Notes on the 51j Series Gear Box.

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This document is intended to aid those intrepid soles wishing to take apart and re-assemble the gearbox on the 51J series receivers. It is meant to be freely available and may be freely distributed.

Before proceeding I recommend that you secure the proper tools including at least one copy of a 51j series manual. Due note that there are subtle differences in the descriptions between the 51j-2, R-388 and 51j-4 manuals. The principles are the same in all the manuals.

One should spend prep time reading the manual along with these notes, inspecting the operation of the mechanics of the gearbox and reviewing the diagrams at the end of this document.

In particular:

- Checkout the synchronization and operation of the gearbox as well as the location of the RF CAMs and switches.
    1. Turn clockwise past Band postion 1 until the bandchange shaft stops. Look down into the top of the gearbox above Shaft F and see how the pins engage to stop over rotation.
    2. Turn back to Band position 1. Looking up into the bottom of the gearbox behind the Geneva wheel locate the over travel coupler and its radial pin. Notice that it is about 60 degrees to the left. As you switch bands to Band position 16, this pin rotates clockwise. At Band position 16 this pin should be touching or just about to touch the stop pin in the rear panel.
    3. Take note of the positions of the IF, RF and Crystal switches when in Band positon 1. Unless you happen to have a spare 51J handy, this is very important as once the gears are synchronized, you will need to align them with the proper switch positions
    4. Turn to Band position 30. Take note of the positions of the RF CAMs. Also check to see how they are positioned relative to the alignment description in the manuals. If you note the position of all 3 CAMs when in Band position 30, (and how far off the CAM riders are from the CAM tips for Bands 15 and 7) it will make aligning the CAMS much easier later on.
    5. Turn to Band position 30 and continue past until the stops are engaged. Look down into the top of the gearbox above Shaft F and see how the pins engage to stop over rotation.

    The above points are key synchronization points of the gearbox, switches and CAMS.
- Take note of the feel on the band change and tuning controls. You do not wish to take apart and re-assemble a gearbox and be left wondering if it is worse than before.

- Check to see if the Geneva wheel has worn a hole in its spring. If it has, this will make changing bands difficult, as the Geneva wheel will easily get out of synch. This can be remedied by shimming the spring outwards so that the Geneva wheel engages the dimple on the spring.
- Check the spring tension and their position in the gear on Shaft B. If these are not properly tensioned there will be backlash in the kilocycle tuning. Unfortunately, if you cannot unpin the pulley on this shaft, you will not be able to fix it. It is good to note this ahead of time.
- Check the spacing for all the gears that are adjacent to either the front or back panels. Check to see how much play there is.
- Take note of the location of washers or spacers. I hate having a washer left or two left over. I have included a section which describes the shafts and the their assemblies as illustrated in the Dial and bandswitch gear box diagram in the manuals.

Tools:

- 51J-x manual
- Bristol Wrenches
  No 4 Bristo set screw: 4 flutes, 0.060" dia
  No 6 Bristo set screw: 4 flutes, 0.076" dia
  No 8 Bristo set screw: 6 flutes, 0.096" dia
  No 10 Bristo set screw: 6 flutes, 0.111" dia (used on large knobs)

- Retaining rings for 1/4" shaft
  Replacements in case any break, but also recommend C type for stop/idler gear.

- Fine sand paper: for removing burrs on shafts

- Solvent or 45 watt soldering gun for softening glue on the setscrews.
  Glue remover from Loctite. This is a gel that removes cyanoacrylate glue.
  Also you may try varnish remover.

- Spring/Retaining ring clip wrench.
  I found that a pair of side cutters with sharp tips works well. (Don't cut them!!).
  Close the side-cutters and push their tips into the opening in the retaining ring up to the shaft and then open up the side cutters.

- Extra shims.
  Check the each of the shafts for play and to see well the assemblies press against the front or back panels. I've forged some from shim stock. This is generally available from machine shop supply stores.

Before even attempting any disassembly of the radio make sure you can get at and loosen all the setscrews. As these have all been cemented in place you will need either some solvent or heat. I like using my SMT hot air rework gun. It has a very fine nozzle and can direct heat in a very concentrated manner. Particularly troublesome are the screws for the

VFO and the brass pulley on the front of the panel. The setscrew for the pulley is deeply recessed. If you can't get all the necessary setscrews loose STOP HERE and think hard if you want to procede. The procedure described herein requires you to remove the gearbox from the radio. This requires undoing the appropriate setscrews. If you cannot, then you may be able to disassemble the gearbox in place by removing the front panel. However you may not be able to align the gears and the switch assemblies unless you can loosen the necessary set screws.

