Repairing the KWS-1 Plate & Ant Loading Controls - WBear2GCR © 2018

(Or, a lot of words about fixing just two knobs)

The Collins KWS-1 Plate & Antenna loading controls frequently bind up and/or fail to run smoothly. The causes of this problem are found, discussed, and solutions presented. (more pictures still to come)

These *dial indicators* are made by Helipot. They are of course now about 60 years old and as used suffer from wear in several areas. Some of this can be repaired, some can not be repaired with ease. This drive is NOT a reduction drive. It is a multi-turn indicator.

The material is pot metal. The knurled part that you see is made of anodized aluminum and is added on to the basic knob.

Here's the simple version of one of the main problems: The bottom half of the knurled knob is made from potmetal, the top half is aluminum. Where the shaft enters the knob, the opening becomes *elliptical in shape* and so the knob no longer rests square and flush to the shaft. In fact it sits cocked to one side and no longer rotates parallel to the front panel. <u>This causes binding</u>.

More detail.

The knob is made of two parts. The outer/upper part of the knob is knurled and black finished aluminum. It can be removed from the bottom half using a Phillips screwdriver through the hole that the shaft sits in, by removing the screw. Some of these repair methods will require the remove and it may help if you are cleaning the numbers found around the skirt and the knob will be in the way.

Note: the brass gear in the knob is the *other* source of failures. There is no simple or easy way to repair this gear. It is pinned and staked, and is small. It could be precision drilled, but there is no simple way to drive it out from the reverse side. One would need to precisely drill a hole from the other side to drive it out... easier to buy a surplus knob.

The PROBLEM & CURE:

What happens is that over time the 0.250" hole in the knob that fits the stainless steel shaft becomes *elliptical*. This happens because it was made of cast *potmetal*. Potmetal is malleable (before it just breaks) and after time and under the pressure of the setscrew and use it will not keep its shape. This hole has not kept its shape.

The solution is to correct the hole in the knob.

Rotating the shaft, looking at the knob, there must be NO WOBBLE!

I've measured a few. They vary a bit. One measured 0.264" in one direction (on the axis of the set screw!) and 0.254" in the other. All measured "over" by a significant amount.

The shaft is dead bang on at 0.250".

The knob disassembled. Note the right most knob has a thicker wall and is faced down (from the factory) more than the left knob. Both were spread and out of round. The 6-32 screw hole is barely visible left knob, and can be seen in the center of the Collins anodized aluminum upper knob (center).

To remove the Collins machined aluminum upper knob section from the Helipot knob (which has the skirt) what I have done is to put a few drops of penetrating oil on the junction of the machined upper knob section and the skirt. Also *remove* the connecting screw from the knob. Put some drops in there. Let sit. This screw sits in the hole at the

end of the 1/4" shaft hole. Remove this screw first. Place a *long* 6-32 screw into that threaded hole. The long 6-32 should reach above the level of the skirt, tighten it just firmly hand tight. Hold the skirt in your hand, and with a small hammer tap lightly on the screw - the upper knob will pop out after a few taps. No need for a vice.

There is ***another problem***. The shaft that Collins provided (at least in this early KWS-1) is short. By short I mean that it does not reach fully to the rear of the hole in the knob. This is bad considering that we're talking a cast potmetal knob. All the force is on a short section of shaft, at the front of the knob hole. It would improve matters to spread the force along the full depth of the hole. SO, the shaft ought to be extended by about 0.20" to 0.25" in length. Then it will reach to the back of the hole.

How to extend the shaft length? There are two possibilities. A) move the shaft out, by loosening the shaft coupler set screws, and the shaft collar and sliding the shaft outwards, or B) fabricate a new shaft.

Now, (A) will *not work* because there is insufficient "meat" available inside the stock shaft coupler. What to do? Change shaft couplers! You'll need a longer shaft coupler (one for each control) one that permits about 1/4" at minimum additional distance from the PA cage input shaft(s). Those PA input shafts are "shorty" as well. It MUST be a flexible shaft coupling. Watch the coupling's diameter so it is sure to clear the nearby tube (6AK5) (only for the ANT TUNING control shaft).

