squirreliness issues with my two Cosmos VFO's for good: The pics on the net show the lead-screw and slug. What may not be clear is that the bottom of the slug is threaded, and the top (above the arm assembly) is threaded separately.

Backlash is removed by taking the three tiny screws off the top of the arm assembly. You will find two rings (top with three holes, bottom with six holes) and a threaded piece in between them. I removed the threaded piece, cleaned and polished the rings and the threaded piece (they seem to be copper or a copper alloy and had a good amount of green-red crud on them), tighten the threaded piece back down, and reassemble the ring back on top. How tight? Well, I don't think I tightened mine



down any more than they originally were, but mostly removing the crud did the job. This is not something you tighten with a wrench! Finger-tight seems to be more than enough. Make it too tight and there will be too much "drag" as you turn, I guess (I didn't try tightening them that much.)

I am now deep in the math of optimizing the linearization. It is a rather interesting thing with a number of controls. Of course there are the 40-some little linearization screws, but the effect of these screws is also affected by the overall adjustment of the slug in the linearization coil (for MOST RANGE, you adjust this slug so that it is JUST ENTERING the coil region; for LEAST SENSITIVITY you want to pick an area where the end has ALREADY ENTERED the coil region.). The endpoint adjustment comes in too (and while setting end-to-end to be 1MHz is a good place to start, for optimal adjustment the number may be a kHz higher or lower depending on where the linearization deviations are, if they're in the middle or at the ends.) To make things just a little bit trickier, the linearization setting is MOST SENSITIVE at the 3.455MHz end, where the fraction of inductance provided by the linearization coil is the largest, and it is the LEAST SENSITIVE at the 2.455MHz end, where the fraction of inductance provided by the linearization coil is the smallest.

I am PROBABLY OVERANALYZING the linearization issues. Maybe I should just tweak the little screws more rather than graphing all this stuff! At least the squirreliness is gone. Before, when I tuned the VFO through while listening to the 2.455 through 3.455 MHz end on a nearby receiver, I could clearly hear some funny wiggles going on. Now, it's smooth as silk! Tim.

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Date: Sun, 05 Mar 2006 10:57:45 -0800  
From: "Dan Merz" <mdmerz@verizon.net>  
Subject: RE: [R-390] VFO squirreliness solved FOR GOOD

Tim, thank you for taking the time to relay your findings. I never messed with the linearization on my Cosmos because it looked messy. And I don't recall really cleaning mine like you did when I had it open to take a turn off, which might be worth the effort. As far as "overanalyzing" goes, this happens. I'm glad you took the effort. I wonder how much the linearization scheme improves the linearity. How non-linear are the other pto's that don't have this feature? Or how much correction are you making as you tweak these? I'll now have to monitor my pto with a frequency meter to see what I sacrificed by ignoring further adjustment of mine. Best regards, Dan.

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Date: Sun, 05 Mar 2006 15:27:03 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] VFO squirreliness solved FOR GOOD

I doubt that the grease-monkeys at Raytheon put so much oily goo inside your PTO's, Dan :-). One of my two units has a nonlinearity of about +/- 1.2kHz without linearity correction, and the other one (the one Raytheon gooped all up inside) is about +/- 2.0kHz without linearity correction. (By "without linearity correction" I mean that all the little screws have been adjusted to midrange and I've already

optimized the endpoints.)

The maximum range of linearity correction by turning the little screws is about 4kHz at the 3.55MHz end (and 2.something kHz at the 2.455 MHz end), so even the extreme one is still within correction. That's about two turns of the little screw. To align at the 200Hz level the screws need to be adjusted to the tenth of a turn, and this is probably about as good as can be done. (I'm sure somebody's gonna chime in here about how they linearized theirs to the 10Hz level...!) I don't think my PTO's are "cream of the crop" with respect to accuracy before correction.

Getting them much better than 200Hz is probably not feasible because the linearity screws aren't flat to that level on the back. Hypothetically, I think the correction range could be extended somewhat by taking turns (there aren't that many to start with!) off the endpoint inductor and moving them to the linearity inductor. Just moving some of the flying wires inside the PTO can will change linearity at the 1-kHz level. As to "overanalyzing" this, I've got a few dozen tables of frequencies vs dial positions as I tweak the endpoint, sometimes at the 25kHz points but usually at the 100kHz points. It's interesting to an extent (but also realize that I spent many many years in grad school graphing data and fitting curves so I'm not actually averse to the subject.)

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Date: Sun, 05 Mar 2006 13:05:03 -0800  
From: "Dan Merz" <mdmerz@verizon.net>  
Subject: RE: [R-390] VFO squirreliness solved FOR GOOD

Tim, same here on the "I like to graph things". Thanks for the hard data on the amounts. I measured the pto on my Collins R-390 a few minutes ago... The 390a Cosmos isn't as easy to get to at the moment. I found: the Collins pto output spans about 997.8 khz, or 2.2 khz short of the 1000 khz range in going from 000 to 1000 on the dial. The error in dial readout is almost all due to that problem.

If I correct the readings as though I stretched the pto span by adding a turn or whatever it would take to the coil, I estimate the non-linearity of the pto to be in the range of 0.1 to 0.2 khz, pretty darn good for something that's probably not been messed with as far as I know. I'll check my Cosmos unit sometime to see how it fares. I'm not going to try to improve this particular unit, which spans 997.8 khz instead of 1000 khz..

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Date: Sun, 05 Mar 2006 17:28:59 -0800  
From: "Dan Merz" <mdmerz@verizon.net>  
Subject: RE: [R-390] VFO squirreliness solved FOR GOOD

Tim, I checked my Cosmos pto in the EAC 390a with following observations: The pto output span was 1000.4 khz for 000 to 1000 on the dial The non-linearity (after assuming I reduced the span from 1000.4 to 1000.0) was typically about 0.3 khz but two points at 200 and 300 on the dial were about 0.5 and 0.6 khz away from linearity. Interestingly, the way the pto is now, if I were to calibrate the dial to a known signal at mid scale, 500, the indicated frequency would be within 0.2 khz over the entire range except at 000 which would be off by 0.5 khz. That seems good

enough for me. I don't recall that I adjusted the linearity at all when I took a turn off the coil about 5 years ago.

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Date: Mon, 6 Mar 2006 16:22:58 -0800  
From: "David Wise" <David\_Wise@Phoenix.com>  
Subject: RE: [R-390] Corrector plate PTO's,

Caveat: I have linearized one Collins R-390A corrector plate PTO. I can't remember the range of correction. There is a very real limit on rate of change of correction. If there's a valley, it has to be wider than the follower, or it will never touch bottom. The plates slide individually quite well, as each pair is separated by a thin stationary finger. A thumbnail is a pretty good tool for sliding individual plates. Just thin enough and stiff enough, and always handy :)

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Date: Sat, 11 Mar 2006 22:03:41 EST  
From: DJED1@aol.com  
Subject: Re: [R-390] VFO squirreliness solved FOR GOOD

Thanks, Tim, for inspiring me to tackle one of my PTOs. I replaced my original Progressitron PTO with a Cosmos because it was warbling as I tuned. I had cleaned the grounding wiper, and had disassembled the PTO and cleaned the threads, but couldn't solve the problem. Based on your comments, I pulled the PTO apart, removed the back plate, and removed the slug and cams (all in one piece). I didn't disassemble the slug, but I was able to clean and lube the entire threaded shaft. I also resoldered the small caps as Les had suggested. I put it in the radio tonight, and it tunes great- no warbles. The only problem I have is that it's off about 2 Kc end-to-end, and the variation is not linear. I'll tweak the end point and see how close I can come- it will probably meet the original specs when completed, but won't be as good as a tweaked Cosmos. Speaking of which, I also tweaked the end point on the Cosmos because it was out by 1 Kc. Fixed that right up, but now intermediate points are out by as much as 1.8 Kc, where they were within 0.4 before I touched it. And the strange thing is that all the 25Kc points are off the same amount- 1.8 Kc. All the 100 Kc points are right on, and the 75 Kc points are out about 0.8 Kc, and also all the same. Very strange. I'll look at the data tomorrow and decide if I want to tweak all those little screws, or just put the end point adjustment back to where it was. While I was in the radio, I found I had a bunch of BBODs in the IF. I thought I had all Vitamin Q metal caps, but I was mistaken. I don't have a full set of replacements, but I did replace C553 with an Orange Drop, so at least that is taken care of. Ed

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Date: Sun, 12 Mar 2006 17:48:09 EST  
From: DJED1@aol.com  
Subject: [R-390] PTO success

Thanks to all the lore collected through this group, I have gotten both my PTOs into shape. I adjusted the endpoint on the Progressitron, and it now meets original specs (300 cycle error after calibration at the nearest cal frequency. I'm impressed, for the most part it's within 100 cycles within 50 KHz of a calibration point. Off by a max of 1 KHz if calibrated only at mid-range. I resolved the problem with the

Cosmos after recollecting a list discussion about having pressure on the tuning shaft giving a cyclic variation in error. Sure enough, I loosened the mounting screws, moved things around a bit, and it looks good- almost all 25 KHz points within 300 cycles without recalibrating. I wasn't looking forward to tackling all those little screws again. Now I have to decide which one to leave in the radio. I wanted to see if the Progressitron was more stable, but I hate to mess up the setting on the Cosmos now that I've got it screwed in just right. Incidentally, calibration is easier with the synthesized HP generator I got. Just dial up each 25 KHz increment and read the error on the radio dial.

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Date: Sun, 12 Mar 2006 13:12:57 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] VFO squirreliness solved FOR GOOD

The endpoint adjustment does interact at least a little with the calibration. A couple kc is the limit of adjustment possible with the little linearity screws. I think that in some cases it may be wiser to add some small amount of capacitance rather than tweak the endpoint. Maybe I'll experiment with that tomorrow, AFTER replacing the toilet AND seeding the lawn AND installing the ceiling fan... (meaning it probably won't happen!) Was C553 a BBOD? The IF decks I've owned had BBOD's in a lot of not-so-critical-for-leakage places (e.g. screen and filament bypasses) but better quality metal cans - Vitamin Q's or Westcaps - at the filters.

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Date: Sun, 19 Mar 2006 12:31:52 -0500  
From: <mfisch@kent.edu>  
Subject: [R-390] Cosmos PTO

I know there is a lot about the Cosmos PTO out there, but nerves have got the best of me. I want to adjust the end point (out by about 1 kHz) and I took off the screw to adjust the end point, but the end point adjustment screw looks like a spanner nut with a rubber center. Do I just take a 1/8 inch blade screwdriver and have ho or is there something I need to be careful of? I was expecting a slot and it looks like I should stone a screwdriver to have parallel sides. Is this the case? Thanks in advance.

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Date: Sun, 19 Mar 2006 12:44:53 -0500  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] Cosmos PTO

There are three "holes". The endpoint one is the one that is partially obscured by the transformer can. Removing the can might help get you access (especially if you have a stiff-bladed driver). BUT... I think there is "hot" wiring inside the transformer can so be careful if you do so. If you do not remove the transformer can you can use a metal screwdriver without fear.

The one next to the endpoint hole reveals all the little linearity adjustment screws. (I bought the 4-flute spline driver for these from McMaster, let me know if any of you need the official McMaster part number.) And there's a third hole that reveals the thermostat set point. This is a BIG (in comparison) brass screw.

Not sure what a "spanner nut with a rubber center" is, but the endpoint inductor has a brass three-wing section that has an external nut which can tighten down on the brass adjustment screw. I think the purpose of the three-wing section is that it is adjusted to minimize wiggling/backlash of the internal brass adjustment screw. The brass screw is attached to the slug.

If you find you do not have enough adjustment range, you probably have to open to the PTO can and adjust the turns on the inductor. Others talk about removing whole turns, but for mine I found that removing half a turn (reversing the direction of the winding so it went from 2.75 turns to 2.25 turns) was the best choice. In my case removing a whole turn took me too far in the direction of increasing the span. But removing half a turn got me in the "sweet spot". Since you're only 1kHz off in endpoint, maybe you don't have to do this surgery. But if you find yourself with the brass screw all the way inside the three-wing clamper, or sticking out so far it would interfere with the threaded cover, then maybe it's time.

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Date: Mon, 03 Apr 2006 08:37:17 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] Question on COSMOS PTO

> 1. Zero beating against the calibration 100Khz signal at x.000 after using  
> the zero adjust knob to be exactly at x.000, I noticed that if I either dial  
> up or down from this calibration spot, coming back to this mark, I'm always  
> either +/-100Hz off depending on the direction I'm turning. Is this what you  
> call backlash or hysteresis?

This is backlash, and it is probably in the gears coupling to the counter mechanism. Assuming that all the springs are in place and tightened, the worst offender in the chain is the bevel gear that comes right before the counter. This can be adjusted a little bit (setscrews) to tighten it up. If you watch the bevel gears (either looking in from top/bottom or with the front panel off) you can see and feel the backlash as you wiggle the front knob.

> calibration. Am I approaching the design limit being off +/- 100Hz on the  
> calibration mark?

Pretty much. While the bevel gears can be squished into each other tightly this still doesn't remove all the backlash (and it certainly isn't "right" in terms of mechanical operation, you quickly start noticing a lot of rubbing friction from those gears as you tighten things up.) See my thread from last month about a different problem, a "squirrely PTO", which I had to tear down the entire PTO for.

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Date: Sat, 29 Apr 2006 22:22:35 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: [R-390] No Peak on T701

I've been doing some more tweaking on one of my R390As. T701 (output transformer from the PTO) will not peak. I'm getting slightly less than 2V peak to peak no matter how I adjust the slug. Anyone ever seen this behavior? If so, any

ideas what's wrong? I've done some resistance checking on V701 and nothing is all that far off. Since the slug tunes the plate tank, I'm wondering if the problem might be with C706. It's supposed to be adjustable, but how? Reading the Y2K manual, it states C706 is a variable glass dielectric cap. Not sure what that is, but with the PTO out of the radio and the cover off of Z702, I see a clear cylinder in which the slug moves. Is that C706? Thanks for any help or advice on this.

By the way, FC7 (changing R702 from 56k to 220k and thereby reducing the output of the PTO voltage) has not been done on this PTO.

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Date: Sat, 29 Apr 2006 22:30:49 -0500  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: RE: [R-390] No Peak on T701

Ah, les'see, the output PTO coil will not peak. Doesn't seem like it would be a good idea for it to peak. The PTO generates 2.5 to 3.5 megacycles, and they've all got to be mixed with the masticated RF from the RF deck. A sharp peak at 3.0 MC would seem like a very bad idea. If you want a reasonably level signal for 3 +/- 0.5 MC, you want a really low Q circuit. What have I missed?

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Date: Sat, 29 Apr 2006 22:54:31 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: Re: [R-390] No Peak on T701

That's a good point; however, why is the transformer slug tuneable? I realize that just because a component happens to have an adjustment that's not a reason to go about adjusting it (golden screwdriver syndrome), but it would seem they put adjustments on these components for some reason, right? I assumed the output of the oscillator should be maxed somehow, even if it is a low-Q circuit. Although I don't see it in the Y2K file, I do seem to recall seeing something about adjusting this in one of my other manuals. I'll have to check.

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Date: Sat, 29 Apr 2006 23:09:55 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: Re: [R-390] No Peak on T701

Hmmm. It appears the adjustment I \*thought\* I was making to the transformer was not the transformer at all, but C706! Although the schematics are drawn with an arrow through T701 (which I always took to mean an adjustable (usually slug-tuned) transformer), it appears the transformer in Z702 is fixed (the windings are on top of each other with no slug tuning).

Now, I'm still wondering what C706 is tuned for. Maximum output? If so, I'm not seeing any change with it. Thanks again, guys.

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Date: Sun, 30 Apr 2006 07:18:50 -0400  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] No Peak on T701

Check resistor values and DC voltages inside the PTO chassis. IIRC there's one of

them 2.2K's that are always off by a few hundred percent.

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Date: Sun, 30 Apr 2006 07:47:55 -0400  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] No Peak on T701

2V RMS is not awfully low. When I scope the PTO output I see 6-8V P-P, the max in the middle of the range and falling off towards the edges (especially the high freq/ low counter edge). This is the raw unterminated PTO output; putting a 50-ohm terminator on it drops the value by a little more than a factor of two.

Let's see, 6V Pk-Pk is a little above 2V RMS. Maybe your PTO output is a little bit low but I can't say that it's "bad".

It's been a while since I screwed around with it but IIRC there was not a lot of variation to be had by swapping PTO tubes around. (I was mostly looking for frequency stability not PTO output level as I swapped tubes around.) I seem to recall past postings on this list that suggested that the PTO output network was there to "squash" any resonances and make the output roughly flat across the PTO range. So actually peaking it up for one particular frequency may be not good (may in fact be impossible! As another data point, most of my crystal oscillator band outputs are in the 8 to 10V Pk-Pk range, with some going up to 12 or 13V and a few bands as low as 5 or 6V (I guess the variations are due to crystal activity or just the way picking off the harmonics works; the units have been peaked up on each band.) Getting back to my mixer design obsession, I guess this means that most of the mixers were designed with LO inputs in the range of a few (1-3?) volts RMS in mind and that a factor of two variation in level throughout the frequency range is not out of design specs.

I'm not claiming that my values are golden reference standards either, just what I see on my two 390A's. Is there an official output level that the PTO is supposed to meet? And is that value into a terminator or not?

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Date: Sun, 30 Apr 2006 14:07:02 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: Re: [R-390] No Peak on T701

I'm seeing about 1.8V peak-to-peak, unterminated into my 'scope. The more I think about this, the more I'm wondering if C709 might be bad. Wouldn't this cause low output? It's spec'd as a 2% so I'm thinking if it has changed, even slightly, it might be causing a problem. If I recall, C327 (the cap across L230/T207) is of the same type and it has been known to cause low output from the 1st crystal oscillator. I haven't found a 510pF, 2% cap yet, though. :( Surplus Sales of Nebraska has them, but they also have a \$10 minimum order and I really don't need anything else from them right now. Any sources, anyone?

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Date: Sun, 30 Apr 2006 15:07:14 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] No Peak on T701

Barry - N4BUQ Reports that he has done some resistance checking on V701 and nothing is all that far off. Since the slug tunes the plate tank, I'm wondering if the problem might be with C706. It's supposed to be adjustable, but how? Reading the Y2K manual, it states C706 is a variable glass dielectric cap. Not sure what that is, but with the PTO out of the radio and the cover off of Z702, I see a clear cylinder in which the slug moves. Is that C706? --- YES ---

Barry - N4BUQ Reports that he has been doing some more tweaking on a R390A's T701 transformer (output from the PTO) that will not peak. Getting slightly less than 2V peak to peak no matter how he adjust the slug. By the way, FC7 (changing R702 from 56k to 220k and thereby reducing the output of the PTO voltage) has not been done on this PTO. He asks, Anyone ever seen this behavior? If so, any ideas what's wrong?"

Barry, R702 is the screen grid resistor, Changing the value from 56k To 220K will just reduce the screen grid current. Maybe a bit less noise in the oscillator output. Like a little longer tube life. Not a lot of change in the oscillator output. Tim Shopp recommended that you check resistor values and DC voltages inside the PTO chassis. We know the 2.2K's are always off by a few hundred percent. The one in the plate circuit R703 could be drooping B+ and thus giving your low output. Figure 49 page 75 in TM 11-5820-358-35 8 December 1961 Shows Z702 with both the cap and slug adjustment on the top of the can. If you are working on a Cosmos PTO or some other clone of the Collins Variable Frequency Oscillator then all bets are off.

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Hmmm. It appears the adjustment I \*thought\* I was making to the transformer was not the transformer at all, but C706! <snip>

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Oops, Barry, you should have a C and a T to tune. Several photos and drawing in the 1961 TM show both items. My R390/A is bolted in a case and I can not get a look its internals. Some models of the PTO may have put the C outside the Z702 can on the "subassembly chassis". The Cosmos PTO's may have a fixed transformer with no adjustment. Some other models may also have no transformer adjustments. Is it time for every one to look at their PTO and report what we find for models and setup?

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Both C706 and T701 of Can Z702 are variable. C706 will be a thread shaft that gets longer and shorter when adjusted. T701 will have a nut on the coil thread shaft like T401. What you want is a flat output from 3.455 to 2.455 into the load of the V204. Any other test is just an educational opportunity and has no relation to the actual operation of an R390/A receiver. The cathode DC current of V204 flows through the secondary of T701. The mixer output of V701 is imposed on the DC cathode current of V204. For inspection purposes only, place a tube extender under V204, ground E211, and observe the peak to peak output of the oscillator signal on the plate of V204. As you run the VFO through ten turns watch the peak to peak level on the plate of V204. The output should be flat from end to end. Oscillator peak to peak output likes to change with a change in frequency. The tuned circuits are to oppose the change and thus provide a "flatter" output across the tuning range. DO NOT expect the oscillator output to peak at any point. DO



expect a flat output across the full range. The 1961 TM offers no suggestions for tuning C706 or T701. The Y2K Manual is based on this early publication and likewise offers on help with C706 and T701. We see that in the RF section we adjust the slugs on the bottom frequency and the cap on the top frequency. We see that in the RF section we make these adjustments at the quarter band points. So  $2.455 \text{ plus } 250 = 2.705$ . Thus  $3.455 \text{ minus } 250 = 3.205$ .

Use the procedure above with a tube extender. Watch the B+ on the plate of V204. Ground the test point E211 just to keep the V204 mixer output content down to a minimum number of mixed output signals. Adjust C706 for maximum output with the KC knob at 705 on any MC band. Dial the KC knob through the ten turns and watch the output on the plate of V204. Adjust T701 for best equal output across the KC. Repeat the process until you get the output as flat as you can. If you find your receiver output is lower at 1.750 than at 1.250 then the VFO Z702 may need adjusting. Or if the band has more output on the other end. Bad PTO adjustment will look likes lower output or less sensitivity on one end of every KC than at the other end. Or you could have a peak where the middle is peaked or sags. If you have a VFO you think has a low peak to peak output, by all means start checking those resistors.

Most of us do not have a signal generator that we can run over 8 Meg (just to dodge the first mixer) with a flat output across a 1 meg band to check the output of the VFO through the mixer. The number of variables just make the effort not productive. I am sure some one will be happy to tell me they can and did it. Most of us just do not care.

In summary, check the resistors, scope your VFO output once and then leave C706 and T701 in Z702 on your receiver alone for the rest of your life.

Bill Hawkins added, Also recall past postings on this list that suggested the PTO output network was there to "squash" any resonance and make the output roughly flat across the PTO range. So actually peaking it up for one particular frequency may be not good (may in fact be impossible!)

Ah, les'see, the output PTO coil will not peak. Doesn't seem like it would be a good idea for it to peak. The PTO generates 2.5 to 3.5 megacycles, and they've all got to be mixed with the masticated RF from the RF deck. A sharp peak at 3.0 MC would seem like a very bad idea. If you want a reasonably level signal for  $3 \pm 0.5 \text{ MC}$ , you want a really low Q circuit.

Bill Hawkins asked, "What have I missed?"

Bill's right, the VFO output needs to have the same output level across the output range of 2.455 - 3.455.

Tim Shopp, tells us 2V RMS is not awfully low. When he scoped the PTO output he sees 6-8V Pk-Pk, the max in the middle of the range and falling off towards the edges(especially the high freq/low counter edge). This is the raw unterminated PTO output; putting a 50-ohm terminator on it drops the value by a little more than a

factor of two.

Let's see, 6V Pk-Pk is a little above 2V RMS. Maybe your PTO output is a little bit low but I can't say that it's "bad".

Tim Shopp's following is also relevant knowledge.

As another data point, most of my crystal oscillator band outputs are in the 8 to 10V Pk-Pk range, with some going up to 12 or 13V and a few bands as low as 5 or 6V (I guess the variations are due to crystal activity or just the way picking off the harmonics works; the units have been peaked up on each band.) Getting back to my mixer design obsession, I guess this means that most of the mixers were designed with LO inputs in the range of a few (1-3?) volts RMS in mind and that a factor of two variation in level throughout the frequency range is not out of design specs. I'm not claiming that my values are golden reference standards either, just what I see on my two 390A's. Is there an official output level that the PTO is supposed to meet? And is that value into a terminator or not?

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Date: Sun, 30 Apr 2006 15:19:27 -0400  
From: "Jim M." <jmiller1706@cfl.rr.com>  
Subject: Re: [R-390] No Peak on T701

www.mouser.com takes small orders.

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Date: Sun, 30 Apr 2006 14:29:52 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: Re: [R-390] No Peak on T701

I don't know the brand name of this PTO. Someone removed the label before I got it. It definitely has no T adjustment, though. The primary and secondary are wound together on a "resistor-like" form. The glass cap is definitely there and I can see the slug in it moving as I turn the adjustment nut (made a special tool to do this). I'll have to try the tests you describe. As you may have noticed my earlier reply, I'm wondering about the cap across the output. Ever seen one of those go bad?

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Date: 1 May 2006 13:57:21 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] No Peak on T701

I attempted to perform the "ground E211 and measure the output on the plate of V204" test. I'm not sure, but I may have 'scope problems. In order to see the signal, I have to select a very small vertical deflection value (say 0.1V/div or less). When I do this, the 'scope "wobulates" up and down on the screen on the order of 0.05V or more. If I look at the output of the RF-IF output at F103, it is doing the same thing. I don't know if the power is dirty, the power supply is acting weird, the 'scope is flaking, or what. I have noticed this on other power supplies I've checked, so I'm not sure what to make of it. At any rate, it makes seeing small differences in peak-to-peak on the plate of V204 very difficult to measure. Am I doing something incorrectly here or is this something others have seen? I'm still thinking I could have 'scope

problems. It's a TEK 561A and is definitely has its own set of problems, but this seems to be a repeatable, almost expected anomaly, at least with this 'scope.

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Date: Mon, 01 May 2006 10:28:12 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] No Peak on T701

Is the wobulation 60Hz/120Hz? Could be anything from real 60Hz power supply hum in the radio, in the scope, ground difference between the two, etc. As long as the wobulation isn't inside the scope, isolating the 60Hz hum can make a world of difference. Standard workaround is use smallish capacitors in series with the scope probe that will block 60Hz you do not want to see but not block the MHz signals you want to see. Typical values might be 100pF to 0.005uF.

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Date: 1 May 2006 14:38:45 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] No Peak on T701

No, it isn't steady. That's why I called it "wobulating". It's almost like some component is randomly, but rapidly, changing value causing the pattern to shift up and down at a varying rate and varying amplitude. Looks kind of like it needs to check in down at the "nervous hospital" (reference to the movie Slingblade).

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Date: 1 May 2006 18:15:23 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: [R-390] Speaking of C709

The specs call for a 300V capacitor for C709. I assume this is just because this is what was commonly available, right? With only a few volts across the output, is there any other reason to insist on a 300V capacitor here?

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Date: Tue, 2 May 2006 22:49:13 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: [R-390] More C709 info

I was able to carefully lift one side of C709 and watch the output of the PTO with and without it connected. With it disconnected, the output nearly doubles in amplitude. Is this expected behavior or is the capacitor most likely leaky? I'm just not sure of its intended function. I assume it and R704 limit/shape the output (but I may be waaaay off on that). Any input or other info?

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Date: 3 May 2006 14:31:15 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] More C709 info

> The 2.2k plate resistor in this PTO checks about 2.8k. I put a 10k resistor in parallel with it just to see what effect it would have (effective resistance should have dropped to just under 2.2k). It only made a difference of a couple of volts at best on the plate and very little (if any) difference in the PTO output. While it's technically

out of tolerance, I don't think this is far enough out to warrant replacement (yet). I would replace it now, but the gain-to-damage ratio to replace it in those tight quarters just isn't worth it at this point.

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Date: 3 May 2006 18:30:16 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] More C709 info

I bought a pack of 510pF, 5%, 500V capacitors today and will try one tonight. I'm curious to see what effect (if any) I see with a new capacitor in there. I gave up on finding new 2% capacitors for this without having to pay a large minimum order. I just checked the calculated frequency of the secondary circuit of the output transformer in the PTO. 5.75uH and 510pF yield 2,933,264Hz. Pretty much in the middle of the PTO range. The Q, however, is quite low (0.01?) due to the 150-ohm resistor across the circuit. I'm curious if I'll see much increase (if any) signal level after installing the new capacitor. I assume the output level would peak nicely at some frequency near 3MHz without the resistor in place, though. It would be interesting to watch but unless the resistor is easily unsoldered, I don't want to do that just to see the resulting effects.

---

Date: Wed, 3 May 2006 19:42:34 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] No Peak on T701

Open up the sweep. Rather than try and see the wave pattern just go for a big blur. All you really care is the amplitude is equal across the range. Pick the largest peak to peak point on the scope face. Run the VFO to the other end and look at the peak to peak there. Expect the garbage on the trace to be of equal amplitude from one end of the VFO to the other end of the VFO and to trash the wave form equally every where.

Let the wobble be. Grab a grease marker and mark the high point, mark the low point. Dial the VFO to the other end. Is the VFO output now the same as larger than or smaller than the grease marking? Turn the scope to a low voltage setting and shift the trace off the screen. Mark your maximum point as the trash on the wave form runs across the screen. Dial the VFO to the other end and compare the output peak to your first reference.

Just watch the maximum excursion on the scope as you dial the VFO through all 10 turns. The signal is in there and all you need is for it to have the same amplitude across the band.

Stop trying for exact science and start trying for get er done. How is the output looking in terms of amplitude?

As an oscillator goes up in frequency, they mostly lose amplitude. The output tuning circuit resonates higher than the oscillator and has low Q. At the low end the oscillator has high voltage and the tuned circuit has little effect. At the high end the oscillator has low voltage and the tuned circuit tries to peak the voltage.

By playing with the tuned output parts (the cap and transformer) you are just trying to get the slope of the low Q output to be the exact opposite as the slope of the oscillator output. The differences cancel and the output is flat across.

Your just looking for a setting of C and L that makes a good fit.

If you work with more stages of the receiver, then you start to introduce more variables into the mix and you wonder if you have a better VFO output or are you tuning the VFO output to compensate for some other circuit non linear problem. Worry not about your test equipment and your unshielded unfiltered environment. Just let that stray stuff ride alone and be part of the picture.

Looking at 2 volt RF signals is a pain in the best of shop conditions. The question is the mess on the scope more or less than the last mess on the scope?

Hope this helps. Roger.

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Date: Wed, 3 May 2006 19:50:10 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] More C709 info

If you can unhook a cap and measure the output almost doubling, how come you can not tell if the output is fault across the VFO tuning range? Roger.

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Date: Wed, 03 May 2006 20:05:42 -0400  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] More C709 info

> Why are you still trying to peak a VFO in the middle of its frequency range,  
> when you know you want a flat output across the range?

I believe that Barry's Q calculation was not correct: my scribblings put the Q at closer to 1. This is extremely consistent with my observation that VFO output is highest near the center and falls off by 20-30% towards the edges.

>Why do you want more mixer noise at 500KC in every band than you want  
>at say 100KC and 900KC?

If he has too low of a injection level, then mixer conversion drops like a rock. Above a certain level, you are mostly insensitive to variations in injection (although you are right, mixer noise does go up.) My guesstimate is that a "good place" is more than 6V pk-to-pk for the 390A mixers. Last I heard he was struggling with a measly volt or two pk-to-pk, and at that low level conversion efficiency in the mixer is gonna be pretty rotten.

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Date: Wed, 3 May 2006 20:56:43 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: Re: [R-390] More C709 info

I'm not trying to peak it for a certain frequency. I realize it needs to be as flat as is possible; however, I want the PTO's output to be of sufficient level so as not to have to compensate for that somewhere else in the receiver. As Tim said, my general voltage level is quite a bit lower than it probably should be anywhere in the tuning range. Lifting the capacitor and seeing the voltage level rise like that is, to me, an indication of significant leakage. I'll know when I try the good capacitor. If I'm correct, I should see a slight rise in voltage level due to resonance. Thanks for the comments!

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Date: 4 May 2006 13:36:05 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] More C709 info

Well, sadly, replacing C709 didn't help one bit. I'm about to give it up. I checked R704 (lifted one side of the coil) and it's about 160 ohms. I'm not sure what else could be wrong. Someone suggested the coil might have a shorted turn. Possible. It shows no sign of physical damage, though.

The only thing I haven't been able to check are the bypass capacitors. I suppose one (or more) of them could be leaking. I'm dreading replacing any of those, though. Not sure how many "brands" of PTOs did this, but this PTO has a "bank" of about six 0.005 caps encased in a waxy substance that holds them together into a single "block" of individual capacitors. Replacing one would be nearly impossible unless one leaves the old capacitor in place and runs the new one in a different position. I'm either going to leave it alone (the radio DOES work), or completely strip it and replace everything I can still get parts for. I did this to the second crystal oscillator in my other R390A. It helped just a bit, but not all that much so I'm hesitant.

I'm still curious what other folks are seeing at the "raw" output of the PTO. I dragged down the ME-26D/U and I'm seeing about one volt at the output connector. I'm getting about 2.8V ptp on the 'scope, but since neither one is calibrated (and the 'scope is acting up anyway), it's pretty much anyone's guess as to the actual value, but suffice it to say, they both are both showing a pretty low voltage so neither one may be that far off.

Sorry for the long post, but it really bugs me not to be able to isolate a problem and fix it (provided there really IS a problem and this voltage output isn't all that abnormal).

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Date: Thu, 04 May 2006 14:13:01 -0400  
From: Miles Anderson <k2cby@optonline.net>  
Subject: [R-390] More C709 Info

Whoa! I wouldn't be so quick about digging into the PTO chassis. There is almost no elbow room, and the unit was designed so that the bypass capacitors have virtually zero lead length. This should be a last resort. First of all, you should really get a fix on your instruments before jumping to the conclusion that the PTO output

is too low. It probably is low, but I would try to calibrate your scope before coming to a definite conclusion. If you have an accurately calibrated VOM or digital meter you can calibrate the scope at 60Hz using a filament transformer as a source. Unless there is something radically wrong with the scope, the frequency response at 2-3 MHz shouldn't be much different than at 60Hz. If the PTO output is definitely low you can check most or all of the bypass capacitors for leakage by unplugging the PTO power lead and tube and measuring the resistance to ground from the screen and the plate. I assume the plate & screen voltages of the PTO are correct. Check these if you have not already done so.

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Date: Thu, 4 May 2006 21:56:53 -0400  
From: "Jim M." <jmiller1706@cfl.rr.com>  
Subject: Re: [R-390] More C709 info

I don't recall if you said or not - did you try replacing the PTO tube? The tube in my SW PTO went bad a few months ago, sensitivity dropped but it would still tune. Checked fine in the tube tester. Decided to replace it anyway, and that fixed it! So even if the tube tester says its "OK" try a new one anyway. Jim

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Date: 5 May 2006 13:22:45 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] More C709 info

>I tried three different tubes, all with the same results. I have a sleeve of NOS >5749's and I may try one of those, but I'm thinking the tube may be okay if all >three of the others produce very nearly identical results in the PTO.

I did check the PTO output from my other R390A ('56 Motorola). The scope shows 8V p-p at its maximum point. It isn't flat, though. There is a definite bell shape to the output that is not centered at 3MHz. It tapers down to about 4V p-p at the endpoints. I suspect that when I built this one (my first), my "vast" knowledge of the R390A was not quite, well,,, so "vast". I probably tuned it for a maximum output and moved on. I might be able to do better now (although the radio does work just fine so I might be sorting the pepper from the fly excrement). One thing I "discovered" last night. A tube extender won't fit in the stock PTO, but if you remove the little tube shield clamp bracket (2 small screws that go in threaded holes so no nuts fall off on the inside, at least not on this PTO), the extender does fit. I checked all voltages and they are spot on (probably the only place in this radio where all voltages check exactly what they should). Thanks for all the help, guys. I have some good suggestions to try and see where the problem is on this PTO. Maybe I'll track it down yet.

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Date: Fri, 5 May 2006 11:54:45 EDT  
From: SHELLY199@aol.com  
Subject: [R-390] Re: R-390 Digest, Vol 25, Issue 6

Plz note this is my first post although I've been reading the mail for 5 yrs. The typical output voltage from a Cosmos PTO fed into the rcvr thru normal connections and taken at the jack on the RF deck thru a X10 (10 meg impedance) is about 2.6

Vac. I have taken the following readings on 4 ea. Cosmos PTO's as follows:

1. 2455 2.49 Vac 2. 2455 2.78 Vac 3. 2455 2.72 Vac 4. 2455 2.56 Vac  
3455 2.59 Vac 3455 2.76 Vac 3455 2.75 V 3455 2.48 vac

I adjust the output cap C706 for max output at 3455. This gives the flattest response. The most significant item regarding output volts is the tube. I have used only tubes which have tested good with highest emission out of a bunch. I then put the best ones one at a time in the PTO and select the one which delivers the highest output. This can be a ratio of 2:1 for output voltage. It's surprising that it changes so drastically from tube to tube.

I've been rebuilding these things for 5 years and have test cables, ovens, cal dial setups, and you name it. I've never seen a defective part in any PTO except R702 which is typically high and once in a while R702. Although I've changed many in a shotgun attempt to achieve super stability which you can expect if everything is just right. I've rebuilt the 5ea. .005 bypass cap and found zero difference. I've almost given up on super stability on one and decided to clean up the tube socket a second time and that was the problem. The 10 pf caps in the osc tank circuit often need changed because they've changed value and the endpoint won't adjust without adjusting the turns on L701 or changing the caps. I prefer changing the caps. Also the 10 pf caps usually don't have the original temp compensation so we change them on that basis. The 370 pf caps seem pretty good and I've never found one of spec from a capacitance standpoint. Hope this helped. Rich WD2Q

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Date: 5 May 2006 16:29:05 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] Re: R-390 Digest, Vol 25, Issue 6

Are those peak-to-peak readings or RMS? I assume since you are talking about 'scope readings, they are peak-to-peak, but not sure. If so, that's about what I've been getting. I wonder if this is because the COSMOS uses a fixed output transformer? As I mentioned, my Motorola has a significantly higher output. I have a sleeve of NOS 5749 tubes. I may just try those and see what results. Hey, post more often! This is very helpful, especially since you obviously have "been there, done that"!

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Date: Sat, 6 May 2006 08:03:34 EDT  
From: SHELLY199@aol.com  
Subject: [R-390] Re: R-390 Digest, Vol 25, Issue 7

The voltage readings are RMS from a Fluke 192 scope thru a X10 probe at J217. The P-P equivalent for the readings I gave you is approx 7.6 Vp-p. Another interesting point is that there is some flatopping at the 2455 end of the PTO range. This is a characteristic of all the Cosmos PTO's. I haven't taken a harmonic reading mainly because it's on all of them so it ain't broke.

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Date: 8 May 2006 18:21:32 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>



Subject: [R-390] Z702 Adjustments

In light of the recent discussions of PTO output, it was mentioned that some PTOs have a slug-tuned T701 and others do not (case in point, the Cosmos PTOs). For those of you that do have a slug-tuned T701, where is the adjustment seen? I have looked on the WEB for pictures of various PTOs and all I've seen are the adjustment point for C706. The Y2K manual also only shows the single threaded shaft for C706 with no mention of locating T701 for adjustment. For Z702s with a slug-tuned T701, I expected to see an additional hole for the slug but, so far, I've seen none. Is the slug-tuned T701 similar to the slug-tuned transformers in the IF deck where the hole for the slug adjustment just wasn't included in the can? It was a busy weekend so I didn't get back to any more testing, but I still plan to replace tubes and "sweep" the output can in hopes of finding what's causing the output to be so low. According to Rich, his experience with all those Cosmos PTOs yielded much better results than what I'm seeing, but he also stated that he's never seen any common failures such as bypass caps, etc., so I'm still left wondering what could be wrong here.

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Date: Mon, 08 May 2006 14:31:53 -0400  
From: Rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Z702 Adjustments

I have NO slug tune inside Z-702 in MY Cosmos PTO either. I just pulled the cover and inspected it carefully. Haven't got to where you are YET. Still restoring this old Blue Striper!

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Date: Mon, 8 May 2006 22:24:47 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: Re: [R-390] Z702 Adjustments

With the PTO disconnected, I hooked the signal generator to pin 5 of V701 while watching the output of the PTO on the scope. There is a definite peak around 2.9Mc so the resonant point is not far from the center of the PTO range. I was thinking if it were resonant somewhere way off from the center point, then that might be the problem, but no dice. Will have to keep looking...

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Date: Tue, 9 May 2006 11:41:51 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] More C709 info

I have not been keeping up with my mail. Who wins in rock-scissors-pancake?

Stop and look what the receiver design is. The VFO varies across its range. That happens to be 2.455 to 3.455 MHz. The idea is to drive a mixer with the VFO output across that range. Coming out of the mixer we would like every thing to have the same performance level no matter which point the VFO is set to. The objective of C709 and the transformer is to compensate the loss of oscillator output as the oscillator frequency goes up. If the VFO has more than enough output to make the mix, then the exact output level is a so what case. It is over the line, and more over

the line is noise. If some where across the range, the output is lower than minimum mix level then we loose some of the incoming signal into the noise floor. No so good. Barry, why do you want a peak in the middle of your mixer range? Why should a tuned circuit not be flat across a span of 1MHZ? I think pancakes fall to rock and scissors.

Other than you have played with the C and T and would like to get them back to their optimal value, I do not think you have a problem with the VFO output circuit. Barry, every thing you have posted is right in line with how I find the VFO circuit to behave. Roger.

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Date: Tue, 9 May 2006 11:50:25 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] More C709 info

Fair radio does have VFO's in stock for about 35.00. It could be a lot easier to just try another VFO rather than rebuild all those caps. Maybe just leave C709 open and see how the receiver aligns that way.

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Date: Tue, 9 May 2006 12:08:33 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Z702 C709 Adjustments

It looks like you are still dealing with a low output on your VFO. You get this one solved and you are going to be the best of class on VFO. It sounded as if running with C709 open did provide a larger output signal. I do not favor running VFO through the dish washer. However a good dry cleaning and some re soldering could be in order here. Get out the magnifying glass and start a good visual inspection. More of a shotgun approach rather than a logical approach. That slug of caps can be replaced. Several disk set up side by side to replace the original mass pack. That's do all replacement to get the things to fit As said lead length is a factor. I can envision a film in C709 that would let that cap leak. I know not how to prove it is leaking. I know not how to clean it. I have all kinds of ideas. But a real solution I do not know.

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Date: 9 May 2006 16:18:32 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] More C709 info

I'm really not trying to get it to peak at a given frequency. The purpose of "sweeping" the transformer was to ensure that the LC[R] circuit wasn't so far out of tune (due to a shorted winding, bad/leaking capacitor, whatever) that it was causing the the output to be substantially low. Since it did show a peak value somewhere near the center frequency of the PTO's range, I'm satisfied the coils are okay (at least the primary and most likely the secondary). Sure, the receiver works with the output value what it is; however, it makes me suspicious that something in the PTO is not where it should be and may be on the verge of going so bad that it stops working. I'd like to circumvent that if I can, that's all. I checked with Fair Radio for another PTO in hopes of finding one more for spare parts than anything. A

dented case with no connector is \$22. I don't think I'd get enough good out of it for that price so I'm going to continue with this one. I tried a NOS Phillips (from a sleeve of NOS) 5749W last night. The output dropped slightly from the Sylvania that's in there so I don't think tubes are an issue here. I'm determined... What I'd like to know is the expected value of the oscillating voltage on the grid. I'm wondering if that's not of sufficient value to get me a good "swing" on the plate? Thanks for all the input, guys! Barry - N4BUQ

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Date: Tue, 9 May 2006 21:00:15 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: Re: [R-390] Re: R-390 Digest, Vol 25, Issue 10

> Did you experiment with different tubes yet?  
> There is only the one adjustment of the cap and not the coil>

Yes, I tried different tubes with little or no difference. I tried something a bit different tonight. I connected the signal generator to the control grid of V701. At a 2.6V peak-to-peak signal, the PTO output shows a nice strong 8V peak-to-peak signal. The same signal at the cathode produced virtually no change on the output. Is it correct to assume that R701 should be developing an AC voltage across it of a similar amplitude as the 2.6V signal from the generator (maybe 1.5V to 2V) in order to get 4V to 6V on the output? Those are just ballpark figures, but I'm wondering if the grid voltages I'm getting are insufficient to drive the output closer to the correct output level? I tried measuring the signal on the grid, but the 'scope takes the wind out of the grid circuit's sails and it stops oscillating when I attempt to view the signal on the 'scope. I'm seeing -1.7VDC on the grid just as it should be so I'm wondering what AC voltages should be riding on this.

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Date: 10 May 2006 17:40:13 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: [R-390] PTO Output Cable

Does anyone have some of the shielded wire used for the PTO output they would be willing to sell to me? I'm considering rebuilding this PTO as I'm just not satisfied that it's not performing as it should. The shielded wire has been damaged near one end (not close enough to the end to simply cut it and discard the excess, though) and I'd like to replace it while I'm at it.

Looking at Jim Miller's article at <<http://r-390.com/cosmos.htm>> I see the cable looks rather new on that one. Anyone have some extra or can point me to a source? I seem to recall someone quoting the RG number for this and the RF-to-IF cables, but I don't remember the designation (and I'm not sure they're exactly the same cable). I thought Skycraft Parts and Surplus carried this stuff <[www.skycraftsurplus.com](http://www.skycraftsurplus.com)>, but I don't see it on their website now. I think they have a LOT of stuff that's not on their website, though, so they might still have it.

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Date: Wed, 10 May 2006 15:56:11 EDT  
From: SHELLY199@aol.com  
Subject: [R-390] Re: R-390 Digest, Vol 25, Issue 12

I made a chart of AC voltages at various points in the PTO. I can email it to. It's now a jpg file.

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Date: Wed, 10 May 2006 16:03:31 EDT  
From: SHELLY199@aol.com  
Subject: [R-390] Re: R-390 Digest, Vol 25, Issue 12

Come to think of it, I once had a PTO that wouldn't oscillate and changing C704 fixed it right up. I measured that cap and it was way way low. That could be your problem.

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Date: 10 May 2006 21:20:49 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] Re: R-390 Digest, Vol 25, Issue 12

I'm thinking I'm going to go ahead and replace the capacitors in the can. I don't seem to be able to find all the replacement values, though. 370pF isn't a common value anymore (if it ever was). I may have to leave that one alone as the only place I've found one is at a place with a minimum order and I don't need anything else from them at this time :(

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Date: Thu, 11 May 2006 07:28:50 -0400 (EDT)  
From: "William A Kulze" <wak9@cornell.edu>  
Subject: Re: [R-390] PTO Output Cable

Barry, I think RG-174 is the cable you're thinking of. This is just a plain black vinyl jacketed cable, not the exact stuff in the radio, but it is 50 ohm and the same size, although I think at these lengths, the impedance isn't as critical.

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Date: Thu, 11 May 2006 08:50:32 -0400  
From: Miles Anderson <k2cby@optonline.net>  
Subject: Re: [R-390] Re: R-390 Digest, Vol 25, Issue 12

You are borrowing a lot of trouble!

(1) The values of the capacitors inside the PTO can are absolutely critical in setting the linearity of the PTO tuning. If you don't get the total capacitance exactly right, you may be able to align both ends, but the errors will be concentrated in the middle. Thus, at the "500" point you are either going to have a huge amount of positive error or negative error (depending on whether you have too much total capacitance or too little) and this is going to be beyond the ability of the screws in the Cosmos pto to compensate. It's 100 times more of a problem with a Collins "stack compensator" type of PTO.