The instructions in the manual call for unpinning the dial pulley on the front of the gearbox. I have never been able to unpin the main pulley. It makes following the procedure outlined in the manuals impossible. A number of the gears overlap each other making it impossible to remove the front panel without unmeshing the gears. Hence reassembly has always taken some jockeying of the gear positions.

The method described in a 51j-4 manual is slightly different than the methods outline in the R-388 or 51j-2 manuals. The 51j-4 manual calls for rotating the band change gear past postion 1 until it stops, about 45 deg of rotation after position 1. The marking of the gears is similar to the earlier manuals however you need to mark the position of the ball in the detent gear because you will need to position the ball at this location for reassembly. My preference is to use the method in the earlier manuals where the band change was left in position 1 leaving the ball in the detent position.

Notes on the Dial and Bandswitch Gearbox Diagram

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The dial and bandswitch gearbox diagram is anotated at the end of this document. I have personally found it a bit confusing and have included the following two comments:

> Shaft "I" is drawn on the right hand side in the vertical view looking down on to the gearbox. It is actually located just to the left of the middle of the front panel.
>
> The diagram shows a washer underneath a retaining ring on shaft "C" running through the detent assembly. These are afixed to the 1/4" shaft at the rear of this assembly. There is a 1/2" bushing that passes through the rear panel. The shaft passes through this bushing.

Shafts and Washers

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A: PTO Tuning.

Pinned, doesn't come apart.

B: Dial Pulley assembly.

Pinned, I've never been able to un-pin it.

C: Shaft for Detent Gear and Sun/Orbital Gears.

Should have washers infront of the rear panel and behind the front panel. There are washers/shims between Detent Gear and Sun Gear assembly.

E: Shaft for IF Rack and Tension Pulley.

There is a washer between Gear and back panel. The retaining ring is behind the back panel.

F: Shaft for Stop-Idler Gear.

Has only a retaining ring. May wish to place a shim under the retaining ring to reduce wabble on this gear. Ensure the shaft is ribbeted securely to the front panel. If not, you will need to compress the ribbet to secure the shaft.

G: Shaft for the Band Change Knob.

Drives gear on shaft K and overtravel gear on shaft H.
No washers used

H: Holds overtravel assembly for RF tuner switch and Genveva wheel.

Gear on Geneva wheel drives gear on shaft I. There is a washer between the Geneva Wheel and the Gear behind it.

I: Shaft for Crystal Selection.

Should have washer/spacer between Gear and Front Panel. This keeps the Gear from rubbing against the front panel.

K: Gear attaches to a shaft, which drives IF switch.

There is a washer between Gear and Back Panel. Sometimes a washer is found between gear and front panel although this is not shown in the Collins figure. There is a retaining ring behind back panel.

Scribing/Marking the Gear Locations

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1. Remove the brass pulley from the front of the gearbox. There is a setscrew deep inside and yes; Collins did apply the glue here as well.

2. Place the band switch into postion 1.

3. Before disassembly, scribe the gears and note the postions of all of the switches. The latter is very important if you are disassembling the gearbox while still attached to the radio.

4. Trace the arc of the Geneva Gear on the Band Change Gear. Use a metal pin or knife-edge. If you use a permanent marker it will likely wash off as soon as you start to clean the gears. Also scribe the radial line of the Geneva Gear on the Band Change Gear. This will allow for putting the band change gear into position 1 when reassembling.

5. Mark the tooth of the Crystal Frequency Gear that lines up with the Vertical Line of the Geneva Gear. Alternatively mark the tooth that linesup with the pin in the panel underneath the Crystal Frequency Gear.

6. Using the top of the front panel of the Gear Box as a guide, scribe a horizontal line across the Stop-Idler Gear on shaft F. This will allow you to properly line up the pin on this gear when you reassemble.

7. Note the positions of all of the switches, IF switch, Band Change Switch, and Crystal Switch. The position of the crystal switch is next to impossible to see. If the gearbox is removed from the radio in band position 1 the switches should be left undisturbed and one should not encounter any difficulting with switch alignment during re-assembly. If the panel is left in place on the radio then it is very easy for the gears and hence the switch shafts to get rotated out of position.

8. Turn the band change 7 1/2 turns counter clockwise to Band 16. Using the Geneva Gear as a guide, scribe a second line on the band change gear. This will be used to line up the pin on the over travel disk. Examine the bottom of the gearbox and you should see that the radial pin on the overtravel disk has just started to touch the stop pin on the back panel. You can use Band 2 as well but then you will not be able to check the alignment of the radial pin.

9. Return to Band position 1.

10. Before disassembling, measure the length of the spring used in the pulley cord. When reassembling, tension the spring back to the same length.