Lacquer Thinner will soften the set screws' lock sealer on the shaft collar. I used a hypodermic syringe and needle to apply a drop or two.

It's a spline setscrew on the collar on my KWS-1.

The option of fabricating a new shaft and using the old couplers ought to be self-explanatory and straight-forward. Add about 0.25" in length. Test and cut to fit.

The shafts coming through the PA section with the stock couplers

NEXT is to consider what to do about the KNOB itself!

Even with the extended shaft seating all the way into the knob, the control will still NOT work properly!

The front, entrance of the knob is "belled". That is spread out. It MUST BE FIXED.

Needless to say, it's a good idea that whatever process is to be used, needs to be "down" first. A good idea is to use "sacrificial" knobs first, before working on the unobtainium

KWS-1 knobs.

The proper diameter is 0.250" plus enough extra diameter to just clear the shaft.

There are 3 1/2 possibilities.

1) Repair the shaft hole in the knob (best)
2) Shim the shaft hole.
3) Permanently bond the knob to the shaft and remove the knob using the set screws on the shaft coupler.

REPAIRING THE SHAFT HOLE

1) To repair the shaft hole there are only two possibilities. BOTH require the hole to be bored. If you have access to a lathe, this is pretty simple. Simple, at least in concept.

One method is to use a hard material for building up the inside surface of the shaft hole. Commercial products exist, one is called Turcite. But likely a hard epoxy would work as well. I'd probably select a slow set metal filled epoxy. Slow set epoxy is usually harder. Do not use "5 minute" epoxies.

So you'd want to drill undersize and then bore/ream to fit after the build-up material has set dead hard.

One could attempt using a drill press to do the job, but you need to really "find the

center" and the drill press ***must*** be precise, with almost zero run-out. If you don't know what this means, don't try it.

The other technique to effect the repair of the bore is to place an insert into the knob.

There are to main methods that might be considered:
- bore out the knob hole and insert an insert.
- do NOT bore out the knob hole and insert an insert.

What to make the insert out of depends on what sort of insert it is and how it will be used...

The first method is likely better, but there is not a lot of "meat" available.
The second method would rely upon an epoxy or anaerobic shaft lock compound to hold the insert in place. THEN in both cases the insert must be bored.

The problem with the second method is that very, very little brass stock would be left behind after boring. You'd end up with as little as 0.004" in some areas for one knob that I measured.

In either case, you need to drill a hole to pass the setscrew through the side of the brass insert, first before installing it.

So, I vote for drilling the hole out to just the maximum "out of round" dimension, then fabricating an insert to fit. For example on the knob I cited earlier that would be a ~0.264" hole and insert to fit.

This leaves a 0.264" - 0.250" = 0.014" / 2 = 0.007" wall thickness!!

One other way to do it would be to put a short insert only into the front, ahead of the setscrew, and rely upon the shaft reaching the rear of the hole and fitting snugly. Best to verify that the shaft *does in fact* fit snug at the rear, all the way down the hole...

(Steel can be used also...)

Note the worn edges, this knob it turns out had a brass insert! Note the broken brass tooth!

Another "trick" way to do this job is to use the threads that are intended for the internal screw that holds the top of the knob to the bottom of the knob. In this method, the end of the shaft itself would be threaded as if *it* was the screw - so the shaft will then screw into the top of the knob. This assures 100% a solid fit at the rear of the knob. Of course this is a job for a lathe. One could simply drill and tap the shaft end, and then Loctite a screw thread in place, which is easier than threading the end.

The front or total insert is still needed - but probably this method will work best WRT getting tolerances right if only a partial sleeve is used in the knob, as the screw threads need to mate to the shaft when inserted. The fit at the front must still be very tight as the setscrew will put hundreds of pounds of side force on the shaft. But if everything was made properly, this is perhaps the most "bullet proof approach of all.