(2) All, repeat all, the capacitors inside the PTO can are temperature compensating. If you don't get the right  $\Delta C/\Delta T$  the PTO is going to drift on warm-up.

(3) Lead lengths and component dress are critical. They affect the total capacitance. Also, they affect the total series inductance, and the slug tuned compensating coil is tiny. Too much lead length, too much inductance and you are going to have to unwind turns on the little compensating coil.

Bottom line: Change components inside the PTO can only when the tuning is non-linear. I really don't think any of these components are going to affect the output so long as the PTO is actually oscillating, which yours is.

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Date: 11 May 2006 13:28:46 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: [R-390] More PTO stuff

Thanks for the warnings. I was thinking of attempting to replace only the 15pF coupling capacitor. That one may not be as temperature sensitive as the others in the "tank". Finding temperature compensating caps that are identical to the originals may be almost impossible to find. I see where the capacitance tolerances are 1% or 2% on the non-bypass capacitors in the PTO, especially the ones in the can. I don't see a temperature compensation designation so I'm not sure what I'd get to replace them. NPO, perhaps?

I did some further checking last night. With the PTO oscillating, the control grid is seeing about 1.4VAC (as checked with my ME26D/U). When I connect the signal generator's 2VAC output (measures about 1.8V RMS on the ME26) to the control grid, the PTO output goes to nearly 8V peak-to-peak (as seen on the 'scope). It appears a very small increase in grid signal causes a vast difference in output voltage. HOWEVER, I'm not sure what effect connecting the signal generator directly to the grid does to the bias point. This may account for the increase in signal more than anything. Arghh?

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Date: 11 May 2006 13:29:38 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] PTO Output Cable

Thanks for the designation number. Someone else on the list has offered to send me a small length of cable so I guess I won't need to find it after all.

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Date: Thu, 11 May 2006 09:54:14 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] More PTO stuff

<snip>...replace only the 15pF coupling capacitor.....

Certainly it has a smaller total capacitance. Regulars will recognize that I had a lot of fun screwing around with Cosmos PTO innards several months back. Investigating what small tweaks to endpoint inductors, cleaning up the grease inside a godawful Raytheon rebuild, etc. If you want to replace PTO innards for fun and educational value, I'm sure there's a good amount to be had. But in terms of productivity, if all you want is a working aligned PTO in the end, then this kind of

horsing around is EXTREMELY time consuming and probably not worth it because you'll end up with a non-alignable PTO most likely. Again, I don't want to discourage you doing experimentation and posting the results. I myself am very interested in the intricancies of PTO alignment and calibration outside the goals of "just get it working right". But if you've got no problem with PTO alignment and only problems with output level, then randomly subbing out tank capacitors will cause you more problems than you solve.

>snip>.....I'm not sure what effect connecting the signal generator directly.....

Very general points: A one-tube oscillator is by its nature a "self-limiting" oscillator. If the gain was less than one with low/zero amplitude, it wouldn't oscillate. As oscillations start to build up, eventually nonlinearities in the active element (in this case, it's supposed to be the tube) to limit the gain to one. The nonlinearities that limit amplitude are VERY closely related to bias points. Indeed, I think you've nailed the problem at bias (including quiescent plate and cathode voltages/currents). Squirrely non-ohmic resistors (especially in the plate and cathode) can make power-off ohmmeter readings not directly relevant. My one piece of wisdom: if a carbon comp resistor exhibits being more than 20% off or shows evidence of past charring/swelling/overheating, then assume the worst and just sub it out. ALL 2.2K plate/cathode resistors are suspect.

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Date: Sat, 13 May 2006 03:57:41 -0700 (PDT)  
From: "KC8OPP Roger S." <kc8opp@yahoo.com>  
Subject: Re: [R-390] Cosmos Linearity tool

This is what I use, fits great. Snap-On multi spline L-Shaped wrench #MS2A. This is a four flute spline wrench that measures .033 inches across. I cut it down and clamped it in pin drill handle so I could reach in and adj the screws.

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Date: Sat, 13 May 2006 13:17:52 -0400  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] Cosmos Linearity tool

>.....recommend the tool for correcting the linearity of a COSMOS PTO.....

Is it possible that you ended up with a six-fluted 0.032" spline key? I bought a "four-flute spline L-key, 0.033" Dia" from McMaster-Carr (part #7048A11). It was not in stock at the local warehouse and they had to ship it in from Chicago. It fits but it still isn't easy work (especially when you've got to repeat dozens and dozens of times.) Like Roger I find it easiest to use if I cut off the "L" and put it in a pin vise. Even then it takes a LOT of skill and patience to stick it through the radio chassis, through the PTO bracket, through the PTO can, and into the screw. It was just about impossible when I was using it as a L-wrench (and I have some experience working tiny SMT stuff and watches and clocks. Easy to blame on my "fat fingers" but the same fat fingers let me solder 0201 SMT stuff...). What would really make a world of difference, if I had one, was a pin vise that had a little spotlight on the end of it. The hole in the screw is so tiny that a lot of times it is hard to get the spline in especially if dust or oil (or worst both!) are inhabiting the spline socket. When I was

degreasing/degunking my PTO I took out all the spline screws and ran them through my ultrasonic degreaser.

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Date: Sat, 13 May 2006 13:26:35 -0400  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: [R-390] Weird-ass PTO parts

OK, I've been into the deep jungle of the PTO can and back out.

I understand at least a little bit the oddball caps inside the can. I'm guessing that the big cylindrical one is some kind of fixed vacuum cap, and that many of the others have special tempcos. But... what's with some of the weird componentry outside the can but around the tube socket? As Barry was asking about, they've got a tiny glass piston cap in the plate circuit, although it's nominally detuned with a resistor to a very low Q. I associate glass piston trimmers with VHF/UHF high-Q (or at least "as high a Q as we can get") stuff, not with low-Q broadbandish type stuff. And then there's that bizarre waxed-up stack of ceramic bypass caps. Clearly really smart and experienced people, who understood lots of complicated mechanical AND electrical compensation stuff, made the PTO's. I'm not gonna try to second-guess what they put inside the can at all. BUT... the weird combination of stuff around the tube socket is just bizarre. Sort of like Gary Larson's "Cow Tools" cartoon

<http://www.salon.com/people/portfolio/1999/12/21/larson/older4.html>

I'm left trying to figure out the deep meaning and purpose of these odd constructs. Any insights? (into either the PTO or cow tools, that is!)

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Date: Sat, 13 May 2006 12:49:41 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: Re: [R-390] Weird-ass PTO parts

One thing I do find a bit odd is the lead-length on the bypass capacitors in that wax stack. While the ground leads are certainly short enough, they snake the "signal" end quite a way, at least for some of them. I was thinking if I rebuilt this, I would make these lead-lengths shorter; however, like Tim says, I'm not in a position to second-guess why these guys did things like they did. They knew more about this than I'll ever hope to.

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Date: Tue, 16 May 2006 11:27:12 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] VFO Output Level

I acknowledge your concern that the VFO in hand has low output. Thinking that dealing with the problem now rather than later after complete failure is very reasonable. Considering the thing could hang at the current condition for the rest of your life and just living with it is equally unacceptable. I see your need to get the thing fixed.

As Tim pointed out any one of those resistors or caps could be the problem source. In fact there may be more than one problem. Also suspect the chassis wire harness and connectors. Any connector point (tube socket pin) could be a resistive problem. Any solder joint could also be a problem. So its not just the parts that need inspection. You need to look at solder joint and wire.

I was thinking of the ballast tube and BFO tube in the filament string. A small drop in filament voltage from a change of resistance in the filament string could be a cause for low tube emission. Any tube changed into the VFO would act the same (low output) because the problem could be elsewhere in the filament string circuit.

You may not be up against a sudden failure. Your VFO could hang like it is for a long time. OK but not good enough. Tim's idea to check those resistors is sound advice. I would pick an easy one to get to as a candidate for adjustment. You can get a larger output voltage by changing the grid, screen or plate resistor. But first I would do a whole rebuild. The schematic shows a set of four 5,000 caps as bypass caps on the screen and plate. Shoot my self in the foot here and suggest that their value and lead length are not critical. The figure in the TM is not the same as the as built circuit. (new models). The block of caps (Zenith TV) was just an easy assembly procedure. Some early production has the caps all set in the same location side by side.

One common construction practice is to place all grounds to the exact same point under a tube circuit. So likely all the caps have short leads to the same ground point for the caps on the cap block package. Then the other lead is what ever was needed to get the circuit built. Bunching the cap block near ground provided some extra working room on the other side of the caps. These caps are in the decoupling circuits. As long as they were in the box under the VFO tube and decoupled the VFO signal off the DC lines before it gets coupled elsewhere in the receiver it is OK.

You were looking for a new length of coax. One of the Fellows pointed out, that due to it's short length (under 24 inches) that the impedance of the coax did not exactly matter. Nevertheless you found and went with some good coax. Likewise, decoupling caps and lead length at the VFO frequency is not as critical. While RF is a science you can still do a lot of cooking in the kitchen without resorting to a cook book. Use good caps and good resistor and just rebuild the circuit under the tube socket.

A shoot gun replacement of:  
R701 150K Grid resistor.  
R702 56k Screen resistor  
R703 2.2K Plate resistor

and the four by pass caps.  
C705, C714, C708, and C707 all 5,000 pf with some .0047

Some disk caps of better quality than a Radio Shack Value Pack would be good. The voltage rating is not critical. All these parts are out of the frequency determining circuit. But they sure do impact signal size. I would round up the parts and plan a



couple evenings work to just rebuild the circuit under the tube socket. If you think the variable cap C706 is leaking to much signal to ground, you could run a cap in series with it. Any thing bigger than the 1.5 - 8 PF would leave you with an effective 1.5 - 8 PF. A 100 PF mica would do as a new isolation if you think the variable glass cap is leaking. You may just unmount and remount that item to ensure you have a good ground bond for it. Time consuming and educational. Then again this is part of one of your recreational activities. Time invested and return on time have no tangible metric. Go for it and enjoy your self along the way. Roger AI4NI

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Date: 16 May 2006 19:30:50 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: [R-390] More PTO stuff

I would reply to your email, but since setting up Outlook Express on this new machine, it is deleting the messages from the server and it won't let me send new mail from this machine. Not sure why it's deleting messages as I'm not deleting them or moving them to the DeletedItems folder. Oh well.

But, as for your post, the parts you are suggesting to replace are my targets. I went to the local parts store (not Radio Shack) and picked up some resistors. I already have some 4700pF 1kV ceramic disk capacitors that are quite small for 1kV rating (bought at the same place). I got a pack of 15pF, 300V, 5% capacitors too. If shot-gunning the aforementioned components doesn't get it, I'm going into the can and replacing the grid coupling capacitor. Hopefully this will all be worth it in the end. Like you said, this is a hobby. Spending this much time on it for any other purpose would most likely be a waste of time and effort. If it works better when I'm finished, I'll be happy.

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Date: Tue, 16 May 2006 23:30:56 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: [R-390] Interesting find in my Cosmos PTO

In order to facilitate replacement of the parts in this particular PTO, I removed the surrounding hardware (brackets, etc.). I then took a much closer look at the innards. Point your browsers to the following address and look at the two pictures there. <http://www.knology.net/~thelanding/>

In PTO1.JPG, notice how the lead from the bypass capacitor appears to be touching the frame. Note that this is NOT the ground side of the capacitor. PTO2.JPG show the same area from the "top". I have not moved the lead yet nor checked anything else (too late in the evening), but I'm guessing if I move this lead so that it isn't touching the chassis, I may see some rise in the output level. At any rate, it looks like this has been there from the factory and it's just a wonder to me it works at all. I'm actually surprised there isn't close to 200VDC on the PTO chassis, but I'm also guessing that the wire isn't actually making solid contact with the chassis since I have the correct plate voltage; however, it sure is close to the chassis to not make contact. Barry - N4BUQ

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Date: Wed, 17 May 2006 00:07:05 -0500  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: RE: [R-390] Interesting find in my Cosmos PTO

Wanna tell us how you took those pictures?

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Date: Wed, 17 May 2006 07:02:38 -0400  
From: "Jim M." <jmiller1706@cfl.rr.com>  
Subject: Re: [R-390] Interesting find in my Cosmos PTO

Sure looks suspect. Check solder connections too. I once had an IF deck in one radio (an EAC) where there were about 6 unsoldered connections! Poor workmanship can happen. Also be sure to tighten all screws that hold ground lugs or tube sockets. They can work loose with heat cycling over time and cause reduced performance in a circuit.

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Date: Wed, 17 May 2006 12:22:24 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: RE: [R-390] Interesting find in my Cosmos PTO

> Wanna tell us how you took those pictures?

> <snip> .....Nikon Coolpix 3000 I think it is.....

Certainly it'd be interesting to do that and some other locations too. The shots you've already made are way above average. Your 2.2K seems to be more deeply buried than in my Cosmos PTO's. There are some truly amazing techniques I've seen used to document complex mechanisms with Macro photography that uses progressive lighting/variable focus to do some truly amazing things with seemingly infinite depth of field. I'm not volunteering to apply these to my 390A's but if they could be done the results are STUNNING.

> I'm really curious if lifting this lead away from the chassis.....

I'm guessing that if it shorted to ground that you would have blown a fuse (or sacrificed a wiring harness) but it doesn't look right and it looks like you can do this at the same time as the 2.2K.

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Date: Wed, 17 May 2006 11:35:00 -0500  
From: "Cecil Acuff" <chacuff@cableone.net>  
Subject: Re: [R-390] Interesting find in my Cosmos PTO

It's probably a pretty good capacitor though at RF frequencies....as close as it is....

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Date: 17 May 2006 17:09:08 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: RE: [R-390] Interesting find in my Cosmos PTO

Yeah, I figured it wasn't making contact as I'm getting correct plate voltage and the

2.2K isn't burned, etc., but it's amazing it isn't as close as it is. I'm going to try to slide a feeler gauge underneath it just to see how close it is. Like someone else said, it's probably a pretty good capacitor the way it is. I picked up both a 1/2W and 2W 2.2K resistors yesterday. Their 1W versions were much larger than the 2W version - go figure. The 1W probably wouldn't have fit, but this 2W looks like it will. I have the 1/2W just in case it won't though. I have some closeup shots of my IF deck's innards I should post too. They turned out pretty nice. I do notice that PTO1.JPG shows up a lot brighter on my laptop's monitor than it does on one of my other CRTs here at work. Weird. I was just happy there was a small hole in front of the PTO that allowed me to get that shot. The flash was partially blocked, though, because I was shooting through that hole and I had to adjust the brightness a bit.

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Date: Wed, 17 May 2006 23:05:40 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: [R-390] More PTO pics  
To: "R-390-List" <R-390@mailman.qth.net>

I put some more hi-res pictures on the website [www.knology.net/~thelanding](http://www.knology.net/~thelanding)  
They are large (~1.5MB) files, though.

I'm curious about the "feedthrough" clamping device in PTO5.JPG. Does anyone know if unscrewing this will release the coaxial cable? I want to replace the cable, but I'm not sure how this "clamp" is disassembled. I did a little testing on that capacitor lead tonight. A very slight pressure on it would cause it to fully touch the frame. I could slide some dental floss under it, but I could feel a slight pressure as it slid under the wire so that gives you some indication of just how close it was to the frame. I moved the capacitor lead well away from the frame and tested the PTO. After calibrating my 'scope (it was reading just a bit low), and measuring the output with a scope probe (instead of with a direct connection with RG-58 coax), I'm seeing 4.8V peak-to-peak now. This is an improvement over what I was seeing. Part of this was due to my incorrect measurement methods, part of it was calibration issues, and part of it may have been that lead so close to the frame. I'm thinking it wouldn't be worth it to rebuild the thing at this point. I might see 5 or 6 volts if I did, but I might not and it's not worth risking those little irreplaceable solder posts to find out. I \*might\* replace the 2.2k simply because they have a bad reputation for going high (this one is a little high already) and I have a 2W replacement that would ensure good operation for a long time to come. Anyways, thanks to all for "listening" to me. It's been "fun", but I think I'm going to move on to other parts of this restoration project.

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Date: Thu, 18 May 2006 03:32:31 -0700 (PDT)  
From: "KC8OPP Roger S." <kc8opp@yahoo.com>  
Subject: Re: [R-390] More PTO pics

When I look at the pictures, especially PTO4 I wonder if tube pin #7 is a little shy on solder. Good Pics, hope you get this PTO working.

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Date: Thu, 18 May 2006 07:50:36 -0500  
From: "Cecil Acuff" <chacuff@cableone.net>

Subject: Re: [R-390] More PTO pics

I'd agree with that....I see no flow at all...even can almost see through the loop on the left side of the pin.... Good catch....

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Date: 18 May 2006 13:22:16 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] More PTO pics

I noticed that last night when I put the pictures on the computer and saw them "full size". I didn't notice that with my bare eyes or under the magnifier. I'll probably give that pin a touch-up. A poor cathode connection could certainly be an issue with low drive in this circuit.

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Date: 18 May 2006 20:39:39 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] More PTO pics

I checked that solder joint at lunch. It's in a lot better shape than that picture makes it out to be. Must be the angle or lighting. I think what is the appearance of a "hole" in the loop may be flux. I did pull the can back as far as I could without disconnecting any wires the other evening. The innards are wrapped in an insulating material. Anyone know if this stuff is safe? I assume it's the same as the insulation around the crystal deck's heater and I've been told that's just fiberglass (no asbestos), but was just wondering. It will make repacking it messy should I ever need to go in there.

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Date: Fri, 19 May 2006 10:58:05 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] More PTO pics

All the caveats apply. Do not eat it. Do not use it for eye wipe. It is fiberglass. Mostly it is a very nice blanket and un packs and re packs very nicely. During re assembly, grab a pair of her knee high nylon socks. Place one over the insulation blanket and slide the whole thing back into the can. You can use the second one as a temporary restraint and remove it just as the can slides shut. The PTO is in a double can assembly. Inside is the Oscillator parts in a can. Then there is the heater element and insulation outside the inside can. Then there is the very nice cover we see as the VFO. Those cans as 1950 extruded aluminum were then state of the art in extrusion.

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Date: 19 May 2006 15:39:56 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: [R-390] More PTO questions

Still poking around in this PTO. Were some PTOs manufactured without linearity adjustments? I seem to recall some discussion a few years ago that some did not have them. This one doesn't have an access hole for any adjustments. The large hex bolt plug on the "right" exposes only the endpoint adjustment. Also, there is

another hex "bolt" on the "left" made of the same material as the bulkhead (bakelite perhaps?) that has "S701" labelled beside it. It exposes a hollow shaft with a slot that is assumable for a screwdriver. Is this a way to disable the heater thermostat? A reset for it, perhaps? I haven't seen it discussed anywhere or mentioned in any of the manuals.

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Date: Fri, 19 May 2006 14:32:56 EDT  
From: DJED1@aol.com  
Subject: Re: [R-390] More PTO questions

Only the Cosmos had "front-panel" linearity adjustments. Are you saying you've got a Cosmos with a stack adjustment? I believe the adjustment on the left set the temp of the oven.

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Date: Fri, 19 May 2006 14:44:49 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] More PTO questions

Some Cosmos PTO's have screws in the linearity disk "all the way around" and others only have "most of the way around". I've gone one of each. But I think they all had to have linearity adjustments. Non-Cosmos ones have internally-adjusted corrector stacks.

> This one doesn't have an access hole .....

The linearity hole isn't exactly behind the transformer can but is just a little bit towards the center. Inside the hole you will see a circular zig-zag of little 4-flute socket screws.

> Also, there is another hex "bolt" on the "left" .....

Thermostat set point. I messed mine all up but it doesn't matter because I don't ever plan on turning it on :-).

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Date: 19 May 2006 19:14:07 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] More PTO questions

At this point, I'm not sure what I have. From other indications (no output transformer adjustment, stack of wax bypass capacitors), I was assuming it was a Cosmos. Someone relieved it of its label before I got it and I can't find anything else with a manufacturer's name. It does only have temperature setting and endpoint adjustments from the front portholes, though.

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Date: 9 Jun 2006 18:55:53 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: [R-390] Impedence Matching Question

While searching for some replacement coax for my PTO output cable (thanks

again, Roy!), I got to wondering what the correct impedance of a cable would be for this application. I realize the short length cable and the relatively low frequency make this not as much of an issue as it might be in other situations, but I was still curious. I calculated the reactances of the output coil and the parallel capacitor at 3 Mhz (close to the center point of the PTO range). Using Ohm's Law, I calculated the effective impedance of the three components -- the coil, the capacitor, and the resistor (150 ohms) in parallel. Unless I did something wrong, this comes out very close to 40 ohms. Is this a correct method to calculate the output impedance of this circuit (and possibly why the output cable is most likely 50 ohm coax)?

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Date: Sun, 11 Jun 2006 03:47:55 -0400  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] Cosmos question

Test Jig = "in the 390A chassis"? The mechanical phenomenon that causes hysteresis is "backlash". This is due to looseness in couplings, gearings, assemblies, etc. If it's in the 390A chassis, the first place to look is the Oldham coupler and the anti-backlash springs. If it's off the 390A chassis, then I would suspect mechanical looseness in the PTO chassis itself, requiring a complete teardown/clean/reassembly.

There are gears in the front of a Cosmos driving the corrector stack but the most relevant gear for fine-tuning is the worm gear that drives the core in and out of the main inductor. Have you listened (as opposed to just watching numbers on a frequency counter) to the PTO? Is it smooth except for backlash, or does it sound "squirrely"? In the case of my gunked-up PTO, it was within a few hundred Hz of the dial but it never \*sounded\* right when reversing direction, making lots of wiggly squirrely noises when beating a carrier or CW signal. I completely tore my PTO apart earlier this year, cleaned out a bunch of gunk, realigned and put it back together and am very happy. Was documented on this list.

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Date: Mon, 12 Jun 2006 11:54:57 -0400  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] Impedance Matching Question

>.....what the correct impedance of a PTO cable.....

"correct" depends on the criteria you use.

Case A: You apply a very firm requirement that the cable be the same as exactly as possible as the original. This is impractical perhaps. Don't bother.

Case B: You are practical and use what you can get. It will work fine.

Case C: You are practical, but inquisitive. You investigate the topic of "Characteristic Impedance" of coax cables and come to the conclusion that the impedance of a cable can be important when the length of the cable is greater than perhaps a tenth of a quarter wavelength at the operating frequency, IF the system is unmatched. Then you calculate the wavelength of 3 mc and decide that your one-

foot piece of coax is WAY less than about 60 feet and you realize that worrying about coax impedance is not needed. You revert to Case B.

> I realize the short length cable .....

The cable impedance is simply not an issue. The capacitance it adds in parallel to the circuit \*may\* be an issue, if the adjustments cannot compensate for the difference between the original cable and your substitute.

>I calculated the reactances of the output coil and the parallel capacitor  
>at 3 Mhz...very close to 40 ohms. Is this a correct method to  
>calculate the output impedance of this circuit

Sounds about right. A way to test for output impedance is to run your PTO open circuit and measure the RF output voltage, then load it with common resistors till the output voltage drops to one half the original. The value if the added resistance is about the output resistance of the PTO. An Allen Bradley Type J pot of 250 ohms or so is useful for this experiment.

>(and possibly why the output cable is most likely 50 ohm coax)?

Possibly, but it's my guess that the Collins engineers understood very clearly that the coax characteristic impedance did NOT matter, and other factors were used in choosing it and the connectors. Note: the R-390/URR uses BNC connectors and larger coax. It's quite likely that the MB connectors and smaller coax used in the A version, were part of the "Cost Reduction Program" that resulted in the R-390A/URR as we know it.

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Date: 12 Jun 2006 18:07:34 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] Impedance Matching Question

Thanks, Roy. No, I wasn't worrying about whether or not the cable's impedance was a close match to the output. I was just curious if this was the correct method to determine the output impedance of the oscillator. I suppose if one were to worry about this, the impedance on the other end of the circuit would also be a factor (if they were different). For this short run, the coax is there to provide shielding and cable impedance isn't much of a factor. It was more of an academic question than anything else so Case "C" applies. Thanks again for the cable. It's been pretty hot here the last couple of days and my workshop (aka the utility room) is not very comfortable, but hopefully I'll get this done very soon.

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Date: Sun, 18 Jun 2006 07:49:41 -0500  
From: "Les Locklear" <leslocklear@cableone.net>  
Subject: Re: [R-390] RE: Re: 807 Anyone?

PTO's were manufactured by:  
Collins      Motorola      Dubrow      Progressitron      Cosmos

Raytheon had a contract to refurbish PTO's.

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Date: Sat, 19 Aug 2006 15:25:52 -0500  
From: Rick Brashear <rickbras@airmail.net>  
Subject: [R-390] Dangling PTO

I realize this is a R-390 list, but I am sure the PTO in my R-388 is about the same if not dential. I have it dangling inside the 388 and I felt it better if I ask a question or two before I go further. I need to adjust the end calibration, I think that what it's called, as I am unable to correct the dial with the "ZERO" adjustment on either end of all bands. The 388 manual is very limited on information, suggesting to simply exchange the defective VFO for a properly functioning one. I understand there is an adjustment under the can to take care of this. I have yet to remove the can, so I don't know. It is a Collins PTO #70E-15. Any help or direction would be most appreciated. Do I need to remove the PTO completely from the circuit by taking the wires loose or can the adjustment be performed as is?

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Date: Sat, 19 Aug 2006 14:40:58 -0700 (PDT)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] Dangling PTO

The R-388 is not very PTO friendly, but that said, the endpoint can be adjusted from the outside. What I do is to uncouple the PTO (don't move anything) and access and turn the endpoint adjusting screw on the front of the unit until the endpoint error improves. You may want to overshoot a tad because the 388 PTO endpoint moves rapidly (in boatanchor years anyway). If you are out of adjustment range with the endpoint adjusting screw then you'll need to open the PTO can and take one turn off the endpoint adjustment coil, and then start the endpoint adjustment all over again.

Some purists don't like opening the PTO because you expose the inards to moist air. What you can do before reassembly is to bake the PTO in any oven at about 110 F for several hours to dry it (and the dessicant bag) out and then reassemble.

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Date: Sat, 19 Aug 2006 20:20:34 -0400  
From: "Al Parker" <anchor@ec.rr.com>  
Subject: [R-390] re: Dangling PTO

If the end-to-end span is more than 7 or 8 kc off, you probably won't be able to adjust it externally to get within reasonable dial "zero" adjustment. They drift over the yrs, usually by now at least 7kc. The compensating coil slug can be moved externally, without doing more than removing the panel, or less if you have u-joint fingers and some small tools. There's a hex cap over the coil slug adjustment, on the front end, top, of the PTO. I have remedied a number of them, from R-388's, 51J-'s and 75A's, after removing them from the chassis, which can be a little dicey, but not hazardous to anything. 1 or 1-1/2 turns need to be removed from the compensating coil. Take a look on my website under the "Collins" links to see some of it. <http://www.boatanchors.org>

There have been some articles written in past QST or CQ, etc., I have some cc's,



will scan for you if you'd like. Don't worry about the "WARNING" about breaking the seal, somebody's probably done it anyway, and even if not, the desiccant is long past it's usefulness, and I haven't been able to reclaim it ever.

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Date: Sun, 20 Aug 2006 11:35:59 EDT  
From: ToddRoberts2001@aol.com  
Subject: Re: [R-390] re: Dangling PTO

I agree - In fact I would make it a point not to replace the original plastic dessicant bag in an R-388, R-390 or R-390A PTO. The plastic bag is probably brittle and could break making a mess inside the PTO as described. The factory never intended for the chemical to last 40-50 years or more. The PTO has long since been exposed to air migrating into it every time it heats and cools for the last 40 years probably and it won't make any difference in performance to try to replace the dessicant. Best to leave it out and avoid future trouble and possible corrosion problems. 73 Todd WD4NGG

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Date: Sun, 20 Aug 2006 12:24:58 -0500  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: RE: [R-390] re: Dangling PTO

Desiccants remove moisture down to 30-40% relative humidity. If your house maintains that, or less than 50% or so, then you don't need a desiccant. If your radio stays on all the time, then the PTO can doesn't "breathe" much with changing temperature, and doesn't need a desiccant. The common desiccant today is silica gel - beach sand treated to have lots of tiny water absorbing pores. Cobalt chloride (poisonous) is added to show blue for dry and pink for wet.

Calcium chloride was used in the 50's as a desiccant. Father spread out a five pound bag of it on a few square feet of cloth over a wash tub to keep the basement dry near Boston, Mass. Calcium chloride can be regenerated, but it breaks down into different chemicals if it stays wet. Silica gel can be regenerated, but after a while the cobalt chloride breaks down and becomes colorless.

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Date: Sun, 20 Aug 2006 13:26:10 -0400  
From: "Al Parker" <anchor@ec.rr.com>  
Subject: Re: [R-390] re: Dangling PTO

I don't know why I haven't had any luck with dessicating the small tubes in the PTO's. Maybe I didn't get them hot enough, I've tried a few times. I know it should be reactivateable, just figured it was too old. Craig's experience is the first I've heard of the tube breakage & corrosion problem, but it sure makes sense if it does break, the damage is worse than the cure. In the environment most of us have nowadays for our operating area, I doubt that it would be much needed, and don't worry about pitching it out. If we had bad conditions, like maybe in a storage shed, there's not enough of it to be effective for too many cycles I suspect.

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Date: Sun, 20 Aug 2006 17:02:43 -0500  
From: "Cecil Acuff" <chacuff@cableone.net>

Subject: Re: [R-390] re: Dangling PTO

I have been making a habit of just cutting the strings loose and removing the bag. If it ever gets loose inside the PTO it's a real mess. My radios are kept in an air-conditioned shop anyway. I think the idea was along the lines of the MFP coating used on the earlier SP-600. Just in case one ended up in a jungle environment....also I'm sure the Navy's were not in humidity controlled compartments when on a cruise... We don't have to worry about that type of exposure with most of these surplus units. I would guess they are living the easy life at this point.

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Date: Wed, 30 Aug 2006 17:03:07 -0400  
From: "Jon" <jonklinkhamer@comcast.net>  
Subject: [R-390] Cosmos Drift

If I had to write about my summer vacation at 44, I would tell the class how I performed major surgery on a Cosmos PTO. How every night I turned 40 screws, that are the size of an ant with a homebrewed tool, which sometimes caused havoc in restricting the turning of the shaft to messing up the end points, to interaction between other cal points, how I must of taken apart that \$#%#\$ thing 14 billion times. It is truly amazing that it is still working. Sorry, I had to get that out of my system. Now I was curious on what I will call long term drift. After installation of the PTO into the radio with it connected to a freq counter, I let it warm up for 48 hours before I cal'd it. After which, I brought it back to the set point in this case, 3.455000Mhz and let it sit. It is now over 3 days and the PTO has drifted over 1000Hz increasing in frequency. It seems to me that it will not settle out like I thought it would. I was wondering if anyone else has experienced this or knows any 'quick' remedies. I would appreciate any comments at all. Thanks for the bandwidth!

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Date: Wed, 30 Aug 2006 17:43:22 EDT  
From: ToddRoberts2001@aol.com  
Subject: Re: [R-390] Cosmos Drift

I have seen some R-390A PTOs with long term drift that were cured by plugging in a new 6BA6 tube. A weak 6BA6 could be the cause, might be worth a try replacing it. After 3 days does it continue to drift or does it ever settle down? I would think after 3 days all the components would heat soak to an even temperature. Could be a bad cap or other component somewhere. Not sure if it is possible to replace the negative temp coefficient caps in there. Maybe at some point it is just not worth it to spend more time on that PTO and find a nice Collins or Motorola PTO with the good old corrector stack.

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Date: Wed, 30 Aug 2006 18:05:55 -0500  
From: "Cecil Acuff" <chacuff@cableone.net>  
Subject: Re: [R-390] Cosmos Drift

Still got a 3TF7 in it....or another solution such Kielbasa. Could be power line fluctuations, room temp changes. You are not running the ovens are you....

shouldn't be... Might be the tube but I've heard of more problems with new tubes in PTO's than well seasoned ones...

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Date: Wed, 30 Aug 2006 20:44:35 -0400  
From: "Jon" <jonlinkhamer@comcast.net>  
Subject: [R-390] Cosmos Drift

Thanks for all the comments. Let me explain a little more on the setup. The radio does not have the ovens on. In fact the oven cover internal to the PTO is not installed, just the inner one - the one with the value for nitrogen and of course the outer one along with the insulation. The output of the PTO goes directly in a counter. I did not fool with the BFO or the CAL for zero beating yet. Just sitting on freq and watching it drift. The first day it drifted 95Hz, second day was 380Hz, the third day, 330Hz and the fourth day (today), 250 Hz. A total of over 1000Hz, always increasing in frequency.

The radio room is down stairs in the cellar that was converted into two rooms, play room and a radio room. I have a dehumidifier always running in the playroom. The door to the shack is always open however not fully. I have not monitored the temp or humidity but I'm positive the temp variance is within 5 degrees F. The power supply has the conversion to solid state. As for line variance, not sure but would this cause a steady increase in frequency? It would seem to me that at some point the temp internal to the radio would reach some type of quiescent level along with the capacitance and inductance with respect to the temperature coefficients of the components which would result in 'hovering' around a certain a freq. Maybe I'm not there yet. The onset of restoration I 'retubed' I'm sure that I put in a better tube, that is higher transconductance. I will certainly tried other tubes. Hope this helps.

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Date: Wed, 30 Aug 2006 21:02:30 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Cosmos Drift

I think Cecil hit it with the new tube idea. However, as operators we never tried to keep a R390/A on a frequency for days. A 1000 Hz drift over 3 days ain't all that much unless you are doing SSB. All that care you gave that PTO may take some time to settle in. Some of it may be your freq counter settling down. How often do you run it 3 days at a time? Leave the receiver on and get some time on the tubes. 30 days 24 x 7 minimum. Then check the drift.

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Date: Wed, 30 Aug 2006 19:07:35 -0600  
From: DW Holtman <future212@comcast.net>  
Subject: Re: [R-390] Cosmos Drift

I would try listening to a time hack for three days. That takes your counter, impedance mis-match to the counter out of the equation. If you stay on a time hack for a few days, I don't think you have anything to worry about. Just a thought.

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Date: Wed, 30 Aug 2006 21:48:42 -0400  
From: Barry Hauser <barry@hausernet.com>

Subject: Re: [R-390] Cosmos Drift

I seem to recall reading in one of the manuals or a thread on this list a few years back, that it was not advisable to use a "hot" tube in the PTO. It was better to select a new tube with more typical transconductance readings, or a used one rotated in from another socket in the rig that was well broken in. You might try that and repeat the readings and see if they're more stable. Be sure to test for gas/grid emissions, not just transconductance.

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Date: Wed, 30 Aug 2006 22:09:06 -0400  
From: Scott Bauer <odyslim@comcast.net>  
Subject: Re: [R-390] Cosmos Drift

I bought 120 5749's all from the Philips contract dated 1987. These tubes have been giving me a lot of trouble in the PTO as well as V505 (a) V508 non a. The tube will work fine for the first 40-60 hours and then start acting up. Anybody want to buy some NOS tubes? :-)

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Date: Wed, 30 Aug 2006 23:19:07 -0400  
From: "Jim M." <jmiller1706@cfl.rr.com>  
Subject: Re: [R-390] Cosmos Drift

Capacitors changing value with temperature? Believe it or not I have seen the .005 bypass caps in a Collins PTO go bad with age, change values with temperature. A change in screen or other bypass caps could cause a slight change in frequency. Otherwise, a temperature compensated mica cap inside the can could be failing. Maybe mechanical drift? If the Oldham coupler is too tight against the PTO side, mechanical variations could cause drift. There should be about 1/32 inch gap both sides of the Oldham coupler. Maybe these could be causes other than the tube...

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Date: Thu, 31 Aug 2006 11:53:46 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] Cosmos Drift

I agree fully with Roger here: 1000 Hz drift on a PTO over 3 days is not a big deal, especially after a major overhaul (probably some parts are outgassing etc.). This is exactly what the "ZERO SET" adjustment on the front of the radio is for. If the PTO is wiggling up and down 100 or 200 Hz over a very short time frame (something that can seriously impair SSB or RTTY operation) then it IS a big deal if you care that much (listening to AM you'd probably never notice). ON THE OTHER HAND I've overhauled some Cosmos PTO's and on the bench (NO KNOB, NO GEARTRAIN) they have stayed steady to 50 Hz over several days, but only AFTER many hours of burn-in. This is checked with a GPS-locked OCXO (to invoke an instrument that a technician of the 50's or 60's could only dream about!) One factor that I allude to above, is that when the PTO is mounted in a 390A is that the PTO is hooked to the geartrain. Now the PTO shaft is supposed to drive the geartrain, but in real life there will be some mechanical backlash feeding back into PTO shaft rotation. Very often the 17MHz crystal is a kHz or two off

nominal and in real life that's going to be a bigger deal than the PTO drifting a kHz over days.

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Date: Mon, 25 Sep 2006 10:27:39 -0400  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] Cosmos PTO End Point Adjustment Tool

Do you mean (single) the end point adjustment, or the (many many) linearity adjustment screws? Apparently some but not all Cosmos PTO's have linearity adjustment screws that accept a four flute spline wrench that measures .033 inches across. Folks have reported on the list that they cut off the short arm of one and put it in a pin vice, then fussed with it to get it into the right spot. The part numbers are: McMaster-Carr (part #7048A11) or Snap-On multi spline L-Shaped wrench #MS2A. It appears to me from a picture I have that the END POINT inductor adjustment screw is a slotted screw like many IF cans we have in other radios. If you can't \*see\* the thing to get a small screw driver into it, you may have to make a tool by soldering or epoxy-ing a little metal cylinder around a jewelers screw driver tip of the right size to simulate the more common plastic or metal adjustment tools with a recessed metal blade at the tip.

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Date: Mon, 25 Sep 2006 18:03:26 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Some practicalities on alignment of the R-390A/URR

What is a good insulated screwdriver to adjust the RF transformers and BFO neutralizing trimmer?

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In the old days boys knew how to hold a screw driver without getting bit. Its not the insulation between the blade and receiver that counts, it's the insulation between the blade and operator that counts. (> We would turn the power off and work the offending adjustment over with a real screw driver and get it free. Then with the power on we could get it adjusted with a wood stick. The sticks were called orange sticks. They looked like a round dowel to me. You keep them trimmed with your TL29. Tool Lineman 29 is a pocket knife to some. With a lot of work it could become sharp and less dangerous that as issued. I liked to sand mine to shape on the grinder. The wood stick that is.

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Date: Tue, 31 Oct 2006 12:54:09 -0600  
From: Tom Norris <r390a@bellsouth.net>  
Subject: [R-390] Cosmos Linearity Adjustment Tool Sizes?

I realize this has been asked a dozen times before, but I've searched the faq and the archive and can't find it --What size of tool do I need to perform the linearity adjustment on a Cosmos PTO? Looks like a 4 flute, size "teenietiny"

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Date: Tue, 31 Oct 2006 14:35:09 -0500  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] Cosmos Linearity Adjustment Tool Sizes?

My CosmosPTOnotes.txt file has info for you: CosmosPTOnotes.txt

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Date: Sat, 13 May 2006 03:57:41 -0700 (PDT)  
From: "KC8OPP Roger S." <kc8opp@yahoo.com>  
Subject: Re: [R-390] Cosmos Linearity tool

This is what I use, fits great. Snap-On multi spline L-Shaped wrench #MS2A. This is a four flute spline wrench that measures 0.033 inches across. I cut it down and clamped it in pin drill handle so I could reach in and adjust the screws.

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Date: Sat, 13 May 2006 13:17:52 -0400  
Subject: Re: [R-390] Cosmos Linearity tool  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)

Is it possible that you ended up with a six-fluted 0.032" spline key? I bought a "four-flute spline L-key, 0.033" Dia" from McMaster-Carr (part #7048A11). It was not in stock at the local warehouse and they had to ship it in from Chicago. It fits but it still isn't easy work (especially when you've got to repeat dozens and dozens of times.)

Like Roger I find it easiest to use if I cut off the "L" and put it in a pin vise. Even then it takes a LOT of skill and patience to stick it through the radio chassis, through the PTO bracket, through the PTO can, and into the screw. It was just about impossible when I was using it as a L-wrench (and I have some experience working tiny SMT stuff and watches and clocks. Easy to blame on my "fat fingers" but the same fat fingers let me solder 0201 SMT stuff...). What would really make a world of difference, if I had one, was a pin vise that had a little spotlight on the end of it. The hole in the screw is so tiny that a lot of times it is hard to get the spline in especially if dust or oil (or worst both!) are inhabiting the spline socket. When I was degreasing/degunking my PTO I took out all the spline screws and ran them through my ultrasonic degreaser.

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Date: Mon, 22 Jan 2007 20:58:15 +0000  
From: "Gene Dathe" <dathegene@hotmail.com>  
Subject: [R-390] Insulation

When rebuilding PTOs and crystal ovens, do most of you just throw away the fiberglass insulation? My guess is that since no one uses the ovens, lack of insulation in no way affects the hard core user or collector. Thoughts?

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Date: Mon, 22 Jan 2007 16:59:51 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Insulation

To extent that it is easy to get the pink stuff stuffed back in do it. It does help hold the ambient temp in the can a little more stable.

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Date: Thu, 22 Feb 2007 08:03:26 -0500  
From: Carole White-Connor <carolew@bellatlantic.net>  
Subject: [R-390] New Project (PTO)

Thank you, everyone, for your help. As always, your knowledge staggers me. More than that, your willingness to help out shows just what a great group you are. The problem is in the PTO linkage. The KC knob does not turn the PTO shaft. In looking at the Oldham coupler, I have a stainless steel disc between the KC knob drive and the PTO shaft. It has a groove that mates with a ridge on the KC knob drive. There appears to be groove in the back that does not mate with the PTO shaft. The stainless steel disc fits very loosely between the KC knob drive and the PTO shaft. It's definitely more than the 1/32" gap shown in the Y2K manual. There is no anti-backlash spring.

1. My first question is whether there should be one or two discs between those drives. I'm looking at Pete Wokoun's diagram in the Y2K manual (Figure 6-4) and it's a little hard to tell.
2. If there is only supposed to be one disc, why is everything so loose and why doesn't the KC knob turn the PTO shaft? What's the fix?
3. I've never had to work on a PTO or Oldham coupler before so I need simple instructions (very simple, might be more like it!).
4. When I turn the PTO shaft a little by hand, I receive stations loud and clear, so I'm pretty sure the linkage is the problem.

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Date: Thu, 22 Feb 2007 08:52:19 -0500  
From: JMILLER1706@cfl.rr.com  
Subject: Re: [R-390] New Project (PTO)

Sounds like a loose clamp on the PTO linkage. Check the clamps holding the coupler on the PTO shaft and also on the main drive shaft coming from the front panel. If they are loose the PTO shaft will slip. These clamps have been known to crack, or the screw threads have stripped, after prolonged maintenance activity. Check for that also - someone may have broken a clamp in the past. You will need a "Bristol" type driver to tighten the clamps. If the clamp is bad, you will need a new one (you can probably get a spare from someone on the list). The spacings within the Oldham coupler and its two mating discs should be around 1/32. You can eyeball it. But not too close or too tight because then you can get PTO instability if it binds. To correct the spacing you loosen one of the clamps and use a thin screw driver to gently push the coupler surfaces together (or spread them apart as needed). There should also be a little tensioner spring between the two little posts on the two coupler discs - this is to prevent tuning backlash. It will tune without the spring but you will notice a slight amount of backlash. To initially get the PTO back synchronized with the coil linkages again, tune the radio dial readout to the frequency a known station on the dial. WWV at 10 Mhz is good, or a local broadcast station. Loosen the coupler coming from the panel side, and then spin the PTO shaft by hand (using its coupler disc as a "knob") until you hear a peak in noise or you hear the station (but do not allow the dial readout to change) Then retighten the clamps. You should be OK from that point on.

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Date: Thu, 22 Feb 2007 13:48:14 -0500  
From: n4tua@aol.com  
Subject: Re: [R-390] New Project (PTO)

Be sure not to turn past the end of travel on the PTO. Be very gentle and it should be evident where the end is.

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Date: Thu, 22 Feb 2007 17:29:13 -0500  
From: "Steve Hobensack" <stevehobensack@hotmail.com>  
Subject: RE [R-390] Diagnostic Help Needed

Make the frequency show 7+000. The egg shaped cams should all point to paint or scratch marks on the chassis. There should be a mark for each cam. This shows that the rig is mechanically aligned. Electronic repairs should be made after mechanical repairs.

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Date: Thu, 22 Feb 2007 22:33:38 -0500  
From: Carole White-Connor <carolew@bellatlantic.net>  
Subject: [R-390] New Project (Progress)

Well, we're getting somewhere:

1. The PTO problem was a loose coupler. I loosened a clamp, fit the ridges and indentations, tightened it up, and it works. It's 25 khz off but I'll fix that later. You folks pointed me in the right direction there. Thank you.
2. I have reception on all bands. However, there is a lot of hiss/static and sensitivity is not where it should be. This may be a long-standing problem with this radio. I see that the IF gain is set at max. If I back it off a bit, I lose a lot of sensitivity. Any ideas? Reception is consistent on the bands above and below 8 mhz. The noise limiter works well to remove a fair amount of the hiss/static.
3. I tested the tubes and replaced 4-5 that were weak or had shorted elements. I noted minor improvement.
4. Reception on the 0-1 mhz band is really lousy. Strong BCB stations come in weakly. This is the only band that is this bad. (The 2-3 mhz band may be bad, too, but I haven't played with that band too much).
5. The crystal oven heats up even though the switch on the back is off. I disconnected a lead from this switch to disable it, but the oven still heats. Is this a problem? Is there an easy way to disable it?
6. On a strong local AM station, the audio is strong and clear. On the strong SW stations I receive, the audio is good, too.

I'm just wondering where I should go and what I should do next. Again, my test equipment is limited to a VTVM, signal generator and tube tester. So far, I'm having fun with this set and am learning a lot. The Y2K manual is a amazing. I wish I had



something comparable for every set I work on. Any ideas or suggestions would be gratefully appreciated!!

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Date: Thu, 22 Feb 2007 23:15:53 -0500  
From: "Jim M." <jmiller1706@cfl.rr.com>  
Subject: Re: [R-390] New Project (Progress)

Some random thoughts: If the mechanical alignment is not sync-ed to the PTO, your sensitivity will suffer some. The preselector circuits are very selective and if not synced to the PTO, it will suffer. Just for comparison I usually get between 30 dB and 50 dB carrier level on the calibrate signal on the mid bands, even higher on the broadcast band. So get the mechanical side lined up with the PTO before trying to fix anything else.

On SW bands the big stations (7 Mhz range at night) should be booming in with midscale to 3/4 scale carrier levels on a good antenna. Be sure all the slugs are moving up and down without sticking too. Sometimes the slugs stick in the coil and a rack will not move as it should. The slug racks should each have two springs to keep them seated. Press down on the racks gently as you tune to see if they seat better - if so then a slug is probably sticking - there's a way to fix that too - later.

The plug in crystal oven does heat up on my radio even with the switch turned off. That is normal. The oven switch only turns on the PTO and Xtal Osc chassis oven. I have aligned a 390a pretty well with just the built in calibrator and the carrier level meter to work with. It's not perfect but it works. The Y2K manual has an alignment procedure using an external signal source but it can be done with just the calibrator signal. But first be sure the mechanical parts are working together with the PTO. And since you had one loose coupler, check the other couplers that you can get to - if a coupler somewhere in the other gear trains has loosened, then the problem may become more difficult - lets hope not.