Removing the Gear Box:

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1. Make sure you are in Band position 1!!

2. Loosen all, and I mean all of the setscrews on the shafts for the: VFO, RF slug rack and IF slug rack (and the front IF CAM) and the two band change shafts (bottom of receiver). If you forget any, you will have the gear box half disassembled and realize that you are stuck. (Been there, done that.) This includes the cams and shaft coupling that raise and lower the IF tuning rack.

3. Remove the right side panel.

4. Remove the VFO mounting screws and the gearbox mounting screws. Lift the gear box from the receiver.

Disassembling the Gear Box:

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I suggest working on the floor, that way you don't have to worry about dropping something and having it bounce away. Work on a sheet of cardboard or lay down some newsprint (packing material).

Take the time to remove any obvious burrs from the shafts as these may cause the shafts to bind as they pass through the gearbox panels - again, another awkard moment.

1. Remove the 4 screws from on the front panel of the gearbox.

2. Place the gearbox upright with its bottom on the floor. Take note of the detent/orbital gear assembly. When you pull the panels apart this assembly will come apart because it is intertwined with other gears. It is likely that the front washer from this assembly will fall on the floor.

3. Slowly pull the panels apart and watch all the shafts carefully for washers. Try to keep the washers with the appropriate gears.

4. When the gearbox is partly apart the pulley cord will slacken. Take this opportunity to remove the spring and place it in a safe spot, i.e. its own plastic baggy.

5. Pull the panels apart. This is where it pays off having removed all the burrs from the shafts.

6. Once the panel is apart, remove the retaining rings on the gears on the front and back panel. This allows for more degrees of freedom to jockey the gears about during re-assembly.

Reassembly/Alignment Check

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When assembling the gearbox, lay the back panel across two 2x4"'s. This allows the rear panel to lay flat when gears plus their shafts are inserted into the panel.

Grease all bearing surfaces during assembly.

1. Insert shaft E with the pulley/gear into the back panel. Do NOT attach the retaining ring. This will make re-attaching and tensioning the cord and spring easier.

2. Insert the Gear for shaft K. Leave it unpinned so it may be repositioned later if necessary, e.g. to facilate getting to the set screws.

3. Reassemble the overtravel disk with the 144-tooth overtravel gear (two pins on top with 1 pin underneath). Make sure the two pins are on the opposite side of the gear from the overtravel disk. Detent the two together with the detent ball. Use grease to hold ball in place.

4. Replace overtravel assembly, lining up the mark on overtravel gear with the notch on the Geneva detent spring. This should correspond to Band 1. The radial pin on the overtravel coupler in the bandswitch shaft assembly should be placed about 60 degrees clockwise from the stop pin in the rear plate. The pin on the overtravel gear should be above (to the left of) the pin on the overtravel disk. See the gearbox figure.

5. Replace the gear/shaft assembly used for the band change. The manual refers to this as the 85-tooth gear, shaft G and 16-tooth gear assembly. Line up the scribe mark made when in the Band 1 postion with the circumference of the overtravel gear. This will line up with the Geneva wheel when the wheel is place down in the next step.

6. Replace the shim washer (item D) and Geneva wheel/33-tooth gear assembly. Make sure that the Geneva drive pin on the gear from the band change shaft will engage the slot in the Genevea wheel while the Geneva detent is engaged.

7. Take this opportunity to ensure that the scribe on the 85-tooth gear on shaft G lines up with the circumference of the Geneva gear. The pin on the gear on shaft G should be set so that it is just about to engage the bottom of the Geneva wheel.

8. This is also a good time to check the synchronization of the over travel assembly. The initial assembly should have the pins on the overtravel assembly about 60 degrees clockwise from the bottom. The two pins on the top inner surface of the overtravel gear should be almost vertically aligned with the edge of the gear panel. From Band position 1, rotate the band change shaft 7 and 1/2 times counter clockwise. This is Band 16. At this point the radial pin on the overtravel disk

should just be about or touching the stop pin on the panel. The scribe mark made when using Band position 2 or 16 should line up with the circumference of the Geneva wheel. The pin that is used to engage the Geneva wheel should be away to the upper right from the Geneva wheel. For anyone that has a gearbox that isn't synchronized, this position can be used to re-synchronize their gear box. Start at band postion 16 and go back and forth between bands 1 and 16 to properly position the overtravel disk and the Geneva drive pin.

9. Reset the gear assembly to Band position 1. With the gears on the back panel in proper position, tape gears on Shaft H and G in place. Make sure you positon the tape so that it can be removed after the gearbox is assembled.