> *Note: after a lot of thought, tests and work, I discarded the concept of a thinwall insert entirely. My finding is that it is not strong enough to resist the forces from the setscrew! I went with a thin shaft end, and a thicker insert wall*.

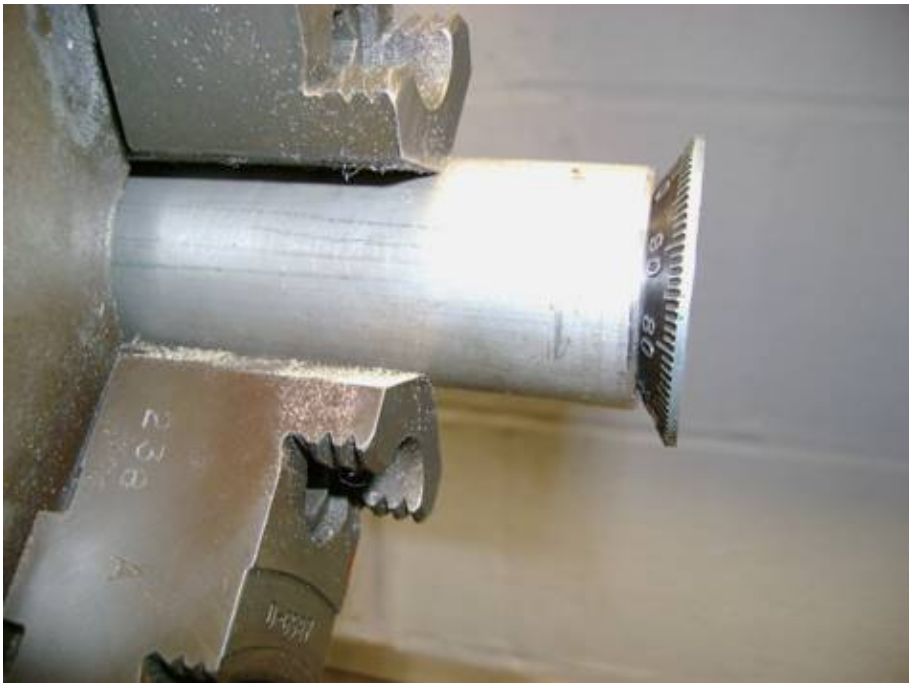
Variation on (1) - machine an oversize shaft to fit, like 0.264" over, at the knob end, and 0.250" for the rest. A taper is even possible... This way you use the existing setscrew and do not need to fit a brass insert... So rather than put in an insert, you use a larger diameter shaft. It's larger selectively, only where it fits the knob. The knob still probably needs to be bored a bit to enforce roundness. The shaft can be stepped, 0.264 at the entrance to the

knob, and stock 0.250” where it reaches all the way into the knob. Lathe required

However, this will suffer from the same problem as did the original knob, as no strength has been added to the potmetal knob. So, the insert method potentially adds strength and extends the usable life of the knob system. (see my solution later on...)

2) Shim the shaft. This is a bit tricky. The knob needs to end up solidly connected to the shaft and pretty much dead perpendicular to the axis of the shaft. If it isn't, then the little gear on the underside of the knob won't run smoothly, and the entire assembly will act rough, will bind, and in general will have a bad "feel".

Rotating the shaft, there must be NO KNOB WOBBLE!



This is the knob holding fixture I made from 1.250 aluminum bar stock, drilled, and then lightly bored to mate tightly with the outermost edge of the inner knob. The knob is held by a 6-32 screw that like the Collins assembly goes up through the top of the knob - the fixture is tapped to accept the screw.

After measuring the knobs, I find they are all different. So whatever you do to try to shim, it will have to be "worked in" until it is right. Tricky.

Brass shim stock is likely a good bet. Aluminum foil is possible, and cheap and available.

The whole idea here is to compensate for the *non-circular and uneven* "belling" of the *ENTRANCE* hole of the knob. So for the example above you'd have to shim a *maximum* of 0.007" on two sides - but that may or may not be the same on opposite sides of the hole. That's what you have to figure out. The knob has to be on tight, and square to the

shaft. And, the shims need to be only at the first entry part of the hole... since the hole is now elliptical (uneven in diameter) and tapered from the entry to the rear (where it is untouched and still of original dimension).