An interesting experiment is to tune to a strong signal, then watch the carrier level meter as you slightly rock the MC change knob back and forth. If the meter wants to start peaking either side of the detent, you are out of mechanical alignment. You can also pull up gently on the slug racks and watch the carrier level. If it wants to peak anywhere other than at rest, then the mechanicals are off. Get them synced with the PTO - an easy way as I said before is to loosen the PTO clamp, tune it to a known station or calibrate signal, hold it there and then turn the KC knob for maximum meter reading - with the PTO held still, what that does is peak the mechanics to the signal. This will be a start only, from there a realignment may be needed (as described in the Y2K manual). Other things could be happening - such as bad oscillator crystals, but that comes later. Good luck.

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Date: Fri, 23 Feb 2007 11:52:34 EST  
From: DJED1@aol.com  
Subject: [R-390] R-390 New Project

"1. The PTO problem was a loose coupler. <snip>

That's your problem- you must correct the alignment of the PTO and the tuning racks- That's what is killing your sensitivity, especially on the low band. Check the alignment process in the Y2K manual. Go through the process of setting the readout to 7.000+, that is, at the top of the 7 MHz band, and check that the cams are set on the calibration marks. If that looks OK, then use the signal generator or the calibrator to set a signal on 8.000 MHz, loosen the PTO coupling at the front coupler, and manually tune the PTO until you zero beat the 8 MHz signal. Then retighten the coupler. This should improve your sensitivity a lot. Check that the readout is now within a couple of KHz. Once you've checked out the rest of the radio, you can go through the entire mechanical and electrical alignment to get best sensitivity.

Ed

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Date: Fri, 23 Feb 2007 11:16:07 -0600  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: RE: [R-390] R-390 New Project

"1. The PTO problem was a loose coupler.<snip>

The PTO covers 1 MC in 10 turns. 25 KC is exactly 1/4 turn. Just do that 1/4 turn and then see if you went the right way. Then you can dig out the alignment instructions and finish the job.

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Date: Tue, 13 Mar 2007 21:19:35 -0500  
From: "Fred Stillwell" <roswell@apk.net>  
Subject: [R-390] VFO end point adj.

I have a question on the R-390 (A) VFO. When performing the end point adj. do you start at 7+000 and adj L-701 at 7.000 or is it the other way, starting at 7.000 and adj at 7+000. ? I'm sure this has been covered before but I can't find it. The original manual seems to center everything around 7+000. BTW, is there a list or page that covers the changes to the original Y2K manual. I'd like to correct my original printed copy if possible.

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Date: Thu, 15 Mar 2007 03:33:02 -0700 (PDT)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] VFO end point adj.

If you're only adjusting the PTO endpoint, then it really doesn't matter where you start as long as it's at one of the ends. The 7+000 is really for alignment of the RF deck cams. The PTO needs to output 3.455 Mhz on the low end and 2.455 Mhz on the high end after exactly 10 turns of the shaft. If you want a start point, start at 3.455 and turn clockwise to get to 2.455 in ten turns. If you don't have a counter you can listen to the PTO on a HF radio with an accurate dial.

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Date: Tue, 20 Mar 2007 21:42:42 -0600  
From: DW Holtman <future212@comcast.net>  
Subject: [R-390] Cosmos PTO labels

Were the labels for the Cosmos PTO made in a several shades of blue over the

years of production? I have seen pictures of everything from light robin egg blue to dark almost navy blue. Maybe the differences are due to fading over the years? I'm trying to make some reproduction labels and I'm at a cross roads on the color of the Cosmos labels. Any pictures of them would be a great help. Thank you for any help in this matter.

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Date: Mon, 26 Mar 2007 01:40:05 -0400  
From: "Bob Young" <youngbob53@msn.com>  
Subject: [R-390] R-390 zero adjust problem fixed and have more questions.

I fixed the problem with the zero adjust that I caused the other day by screwing the shaft in too far. I took off the panel with the help of the manual which will be my 390 bible from now on. Basically the clutch was not releasing enough to engage again. I took a screwdriver and applied pressure between the little round thing between the big gear nearest the panel and the cotter(?) pins. I had to do this more than a few times, but it worked, it's back together again and working fine. Ok my first questions <snip>

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Date: Mon, 26 Mar 2007 13:09:37 -0400  
From: Mark Huss <mhuss1@bellatlantic.net>  
Subject: Re: [R-390] R-390 zero adjust problem fixed and have more questions.

For what it is worth, you have to be careful with the R-390 (non A) zero clutch. They changed the design in the R-390A because it is so easy to break the clutch on the R-390 by overtightening it. <snip>

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Date: Mon, 26 Mar 2007 13:09:37 -0400  
From: Mark Huss <mhuss1@bellatlantic.net>  
Subject: Re: [R-390] R-390 zero adjust problem fixed and have more questions.

<snip> Go ahead and linearize the PTO, you will have to do it anyway. Another test, especially if you have a frequency counter, is this. Remove the shield from the Second LO Tube. Wrap about twenty or so turns of #28 or #30 wire around it about in the middle. Secure with tape, or if it holds its shape, just twist the ends to keep it compressed. Now, wire the ends to the input of the frequency counter. This will let you read the frequency of the second LO directly. Then run through the bands, monitoring how far off each crystal frequency is. The results may surprise you. Crystals not only drift with temperature, they age 2 to 5 ppm per year, and temperature accelerates this. After fifty years, drift would be about 4250 Hz on a 17 Mc crystal. Since heat accelerates this process, and the crystals are in an oven, you can expect more. Maybe more than 8 kHz. One of the design compromises in the R-390 series was no trimmer. But then again, who knew these things would have an operational life of better than 40 years, and still be going strong after fifty. :-)

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Date: Mon, 02 Apr 2007 08:09:14 +0000  
From: "Gene Dathe" <dathegene@hotmail.com>  
Subject: [R-390] adapter

Thank you to all on the list who responded about my PTO problems, especially

Dave Medley who went to the n th degree... I recently acquired a 8640B and so am having the usual fun, alignment etc; and so the question is:

What is the nomenclature the connectors J217 and J116? That is, to hook up the PTO to my frequency counter, I need an adapter from what to BNC? Also, do folks drill a hole in one IF can and move it around when aligning all three, drill all three cans, or find a drilled spare?

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Date: Mon, 2 Apr 2007 07:48:38 -0400  
From: "David C. Hallam" <dhallam@rapidsys.com>  
Subject: RE: [R-390] adapter

If you are referring to the connectors on the R-390A, the correct nomenclature is MB series. They are often referred to a "mini BNC" but that is not correct. They were not widely used and a little difficult to find. The last I knew Skycraft Surplus in Winter Park, FL had some stock or William Perry Co, in Louisville, KY may have them.

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Date: Mon, 02 Apr 2007 11:29:15 -0400  
From: "Bob Young" <youngbob53@msn.com>  
Subject: [R-390] PTO question for R-390/URR

I bought an early Collins R-390/URR with a Cosmos PTO in it, can I assume that this is not original and the receiver has to have been modified? (It is off about 9 KHz end to end) The reason I ask is I am interested in a Collins PTO on ebay but don't want to buy it if there will be extensive modifications involved, the receiver seems to be all original otherwise. The PTO plug (6 prong?) seems the same but there are several wires on the front of the Cosmos that run under the PTO that are not on the Collins or I don't see them anyway (I also have one with a Collins PTO). (These are both 390's they are not 390A's) Thanks,

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Date: Mon, 2 Apr 2007 14:20:40 EDT  
From: R390rcvr@aol.com  
Subject: Re: [R-390] PTO question for R-390/URR

I have seen 3 or 4 R-390s with this mod. I suspect that it was in fact a military mod later in the radios service life, when Cosmos were in the pipeline, and not the original R-390 style PTO. The other possibility is that someone published a hack to put them in the R-390. The fact that all of the mods have used Cosmos PTOs, and not any other mfg., makes me think it was a military mod. It seems to work just fine in the one I have had up and running, so wouldn't be in a big hurry to swap it back. I don't think however it would be prohibitly difficult to reverse engineer it.

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Date: Mon, 2 Apr 2007 17:48:56 EDT  
From: DJED1@aol.com  
Subject: Re: [R-390] PTO question for R-390/URR

I've only had experience with the "A", but at one point I bought a PTO on eBay that was advertised as being from a R-390A, but I found the power plug wouldn't fit, and

it had a real BNC vs a mini-BNC on the RF cable. I'm pretty sure it was an original non-A PTO, which says someone either modified your radio or the Cosmos PTO in it. It's not hard to set the endpoint on the Cosmos, unless it need to have the coil modified because it has used up all the adjustment range. Good luck with it-Ed

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Date: Mon, 2 Apr 2007 18:02:21 -0400  
From: "David C. Hallam" <dhallam@rapidsys.com>  
Subject: RE: [R-390] PTO question for R-390/URR

I don't think there is any basic difference between the R-390 and the R-390APTO. There is a difference in the cables and plugs, both power and RF. As I remember there is also some difference in the mounting bracket. At one point I was looking at modifying a R-390A PTO to fit my R-390. I didn't think any of the problems were going to be difficult to overcome. R-390A PTO's were both more plentiful and less expensive to buy than ones for a R-390. Ultimately I found a R-390 PTO at a good price and the project stopped.

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Date: Mon, 09 Apr 2007 12:06:23 +0000  
From: "Gene Dathe" <dathegene@hotmail.com>  
Subject: [R-390] PTO

Well, my pto project was successful and I now have a working spare. Aligning the Oldham coupler on the PTO shaft took a bit of time, though. With the Khz set at -000, there were 3 1/2 turns left of travel. That got me within 25 khz, then rotating the Oldham coupler on the shaft got the spare within 2 khz of my original. The point being that I could drop in the spare without having to radically reset the zero. It seems to me that as long as the 1 Mhz travel of the PTO is within the total mechanical travel between the stops that the radio will work fine, just re-zero for that particular PTO. But say I accidentally installed it with 5 turns on the shaft, up about 200 khz. I couldn't zero it before I hit the end of travel. Now a fanatic might want to "center" the 1 Mhz travel within the stops. My question to those that did this sort of thing for a living is: Did you have a SOP when installing the PTO to mechanically align it?

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Date: 9 Apr 2007 14:57:38 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] PTO

> My question to those that did this sort of thing for a living is: Did you  
> have a SOP when installing the pto to mechanically align it?

I never did this for a living (thankfully, because I would have gone hungry) so you may not want to hear my advice, but if the PTO were to be 200kc off, the radio would behave very badly and you would know something was wrong. I use a frequency counter, set the dials to wherever they should be (based on where the frequency the counter says the PTO is currently running (usually at 2.455 or 3.455 but anywhere in its range will work)), center the clutch, and go from there.

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Date: Mon, 9 Apr 2007 12:37:07 EDT  
From: DJED1@aol.com  
Subject: Re: [R-390] PTO  
To: dathegene@hotmail.com, r-390@mailman.qth.net

Well, I never did it for a living, but here's my understanding of how to align the PTO. Incidentally, the experts say it is critical to get the PTO correctly aligned with the geartrain, otherwise the gain suffers a lot. You need to be within a few Kc to get good performance. I just went through this alignment after consulting the archives:

- 1. First, set the overrun on the dial so it's symmetrical at about 35 Kc at top and bottom of the band.
- 2. Center the zero adjust, then don't touch it.
- 3. Set the PTO end point to within 2 or 3 Kc.
- 4. Set the radio to 7.000+ (that is 8.000 on the 7 Mc band)
- 5. Loosen the Oldham coupler at the front side, set the PTO to 2.455, then tighten the coupler.

The PTO should now track correctly with the rest of the radio. This assumes that the radio geartrain is in correct mechanical alignment to start. If you don't have a frequency counter, and the PTO is close to correct, you can use the calibrator to do step 5. Loosen the coupler, turn the PTO by hand until you zero beat the calibrator signal, then tighten the coupler.

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Date: Mon, 9 Apr 2007 09:46:36 -0700 (PDT)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] PTO alignment

The mechanical stops and veeder root counter on the RF deck should be set up with about 35 kcs overtravel on each end. After that, put your dial counter on 000 and set the PTO for an output of 3455 kcs (read on a counter or listen on another receiver for it) and you'll be real close to proper alignment. Doing this you should never hit the stops on the PTO. The PTO stops are much weaker than the stops on the RF deck. By design (I guess) the RF deck stops hit first.

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Date: Thu, 12 Apr 2007 09:04:37 -0400  
From: "Keith Densmore" <densmore@idirect.com>  
Subject: [R-390] Two questions

I have a Imperial unit which I will be getting into shortly. It works well now, and the PTO is all re-aligned and stable. I notice a couple of problems with it, and I wonder if anyone on the list has had these and/or has any thoughts. Forewarned is forearmed!

1/ Sensitivity drops noticeably going from the wider mechanical filters to the narrower ones. The level meters are out of it but it's probably more than 10-15db from 16 to 2 kc. This is actual signal loss not just noise loss of a narrower filter. Anything to look for?

2/Lower sensitivity on the 7 mcs band compared to all other nearby bands. Does

not appear to be the band switch, it makes positive contact on all ranges. I thought might be alignment of the 7-24 mcs crystal but it peaks nicely with its trimmer. Any thoughts?

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Date: 12 Apr 2007 13:13:06 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] Two questions

If your IF unit is equipped with trimmers on the input and output of the filters, they may need to be adjusted. I had the same problem with mine and tweaking the trimmers helped greatly.

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Date: Thu, 12 Apr 2007 09:25:04 -0400  
From: "Walter Wilson" <wewilsonjr@gmail.com>  
Subject: Re: [R-390] Two questions

Make sure it will peak in TWO spots during a full rotation. If it only peaks in one spot, that's not a true peak.

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Date: Thu, 12 Apr 2007 09:30:38 -0500  
From: "Cecil Acuff" <chacuff@cableone.net>  
Subject: Re: [R-390] Two questions

Good point Walter....I ran into that a while back and when this happens you need to change the fixed cap to get things into the range of the trimmer. It made quite a difference. Got to have two peaks....don't matter which one you adjust to.

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Date: Thu, 12 Apr 2007 11:50:40 -0400  
From: JMILLER1706@cfl.rr.com  
Subject: Re: [R-390] Two questions

Hopefully the narrower filters haven't gone bad - did you replace the coupling capacitor in the IF unit that has a history of failing - and destroying filters? And if you go to a narrower filter, you may need to tweak the tuning to center the signal in the narrower filter passband - should be obvious but just wanted to mention it.  
<snip>

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Date: Mon, 16 Apr 2007 20:37:52 -0600  
From: DW Holtman <future212@comcast.net>  
Subject: [R-390] PTO Question

I'm in the process of restoring a PTO for a friend. I have done about at a dozen or more with good success, but they have all been Collins or Cosmos. This one is either a Progresstron or a Dubrow. I would like to know which one?

It has a corrector stack similar to the Collins. The the internal compensator coil (the end stop adjustment) has about 6 turns of wire vise two turns on the Cosmos. The heating coil is a glued on red rubber mat instead of the coil being sort of inside of a metal Pocket on the middle cover.

It does not present any problems that I can see servicing it, I'm just very interested. Any help identifying this PTO would be greatly appreciated. Thank you in advance.

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Date: Mon, 16 Apr 2007 23:21:53 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: [R-390] Interesting R390A for auction on eBay

Seller claims no known modifications but that PTO cable doesn't look original to me. Anyone seen anything like it before? It appears the repairer didn't have the correct cable or connectors so he straight wired it to a regular BNC connector.

---

Date: Tue, 17 Apr 2007 07:46:39 -0400  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] Interesting R390A for auction

The tape holding the power connector on the PTO looks very professional ...The PTO has been fiddled quite a bit.

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Date: Tue, 17 Apr 2007 12:31:23 +0000  
From: "Gene Dathe" <dathegene@hotmail.com>  
Subject: [R-390] Interesting R390A for auction

The blue Amphenol connector that plugs into the PTO must have extensive damage; otherwise why duct tape over it? ( I know, I just got done replacing one!)

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Date: Tue, 17 Apr 2007 09:29:03 -0400  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] Interesting R390A for auction

Auction interested folks, The 70H-2 PTO is meant for the R-390/URR (the "non-A"). It appears to have the original BNC output cable that has been adapted to work in the R-390A/URR. The blue Amphenol connectors on the 70H-2 (R-390/URR) and the 70H-12 (R-390A/URR) are not the same. So, it's possible that the PTO is as originally configured for the "non-A" radio and has been adapted for the "A" with the needed connectors for both power and PTO output.  
(I added brackets <...> around the long URL so it will work in most browsers even if line-wrapped in transit.):

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Date: Tue, 17 Apr 2007 07:40:20 -0600  
From: DW Holtman <future212@comcast.net>  
Subject: Re: [R-390] Interesting R390A for auction

Speaking of Ebay auctions, why did this auction go for so much money? Is there something that I did not see? The antenna relay has been butchered, poor quality pictures, no pictures of the inside. He does not even say is it works.

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Date: Tue, 17 Apr 2007 11:09:18 EDT  
From: DJED1@aol.com



Subject: Re: [R-390] Interesting R390A for auction

Yep, it's a "non-A" PTO patched into an "A" radio. I bought a "non-A" PTO on eBay, advertised as an "A" PTO. I found it had a regular BNC connector, and the power connector did not mate with my radio. The telltale in the photo is the cover on the transformer in the PTO- the non-A cover has a sharp rectangular top, while the later A covers have a rounded edges of a formed can. You can see the adapter to the BNC, and the tape must cover a spliced power cable.

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Date: Tue, 17 Apr 2007 12:30:31 -0400 (EDT)  
From: "Paul H. Anderson" <paul@pdq.com>  
Subject: Re: [R-390] Interesting R390A for auction

My guess? A Collins tag with a 1 fuse chassis \_may\_ mean a relatively clean original Collins unit... Who knows what pictures the seller sent buyers in email. Otherwise, no clue...

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Date: 17 Apr 2007 17:01:53 -0000  
From: "n4buq@knology.net" <n4buq@knology.net>  
Subject: Re: [R-390] Interesting R390A for auction

Interesting. I didn't know the 70-H1 and 70-H12 PTOs were mechanically and electrically compatible. It appears a fellow could make the an adapter for the power plug and a suitable cable for the output and not have to hack the R390A to use the 70-H1 but I suppose one uses what one has available at the time.

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Date: Fri, 20 Apr 2007 22:22:32 -0500  
From: W Gladhart III <willysgarage@cox.net>  
Subject: [R-390] 390-A VFO Rebuilders?

Hello Group, I've been awarded the care of a Collins R-390A. It was received upside down with the VFO removed. The VFO shaft is stuck solid. I picked up a beater replacement from Fair mainly for a set of bearings(?) but I don't think I should attempt messing with it. Can anyone recommend someone that can repair and align this VFO so I can power the unit up and find what other surprises it holds in store?

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Date: Sat, 21 Apr 2007 09:25:53 -0400 (EDT)  
From: "Paul H. Anderson" <paul@pdq.com>  
Subject: Re: [R-390] 390-A VFO Rebuilders?

I suggest this strategy... Make sure it is the VFO and not the front panel bushings or other parts of the RF deck. Do this by removing the VFO from the radio. The tuning shaft should turn freely with light fingertip pressure (do not force). You have an example from Fair to help you see what might be normal. If it is stuck then, you are most likely doing triage on it - it likely is corroded inside, badly bent, or otherwise generally unrepairable, IMHO. You can check for this by taking the cover off, which is fairly safe to do - in my opinion you're just looking to see if there is something

grossly wrong that can be readily fixed. So, pull stuff off, save the parts, and see if you can locate the problem - bent shaft, corroded bushings, broken parts.

Another perfectly reasonable approach, if the VFO itself is stuck, is to set it aside as a spare (or mid-winter repair project), buy another one that can be restored or used, and go with that one.

I lean towards replacement rather than repair because R-390A VFO's are relatively available at not too much money, and repair of this type of problem is best done 'because you want to' - not because it makes time or money sense to do so. This is all my opinion, and clearly, there are many reasonable points of view on this.

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Date: Sat, 21 Apr 2007 09:58:52 -0500  
From: "Cecil Acuff" <chacuff@cableone.net>  
Subject: Re: [R-390] 390-A VFO Rebuilders?

Also make sure it's not just driven hard against one of it's end stops which can happen if it is reinstalled out of sync and it reaches it's stop before the mechanical drive train reaches the 10 turn stop point. That can make it appear to be locked up... It can also be permanently damaged that way also if taken too far. Disassembly and a visual inspection should help to figure out if it's stuck all the way in or all the way out.

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Date: Sat, 21 Apr 2007 11:06:38 -0500  
From: W Gladhart III <willysgarage@cox.net>  
Subject: [R-390] Re; StuckR-390A VFO

Thanks Cecil and Paul for the responses. For clarification; The VFO is completely out, the plates are off (the coupler spring is long gone) and there is no sign of corrosion (yet.) I backed the cover off the beat up Fair unit and saw the 2 pairs of wires being pulled tight and quit. I suppose I just mark them and unsolder to continue removal? The main reason I hoped to save my original is it's visually clean like it was built last year and it is a Collins ( I've drank the koolaid!) I have tried twisting the shaft with a small pair of pliers, knowing I shouldn't need too much force to turn it. I guess I'll dive into the disassembly but if you fellas are right, I guess I'm in the market for a good, checked spare. Any sources? The one I got from Fair is by far the worst piece of junkbox filler they've ever sold me but they did say it was "dented with cut wires..." Thanks again, Wes

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Date: Sat, 21 Apr 2007 20:14:39 -0400 (EDT)  
From: "Paul H. Anderson" <paul@pdq.com>  
Subject: Re: [R-390] Re; StuckR-390A VFO

When pulling the cover back, the two wires are VFO heater wires - they can safely be unsoldered, then the whole mess removed. Some people remove the whole mess and toss it, because the VFO doesn't usually benefit from the heater being on. There is a benefit, it is just a small one for most users (the radio was designed to operate in arctic and desert regions equally well and remain stable across them). Plus, NOS looking or not, no one is going to see inside the cover if you put it back

on when fixed! I know what you mean about wanting to save the unit. You might get lucky and track it down - heck you've really got nothing to lose!

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Date: Sun, 10 Jun 2007 20:57:33 -0500  
From: "Barry" <n4buq@knology.net>  
Subject: [R-390] R390A PTO?

That sure looks like an R390A PTO to me. Wrong?

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Date: Sun, 10 Jun 2007 20:33:04 -0600  
From: DW Holtman <future212@comcast.net>  
Subject: Re: [R-390] R390A PTO?

I can't read the Type from the label, but it looks like a BNC connector from an R-390 to me.

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Date: Sun, 10 Jun 2007 22:39:30 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] R390A PTO?

Only thing need to do is change the BNC to an MBNC. Same circuitry on front INCLUDING naming on coil assembly T-702. It IS a Cosmos.

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Date: Sun, 10 Jun 2007 22:42:08 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] R390A PTO?

BTW, it has ALL parts of the Oldham coupling in place. THAT alone could be worth the price!

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Date: Sun, 10 Jun 2007 23:13:01 -0400  
From: "Bob Young" <youngbob53@msn.com>  
Subject: RE: [R-390] R390A PTO?

I have a 390 with a Cosmos PTO in it, looks identical to that one, I was told it was maybe a depot mod later in it's life, he's also got a lot of other 390 stuff for sale including a front panel.

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Date: Sun, 10 Jun 2007 22:07:05 -0600  
From: DW Holtman <future212@comcast.net>  
Subject: Re: [R-390] R390A PTO?

To put it on a R-390A, the blue Power Plug would have to be changed also, they have a different pin arrangement.

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Date: Mon, 11 Jun 2007 07:31:09 -0400  
From: "David C. Hallam" <dhallam@rapidsys.com>  
Subject: RE: [R-390] R390A PTO?

It is a R-390 PTO. It can be used in a R-390A but the RF connector has to be changed as well as the power connector. The R-390 has a regulated B+ supply so the plate and screen were fed from the same point. The R-390A only regulates the screen supply and so uses different B+ supplies for the plate and screen.

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Date: Wed, 13 Jun 2007 09:25:43 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] PTO

The guy is clearly spit-and-polish and not a guy to technically recalibrate a PTO or even distinguish one from another. Having the endpoint out on a rather "original" PTO is to be expected (although 40kc is more than I've ever seen - perhaps a misguided attempt at remedying?) This is just the direction that the parts drift over time, and the reason that so many of us have disassembled our PTO's to remove a turn or two and bring it back into line.

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Date: Sat, 21 Jul 2007 06:26:24 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: [R-390] PTO: Why does endpoint shift over time?

Do we know why PTO endpoints shift so consistently in the same direction over time? (To the point where every PTO I've found has needed a turn or two removed from that little slug-tuned coil to get the endpoint right.) It must be either the fixed capacitors drifting in one direction, or the permeability of the inductors drifting over time. I do know that caps aren't truly constant in value. And that there is, for example, some silver migration in mica capacitors etc. but for mica capacitors, this migration is known mainly by me for crackly audio, not a slow term drift in value. I don't know what would make an inductor's slug drift so consistently in time. I know some are temperature sensitive, and some types of slugs go "bad" if over a certain temperature, but that's not what is happening here. How come, after 30-40-50 years, haven't things stabilized? I know for a lot of components there is some drift after manufacture and bake-out during use, but this period seems to be measured in days and weeks, not big chunks of a century!

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Date: Sat, 21 Jul 2007 08:32:18 -0400  
From: "Jay Rusgrove" <JRusgrove@comcast.net>  
Subject: Re: [R-390] PTO: Why does endpoint shift over time?

I went the route of removing one of the 10 mmF flat silver mica capacitors to restore end point calibration(btw, this method appears to work well). The capacitor I removed measures 10.2 pF on the General Radio 516C bridge.

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Date: Sat, 21 Jul 2007 08:39:16 -0400  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] PTO: Why does endpoint shift over time?

The PTO's in the R390's shift due to aging of the tuning coil. There was a \*lot\* of work done by Collins after the 390 was designed to eliminate this problem. One of my ex-bosses was part of that particular effort. When I asked him why they didn't

incorporate the "improved" coil in the later radios the answer was pretty simple - "the contract didn't call for it". The two main components of the drift are the aging of the particular material used in the tuning slug and shrink of the coil form that the coil was wound on. Both essentially just keep moving forever and ever ....

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Date: Mon, 23 Jul 2007 09:26:38 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] PTO: Why does endpoint shift over time?

If I knew some metallurgy I might be able to make some half-assed explanation for why it should drift and keep on drifting over fifty years (and presumably, a hundred, and two hundred, and...). As it is, I could only make fully-assed explanations! Oxidation? Cumulative background radiation causing crystal defects? I know, it must be that kryptonite in the 0A2 that's doing it! (Sorry, that last one was more than fully assed, but really the labels on 0A2's do talk about some small number of microcuries of Krypton!) Shrink of the coil form - I guess this would fall under polymer science. In my delving into the innards of PTO's the form seemed to be phenolic/bakelite. I do know that lots of plastics will for example swell in the presence of humidity but I do not know of any examples where the swell continues on for half a century. Seeing as how we have to take turns off the endpoint adjustment inductor, I would guess that the direction is towards larger inductance which would mean larger diameter which is vaguely consistent with "swell", but you describe it as a "shrink" Bob, so maybe I don't understand everything!

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Date: Mon, 23 Jul 2007 12:04:26 -0700  
From: "Dan Merz" <mdmerz@verizon.net>  
Subject: RE: [R-390] PTO: Why does endpoint shift over time?

Hi, dimensional change of the order of 1/2% over 50 years doesn't surprise me for a composite material like a reinforced phenolic, which is the amount of dimensional change to account for 10 khz change. That's on the order of 1/2 mil for a 1 inch diam and proportionately less for a smaller coil. But I'm wondering what evidence pins the change on the coil form and not the permeability of the core material that moves in the coil? I suspect that such drift in the other cores of the radio would mostly go undetected or be of little concern but the pto drift has been the subject of a lot of scrutiny because it relates directly to tuning accuracy. Maybe we should be grinding a little off the core instead of pruning the coil. I pruned the coil in mine. The phenolic is probably paper or linen reinforced so this may be the avenue to swelling over time. Dan.

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Date: Mon, 23 Jul 2007 16:17:13 EDT  
From: ToddRoberts2001@aol.com  
Subject: Re: [R-390] PTO: Why does endpoint shift over time?

I "fixed" a couple of R-388 PTOs by removing one or two turns from the end point coils back in the 1980s. Since then the PTOs have remained dead-on, exactly ten-turns for a 1MHz change in frequency. So assuming the radios were built in the 1950s, in my cases the drift in the PTO end point seemed to stop after about 30 years from manufacture date.

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Date: Mon, 23 Jul 2007 19:37:29 -0400  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] PTO: Why does endpoint shift over time?

There is a very small gap between the turns in the coil and the core that moves in the coil. That magnifies the impact of the dimensional change. The material in the tuning slug oxidizes over time. For some interesting reason that changes its magnetic properties.

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Date: Wed, 25 Jul 2007 11:37:37 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] Cosmos PTO Schematic?

> Anyone got a Cosmos schematic?

I've opened up two Cosmos's and as far as the 6BA6 and the resistors and capacitors on its little subchassis go, it's the same as in the Y2K manual. There probably are some differences in corrector stack inductors and fixed capacitors etc. inside the can between the Cosmos and the other cans, but I don't remember these being actually specified to that extent.

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Date: Wed, 25 Jul 2007 12:23:21 -0700  
From: "David Wise" <David\_Wise@Phoenix.com>  
Subject: RE: [R-390] Cosmos PTO Schematic?

Right, the Cosmos is a mechanical redesign, not an electrical one.

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Date: Wed, 25 Jul 2007 15:46:53 -0400  
From: Barry <n4buq@knology.net>  
Subject: RE: [R-390] Cosmos PTO Schematic?

Could it be? [http://en.wikipedia.org/wiki/Travelin'\\_Band](http://en.wikipedia.org/wiki/Travelin'_Band) Nah...

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Date: Mon, 30 Jul 2007 10:08:32 -0400  
From: Charles A Taylor <WD4INP@isp.com>  
Subject: [R-390] decals and stencils? HELP!

I have here,

1. One PTO assembly with a defaced rework facility decal attached to it in place of the original COSMOS decal (or whomever). The decal says:

SHOP 67  
PART /O R-390A  
4G 5870-327-4393  
REPAIRED [blank]  
HPNS

Not sure of the FSN. May require some research.

Would anyone on this reflector be able to replicate this decal at a reasonable price?

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Date: Sun, 28 Oct 2007 09:11:28 -0700 (PDT)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] R-390/URR

You need 1/32" between the parts of the Oldham coupler. BUT, if the shaft doesn't run true or the mounting doesn't allow the shafts to align properly then you will need more clearance. You might want to check that there is some clearance between the parts of the coupler as it turns through 360 degrees, it may be binding somewhere.

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Date: Sun, 28 Oct 2007 12:14:55 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Oldham Coupler Maintenance

Bob wrote about having to readjust an Oldham coupler after a maintenance procedure to the VFO. The VFO should run with the KC shaft with ease. The KC knob in a good clean gear train should almost free wheel when spinning the knob and the cams are dropping. That was long ago and your mileage may vary in an older receiver. This implies it takes very little torque to turn a VFO shaft. If you have an original strength Oldham coupler the spring should not stretch when the KC shaft is moved. The resistance of motion in the VFO should be less torque than the torque needed to stretch the coupler spring. If you have a rubber band on the coupler, or a very weak spring (ball point pen spring tailored to fit) then the springy thing you have employed may stretch. An over stiff spring may not help as it may place side stress on the VFO shaft as they go around their respective corners.

You may not want to run the coupler end faces to tight. The angle of the two shaft alignments forms a high pinch point some where around the shaft axis. The coupler faces may not be true to the axis. You need to open up the faces. Some where between the coupler spacer falls out and the coupler binds at some point. Run the shafts around a few turns and find that close point between the two coupler end faces. Then adjust the end faces up close at that pinch point.

With the spring off, anywhere in the rotation of the shafts, the coupler spacer should be a bit free between the two coupler end faces. With the spring on the coupler the resistance to rotation of the VFO shaft should be less than the force needed to stretch the spring. If not your VFO need its shaft cleaned and lubricated. Not a hard thing to do. Most of that effort is to have a good oil on hand for the purpose. Mobil Synthetic lube is OK I hear. Good sewing machine oil was used in the 70's Watch oil or whale oil is good.

To oil the shaft, just set the VFO up on end and oil the shaft. Run it by hand both way for a bit to see if that solves the problem. Most times in younger receivers it was not necessary to open the VFO and clean out the crud. In these now aged

receivers, who knows what it will take to get a shaft and bearing cleaned up. Worry not it can be done. The job is just time consuming and not high technology.

Getting the back lash out of the VFO Oldham Coupler is mostly just attention to cleanliness, lubrication and mechanical spacing.

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Date: Sun, 28 Oct 2007 09:33:37 -0700 (PDT)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] Oldham Coupler Maintenance

But we might be getting ahead of ourselves here.

What you might want to do first is to check that the KC CHANGE shaft is straight! It may not be if the knob has been whacked sideways. The bushing directly under the knob should not be tightened too much, just snug. Having three bushings on that shaft can cause binding unless the shaft is exactly true and straight.

You might have to shim the PTO mountings in order to get the shafts in line. Remove the center of the Oldham coupler and use feeler gauges, or shim stock, to check for parallel running of the two face plates as they turn.

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Date: Sun, 28 Oct 2007 15:35:39 -0400  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] R-390/URR

The most incredibly severe backlash I had on my 390A was when I realigned the Oldham coupler and neglected to tighten all the set screws sufficiently. It worked fine for a while. Then, a few weeks later, all of a sudden the geartrain would move but the PTO wouldn't, producing some severely disconcerting results! I did not see the cause until I hooked a frequency counter up and found that no matter how much I turned the front knob, sometimes the PTO didn't budge :-).

So frequency counters are, in the case of doofus like me, capable of detecting the set screw that I forgot to tighten. Never saw that on the capability list of a frequency counter, huh? :-). (Others would argue that the frequency counter was detecting a doofus!) I'm willing to bet your backlash is because you didn't tighten all the set screws back up after tinkering with the coupler.

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Date: Sun, 28 Oct 2007 19:48:20 -0400  
From: shoppa\_r390a@trailing-edge.com (Tim Shoppa)  
Subject: Re: [R-390] Oldham Coupler Maintenance

The worst-lubed PTO I ever saw was a Cosmos that had been rebuilt (according to a sticker on it) by Raytheon in the mid-70's. It was severely gunked up with overlube. IMHO based on that experience, not getting a "Regular clean and lube" that's done by gunking everything up with too much lube is the worst thing that can be done to a PTO!

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Date: Sun, 28 Oct 2007 19:58:54 -0400



From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] Oldham Coupler Maintenance

It's the clean rather than the lube that's the important part in my mind.

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Date: Mon, 29 Oct 2007 11:04:38 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Oldham Coupler Maintenance

If you stretch the spring on the Oldham coupler while spinning the KC knob and thus change the relation of the rotation angle between the KC knob and cam shafts to the VFO position shaft then you have backlash. Too much friction causes the lash problem and maintenance fixes the lash problem. Sorry to make this look like a binding problem. Sorry, the fix to a lash problem is cleaning and lubrication. Read Tim's tales of the stuff he has encountered. Backlash in gear trains is also a friction problem. If the gears have low friction then they are just sloppy and have play but not suffering from back lash.

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Date: Mon, 29 Oct 2007 10:11:45 -0500  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Oldham Coupler Maintenance

The problem INDEED is binding! I was just trying to understand/IDENTIFY "which" it was!  
His PTO "MAY" be locked up, for lack of a better term and understanding.

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Date: Mon, 29 Oct 2007 10:18:49 -0500  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Oldham Coupler Maintenance

Roger - NO APOLOGY NECESSARY!!! You were RIGHT! I took HIS "words" - tried to understand WHAT he meant. I've worked with gear systems for "ages".

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Date: Mon, 29 Oct 2007 12:09:51 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Oldham Coupler Maintenance

A much different problem than I was writing about under this subject. The other Bob does have a locked up receiver. That could be anything from the dial lock engaged to lots of problems.

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Date: Mon, 29 Oct 2007 12:12:56 -0500  
From: "Bob Young" <youngbob53@msn.com>  
Subject: [R-390] Re: R-390/URR

I looked at it today and the PTO is turning fine and there is no play there, the problem is in the big front clutch gear (counter drive gear?) right behind the front panel. There is a little space between the clutch and the mating surface which is not in my other one. This allows the PTO to turn (had it opposite, sorry) but the

whole rest of the mechanism doesn't turn, you can feel it in the kilocycle knob, there is a little play in it which is why I called it backlash. I have loosened the clamp and moved the large gear to see if the gears were worn but this had no effect. I would say there is about 1Kc of play there in which the PTO turns but the readout doesn't, I judge this by the BFO. The PTO turns freely and there is no play there at all. The Oldham Coupler was fine. I found out something else today, there is no spring on the PTO oldham coupler on my other one, does anyone know of a source for these? Also I will measure those voltages on E210 today as I plan to do a rough line up of this one today,

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Date: Mon, 29 Oct 2007 12:21:18 -0500  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Re: R-390/URR

Do you by chance have the Dial Lock engaged? As if you were going to adjust the PTO to agree with the Veeder Root readout with the calibrator?

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Date: Mon, 29 Oct 2007 17:55:32 -0700 (PDT)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] Re: R-390/URR

That would be the ZERO ADJUST clutch, the knob should be turned all the way counter-clockwise, but be careful, it may not be working correctly if not it may come apart. Take a look at your working receiver and see how it is supposed to work. Then verify that it does or doesn't. If not, prepare to remove the front panel. You'll want to do some research on how to repair the clutch.

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Date: Mon, 29 Oct 2007 22:12:18 -0500  
From: "Bob Young" <youngbob53@msn.com>  
Subject: [R-390] RE: R-390/URR

I have found the problem as far as the backlash (play actually) in my 390 but it is very hard to explain. I took the counter drive gear apart which is part of the Kilocycle change control locking disc which is shown in figure #40 in TM 11-5820-357-35 and is right behind the panel. One side being the split gear and the other being the larger disc which is facing forwards. The problem is there is a little round piece of metal riveted to the outer gear of the split gear, this goes through the other gear and goes into the middle of two pieces of metal which are held together by a spring on their opposite side and are on the shaft. This little round piece of metal is loose where it is riveted to the first split gear and is the cause of the play in the control, it is worn and I doubt it can be fixed, it is supposed to be firm, the spring is supposed to absorb the play I think. Does anyone happen to have one of these for sale?

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Date: Tue, 30 Oct 2007 11:17:59 -0500  
From: "Bob Young" <youngbob53@msn.com>  
Subject: [R-390] RE:R-390/URR

I'm sorry if I mislead everyone with my hurried description, it is not a clutch at all, (I

found this out when I took it apart). The Oldham coupler is fine, the PTO turns as it should (no play), the dial lock is not engaged and the zero adjust clutch is fine. The problem is in the kilocycle change control locking disc and split gears which is on the same shaft as the PTO but right behind the front panel. This disc turns the split gears which in turn drive the veeder router. The backlash as I called it is caused by a loose rivet that goes from the split gear to the disc, the disc turns the split gears through a riveted little shaft, this little shaft is riveted to the split gear and is loose which is causing the play. It is shown on page 72, #40 of the Field and Service Maintenance Manual for 390's, can also be seen on page 61 right in the middle of figure #37, but I have not been able to find an exploded view of it anywhere in the book. You can feel it when turning the kilocycle change knob back and forth, the PTO turns but the veeder router doesn't (just a little bit of back and forth play). I took the panel off and pulled the part which consists of an approx 2 1/2" split gear and a disc, it is very hard to explain without the correct terms, but I need a new kilocycle change control locking disc with split gears (which is probably unobtainium.)

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Date: Tue, 30 Oct 2007 12:44:29 -0400  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] RE:R-390/URR

It's possible that all you need is a light tap with a hammer to re-seat that little pin.

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Date: Tue, 30 Oct 2007 11:11:30 -0600  
From: mikea <mikea@mikea.ath.cx>  
Subject: Re: [R-390] RE:R-390/URR

If that doesn't work, it might be possible to make a new pin out of suitable stock, drill-and-tap it for a small-enough screw, and fasten it down with screw, lockwasher, Loc-Tite, suspenders, and belt. It all sounds like fun for someone with a Unimat or a jeweler's lathe.

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Date: Sat, 03 Nov 2007 01:17:12 -0400  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: [R-390] PTO Problems

The PTO shaft seemed way too stiff so I opened it up and found this amazing colony of crystalline entities growing all over inside. It's a real mess. It looks like it had a LOT of moisture in it at one time but the rest of the receiver doesn't really show signs of water problems. Nevertheless the PTO looks original to the receiver (both Motorola). Should some kind of repair attempt be made or should go out with next Thursday's trash? I have an interesting photo but I suppose that would be inappropriate for the list.

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Date: Sat, 03 Nov 2007 01:56:23 -0400  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: Re: [R-390] PTO Problems

Well it's a consensus then. When I opened it up I finally understood the corrector stack that I hear people talk about. Guess it's time warm up the counter and

generate some more gray hair.

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Date: Sat, 3 Nov 2007 04:55:51 -0700  
From: "Craig C. Heaton" <wd8kdg@worldnet.att.net>  
Subject: RE: [R-390] PTO Problems

I had the same issue with a PTO in a Motorola R-390A. After applying liberal amounts of elbow grease, life was good. The desiccant was scattered throughout the PTO, stuck to the shaft that moves the widget along the corrector stack, ugly but fixable. First, I wouldn't do anything to move any of the plates of the corrector stack! Clean the inside of the PTO as best as possible. Check the condition of the little spring used to keep pressure between the widget and roller which moves along the corrector stack. A little De-Oxit here didn't hurt my PTO. A drop or two of synthetic 90 weight on the threads of the shaft didn't seem to hurt either. Reassemble the beast and adjust the end-point per Y2K manual. Keep your fingers crossed, the linear points are close and the plates of the corrector stack are where they should be. If the plates need adjustment, it will be a long night.

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Date: Sat, 03 Nov 2007 08:31:57 -0400  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: RE: [R-390] PTO Problems

The desiccant. So that's what all that stuff is. There is no evidence of any type of bag or container they use to contain that stuff and only now have I put it all together as to what happened. Is there a specific procedure for setting the compensation stack if it comes to that? Also how easily should the shaft turn? With the Oldham coupler plate removed, the shaft is turnable with my fingers but with difficulty. This is the original reason I suspected a problem in the PTO. What about desiccant? Should I insert a new pack and if so, where?

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Date: Sat, 3 Nov 2007 09:18:07 -0400  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] PTO Problems

If you throw it away you will have a major hit in your Karma account. The PTO is the crown jewel of the Collins design. Of course they also were the most replaced sub-assembly in the entire radio. Back when I worked for Motorola, our engineering assemblers were ex-R390 people. They had not made R-390s for nearly 20 years at that time. The \*one\* thing they remembered vividly was the PTO assembly process. I think I listened to an hour of "information" when I happened to mention R-390's to one of them. Never knew gray haired little old ladies knew all those four letter words ....

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Date: Sat, 3 Nov 2007 07:02:49 -0700  
From: "Craig C. Heaton" <wd8kdg@worldnet.att.net>  
Subject: RE: [R-390] PTO Problems

Yes, I've heard the stories about a bag, etc., used to contain the desiccant. In my PTO there seemed to be a rubber seal towards the end of the PTO that holds the

bearing for the shaft. The seal broke and let the desiccant move throughout the PTO. When I got to the third layer of disassembling the PTO; seal, desiccant, broken spring and all that good stuff dropped to the work bench. After getting the desiccant out of the PTO and off of the square thread of the shaft, just a smidgen of 90W synthetic oil should do the trick. The shaft will turn like hot butter, even after complete reassembly of the receiver. (the bushings in which the shaft(s) pass must be in alignment) I didn't have to mess with the corrector stack! A good cleaning, a little De-Oxit, seems to get everything back to square-one. As I check frequency at every 100KC, all is well within spec, after adjusting the end-point.

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Date: Sat, 3 Nov 2007 09:31:20 -0500  
From: "Cecil Acuff" <chacuff@cableone.net>  
Subject: Re: [R-390] PTO Problems

I've started making it a habit of removing the desiccant bags from the PTO's I go into to remove this possibility. The stuff has long since saturated anyway. It could be regenerated I guess but no real point. Mine live in an air conditioned shop.....as opposed to the jungles of Southeast Asia.

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Date: Sat, 3 Nov 2007 07:32:44 -0700  
From: "Craig C. Heaton" <wd8kdg@worldnet.att.net>  
Subject: RE: [R-390] PTO Problems

Only if the receiver will be installed in a submarine with leaks.

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Date: Sat, 3 Nov 2007 13:08:02 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO Problems

You touched on adjusting the corrector stack in the VFO.

>From old war stories YMMV.

Once you get the end points adjusted the VFO is likely to be linear. As you look down the adjusting stack it likely has a nice S or C curve. The curve is not necessarily symmetrical from end to end. But the curve should be nicely done with not sudden jumps. The stack is likely "sealed" with some varnish. If your end points and if the linearity is not off by more than 100 hertz at any 100KHz cal tone within a MHz band then just live with it. Never having had a good jig to help align the stack doing it has always been a venture of trial and error.

Get the end point spread set first. Remember what your stack curve looks like. The disassembled, cleaned, reassembled, tuned tightened and resealed stack will look very much the same. Take the stack all apart and clean out all the old varnish used to help keep the stack aligned after it was adjusted during assembly. Run ample amounts of Vaseline on all the plates in the stack to stick them together.

Reassemble the stack and just snug up the bolts. Squeeze out the excess Vaseline and wipe up all that is sticking out and all that is any where except between the

plates.

Using you sticks, pliers, levers and other improvised tools, get the stack straight and about center from end to end.

If you get the bolts to tight you cannot get easy adjustments.

If you get the bolts to loose the stack will move out of alignment inspite of the Vaseline.

Now it is a process of test, and adjust until yo are happy.

Leave the Oldham coupler on the shaft as a knob and indicator.

Mark the coupler to the face plate.

At a 1/2 turn you can get an exact alignment at each 50Khz.

You then adjust the stack plates between the 50Khz points for a "smooth" curve.

When you are happy with the whole stack you tighten up the stack bolts and test the whole curve again.

The shaft position may change at the end points.

The total spread should stay the same from end.

Using the stack to trim the end points is not the way to go.

The stack is to provide a very linear change of the VFO from end point to end point. Once you get the stack reset and tight, clean out any Vaseline. The stack can now be resealed along the outside edge with varnish "glue". In (68- 75) We talked about doing the stack with slow drying varnish or paint between the stack plates. The velocity of the wet varnish would hold the plates, not dry before the adjustment was complete, form a seal after adjustment was complete to hold the alignment. We never did it this way. We only did this stuff because we had the time to mess with it. Back then we just did the paper work and got a new VFO out of the box we received from the supply room.

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Date: Sat, 03 Nov 2007 21:46:58 -0400

From: Jon Schlegel <ews265@rochester.rr.com>

Subject: Re: [R-390] PTO Problems

I've discovered another possible problem with this (Motorola) PTO regarding the corrector stack follower. There appear to be two rollers that follow the compensator stack (both are now frozen). The one normal looking roller has what appears to be a fiber bushing, grayish tan in color. A domed cap appears to retain the bushing on its shaft. I can see vertical striations around the circumference of the fiber bushing which would tend to indicate that this bushing did at one time roll as it followed the corrector stack.

The other roller has neither a domed retaining cap nor a fiber bushing. All that appears to be present is a stainless roller. I found no evidence of these seemingly missing parts when I opened the PTO. When the follower arm is at a position on the corrector stack where it's ramping up or down, there does not seem to be any radial

play of the arm on the lead screw. When the arm is dialed to a spot where the corrector stack is flat meaning no change in cam height, there is about 10 or 15 thousandths radial play of the arm. Is this play normal? Are there parts missing? I can only imagine that the play I'm seeing could cause some nasty hysteresis in the tuning of the receiver.

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Date: Sat, 3 Nov 2007 19:00:27 -0700 (PDT)  
From: GARY WEBB <garylandsusanawebb@prodigy.net>  
Subject: RE: [R-390] PTO Problems

Or Guam, or the Canal Zone where I used R390A's for 3 1/2 years. Actually since those receivers were on 24 x 7 x 365 they didn't really need a dessicant at all.

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Date: Sat, 3 Nov 2007 19:33:54 -0700  
From: "Craig C. Heaton" <wd8kdg@worldnet.att.net>  
Subject: RE: [R-390] PTO Problems

Going from memory here, I should of taken digital pictures, shame on me. Anyway, there should be a small spring pulling those two arms together pinching the corrector stack, (where the rollers, wipers, etc., are attached). I think mine had one rubber roller, it did have a shaft and rolled across the corrector stack. The other arm might have had something more like a wiper that slid across the corrector stack. In any event, search for two small holes on the arms where the spring was attached. The spring might of rusted into tiny flakes long ago! A little penetrating oil, WD-40 used sparingly where the two arms pivot should free things up where the roller and wiper can function. A trip to the hardware store might be in your future searching for a tiny extension spring.

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Date: Sat, 03 Nov 2007 22:56:40 -0400  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: RE: [R-390] PTO Problems

I'd say your memory is pretty good because it's just as you describe. The entire arm thing is so corroded that I missed the fact that there is that smaller secondary arm that pivots on the main arm. I can just make out the spring holes. As you suggested, the spring has long turned into some other iron compound and is no longer with us. Guess I'll have to play Goldilocks and find a spring that's just right. Thanks very much, Craig. That solves that problem.

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Date: Sat, 3 Nov 2007 20:10:36 -0700  
From: "Craig C. Heaton" <wd8kdg@worldnet.att.net>  
Subject: RE: [R-390] PTO Problems

Don't ask me how I know, but a spring from a ball point pen will work. Granted it is a compression spring, with a little work; cut to length and a hook bent into each end you are in business. Later, after I got my PTO back together and the endpoints set I found an extension spring at a local hardware store. It is still in a little box just in case I ever get bored and want to open the PTO again. I'd rather poke needles in my eye! But I'm ready for the next go around.

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Date: Sun, 04 Nov 2007 16:07:19 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: RE: [R-390] PTO Problems

This PTO may be in pretty poor shape. After cleaning, the fiber roller's staked in shaft broke off with only a reasonably gentle wiggle to see if there was any play to allow things to get going again. I should be able to fix it if I can find suitable non-magnetic odds and ends to use to make a new shaft. There is what appears to be a stainless "roller" that follows the opposite side of the corrector stack. Is this "roller" supposed to spin or not as it follows the stack? Also, a few weeks ago I recall some list members working out some backlash problems. I can now see that I can see numerous spots where backlash could creep in that might need adjustment.

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Date: Sun, 4 Nov 2007 12:36:17 -0800  
From: "Craig C. Heaton" <wd8kdg@worldnet.att.net>  
Subject: RE: [R-390] PTO Problems

If things are rusted that much, I'd look for another PTO. Other parts may have failed inside or are about to. Booted my other PC to check some notes, didn't find any information as to the roller/wiper on the two arms. In all I had quite a bit of labor invested in fixing my PTO, I'd hate to put too much time into one rusted like yours, only to have it fail in a short time. Someone on the list will have a repairable PTO to offer.

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Date: Sun, 04 Nov 2007 18:00:50 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: RE: [R-390] PTO Problems

I still think its reliably repairable but with some work. The broken roller shaft is the only real bugaboo. The other effort is getting it cleaned well. There was a lot of corrosion and crystalline silica gel all over inside. If I can get the roller repaired I should be home free (famous last words).

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Date: Mon, 05 Nov 2007 09:44:17 -0500  
From: Roy Morgan <roy.morgan@nist.gov>  
Subject: Re: [R-390] PTO Problems

> When the arm is dialed to a spot where the corrector stack is flat  
> meaning no change in cam height, there is about 10 or 15 thousandths  
> radial play of the arm. Is this play normal? Are there parts missing?

No, Yes.

There should be a spring that maintains pressure between the steel roller and the corrector stack (Or between the steel roller and whatever presses against the OTHER side of the corrector plates.) (I'd have to open one up to refresh my memory, so if this is either incorrect, or partly correct, I apologize.) The little steel roller SHOULD ROLL FREELY!



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Date: Mon, 05 Nov 2007 11:12:50 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: Re: [R-390] PTO Problems

I'd be interested in a copy of the info on Simple Green. Please. Mail away. Thank you!

The steel roller is also frozen. Also, as I had just emailed Renée, I was cleaning parts I made a new unfortunate discovery. After removing the surface scale, I found that what looked like a three washers corroded together was actually a caged thrust ball bearing in the form of a copper cage (the center "washer") with little steel balls pressed into a radial set of holes. I'll presume that the steel balls were at one time free to rotate <G>. Now they're just frozen rust balls. I cooked up a solution for the broken fiber roller on the swing arm but this one's beyond me. Now I see that the stainless roller is also frozen (Thanks Roy). If I try to coax that into turning I know it's shaft will break off. Looks like it's time to scavenge another PTO for parts or repair.

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Date: Mon, 5 Nov 2007 14:21:40 -0800  
From: "David Wise" <David\_Wise@Phoenix.com>  
Subject: RE: [R-390] PTO Problems

>The curve is not necessarily symmetrical from end to end..But the curve should  
>be nicely done with not sudden jumps.<snip>

If your PTO frequency curve has a bow, you may get away without a corrector stack recal by changing the tank circuit capacitance. Beware - the originals were selected for temperature compensation. For curiosity's sake, I replaced the little ones with two trimmers with different tempco's, and got to where the curve was pretty much a horizontal line, and the frequency drift was also low. Don't try this unless you have lots of time on your hands, and patience too.

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Date: Mon, 12 Nov 2007 13:49:41 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: [R-390] PTO Connector

I'm looking for a source for the round, blue Amphenol connector that's part of the PTO assembly. It's the male connector, 9 pins that's mounted to the triangular bracket attached to the back end of the PTO. An Amphenol part number for this connector would also be a help.

I got a scrap PTO from Fair Radio (appears to be a Progresstron) expecting to use it for parts. The condition of the unit inside is picture perfect. I'm not able to check it's electrical functionality yet but the shaft has observable rotational backlash and I suspect that was why it was pulled from service.

I'm almost finished rebuilding the original PTO from my 390A but would like to get this Fair Radio PTO running also. For our convenience however, the blue

Amphenol connector has been smashed beyond repair, no doubt to make sure the bad unit didn't get back into service. Anyway, if anyone has a line on a source of these connectors or their Amphenol part number, I would certainly appreciate it.

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Date: Mon, 12 Nov 2007 15:22:47 -0600  
From: "Dave Merrill" <r390a.urr@gmail.com>  
Subject: Re: [R-390] PTO Connector

Amphenol 126-220 Miniature Hexagonal Connector  
This place claims to stock them : <http://www.electronicplus.com/>

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Date: Mon, 12 Nov 2007 17:50:15 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: Re: [R-390] PTO Connector

They don't give them away, do they? Why it's almost 3/4 of what the entire PTO cost. Thanks again.

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Date: Mon, 12 Nov 2007 16:22:06 -0600  
From: "Dave Merrill" <r390a.urr@gmail.com>  
Subject: Re: [R-390] PTO Connector

If you want just the 9-pin connector without the shell, try 126-012 or 126-219. Newark has them in their catalog in the \$8-9 range. Looks like they are sold under the Wire Pro name now.

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Date: Mon, 12 Nov 2007 14:31:56 -0800  
From: "James A. (Andy) Moorner" <jamminpower@earthlink.net>  
Subject: Re: [R-390] PTO Connector

If you are ever in San Rafael, CA (Marin County, 35 mins North of SF), you MUST drop in at Electronics Plus. It has been run by two (twin) brothers for about 40 years. It is the "old" style electronics store, with bin after bin of components, kits, tools and books. Yes, they have a good selection of vacuum tubes, as well as a free DIY tube tester. They have odd-size batteries, lamps, switches, and all the rest. They actually have a stock of twist-lock can electrolytics. (I have no connection with them, except that I have spent enough there that I should be a part-owner by now). Yes, they are expensive, but they have stuff that nobody else has. They are also great with kids' science projects - they have a rack of electric motors, gears, and will actually take the time to explain things (what a concept!).

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Date: Thu, 15 Nov 2007 15:25:54 -0600  
From: "Bill & Becky Marvin" <wmarvin@hickorytech.net>  
Subject: [R-390] A Few R390A Issues

Hello The restoring of my R390A nears completion I have a few issues that remain.

#1 The PTO won't stay zeroed. I put the dial on a calibration point then snug the "Dial Zero". Turn the PTO till I get a Zero Beat then totally

release the "Dial Zero". If I turn the PTO upward 10-20 KHz upward then tune the PTO downward the zero point has now change 10 KHz. The PTO has slop in that the when turning the VFO the Dial doesn't move with turning it. About a 1/5 of a turn slop.....is this typical?

#2 What are the wire colors that are attached to the Audio Level Meter?

Left Terminal Red/Wht      Right Terminal   ????  as viewed front panel.

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Date: Thu, 15 Nov 2007 16:39:43 -0500  
From: "Jim M." <jmiller1706@cfl.rr.com>  
Subject: RE: [R-390] A Few R390A Issues

#1 There is supposed to be a little spring across the two halves of the Oldham coupler (on the PTO shaft). If it is missing, there will be some play. Sometimes it gets lost when others have worked on the radio.

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Date: Thu, 15 Nov 2007 16:57:35 -0500  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: RE: [R-390] A Few R390A Issues

One fifth of a turn slop is not at all explainable by the Oldham coupler spring. It must be a loose clamp or gear between the knob and the counter. Or maybe the "Dial Zero" setting isn't totally releasing - a lot of old grease can cake up around there!

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Date: Thu, 15 Nov 2007 15:26:35 -0700  
From: "DW Holtman" <tubestuff@comcast.net>  
Subject: Re: [R-390] A Few R390A Issues

That is a lot of slop. The first thing I would check is the Non-Mar clamps on the Oldham coupler. There are two of them, one in each of the sides of the oldham coupler. Make sure they are not cracked or loose. Cracked clamps are very common. If your PTO is slipping internally that much, you have some serious PTO issues. <snip>

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Date: Fri, 16 Nov 2007 10:08:59 -0600  
From: "Bill & Becky Marvin" <wmarvin@hickorytech.net>  
Subject: RE: [R-390] A Few R390A Issues

I think the Dial Zero adjust is the problem. I only have a quarter turn CCW or CW adjustment right now. How do I release the DZ adjust without causing damage?

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Date: Fri, 16 Nov 2007 12:20:28 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] A Few R390A Issues Zero Adjust

You say you only have a 1/4 turn on the zero adjust shaft.

The knob has been jammed back against the bushing.

Remove the knob, move it out on the shaft.

The zero adjust should have about three turns or more.

The shaft is threaded and the panel bushing is a threaded nut inside.

The shaft screws in to apply pressure to the clutch release pins and open the clutch.

The shaft screws out to release the pressure and engage the clutch.

It is just like the clutch pedal on manual transmission vehicles.

The zero adjust should disengage until the disk on the zero adjust shaft is free of the clutch pins. This saves wear on all the parts, reduces friction, (wrist injury from dialing receivers all day is no joke, Its right there with finger injury from pounding mills) [mills are typewriters with no lower case]. {mills are not electric}.

Someone engaged your zero adjust until the knob skirt bound on the bushing.

If you have original knobs, the knob has a tab inside the skirt, On the midsize knobs the tab hits a knob stop. The knob stop is a special washer that goes between the panel bushing and the front panel. On the small knobs the tab stop hits a knob stop. There is one under the limiter knob as an example.

So the tab is in every knob. The zero adjust screws in. The tab runs over a corner of the hex bushing. It takes a bit of force. But the corners have been rounded off because this has happened often in the receivers life time. So getting the dial lock jammed is easy. Now the knob and shaft are locked with the angle of rotation limited to 60 or 120 degrees. More or less depending on clearance. You cannot just crank the knob CCW over the tight spot because the burr from forcing the knob CW forms a nice square corner. You get a ratchet effect.

You need to remove the knob and reset it.

The zero adjust shaft really sticks out when the dial lock is fully disengaged. So folks like to set the knob as close to the front panel as they can. Thus as the zero adjust is rotated CW to disengage the dial lock, The clutch just slips when the knob and shaft are screwed in to where the knob skirt smacks the panel bushing. A bit of file on the tab in the knob will let you get the knob a bit closer to the front panel and reduce how far the knob hangs out when the zero adjust is disengaged.

A good clean set up only needs about one turn of the zero adjust. One turn in with the knob against the clutch pins with enough force to let the clutch slip. One turn out with the knob leaves the knob hanging free of the front panel. The knob is looking good, while not looking like the knob is about to fall off the shaft. The zero adjust shaft disk is clear of the zero adjust clutch pins. You can spin the zero adjust out a couple more turns but it just leaves the shaft and knob sticking out.

Some times a chunk of rubber hose is cut as a washer to fit the zero adjust shaft between the disk and the bushing. Split the hose to slip it over the shaft without doing a whole front panel disassembly to get it installed. This washer then limits how far the zero adjust shaft can be screwed out. Now you want to look either down into or up into the receiver behind the front panel and check the zero adjust shaft

operation.

As you rotate the zero adjust knob on the front panel, the shaft screws through the front panel bushing. The inside end of the shaft has a large fender washer disk. This disk pushes three pins in the zero adjust clutch to release the clutch.

The test you want to conduct is to ensure that the disk comes free from the pins when the zero adjust knob is used to rotate the zero adjust shaft (CCW) to the dial unlock position.

If this test fails, some adjustment of the zero adjust knob on the shaft may be in order. Knob skirts will catch on the bushing and you cannot get enough turns on the zero adjust shaft to get a full clutch disengagement. The knob gets jammed against the bushing.

If this test passes then you need to go with Tim's input that the clutch is gummed up and slipping.....Or you have a broken loose clamp.

Turn the receiver up on end, get out the interrogation lights, get mean and go looking. When you turn the KC knob, The VFO shaft (Oldham coupler) and dial counter should both run in exact no slop relation with the KC knob. There are clamps, gears, and other things that can come loose in the mechanical links between the KC knob input and the two observable outputs. There is also a link to the many cams. The VFO is direct to the KC shaft. There should be no slip between the KC knob and the VFO.

Turn the receiver to CAL, BFO on and find a cal point at 100KHZ somewhere. As you rotate the KC knob the BFO pitch should change. No slop. No backlash. No binding. If you have a problem here, then you are looking for missing Oldham coupler spring, binding VFO, loose or broken clamps.

As you rotate the KC knob the dial counter should move. Gear clearance in the bevel gears can allow a small play. This can be adjusted to minimum.

If you have about a 90 degree (or less) of slop between the dial and the knob as you change the direction of knob rotation then you have a slipping zero adjust clutch. Mostly this is solved by cleaning the clutch, or adjusting the zero adjust shaft and knob to get it located properly.

In the last year, we are starting to have reports of broken rivets in the clutch assembly. These can be fixed. Parts are available if you need them. Mostly this problem just needs a good eyeball and understanding of how the mechanism is supposed to work. You may want to drop the front panel to do some of the cleaning and inspection. The term is drop the front panel, because the panel slips off the antenna shaft and two frequency select shafts to swing down on the wire harness. You pull the panel forward and it drops. There are a couple harness clamps on the chassis that need to be unbolted to help provide some extra harness slack. The IF shafts are best separated at the shaft couplers like you were going to remove the IF deck. I hope this helps. Roger AI4NI

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Date: Fri, 16 Nov 2007 12:41:37 -0500  
From: <jmiller1706@cfl.rr.com>  
Subject: RE: [R-390] A Few R390A Issues

Try removing the DZ knob and then loosening the bolt that holds the DZ shaft to the front panel. Loosen it enough that the DZ mechanism can be moved and twisted by hand. Look at how the DZ clamp interacts with the disk behind the front panel. A previous owner may have reinstalled the DZ incorrectly in the process of removing and replacing the front panel.

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Date: Fri, 16 Nov 2007 17:23:42 -0600  
From: "Bill & Becky Marvin" <wmarvin@hickorytech.net>  
Subject: Re: [R-390] A Few R390A Issues

Hi Jim Thanks for the info. I think I fighting two issues.....the DZ mechanism and the 1/5 turn slop before the digits rotate.....PTO is moving properly, reacts immediately I took the DZ parts off the front panel, reinstalled the knob and found the adjustment still 3/4 before the outer bushing starts to rotates.....rotates the same with hardware is in place?? Stripped????housing shaft? Put lubricant outside/inside bushings.....no change however tuning is easy with only a half turn of the DZ knob. The tuning play is about 1/5 Pto knob before the readout start.....left or right turn the same. DLk is off.. OH Coupler spring is in place (correct one?) I'll have to track the gears from the OH to the readout gears. This is fun.....thanks to all with solutions provided.

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Date: Sat, 17 Nov 2007 18:22:26 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: [R-390] Oldham Coupler Idea

I was just looking at the three Oldham coupler pieces and the effect that the antibacklash spring has on them. The single spring has a tendency to put the two shafts into shear which would seem to create an unnecessary radial load on both shafts. The gears on the RF module have two springs. Why didn't the coupler designer add a second set of pins for a second spring? I was thinking of adding a second set of springs myself. Any thoughts on this?

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Date: Sat, 17 Nov 2007 19:09:27 -0800 (PST)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] Oldham Coupler Idea

That does not need to be done.

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Date: Sat, 17 Nov 2007 22:54:09 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: Re: [R-390] Oldham Coupler Idea

Is there a likelihood that this will degrade backlash or is there something else that I'm missing here?

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Date: Sat, 17 Nov 2007 23:09:31 -0500  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] Oldham Coupler Idea

With a normally functioning PTO the Oldham coupler works just fine. There's not a lot of torque involved. The spurious loads on the shaft(s) are quite small. There are other things in the drive train that I would worry about ahead of that coupler.

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Date: Sat, 17 Nov 2007 20:10:48 -0800 (PST)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] Oldham Coupler Idea

It likely will have no effect on anything. Like Roger said, backlash is a function of friction, properly maintained that coupler should give no problems. If you want to improve its operation the best move would be to take out any mis-alignment by shimming the PTO mounts so that the shafts are as close to parallel as possible, then the Oldham coupler is basically out of the equation as it's only function is to make up for sloppiness in the shaft alignment. Backlash isn't a problem there as much as binding is. Even if the coupler sections are excessively worn the spring will take out any backlash IF there is no friction on the PTO shaft. Don't forget to loosen the bushing on the front panel, under the KC CHANGE knob, it should be only snug.

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Date: Sun, 18 Nov 2007 13:04:01 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Oldham Coupler Idea

On most receivers the shaft alignment is very good. The shafts and coupler have more than enough mechanical stiffness. With the original specified spring, the spring provided enough tension to keep the coupler parts "lashed" together to remove slop but not so much tension as to deform the shafts. In mechanical assemblies, the order in which retainers are tightened often have a big effect on the final alignment. You may want to consider "resetting" your VFO if you feel yours is too far out of alignment. If that work still leaves your VFO with more offset in the coupler than you would like, you can start to file mounting holes to get more freedom and range of adjustment. You should be able to reset the VFO to remove all angle off set so the coupler faces set flat to each other.

Most couplers are die cast and the face of each side is not real square to the bore. This is an effect of cooling casting or not an exact drill press to jig alignment during manufacturing. It is close enough for government work. Live with this. Some times flopping one coupler side around 180 degree will get a better fit. You get the error in each side to complement for a best fit.

There is some shaft to shaft offset.  
You can adjust out the side to side offset.

If the off set is from the VFO setting to close to the chassis it can be shimmed to

remove the off set. If the VFO sets to high, you will likely have to live with that offset or do a major overhaul of the front box assembly to can front plate on the VFO to adjust the offset. Mostly life is good enough and we just live with it as is. That coupler with one spring will compensate for the range of offset.

I hope this provides enough depth to help you get your receiver into a mechanical condition you can live with without modifying your coupler.

Once you get the alignment correct, more springs just are not needed. The coupler becomes a method to effect module disassembly and repair, as opposed to a device to compensate for poor part fabrication.

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Date: Sun, 18 Nov 2007 13:32:01 -0500  
From: "Jim M." <jmiller1706@cfl.rr.com>  
Subject: RE: [R-390] Oldham Coupler Idea

In case it hasn't been said, the surfaces of the coupler should NOT be snug tight. There should be about 1/32 spacing between the surfaces according to the technical manual I have. If they touch or are too tight, the pressure on the PTO shaft can cause instability and warble (in CW signals) when tuning. The coupler disc should be able to move freely. I think the whole purpose of the coupler is to accommodate slight misalignments between the PTO shaft and the main tuning shaft, which are inevitable.

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Date: Sun, 18 Nov 2007 17:31:55 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Oldham Coupler Idea

I think Nolan is another fellow with far to much time on his hands. He for sure would have gotten the KC shaft and VFO shaft into alignment no matter how many time he had to pull the VFO and readjust the parts until the VFO module shaft set into alignment with the KC shaft. He would certainly have gotten the KC shaft to run true. If he thought the end of a VFO shaft was bent he would have gotten it straight. Someday I would like to have the skills Dave Medley, Nolan and Rick have developed. And they are not the only fellows I aspire to be as skilled and knowledgeable as.

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Date: Wed, 21 Nov 2007 21:47:57 -0800  
From: "Chris Kepus" <ckepus@comcast.net>  
Subject: [R-390] Cosmos PTO for 390A - newbie - Help requested

This is a bit long but I would really appreciate your taking a look. I have to operate on a PTO, I believe, and this is the first one I've put a hand on.....yep....I haven't taken one apart...yet.

I just picked up a Cosmos PTO that is intended as a spare for my R-390A. I have a Collins built R-390A but I am unwilling to pull anything out of it at this time. It is working quite well. I got the Cosmos because I like the fact that Cosmos came up with a PTO design that didn't require tinkering with a corrector stack in order to



adjust linearity. Others have pointed out that repairing and calibrating the Cosmos (or any PTO) isn't for the faint of heart, but it can be done. (I know, fools rush in..) And, as I have read in the archives about the repairs that have been done by you all, you "git it done"!

Back to my Cosmos. Although the seller said it was dusty (it is), he didn't say the outer cover of the PTO had numerous scratches suggesting a rather "rough" storage environment. Nonetheless, the fragile elements on top of the output transformer are in good shape with no observable damage... It is also evident that someone had pulled the external cover since only one of the screws had the accompanying lock washer. And the heater and/or thermostat was possibly removed. The screws that retain the inner cover are missing. Is it possible to remove the heater without unsoldering any of the leads? The 11-856A Tech Manual talks about unsoldering the thermostat leads when replacing it but nothing else except a warning about not removing the inner cover. The heater or thermostat wires did not look as they had been unsoldered although under a magnifying glass, it is possible a resoldering job was done that was equal to the original. One of my heater leads crosses behind the inner cover and has what appears to be shrink wrap over about an inch where it is routed across the rear of the inner cover assembly (could they have been cut at the top?). I have posted a number of photos at <http://www.flickr.com/photos/w7jpg/>. When you click on a photo, it gets larger. Just above the picture on the top left side is a small "All Sizes" and magnifying glass icon. Click on that for yet another enlargement.

How should the PTO shaft feel when rotated by finger power? I expected low resistance and a smooth feeling rotation. Mine is quite stiff and when rotated, has an odd feeling, similar to rotating a shaft with "soft" detents...kinda lumpy and not smooth at all.

Is there a manual that shows how to disassemble the PTO (and other modules) in detail? My 11-856A Tech Manual doesn't except. Can someone tell me what's necessary to remove the heater and insulation? It sounds like the thermostat leads may have to be unsoldered but I hate to unsolder something if it's not necessary. Once past that, I can pull the inner cover and take photos of the innards. And, Miller's article on "A JOURNEY THROUGH THE COSMOS (PTO)" should be very helpful. Hopefully, I won't find an exploded dessicant pack or rusted out assemblies.

I am encouraged by the writing on this list and the articles on R390.com and elsewhere by authors like John Harvie, J Miller Dallas Lankford, and Tom Marcotte. There doesn't seem to be many conditions that cannot be repaired. Is there anything I mentioned or that you see in the photos that causes you experienced folks to be concerned to the point that I should perhaps have a discussion with the seller before proceeding further? The PTO was described as "pulled from a working unit" by the seller (no, it's not Martyn! <g>) in response to my question about where it came from. Otherwise, it's time for me to get my feet wet.

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Date: Thu, 22 Nov 2007 10:59:56 -0500  
From: Bob Camp <ham@cq.nu>

Subject: Re: [R-390] Cosmos PTO for 390A - newbie - Help requested

There may be some magical twist / turn / tug / bend combination that gets the cover off without unsoldering the leads. The simple answer is to unsolder them. You certainly do not want them to break while you are working on the rest of the unit.

Electrically all of the PTO's are basically the same. Mechanically they can be very different. There were pictures of the insides of a Cosmos up on the net a few years back. There also were basic instructions on working with the corrector on them. The PTO was replaced as a unit by the military when it went out. If they re-did correctors it was at some kind of 9th level depot. I don't think you will find a lot of PTO alignment stuff in the TM's. The Cosmos PTO's exist mostly because of large replacement orders placed after the radios were in service.

The PTO should turn under finger pressure. How easy / hard depends on a lot of things. In an older unit, you probably have a lot of caked up grease inside everything. Once you get that out it should smooth out some.

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Date: Thu, 22 Nov 2007 13:12:14 -0500

From: "Jim M." <jmiller1706@cfl.rr.com>

Subject: RE: [R-390] Cosmos PTO for 390A - newbie - Help requested

The PTO shaft passes from the inside to the front outside through a bearing assembly. This can collect dried out grease. A drop or two of light weight oil may loosen it up a bit. The "soft detent" feel may be the effect of the corrector screws (on the corrector disk) rubbing against the spring loaded slug of the corrector coil (which it should). You probably won't feel this when the unit is installed and you tune from the front panel knob. I cleaned my PTO by removing the shaft entirely and cleaning out the dried grease. BUT---Be careful if you remove the shaft. The corrector disk position relative to the unit is critical. Also if the unit was ever tuned beyond its range, or there was excessive pressure on the shaft, the corrector disk can come loose... it is spot welded to the shaft internally. If you can get relatively good end point alignment, then the calibration should be acceptable between end points. Unless it is excessively off, I wouldn't mess with the screws. I was a perfectionist with mine, tweaking each screw against an accurate signal source every 10-20 khz...but it was literally an all-weekend job. What's worse is that the screws tend to interact. Tweak one and the calibration either side of it may get pulled off slightly. Be happy if you are within a few khz across the band. That's why they included the dial zero adjust - to correct for inaccuracies. You can get better, but be prepared for a long time of tweaking. Good luck. Jim N4BE

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Date: Thu, 22 Nov 2007 23:55:21 -0500

From: Jon Schlegel <ews265@rochester.rr.com>

Subject: Re: [R-390] PTO Connector

The one I got from Fair came from the link below. I still have it (a Progresstron) and installed a new power connector I found here in the junk bin to replace the smashed connector that came with the unit. Inside, the PTO looks physically perfect. How similar a unit you might get from Fair is anybody's guess. I have yet to actually try it but I initially suspected it was removed from service because of

excessive backlash. If you put the Oldham coupler plate on and turned the shaft, you could see it spring backwards a little upon letting go. Since talking with Bob Camp in some depth I find out that many of these PTOs had problems with endpoint adjustment and now I have to consider that as a possible reason as to why it was pulled. I'll know more when I get the radio up and running. Endpoints will probably be the first thing I scrutinize...

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Date: Thu, 29 Nov 2007 15:24:54 -0600  
From: "Bill & Becky Marvin" <wmarvin@hickorytech.net>  
Subject: [R-390] Dial Zero Adjustment (cont)

About a week ago I wrote about the DZ problem, jammed adj.....little or no clutch release..... high amount of backlash. I dropped the front down and removed the DZ assembly from the panel. The inner shaft was jammed inside the outer bushing. I soaked the shaft- bushing in mineral spirits overnight..... the assembly then unjammed and turned in and out freely. Spent sometime lubricating a gears,cams, guides etc. The VFO now tunes with one finger..... very very smooth. PROBLEM After reassembly, the DZ still doesn't retract (CCW) enough outward to fully release! Does the clutch have an adjustment to move the gear back away from the panel (Finger Plate). The Fender plate is retracted outward maximum???

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Date: Fri, 30 Nov 2007 13:28:46 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Dial Zero Adjustment (cont)

There should be plenty of clearance between the plate on the end of the zero adjust shaft and the pins on the clutch assembly. The zero adjust bushing in the front panel should be assembled with the nut of the bushing to the outside of the front panel. Your bushing may be in backwards. The clutch gear assembly meshes with many other items in the gear train. It is not likely that the assembly is moved forward and is out of line with the rest of the assembly.

Is your zero adjust disk on the end of the shaft about 1/8 inch thick. About the same thickness as a gear in the gear train? The disk may be a replacement thing and make from some metal that's too thick. The shaft should screw back into the front panel bushing until the disk comes flush against the bushing. Most of that bushing goes on the outside of the front panel and under the knob.

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Date: Fri, 11 Jan 2008 12:53:40 -0800 (PST)  
From: Michael OBrien <mikobrien@yahoo.com>  
Subject: [R-390] PTO setup ?

I have 2 R-390A with their PTO's removed and need to know what is the best way to set them up with PTO's both mechanically and electrically. Also I am missing the springs for the couplings . Do I need them and where would I find them

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Date: Fri, 11 Jan 2008 19:31:47 -0500  
From: Bob Camp <ham@cq.nu>  
Subject: Re: [R-390] PTO setup ?

The spring is pretty easy to replace. A spring from a ball point pen is a bit more than you need, but it works. Are you missing PTO's - as in you need to buy a pair? I assume they are simply out of the radio. 1) Get the PTO on the same frequency as the radio. A frequency counter is a good thing here. 2) Drop the PTO in and line up the axis of the PTO with the tuning shaft in the radio as best you can 3) Put in the coupler and spring 4) Check to be sure the coupler is a bit loose (not binding) 5) Tighten down the screws 6) Re check everything

That should do it

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Date: Sat, 12 Jan 2008 04:59:20 -0800 (PST)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] PTO setup ?

If you don't have a freq counter you can listen for the PTO signal on another receiver. The signal should be at 3455 kcs when the dial is at 000 and should decrease to 2455 as you tune up. Align your dial at 000, with the PTO uncoupled listen for it at 3455, then couple it up.

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Date: Mon, 14 Jan 2008 21:40:10 -0600  
From: "Bill & Becky Marvin" <wmarvin@hickorytech.net>  
Subject: [R-390] R390A Local Gain Pot (R105)

Having taken the front panel down numerous times I find the lower Pot(s) (RF & AF) wires are breaking. I fixed the RF Gain wiring but the AF Gain wiring is causing problems. They are:

The Y2K wiring shows Pin 1 Wht/Blk - Wht/Blk  
Pin 2 Wht?  
Pin 3 (3) Whts-Shields

My question is this.....I have a Red/Wht wire, not Wht for Pin2. Both the Y2k Manual, R390A Service show Wht for Pin 2 (R105) perhaps a Typo?? Is Pin 1 away from the bottom edge? My Unit is a "55" Collins.

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Date: Tue, 15 Jan 2008 07:28:55 -0500  
From: Steve Hobensack <stevehobensack@hotmail.com>  
Subject: RE: [R-390] 75A4 PTO Repair

Look for a shorted screen capacitor.

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Date: Fri, 18 Jan 2008 08:34:40 -0700  
From: "DW Holtman" <tubestuff@comcast.net>  
Subject: [R-390] PTO Plug

I'm in the process of swapping out a broken plug on a PTO. The good one is still attached to a parts PTO so it gives no clue as to its removal. How does the plug come apart? After removing the screws for the metal cable clamps, the blue plastic parts seem to be glued together. Does it unscrew? Don't want to force anything.

Has anyone replaced this before?

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Date: Fri, 18 Jan 2008 10:55:20 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: Re: [R-390] PTO Plug

Yes, the blue shell unscrews from the connector. The first step is removing the clamps as you have already done. Carefully hold the connector and unscrew the shell. It's a standard right hand thread. Be very careful of the pins. They are exceedingly brittle and if become bent will likely break when you try to straighten them. Insert the pins in a stiff piece of foam or perhaps the mating connector to protect the pins while you work. If the shell does not unscrew, try tapping the the shell very lightly with a light screwdriver handle or such. TLC is most important when handling these connectors.

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Date: Thu, 14 Feb 2008 16:40:03 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: [R-390] Cosmos PTO - No Teflon Disk???

Just opened a Cosmos PTO expecting to find a Teflon disk as described in "Calibration of the COSMOS PTO" by Tom Marcotte, N5OFF at [http://www.r390a.com/html/n5off\\_pto.html](http://www.r390a.com/html/n5off_pto.html). I found no Teflon disk inside. Is the disk really missing or is Tom using the idea as a visualization technique? I see that the slug driven by the cam follower is itself screwdriver-adjustable. Among other things, no doubt, I can see that this slug's baseline adjustment would affect the sensitivity of the linearization adjustments. Is there any accepted procedure for the baseline adjustment of this slug? Also, the "varnish" on the main coil shows signs of breakdown due to either due to mild corrosion or perhaps some sort of fungus among us. About 1/8 of the surface of the coil is affected. Should I attempt to clean/re-coat it or just leave it alone. If re-coat, then with what? This Cosmos unit is mechanically kind of on the edge - some worn surfaces, bugged screw heads, even a bent 370 uuF mounting stud - but probably salvageable.

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Date: Thu, 14 Feb 2008 16:22:02 -0700  
From: "Tony Casorso" <canthony15@msn.com>  
Subject: Re: [R-390] Cosmos PTO - No Teflon Disk???

Check out this one. Lots of pictures of the deep innards.  
<http://www.r-390.com/cosmos.htm>

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Date: Thu, 14 Feb 2008 20:24:11 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: Re: [R-390] Cosmos PTO - No Teflon Disk???

That pretty much lays it all out.

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Date: Fri, 15 Feb 2008 09:23:07 -0600  
From: "Les Locklear" <leslocklear@cableone.net>  
Subject: Re: [R-390] Cosmos PTO - No Teflon Disk???

Some of the earlier Cosmos PTO's did not have the teflon disk.

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Date: Fri, 15 Feb 2008 10:33:51 -0500  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: Re: [R-390] Cosmos PTO - No Teflon Disk???

If that's the case, I might consider cutting and installing a disk myself. The little spring steel cam follower is showing wear and the edges of the adjustment screws are rather sharp.

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Date: Wed, 18 Jun 2008 20:30:17 -0700 (PDT)  
From: C E <catman351@yahoo.com>  
Subject: [Collins] R390A Oldham coupler assembly dimensions wanted

Can anyone provide the dimensions of the Oldham coupler assembly for the R-390A PTO? I'm considering making/sourcing a new set of these units. I need the shaft distances, the diameter of the middle plate and the two end plates, and the thickness of the middle plate. Thanks. Cal, n6KYR

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Date: Thu, 19 Jun 2008 09:06:12 -0600  
From: "Dr. Gerald N. Johnson" <geraldj@storm.weather.net> (from Collins listserv)  
Subject: Re: [Collins] R390A Oldham coupler assembly dimensions wanted

The drawings for those parts are sure to be in the drawing set that was available on CD-ROM a few years ago. I have one, it will take some searching on another computer after I find the CD-ROM. But first I have over a million soybean seed to plant today.

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Date: Thu, 19 Jun 2008 05:27:58 -0600  
From: "DW Holtman" <tubestuff@comcast.net>  
Subject: Re: [Collins] R390A Oldham coupler assembly dimensions wanted

As far as sourcing goes, McMaster-Carr sells a line of Oldham couplers. They are not identical, but will work to couple a PTO. Type oldham coupler in their search engine. <http://www.mcmaster.com/>

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Date: Thu, 19 Jun 2008 18:39:54 -0600  
From: "Dr. Gerald N. Johnson" <geraldj@storm.weather.net>  
Subject: Re: [Collins] R390A Oldham coupler assembly dimensions wanted

Its entirely possible that the original Oldham coupling was a purchased assembly, not made by Collins or the other 390A vendors. Looking through the selection of couplings in the McMaster-Carr catalog I wondered if maybe a bellows coupling would have been used had it been an option when the 390A was designed. It would have required a larger gap between the shaft ends than the Oldham coupling though. I don't know of any reason that could not have been accomplished simply by shortening the two shafts and leaving a bit more room in that area of the gear train.

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Date: Thu, 19 Jun 2008 19:10:19 -0600  
From: "DW Holtman" <tubestuff@comcast.net>  
Subject: Re: [Collins] R390A Oldham coupler assembly dimensions wanted

Isn't a bellows coupler used on the BFO linkage?

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Date: Fri, 20 Jun 2008 11:36:06 -0600  
From: "Dr. Gerald N. Johnson" <geraldj@storm.weather.net>  
Subject: RE: [Collins] R390A Oldham coupler assembly dimensions wanted

Being that I approach being an old ham, (licensed nearly 53 years) I'd consider an Oldham coupler in some situations, but those situations would require both shafts to be anchored axially so the center disk of the coupler invented by some one named Oldham would be kept in place. For my projects, I might tend to think of a Millen (if I had a sufficient supply in my parts collection) molded insulated flexible coupling or a WW2 surplus ceramic insulated coupling from a BC-375 tuning unit. or if all I needed was shaft extension I might use a simple brass shaft coupler and take care to line up the shafts. The beauty of an Oldham coupler is that it smoothly takes care of shafts that are nearly parallel and not quite aligned. It allows for offset and a little bend. If my supply permitted and the transmitted torque admitted, I might even use an Oldham coupling in my parts collection with a nylon center washer. Providing the shafts had constraint so they couldn't slide apart and I thought the nylon insulator could handle the applied voltage.

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Date: Fri, 20 Jun 2008 12:12:35 -0600  
From: "Dr. Gerald N. Johnson" <g369n849j@weather.net>  
Subject: [Collins] R390A Oldham coupler assembly dimensions wanted]

> It is fairly complex. I've found it in the drawings. The coupler is spring  
> loaded with a little spring having square hooks.  
>  
> These parts:  
> SM-B-178481 spring.  
> SM-B-178491 insulator (3/16" i.d., 1/4" o.d. cemented to PTO shaft)  
> SM-C-178492 Guide. This is the center washer. 1-3/32" O.D. I didn't  
> note the thickness. One groove is square, one is tapered at 30 degrees.  
> SM-B-178665 Coupler assembly. Two parts, mounted to shafts with servo  
> clamps (SM-B-178414 plus screws and nuts). One with square (though  
> beveled) bar, one with tapered bar. Made of SM-C-178666 plates and SM-  
> B-343637 pins.  
>  
> This CD-ROM has its own drawing formats, that it won't convert to  
> anything known by other programs. Its all scanned drawings, sometimes  
> tough to read. It allows printing but I don't have a working printer at  
> the moment. I wonder how many R-390A have the coupler loading spring.

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Date: Thu, 23 Oct 2008 22:50:18 +1000  
From: "Pete Williams" <jupete@bigpond.net.au>

Subject: [R-390] Collins PTO Linearity adjust

G'Day List...having rejuvenated a couple of Collins 70-H2 PTO's, is there info available as to how best adjust the internal cams for linearity.? I have read Ray Osterwalds comments ex past issue of ER but this only addresses the 100kHz -one turn of the shaft-calibration points. It would seem to be laborious process to adjust these cams as there are in excess of 60 for the complete travel of the core, although, they are not all required for adjustment for the 1 mHz range . How the factory did it is one thing-- how one might do it now is another... My preliminary excursion into this finesse appears to show that adjusting at the 100kHz points seems to take reasonable care of what's in between, bit I'm sure there was a bit more to it, albeit labor intensive . A bit more light on this would be appreciated.

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Date: Thu, 23 Oct 2008 09:27:39 -0400  
From: ews265 <ews265@rochester.rr.com>  
Subject: Re: [R-390] Collins PTO Linearity adjust

I've pondered the same issues. Came to the conclusion that for the kind of mechanical resetability needed to make the job manageable a stepping motor was needed. Granted a complex solution but the most exact arrangement I could come up with. To that end I've got all the mechanics of a fixture built; PTO mount, stepper, driver, etc. It's very solid and should work well. I've yet to write the software to run everything so I can't offer direct help now but throw the idea out to you or anyone interested.

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Date: Fri, 24 Oct 2008 14:43:43 -0700 (PDT)  
From: "Drew P." <drewraille807@yahoo.com>  
Subject: [R-390] Re: PTO

My version goes something like this:

1. Remove linearizing cam assembly (also known in R-390speak as a "corrector stack"), stash in a safe location and replace with an appropriately-dimensioned straight bar.
2. Using fancy fixture or even just the radio, record PTO frequency for each 90 degrees (corresponding to 25 Kc points) of rotation.
3. Enter recorded data into computer program which spits out G-code which is then loaded into CNC machining center. CNC mills a bar having the required correction contour for entire frequency range of PTO.
4. Replace just-installed straight bar in PTO with contoured bar and enjoy new found linearity.

I'll do all this in another lifetime, perhaps. Note that if one uses an aftermarket DRO (EDRO, not the radio's stock MDRO) to display frequency, all this linearizing becomes moot.

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Date: Sat, 25 Oct 2008 12:18:16 +1000  
From: "Bernard nicholson " <vk2abn@bigpond.net.au>  
Subject: [R-390] Re: PTO

Re PTO linearity . Guday Pete & List , I think how it would have been done in the Collins factory - They would have used a Dummy PTO Cover with holes strategically placed to make the adjustments , This way the capacity of the cover would be taken into account, So one needs to find a tin can at the supermarket that's the same dia ,That would be my approach to the problem !

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Date: Fri, 28 Nov 2008 19:21:12 -0500  
From: Roy Morgan <k1lky@earthlink.net>  
Subject: Re: [R-390] new guy

Yes. And there is a very uncommon and little documented condition whose sufferers may be members of a group known variously as:

- The Knights of the R-389 PTO
- The 70H-1 Society
- The 70H-1 Reclamation and Memorial Society and Support Group
- The Ancient and Honorable Society of the 50 Turns

To explain somewhat:

The R-389 is the VLF version of the R-390 family of radios. It has some parts in common with the R-390/URR (which is sometimes known as "The Non-A"). One of the unique parts in the R-389 is the type 70H-1 PTO, and the drive system that it lives behind. The PTO operates over FIFTY turns, not ten as in most other main tuning PTO's designed by Collins. It has a unique frequency coverage, and a unique corrector stack mechanism. The drive system involves a main manual tuning knob with a friction clutch built into it, and an electric tuning motor operated by a toggle switch on the front panel. It appears that there is a great possibility of seriously damaging the PTO under certain circumstances.

There are at least two of us who have hopelessly damaged PTO's in otherwise would-be-working R-389's. This would not be a problem except that 70H-1's are essentially unobtainable. I know of only two that were offered for sale in the last 10 or more years. One was auctioned from Greece on ebay some years ago. It turned out to be munched. The second one I know of having been offered for sale was on ebay just recently, and the auction was ended prematurely by the seller. Sooo... if you think you should belong to the above named societies, do let me know. Roy

Roy Morgan k1lky@earthlink.net  
529 Cobb St. Groton NY, 13073

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Date: Fri, 6 Mar 2009 17:44:46 -0800 (PST)  
From: wli <wli98122@yahoo.com>  
Subject: Re: [R-390] setting the PTO endpoints (long)

Over the last 10 years, there have been many posts about the PTO. Half dealt with the non-linear PTO, which is clearly a challenging and time-consuming task. The others have been more elementary: dealing with setting end-points. Chuck Rippel correctly points out that setting the endpoints is probably the most important thing to do to get these receivers functioning as they were designed to operate. Recently, I set the endpoints in my 62 Capehart PTO. What follows depends on using a counter, and avoids dropping the front panel. The Y2K, Navy, and Army manuals use a different approach that does not require a counter, but I felt that approach was too cumbersome. Furthermore, they drop the front panel in their method. I used the wisdom contained in previous postings to this list to try to get everything everyone said on one piece of paper. There were valuable tips contributed by all. To that end, I documented each step in my task... trying not to forget anything or goof it up. I managed to get my PTO to cover 1000.2KC over exactly 10 turns, so I was happy.

So here is how I did it: <SNIP>

SEE REVISED METHOD ON NEXT PAGES

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Date: Tue, 10 Mar 2009 12:06:46 -0700  
From: David Wise <David\_Wise@Phoenix.com>  
Subject: Re: [R-390] setting the PTO endpoints (long)

I adjusted my endpoints with the PTO in the radio. I only removed it to remove the endpoint cover nut; then I reinstalled it. The key is a sawed-off diddle stick. Plastic with metal screwdriver tip. Short enough to finagle into position, long enough to grip between the fingertips. It just barely fits, but it's SO much easier. I'll measure it and report back.

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Date: Tue, 10 Mar 2009 17:27:03 EDT  
From: DJED1@aol.com  
Subject: Re: [R-390] setting the PTO endpoints (long)

Yep, adjustments can be done with the PTO in the radio. As noted, I removed the PTO to take out the nut which covers the adjusting screw, then used a cut down jewelers screwdriver to do the adjustment. I even went one better and did all 42 adjustments on a Cosmos with the PTO in the radio. In that case, adjustment was unmanageable while pulling the PTO out, as I was trying to get resettability to 100 cycles or so. It was a case of doing it in the radio or making a special test fixture. But it was an undertaking, using a small mirror to see where the slot was on each adjusting screw. By the time I got done, I swore I would do whatever it took to build a test fixture next time. Ed

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Date: Tue, 10 Mar 2009 15:18:17 -0700  
From: David Wise <David\_Wise@Phoenix.com>  
Subject: Re: [R-390] setting the PTO endpoints (long)

So you can even do Cosmos linearity in the radio, though it's hard. How about a frame to suspend it a foot or so off the floor, and you go in on a mechanic's

creeper? Of course the consequences are dire if the frame isn't solid... Were you able to use the same tool for linearity and endpoint? I seem to remember that Cosmos used more than one screw-head type.