I think if you do this properly, it's like a "one time" operation that will involve some lube and gentle tapping to get the shaft all the way on. Then use the shaft coupler and the shaft collar to affix the knob in place and set the proper distance & mesh with the gears on the front panel.

> *Note: My conclusion is that shimming is virtually impossible, won't work, and at best is a short term fix.*

3) Bond the knob to the shaft. This is actually only semi-permanent, *IF* you use most epoxies or anaerobic shaft lock compounds. Heat will cause them to "give up".

Here the bore is being lightly cut on the lathe. Note the bright brass color, this knob had an insert made and inserted by a previous owner to try to save the knob. It did not last.

The main trick here is to get the shaft and the knob properly aligned. Super simple with a lathe. But the idea remains constant. The shaft must go as far as possible into the knob, where there is no wear, so that it is centered - then the only thing that is required is for the skirt to end up perpendicular to the shaft. A machinist's vise or some other solid fixture that will maintain the proper perpendicular relationship between the shaft and the knob will be sufficient. What I am saying here is that by using the unworn part of the knob, this will assure centering, while a machinist's vice (etc) will maintain perpendicularity)

Using the lathe for alignment, and bonding, boring is not even required.

> *Note: In the future, the shaft and the shaft collar would be required to be removed in order to for the knob to be taken out. Also, setting the mesh at the panel of the counter gears would be done at the shaft coupler.*

SUGGESTION: if you permanently affix, or somehow manage to tight shim the knob to the shaft, place a note inside the radio to prevent damage from someone trying forcing the knob off, and/or make the setscrew defeated, or removed entirely.

In an online forum responding to my post, W8FAX related that he had filled the 1/4" hole with metal filled epoxy and rebored the hole with success. This is a combination of bonding and an insert in one shot, similar to the turcite method suggested earlier.

He wrote: "I made a solid aluminum fixture that the knobs would sit in securely and the center located very accurately, and located radialy by using the set screw hole so I could re-drill it later.. I had some end mill cutters ground to a few sizes that I thought would work to re-size the hole and repair the out of round. Then, on a Bridgeport vertical milling machine, I bored the hole out as far as I thought was safe. I then filled the back of the knob and hole with aluminum base JB Weld, avoiding the area where the gear is. By filling the void around the repair, it added some support to the wall of the hole. After letting this cure a couple of days, I re-bored the hole to the proper size, plus a thousandth or two. My fixture was made so I could also use it to re-drill the set screw. Success. I re-installed the knobs and they worked great. I still avoided over torquing them on installation tho'."