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Date: Wed, 11 Mar 2009 08:15:49 -0700 (PDT)  
From: wli <wli98122@yahoo.com>  
Subject: Re: [R-390] revised PTO endpoint adjustment (long)

Hi. Have revised the previous post thanks to the comments received. Here is version 2.0

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PTO End-point adjustment by W. Li v2.0

1. From top of receiver, disconnect mini-BNC plug P217 and drop it thru the chassis hole to the bottom side. This coax carries the PTO output.
2. Disconnect P116 mini-coax from rear panel
3. Remove J116 from rear panel
4. Tune the MC dial to 7MC (I did this in anticipation of further RF work)
5. Tune the KC dial up to (+) 000
6. Turn receiver over so it is up-side-down on the bench
7. Remove Oldham spring using a fine forceps clamp (may have to rotate the KC dial a few degrees so that you can get at both ends of the Oldham spring). Tie a string on the spring before it flies off.
8. Do not touch the KC dial again until step 28. Consider locking it.
9. Remove both stainless steel 6-32 screws off of the trapezoidal metal support bracket on the back of the PTO. This support secures the rear of the PTO to the chassis. Do not disturb the single green captive screw.
10. Loosen both front green 8-32 captive screws. The entire PTO subchassis should now be free to slide aft.
11. Wiggle the PTO subchassis and slide it aft about an inch to free it from the KC shaft. The Oldham coupler will come apart and the center disc will fall free... save it. You now have one Oldham disc attached to the KC shaft, and the other Oldham disc attached to the PTO shaft, and the middle one loose somewhere.
- 12.. Tilt PTO chassis upwards 45 degrees. Rest it on small plywood shelf so the rear bracket sits down in its compartment, and the front rests up on the chassis cable loom. This exposes the front of the PTO . Note: the cable in the back with the blue plug carries power to the PTO and is left attached.

13. Use J116 to adapt the PTO's mini-BNC to a standard BNC jack.
14. Hook up your frequency counter to J116 using a short BNC cable
15. On the front face of the PTO, remove the large hexagonal adjusting screw cover behind Z702. This cover screw has a very shallow thread, and comes out in 2 turns. Store it with the small Oldham spring for later.
16. Plug in the receiver and counter and allow an hour or longer to warm up and stabilize the electronics.
17. Using your hand, slowly twist the Oldham disc on the PTO shaft until the counter reads exactly 2455. Look at the counter to figure out which way to turn. Note: the PTO has its own stop, which can be easily damaged. GO SLOW.
18. Using the Oldham spring post as a point of reference, mark the front PTO plate with a pencil as your start point.
19. Now manually rotate the Oldham disc on the PTO shaft exactly ten turns. Watch the counter readout rise as you turn. Stop at exactly ten turns lining up the spring post with your pencil mark. The counter now reads something fairly close to 3455KC.
20. Without any further rotation of the PTO, turn the tiny PTO adjusting screw with a fine screwdriver until the counter reads exactly 3455KC.
21. Go back about ten turns, stopping when the counter reads exactly 2455KC..
22. Chances are your start point will not align with the spring post, so erase the old pencil mark and make a new one. Changing one end-point alters the other.
23. Now hand rotate the PTO shaft exactly 10 turns the other way and see how close you end up to 3455KC. Chances are you will be off a bit.
24. Readjust the PTO adjusting screw again, so that the counter reads exactly 3455KC
25. Repeat steps 21-24 as often as necessary until 10 turns gets you from precisely 2455KC to 3455KC.(this took me 6 cycles of fooling around). Note all the PTO adjusting screw tuning is at the 3455KC end. All you do at the 2455KC end is redraw your pencil mark.
26. OK, now the PTO has the correct frequency range of 1000KC in exactly ten turns of the PTO shaft
28. Be sure the KC dial is unlocked. Gently turn the KC dial down as far as it will go until it is stopped by the 10-turn stop. The Veeder-Root should now read between -963 and -972. If it does not, adjust the ten-turn stop until it does (another issue entirely).

29. Rotate the PTO until the counter reads exactly 3455KC
30. Rotate the KC dial up a few turns until the Veeder-Root reads exactly (-) 000, and lock it in place.
31. Stick the middle Oldham coupler disc to its mate on the PTO shaft with a blob of grease.
32. Replace the large cover screw you took off in step 15.
33. Now loosen the Bristo screw clamp nearest the KC dial, so that the Oldham coupler nearest the front may rotate on the KC dial shaft to mate precisely with the Oldham coupler disk of the PTO shaft. Since the KC dial is locked, only the Oldham disc and its clamp will rotate. Take great care NOT to rotate the PTO shaft. You can tell if you do inadvertently rotate it, because the counter will show a change in frequency.

In some cases, there is no room to access the Bristo clamp on the KC shaft. Plan B is to loosen the Bristo clamp on the PTO shaft, so that it can rotate to mate with the other Oldham disc. Here again, you must not allow the PTO shaft to rotate whilst you fiddle with the Oldham disc. There is no way to lock the PTO shaft, so great care must be taken not to move it. Again the counter will detect any rotation of the PTO shaft at this time.

34. Now you can slide the entire PTO subchassis forward to mechanically re-engage the Oldham coupler..... this step is to mechanically synchronize the PTO to the rest of the RF gear train. This will require minute fiddling of the now loose Oldham coupler disc as the fit is very close. Take your time in getting all the Oldham discs to mate.

35. Loosely start both 8-32 green screws in, to stabilize the PTO chassis

36. Now that the coupler is together, both the PTO shaft and the KC dial shaft will rotate together. The KC dial is at (-)000 and the counter shows 3455KC.

37. Unlock the KC dial now.

38. Rotate the KC dial up slowly and gently until the spring posts are accessible for you to replace the Oldham spring. Note that the PTO shaft will also rotate the same amount since the coupler is now mechanically engaged.

39. Wiggle the PTO such that both PTO and dial shafts line up, and so that there is a small gap visible between the Oldham coupler discs. At this point, if things are tight, you can gain an extra mm by loosening the single rear green screw.

40. Tighten the Bristo spline clamp on the shaft of the KC dial

41. Secure things by tightening down both front green screws, and reinstalling both

rear deck 6-32 screws.

42. Now that the PTO is physically secured, do a final electrical check on the PTO with the counter. Turn the KC dial to (-)000. The counter should read exactly 3455KC. Now run the KC dial up to (+)000. The counter should read exactly 2455KC. This is the whole reason for setting the PTO endpoints.

43. If you can not get exactly 1000KC in ten turns, go back and redo things until you can.

44. Disconnect the counter, and restore the mini-coax interconnections.

45. Final check: tune in WWV, it should come in exactly at 5MC, 10MC etc

46. You are done

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Date: Wed, 11 Mar 2009 08:49:49 -0700 (PDT)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] revised PTO endpoint adjustment (long)

Good procedure. I just wanted to add that if you do not have a frequency counter, you can "listen" to the PTO on a calibrated HF receiver by listening to the 2455 and 3455 signals, either with BFO on or SSB mode.

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Date: Wed, 11 Mar 2009 12:16:28 -0400  
From: "Tim Shoppa" <tshoppa@wmata.com>  
Subject: Re: [R-390] setting the PTO endpoints (long)

Every PTO I've ever met needed a turn or two removed from the endpoint adjusting coil. Maybe I'm being overly pessimistic but I thought that simple aging of the PTO pretty much guaranteed that any PTO would require this turn-sectomy.

HSN's #45 and #46 addressed the subject quite thoroughly.

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Date: Wed, 11 Mar 2009 12:27:56 -0400  
From: Barry <n4buq@knology.net>  
Subject: Re: [R-390] setting the PTO endpoints (long)

Of the two R390As I rebuilt, neither needed this. Guess I was just lucky.

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Date: Wed, 11 Mar 2009 10:07:50 -0700  
From: David Wise <David\_Wise@Phoenix.com>  
Subject: Re: [R-390] setting the PTO endpoints (long)

My cut-down diddle stick is 3-1/4".

"Mechanic's creeper"... Need to warm up brain before engaging mouth. Turn the set over, duh. But it's still hard to see, and if your eyes can't handle the mirror and close quarters, then you have little choice but to remove the PTO. (I wouldn't drill an adjustment port in the front panel.) My set has a Collins PTO.

I bought a Cosmos spare a while back, and looking at it now, I can see that it would

be harder to do in situ. (Mine needs repair first; the slug must have frozen, because the slot is completely chewed away.) My Cosmos has the odd linearity screws.

I didn't put a magnifier on them, but they look like Robertson (square) head. I'll put it under a microscope and report back.

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Date: Wed, 11 Mar 2009 12:51:53 -0700 (PDT)  
From: "Tom M." <courir26@yahoo.com>

The 51J PTO moves faster than kudzu weed. I have to lead mine like when bird shooting so that it is spot on at some random time in the future. Attempting to keep the 51J3 PTO perfect is futile.

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Date: Fri, 13 Mar 2009 07:55:00 +1100  
From: "Pete Williams" <jupete@bigpond.net.au>  
Subject: [R-390] PTO endpoints

I've done over 20 PTO for R-390's- both types...never done end points or linearity in the receiver and always use an external PS with the two HT for the R-390A or the 180V only for the R-390/URR-- so much easier, Yes have taken a turn off on occasions... have also reduced the 10p to -say 5 pf..... no long term obvious effect on stability. Linearity in the COSMOS type a real PITA,, some of the screws are Bristol wrench type heads and the perfect tool is the smallest wrench in the Bristol spline key kit # SS-508. I break it at the right angle bend and fit the shank into a small pin vice. For the ones with slotted heads I use a long thin Allen key ground to fit. It's worth the trouble to make up /get an external PS tho.

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Date: Sat, 9 May 2009 08:28:37 EDT  
From: ToddRoberts2001@aol.com  
Subject: Re: [R-390] Second R-725 on ebay

It looks like a true R-725 has a mu-metal shield added around the outside of the round PTO shield can. Does anyone know if it really makes a difference in the performance of the PTO? I know mu-metal shielding is added around small audio transformers to reduce the chance of any hum pickup. Is the R-390A PTO susceptible to hum pickup from the power transformer next to it on the underside of the chassis? I see it looks like there is some kind of added transformer next to the regular power transformer on the underside also on the R-725? If adding a mu-metal shield is beneficial there are places that sell mu-metal foil that one could wrap around the PTO can.

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Date: Sat, 9 May 2009 12:01:46 -0400  
From: Roy Morgan <k1lky@earthlink.net>  
Subject: Re: [R-390] Second R-725 on ebay

It COULD be that the shield was needed in aircraft installations because of the use of 400 cycle power in other nearby equipment. The 400 cycle fields might cause more trouble than the same power at 60 cycles.

> i... are places that sell mu-metal foil that one could wrap around the PTO can.

Likely, though I don't know about them.. Note: the Mu Metal sheets are formed carefully in manufacture, and mis handling the material can reduce the shielding quality quite a bit. Some oscilloscopes resorted to mu metal shields around the CRT. Low acceleration voltages may have made that necessary. So look for that kind of thing in derelict oscopes at hamfests.

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Date: Sat, 09 May 2009 14:33:19 -0400  
From: "David C. Hallam" <dhallam@rapidsys.com>  
Subject: Re: [R-390] Second R-725 on ebay

The magnetic shielding properties of Mu metal are very sensitive to cold working such as bending, etc. I believe Mu metal shields were annealed after forming to obtain maximum effect.

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Date: Wed, 22 Jul 2009 14:07:36 +0200  
From: sigmapert <sigmapert@gmx.de>  
Subject: [R-390] Role of the 3TF7 in PTO frequency changes

I was an active member of this list for several years in the mid-nineties. After my retirement I'm back. In context with building a jig for the measurement and alignment of PTOs I began to experiment with the 3TF7. I measured the effect of power line voltage variations on PTO frequency. The results are in accordance with the findings of Dallas Lankford. I can document that the current regulator 3TF7 is the main cause for the observed PTO frequency changes. Follow the link to get more information about my recent experiments.

<http://schmid-mainz.de/3TF7-Results.pdf>

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Date: Wed, 22 Jul 2009 08:23:57 -0400  
From: "Shoppa, Tim" <tshoppa@wmata.com>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

I think something gets lost in the translation from German to English. This is like saying that fire trucks cause fires.

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Date: Wed, 22 Jul 2009 14:47:25 +0200  
From: sigmapert <sigmapert@gmx.de>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

More precisely, the measurements prove that the observed power line voltage induced PTO frequency changes result from poor regulation of filament current by the 3TF7 current regulator.

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Date: Wed, 22 Jul 2009 14:54:17 +0200  
From: Heinz Breuer DH2FA <dh2fa@darcd.de>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes



I don't see it that way. Kurt confirms Dallas' observation, that a change of the mains voltage will cause a variation in PTO frequency due to variation of the PTO tube's filament supply which is regulated by the 3TF7. A 12Hz jump for a 9% mains voltage change is probably nothing serious to worry about and the 3TF7 might have been the best regulator available in the mid 50s to achieve this. Nevertheless a solid state regulator can even avoid this 12 Hz jump. I am not into digital modes, a 12 Hz jump doesn't bother me.

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Date: Wed, 22 Jul 2009 14:54:39 +0200  
From: sigmapert <sigmapert@gmx.de>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

The following link describes the the plug-in in more detail:  
<http://schmid-mainz.de/Flyer.pdf>.

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Date: Wed, 22 Jul 2009 08:57:36 -0400  
From: "Shoppa, Tim" <tshoppa@wmata.com>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

> the measurements prove that the observed power line voltage induced  
> PTO frequency changes result from poor regulation of filament current  
> by the 3TF7 current regulator.

I'm sure that filament current changes can make the PTO and BFO shift frequency. In fact Dallas wrote some recommendation on picking 6BA6's which would be less sensitive to any such changes.

IMHO the 3TF7 is more than good enough in the real world. Meaning it's overkill already, especially if you aren't using the 390A in a truck run from unregulated generators in the middle of nowhere. You were measuring +/- 6 Hz changes around nominal line voltage and those aren't really audible to me (I am not a particularly musical person) in my usage.

For me, the shift in the crystal oscillator frequencies due to AGC action is much more noticeable and annoying (I'm a big CW junkie). I've made some mods and measurements but haven't written them up, mostly because I'm not satisfied with the results.

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Date: Wed, 22 Jul 2009 16:47:44 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

Will you please conduct two more experiments and report the results for us.

Test 1. Short the ballast tube out and install 12BA6's in the BFO and VFO.

Test 2. Use 5749's in the VFO and PTO and use a 12BY7 as a ballast tube.

The question is, does the ballast tube really regulate the current shortterm and long

term better than lower filament current of the 12BA6's or any other filament at 0.6 amps. I see the argument for the ballast tube smoothing short changes when the receivers were run off generator power. Also the ballast would smooth line transient from devices being switched on or off. I do not see any long term regulation as the line voltage drifts several volts do to power line sag as the neighborhood changed demand during the day. Thanks  
Roger Ruskowski

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Date: Thu, 23 Jul 2009 00:46:07 +0200  
From: sigmapert <sigmapert@gmx.de>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

Hi Roger, THX for your suggestions. As far as I remember a huge number of post have dealt with 3TF7 substitutes of all sorts. Most of them tried to improve current regulation of the filament supply.

It has shown by Dallas and me that voltage regulation is the better alternative to achieve constant VFO frequency when power line voltage changes. Similar to the perfect regulation of B+ using constant voltage devices (R-390A: 0A2, R-390: 2 x 5651) constant voltage supply of the filaments leads to perfect results. Why go back? Besides the the better regulation of my replacement device power dissipation is reduced substantially. Touch the 3TF7 with your finger after touching the solid state device for several minutes and count the seconds you can grip the 3TF7 (LoL).

Now a comment to the replacement of original parts with new ones. I would e.g. NEVER replace original capacitors with orange drops. In my eyes they are oversized and look unaesthetically (the orange drop lovers will kill me).

If possible I'd avoid any soldering in the radio. That was the 'ultima ratio' when designing the 3TF7 replacement. But if a replacement (even a solid state device, Hallo Heinz Breuer) fits well into the look of the radio I see no problem to install it. The 3TF7 replacement with the medium size IERC tube shield installed (<http://schmid-mainz.de/Flyer.pdf>) to my feeling isn't recognized as a foreign body even by the purist.

Currently I'm experimenting with solid state replacements of the two 6082 tubes in the R-390 non A. These beasts cook the radio. As I stated above I'd never tolerate to do any soldering in the radio. I've good evidence to succeed in the design of a direct plug-in replacement of small size and low power dissipation using most recent switching voltage regulators.

So Roger, I've plenty of projects to deal with. Voltage regulator issues was a deviation from my long-time project 'Measurement and alignment of PTOs'. I have built a jig that uses an absolute rotary encoder to quantify the rotary angle of PTOs with high precision together with the related output frequency of the PTO. Here a picture of my setup. (<http://schmid-mainz.de/Jig.jpg>) For this subject I'm preparing a manuscript for 'Electric Radio'.

Regards to you and all list members. I hope you like my work and my enthusiasm for our beloved R-390(A) radios.

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Date: Wed, 22 Jul 2009 19:06:57 -0500  
From: "Cecil Acuff" <chacuff@cableone.net>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

True to form Lankford fan.... Dallas wasn't the first to look at voltage regulation. If you go back far enough in the archives and also check the Chuck Rippel pages you will find him building a solid state voltage regulated replacement many years ago. You will also find Lankford's last stand on cap failures and their direct lineage to the blue striper pile which don't hold water. He has gone as far as to boil some on the stove, and then freezing them in his analytical testing to prove that as the cause and posted the results on the site he now frequents. Sorry but I'm not a big follower..

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Date: Wed, 22 Jul 2009 17:13:27 -0700  
From: "Craig C. Heaton" <wd8kdg@worldnet.att.net>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

So, you would leave failed components in a radio? Inquiring minds would like to know? Long live BBOD's!

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Date: Tue, 4 Aug 2009 17:46:06 -0700  
From: David Wise <David\_Wise@Phoenix.com>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

I offered a similar plug-in replacement (proudly named the "3DW7" after my initials) a few years ago and was mostly ignored. My design does not need grounding. I regulate RMS current (necessary to avoid the ground pin) by switching individual cycles of AC. I figure that Kurt rectifies, and then regulates the output with a high-frequency switcher. This has been done before, but not in a 3TF7-size package. Is your output smooth DC, Kurt, or pulsating DC who's RMS value is 12.6v ?

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Date: Wed, 5 Aug 2009 08:06:27 +0200  
From: sigmapert <sigmapert@gmx.de>  
Subject: Re: [R-390] Role of the 3TF7 in PTO frequency changes

THX for another NON-OT msg. You are right that the main component is a high frequency high efficiency (95%) switching voltage regulator. The output is pure DC. Maximum ripple & noise is 30mVpp. Thorough testings (e.g. using a network analyzer) showed no signs of spurious harmonics of the switching frequency in the receiver. Kurt Schmid

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Date: Mon, 14 Sep 2009 17:38:01 -0500  
From: <ka9egw@britewerkz.com>  
Subject: [R-390] [KA9EGW] progress

Well, I attacked what is [for me] the scariest thing first--PTO endpoint adjustment.

Piece of cake. I don't know if my rx is typical, it's a Collins 8719-p-55 unit, but there's an original [anodized bore same as the rest of the chassis] hole in the exact right spot in the subchassis so if your screwdriver is the right length and diameter [it is now] nothing but the endpoint screw cover plug [missing on my radio anyway] need be removed. I could make another one, or several, if I had the dimensions. Well, it took about 20 minutes to get it within a couple-three hundred cps, such that backlash is now the bigger linearity issue...good enough for now and lots better than the 5 kc it was off. [it was 1000.5-kc-worth-of-turns for 1000 kc when I started].

Which creates a new problem. I have exactly 1000.3 kc from a reading of x.002 mc to +x.002 mc. The pto is doing close enough to 1000kc-in-10 turns for now, but it seems that the 'zero adjust slipper clutch' [dunno the right name, it's the wave washer thingy the 'zero adjust' mechanism compresses] well anyway it quits slipping before i can get any closer than reading 2kc high across the band. If I could get one end spot-on the other'd be within a couple hundred cps and I'd be happy for now. I can easily use the zero adjust to go to reading 20kc high across the band, then it runs out of range in that direction too.

It's almost like a gear slipped a couple teeth. Next I will check that the nominal 70kc of overrange is even split between the ends of the range. If it isn't, what do you guys recommend? Or should I not worry about it further at this preliminary pre-resto checkout? Gads, I hope I explained that right.

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Date: Mon, 14 Sep 2009 18:07:41 -0500  
From: <ka9egw@britewerkz.com>  
Subject: [R-390] [KA9EGW] pto ok now?

So I zeroed the calibrator, went up 5kc, locked the dial, loosened the clamp, disengaged the driven bevel gear, rolled the veeder-root to .010, re-engaged and tightened the bevel gear, unlocked the dial, tuned to .000, locked the zero adjust, tuned in the calibrator, unlocked the zero adjust. Just as a sanity check my local 1000kc powerhouse and wwv on 5 and 10 are right where you'd expect. So I checked overrun and I have 45 kc overrun on the low end and 20 kc overrun on the top end. The pto appears to be covering the right range with acceptable linearity, but it would seem the end-stop mechanism is out of sync with everything else. Is this normal, to have asymmetrical overrun?

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Date: Tue, 15 Sep 2009 08:59:10 -0400  
From: "Shoppa, Tim" <tshoppa@wmata.com>  
Subject: Re: [R-390] [KA9EGW] pto ok now?

> <snip>.....Is this normal, to have asymmetrical overrun? <snip>

There's multiple physical end-of-run stops. There's one made of discs right behind The front panel. This is to prevent you from physically hitting the PTO's end of Run which could (if you apply too much force) potentially damage it or knock it out of kilter. These are the stops that you are supposed to hit! The PTO's physical range is more than ten turns, but there's an optimal range over which the linearization adjustments do the most good, go to the wrong ten turns, and you may not only has

linearity gone out of whack, but that it cannot be adjusted back into whack. To "center" the overrun you can loosen the screws on the Oldham coupler turn a fraction of a turn in the correct direction, and Rezero the counter. All assuming you aren't coming close to the internal-to-PTO end of travel. There's probably also some way to tweak the front panel disc stops, but the Oldham coupler is the usual place.

Most of us have unintentionally had the Oldham coupler screws be less than tight :-).

You're doing great, IMHO, if you've got the thing zeroed and 1000kc is exactly 10 turns. Before messing with the overrun I'd check the linearity and after adjusting the overrun I'd recheck it to see if it got worse or better. Could go either way. Adjusting the linearity screws on a PTO is do-able but if it's "good enough" I'd say just to leave it. How good "good enough" is to you I don't know. It is conceivable to linearize The PTO until it's within a few hundred Hz over the whole dial, but it's a lot of tweaking of corrector screws or stacks and charting.

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Date: Tue, 15 Sep 2009 19:20:39 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO Mechanical Alignment.

The usual sequence is to proceed in the following order on the mechanical alignment.

Run the KC dial from end to end and remember the dial over run on each end.  
Add those two numbers together and divide by two. (about 35).  
Run the KC Knob off the end point.  
Engage the zero adjust.  
Run the KC knob to both ends without moving the zero clutch.  
Feel the middle point of the zero range. (its a learned thing as you cannot eyeball it).  
Pencil marks between knob and face plate do help.  
Set the KC knob to the center of the zero adjust.  
Release the zero adjust with the KC knob center.  
Roll the KC knob to the hard stop end point (top or bottom your choice).

Open the veeder root counter dial cover and set the over run to the number you need.  
(about 35 over or under).

Tighten that all back up and run the KC knob end to end the over run should be equal on both ends.

If not, think how many numbers you are off and which way you want to go.  
Pick a number somewhere off the end points.  
Mark the KC knob against the front panel plate with your pencil.  
Dial the number off set you need in the opposite direction.  
Engage the zero adjust, move the KC knob back to the mark,  
release the zero adjust shaft.

Go to an end point.  
Adjust the veeder root dial back to the end point over run number.  
Tighten every thing up again.  
Run to both ends and see if you have equal over run on each end.  
Get to with in 5 and quit this. You have other things to do in life.  
Put the dial cover back on.  
Do not play with the zero adjust clutch any more in this procedure.  
Go to 7+000 and align the cams (.5 - 1) should be the only one that changes.  
But do what ever RF deck mechanical alignment is needed.

You may need to position the clamp bolt on the Oldham coupler so you can  
loosen and tighten it when the dial counter is at 000.  
You can loosen position and retighten the Oldham coupler clamp without  
changing the relation of the VFO shaft to the KC knob shaft.  
Dial up 000 on either end.  
Lock the KC shaft with the dial lock.  
Loosen the Oldham coupler clamp.  
If you have a counter loosen the VFO oldham coupler and set the VFO to  
3.455 or 2.455 which ever end you selected.  
Tighten up the coupler.

Or else:  
Go to WWV at 10.000 or 9.+000. or where ever you find it in propagation range.  
Rock WWV into max signal.  
Change the band width down to 0.1 and peak WWV.  
Loosen the Oldham coupler clamp.  
Try the KC shaft side if you can.  
Hold the VFO shaft with a pair of pliers.  
Dial the KC knob back to zero.  
Retighten the clamp.

If you think your BFO is close you can use the 0.1 IF band width, the BFO zero beat  
and position the VFO to within about 50 hertz or better. You can watch the meter  
twitch down to zero. But how close is the BFO to start with? You can rock the BFO to  
under a 100 hertz with a signal generator and the 0.1 IF band width through the  
455 crystal in Z501.

This should get:  
Zero adjust centered  
Over run even on both ends.  
Mechanical cams aligned.  
VFO set.

And you are good until a clamp slips. Roger

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and from the Collins listserv  
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Date: Sun, 22 Nov 2009 11:29:04 -0500  
From: frankshughes@aim.com

Subject: [Collins] R-390A frequency measurement - in service

I am searching for a way to connect my HP 5316A frequency counter to the R-390A so I can get an accurate measurement of what frequency it is tuned to while in operation. I searched around and it looks like I need to connect to the PTO output. If this is the best way, what should I use to make the connection w/o effecting the circuit operation?

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Date: Sun, 22 Nov 2009 17:11:54 -0500  
From: Jim-2 <jbrannig@optonline.net>  
Subject: Re: [Collins] R-390A frequency measurement - in service

If you only count the PTO then you will have to guesstimate the heterodyne oscillator frequencies. To use a counter directly requires mixing all the oscillators and reading the resultant output. A few pf of capacitance should couple enough RF to count the PTO output.

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Date: Sun, 22 Nov 2009 12:23:40 -1000  
From: pete wokoun <pwokoun@hotmail.com>  
Subject: Re: [Collins] R-390A frequency measurement - in service

A few turns of insulated wire on the outside of the PTO oscillator tube (inside the tube shield) is usually enough to couple the pto signal to a sensitive counter. You might want to use teflon wire as some insulations may melt.

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Date: Sun, 22 Nov 2009 18:34:15 -0600  
From: "Dr. Gerald N. Johnson" <geraldj@weather.net>  
Subject: Re: [Collins] R-390A frequency measurement - in service

You need to measure three frequencies, and add or subtract them according to the band. You have to take account also if a crystal injection is used on the second harmonic. You have to measure the PTO, the BFO and the crystal injection frequencies, taking sums or difference. If on AM, you have to add the IF frequency to the count even if the BFO isn't running.

Some vintage receivers do all that by using band data to preset the V/PTO counter to the negative of the appropriate sum or difference frequency of the crystal and the BFO. And they are right once in a while.

There have been mixers made for that purpose, maybe AAST electronics was one, probably intended more for the S-line, but it might be customized for the 390 except the S-line always has the crystal on the high side. And on some bands the 390 has an extra mixing, like the 1/2 to 2 MHz ranges and that LO has to be included in the sum or difference to the counter.

It might be easiest to program a PIC chip that had four built in counters to count each oscillator, check the band switch position by some other means, then to compute and display the appropriate sums and differences. Its not a trivial project.

> I searched around and it looks like I need to connect to the PTO output.....

For coupling you want a small coupling capacitor to a high impedance buffer amp near the sample point. For each oscillator. Four of them.

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Date: Fri, 4 Dec 2009 11:00:24 -0800 (PST)  
From: Perry Sandeen <sandeenpa@yahoo.com>  
Subject: [R-390] VFO Heater Questions

I read an article in ER magazine on the Collins VFO and learned it had an adjustable thermostat.

1. Does anyone know what is the nominal temperature setting as well as the high and low limits?
2. Does anyone know what is the nominal current draw of the VFO heater.
3. Although the Y2K-R3 BFO schematic shows no heater, is that correct?

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Date: Fri, 04 Dec 2009 14:03:24 -0500  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] VFO Heater Questions

Remember the R-390A does have a heater on the PTO.  
It does not have one on the BFO.

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Date: Fri, 04 Dec 2009 14:39:10 -0500  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] VFO Heater Questions

The PTO heater is HR-701. It ONLY runs when the rear OVENS switch is turned ON. The heater is a 45W rating.

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Date: Fri, 4 Dec 2009 12:21:56 -0800  
From: David Wise <David\_Wise@Phoenix.com>  
Subject: Re: [R-390] VFO Heater Questions

I don't know how much of the R-390 VFO oven design was carried over to the R-390A (It's not discussed in the Cost Reduction Report), but the R-390 Final Engineering Report suggests on page 71 that the oven runs at 70 degrees C. As Bob Bethman mentioned, it, and the second oscillator's crystal oven, run only when the OVENS switch is on. This is not recommended for normal use due to reduction in component life. The only always-on oven is the one containing the calibrator crystal and the 17MHz first oscillator crystal. The BFO is unheated.

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Date: Mon, 21 Dec 2009 14:59:56 -0600  
From: "Bob" <rfay@charter.net>  
Subject: [R-390] R-390A PTO sync



I have an R-390A that I have been working on. The receiver does not receive and in the process of cleaning and reassembling the RF deck the PTO is no longer in sync with the RF mechanics. I have heard that there is a way using a freq counter that it can be aligned at 7.000+. Can anyone explain this procedure.? And yes I will have more questions

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Date: Mon, 21 Dec 2009 16:46:14 EST  
From: flowertime01@wmconnect.com  
Subject: Re: [R-390] R-390A Cosmos pto value

Fair Radio in Ohio is still selling them for \$35.00. Tested working. Cosmetic condition as is.

If you have a counter you can count either of the PTO's in your receiver. Count the BFO PTO off a tube socket pin through a capacitor.

To count the VFO PTO remove the adapter from the back panel so you can couple the VFO output cable to the counter BNC cable. Do a bit of math to decide what the VFO output needs to be compared to the dial readout. Watch out that you do not run the VFO hard against an internal end because the VFO is way out of alignment with the KC dial read out.

Set the KC dial to the center of the zero adjust.  
Read the VFO where it sets.  
Do some math (the VFO is upside down)  
Where +000 is 2.455 and -000 is 3.455.  
Think about where the KC dial needs to be.  
Loosen the Oldham coupler, hold the VFO shaft, dial the KC as needed.

You can set the VFO with the calibration osc, BFO set to zero and the KC dial at any 100 KHz. It will get you close. Be care full not to jam the VLF against its end points and you can get the alignment close enough to use the receiver. It may take a time or two to get on the right 100Khz and get WWV at 5, 10 or 20 Mhz. But the process works well.

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Date: Wed, 17 Feb 2010 12:44:14 +1100  
From: "Pete Williams" <jupete@internode.on.net>

List.... Checking end point and linearity on a COSMOS is time consuming and everyone I've done needs the one turn off the end point coil.--- until now. The last one I've just done was very recalcitrant and I opted to remove one of the 10pf N300 caps across the main coil to bring it into line. One turn didn't make the appropriate distance. There 'appears' to be no ill effects --- endpoint adjust OK and easily achieved linearity.

I realize that clever engineers spent time and money designing/proving their product but what ill effects might accrue from this heresy and deletion ! I would expect temperature stability might suffer at extremes both + and -

Comments/dissertations welcomed .

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Date: Wed, 17 Feb 2010 19:01:04 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] R-390 Oldham Springs

You are good to go as is.

If you squint just right and peer into the R390 long enough, you will see there is not two little pegs on the Oldham coupler between the RF deck and the Crystal oscillator deck. Thus no place to hang a spring. Or your coupler may not be original. It could happen! The Osc deck coupler should be a smaller dia than the VFO coupler. The coupler sets so close to the deck you cannot run a spring under it.

The crystal deck is in fact a switch and "continuous" It also has a reduction gear so some slop in the shaft is not a problem. As long as the "backlash, slop, play" does not keep the switch in the oscillator deck from switching on each megahertz change, the mechanism is OK and needs not repair.

A lot of VFO's are running with no spring on the coupler. A good receiver has very little play in the coupler. Most operators would never know if their receiver had the spring missing or not.

Better to space the coupler faces apart a bit to keep from jamming a shaft into the VFO and getting more frequency off set from the deforming of the VFO mechanism. This again is not a lot but nice smooth operation is more fun to work with day in day out.

Any small spring you can work into the VFO Oldham coupler space will do the job.

Some children wear dental braces that use small rubber bands. These also work nice but only last a couple years before they give out.

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Date: Wed, 17 Feb 2010 19:10:14 EST  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO -COSMOS query

Worry not. Go forward and enjoy your more linear receiver.  
You gatta do what ya gatta do.

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Date: Sat, 27 Feb 2010 09:55:22 -0500  
From: Norm - WA3KEY <norm@wa3key.com>  
Subject: [R-390] Powering PTO's out of circuit

Has anyone on the list powered an R-392 PTO out of the receiver? I constructed a simple fixture using a Heath IP-17 power supply and frequency counter for setting end points and have used it successfully with R-390A and R-390 PTOs, but have been unable to get an R-392 PTO to run out of circuit. Perhaps it has something to

do with the 26D6 serving double-duty as an oscillator/mixer. Attached are the pin-outs I'm using on all three.

R-390 (Non-A) Range: 3.455-2.455MHz

A - +180vdc B+  
B - n/c  
C - 6.3vac filament  
D - Filament ground  
E,F - n/c Oven  
H - Ground

R-392 Range: 3.455-2.455MHz

A,B,C,D - n/c  
E - +28vdc filament  
F - +28vdc B+  
H - Ground

R-390A Range: 3.455-2.455MHz

A - +180vdc B+  
B - +150vdc Screen  
C - n/c Spare  
D,E,J,K - n/c Oven  
F - Ground  
H - 6.3vac filament

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Date: Sat, 27 Feb 2010 13:54:22 -0500  
From: Paul Anderson <paul@pdq.com>  
Subject: Re: [R-390] Powering PTO's out of circuit

I went through this with one of mine. It has been awhile, so I am fuzzy on the precise details. However, unlike the R-390 and R-390A PTO's, I think I figured out that it needed to be in circuit in order to oscillate. Someone smarter than I am should be able to confirm this by looking at the circuit diagram.

The symptom I had was that it would oscillate fine in circuit, but removing it from the circuit made it not oscillate cleanly (it did have a waveform, but it was very unclean).

I would like to be able to operate it externally as well (for alignment and testing)... so if someone has ideas as to how to accomplish that, I'd be grateful if they shared.

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Date: Sun, 14 Mar 2010 21:26:19 -0600  
From: <wb5uom@hughes.net>  
Subject: [R-390] R-390A Tuning issue

If this issue has been covered I missed it, and I am betting more than one of you

guys (gals) know the answer: My 390A has been doing perfectly fine. I had an antenna issue and was too lazy to go out and fix it until this weekend so I had not been listening to the Receiver for 2 or 3 weeks -although it is ON all the time. What I find today is that it appears the lower 500Khz in each Mhz range is dead. (I tried several different Mhz settings all with same response). And yes above and below 8Mhz. If I tune to say 11.820 it receives perfectly, tune down to 11.500 and then it's dead as a doornail. The same for say 8.920 and 8.500 as so on. Hints anyone? Thanks in advance. David / WB5UOM

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Date: Mon, 15 Mar 2010 00:07:55 -0400  
From: Roy Morgan <k1lky@earthlink.net>  
Subject: Re: [R-390] R-390A Tuning issue

Get another receiver that can hear the PTO, follow the PTO signal with that (A little wire stuck into the PTO oscillator tube shield for a pickup) as you tune. You may find that the PTO is quitting about mid-range. If so, start with a new oscillator tube.

---

Date: Wed, 14 Apr 2010 22:25:40 -0400  
From: wa3frp@aol.com  
Subject: [R-390] R390A Cosmos disassembly question and a second question too!

I've decided to keep going in my efforts to restore my R390A. So far I've been able to get the front panel off and that was a lot less complicated than I thought that it would be. I've also removed the RF deck, cleaned and checked the position of the RF bandswitch and the crystal oscillator bandswitch. So far so good. Now, I'm working to open my Cosmos PTO as I am going to have to remove a turn, maybe two, from the endpoint adjustment coil so I can correctly set the endpoint. In doing so, I've found a lot of documentation on how to adjust the endpoint but not a lot of documentation on how to get into the inner sanctum. I've gotten as far as unsoldering the two heater wires and the heater system is free BUT now I can't figure out if the final metal chamber is just stuck or is a tight fit or is possibly a screw on. I'm not about to use maximum force as I don't have a good backup plan if things go badly. So, is there a trick? Any advice is appreciated.

Also, I was surprised to find that my Cosmos was assembled and then pressurized with 15 pounds of dry nitrogen. (This was on the warning label). The nitrogen has long since dissipated but I'd like to know if others have repressurized after assembly or not. Interesting to note that I haven't seen this mentioned in any document I've read so far.

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Date: Wed, 14 Apr 2010 22:41:29 -0400  
From: Roy Morgan <k1lky@earthlink.net>  
Subject: Re: Cosmos disassembly question and a second question too!

Likely it's just stuck. There is an O-ring that the can slides over at the last quarter inch of travel as it's installed. Likely the O-ring is stuck. I suggest you slip a modestly small thin screwdriver under the lip of the can and pry - do this at a number of places and the thing may well loosen up and come off. A tiny bit of wax or silicone grease might be right as you re-assemble.

> ... pressurized with 15 pounds of dry nitrogen. (This was on the  
> warning label). The nitrogen has long since dissipated but I'd like  
> to know if others have repressurized after assembly or not.

I've never heard of anyone putting pressurized nitrogen in there, or even unpressurized nitrogen. I suggest you ignore the pressure and the nitrogen altogether. You may well find some dessicant capsules in there. These can be dried out in a 200 degree oven for an hour or so and re-installed if you like.

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Date: Thu, 15 Apr 2010 09:19:21 EDT  
From: DJED1@aol.com  
Subject: Re: Cosmos disassembly question and a second question too!

I haven't had a Cosmos apart, but the PTO I disassembled just had the three screws holding the inner cover on. There was a gasket which may be holding the inner cover closed. I have never heard of anyone trying to re pressurize the PTO. Some do bake the unit at low heat to drive any moisture out. I assume you have found some of the information on the web about the Cosmos (linearity adjustment vs end point adjustment)? I did the linearity adjustment and it worked fine, but the end point seemed to drift after a year, then I would have to readjust.

---

Date: Thu, 15 Apr 2010 10:25:21 -0400  
From: wa3frp@aol.com  
Subject: [R-390] An update - R390A Cosmos disassembly question

Thanks to everyone for their feedback. Now inside. It was quick work once I knew that the final chamber was held by a rubber gasket and not screwed into place. Happy to report that the interior is pristine. The valve stem appears to have a manufacturing defect so it's very doubtful that this PTO was pressurized for longer than a few minutes. The two dessicant capsules are still tied in place and are blue. I'm not sure from a quick scan of the documentation if blue is good or bad.

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Date: Fri, 16 Apr 2010 12:27:13 -0500  
From: Tisha Hayes <tisha.hayes@gmail.com>  
Subject: [R-390] Cosmos Dis-Assembly

At least you didn't open the case to the nice aroma of roasted PTO with the commensurate melted components from a heater that was stuck on. "I love the smell of roasted PTO in the morning.. it's like.. victory"

---

Date: Fri, 16 Apr 2010 13:51:47 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Cosmos Dis-assembly

No, you are NOT lost! Someone simply posted a description directly from a "reference". Thereby unintended but overkill in "honing" your very apt and correct post! We didn't "need" to know the chemical "structure" and reactant means. The bloody desiccant is a bright deep blue when first dried/manufactured. It goes

through a progression of changes in color as it absorbs water vapor/humidity. Eventually it is indeed very pink when it has done its job. We had dozens of these packages about a quart in size that used to go into the Engine containers when we either shipped a re-manufactured gas turbine engine, or a new one to whom needed it. We had these bags by the case. Once the smaller box was opened, we had to bake the dozens needed to deal with the next engine. We always had a BUNCH sitting in an oven purchased off the commercial market that any of us would have loved to take home! I don't believe that it was shut off the whole time the shop ran. <snip>

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Date: Fri, 16 Apr 2010 14:07:04 -0400  
From: Gord Hayward <ghayward@uoguelph.ca>  
Subject: Re: [R-390] Cosmos Dis-assembly

One neat thing I've found is that all of the dessicant bags I've seen have the words DO NOT EAT in big letters. I guess there's a regulation that comes from the little bags you find in pill bottles. Some people think you have to eat those first ;-). I save those little bags too.

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Date: Fri, 16 Apr 2010 14:35:44 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Cosmos Dis-assembly

Yep! I was mostly replying about the desiccant and the nitrogen pressurization. I was trying to put it into ANOTHER context. Sorry - Got a little carried away! <snip>

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Date: Sun, 18 Apr 2010 14:14:58 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Cosmos Dis-assembly

I'm confused!  
How can you use the PTO if the slug is off its track?  
It may be that the PTO was turned too far while NOT installed.  
Please enlighten us. <snip>

>  
> Hi Bob, Thanks for your message. I've been inside, tried some  
> adjustments but was not successful as the tuning slug looks to be  
> damaged. It appears to be off its track and too far down in the  
> endpoint adjustment inductor. So, I've close things up and put my  
> R-390A back in use temporarily. I need a nice solar flare, something  
> that knocks the HF signals off the air for a few hours, so that I can  
> go back in and unsolder the two leads on the endpoint adjustment  
> inductor and see what it will take to get the variable inductor to vary.  
> While things were opened, I did unscrew the cap to see what the screws  
> looked like associated with linearizing the PTO. They sure are tiny!  
> First things first. Once the endpoint adjustment has been completed, I  
> do plan to take a look at linearization.  
> Thanks and 73 Russ WA3FRP

>  
> -----Original Message-----  
> From: rbethman <rbethman@comcast.net>  
> To: r-390@mailman.qth.net  
> Cc: wa3frp@aol.com  
> Sent: Sun, Apr 18, 2010 11:46 am  
> Subject: Re: [R-390] Cosmos Dis-assembly  
>  
> Russ!>  
> Okay! Now the "original" post finally got the can off.>  
> Now - How is it going?>  
> Any reall issues with the endpoints?>  
> How about all the "intermediate" alignment screws? ( Yes - they ARE a  
> pain! )  
>> Don't worry about pressurizing it after you are done. BTW - it is an  
> everyday schrader valve, just like on the car tires.

---

Date: Sun, 18 Apr 2010 15:03:05 -0400  
From: wa3frp@aol.com  
Subject: Re: [R-390] Cosmos Dis-assembly

Sorry that I was not clear. The PTO works but now that I've removed a turn on the midpoint adjustment coil, the PTO tunes 1000 Hz in slightly less than 10 turns. So, I tried to turn the adjustment screw counterclockwise only to find that the core turns but is not coming back toward me as I face the screw slot in the coil from the front of the PTO. In checking further, I see that I am turning the slug (why does this have to be slightly behind the transformer?) and with a light and some extra magnification, it looks to me that the screw is past the screw track or at least that it what it looks like to me. So, I figure the next step is to remove the midpoint adjustment coil by unsoldering the two attached wires and then backing off the locking nut and removing the entire coil to see if I can get a better look at what is happening and to see if I can get the screw back in the screw track. Except for this problem, the PTO is in excellent condition. Thanks and 73 Russ WA3FRP

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Date: Sun, 18 Apr 2010 19:58:23 -0700 (PDT)  
From: "Drew P." <drewrailleu807@yahoo.com>  
Subject: Re: [R-390] Cosmos Dis-assembly

> Don't worry about pressurizing it after you are done. BTW -  
> it is an everyday schrader valve, just like on the car tires.

Let's see...remove the 3 screws securing the inner can, then apply compressed air to the Schrader valve - KaPOW!!!, just like removing pistons from automotive disc brake calipers. On second thought, maybe best not to attempt this method...

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Date: Sun, 18 Apr 2010 23:11:07 -0400  
From: Roy Morgan <k1lky@earthlink.net>  
Subject: Re: [R-390] Cosmos Dis-assembly

A bit of strapping or nylon line would allow the thing to unseat and not fly across the room. BY the WAY: I don't remember any schrader valves on Cosmos PTO's here. Do all of them have such a valve? Maybe I did not look in the right place.

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Date: Mon, 19 Apr 2010 21:08:55 +1000  
From: "Pete Williams" <jupete@internode.on.net>  
Subject: [R-390] COSMOS Pto EP ADJUSTMENT

Russ... once the endpoint adjustment slug is fully in and out of thread. you've got to have the PTO apart and put back in. I've done a few COSMOS and in lieu of removing a turn off the EP coil I've now opted for adding another 10 pf in series with the one already there...

The resulting 5 pf then across the coil does the trick with no obvious side effects. The linearising screws are a PITA--- you may be lucky and find yours have slotted heads... I'm usually unlucky and find that mine have a miniature Bristo flute socket head. If you go the whole way and disassemble, make sure you get the disc with these linearising screws is back in the same position.... some models don't have screws in all the holes so you end up with a problem.

Get full story on revival of a COSMOS from the archival information 'A Journey through the Cosmos' (PTO) by Jim Miller.

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Date: Mon, 19 Apr 2010 12:38:23 -0400  
From: wa3frp@aol.com  
Subject: Re: [R-390] Cosmos Dis-assembly

Yes, my Cosmos PTO did have a schrader valve. In my case, it can be seen at the back of the Cosmos once the outer case has been removed. I assumed that they were all made that way. I'm thinking that I will try to repressurize the unit if I can find a source of dry nitrogen in the area. My first thought is to approach the Chemistry Department of a local University. 73 Russ WA3FRP

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Date: Mon, 19 Apr 2010 12:53:36 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Cosmos Dis-assembly

While they originally used dry nitrogen, you "may" want to consider Argon, available at welding shops. Why the change? Argon is much less reactive than Nitrogen, and most likely easier to obtain.

Either of these gases is normally supplied in 300 cubic foot cylinders, and comes pressurized at about 2700 - 3000 psi. (I used to do welding and am a Scuba Diver. Used to large volume high pressure gases. Scuba tanks get filled from a bank of these large cylinders while placed in a plastic container of water. Just in case the tank lets go! )

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Date: Mon, 19 Apr 2010 12:55:34 -0400  
From: wa3frp@aol.com



Subject: Re: [R-390] Cosmos Dis-assembly

Thanks for your comments and advice. I like your idea about add capacitance as my search of the literature on the subject shows that this is not a once and done adjustment. Instead, I see that the endpoint needs to be looked at annually as the endpoint frequency continues to decrease over ten turns as a function of time.

Also, I was happy to see slotted screws so I MAY try to adjust linearization. I have a frequency counter. The question is do I have the patience.

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Date: Mon, 19 Apr 2010 14:35:22 -0500  
From: <ka9egw@britewerkz.com>  
Subject: Re: [R-390] Cosmos Dis-assembly

A lot of hot-rod and chopper and crotch-rocket [...er, sportbike] shops have nitrogen for 'airing' up tires, makes for less change in the vehicle's handling as a function of tire temp, supposedly.

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Date: Mon, 19 Apr 2010 15:58:47 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Cosmos Dis-assembly

Costco also is using Nitrogen for the tires it sells. They even put a "green" cap on the valve stem.

I only suggested Argon since it is one of the "Noble" gases. This means that it does NOT react with other elements, at least not in a detrimental way.

Nitrogen is NOT a noble gas. It DOES react with things. To keep items protected with a gas "blanket" or such that constantly varies, Nitrogen is fine. Very long exposure periods without BIG variations in temp and pressure are "usually" better served with a "Noble" gas, as there will not be corrosion.

No one is worried about the steel wheels of your car to be protected against corrosion when you see the outside is exposed to temp extremes along with salt, sand, and the like. We've changed since these radios have come out. Now we are trying to preserve, restore, and use them. ( A bit of a mixed bag! )

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Date: Mon, 19 Apr 2010 16:24:37 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Cosmos Dis-assembly

Being completely honest, I wouldn't even bother with pressurization with ANY gas. I would most likely consider pulling a vacuum. All you and I are trying to do is to keep it dry and corrosion free. You could bake the entire PTO at 200 Deg F, with the covers off. Using oven mitts, IMMEDIATELY place the inner cover on. The O-ring should be able to stand this - it used to be heated! Pop the screws in along the front. By then the remainder should be cool enough that you can take it to the bench and continue re-assembly. The cooling will pull the inside to a pressure

below that of "normal" at room temp. Yep! It is a mixture of Oxygen, Nitrogen, and all the other traces. I bet that when Roger and crew worked on them, they didn't play with nitrogen.

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Date: Mon, 19 Apr 2010 13:42:39 -0700  
From: David Wise <David\_Wise@Phoenix.com>  
Subject: Re: [R-390] Cosmos Dis-assembly

If it's dry enough, that's a neat tip for members; probably get a little shot for next to nothing. But I don't think it makes any difference over the long run. The seal is far from perfect, so with every change in temperature or atmospheric pressure, the PTO will "breathe" out or in, a little, and every inhalation will dilute the interior gas with whatever's out there. Eventually the interior will just be air. An initial load of dry air gives the dessicant a little boost, but that's all.

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Date: Tue, 20 Apr 2010 10:39:57 +1000  
From: "Pete Williiams" <jupete@internode.on.net>  
Subject: [R-390] FW: COSMOS Pto EP ADJUSTMENT

Russ... once the endpoint adjustment slug is fully in and out of thread. you've got to have the PTO apart and put back in. I've done a few COSMOS and in lieu of removing a turn off the EP coil I've now opted for adding another 10 pf in series with the one already there... The resulting 5 pf then across the coil does the trick with no obvious side effects. The linearising screws are a PITA--- you may be lucky and find yours have slotted heads... I'm usually unlucky and find that mine have a miniature Bristo flute socket head. If you go the whole way and disassemble, make sure you get the disc with these linearising screws is back in the same position.... some models don't have screws in all the holes so you end up with a problem. Get full story on revival of a COSMOS from the archival information 'A Journey through the Cosmos' (PTO) by Jim Miller.

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Date: Mon, 19 Apr 2010 20:23:53 -0500  
From: Tisha Hayes <tisha.hayes@gmail.com>  
Subject: Re: [R-390] Cosmos Dis-assembly

I do not think it matters if you use nitrogen, argon or any other inert gas. If you have it available to you that is fine. If you have just dried air and a decent desiccant package that should be fine too.

On large substation transformers we use a nitrogen blanket in place of air above the transformer oil. We keep it under a very low positive pressure just so if there is a leak it is away from the transformer and it does not suck moisture in. If you look at a giant substation transformer you will see a pressure gauge that shows +/- pressure of only a few PSI.

Argon is more inert than nitrogen and it is also denser so maybe the leakage rate across seals may be slightly less. Keeping a pressure seal on any type of vessel is going to require very good shaft seals and the cover seal will need to be in great shape. I doubt that any of the seals on any of our PTO's are in great shape any

more.

If you have it, and it makes you feel better than by all means use it. I would not go running out to buy a tank of gas just so I could put an inert gas in the PTO. Heck, if it did not dissolve things and totally screw up the dielectric constant you might as well fill the entire PTO with transformer oil. That is something else to consider, gasses that significantly vary from atmospheric may alter the dielectric of the PTO assembly. Who knows to what degree. Nitrogen is 78% of our normal atmosphere so it would have the least impact.

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Date: Tue, 20 Apr 2010 09:53:56 -0400  
From: wa3frp@aol.com  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

One question for you (and anyone else on the list who may wish to comment) as I want to go in, fix the problem and get back out quickly. I can't afford to have a lot of downtime as this R-390A is my primary receiver. And, knowing how things work, something that I haven't worked is sure to show up if I am off-the-air.

You said "...once the endpoint adjustment slug is fully in and out of thread, you've got to have the PTO apart and put back in..."

Are there any hints or things that I should know in working to get the endpoint adjustment slug screw back in the threads. Or, is this fairly straightforward once I've removed the coil from the PTO? I have tried turning the screw counterclockwise with a hope that the threads would simply re-engage - without success.

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Date: Tue, 20 Apr 2010 13:04:05 -0400  
From: wa3frp@aol.com  
Subject: [R-390] COSMOS - Sources for Nitrogen

I located this site that gives locations that will supply nitrogen for inflating tires (tyres). <http://www.getnitrogen.org/index.php>

I'm not going to get into the issues related to nitrogen vs. air in tires but it will be interesting to see if the handling improves on my R-390A after inflation.

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Date: Wed, 21 Apr 2010 12:40:32 +1000  
From: "Pete Williams" <jupete@internode.on.net>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

G'day Russ. You will have to take off the outer and inner covers. The threaded slug in the EP coil is easily screwed back in again if you were unlucky enough to screw it right through. No other disassembly is required.

To make the EP adjustment approximately correct on the bench, I suggest you make up/acquire a power supply to give you the 150 and 250 V plus 6.3 for heater. Make the appropriate connections. Just put the inner cover on pro tem and do the 10 turn trick checking both points.

When you find you have sufficient adjustment range by doing the 1 turn removal or a series capacitor on the EP coil, a more deliberate /accurate setting can be got when it's all back together.

I am fortunate that I have a dual adjustable two voltage supply and have made up a test cable with a spare plug to do EP and linearization.

Let the PTO warm up at room temp for an hour or so..DON'T use the oven - you'll go ballistic trying to keep the freq from moving around ( lots of HZ )

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Date: Tue, 20 Apr 2010 20:28:08 -0700 (PDT)  
From: "Drew P." <drewrailleu807@yahoo.com>  
Subject: [R-390] COSMOS PTO EP ADJUSTMENT

One design feature of the receiver which suited the military, who, like you desire equipment with minimum downtime, was modularity. This enables a swap of an entire subsystem with minimum time and effort to get the receiver back on line. You might do well, therefore, to keep a few spare modules available. If you had a spare PTO, you could quickly swap out the one in your receiver and immediately be back on line. You would then repair the errant, swapped-out PTO at your leisure.

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Date: Wed, 21 Apr 2010 10:54:32 -0700  
From: David Wise <David\_Wise@Phoenix.com>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

I have concerns about your series cap approach to endpoint adjustment. But first, let's make sure I understand. You propose adding a small cap in series with C702 or C703, right? If so, there are two problems.

First, those caps are for temperature compensation. All three caps (C701, C702, and C703) are negative-TC ceramics. Their decrease as the PTO warms up balances the increase in L701 and L702 as their forms and wire expand. C702 and C703 were selected at the factory to trim the overall TC. Unless your cap is just right, it will throw off the TC, which increases drift.

Second, you may go outside the linear range of L702, or even run out of slug travel. Reducing C requires a corresponding increase in L, effected by running the L702 (main tuning) slug deeper into the coil. With L702 now making a larger percentage of the L701+L702 total, the frequency range swept by ten turns becomes wider. This gets your endpoint back, but does not correct the root cause, namely, increase in L701's inductance. The cure for that is cutting off a turn, or (perhaps) shaving the slug.

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Date: Wed, 21 Apr 2010 13:33:38 -0400  
From: Barry <n4buq@knology.net>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

I wonder if anyone has attempted to replace the PTO with an encoder-driven LO?

Yeah, it's "heresy", but it sure would put an end to endpoint and linearity problems...

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Date: Wed, 21 Apr 2010 14:18:33 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

I believe the very first hurdle would be the need for ten turns of the KC knob. Since this not only turns the PTO for frequency adjustment, but tunes the slug racks, and the Veeder-Root counter. This would become a significant engineering task. I for one am not about to go that path. It is simpler to work on the PTO.....

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Date: Wed, 21 Apr 2010 14:18:48 -0400  
From: "Shoppa, Tim" <tshoppa@wmata.com>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

That would be taking what is perhaps one of the lowest phase noise PTO's ever manufactured, and replacing it with the cacophony of digital circuitry. I don't see the point. And after you're all done you would still have the 17MHz oscillator pulling under AGC action (a weak point of the 390A that occasionally bothers me).

An unobtrusive low-noise (even better, no noise!) frequency counter replacing the veeder root and the window, used with the existing PTO, that I could see. Wouldn't do it, but I could see it. It would change the knob feel because there wouldn't be the slap-slap-slap-slap as the decades whip by in the veeder root... for some this would be a loss, maybe for others a gain.

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Date: Wed, 21 Apr 2010 14:07:10 -0400  
From: Barry <n4buq@knology.net>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

I was talking about only from the Oldham coupler back (just the PTO) so it wouldn't involve the slug racks, counter, etc. As for the noise, yes, that's a point; however, it could be viewed as a trade-off between being spot-on frequency every time all the time (or at least as "spot-on" as the 17mc oscillator allows) versus some noise. It was just a thought...

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Date: Wed, 21 Apr 2010 15:13:25 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

Yes, from the coupler back takes out "some" of the engineering and design issues. You still have a ten turn encoder system. It would require "another" frequency source, and at a very odd start and stop point(s). I use encoders in VHF radios, I have one in an HF dedicated receiver. (SS) Birdies all over the place! My other use is in the guidance and tracking of a telescope. They indeed have their place. I'm just trying to balance the function vs. the effort, issues, and \$\$\$ to get there. As to heresy. I've probably committed it in the restoration process so far. To some I've gone too far already! I've removed the "Blue Stripe" in the process of restoration. I guess I'll get burned at the stake in Salem!

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Date: Wed, 21 Apr 2010 11:22:29 -0700  
From: Dan Rae <danrae@verizon.net>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

Barry, using an accurate frequency counter, something that is fairly common these days, these adjustments become very easy, I did mine in about 30 minutes, no jigs, obscure foodstuffs or anything difficult at all needed. This may be as heretical as your suggestion and of course was not the way it was done way back when but I'm sure it would have been had the tools been available.

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Date: Wed, 21 Apr 2010 15:57:38 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Cosmos PTO end point adjustment

Encoders in and of themselves, do NOT normally cause spurs.

One of the issues that IS directly a side effect of removing the PTO and replace with an encoder system - It \*IS\* a "Permeability Tuned Oscillator". Therefore, you must ALSO create a "new" oscillator with oddball start point and endpoint since it WILL become a VFO, albeit a digital one.

Issues with digital encoders in HF (SS) equipment does turn up in YaeComWood receivers. It is one of those I currently have that has the spurs. They have now become MUCH worse since I performed an alignment and improved its sensitivity. Everything has its good points and its bad points.

I'm "still" not leaving the "Blue Stripes"! \*MUST\* be time to make another batch of Kielbasa and Pierogi!

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Date: Wed, 21 Apr 2010 16:22:50 -0500  
From: Tisha Hayes <tisha.hayes@gmail.com>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

<snip> There are real heretics who dissect a perfectly good radio so they can sell the parts for more than the sum of the radio. Just buy a spare PTO and keep one in the radio and the other ready to go at a moment's notice. Then you can mess around with endpoint adjustments and linearity screws until the cows come home. I have collected enough spare modules to build a complete radio (or two). the ePay place is a good source and you can wait until something shows up at bargain basement prices (like 10 minutes before an auction ends. I purchased good Tascam DAT recorder for \$1.99 that way, it only needed a new belt. Patience grasshopper, and sniping bids!

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Date: Wed, 21 Apr 2010 17:45:50 EDT  
From: DJED1@aol.com  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

I thought about a synthesized PTO replacement, although I'm really an RF engineer

by trade. I found two problems I couldn't solve- maybe someone else can help out. First, you need better than 100 Hz resolution, which means either an encoder with better than 1000 bits/rotation (very expensive), or a gear driven encoder. You definitely need two encoders- one to count in Hz and one to count in 100 KHz. Finally, if you solve all that, you need to retain the settings in memory on power down so you don't lose the synchronization between the - and the rest of the RF module. Probably a simple micro could do that. I thought it would be really neat to have an absolutely linear PTO accurate to 100 Hz over the whole range, but it's beyond me. If anyone wants to help out, just jump in.

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Date: Wed, 21 Apr 2010 18:04:12 -0400  
From: "Bernie Doran" <qedconsultants@embarqmail.com>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

If one thinks they have some need to read frequency that close, would it not be simpler to simply buy a POS jap rx and either use that, or zero beat what ever it is you are listening to? Or better yet, buy a SDR-IQ and tell everyone that you are looking at the band for signals.

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Date: Wed, 21 Apr 2010 19:03:35 EDT  
From: DJED1@aol.com  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

I have to agree, Bernie, I finally decided it was working fine just the way it is. Settability to 300 Hz is close enough to find any signal. The only "fix" I now use for my R-390A is an outboard SSB adapter, since that is the dominant mode of operation these days. (It's interesting that in the heyday of the R-390 most of the intercept work was on CW signals, for which the radio is well suited).

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Date: Wed, 21 Apr 2010 19:24:54 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

Yep! Between the R-390A, SP-600, and the BC-610 (plus a T-213), I figure that the 100KC calibrator on the R-390A gets me more than close enough to get everything synced and where I want to be for AM. The SS Digital RX is for "portable" in the house or on the deck.

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Date: Wed, 21 Apr 2010 22:02:21 -0700 (PDT)  
From: "Drew P." <drewraille807@yahoo.com>  
Subject: [R-390] COSMOS PTO EP ADJUSTMENT

On Barry's pondering replacement of a PTO with a synthesized VFO, Tim Shoppa wrote: [snipped] "An unobtrusive low-noise (even better, no noise!) frequency counter replacing the veeder root and the window, used with the existing PTO, that I could see. Wouldn't do it, but I could see it."

And if you wanted to really see it, and to truly appreciate it, the display device of choice would be Nixie Tubes. Truly Beautiful!

"It would change the knob feel because there wouldn't be the slap-slap-slap-slap as the decades whip by in the veeder root... for some this would be a loss, maybe for others a gain."

And for still others, a challenge. I can envision list heavyweight Dave Wise (perhaps best known for his high tech, microcontroller based 3DW7 "tubester" ballast replacement) putting together a microcontroller based sound synthesizer to replace the missing slapitty-slap of the Veeder-Root counter. All in an enclosure the size of a thimble.

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Date: Thu, 22 Apr 2010 13:40:24 +0000  
From: <kirklandb@sympatico.ca>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

You don't need that accurate of shaft encoder, you just need to adjust the tuning rate according to the speed at which you rotate the shaft encode.

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Date: Thu, 22 Apr 2010 12:39:24 -0400  
From: Barry <n4buq@knology.net>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

> <snip> "An unobtrusive low-noise (even better, no noise!) frequency counter  
> replacing the veeder root and the window, used with the existing PTO, that  
> I could see. Wouldn't do it, but I could see it." <snip>

Essentially, that would be this: <http://www.aade.com/dfd3.htm>

Of course, you'd have to convert the readout to NIXIEs...

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Date: Thu, 22 Apr 2010 12:47:32 -0400  
From: Barry <n4buq@knology.net>  
Subject: Re: [R-390] COSMOS PTO EP ADJUSTMENT

> Of course, you'd have to convert the readout to NIXIEs...

After I sent this, something occurred to me. While this would allow the PTO endpoints to go wherever they want, linearity can go out the window, and you'll still see the correct frequency, it does not take into consideration the position of the slug racks. I could see where eventually one could see some degradation in performance due to end point movement and/or linearity and it wouldn't be obvious as to why.

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Date: Fri, 23 Apr 2010 12:48:43 -0600  
From: Robert Harding <robt\_e\_hardingiii@hotmail.com>  
Subject: [R-390] Nixie Tube Freq Readout

Try a "Systron Donner" Model 6152A Frequency Counter. Has lots of other uses around the shack and uses bright Nixie tubes. Used in the late '60s to mid '80s,



these counters are military/cal lab grade and can be found in decent shape for \$50-\$150.

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Date: Sat, 24 Apr 2010 07:54:44 -0700 (PDT)  
From: Masters Andy <nu5o@yahoo.com>  
Subject: [R-390] Nixie Tubes

The venerable HP-5245L should not be overlooked.? With its tunnel diodes, you could spend perhaps months of daily repair...built like a sunken battleship!

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Date: Sat, 24 Apr 2010 11:06:40 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Nixie Tubes

Why fight the daily repair? Use and HP-312 or 312A?  
Also built like battleship. Only tubes in one ARE the Nixie Tubes!

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Date: Sat, 24 Apr 2010 14:27:38 -0700 (PDT)  
From: "Drew P." <drewrailleu807@yahoo.com>  
Subject: [R-390] Nixie Tube Freq Readout

> .....With its tunnel diodes,.....

Are tunnel diodes even manufactured anymore? Methinks that they are only available as NOS now. The tunnel diode - that miracle device whose miracle never materialized.

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Date: Fri, 3 Sep 2010 19:36:59 -0500  
From: <ka9egw@britewerkz.com>  
Subject: [R-390] PTO

The saga continues...it goes without saying the RF deck is now horribly out of alignment. I can get the rx to hear my sig/gen on the antenna input, but that's about it.

Lacking access to a freq counter, but having a decent sandstate general coverage rx, [a Rat Shack DX390 which is possibly too sensitive for this use] how do I go about telling where the pto is really at? I've got more than my share of intermod and spurious mixing products and can blank the receiver 50 times when tuned through 10 turns starting at the counterclockwise. [When I say 'stop' I mean that point where the resistance of the bare pto shaft to my bare fingers just starts to increase marginally, I am being very careful not to run the pto past it's physical limits...]

Assuming I'm at the full CCW stop on the pto, where should it be? It's a Collins PTO FWIW. I won't even go into my planned 'someday' change to the Cosmos I have on the shelf... Any help would be appreciated.

---

Date: Fri, 3 Sep 2010 18:22:11 -0700

From: "Craig C Heaton" <wd8kdg@att.net>  
Subject: Re: [R-390] PTO

Looking back, I think this is still about an "A". So if it is get a copy of the Y2K, print the beast and follow along. The mechanical alignment has to be done first, check cam position at 7 +000, etc. If the receiver can hear signals, set it for one of WWV's TX's; 5 10 15 or 20 MHz. Loosen a clamp on the PTO, keep the veeder root, cams, etc from moving, turn PTO shaft only until WWV is zero beat. (BFO on)

This should get you in the ball park.

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Date: Fri, 3 Sep 2010 21:11:03 -0500  
From: <ka9egw@britewerkz.com>  
Subject: Re: [R-390] PTO

Nah, the only thing it can hear is my sig/gen at an absurd input level, at 7.035 and 8.035 [seemingly verifying what visual inspection told me when I reassembled the RF deck...although that jibes with the display indications...and some spurs at indicated 0+000 and 1+000 and a birdie at 910. I haven't looked higher than that. The cam alignment at 7+000 is spot-on, the rf bandswitch rolls over between 7 +000 & 8 +000 just like in the tutorial, and 7+000 equates to the 7 showing in the window on the crystal oscillator deck, and visual inspection before reinstalling the rf deck/crystal deck assembly confirmed the contacts were right in line. Is it somehow possible to have the crystal oscillator bandswitch mis-indexed to the indicator drum inside the crystal deck, without having done anything to the crystal deck on a previously-working receiver?

By the way, I'm using a known-good, plug-and-play IF deck just received from Fair Radio. The known-good PnP RF deck should be here Tuesday. Or could I have the MHz side of the...I dunno. I need to walk away from it for a few hours. I'll be yanking the blankety-blank rf deck again tomorrow.

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Date: Fri, 3 Sep 2010 21:11:03 -0500  
From: <ka9egw@britewerkz.com>  
Subject: Re: [R-390] PTO

I did find the 2455 and 3455 points on the PTO; there was a ton of spurs and trash audible on the general-coverage sandstate ersatz freq counter, but every 100khz I can find the signal from the pto [which appears to have a much slower tuning rate than the intermodded trash]. 3455 is about 3 or 4 turns clockwise from the end stop; does that seem about right for a collins pto?

Sanity check: 2455 equates to +000, yes?

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Date: Fri, 3 Sep 2010 21:41:26 -0500  
From: <ka9egw@britewerkz.com>  
Subject: Re: [R-390] PTO

I just had the rf deck out again, and the RF bandswitch is right, crystal switch is

spot-on, cam positioning is right at 7+000. I'm planning when/if I go back to it to start looking for a failure elsewhere in the system.

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Date: Sat, 04 Sep 2010 00:11:30 -0400  
From: Jon Schlegel <ews265@rochester.rr.com>  
Subject: Re: [R-390] PTO

As a reality check, you might consider injecting a signal more towards the back end of the receiver. Insert the hot lead of the sig gen output down in between a selected stage's tube and its shield. Use a wire with high temp insulation like teflon. Be careful not to let the end of the wire touch any of the tube pins. Some tape or heat shrink on the wire end would help here.

Likewise, to use your DX390 to sniff oscillator frequencies, connect a suitable length of coax and expose a stub of the insulated center conductor at the far end. Again, use tape or heat shrink on the very end. With this you should be able to sniff oscillator signals without overloading the DX390. If you need more attenuation, try adding additional shunt C or shunt R at the input of the DX390.

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Date: Sat, 4 Sep 2010 00:26:56 EDT  
From: Flowertime01@wmconnect.com  
Subject: Re: [R-390] PTO

The cam alignment at 7+000 is spot-on.  
The rf band switch rolls over between 7 +000 & 8 +000 just like in the tutorial.  
7+000 equates to the 7 showing in the window on the crystal oscillator deck.  
Visual inspection before reinstalling the rf deck/crystal deck assembly confirmed the contacts were right in line.

Is it somehow possible to have the crystal oscillator bandswitch mis-indexed to the indicator drum inside the crystal deck, without having done anything to the crystal deck on a previously-working receiver?

No. you are likely good here.

Tubes and alignment.  
It worked yesterday.  
Today it does not.  
Only one thing is likely wrong.

As you will learn, alignment is everything.  
A little bit goes a long way in the RF deck.

Sanity check: 2455 equates to +000, yes? True  
Conversely 3455 equates to 000.

Assuming I'm at the full CCW stop on the pto, where should it be? It's a Collins PTO FWIW. (FWIW is good money) Something more than 3455. Three turn should get you 300 K hertz more than 3455. Its still linear (well mostly). Like wise the other end

should get you 100 K hertz less than 2455 for every turn of the shaft. The real value at the limits will vary with every VFO.

I won't even go into my planned 'someday' change to the Cosmos I have on the shelf. Once you get the receiver operating, you may want to swap in the Cosmos just to make sure it works. From an electric point of view the models are equal. The Cosmos may have a higher output thus higher mixer level and may or may not provide an overall better signal to noise ratio. You do not know until you can compare what you have on hand and see.

There are two PTO's in any R390.  
Which do you speak of? (BFO VFO)  
They both have like stops and get treated the same.  
Finger resistance is the end point.

When I say 'stop' I mean that point where the resistance of the bare VFO shaft to my bare fingers just starts to increase marginally I am being very careful not to run the VFO past it's physical limits

3455 is about 3 or 4 turns clockwise from the full CCW end stop.  
Does that seem about right for a Collins pto? True

Lacking access to a freq counter, but having a decent sandstate general coverage rx, [a Rat Shack DX390 which is possibly too sensitive for this use] how do I go about telling where the pto is really at?

The VFO puts out a nice 4 plus volt signal from 3455 to 2455.

On the back panel of the R390/A should be a mini BNC to BNC connector. Most days it couples the 455 K hertz IF out to the back panel. Pull this connector off the back panel and use it to couple the VFO to a BNC cable and then a wire to your receiver. The connector will match the VFO cable to BNC cable. Do include a cap in the line between the VFO and the receiver. The VFO should put out more than 4 volts and easily over drive the receiver. The VFO should have a nice output from 3455 to 2455. you should be able to tune the VFO and receiver along nicely.

Expect all kinds of mixing between the VFO and every signal in the universe. As you have no way to isolate the antenna input of the Rat Shack DX390 receiver, the receiver will accept every signal and the VFO and then mix every combination you can imagine. Only if you can couple the VFO through a good attenuate and directly into the receiver antenna input and isolate all that from any outside sources, will you get just the nice VFO.

As you have found the 3455 and 2455 points, you can say the VFO is good and it is time to proceed.

Put the VFO back into the R390 and perform the best mechanical adjustment and alignment you can. Mechanical adjustment is green screws and Oldham coupler spacing. Alignment is getting 3455 at 7000 or 2000 depending on model.

Now you must ask your self, Self, why am I trying to shot gun a receiver with a rifle?

Indeed jam one frequency into the antenna input, listen for one signal out of the head phones and believe you can determine the exact ill of a very complex receiver. Not knowing what the problem is, it is time to systematically trouble shoot the receiver one stage at a time until you isolate all the problems and resolve each of them. Easy can do with a 4 hour time horizon. Because any R390 can be fixed in 4 hours by an experienced repairperson. Caveat, parts are on hand to effect the repair.

Tools required, head phones, signal generator, analog volt meter (two preferred), 600 ohm resistor (1 watt [2ea 1200 ohm 1/2 watt]), tweaker for caps, magic spline wrench. Other things are nice, but not required, but may make the task more fun. All real time experiments have shown that other item only divert time into superfluous tasks. When your done with the extra fun toys, the receiver does not receive any additional signals as determined by a human with head sets. It just takes longer to get the job done while playing with the toys. You need not start with a set of known good tubes. The "inspection and alignment process" will select and grade all the tubes you wish to include in the process and should leave the best tubes in the receiver in the optimum location.

You may not be able to hear any signal from / through your receiver because it cannot pass any signal through itself, for any number of reasons that have nothing to do with the VFO.

By the way, I'm using a known-good, plug-and-play IF deck just received from Fair Radio.

So you used the IF output cable and that back panel adapter to put 455 into the IF deck like it shows in the Y2K manual or any of the TM's. You get 455 to peak through the .1 Kilohertz band width and thus the 455 crystal. You did look under the lid of the first IF can and did find a crystal?

Then set the bandwidth switch to 2 KC.

Not having a calibrated signal generator, you find something around 150 micro volts will provide - 7 volts on the diode load. When you hang the 600 ohm load on the local output you can measure about 1/2 watt of power when you use a modulated signal from the signal generator. Your meter may read in power watts (nice), or DB (ok) or just AC volts (some math required 14 volts = 27 db = 500 mili watts)

The IF gain is about mid adjustment. The diode load is -7 volts the BFO is off. With the modulation on you get 1/2 watt out.

Wiggle the generator level to get 24.493 AC volts across 600 ohm load on the local audio output.

Turn the modulation off. The AC volt meter must drop to .775 volt. At most 1 volt.

This is a 30 DB difference in level between a modulated and unmodulated output. If you cannot get this difference, then the IF deck and audio deck need tubes replaced and or additional work until you can get 30 DB difference and a 1/2 watt out put.

If you cannot get the receiver to pass this test, post some mail and more details will come your way.

Put the RF to IF cables back to gather and put the 455 through a cap and into the 3rd mixer test point. The gain should be 10 times the level that goes into the IF deck. The 1 volt CW should become 2.449 volts CW and you will need to back the generator level down before you turn on the modulation.

With 30 % modulation on, adjust the generator for 24 volts on the local audio output.

Turn the modulation off and the level should be under 2 volts (about a 25 DB difference).

Now you have to get out the manual and start moving back through the stages.

You have the mechanical alignment good. Bad tubes will stop everything. Just because a tube reads good on a tester does not mean it will provide good low noise performance in the receiver. A tube can read good on a tester and generate so much noise it swamps any signal. Having trimmed the cams to exact alignment you can expect all of the RF deck alignment to be off. You may have to drive high levels of signal through the RF deck and make more than one pass to get the alignment close enough to start receiving signal from an antenna. You may have to inject signals into the mixer test points and align the second and first variable IF stages of the RF deck before you can get signals through the RF deck.

You can set the signal generator to your other receiver to help you get it on frequency close enough to help you peak it through the R390.

Let us know where you are at and how its going and we can offer some more specific detail.

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Date: Wed, 23 Feb 2011 10:04:37 -0600  
From: Paul Staupe <pstaupe@qwest.net>  
Subject: [R-390] Non-A alignment question

I recently got a R-390/URR (non-A) that was working properly when it was put in storage about 20 years ago. When I received it, there was audio hiss, but no stations received. I tried tuning it up using the manual with my URM-25D and a VTVM on the diode load to no avail. I finally gave up and tried to peak a 1500 kc signal directly to the unbalanced input. What I got was a band of BCB stations that was received about 630 kc higher than indicated on the Veeder Root counter... eg.

WHO, Des Moines at 1040 would be received at 1670 kc, WLOL on 1330 would be at 1975 etc... Does anybody have any suggestions as to what this could be?

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Date: Wed, 23 Feb 2011 10:09:54 -0600  
From: "Les Locklear" <leslocklear@cableone.net>  
Subject: Re: [R-390] Non-A alignment question

I had that happen on a R-390A many years ago, turned out to be one of those tiny temperature compensating caps 10 mmf? Inside the PTO (progressitron pto) it had broken the solder joint, but would make intermittent contact. If I remember this one was consistently 120 kc up the band. YMMV

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Date: Wed, 23 Feb 2011 11:13:25 -0500  
From: "Shoppa, Tim" <tshoppa@wmata.com>  
Subject: Re: [R-390] Non-A alignment question

Severely out-of-whack PTO, as in broken wire or cracked capacitor or maybe just a loose shaft clamp between main tuning knob/Oldham coupler/PTO?

The original R-390 docs don't reference a frequency counter because that was only a gleam in anyone's eye at the time, but it's a very handy tool for 2011 :-).

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Date: Thu, 24 Feb 2011 00:07:25 -0500  
From: Roy Morgan <k1lky@earthlink.net>  
Subject: Re: [R-390] Non-A alignment question

See if the IF strip is working (inject 455 kc in to the in put of the IF strip from the URM). Then see what frequency the PTO is really on: use another receiver with a bit of wire as antenna stuck down into the PTO oscillator tube shield, A bit of manual study will reveal what the PTO frequency should be. <snip>

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Date: Thu, 24 Feb 2011 19:05:05 -0600  
From: Paul Staupe <pstaupe@qwest.net>  
Subject: Re: [R-390] Non-A alignment question

After several days of running down clues, I'm listening to jazz on the R-390 right now after all your help, and some phone conversations with Don Heywood.

Long story short, it appears as though someone tuned it past the high band stop, and the PTO was completely off. I noticed that there was a red band between the MC and KC which should have alerted me to the problem, but I just thought that the display was different. I had never a pure red band before.

I took the RF deck out of the radio, and thanks to Don's help, I was able to see that the cams in the rear aligned up, but in a completely different spot than they were supposed to in the manual. However, once I saw that the cams were lining up, it was only a matter of time....

I went though the alignment process this afternoon, and was successful in the 455

kc alignment steps, but I was less successful with the 2nd IF and totally stymied by the first IF procedure. I then tried to pump a 1500 kc signal directly into the balanced antenna input, but really wasn't getting anywhere, so I brought it back upstairs to plug into my 160M dipole which should have melted the front end with BCB RF.. but nothing.

Then, I brought up the counter and attached it directly to the PTO output. At the top stop "931" the readout was 2.2096 and I discovered a bottom stop at -869 which was 3.221 The normal PTO output is 3.455 kc at the low end of the band and 2.455 kc at the high end of the KC band (10 turns)

Out came the Bristol wrench, and I hand turned the PTO until I was getting 3.455 at "000." Sure enough, I was getting a het with the BFO on a local BCB powerhouse at 1330 kc, and knowing that I had my 2nd IF tuning way out of whack, I started dropping the slugs back down, and the radio came to life!

Tomorrow, I'll go through a proper alignment, since it is completely hot at 1500 kc and above, but pretty deaf at the low end which would be expected since I tuned it up at the top end without test equipment to do the same at the low end of each band . Thanks so much for all your help.

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Date: Sat, 26 Feb 2011 20:50:25 -0500  
From: Curt Nixon <cptcurt@flash.net>  
Subject: Re: PTO

Collins PTO in R390A ser 3981. I am hunting down all sources of friction in the KC change chain and decided to pull and inspect the PTO. It is smooth but stiffer than I would expect with ball bearings. So it is apart and looks to be in clean condition..pix on my blog site. One thing I noticed is the stack follower rollers....the fiber side rolls fine. The opposite side, the steel roller, does not roll at all. It is greased lightly and the grease is still soft, but it looks like that roller should spin freely. Is this correct? Also, as the followers ride along the travel length of the stack shims, it would seem that both rollers should ride on the shims--in this case, the fiber side roller is not in contact with the stack. The spring is in place and the arms for the followers are free. There was no rebuild sticker or data on the PTO. the original Collins security sticker over the cover seam was intact..so I am the first to be inside since new I suspect. PTO Pics at <http://curtsworkshop.blogspot.com/>

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Date: Sun, 27 Feb 2011 01:26:38 -0800 (PST)  
From: "Drew P." <drewraille807@yahoo.com>  
Subject: Re: [R-390] Friction in KC Change Chain

"I am hunting down all sources of friction in the KC change chain and decided to pull and inspect the PTO. It is smooth but stiffer than I would expect with ball bearings. So it is apart and looks to be in clean condition..pix on my blog site."

On both Cosmos and non-Cosmos design PTO's, there is a small o-ring in a groove in the bore in the housing through which the lead screw shaft passes. The function of that o-ring is to provide a seal to prevent the pressurized nitrogen from escaping.



The small o-ring is in addition to the larger one around the outside of the housing between it and the can.

Removal of the shaft o-ring will quite noticeably reduce PTO shaft drag. The o ring would not be needed by most of us as the nitrogen leaked out long ago. To remove the o-ring will require disassembly of the PTO and removal of the tank coil, slug, and lead screw. Once these parts are removed, the o-ring may be removed with a sharp hooked tool such as an appropriate dental pick. I have also found that the anti-backlash nut on the slug can be set somewhat looser and this will reduce drag further and make tuning smoother as well. If too loose, there will be annoying backlash.

It has been recommended to remove the dessicant packs inside the can as these have been known to disintegrate, filling the PTO mechanism with an apparently corrosive grit, as mentioned in forum postings past.

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Date: Sun, 27 Feb 2011 10:55:50 -0500  
From: Curt Nixon <cptcurt@flash.net>  
Subject: Re: [R-390] Friction in PTO

Thanks Drew: The seal O-ring is EXACTLY what it feels like. I mentioned that to another tech off list and said it was smooth but felt like an shaft sealed with an O-ring. I have dry nitrogen here purge with but being there is no valve, it must have been assembled in a nitrogen chamber which I DON'T have :). knowing what is involved to get that O-ring removed, I might just leave it in there and live with the friction at this point. I can always pick up another PTO assembly and do the dissection on it instead of this original one.

I looked and searched a lot but never saw any type of drawing or internals information on the non-cosmos PTO.

BTW, sorry for the messed up subject line..it was late. I attached the rest of my original post here so it would show up with the good information you offered.

I re-looked at the stack follower and believe they are both riding on the stack. It must have been a light reflection making it look otherwise.

The metal roller does not rotate..the stack edge is simply greased. It sure would seem that they would have made that a roller and not a slider. Can you confirm this one way or the other. Also, is there a reference somewhere on the internals and assembly, etc of the Collins PTO..I have had no success finding anything.

I did find the reference to removing the dessicant bags. Wonder if its worth adding one of the current generation no-plastic dessicant containers?

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Date: Sun, 27 Feb 2011 11:38:04 -0800 (PST)  
From: "Drew P." <drewraille807@yahoo.com>  
Subject: Re: [R-390] Friction in KC Change Chain

In my Progressitron unit, the steel "roller" did not roll.

There is an excellent online reference for the Cosmos unit but I have not yet seen any for the non-Cosmos type. You have started the process with the series of photographs on your blog site. It would appear that aside from the aforementioned ER article that you will be the trailblazer for non-cosmos PTO documentation.

Thank you for posting photographs and starting the documentation process. The excellent online references we have for other aspects of these radios have all been the work of generous individuals such as you. All of us in the R-390x community look forward to referencing your completed work.

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Date: Mon, 28 Feb 2011 11:20:49 +1100  
From: "Pete Williams" <jupete@internode.on.net>  
Subject: [R-390] PTO friction ?

G'day all..from my experience,over both Cosmos and Collins PTO some friction/ resistance to rotation is inevitable ---- question is one of relativity. Those who can 'freely' turn the kHz knob with one finger have hitherto undisclosed digital muscle development in my view, or definition of 'freely'somewhat elastic!

The lead screw and sliding restraint have non negligible resistance.. It would be better if there was a turning torque stated as so many inch- ozs. to a pull point on the spigot that connects to the Oldham coupler. Anyone got or want to quote a figure ?

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Date: Mon, 28 Feb 2011 16:10:28 -0600  
From: Randy and Sherry Guttery <comcents@bellsouth.net>  
Subject: Re: [R-390] Friction in KC Change Chain

Of course you do... with a bit of imagination... Here's a small blurb on nitrogen "purging" and/or charging... <http://www.comcents.com/radios/PTO.html>

Since there is quite a bit on repairing, linearizing, etc. I didn't get into any of that - but there wasn't much on nitrogen - so here 'tis.... HTHs...

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Date: Mon, 28 Feb 2011 21:41:23 -0500  
From: Curt Nixon <cptcurt@flash.net>  
Subject: Re: [R-390] Friction in KC Change Chain

That link was exactly what I needed. It answered a couple of questions on the Nitrogen purge process.. Also, it got me to search through all 255 pages of the PTO archive for references to non-Cosmos version.

So..here is where I got to:

Dis-assembled the PTO down to pulling the slug and leadscrew assembly. Cleaned all that with the end bearings and thrust bearing/Belleville washer, etc. and evaluated the drag in the assembly.

I found the front end shaft seal O-ring to be brittle and cracked and was offering very little detectable drag. After cleaning and relubing and assembling the leadscrew and slug and its preload nut, I found that the majority of the drag I could feel was not the O-ring but the screw preload nut. I re-assembled with the minimum preload available--ie run the nut down all the way to the slug and then back it out only far enough to align the first available hole pattern---less than 1/3 of a turn. This was 1/3 less than the original preload amount but did not reduce the drag significantly. I tried several types of lubricant on the screw. Phil Wood teflon, pure teflon grease, light oil, etc. The pure teflon grease seemed the best but was still not real free.

I left the O ring out of the re-assembly

I am in process of building an adapter to use in quantifying the torque to turn using a special small dial torque meter..more to follow on this.

Also, as I mentioned earlier, the "roller" follower for the linearization stack did not rotate. After studying the construction, I am convinced that it is supposed to rotate. It has a steel roller over a plastic bushing over a staked-in pin. I forced it to turn and tried to free it up but the whole pin turns in the bracket so I gave up. Even tried heat cycling it with penetrating oil..no go. I suspect the thing is either over staked, or the plastic bushing has been affected by heat, or it was just bad from scratch. When opened up, the stack had grease along the contact area of the follower and no wear is noticeable, but I still think it should turn.

I re-assemble it all with clean grease there and left it frozen in place. I will investigate later when I get ahold of another Collins PTO to experiment with. I have sourced some miniature roller bearing cam followers that will replace the staked-in unit with a real ball bearing roller.

I will also experiment later with putting washers under the screw pre-load nut spring leaves to reduce the preload and drag more than simple backing it off 1/3 of a turn. (reducing the spring tension on the pre-load nut)

No particular problems encountered in the process..thanks to having pieced together numerous tid bits from the archive.

One problem I anticipate, and others will need to be aware, the holes in the forward and rear mounting brackets (the green screw brackets) are much larger than the screws to allow for significant movement of the PTO body upon re-assembly into the radio. Alignment of the Oldham coupling can be tedious but is critical to the free operation of the assembly.

I left the heater wires disconnected inside the enclosure as I believe the advice about the ovens not being needed. I will be monitoring the overall stability later and may choose to re-connect them and run all the ovens for FMT events. Also decided to put off the nitrogen purge until I have a chance to verify the PTO linearity and operation. I have some ideas regarding the stack adjustment process that I would

like to try later with a second PTO. It should be possible to correlate the amount of stack offset to frequency error at a series of points and create a "template" of sorts for adjusting the entire stack at once.

So thanks to all for the inputs so far. I will be finishing up the gearbox cleaning this week and should have my cap order by then.

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Date: Mon, 12 Dec 2011 10:28:02 -0800 (PST)  
From: Garry Stoklas <jergar@sbcglobal.net>  
Subject: [R-390] Motorola PTO

I recently aquired a Motorola R-390A at a yard sale. It looked good overall and all knobs turned. After getting it home and taking a closer look, I saw that the oldham coupler to the PTO had been backed off and the PTO shaft wouldn't turn. I pulled the PTO which had the decal seal still intact. Since it would turn, I decided to open it up. What I found is that it had been turned so hard that the slug was at the far end and the tuning shaft had been bent. Hard to believe that someone could turn it that hard.

I am looking for two things: a replacement PTO, but also a replacement tuning shaft as I plan to try and rebuild the one I have as a spare. The gentleman that rebuilt his COSMOS PTO has inspired me. I would also appreciate any advice on the subject.

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Date: Mon, 12 Dec 2011 13:56:18 -0500  
From: Curt <cptcurt@flash.net>  
Subject: Re: [R-390] Motorola PTO

Not sure of which mfg, but Fair Radio is still advertising PTO's. They are also usually available via eB&\*Y. See some additional Collins PTO internal rework.  
[www.curtsworkshop.blogspot.com](http://www.curtsworkshop.blogspot.com)  
Depending on condition, you can check out a local electric motor repair shop. They straighten small motor shafts all the time.

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Date: Mon, 12 Dec 2011 15:02:29 -0500 (EST)  
From: ToddRoberts2001@aol.com  
Subject: Re: [R-390] Motorola PTO

I have straightened out an R-390A PTO shaft- end by hand before. The shaft is made of stainless steel I think and not hard at all to bend. It was the end of the shaft protruding from the PTO. I used a set of Vise Grips and just carefully bent it back into shape as close as I could get it to perfect by sighting along the shaft and turning the shaft. It now turns just fine with good precision and no binding. Not sure if your situation is similar but the shaft can be bent by hand using simple tools and patience.

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Date: Mon, 12 Dec 2011 16:33:21 -0500  
From: Barry <n4buq@knology.net>  
Subject: Re: [R-390] Motorola PTO

It's probably fairly soft and an engine lathe, a soft hammer, and a dial indicator, and some finesse would bring it back pretty easily.

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Date: Tue, 13 Dec 2011 21:15:50 -0500  
From: Steve Hobensack <stevehobensack@hotmail.com>  
Subject: Re: [R-390] Motorola PTO

Anything less than perfect results would cause a slight wobble. Calibration would vary with the same pattern within each 100 khz segment of the tuning range. If it were me, I'd try to locate a junker and salvage the shaft. Is the shaft the same in other pto driven receivers/transmitters?

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Date: Wed, 18 Jan 2012 22:25:10 +1100  
From: "Pete Williams" <jupete@internode.on.net>  
Subject: [R-390] COLLINS PTO

G'day List... My efforts over several days to endpoint and linearise a Collins PTO-- specifically one from a R-388 (51J-3) have been an abject failure .--- procedures documented tried with limited success with results way out of useful spec. At the risk of boring readers, what I have done is documented below and pose points requiring better engineering background to supply answers/explanation.

DONE...

1. Trimmer coil turn removed -- end point acceptable with slug right in, but linearity at 100 kHz points (each 360 deg. urn) can vary from 8 to 12 kHz from one point to the next,

2. . . . reducing the 20 pf cap to say 10 or 15 pf across the coil assists setting end points but linearity still varied per above comment. Small variations in that cap from 10 to 15 pf change all aspects -- endpoints and linearity but still unacceptable Even very small incremental changes up or down similar results .

3. It is a fact that linearity starts with the design of the main tuning coil, but what is not obvious is that the total capacitance across the coils IN CONJUNCTION WITH THE POSITIONING OF THE TUNING SLUG MUST DETERMINE THE CORRECT CONDITIONS FOR LINEARITY OVER THE FULL 10 TURNS... is this interpretation correct ? ? It is obvious then , that if the total capacitance is reduced, the tuning slug must have to be moved that little bit more within the tapered coil to achieve resonance--- thus changing the design parameters .

4. Therefore ..not tried is changing the 250 pf pf capacitor, the major contributor to the tuning range. It probably determines the point coincident with linearity over the range and where the slug is positioned within the coil.

5, The shims set the frequency at any given point in the tuning range... their effect is minimal and at any given point, the maximum change that is possible is only a few kHz to set that point of rotation accurately . They DO NOT have any major effect in providing linearity. In conclusion...are there knowledgeable folks that can give an

explanation as to how linearity is achieved with special reference to my comment in point 3 above Apologies for being so pernickety !

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Date: Wed, 18 Jan 2012 18:20:16 -0500 (EST)

From: Flowertime01@wmconnect.com

Subject: Re: [R-390] COLLINS PTO

Inside secret R388 VFO were never as linear as R390 or R390/A VFO's. That little tidbit never made the TM. If you needed to receive those frequencies you were happy to have a R388 to get the job done. Other than beating the receiver against a calibration tone you would never know the frequency of the signal being received. This problem lead to the use of split headphones. Here listen for this signal where ever you find it around some dial number.

No one wanted to try and lay tapered winding on the form with more exactness. The specified wind pattern was just the best average to make production. I do not suggest you start your education into VFO's by reinventing a R388 VFO.

First worry not about end points.

End points are second.

In any VFO adjustment, the last thing we do is reinstall the VFO.

The second last thing we do is set the end points.

Logically then linear must come before these two steps.

Every thing that follows is just stuff I have read elsewhere and have never had to do my self. But R388 VFO's are not real available and thus this restoration must be done.

Back when the shim stacks were "factor set" the secret ingredient was a high viscosity slow drying varnish. This let the shims be set and sort of stuck in place while other shims were brought into adjustment. The end results is that a good VFO has an S curve to the shim stack.

You would like the ten turns to be 1 megahertz. You do not care where it starts or ends as that will come later. The trim caps, and the end point adjustment in about the middle of its range needs to give you 1 megahertz over ten turns. Set the end point coil device to about mid range. Add or remove caps to get a 1 megahertz span. Sort of close to 455.

Then the non linear deviation needs to be where the shim stack will bring the 100 K hertz points into range. This is a very well aged VFO and exact may not be possible.

Pull the stack apart and clean all the shims.

You will need to build a template S curve. (soft pine and sand paper. Bondo and resand. A stiff but soft aluminum strip that can be formed. Hammered copper.

The template needs to set against the shims to set the stack. With the template in place you loosen the shim stack and use the template to give form to the shim stack curve. Tighten the stack. Test the VFO. Think about the template adjustments that need to be made. Modify the template. repeat the process. Once that template was found at Collins. It was just applied to every VFO. Not having that original factory jig in hand you get to reinvent and re calibrate it.

At the factory, one had a template and slow drying varnish. The VFO was determined to be working and needing its shims set for final assembly. The shim stack was loose. The shims were varnished. This stuck them to each other. The template was applied. the shim stack was tightened. With a slow varnish the points could be checked and the process repeated. Likely several templates were on hand in a set so the best fit could just be applied and "experienced" tuners could hand set a section as needed.

Then the end point was set.

Select a slow drying varnish (hours) Find a thinner that will dissolve the varnish. (Undo).