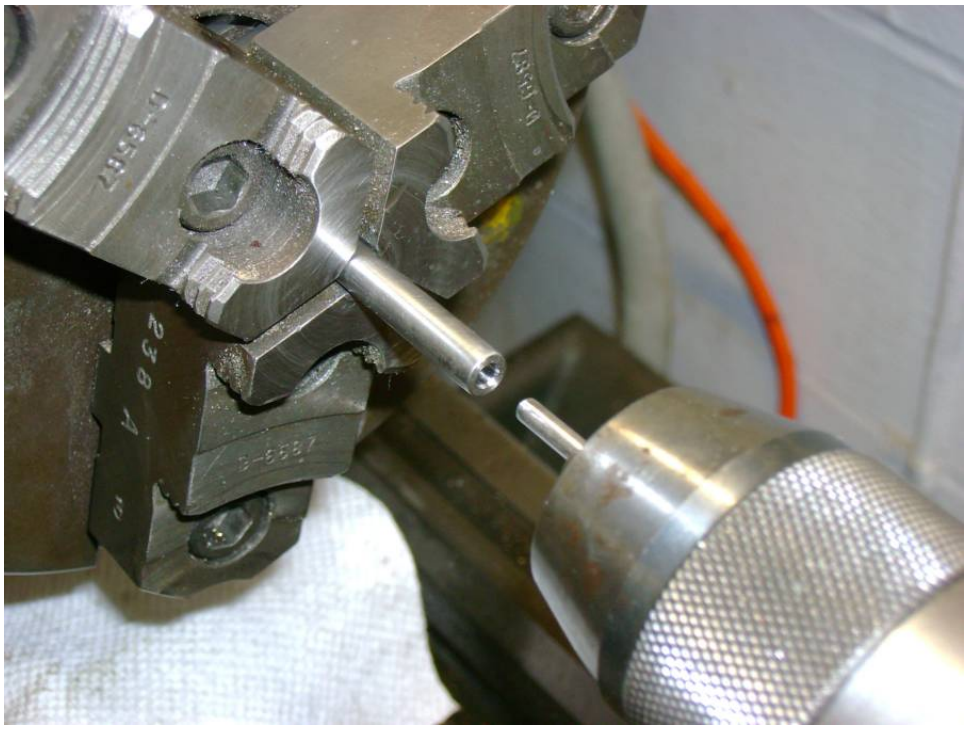
WHAT I FINALLY DID FOR THE SHAFT & KNOB

After trying several shafts and materials, I realized that for the repair to work, the issue was going to be the pressure of the setscrew against the shaft, pushing on the opposite wall of the knob's hole. No good, that's what caused the knob to bell originally. So, my solution was to make a steel insert that uses a 0.125" shaft hole, rather than the full 0.250" shaft hole that the knob usually uses. This way the setscrew can "grab" a few turns of the insert. In this way the force is now transferred to steel, rather than the potmetal. Doing this ought to keep the knob from being distorted.

After coming up with this idea - and thanks to the fellow AMers on 75m that participated in discussions about this project - I set out to try the 0.125" shaft method. Doing it requires that the assembly go together true, since there is bonding taking place and it's not exactly precision fit machining.

Here's how I fabricated the shaft - two parts. It was easier to drill the 0.250" shaft than to machine it precisely down to 0.125". Easier and faster by far. I used some 0.125" rod and some 0.250" rod, drilled the end of the larger, and used anaerobic "shaft locker" to bond them permanently.

Here's the shaft being readied for assembly:



The 0.125" rod has been cut to length, polished and finished. The hole has been drilled deeper than needed. The tailstock of the lathe slides the two together and holds them in alignment. Anaerobic shaft locker is first placed on the mating surfaces prior to assembly (not shown).

I had tried machining up brass shaft with a 0.125" end, but found that the setscrew deformed and indented the brass! Don't underestimate the force that a setscrew can exert!

The hole in the knob itself was machined round and then measured. A custom steel insert was made with an 0.125" hole bored to fit the ID of the hole in the knob. Another hole was drilled to meet the setscrew hole. This hole was made undersize by a bit to permit both easy alignment with the setscrew hole and for a cutting tap and then a plug tap to be run through, *after* the insert was bonded in place. This allowed the setscrew to "grab" a few turns in the steel insert.

The benefit of doing this is that now the force is across the steel insert, not between the potmetal setscrew hole and the opposite side of the hole - insert in place or not!

Note that the insert I made is "taller" than the original hole in the knob - there is space between the front panel parts and where the knob meets the ring teeth, so why not use it for some added strength?

I held the knob in the lathe using a 1/4" hex standoff and the setscrew that holds the knurled outer knob. (I had wanted to use the original fixture, but you have to use the short

screw in that holds the knob head on, and that does not reach the rear surface and threads of my holder! I did not anticipate this step when I machined the holder jig. Even if I had, it would have made it that much more difficult to machine the holder...) After checking for true on the lathe, I put a small amount of candle wax down in the bottom of the hole, over the setscrew. Then holding the knob with the hole up, I hit it with my heat gun until the wax melted. The reason for this was to permit the bonding agent (anaerobic shaft locker) to NOT bond the setscrew! It is necessary to use the setscrew to pull the outer knob onto the inner (stock Helipot) knob and to hold it in place.