You have a feel for how far you can move a point with the shims. Put all the shims over to one or the other limits. You can add / remove turns to the trim coil, and add / remove small caps from the circuit. You have to work that mix until you feel the VFO runs ten turns and tracks close enough so that you can "shim" the mid points. You have to move the circuit back onto the fit of the PTO coil taper. When you get there you will see the mid points draw close to where they are expected to be. As you are off the "sweet spot" you see one end or the other of the VFO range fans fast out of range. This will tell you if you need to drive the trim caps and coil up or down in frequency to get the VFO back on to the sweet spot of the VFO coil.

Take Care. Stay with it. A simple frequency counter and a pencil mark for the ten turns should get the job done. Like the R390's you can turn the R388 up on end and work the VFO while hanging out of the chassis. Do pull it out and get the outer cover and heater off it just to make the process easier. You ca pull all the cans off so you can work the shim stack.

Last resort you may want to file the shims (holes or ends) to get some more range. You may want to invest in a R390/A Collins VFO for parts so you do not have to file on R388 shims.

Pete, I do not read my mail every day, But I will get back to you if you need more info. Roger Ruskowski AI4NI (68-74 R390 Radio Repair Person USASA)

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Date: Wed, 20 Jun 2012 23:10:37 -0400  
From: Bob Young <bobyang53@hotmail.com>  
Subject: [R-390] 390 Oldham coupler springs

I just pulled a 390 I've had for a few years out of retirement and adjusted the end points and found that the springs on the Oldham coupler are missing. Does anyone

have any spares or can anyone point me toward good substitutes for the real thing? Thanks,

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Date: Thu, 21 Jun 2012 05:13:15 -0700 (PDT)  
From: Michael OBrien <mikobrien@yahoo.com>  
Subject: Re: [R-390] 390 Oldham coupler springs

I have heard that the springs out of old ball point pens will work (Modified)

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Date: Fri, 22 Jun 2012 07:57:02 -0500 (CDT)  
From: nryan@mchsi.com  
Subject: Re: [R-390] 390 Oldham coupler springs

That's a super idea! Much like the original spring -- you only have to bend loops on each end. (Only one spring is to be found on the oldham coupler, BTW.)

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Date: Fri, 22 Jun 2012 09:19:34 -0400  
From: Barry <n4buq@knology.net>  
Subject: Re: [R-390] 390 Oldham coupler springs

A small o-ring or two would work as a temporary solution.

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Date: Fri, 22 Jun 2012 10:21:57 -0400  
From: Bob Young <bobyong53@hotmail.com>  
Subject: Re: [R-390] 390 Oldham coupler springs

I'd like to thank everyone for their suggestions on using ball point pen springs for the Oldham coupler which worked great. I thought I'd read that somewhere but said no that can't be, haha!

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Date: Tue, 17 Jul 2012 13:42:52 -0400  
From: Bob Young <bobyong53@hotmail.com>  
Subject: [R-390] R-390A PTO ground strap screw

I took the ground strap off that touches the shaft to clean it and dropped one of the little screws and lock washers onto the floor to be found in maybe a few years. Does anyone have a junker PTO hanging around with these screws on it? I only need the one screw but would take the whole PTO if need be. The PTO is working well with only one screw but I really want it to stay that way, thanks,

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Date: Tue, 17 Jul 2012 14:07:09 -0400  
From: "David C. Hallam" <dhallam@knology.net>  
Subject: Re: [R-390] R-390A PTO ground strap screw

I have learned to do as watch makers do. When disassembling small items with tiny bits and pieces, do in a tray with a rubber mat. I am still looking for a small plastic gear from a Johnson Invader VFO that fell from the bench to the floor several years ago. My work bench is raised about 3" above the floor. Even with a rubber mat on the floor, parts always roll under the bench. Watch makers often worked at



desk with a lined drawer. Watches were disassembled in the drawer.

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Date: Tue, 17 Jul 2012 13:57:49 -0600 (MDT)  
From: Richard Loken <richardlo@admin.athabascau.ca>  
Subject: Re: [R-390] R-390A PTO ground strap screw

I recently invented that one independently, I was replacing the bearings in some fans that were held together with a miniscule snap-spring and (after chasing a washer across the floor) concluded that I would have fewer lost parts if I did the disassembly in the lid off a Xerox printer paper box. I will do that with many things after this.

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Date: Tue, 17 Jul 2012 19:51:55 -0500  
From: "chacuff" <chacuff@cableone.net>  
Subject: Re: [R-390] R-390A PTO ground strap screw

How can you possibly loose any screws when falling from a work bench only 3" from the floor... Yea...Yea I know theres one in every crowd. I feel your pain...I put dirt colored carpet on my shop floor...everything gets lost. It an indoor/outdoor type very low pile but still loose things. You would think they wouldn't bounce as easily but it does..

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Date: Tue, 17 Jul 2012 22:31:42 -0400  
From: Roy Morgan <k1lky@earthlink.net>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Trick developed while overhauling an SX-88, which has two gear trains loaded with anti-backlash gear sets, and very little room to get things together. Pass a length of dental floss through one or two of the middle turns of the small spring (or in the case above, through the teensy hole in the snap ring if it has them, or around the middle of the snap ring). Fasten the ends of the dental floss to the radio or some moderately heavy thing on the bench: the string can be as long as needed for this. After assembly is complete, you can pull the dental floss out of the spring easily, not so sure about the snap rings but the thinnest kind of floss might work best.

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Date: Tue, 17 Jul 2012 21:46:43 -0500  
From: n4buq <n4buq@knology.net>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Bet you wish you'd had all this advice before you lost the screw that no one seems to have a replacement for... :-) Isn't it just a standard stainless panhead Phillips #4-40 or #2-56, etc.? I can't remember as it's been a few years since I looked at one.

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Date: Tue, 17 Jul 2012 23:12:17 -0400  
From: "Charles P. Steinmetz" <charles\_steinmetz@lavabit.com>  
Subject: Re: [R-390] R-390A PTO ground strap screw

I used bright white polyamide epoxy (with a matting agent -- not full gloss) on my

[concrete] shop floor. Makes it easy to clean, and easy to spot anything that falls. If I had a wood floor, I'd put down bright white linoleum sheets (not tiles -- too many cracks for things to fall into). I have, in the past, put several magnetic bench mats on the floor where parts tend to land, but of course that only helps for ferromagnetic parts, and only if they land on a mat.

A related point -- I had the contractor install twice as many light fixtures as he had planned (he told me he had already doubled the number he would use for a kitchen, which he makes the brightest room in a residence). 24, 40 watt fluorescent tubes in a 9' x 15' room with a 10' ceiling. Walls, ceiling, and floor are all bright (matte) white, which gives a beautiful, shadowless light everywhere. Best shop lighting I've ever had. I have some task lights, but don't need to use them often, even to find stuff on the floor.

Finally, I use sturdy (8 mil or thicker), clear plastic storage bags large enough to contain the item I'm working on if I'm really concerned about losing tiny parts. Industrial suppliers have them large enough to contain whole radios, if need be. I use these to keep dust off equipment that is just sitting on a shelf, as well, including disassembled equipment that is waiting for parts or waiting for inspiration. None of these tricks is very expensive -- anyone can use them to make their life easier.

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Date: Wed, 18 Jul 2012 15:15:35 -0400  
From: Bob Young <bobyong53@hotmail.com>  
Subject: [R-390] R-390A PTO ground strap screw

>Isn't it just a standard stainless panhead Phillips #4-40 or #2-56, etc.....

I don't know but will check today at the hardware store, thanks, (Let me put it this way: I knew when I had the PTO up over my head and the little screw balanced on my screwdriver that it wasn't a real smart thing to do, haha!)

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Date: Wed, 18 Jul 2012 19:28:47 +0000  
From: "Webb, Gary" <glwebb@gundluth.org>  
Subject: Re: [R-390] PTO groundstrap screw

I use a magnet from a junked hard drive to find most of my dropped items. But if the screw is non-ferrous..... which is probable in a PTO. A lot of fasteners in the medical equipment I work on are stainless which also are immune to the magnet. So some items never are retrieved.

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Date: Wed, 18 Jul 2012 18:39:49 -0400  
From: "KR4HV" <kr4hv@numail.org>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Hi Bob. When you find out exactly what type screw it is you may want to try Fastenal([www.fastenal.com/](http://www.fastenal.com/)). I am not connected with them, just a customer. They are an industrial supplier and can get just about any screw & bolt made with any thread count, US, course or fine and metric) . They don't cater to the individual trade but will sell to us. Most of their locations (check the computer, they

are all over the US) stock down to 4-40 or 6-32 in stainless, cadmium and brass but I have just gotten some 3-48s, 2-56s, 0-80s & M3s in different lengths in stainless from them (they ordered them for me and it took all of 3 days delivered to their store). I particularly like the stainless nuts with captive star washers in 4-40, 6-32 & 8-32, etc. Work great in tight places. They sell them in bags of 50 or 100 in these sizes.. You may have to order 25 or 50 of a part number as they typically don't sell by "each". They are much more affordable than the hardware or builder's mart.

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Date: Wed, 18 Jul 2012 23:22:55 -0400  
From: Barry <n4buq@knology.net>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Actually, the local store here will sell just about any quantity to me if it's in stock. If they don't stock it, then they may have a minimum on very small screws, etc., but typically it's a very reasonable quantity (not like a \$25 minimum or anything like that). I've started using them more as the store is right on my way to work and, like you say, they have just about any kind of fastener. Watch out which kind of stainless fasteners you order, though. One grade is vastly more expensive than the other.

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Date: Thu, 19 Jul 2012 11:46:14 +0000  
From: William A Kulze <wak9@cornell.edu>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Do you think they would have the square 4-40 nuts used on the shaft clamps? I lost the one for the BFO shaft a long time ago. I've since put on a hex, which seems to work well enough, but it doesn't seat down into the clamp.

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Date: Thu, 19 Jul 2012 13:28:21 -0400  
From: "KR4HV" <kr4hv@numail.org>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Bill, just checked with my contact at Fastenal. They have the square #4-40 Stainless Steel nut. Their computer showed about 5000 in stock at various company locations. The Fastenal part # is 0170846. They sell these in "each" quantities for about \$0.45ea. May take your local Fastenal store about 3 days or so to get one or more for you from another branch store if they don't stock them. BTW, the price is a lot more per unit for this square nut than standard SS #4-40, #6-32, #8-32, etc. hardware in bags of 50. Guess they don't sell many square ones nationwide. Hope this makes your day a little brighter!!!

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Date: Thu, 19 Jul 2012 12:57:59 -0500  
From: n4buq <n4buq@knology.net>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Doubtful as those aren't very common anymore. You can check their website, though.

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Date: Thu, 19 Jul 2012 13:34:29 -0500

From: n4buq <n4buq@knology.net>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Well, well, well. I didn't think they had them, but:  
<http://www.fastenal.com/web/products/detail.ex?sku=0170846>

They have many other sizes as well.

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Date: Thu, 19 Jul 2012 13:28:21 -0400  
From: "KR4HV" <kr4hv@numail.org>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Bill, just checked with my contact at Fastenal. They have the square #4-40 Stainless Steel nut. Their computer showed about 5000 in stock at various company locations. The Fastenal part # is 0170846. They sell these in "each" quantities for about \$0.45ea. May take your local Fastenal store about 3 days or so to get one or more for you from another branch store if they don't stock them. BTW, the price is a lot more per unit for this square nut than standard SS #4-40, #6-32, #8-32, etc. hardware in bags of 50. Guess they don't sell many square ones nationwide. Hope this makes your day a little brighter!!!

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Date: Thu, 19 Jul 2012 12:57:59 -0500  
From: n4buq <n4buq@knology.net>  
Subject: Re: [R-390] R-390A PTO ground strap screw

Doubtful as those aren't very common anymore. You can check their website, though.

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Date: Tue, 24 Jul 2012 10:34:19 -0400  
From: Tom Bridgers <tarheel6@msn.com>  
Subject: [R-390] Newark Electronics sells square nuts  
To: Barry N4BUG <n4buq@knology.net>, R-390 Group

Newark Electronics sells Vector square nuts.  
See: <http://tinyurl.com/c546fnw>  
Excellent: Have used these for years. Best, -Tom KE4RHH

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Date: Sun, 7 Oct 2012 04:20:46 +0200  
From: sigmapert <sigmapert@gmx.de>  
Subject: [R-390] Discovery of a genuine COSMOS PTO for the R-390 receiver

Recently we stumbled across a box containing three PTOs produced by Cosmos Industries, Inc. that a few years ago had come from a Japanese military gear dealer. To our surprise one of these PTOs turned out to be an uncommon COSMOS PTO for the R-390 Non-A receiver. The PTO shows original wiring without any sign of modification.

For further info:  
[http://schmid-mainz.de/Genuine\\_COSMOS%20\\_PTO%20\\_for\\_the\\_R-390\\_Non-](http://schmid-mainz.de/Genuine_COSMOS%20_PTO%20_for_the_R-390_Non-)

A.htm

Qualified discussion of the above presented data is welcome.

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Date: Thu, 27 Jun 2013 12:15:21 -0300  
From: PY1NB - Felipe Ceglia <felipeceglia2@gmail.com>  
Subject: [R-390] How to identify pto

I need to identify a pto which had the labels badly removed. It is slipping a few khz while turning. Like a loose axle, Oldham coupler is ok.  
I haven't yet checked its linearity.



Date: Tue, 9 Jul 2013 15:12:47 -0300  
From: PY1NB - Felipe Ceglia <felipeceglia2@gmail.com>  
Subject: Re: [R-390] How to identify pto

Here are the pictures of my PTO:  
<http://goo.gl/ahwWC>      <http://goo.gl/UChnQ>

I noticed that when I rotate its axle CCW it has a spring tension feel, but it feels OK turning CW. Is this normal?

Date: Tue, 9 Jul 2013 15:38:01 -0400  
From: Bob Young <bobyong53@hotmail.com>  
Subject: Re: [R-390] How to identify pto

I'm not an expert by any means but I've never felt any difference in a PTO turned either way. Incidentally was there a bluish tinge left on that PTO from the label?

Date: Tue, 9 Jul 2013 19:41:34 -0400 (EDT)  
From: Roger Ruskowski <flowertime01@wmconnect.com>  
Subject: Re: [R-390] How to identify pto

>From the photo we get real no clues.

It is not your fault. The only question of importance is does it or does it not work. We do not hold it against Collins, Motorola or even Cosmos for making the things. We only care if they work. Once you slide that receiver back into a rack no one will ever know what parts are inside.

It should turn equally free either way. You may want to try easy with some WD40 on the front bushing letting the critter stand on end so the solvent has a chance to soak in. and see if that helps the ease of operation. Long road is to do a disassembly so you can work some solvent in from the inside into the shaft bushing. You do not want to take it apart to where you pull the shaft out of the bushing. Aggravation exceeds return on investment. Mostly some select solvents and oils applied to the front with gravity assist and time (days) will resolve the problem of friction. It will always be stiff as that is part of the antilash. but it should run smooth in both directions for a good 11 plus turns (only ten used). As long as you have it this far apart take the time to soak the shaft and bushing clean.

Date: Tue, 9 Jul 2013 21:54:36 -0300  
From: PY1NB - Felipe Ceglia <felipeceglia2@gmail.com>  
Subject: Re: [R-390] How to identify pto

I wanted to identify the PTO so I could search for an exploded view and see what could be happening on my unit. I disassembled it to the point of removing the external can, and got pretty much scared to proceed...

Date: Tue, 9 Jul 2013 18:26:47 -0700

From: "Craig Heaton" <hamfish@efn.org>  
Subject: Re: [R-390] How to identify pto

Years ago I disassembled a Motorola PTO. Sort of felt gritty upon turning. From memory; under the outer can is a layer of insulation, then a couple of wires to remove (heater), then another can covering the corrector stack & roller assembly. The desiccant bag had broken and the gritty stuff was everywhere. DO NOT mess with the corrector stack if it is a Motorola PTO. Clean the insides as best as possible, make sure the spring/scissor assemble is ok. Maybe a little Deoxit on the corrector stack & a drop of your favorite lube on the shaft.

Date: Wed, 10 Jul 2013 18:14:35 -0300  
From: PY1NB - Felipe Ceglia <felipeceglia2@gmail.com>  
Subject: [R-390] my PTO problem, part II

To illustrate what is happening here, I uploaded these 2 videos to youtube: This one tries to show the "spring loaded" feel on the axle, while turning CCW: <http://www.youtube.com/watch?v=hAZf9bn1Dnw>

And this is what happens with the rig turned on and audio: <http://www.youtube.com/watch?v=6atQplq69Ms>

I made a black dot on the pto axle, so we can see when it is moving. The oldham coupler spring is missing, but I wouldnt blame it.

Date: Wed, 10 Jul 2013 17:46:35 -0400 (EDT)  
From: Barry <n4buq@knology.net>  
Subject: Re: [R-390] my PTO problem, part II

Something is very wrong with that PTO. I can tell from watching that you are having to exert quite a bit more torque than is normal. You should be able to turn that disc easily with your little finger.

Date: Wed, 10 Jul 2013 18:03:07 -0500  
From: Les Locklear <leslocklear@hotmail.com>  
Subject: Re: [R-390] my PTO problem, part II

Possibility of a bent pto shaft, there was something about a fix several years back in the Hollow State Newsletter.

Date: Thu, 11 Jul 2013 11:11:27 -0500  
From: Tisha Hayes <tisha.hayes@gmail.com>  
Subject: Re: [R-390] PTO problem, part II

Since it appears there is some sort of internal binding you may want to buy a spare PTO and put it in service. They are not unavailable; even on eBay you can get one for \$30-\$80. Then you will feel less hesitant about opening up the funky one you have to see what is binding.

You can probably fix it but it is going to be a "learning experience" and may be like the wire reattachment saga on the mechanical filters a few weeks ago. If you could not get replacement parts (all of the spare PTO's in the world suddenly vanished) then you could go to heroic lengths after you taught yourself to be a machinist and metallurgist.

If they had been "cooked" by stuck-on heaters or turned way past their end limits you can have a bent shaft, stripped parts or a melted plastic piece (if you saw the inside it would be immediately obvious)

I would rather listen to the radio than to spend weeks working on one item where I have spares. The PTO would become a rainy day project but the problem would not keep me from having the receiver on the air.

That is just my personal opinion, YMMV (your mileage may vary) but I am being a bit pragmatic about it.

Date: Thu, 11 Jul 2013 11:20:04 -0700 (PDT)  
From: Norman Ryan <nnryann@yahoo.com>  
Subject: Re: [R-390] PTO problem, part II

Tisha's mention of "stuck-on heaters" reminds me that it is a good idea to disconnect the heater wires permanently while one has the PTO open. There have been instances where the PTO heater's thermostat gets stuck with disastrous results to the innards.

A special foray into the PTO isn't necessary just to disconnect the heater wires; a simple fix is to remember to keep the Heaters On/Off switch located behind the receiver in the "Off" position. At normal room temperatures the receiver is exceptionally stable after a thorough warm-up.

Check behind the receiver and see where the heater switch is set and try operating with it "Off" if it isn't already; the difference likely will not be perceptible in most instances.

If you operate with the heaters off, change the main 3 amp fuse to a 2 amp fuse for maximum protection of the B+ circuits.

Date: Thu, 11 Jul 2013 13:39:23 -0500  
From: Les Locklear <leslocklear@hotmail.com>  
Subject: [R-390] Info from HSN Issue 37 on repairing a bent PTO shaft

STRAIGHTENING A BENT R-390A KCS CHANGE SHAFT [Shawn Merrigan] An R-390A purchased "as is" from Fair Radio had a bent KCS (vfo) change shaft which wobbled visibly when rotated. This caused binding at the bushing in the gear plate and at the front panel bushing. The result was a hard to turn KC's change control. I could have simply loosened the front panel bushing lock nut slightly, allowing the shaft and bushing to float, but I decided to do the right thing and replace the shaft. This is a fairly straightforward job, but there are a couple of things to watch, and

keeping them in mind will help:

1. A taper pin indexes the dial lock hub and gear to the KCS change shaft. This pin has to come out to remove the shaft. Drive the pin out from the narrow side! This is a small taper pin.
2. A larger taper pin holds the ten-turn stop assembly on the KCS change shaft. This pin must also be driven out from the narrow side. Look for the smaller of the two holes in the ten-turn stop end block (looks like a big thick washer) and drive the pin out from that side.
3. When driving out the pins, particularly the larger one, counterbalance the shaft with a large mass so you will not bend it. Use WD-40 to loosen the pin and tap gently. In fact, I wound up straightening out the old shaft using machinist's V-blocks and a brass drift. I then polished the shaft to remove any burrs and blew out the taper pin holes with WD-40 to prevent binding. The run out of the straightened shaft was very small and, after re-assembly, there was no binding evident and the shaft turned smoothly.

Date: Thu, 11 Jul 2013 14:25:01 -0500

From: Tisha Hayes <tisha.hayes@gmail.com>

Subject: Re: [R-390] PTO problem, part II

Maybe it is the "DO NOT OPEN" warning on the can but the PTO is just a precision tuned variable inductor (Permeability Tuned Oscillator) there is a threaded rod that drives a slug into a coil and a few other compensating devices in there (caps and inductors). It definitely sounds like a mechanical binding issue if you are getting drag in one direction or springiness when tuning it. The electrical connections to the PTO are minimal, it is just an oscillator, you could rig it up on the bench and connect it to a good frequency counter to see it in action.

Maybe the threaded rod is all goosed up with residue of 60 year old grease or someone else had been playing with it or the rod is bent or the carrier for the slug is canted out of alignment (from someone forcing it past its stops).

Carefully cleaning it out. using a little bit of mild solvent to wash away the crud, cleaning up the o rings (on the case and the tuning shaft) and being very sparing in putting lube on the right spots is usually all it takes. Sometimes you need to remove a turn on one of the variable inductors if you cannot reach the end-point (there is an entire procedure out there that shows you how to do that with pictures and step by step instructions). As it has been said, that thing should tune very freely and if done right, the entire mechanical tuning assembly (racks, slides, gears, shafts, PTO) can be worked on so you can tune the radio with the tip of your finger on the knob.

If you were enterprising you could take out the little desiccant capsule and bake it under low heat to dry it out completely (the color will change) and put that back in right when you are ready to button the thing back up.

I would dread the idea of adjusting that swash-plate compensating disk. There is a special type of masochist who will tackle that. Fifty-million little screws to adjust

linearity... euck!

Date: Thu, 11 Jul 2013 15:48:27 -0400  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] PTO problem, part II

I'd \*much\* rather tweak the Cosmos PTO linearity screws than to even think about a Collins corrector stack! There really isn't that much to opening a PTO and cleaning out the dried out lube. One can make a concerted effort to dry out the desiccant capsule. However, unless you KNOW the O-rings really seal, then there isn't much sense in doing so. It is just like going through the drill of pressurizing the PTO with dry nitrogen. There isn't much need for that either. You would be assuming the Shrader valve core was still supple enough to seal. You could replace that valve with a new one from a bicycle shop or automotive parts place. IOW, your mileage may vary, and how far does one want to go? I'm at the point that I am debating whether to even finish restoring the blue striper that I've been working on. <snip>

Date: Thu, 11 Jul 2013 22:50:18 -0400 (EDT)  
From: Roger Ruszkowski <flowertime01@wmconnect.com>  
Subject: Re: [R-390] my PTO problem, part II

I think you just got a good sample of very good advice.  
Tisha's idea that you could be ahead to just buy another PTO is in line.  
I watched your two videos. (nice job).  
You are moving the shaft and the guts have a back lash inside.

We all know this is not good. PTO's do not have internal backlash.  
That is part of what makes PTO so wonderful.  
OK a couple hertz backlash, but not like your video.  
As posted by the other Fellows do not let those cans scare you.  
Do not disassemble the corrector stack.

Find some other method to make your self feel bad before you unbolt a corrector stack inside a PTO. Ok with all the mental health warnings out of the way we can proceed. Do some more video as you go. The next stage in R390 archiving.

We do not have photos of VFO guts in color or moving video.  
We have not been in there since the camera was invented  
We would all like to see what ever video you can get up on the web.

And we thank you in advance for taking the time.  
You are about to become famous if you take on this mission.  
No money and little fame but we know who you are and will always thank you. You will have to unsolder some heater wires as you go. Not a big deal its just part of the disassembly process.

Inside, the shaft is just a nice acme thread on the shaft.  
On the shaft is a carrier with a matching set of threads in it.



Turning the shaft moves the carrier along the axis of the can.  
The carrier slides a slug through a core not unlike watching a slug move in one of the RF deck's tuning coils with cores.

The PTO slug is a bit larger than the RF deck slugs.

The corrector stack acts as the device that keeps the carrier from going round and round as the shaft is turned and thus forces the carrier to move along the threaded shaft.

I am thinking gummed up thread on the carrier mechanism.  
The runner on the carrier must follow the stack and not backlash.

Yours does. The carrier runs one side against the stack. The back side is spring loaded against another rail.

As you change direction the shaft to carrier threads are so gummed up, that instead of the spring having enough strength to hold the carrier against the stack, the spring gets compressed, the carrier torques over to the other rail (back lash) before it meets enough resistance that the threads begin to move.

The shaft bushing is also gummed up or when you dialed the PTO back and let go, the spring would push the carrier back against the stack and you would get a counter lash effect.

I think you just need some cleaning inside the PTO to restore the VFO to good operation.

The stack we describe is like an S Curve. as it is not straight, over the tuning range. It lets the threads get a little ahead or behind the curve to provide a more linear operation. Once you get the PTO open you will see the coil has a magic non linear wind. The coils got wound on the form by machine (lathe). A simple pattern lathe. The pattern was hand made and tweaked to get it as linear with the PTO slug as possible. Real black magic in the manufacturing process. It was tried and retried to get it almost perfect. Then the stack was adjusted by hand during assembly for awesome good behavior.

The secret to getting the stack together in manufacturing was the exact red color of the stick-em. Not true it was air dry time of the stick em. The stuff was sticky enough to hold the mess in place but not so loose it would let things slide out of adjustment. Not so stiff to make adjustment hard. Not to fast drying to prevent you from getting the adjustment done.

Things were painted up and bolted loosely together. Then the unit was let set on the line until it was about the right dry state. Then you selected the unit when it had "cured" just right and popped it into the jig. Hooked it up and with a gauge block S curve in one hand and a stick in the other hand you sweep the corrector stack into perfect adjustment as you dialed the PTO through 11 turns or so from stop to stop.

And then tighten every thing up and run one more pass for a check.

It took longer to type this than it took to do it on the production line.

Not having the magic red stuff in hand with S curve guide, do not loosen the corrector stack and thus cause it to come un-adjusted.

Some brave souls have been down this path. You can read about them in the same history book you are about to be recorded in if you do some video. These wonderful Fellows tell us that when they were done the linearity of the PTO under maintenance was no better than when they started. The women at Collins aligned them as good as could be done.

And Fellows should not try and out-do the women.  
Thus we tell you do not undo the corrector stack.  
But have fun with the rest of it.  
You can likely save in an afternoon.  
And be happy that you did.

You will likely spend more time doing video for every one than it takes to clean the PTO up. Take the time and point out all the parts and what you find/found as you go.

Honest this is an effort that needs to be done.  
Good luck with fixing the PTO and doing a video.  
I hope there is enough info here to guide you through the process,  
I do not hang on my mail like I should.  
But I will get back to you if you need more help.  
If you have problems do some more posts.  
The Fellows will jump in and get you some timely responses.

If you are looking for some history or good words to put with the video just ask the Fellows here. You can see from the mail there is plenty of experience to help you along.

Date: Fri, 12 Jul 2013 08:33:20 -0300  
From: PY1NB - Felipe Ceglia <felipeceglia2@gmail.com>  
Subject: Re: [R-390] my PTO problem, part II

Thank you for the email, advice and all information.

I am scared about messing with the corrector stack. I hope it is solidly held in place so I cant accidentally mess it. I will take pictures and make video on the way.

Date: Fri, 12 Jul 2013 08:47:29 -0300  
From: PY1NB - Felipe Ceglia <felipeceglia2@gmail.com>  
Subject: Re: [R-390] PTO problem, part II

Thank you for the information.  
I will take a deep breath and go for it, I hope I don't mess much with it :)

Date: Fri, 12 Jul 2013 10:48:01 -0400 (EDT)  
From: Roger Ruskowski <flowertime01@wmconnect.com>  
Subject: Re: [R-390] my PTO problem, part II

Worry not about the corrector stack. It will not just fall apart. You have to work at several bolts (small) to get the adjustment plates to come loose. You will see when you get there. If you ever do get a stack loose, no one will ever know without a good counter. The fine tuning is only 10 - 20 hertz on any plate in the stack.

Date: Thu, 7 Nov 2013 11:47:58 -0200  
From: PY1NB - Felipe Ceglia <felipeceglia2@gmail.com>  
Subject: [R-390] PTO disassembly and mechanic fix

Regarding my previously posted video of my PTO problem, I took a deep breath and plunged into fixing (or breaking) it.

The videos:  
<http://www.youtube.com/watch?v=hAZf9bn1Dnw>  
<http://www.youtube.com/watch?v=6atQplq69Ms>

I had just included on picasa a folder with pictures of its guts. One of the pics is commented, showing what was wrong with it. You guys can help finding out which kind of PTO it is. I havent included pictures of re-assembly, as it didn't ended as beautiful as started, hihi.

<https://picasaweb.google.com/111512966454328879960/R390ASlippyPTOFix>

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Date: Wed, 25 Dec 2013 08:19:02 +0100  
From: djelatnik slavonsija <djelatnik.slavonsija@gmail.com>  
Subject: [R-390] VFO assembly wash or not to wash

Currently my process of restoring and rebuilding of R390A receiver is in step on gear cleaning and after this only part, beside main chasis, is VFO. Please advice me on this mather..it is recomendet procedure to wash entire VFO (inside and outside) with water/detergent solution or it is better to leave VFO intact (covered with dust and other particles)?

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Date: Wed, 25 Dec 2013 10:50:41 -0500  
From: "quartz55" <quartz55@hughes.net>  
Subject: [R-390] VFO (PTO)

If the VFO(PTO) is working fine, I'd leave it alone. I'd only get into it if it had serious problems, I understand they are very hard to work on and put back together, not that I've tried. You can clean the outside with a brush and maybe a little alcohol.

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Date: Wed, 25 Dec 2013 11:23:01 -0500  
From: Curt Nixon <cptcurt@flash.net>

Subject: Re: [R-390] VFO (PTO)

I would be very careful about getting any liquid in around the shaft. The seals can dry up and moisture can get in. These are dry air purged originally but the seals wont still be intact. I removed the seals on mine so it would free up the shaft somewhat but if it is working, I would only clean the exterior. See the internals of an collins A style here: [www.curtsworkshop.blogspot.com](http://www.curtsworkshop.blogspot.com)

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Date: Wed, 25 Dec 2013 12:03:23 -0600  
From: Tisha Hayes <tisha.hayes@gmail.com>  
Subject: [R-390] VFO (PTO)

You want to keep the insides of the PTO bone-dry. It is not an environment where dirt or moisture would ever get inside of, if you have a reason to open the case because of a lack of tuning range or mechanical binding then it might need a gentle cleaning with a light-solvent similar to WD-40 and then to be blown dry with compressed air.

Things like shaft seals and the O-rings can be lubricated with a silicone grease that is very inert.

The most that I have ever heard of us doing inside of the PTO is to clean up the threaded rod, careful lubrication (like one drop) or to take a part of a turn off of the variable inductor inside of the can to give you adjustment range. If you are doing more than that you are either trying to rescue a hopeless case or to make modifications to the device that will throw performance way outside of the window of usefulness.

Water inside of the PTO is "BAD". In normal operation that is a sealed environment with the express purpose of keeping water away from the insides. If you wash it down then you will probably never drive enough of the moisture out (even with baking) to be certain that it will perform better than it is right now.

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Date: Thu, 26 Dec 2013 12:29:11 -0500  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Gear train rebuild help needed.....

Let's find out if this is a R-390A or an R-390. Phil wrote R-390A. IF that is the case, there is NO green, Geneva Gear. We can manage to scramble the messages, and confuse the information.

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Date: Thu, 26 Dec 2013 12:48:08 -0600  
From: "Phil Mills" <pmills7@comcast.net>  
Subject: Re: [R-390] Gear train rebuild help needed.....

My mistake.....I thought that the geneva gear was the planetary gear assembly.....it is an R-390A.

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Date: Thu, 26 Dec 2013 14:03:02 -0500  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Gear train rebuild help needed.....

That okay! We all get mixed up at times. I was just trying to get us on track. It would appear that one of the gears is not "exactly" lined up. This will prove to be a royal PIA, and take a trial and error approach to determine which and where. I've got one apart now, and to make it worse - it has been that way for far too long. I am really going to have to keep my head buried in manuals and pictures to get it all together again. Not to mention praying that all works as it should.

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Date: Thu, 26 Dec 2013 15:00:46 -0500  
From: Charles Steinmetz <csteinmetz@yandex.com>  
Subject: Re: [R-390] Gear train rebuild help needed.....

>Phil wrote R-390A. IF that is the case, there is NO green, Geneva Gear.

More misinformation. The Geneva Drive used in both the R390 and the R390A is not the same as the Green Gear in an R390. The Green Gear is not called a "Geneva Gear."

The Geneva Drive is what has been suggested as a possible problem in Phil's radio. It is shown and discussed on pp. 1-2 of Scott Seickel's R390A gear train rebuild tutorial.

The Geneva Drive is a mechanical mechanism that moves a shaft (in this case, the bandswitch shaft) in small steps for each rotation of the driving shaft (in this case, the MC Change shaft). The 390 manual calls it a Geneva mechanism, while the 390A manual calls it an "intermittent gear." Geneva mechanisms typically have a pin that engages a slot in the driven wheel. As the drive wheel rotates, the pin enters the slot and turns the driven wheel some fraction of its rotation. See <[http://en.wikipedia.org/wiki/Geneva\\_drive](http://en.wikipedia.org/wiki/Geneva_drive)>, especially the "internal Geneva drive."

The Green Gear in an R390 is a convenience tool that keeps the KC Change gear train in alignment with the Veeder-Root counter while you have the radio disassembled.

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Date: Thu, 26 Dec 2013 15:07:27 -0500  
From: rbethman <rbethman@comcast.net>  
Subject: Re: [R-390] Gear train rebuild help needed.....

I appreciate your input and correction. My intent was to take the "Green Gear" out of the conversation. It was that simple. Yes, there ARE equivalent gears in the R-390A.

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Date: Thu, 26 Dec 2013 13:19:45 -0800 (PST)  
From: Joe Foley <redmenaced@yahoo.com>  
Subject: Re: [R-390] Gear train rebuild help needed.....

Just for fun, check the ten-turn counter on the MC Change shaft.? The leaves may not be coordinated properly.

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Date: Thu, 26 Dec 2013 14:46:28 -0800 (PST)  
From: Norman Ryan <nnryann@yahoo.com>  
Subject: Re: [R-390] Gear train rebuild help needed.....

Thanks for that link to the Wiki article on Geneva drives.? Fascinating reading! Will capitalize the G from now on.? :-)

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Date: Fri, 27 Dec 2013 02:47:38 -0500  
From: Charles Steinmetz <csteinmetz@yandex.com>  
Subject: Re: [R-390] Gear train rebuild help needed.....

>My intent was to take the "Green Gear" out of the conversation. It  
>was that simple.

But the Green Gear wasn't IN the conversation until you brought it up. Nobody had said anything about the Green Gear, or about R390/URRs, in any of the previous posts in this thread. The only person who was confused was you. You mistakenly thought that a Geneva Gear is the same thing as a Green Gear -- as you put it, a "green, Geneva Gear" -- when, in fact, there is no such thing.

There is a Geneva Drive/Geneva Gear, and there is a Green Gear, but never the twain shall meet. This stuff is hard enough for beginners to learn without subjecting them to posts that spread confusion, like that one.

I know it must seem that I live only to scold you on-list, but that is really not the case and I sincerely apologize for it looking that way. However, you have a long-running habit of posting comments about radio technology that are just plain wrong and must be corrected -- unfortunately, on-list -- so that beginners and people searching the archives will not be misled by them. (This time, you had the OP apologizing for misunderstanding, when in fact he had a perfectly correct understanding of the Geneva Drive until you posted.)

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Date: Fri, 27 Dec 2013 21:57:43 +1100  
From: Pete Williams <jupete@internode.on.net>  
Subject: [R-390] Gear box...MHz out of whack!

Hi ... I would suggest that the intermittent switch drive assembly needs to be reset.. I had to do this and only info I found was in an article in Electric Radio by Jan Skirrow . I have article but no date .

I can email a copy of the sketch but it has to be set up with cams etc in the 7 +000 position. The 8-16MHz gear meshes with another gear to its left and by loosening the collar on this on this shaft, the intermittent switch drive assembly can be set correctly. It's too hard to explain without a pic, but happy to give info as required.

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Date: Fri, 27 Dec 2013 08:14:33 -0500  
From: Charles Steinmetz <csteinmetz@yandex.com>  
Subject: Re: [R-390] Gear box...MHz out of whack!

>...intermittent switch drive assembly needs to be reset..

Not sure if it is the article you mean, but one of Jan's ER articles about restoring R390A RF decks is here:

<<http://skirrow.org/Boatanchors/TechTalk1.pdf>>

It has some discussion of the bandswitch. Some old list posts (1995 era) also have some comments, including Jan's. The synchronization procedure is covered in the various maintenance manuals:

TM 11-856A (1956) -- pp. 153-154 and Fig. 87 on p. 186

TM 11-5823-358-35 (1961) -- pp. 110-112

Y2K\_R3 manual -- pp. 6-7, 6-8. See also pp. 9-63, 9-64, 10-25, 26, 27

These manuals can be easily found on-line.

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Date: Sat, 14 Jun 2014 02:15:37 -0700 (PDT)  
From: Larry H <dinlarh@att.net>  
Subject: [R-390] R-390A Cosmos PTO has erratic linearity

I'm restoring a Stewart Warner R390A with a cosmos pto type 136-1. Although I've had to fix a number of problems on the R390A, it looks and operates well now except for 1 issue (or I think it's an issue). I've graphed the linearity of the pto numerous times every 25 KC, and it tracks mostly +/- 100 - 200 cycles (with a few exceptions up to 300 cycles), but after adjusting the linearity bad spots numerous times, different ones keep popping up. IE, the measurement repeatability is poor, but still mostly with in +/- 300 cycles. ?This is after letting it warm up for 2 hours. ? The frequency stability is very good. Also, if I graph the pto linearity, use it for a few minutes, and graph the linearity again (without making any adjustments to the pto) its different than the previous graph. Everything inside the pto seems tight and the gear train to the readout is tight (IE: very little slack). I have cleaned the pto shaft grounding contact and checked the contact pressure. ?The endpoint also varies about +/- 100 cycles. I have the prescribed spacing in the oldham coupler (its in very good condition) and it is lined up very closely with the KC shaft and the spring is installed correctly. The gear train and the pto operate very smoothly.

Should this be better or is this normal? Any suggestions would be most welcome.  
Thanks.

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Date: Sat, 14 Jun 2014 16:40:41 -0400 (EDT)  
From: Roger Ruskowski <flowertime01@wmconnect.com>  
Subject: Re: [R-390] R-390A Cosmos PTO has erratic linearity

Read all the mail on the topic before you jump in.

I propose a bad cap with a couple PF shift on temperature or voltage or vibration. Also consider a cold solder joint.

For the cold solder joint I would go through the connections on the tube base outside the PTO can. Then do the inside of the can.

Isolating an offending cap will be a shotgun approach. Eye ball for likely suspects. If it looks like it has been run over it may be unstable.

Cold air may not be real diagnostic as changing the temp of any cap may pull the frequency as far as it is drifting. But you could get lucky. The bad cap may go real off the reservation for you and give itself away.

Good luck the problem is very fixable

Any mechanical slop can be taken into consideration when doing the measurements.

Always come up on the way point from the same direction. Get close and roll slowly up to the point from the same side. Roll up to or down to the point you want to measure.

It when you find the difference between points keep moving or the frequency counter keeps drifting around as the PTO is left setting still.

You will have to get the PTO stable first. Then you can try and trim it up. Do set the end to end span before you work on the mid point linearity.

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Date: Sat, 14 Jun 2014 22:06:48 -0500  
From: "Bill Hawkins" <bill@iaxs.net>  
Subject: Re: [R-390] R-390A Cosmos PTO has erratic linearity

Well, 200 parts in 2 million is 0.01% accuracy. I'd say that was amazing for a mechanical, analog device. The answer to your question may be in the Collins Engineering Report, if it states the accuracy for the PTO. I seem to remember +/- 500 cycles, but you should find that in print. The age of digital calculators does make one think that all of the digits ought to be accurate, with no regard for percent error.

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Date: Sun, 15 Jun 2014 04:11:52 -0700 (PDT)  
From: "Tom M. via R-390" <r-390@mailman.qth.net>  
Subject: Re: [R-390] R-390A Cosmos PTO has erratic linearity

This is an article I wrote about how to calibrate the Cosmos PTO. Take a look and see if you find any nuggets. Tom

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Calibration of The Cosmos Permeability Tuned Oscillator for the R-390A  
by Thomas Marcotte, P.E. N5OFF



This article will focus upon the calibration of the Cosmos permeability tuned oscillator (PTO) for both linearity and endpoint adjustments. Few devices have been so maligned or poorly understood than the Cosmos PTO employed in the R-390A HF receiver. This device has been mentioned in articles about the R-390A many times, as well as on several Internet mailing lists, often negatively. The features of endpoint and linearity adjustments for this PTO have often been misunderstood, leading one to suspect it may be a poor device. This article will attempt to convince that the Cosmos PTO is worthy of service in the R-390A when adjusted properly.

Collins designed and built the first R-390A receivers utilizing its own 70H-12 PTO. This PTO covers a frequency range of 3.455 Kcs to 2.455 Kcs in ten clockwise turns. It is a robust device constructed of the highest quality materials, including an encapsulated main coil, sturdy compensating stack, and a temperature controlled oven.

The R-390A receiver was produced by many manufacturers other than Collins. These manufacturers were at liberty to employ the PTO's of suppliers other than Collins, as long as their performance met the specification MIL-R-13947. Consequently, PTO's employed in the R-390A were supplied by many other manufacturers including Motorola, Progresstron, Dubrow, Cosmos and Raytheon. Of all PTO types, the Cosmos seems to be the most common. Electronics Assistance Corporation used these PTO's exclusively in its production run of 11,000 R-390A's around 1967.

Cosmos Industries was a New York manufacturer of radio equipment located at 31-28 Queens Boulevard, Long Island. Among its products was the well known Cosmophone HF-SSB transceiver. The improvements made in the Cosmos PTO over the original Collins device were designed by Lewis Metzger and Harold Goodman, both instrumental in the development of the Cosmophone. They received US patent number 3,098,989 in July, 1963 for their idea and working model of a PTO that could be linearized with external adjustments, unlike the Collins PTO. Anyone who has ever worked on a R-390A PTO soon finds out that there are two important adjustments that can be made. The first is that the PTO must be adjusted such that its output is exactly 1000 Kcs in ten turns. This is commonly referred to as the endpoint adjustment, and is as far as most users will go in PTO calibration. Endpoint adjustment is important as it not only affects dial calibration, but can also compromise front end track tuning on the lower bands.

The second important adjustment is linearity. If one were to graph the ideal PTO output frequency versus the shaft position in number of turns, the graph would make a straight line. This was the goal of Collins Radio in all of its designs of the era, including the 75A, 32V and all of the later models. Art Collins wanted a linear output, and that was that. The Collins PTO was famous for being able to achieve this goal, as well it had to, because the inherently linear Veeder-Root counter of the R-390A exposed nonlinear PTOs with errors as low as 0.1 Kcs.

All PTO's employed in R-390A service have an endpoint adjustment screw. This screw is typically located underneath a sealed screw hole behind the PTO's

transformer can. As a PTO ages, its output will typically decrease, i.e., it will have an output of less than 1000 Kcs in ten turns. To remedy this, the endpoint adjustment screw must be turned (usually clockwise) until the PTO's output is increased to exactly 1000 Kcs in ten turns. The turning of this screw moves a tuning core into a second coil in the PTO to make the adjustment. PTO's of the Collins design will have two inductor coils, a main coil and an endpoint adjustment coil.

Adjustment of the PTO's linearity is another matter entirely. In the Collins PTO, the company employed an internal corrector stack which accomplished this task. This stack is constructed from a set of adjustable shims upon which a cam follower rides. As the PTO shaft is turned, the main tuning slug is advanced axially on a lead screw, and the cam follower is simultaneously advanced on the corrector stack. Naturally, advancement of the main slug on the lead screw is exactly linear, but unfortunately the coil and powdered iron tuning slug do not usually cooperate in linear fashion. The cam follower mechanism allows the tuning slug to either increase or decrease the overall rate of advancement on the lead screw by imposing a slight twist of the tuning slug. This increase or decrease in tuning rate is determined by the shape of the corrector stack and is what accomplishes the linearity correction. If a graph were made of the nonlinear response of the PTO, it might look very much like the profile of the Collins corrector stack when properly adjusted.

Linearity correction is necessary because it is virtually impossible to wind the main tuning coil and match it with an iron slug for an overall linear output. The only problem with the Collins design is that the corrector stack is inside the PTO cover. Naturally, adjustments must be done with the cover off, but unfortunately, replacement of the cover influences the adjustment requiring multiple attempts and no shortage of frustration. Metzger and Goodman solved this problem by improving the Collins PTO design. The Cosmos endpoint adjustment is similar to the Collins adjustment, however the real innovation is found in their external adjustment for linearity. This is the most misunderstood feature of the Cosmos PTO.

Upon careful examination of the Cosmos PTO, one will find the endpoint adjustment in its usual location as described above. To the left of the endpoint screw hole will be found an additional screw cover. Underneath this second screw cover will be found a series of very small screws. During clockwise rotation of the PTO shaft, this series of screws passes underneath this window from left to right. One screw will pass with every 90 degree turn (25 Kcs) of the PTO shaft. It is this series of screws that are used to adjust linearity of the Cosmos PTO.

The Cosmos PTO has three inductor coils instead of two employed by Collins. There is the familiar main tuning coil, an endpoint adjustment coil, and a third coil that is part of the linearizing device. Like the endpoint coil, the linearizing coil is in series with the others. The inductance change of the corrector coil is controlled by a core which goes in or out as the PTO is rotated through its ten turns.

To help visualize the corrector mechanism, picture if you will a Teflon disk laid onto

the front face of the PTO. This disk acts as a cam. A cam follower contacts the slug of the third coil. The corrector disk rotates through a reduction drive as the PTO is advanced its ten turns. Under this disk is a series of screws which are laid out in a staggered fashion all along its circumference, forming a circle. The flat heads of the screws, which are adjusted to varying heights in close proximity to their neighboring screw, make up a (typically uneven) surface upon which the flexible Teflon disk rests. As the screws are adjusted in or out, the Teflon disk (formerly and initially flat) is shaped into a wavy surface (a cam) upon which a cam follower rides. You've seen the kiddy motorcycle rides at the carnival where the miniature vehicles go round and round, and also make a gentle up/down motion on the wavy surface of the merry-go-round floor. It is this slight vertical displacement of the vehicles that is analogous to the in/out motion of the core in the compensating coil. Note: One should refer to the R-390A service manual before attempting to service the radio.