Btw, I changed to a "button head" screw that has an Allen wrench for tightening, instead of the Phillips that it came with. It's lower profile and its Allen wrench fits easily through the 0.125" hole. The button head screw needed a small amount of it's diameter shaved off... this permits the insert to go slightly deeper than the original shaft, again for added strength.

The knob and shaft. The insert stands proud of the potmetal hole for added strength. The hole is 0.125" and the shaft end is polished to make a slide-in fit. The insert was aligned in the bored hole using the shaft held in the tailstock, and after anaerobic shaft locker was applied, the insert, sitting on the shaft was slid into place and left to set-up.

For the second knob, trying to do the most efficient repair, taking the least time, I'm going to use the direct bonding method. This time, no setscrew, the hole will be plugged and sealed. Only the bonding agent will hold it to the shaft. Again aligned for accuracy using the lathe as the jig - the shaft will be centered and square. Likely no need to machine the knob at all.

> *Note: I found that the knob may deform even from very light boring to make the ID round! The way this became evident is that the little brass gear became bound up. I was able to free it by putting water in the section where the gear is, and freezing it! Since water expands when frozen, it moves the pot metal just enough to free the gear. Phew.*

That alone is a good reason to dispense with the "fancy" insert method and go with the "quick and dirty" bonded shaft method!

About the Helipot Duodial mechanism:

After some looking about and searching on the internet I learned more about the origins of the Helipot Duodial. The KWS-1 uses a standard turns counter dial (not reduction drive) that was the original design from Helipot. Most of us are familiar with the chrome colored units that have a window where the numbers rotate with each 360 degree rotation of the knob to do the counting. This style came first.

It turns out that the counter on the KWS-1 happens to be a *version* of the model R-10. The primary difference, is the number of teeth on the gears. Therefore the number of turns it counts. The R-10 is a 10 turn counter. The KWS-1 is not.

Inside the Helipot R-10 box, this is what you will find. It is similar the KWS-1 knob assembly, except the outer counter dial has a different legend printed, a different pitch to the gear and teeth, and the knob does not come with the machined & anodized knob that Collins added. There is also an installation guide.

On ebay I eventually saw a version that had 39 numbers, so it was even finer than the 24 numbers on the KWS-1!

These can be found, but unfortunately this one is only 10 turns, and the KWS-1 needs 24 turns.

Other equipment that used the same counter dial assembly that I have identified so far:
- PRC-47 (Vietnam era transciever)
- 180S-1 (antenna tuner)

The PRC-47 does not have the hole in the end of the inner knob, as it was not supplied with an outer/upper knob extension, as was the KWS-1.

I chose to use all synthetic lube for the re-installation. Silicone grease, synthetic gear oil (automotive 50w), and "shock oil" for RC cars (comes in weights from 10w up into nearly grease), as well as standard synthetic motor all are all candidates. The advantage over the stock grease is that these will never harden or gum up. I suggest the silicone grease for the area behind the outer counter ring that rides over the black rear piece. Between the inside bushing and the outer counter ring, either the grease or one of the heavier lubes seems like the right idea. Some sort of grease ought to be over the area where the gears of the counter and the gear in the knob contact. There needs to be some lube for the brass gear's shaft in the knob too. That ought to be a lighter oil. I'd suggest a removal and re-inspection after some time in service to observe that the lubes are still in place and working.

I have examples here where there are teeth missing from the knob's gear, and with teeth missing from the concentric counter gear rings as well. Maintaining lubrication is a good idea.

The new knob + shaft (0.125" version) has been installed and tested, and it works nicely.

A lot of work for *just two knobs!!*

The front panel's Helipot indicators. One still installed, and one removed. The must be no burrs on the inner toothed gear's mounting nut. A thin layer of silicone grease on the plastic will likely aide smoothness, once the knobs themselves are repaired. The indicator below has been re-glued some time ago.


Hellpot Corp.
SO. PASADENA, CALIF.
MOUNTAINSIDE, N.J.
Duodial
TURNS COUNTING DIAL
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24