The two things needed to calibrate the PTO at 25 Kcs points are 1) an accurate means of measuring frequency, and 2) an accurate means of turning the PTO shaft exactly 90 degrees at a time. The author uses a frequency counter to measure the PTO output, and the Veeder-Root counter in the radio to measure the turns of the PTO. When using the radio's counter to measure turns, take the time to tape exposed 120 VAC power and fuse connections to prevent electrical shock while performing the more than 40 PTO remove/install maneuvers. The frequency counter is connected directly to the output cable of the PTO. A handy crossover connector from the PTO fitting to BNC can be found on the back bulkhead of the radio. Simply borrow the adapter that is present at the IF output jack. There are many alternatives to using the radio frame to measure turns, including using a sacrificial R-392 frame (credit Wally Chambers, K5OP), and various calibrated knobs.

Setting the endpoint on a Cosmos PTO is similar to the Collins PTOs. Test the PTO to see how many turns it takes to achieve an output starting at 3455 Kcs and ending at 2455 Kcs. Most aged PTO's that have not been recalibrated will typically require an additional 1-15 Kcs past the ten turn mark to achieve the proper range. To bring it back to 1000 Kcs output in ten turns, adjust the endpoint screw (usually clockwise). If the proper output cannot be achieved within the adjustment range of the endpoint screw, one must open the PTO and remove one turn from the endpoint adjusting coil. This change in overall inductance of the coil will bring the endpoint back 7 Kcs or so. Once this is accomplished, setting the endpoint can usually be achieved. While the PTO is open, the lead screw and bearing can be lubricated. The author usually takes this opportunity to bake an open PTO in an oven at 150F for several hours to dry it out and regenerate the desiccant.

Perform the calibration only after baking, and keep the PTO in a zip lock bag if you plan to leave the adjustment window screws open for an extended length of time.

When setting the 25 Kcs calibration points, it is extremely important that the screw being adjusted is directly lined up behind the adjustment window. This may be accomplished by simply rotating the PTO shaft until the nearest screw is lined up exactly with the window. The reason this is so important is that the cam follower which rides on the compensating cam is directly behind this window, and will thus

be directly under this screw at this point. If this caveat is not followed, adjustment can still be made, but there will be interaction between the point that one is attempting to adjust, and its neighboring points. This will yield poor results and will be very frustrating. Be advised that if the screw being adjusted is directly behind the window, the PTO position may not yield an exact 25 Kcs calibration point on the dial, e.g. 000, 025, 050, etc. This is not a real problem, but it may be necessary to shift the starting point of the 25 Kcs check points by 5, 10, or 15 Kcs up or down. Simply remember that the PTO has an output of 3455 Kcs at dial indication 000, and 2455 Kcs at dial indication +000. Armed with this information, one can make a spreadsheet calibration chart for all 40 calibration points in 25 Kcs increments. An example chart might look like this:

Frequency Veeder-Root Error (Kcs) Counter(Kcs)

3465-010

3440-015

3415-040

3390-065

And so on . . . for 40 to 42 calibration points

The above example is for a PTO that has the nearest linearity alignment screw falling at a frequency of 3465 Kcs on the frequency counter. This corresponds to a starting point on the Veeder-Root counter of -010. Note that this starting point is not on an even 25 Kcs point, but that is OK as it is most important to start with the nearest screw directly lined up with the adjustment slug at the center of the window. To complete the chart, subtract 25 Kcs from the frequency and add 25 units to the Veeder-Root counter for each point out to 2455 Kcs.

Each screw will have an adjustment range of about 5 Kcs +/- . Clockwise rotation of the screws will reduce the PTO's frequency output at a given checkpoint. One should avoid adjusting the screws to near their full clockwise position as this will cause excessive drag in the PTO.

#### Advanced Procedure for the Stout Hearted

To remedy problems with excessive drag due to adjustment screws reaching their clockwise limits, back all 40+ screws out to their counterclockwise stops, and then turn each screw one turn clockwise. This will give the cam an initially flat position. Start PTO calibration at the point nearest 3455 Kcs moving up the dial toward 2455 Kcs (+000 on the Veeder-Root counter).

Remember to check each calibration point against the frequencies on the calibration check chart (it is not hard to get 5 Kcs off). Some check points may require a touch-up calibration after completion of the first pass. This will be especially true if the PTO calibration was re-started with the cam in the initial flat position as described above. Extreme adjustment changes (5 Kcs) at any given point may cause output changes at neighboring points. These can be worked out with multiple checks and adjustments at problem checkpoints.

With this linearization procedure, it is possible to obtain checkpoint accuracies of +/- .100 Kcs with an initial dial calibration at 000 using the crystal calibrator. This

greatly exceeds the specifications listed in MIL-R-13947B which require a +/- .300 Kcs with a dial calibration at the nearest 100 Kcs check point using the crystal calibrator.

In conclusion, the reader should be left with these points.

- the Cosmos PTO can be calibrated for both endpoint and linearity.
- calibration can be done at 25 Kcs points, typically exceeding military specifications.

References:

Military Specification MIL-R-13947B, "RADIO RECEIVER R-390 ( )/URR", 26 October 1960

TM 11-5820-358-35, "Field and Depot Maintenance Manual, Radio Receiver R-390A/URR", pp. 107-108.

"Serially Connected Course and Fine Inductors with Continuous Adjustment", U.S. Patent number 3,098,989 awarded to Metzger and Goodman, 23 July 1963

Also credit: Discussions with Wally Chambers, K5OP, Memphis, TN.

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Date: Mon, 16 Jun 2014 12:15:43 +1000  
From: Pete Williams <jupete@internode.on.net>  
Subject: [R-390] Cosmos PTO'S

I'm no hot shot on these but having done about 30 over the years can only offer what I have gleaned and applied from others who have been this way before.. First, I have never tried to calibrate a Cosmos or any other 'in situ' ----i,e in the receiver. I went to the trouble of using a dual HT supply and separate heater supply, getting the appropriate connector, and treating the assembly on the bench. Output connected to a counter of course.

Secondly resetability and ability to reproduce a previously documented setting is difficult--- 'fraught' seems an appropriate word.. Do the math and you will see that a change of 1.406 degrees in rotation is a shift of 390.625 Hz.! As a minimum the setting measurement needs to be precise and my PRACTICAL/realistic and achievable method is a 6 inch circular protractor mounted on a PTO shaft connector and an indicator mounted as best possible to correct for parallax error.

IF, repeat IF, you can set and reset to a 1 degree then good luck goes with you, or you have made yourself an exemplary turning mechanism..... 1 degree represents 277.78 Hz. I'd be happy to take advice on more sophisticated indicators but apart from the purist approach, what I do is somewhat better than an 'agricultural' approach via mechanical system in the rx ..... The proof of the pudding is in the eating---- and all my clients have never complained of setting indigestion!.

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Date: Sun, 15 Jun 2014 21:58:14 -0700

From: Norman Ryan via R-390 <r-390@mailman.qth.net>  
Subject: Re: [R-390] R-390A Cosmos PTO has erratic linearity

Probably the best written article ever on the Cosmos PTO. Bravo, Tom Marcotte!

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Date: Wed, 24 Dec 2014 16:14:33 -0500  
From: Roger Ruszkowski <flowertime01@wmconnect.com>  
Subject: [R-390] R390A VFO backlash problem,

I was asked this question and I do not know how to cure the back lash problem in these VFOs. May we have some help please?

Roger, You are going about the end point adjustment the right way. It takes time and is boring. Tweak it a big bit to get closer faster. You may find starting from the other end helps you get the adjustment done.

Hi Roger,

I hope you can shed some light on this PTO problem. I'm asking you because you seem to have had more experience than anyone else on the 390 list. I have a Collins type PTO manufactured by Progressitron Corp. for Capehart. The PTO seems to have some backlash. If I set it for zero beat, it will jump back about 300Hz when I let go of the knob or shaft (with PTO removed). I have cleaned and lubricated the lead screw and put a drop of oil in the front bearing, but it still does this. Any suggestions??

I have the PTO on the bench, coupled to a counter. The freq. was off quite a bit (~2kHz) after 10 turns. I have adjusted the endpoint slug and now have it within 700Hz. I have a pointer knob on the shaft, and have been setting the PTO at 3455.0 and marking the front plate, then after exactly 10 turns (2455.) I see where I am relative to the starting mark and make another tweak of the slug. Back to 3455.0, another mark and do it all over again. Is there an easier way to make this adjustment? I'd like to get it closer, but all this back and forth is driving me to drink ! Looking forward to your comments and suggestions. Roger Gates, W7KVT

Thank you Fellows, Merry Christmas to all

Roger Ruszkowski AI4NI

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Date: Wed, 24 Dec 2014 13:49:56 -0800  
From: "Craig Heaton" <hamfish@efn.org>  
Subject: Re: [R-390] R390A VFO backlash problem,

Merry Christmas and a Happy New Year!! A random thought: I'm not an expert on types of PTO's used in the R-390/A; but here is what was found in a PTO inside a Motorola. There is a gizmo sort of like a scissor. A small spring pulls two thingies in contact with the corrector stack. One of these thingies is the electrical contact. The other is along for the ride and only rubs the other side of the stack. If the spring breaks there is mucho slop! Will drive grown men to cry

trying to make all well again!

If this is the cause, the only hope is to open the PTO and inspect the works inside. My PTO also had the desiccant bag broken with said stuff making the turning of the PTO shaft gritty. More to the story, but at times this can be fixed if the corrosion inside hasn't ruined the scissor.

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Date: Wed, 24 Dec 2014 14:09:44 -0800  
From: "Roger Gates" <w7kvt@wvi.com>  
Subject: Re: [R-390] R390A VFO backlash problem,

Well guys, the problem has been resolved. Like Craig suggested the linearizing mechanism might cause the backlash issue, but mine was in fine shape and no sign of it causing the problem.

I recleaned the leadscrew and relubed it with Mobil 1/WS2, also placing a drop of oil on the rear bearing. I then removed the circlip on the front bearing (hoping to remove the bearing), but had to be content with wicking some oil into the shaft and bearing. I wonder how this bearing comes out?? After working the tuning shaft a bit it seemed to loosen up and quit acting as if it had a mind of it's own. I could not detect any backlash tuning it against a signal from the 8640B and monitoring the signals in another receiver.

The end point adjustment is tedious at best and downright maddening at times. After much back and forth, I finally got the 10 turn spread down to 1.00mHz + about 100Hz. Good enough for me!!

I hope this info helps someone else with the backlash problem. By the way, does anyone know of an exploded view of the Collins PTO??

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Date: Thu, 25 Dec 2014 09:41:49 -0800  
From: "Drew P. via R-390" <r-390@mailman.qth.net>  
Subject: Re: [R-390] R390A VFO backlash problem

[snipped] "I have a Collins type PTO manufactured by Progressitron Corp. for Capehart. The PTO seems to have some backlash. If I set it for zero beat, it will jump back about 300Hz when I let go of the knob or shaft (with PTO removed). I have cleaned and lubricated the leadscrew and put a drop of oil in the front bearing, but it still does this. Any suggestions??"

I have found that if the anti-backlash nut affixed to the leadscrew nut is set too tight, excessive torque will be applied to the spring loaded guide which rides on the guide bar. Turning the VFO shaft / leadscrew will then "wind up" the spring guide slightly, and cause the problem you described when the spring "unwinds". This also will contribute to "R-390A Sore Wrist-itis".

I have remedied this problem by disassembling the anti-backlash nut from the leadscrew nut, then lubricating and reassembling with less tension. The anti-

backlash nut has spring "petals" protruding radially, clamped in place to the leadscrew nut by a ring secured by screws. The "petals" provide tension, and this may be reset by loosening/removing the small screws, rotating the anti-backlash nut, and then tightening the screws. If the anti-backlash nut has too much spring tension applied by the "petals", there will be excessive drag, with attendant "jump back" problem you described. If tension is insufficient, there will be simple mechanical hysteresis, the backlash we all know and love.

Aside: Some of the drag which can cause tuning the R-390A to be less than pleasant is attributable to the o-ring sealing the shaft where it passes through the front housing of the VFO. A new o-ring, lubricated, helps here. For the ultimate in low-drag tuning, it should also be possible (I haven't tried it) to operate with the o-ring removed entirely - we don't pump up our VFO's with dry nitrogen anymore, do we? Comments, anyone?

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Date: Sun, 8 Feb 2015 16:01:02 +1100  
From: Pete Williams <jupete@internode.on.net>  
Subject: [R-390] COSMOS PTO ..E.Point and Linearity

My take... having done about 20+ over the years, I have yet to find one that has never been touched internally, let alone satisfactorily linearised or endpointed. There's always someone that has been there before me, compounded by drift in capacitor value changes to permeability of the core or a combination. The end point adjustment usually gets the advice to remove a turn from the end point coil. I can't recall an instance where this proved to solve the problem and always ran out of slug on the EP coil when going through the procedure Like I said, others have been that way without success, and I don't tolerate a few kHz out at the ends At the risk of raising eyebrows, what I have done for remedy is as follows ..

- 1.. disassemble and remove the EP coil.
- 2.. rewind with equivalent gauge wire and put on 3 turns  
- seal with nail polish.
- 3..remove the 10pf NPO capacitor....
4. return the slug in the EP coil to full in position. ACW. Lower value capacitors have been tried but eliminating 10 pf works for me .. I power the PTO being worked over from a dual voltage ,adjustable and regulated power supply with pto output to a counter. The EP and linearizing procedure is then done per previously recorded info on this list and ER articles. No major change in stability with temperature ..cold start to heating to too hot to hold no worse than about 50 Hz at 3.455Mhz. Maybe others have done something similar, but I've not read of it..

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Date: Wed, 25 Mar 2015 19:20:02 -0700  
From: wli via R-390 <r-390@mailman.qth.net>  
Subject: Re: [R-390] bad audio

Symptom: severe audio distortion in all filter positions except 16kc.



Cause: loose PTO coupling! Looked fine externally, but upon close inspection, turning the KC knob, observed obvious slippage of the coupling to the PTO shaft. Solved by re-setting the PTO to 3455KC, and rotated the coupler so it mated exactly to the KC shaft locked at 7(-)0000. Retightened both Bristol screws on the coupler. Shimmed the rear of the PTO so that both shafts were aligned straight in both dimensions.

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Date: Sun, 17 Jan 2016 11:37:36 -0500  
From: Jacques Fortin <jacques.f@videotron.ca>  
Subject: [R-390] J709 on R390A PTO

I am actually trying to rebuilt a Collins R390A PTO and J709 have some broken pins. Can anyone provide advice about where I can find a replacement

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Date: Mon, 18 Jan 2016 14:42:05 -0600  
From: James Green <jagreen3@sbcglobal.net>  
Subject: [R-390] PTO Oldham anti-backlash spring recommendations

I am putting my R-390A back together and have lost the anti-backlash spring for the PTO Oldham coupler. What what should I be looking for to replace it. I'm could look inside my R-390/URR, but it's in the cabinet and I'd rather not pull it out.

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Date: Mon, 18 Jan 2016 14:44:23 -0600  
From: Cecil Acuff <chacuff@cableone.net>  
Subject: Re: [R-390] PTO Oldham anti-backlash spring recommendations

A spring out of an old ball point pen can be easily made to work...

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Date: Tue, 19 Jan 2016 01:37:51 +0000 (UTC)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] PTO Oldham anti-backlash spring recommendations

I once used the spring from a ball point pen.  
Go down to your local old timey hardware store and ask for the cabinet with all the springs in it and buy a variety with loops on each end. It's not real critical.  
It looks like this:

[http://www5a.biglobe.ne.jp/~jh2clv/main2/r390a\\_oldham&pto.jpg](http://www5a.biglobe.ne.jp/~jh2clv/main2/r390a_oldham&pto.jpg)

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Date: Mon, 9 May 2016 04:25:58 +0000 (UTC)  
From: Larry H <dinlarh@att.net>  
Subject: [R-390] PTO VFO End Point Adjustment tool

Some time ago I started working on an R-390A Cosmos PTO that needed end point adjustment. After reading the immense amount of doc graciously posted about PTOs, I decided to make the adjustment tool suggested by someone (whose name I can not locate). I thank you! They suggested making it about 3.5" long, so it could be inserted into the adjustment hole while the VFO and the front panel were still

installed. This made the EP adjustment very easy. Thank you!

Here's what I ended up with: [http://s32.postimg.org/pxqpdph51/IMG\\_7204s.jpg](http://s32.postimg.org/pxqpdph51/IMG_7204s.jpg)  
As you can see, its 3 13/16" long. That's as long as I could make it and still sneak it into place to make the adjustment. The shaft is aluminum so as to not distort the tuning. There is tape and tubing on the adjustment end. It did not start out that way, but I found that the tool usually found its way between the EP adjustment shaft and the access hole. That is not good as the adjustment coil could be damaged. So I added the tape and tubing to keep it centered in the access hole. Now the adjustment is so easy. I've used it on 3 different PTOs: Collins, Cosmos, and Progressitron, and it was easy to use. I am very glad I made the tool, as getting the Cosmos EP correct was a long drawn out painful experience.

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Date: Sun, 28 Aug 2016 00:31:18 +0000 (UTC)  
From: Larry H <[dinlarh@att.net](mailto:dinlarh@att.net)>  
Subject: [R-390] R-390A Cosmos PTO repair and adjustment

I went through a Cosmos and got it working quite well. I'd like to share my experience with you. There was a lot of great information online, and I studied it carefully. Thank you all very much who contributed. I like the design when the linearity mechanism is in good condition and working correctly. If not it can be a big head ache. Opening it up is like any other PTO. Before you do, check the end play on the main shaft. There should be none that you can feel. If there is and it goes unrepaired, you will have forward/backward tracking issues, and probable warbles trying to zero beat a station or trouble tuning in CW or SSB stations. You should also check the rotational freedom and smoothness of the shaft. You need a slight resistance, but it must be absolutely smooth from end to end. If not, it will have the same tuning and wear issues.

To help you locate a couple key components, look at these photos:

P1. [https://s22.postimg.org/ul7jtkbgh/IMG\\_5889s.jpg](https://s22.postimg.org/ul7jtkbgh/IMG_5889s.jpg)  
P2. [https://s16.postimg.org/56s9uzjyt/IMG\\_5899s.jpg](https://s16.postimg.org/56s9uzjyt/IMG_5899s.jpg)

The EP adjust is the slotted screw on the right. The linearity screws are on the left right above the tuning shaft. Note that the hole is centered above it. One screw should be centered in the large hole with the 3 visible, at each 25 kc point on the dial. The centered one is the currently active one. Do not adjust the ones on either side. This is the one pressing on the metal spring that is pushing on the spring loaded core of the linearity adjusting coil. As the KC knob is rotated 25 KC, the next adjusting screw will become centered. There are 2 rows of screws on the disc. One from the top row will be centered, then one from the bottom row, etc.

Once it's open, here's the 3 inductors I saw:

P3. [https://s3.postimg.org/4gbsaf01f/IMG\\_5589s.jpg](https://s3.postimg.org/4gbsaf01f/IMG_5589s.jpg)  
P4. [https://s21.postimg.org/ikdk0v2zb/IMG\\_5594s.jpg](https://s21.postimg.org/ikdk0v2zb/IMG_5594s.jpg)

The short one is the EP adjustment on the bottom. The one right above it is the

linearity compensating coil. It is a spring loaded core controlled by the adjusting screws. This is the linearity mechanism:

P5. [https://s16.postimg.org/7h6y7xl4I/IMG\\_6112s.jpg](https://s16.postimg.org/7h6y7xl4I/IMG_6112s.jpg)

P6. [https://s21.postimg.org/oc1n30u07/IMG\\_6115s.jpg](https://s21.postimg.org/oc1n30u07/IMG_6115s.jpg)

The first one shows the red phenolic button the cam actuates to move the core inside of the linearity inductor. The second shows my screw driver manually moving the core by pushing on it. I'm making sure it is moving freely and has good spring resistance.

The next photos show the PTO opened up at the cam operating area. It's the round flat metal spring with the cam on it on the opposite side from the red button in the first photo. The cam is moved by the position of the adjusting screws shown in the second photo.

P7. [https://s9.postimg.org/twblI51ov/IMG\\_6162s.jpg](https://s9.postimg.org/twblI51ov/IMG_6162s.jpg)

P8. [https://s13.postimg.org/4n7xow1o7/IMG\\_6164s.jpg](https://s13.postimg.org/4n7xow1o7/IMG_6164s.jpg)

P9. [https://s13.postimg.org/rn875v6dz/IMG\\_5978s.jpg](https://s13.postimg.org/rn875v6dz/IMG_5978s.jpg)

I believe that the linearity adjusting screws can turn a total of 5 turns before falling out. Be very careful that they don't fall, as it is difficult to get them back in. You will probably have to take it apart. The third photo shows a close up of the adjusting screws. When they are unscrewed as far as possible CCW, they will stop on the disc that holds them due to the flat head being larger than the threads. I used a jewelers screwdriver to adjust them, but be careful to not damage the splines. If one is stuck, you will need to use a .033 inch 4-spline wrench.

Here's pictures of the inside showing the moving tuning core:

P10. [https://s21.postimg.org/cbroii8vb/IMG\\_6106s.jpg](https://s21.postimg.org/cbroii8vb/IMG_6106s.jpg)

P11. [https://s12.postimg.org/807j8rn99/IMG\\_5597s.jpg](https://s12.postimg.org/807j8rn99/IMG_5597s.jpg)

The photo P10 shows the linearity inductor pulled away from the frame. You will also see 2 flat compensating caps. They are very fragile. Be very careful with them. In order to bring the EP adjustment into range, one of these needs to be reduced in value by 1.5 to 2 pf.

The next one shows the split nut on the end of the tuning core. It has a spring clamp around the end of it to maintain the correct pressure on the shaft. The purpose of this mechanism is to eliminate end play between the core and the tuning shaft. This is a critical point for minimizing forward/backward tracking alignment and creating smooth frequency change when the tuning shaft is turned. It needs to fit just right.

P12. [https://s15.postimg.org/91cx5zk4b/IMG\\_6158s.jpg](https://s15.postimg.org/91cx5zk4b/IMG_6158s.jpg)

The next two pictures show the flat ring retainer held in place with three round head screws, has been removed in order to unscrew the split nut a little. I did this in

order to check the tightness and play on the shaft. The nut can be removed for adjustment, if necessary.

P13. [https://s21.postimg.org/z3i7lf7nb/IMG\\_6152s.jpg](https://s21.postimg.org/z3i7lf7nb/IMG_6152s.jpg)

P14. [https://s4.postimg.org/fzl51ljot/IMG\\_6155s.jpg](https://s4.postimg.org/fzl51ljot/IMG_6155s.jpg)

If you need to remove the core from the shaft, you might lose synchronization between the core position and the linearity disc position. If this positioning is lost, you will need to go through the linearization from the start.

It is imperative that the metal guide arms and the base for the split nut attachment plate are rigidly attached to the core. If not, it needs to be repaired or replaced. One guide arm is rigid and the other has a spring attached to it in order to keep a reasonable amount of pressure on the aluminum guide bar (it should be lubed very lightly with a very thin slippery lube (not oil)).

After it's in good condition and before you put the covers back on it, see if you can operate it on the bench. A good test is to hook up your counter to it and put forward and backward pressure on the core to see if it will move. Don't worry about the actual frequency, as it will change 40 to 50 cycles when the cover is put on. It should move about 7 to 10 cycles and then go back to the original reading when pressure is released. Do not use a lot of pressure, but enough to move it at least 1 cycle. If it moves about 15 cycles and goes back to the original setting, it's probably ok. Ideal would be about 7 cycles. If it does not go back to the original reading within 1 or 2 cycles, repair is needed.

Also check the guide arm operation. Rotate the tuning shaft slowly and quickly in both directions and make sure the arm contacts do not move away from the guide bar. If they do, repair is required.

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Date: Sat, 27 Aug 2016 19:49:56 -0500  
From: Cecil Acuff <chacuff@cableone.net>  
Subject: Re: [R-390] R-390A Cosmos PTO repair and adjustment

Great stuff Larry...this will probably end up in the "Pearls".

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Date: Sun, 28 Aug 2016 16:36:56 -0400  
From: <wb3fau55@neo.rr.com>  
Subject: [R-390] Cosmos PTO

Well I lucked out on the PTO. Seems there was a large error in the counter setting. I corrected that. My error now is a few kcs. So I am now able to do a zero adj. at the 100kc intervals. Linearity seems pretty good.

Larry, thanks for all the pictures. There is some similarity to the Dubrow, but I think as most do, the Cosmos is a better unit. I will leave it for now, maybe get back to it at a later date. I have 4 other R-390As that are running, but have issues. So I will be going to one of these. I think it will be one with a sensitivity issue on 1st 2 bands. 73s Russ.

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Date: Fri, 9 Sep 2016 10:07:18 +0000 (UTC)  
From: Larry H <dinlarh@att.net>  
Subject: Re: [R-390] connectors- PTO-RF deck

>Are the PTO connectors the same as the RF deck

Yes, those 2 connectors are the same. Sorry, no spare osc.

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Date: Wed, 12 Oct 2016 18:25:02 -0400  
From: <wb3fau55@neo.rr.com>  
Subject: [R-390] Progressitron

So hey guys, a friend of mine says Progressitron made the best of the 390As. My friend also said they were made just for NASA. I know they made some of the PTOs, did they make any complete 390As I do think my friend has a lot of hot air. 73s Russ.

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Date: Thu, 13 Oct 2016 00:00:12 +0000  
From: Les Locklear <leslocklear@hotmail.com>  
Subject: Re: [R-390] Progressitron

Progressitron made R-390A/URR PTO's, they didn't produce any R-390A receivers.

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Date: Wed, 12 Oct 2016 23:59:33 +0000 (UTC)  
From: Larry H <dinlarh@att.net>  
Subject: Re: [R-390] Progressitron, R-390A Manufacturers

Hi Russ, Here's a link to a list that looks to be correct:  
[http://www.jvgavila.com/r390a\\_4.htm](http://www.jvgavila.com/r390a_4.htm)

This same info is in the Pearls/History p21. I don't see Progressitron listed.

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Date: Thu, 13 Oct 2016 00:23:17 +0000 (UTC)  
From: Larry H <dinlarh@att.net>  
Subject: Re: [R-390] Progressitron, R-390A Manufacturers

Oops - I meant p53 in History. Sorry.

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Date: Thu, 20 Oct 2016 03:53:45 +0000 (UTC)  
From: Larry H <dinlarh@att.net>  
Subject: [R-390] R-390A VFO/PTO Quality

Stan, Take a look at the Pearls here:  
<http://www.r-390a.net/Pearls/PTO.pdf>

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Date: Fri, 7 Apr 2017 08:16:10 +0000 (UTC)  
From: Larry H <dinlarh@att.net>  
Subject: Re: [R-390] ADVICE ..... PSE, Cosmos linearity tool

Hi Pete, I assume you're referring to the bristo head screws for the linearity adjustment. They are a .033" 4 spline bristo wrench. Micro Tools makes one. I got mine from Moody Tools on Amazon, part # 4-49-8130. However, if the screws are not locked down tight, I prefer to use a # 4 flat jewelers screwdriver, .040" blade. It fits very nicely. Remember, you can keep turning them clockwise until they fall down inside. Then, they are a little difficult to recover. There's a lot of info written about the Cosmos, if you have not read it yet.

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Date: Tue, 18 Apr 2017 12:06:32 +1000  
From: Pete Williams <jupete@internode.on.net>  
Subject: [R-390] TECHY Q.

The COSMOS pto main coil is logarithmically wound. Can someone improve my view that it must contribute to linearity in tuning..... If so how? I assume tuning core positioning approximates what the shape of the tuning capacitors are in broadcast tuning linearity receivers to achieve low frequency linearity.

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Date: Tue, 18 Apr 2017 04:21:22 +0000 (UTC)  
From: Larry H <dinlarh@att.net>  
Subject: Re: [R-390] TECHY Q., coils wound logarithmically

Pete, Because the resonant frequency of an L/C network varies inversely with the square root of  $L \times C$ , a linear change in frequency is accomplished by an exponential change in L or C. So, yes, the L or C needs to change logarithmically, so all the variable core tuned coils in the 390's are wound that way.

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Date: Tue, 20 Feb 2018 13:35:40 -0700  
From: "Gary I. Biasini" <gary.biasini@shaw.ca>  
Subject: [R-390] 1967 EAC S/N 4998 Cosmos PTO Question

I recently added a 1967 EAC S/N 4998 to my radios. It was a bit dirty but otherwise seemed in good condition and the purchase included the screwdriver and bristo drive.

In checking the PTO however, it was about 5 KHz long so I decided to align the endpoints. Unfortunately, when removing the cover screw, I didn't see an adjustment screw. The picture at the link below shows what I found. Any help as to what to do next would be greatly appreciated.

<https://1drv.ms/u/s!AhXaYQRsUlJ0gclJ7iti9grLEpfMxg>

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Date: Tue, 20 Feb 2018 18:26:33 -0700  
From: "Gary I. Biasini" <gary.biasini@shaw.ca>  
Subject: Re: [R-390] 1967 EAC S/N 4998 Cosmos PTO Question

Thanks to you and to the others that responded.

I wasn't very clear in my original message. On the picture, where I expected to see the adjustment screw after having removed the cover screw, there was instead what looked like a red rubber washer. I decided that I would try to remove it with a dental pick but only ended up shredding the washer. Once enough of the washer was out, I could see the adjustment screw. After adjusting it twice for 1 1/2 turns in total, the endpoint remains 7KHz long, i.e. no change at all.

I was hoping that I wouldn't have to open up the PTO and remove a turn from the particular coil as noted in the various articles. I recently saw an old post (maybe on the PTO Pearls document) where the contributor mentioned that when he replaced the capacitors in the PTO (I think they were temperature compensating capacitors) the end point adjustment worked without having to take a turn off the coil. I am going to look for that post hope I can find that again.

Unfortunately, my time to work on the two R-390a receivers that I have in Arizona has come to an end. When I next get back here in mid-March, I hope to have more time. Again, thanks to all that have helped. I truly appreciate it.

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Date: Wed, 21 Feb 2018 01:44:56 +0000 (UTC)  
From: Larry H <dinlarh@att.net>  
Subject: Re: [R-390] 1967 EAC S/N 4998 Cosmos PTO Question

Gary, I've not seen what your picture shows. Did you look at 'A JOURNEY THROUGH THE COSMOS (PTO)' by Jim Miller? Here's the link:  
<http://www.r-390.com/cosmos.htm>

Hope you got my write up on the Cosmos ok. In the ones I've worked on, I found that although removing a winding does help, it misaligns the adjusting screws. I needed to change the capacitance, instead.

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Date: Tue, 20 Feb 2018 19:23:06 -0700 (MST)  
From: Gary Biasini <gary.biasini@shaw.ca>  
Subject: Re: [R-390] 1967 EAC S/N 4998 Cosmos PTO Question

Thanks. I have seen it. Could I trouble you to elaborate further on the capacitance change?

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Date: Wed, 21 Feb 2018 05:09:53 +0000 (UTC)  
From: Larry H <dinlarh@att.net>  
Subject: Re: [R-390] 1967 EAC S/N 4998 Cosmos PTO Question

Gary, Here's the info you asked for about reducing cap inside instead of removing 1 turn to obtain EP: after removing 1 turn on the e/p coil, the linearity disk no longer placed the adjusting screws close to the center of the linearity cam on each 25 kc point. It does not need to be dead on, but close is

good. Must avoid having the transition between linearity screws on the center of the linearity cam. This will cause erratic frequency at the 25 kc check points due to the play in the linearity gear train. I tried adding 1pf to the main tuning to move the e/p adjustment to regain alignment, but e/p was just 500 cycles out of reach. So, had to replace the 1 turn that I removed and add an 82pf N200 in series with one of the two 10pf caps inside. This reduced the overall capacitance by 1.5pf and this did move the linearity screws so they are close to center at each 25 kc point.

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Date: Wed, 21 Feb 2018 05:17:33 +0000 (UTC)  
From: gary.biasini@shaw.ca  
Subject: Re: [R-390] 1967 EAC S/N 4998 Cosmos PTO Question

Thanks. I will try your method in March when I next am near my radio.

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Date: Wed, 21 Feb 2018 12:50:08 +0000 (UTC)  
From: "Tom M." <courir26@yahoo.com>  
Subject: Re: [R-390] 1967 EAC S/N 4998 Cosmos PTO Question

Everyone has opinions so I'll give you this free; get your money's worth.  
- I would not touch any capacitors-

I wrote a procedure for calibration in 1995.? Here it is. This article will focus upon the calibration of the Cosmos permeability tuned oscillator (PTO) for both linearity and endpoint adjustments. Few devices have been so maligned or poorly understood than the Cosmos PTO employed in the R-390A HF receiver. This device has been mentioned in articles about the R-390A many times, as well as on several Internet mailing lists, often negatively. The features of endpoint and linearity adjustments for this PTO have often been misunderstood, leading one to suspect it may be a poor device. This article will attempt to convince that the Cosmos PTO is worthy of service in the R-390A when adjusted properly. Collins designed and built the first R-390A receivers utilizing its own 70H-12 PTO. This PTO covers a frequency range of 3.455 Kcs to 2.455 Kcs in ten clockwise turns. It is a robust device constructed of the highest quality materials, including an encapsulated main coil, sturdy compensating stack, and a temperature controlled oven.

Cosmos Industries was a New York manufacturer of radio equipment located at 31-28 Queens Boulevard, Long Island. Among its products was the well known Cosmophone HF-SSB transceiver. The improvements made in the Cosmos PTO over the original Collins device were designed by Lewis Metzger and Harold Goodman, both instrumental in the development of the Cosmophone. They received US patent number 3,098,989 in July, 1963 for their idea and working model of a PTO that could be linearized with external adjustments, unlike the Collins PTO. Anyone who has ever worked on a R-390A PTO soon finds out that there are two important adjustments that can be made. The first is that the PTO must be adjusted such that its output is exactly 1000 KC's in ten turns. This is commonly referred to as the endpoint adjustment, and is as far as most users will go in PTO calibration. Endpoint



adjustment is important as it not only affects dial calibration, but can also compromise front end track tuning on the lower bands.

The second important adjustment is linearity. If one were to graph the ideal PTO output frequency versus the shaft position in number of turns, the graph would make a straight line. This was the goal of Collins Radio in all of its designs of the era, including the 75A, 32V and all of the later models. Art Collins wanted a linear output, and that was that. The Collins PTO was famous for being able to achieve this goal, as well it had to, because the inherently linear Veeder-Root counter of the R-390A exposed nonlinear PTOs with errors as low as 0.1 Kcs.

All PTO's employed in R-390A service have an endpoint adjustment screw. This screw is typically located underneath a sealed screw hole behind the PTO's transformer can. As a PTO ages, its output will typically decrease, i.e., it will have an output of less than 1000 Kcs in ten turns. To remedy this, the endpoint adjustment screw must be turned (usually clockwise) until the PTO's output is increased to exactly 1000 Kcs in ten turns. The turning of this screw moves a tuning core into a second coil in the PTO to make the adjustment. PTO's of the Collins design will have two inductor coils, a main coil and an endpoint adjustment coil.

Adjustment of the PTO's linearity is another matter entirely. In the Collins PTO, the company employed an internal corrector stack which accomplished this task. This stack is constructed from a set of adjustable shims upon which a cam follower rides. As the PTO shaft is turned, the main tuning slug is advanced axially on a lead screw, and the cam follower is simultaneously advanced on the corrector stack. Naturally, advancement of the main slug on the lead screw is exactly linear, but unfortunately the coil and powdered iron tuning slug do not usually cooperate in linear fashion. The cam follower mechanism allows the tuning slug to either increase or decrease the overall rate of advancement on the lead screw by imposing a slight twist of the tuning slug. This increase or decrease in tuning rate is determined by the shape of the corrector stack and is what accomplishes the linearity correction. If a graph were made of the nonlinear response of the PTO, it might look very

much like the profile of the Collins corrector stack when properly adjusted.

Linearity correction is necessary because it is virtually impossible to wind the main tuning coil and match it with an iron slug for an overall linear output. The only problem with the Collins design is that the corrector stack is inside the PTO cover. Naturally, adjustments must be done with the cover off, but unfortunately, replacement of the cover influences the adjustment requiring multiple attempts and no shortage of frustration. Metzger and Goodman solved this problem by improving the Collins PTO design. The Cosmos endpoint adjustment is similar to the Collins adjustment, however the real innovation is found in their external adjustment for linearity. This is the most misunderstood feature of the Cosmos PTO.

Upon careful examination of the Cosmos PTO, one will find the endpoint adjustment in its usual location as described above. To the left of the endpoint screw hole will be found an additional screw cover. Underneath this second screw cover will be found a series of very small screws. During clockwise rotation of the PTO shaft, this series of screws passes underneath this window from left to right. One screw will pass with every 90 degree turn (25 Kcs) of the PTO shaft. It is this series of screws that are used to adjust linearity of the Cosmos PTO.

The Cosmos PTO has three inductor coils instead of two employed by Collins. There is the familiar main tuning coil, an endpoint adjustment coil, and a third coil that is part of the linearizing device. Like the endpoint coil, the linearizing coil is in series with the others. The inductance change of the corrector coil is controlled by a core which goes in or out as the PTO is rotated through its ten turns.

To help visualize the corrector mechanism, picture if you will a Teflon disk laid onto the front face of the PTO. This disk acts as a cam. A cam follower contacts the slug of the third coil. The corrector disk rotates through a reduction drive as the PTO is advanced its ten turns. Under this disk is a series of screws which are laid out in a staggered fashion all along its circumference, forming a circle. The flat heads of the screws, which are adjusted to varying heights in close proximity to their neighboring screw, make up a (typically uneven) surface upon which the flexible Teflon disk rests. As the screws are adjusted in or out, the Teflon disk (formerly and initially flat) is shaped into a wavy surface (a cam) upon which a cam follower rides. You've seen the kiddy motorcycle rides at the carnival where the miniature vehicles go round and round, and also make a gentle up/down motion on the wavy surface of the merry-go-round floor. It is this slight vertical displacement of the vehicles that is analogous to the in/out motion of the core in the compensating coil.

Note: One should refer to the R-390A service manual before attempting to service the radio.

The two things needed to calibrate the PTO at 25 Kcs points are 1) an accurate means of measuring frequency, and 2) an accurate means of turning the PTO shaft exactly 90 degrees at a time. The author uses a frequency counter to measure the PTO output, and the Veeder-Root counter in the radio to measure the turns of the PTO. When using the radio's counter to measure turns, take the time to tape exposed 120 VAC power and fuse connections to prevent electrical shock while performing the more than 40 PTO remove/install maneuvers. The frequency counter is connected directly to the output cable of the PTO. A handy crossover connector from the PTO fitting to BNC can be found on the back bulkhead of the radio. Simply borrow the adapter that is present at the IF output jack. There are many alternatives to using the radio frame to measure turns, including using a sacrificial R-392 frame (credit Wally Chambers, K5OP), and various calibrated knobs.

Setting the endpoint on a Cosmos PTO is similar to the Collins PTO's. Test the PTO to see how many turns it takes to achieve an output starting at 3455 Kcs and ending at 2455 Kcs. Most aged PTO's that have not been recalibrated will typically require an additional 1-15 Kcs past the ten turn mark to achieve the proper range. To bring it back to 1000 Kcs output in ten turns, adjust the endpoint screw (usually clockwise). If the proper output cannot be achieved within the adjustment range of the endpoint screw, one must open the PTO and remove one turn from the endpoint adjusting coil. This change in overall inductance of the coil will bring the endpoint back 7 Kcs or so. Once this is accomplished, setting the endpoint can usually be achieved. While the PTO is open, the lead screw and bearing can be lubricated. The author usually takes this opportunity to bake an open PTO in an oven at 150° F for several hours to dry it out and regenerate the desiccant. Perform the calibration only after baking, and keep the PTO in a zip lock bag if you plan to leave the adjustment window screws open for an extended length of time.

When setting the 25 Kcs calibration points, it is extremely important that the screw being adjusted is directly lined up behind the adjustment window. This may be accomplished by simply rotating the PTO shaft until the nearest screw is lined up exactly with the window. The reason this is so important is that the cam follower which rides on the compensating cam is directly behind this window, and will thus be directly under this screw at this point. If this caveat is not followed, adjustment can still be made, but there will be interaction between the point that one is attempting to adjust, and its neighboring points. This will yield poor results and will be very frustrating. Be advised that if the screw being adjusted is directly behind the window, the PTO position may not yield an exact 25 Kcs calibration point on the dial, e.g. 000, 025, 050, etc. This is not a real problem, but it may be necessary to shift the starting point of the 25 Kcs check points by 5, 10, or 15 Kcs up or down. Simply remember that the PTO has an output of 3455 Kcs at dial indication 000, and 2455 Kcs at dial indication +000. Armed with this information, one can make a spreadsheet calibration chart for all 40 calibration points in 25 Kcs increments.

An example chart might look like this:

| Frequency | Veeder-Root Error ( Kcs) | Counter(Kcs) |
|-----------|--------------------------|--------------|
| 3465      | -010                     |              |
| 3440      | -015                     |              |
| 3415      | -040                     |              |
| 3390      | -065                     |              |

and so on . . . for 40 to 42 calibration points

The above example is for a PTO that has the nearest linearity alignment screw falling at a frequency of 3465 Kcs on the frequency counter. This corresponds to a starting point on the Veeder-Root counter of -010. Note that this starting point is not on an even 25 Kcs point, but that is OK as it is

most important to start with the nearest screw directly lined up with the adjustment slug at the center of the window. To complete the chart, subtract 25 Kcs from the frequency and add 25 units to the Veeder-Root counter for each point out to 2455 Kcs.

Each screw will have an adjustment range of about 5 Kcs +/- Clockwise rotation of the screws will reduce the PTO's frequency output at a given checkpoint. One should avoid adjusting the screws to near their full clockwise position as this will cause excessive drag in the PTO.

#### Advanced Procedure for the Stout Hearted

To remedy problems with excessive drag due to adjustment screws reaching their clockwise limits, back all 40+ screws out to their counterclockwise stops, and then turn each screw one turn clockwise. This will give the cam an initially flat position. Start PTO calibration at the point nearest 3455 Kcs moving up the dial toward 2455 Kcs (+000 on the Veeder-Root counter).

Remember to check each calibration point against the frequencies on the calibration check chart (it is not hard to get 5 Kcs off). Some check points may require a touch-up calibration after completion of the first pass. This will be especially true if the PTO calibration was re-started with the cam in the initial flat position as described above. Extreme adjustment changes (5 Kcs) at any given point may cause output changes at neighboring points. These can be worked out with multiple checks and adjustments at problem checkpoints.

With this linearization procedure, it is possible to obtain checkpoint accuracies of +/- 0.100 Kcs with an initial dial calibration at 000 using the crystal calibrator. This greatly exceeds the specifications listed in MIL-R-13947B which require a +/- 0.300 Kcs with a dial calibration at the nearest 100 Kcs check point using the crystal calibrator.

In conclusion, the reader should be left with these points.

- the Cosmos PTO can be calibrated for both endpoint and linearity.
- calibration can be done at 25 Kcs points, typically exceeding military specifications.

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Date: Wed, 21 Feb 2018 13:27:56 +0000  
From: Steve Hobensack <stevehobensack@hotmail.com>  
Subject: [R-390] Cosmos PTO Linearity

I have a Cosmos that was once out of endpoint adjustment. I found one of the endpoint coils was shorted out. It seems one of the copper wire leads to that coil was in contact with a grounded screw and the varnish finally wore off. Check for that.

On another note, I have found different screw heads on the teflon screw disk linearity adjustment, allen square or maybe it was bristol square, phillips, &

slotted. I made an adjustment tool using a small steel wire and a Dremmel wheel (with the aid of a magnifying lamp and jewelers loupe).

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Date: Fri, 23 Feb 2018 05:22:25 +0000 (UTC)

From: Larry H <dinlarh@att.net>

Subject: [R-390] R-390A Changing VFO PTO EP adjusting range

As we know, the aging of our PTO's has often caused the End Point adjustment to fall out of range and can no longer set the VFO range to 1 MH in 10 turns. A relatively easy solution is to remove 1 turn of wire off of the adjusting coil, thus reducing the overall inductance and bringing it back into the 1 MHz range. This solution is probably OK on a Collins PTO, because its adjusting coil has 5 turns of wire on it originally. Removing one turn only reduces the adjusting range by 20%. This should still provide enough adjustment range for another 30 - 40 years.

The question is will someone have to go into it again in the future and make another change so that it can be brought back into adjustment. Maybe.

As for the Cosmos, we all know that it's adjusting range is not near as large as the other PTO's. That's because they added another coil in series with the original two in the Collins. The 3rd inductor is necessary to allow for external linearity adjustment (see a few other write ups by Jim Miller, Tom Marcotte, John Harvie and myself) about the Cosmos). In order to use the same capacitor scheme as in the Collins, the inductance of the EP inductor had to be reduced (thus reducing its range of adjustment). So the EP inductor in a Cosmos only has 3 turns of wire on it, making its range smaller than the Collins. Unfortunately, I've done two Cosmo's recently where removing one turn would not bring it back into range sufficiently, and the range is also reduced by 33%. It would have been barely usable (it was within 1 KHz), but that's really not good enough. And, in a few years, someone would have to go back in and make another fix in order to obtain 1 MH. So instead, I put the one turn I removed back on and reduced the capacitance. I know that the two 10 pf flat wafer caps in there are extremely fragile, so I very carefully added an 82 pf N200 in series with one of them. This reduced the total capacitance by 1.5 pf, making the EP adjustment work quite well again. I did not see any side effects from doing this.

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Date: Fri, 23 Feb 2018 10:00:22 -0500

From: djed1@aol.com

Subject: Re: [R-390] R-390A Changing VFO PTO EP adjusting range

I've also tweaked the Cosmos by changing the linearity trimmers. You can get a final tweak of several KHz on the endpoint, but at the expense of going through a laborious realignment of all the linearity screws. Since I was going to do the linearity anyway, it wasn't a problem. I cut down a jeweler's screwdriver such that I could do the linearity adjustment without removing the PTO from the radio. I found there was enough variation in remounting the PTO that it was hard to get to 0.1 KHz adjustments. My concern with

changing the cap is that it changes the temperature compensation to some unknown degree. Probably not enough to worry about with 60 year old radios.

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Date: Sat, 24 Feb 2018 01:12:32 +0000 (UTC)

From: Larry H <dinlarh@att.net>

Subject: Re: [R-390] R-390A Changing VFO PTO EP adjusting range

Thanks for the comments and good question on the NTC of 200. I didn't do any calculations to arrive at 200. It was mostly an estimate. Most of the VFO's I've seen drift on warm up and take quite a while to stabilize, and I believe more so now than when they were new. This is due to a few reasons (seal leakage (humidity penetration), nitrogen depletion, and component degradation).

These two Cosmo's were drifting a little, so I estimated N200. The two NTC caps in most PTO's are 10 pf at N100. If I would have put in an NPO, that would have reduced the NTC effect a little, but probably would not be noticed. Because they were drifting, I wanted to increase the effect slightly, but not a lot. The drifting was improved, although they still did drift some. The value to use depends on the PTO.

I have tried calculating the correct NTC value in the past, and have not had much success at it. Once I tried a rather elaborate formula and it was not as good as an educated guess. If someone has a good method of estimating or calculating it, I'd be interested. Before I work on a working PTO, I measure the drift with a counter to get an idea of how much drift is there. You can't use the BFO as a basis because they drift quite a bit sometimes (unless you've measured it with a counter and know what you have). It should be installed in the rx, because of temperature considerations.

All things considered, I like a good working Cosmos better than the Collins because it's easier to linearize. I too, make the adjustment while it's installed. The Collins linearization stack is very hard to work with. It's difficult for me to determine which shim needs to be moved and how much.

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