10. Place the front gearbox panel face down. Insert Shaft I and its gear into the front panel. The long part of shaft I goes to the back panel. Assemble the Sun/Orbital Gear assembly and make sure the ball is detented. This is very important!! Insert the sun/orbital gear and detent gear assembly (everything on Shaft C). Make sure the front and back washers are on. Mesh all the gears on the front panel, Shafts B and C. The gear on Shaft I will engage the gear on top of the Geneva wheel on the back panel. If you scribed the gears on Shaft C as per the manual now is the time to align them. Since I start with this assembly in the detented position I don't bother to scribe this assembly. Now, tape the Sun/Orbital Gear assembly in place to the front panel, e.g. run a strip or two of tape from the back of the assembly, overtop of the assembly and onto the front panel. Do the same for the Gear on Shaft I.

11. Insert the Stop Idler Gear on Shaft F aligned it using the scribe marks and the front panel and tape it in place. To do this though will require lifting up the front panel and viewing the face. When you lift it up, keep it horizontal, lift above your head and check alignment of this gear. If you don't keep the panel horizontal the back washer of the Sun/Orbital assembly and maybe the assembly itself will fall off. Do NOT attache the retaining ring for the Stop-Idler Gear. If the gear wasn't scribed, align it so the stop pin is as shown in the diagram and tape the gear in place. Again, do NOT attach the retaining ring. You may need to reposition this gear later to achieve synchronization.

12. Tilt the back and front halves of the gear assembly until they are vertical and bring them together. This will be tricky because of tight tolerances on shaft holes and having to mesh the gears together. Watch that the back washer for the Sun/Oribital gear assembly doesn't fall off. Once the two halves are properly together insert two of the front panel screws just enough to hold the screws in place. This is to stop the whole assembly from coming apart. Carefull remove all the tape. Lay the assembly face down. This is to stop the Stop/Idler gear from falling out of position.

13. For the following check, make sure the Geneva Spring is in place, as this will hold the Geneva gear in place. Otherwise the Geneva Gear will move about and

the pin on the band change mechanism will jam. Check the synchronization of the gears by holding the gearbox in a horizontal plane with the front gear panel facing down, so that the 90-tooth Stop-Idler gear will not fall off during the check. If the gear box has not been removed from the receiver I suggest making a temporary retaining ring for this gear using some 10 thou shim stock. Cut a stip about 1/2" wide and less than the radius of the pins on this gear. Cut a notch at one end just wide enough to engage the slot in the shaft where the retaining ring would go. Use this as a temporary way to hold the gear inplace while checking alignment.

(1) From the R-388 manual. Shaft G, when turned clockwise, must hit the stop after about 45 deg rotation. If not you need to reposition the Stop Gear. Before adjusting this gear make sure to check alignment with the scribes and check step (2). Do not adjust the Stop Gear until step (2) has been achieved.

(2) When shaft G has rotated 71/2 revolutions counterclockwise (15 detent positions) from band position 1, the pin in the gear on shaft H and the radial pin on the bandswitch shaft assembly, must have rotated clockwise until the radial pin is just touching or about to touch the pin in the rear plate. Further rotation of shaft G should cause the pin in the gear to leave the radial pin arrested by the pin in the rear plate.

If this is not achieved at a detent position then you need to adjust the overtravel mechanism.
Disengage the Stop Gear by shifting its position. If necessary, pull the panels apart slightly. At Band position 16 align the pins of the overtravel mechanism. Onced aligned, disengage the Gear on Shaft G and re-align the scribe marks. This is where it pays off having scribed this gear for band postions 1 and 16 (or 2).
Re-mesh all the gears and bring the panels together properly. Go back to Step (1).

(3) From band position 16 continue rotating the band change shaft counter clockwise. If the stop pins on the gears hit before 15 detent positions are made you need to make a slight adjustment to the Stop-Idler gear. After Band 30, the stop pins should engage after about 45 deg of counter clockwise rotation.

14. To adjust the Stop-Idler Gear, disengage the gear from the other gears. It may be necessary to slightly pull the panels apart. Once the Stop-Idler Gear has been disengaged reposition as necessary. Bring the panels back together and mesh all the gears. Go back to step (1).

15. Once synchronization has been achieved, insert and tighten down the 4 front panel screws, attach the retaining ring to the shaft for Stop-Idler Gear and jump for joy. I've found C type retaining rings much easier to apply than the other ones.

16. Having synchronized the gearbox, you will need to re-synchronize the CAMs controlling the RF racks. This is well documented in the manual. Provided the RF CAMs are sychronized and there is no reason they should not be, simply adjust the position of the coupling shaft from the gearbox to the RF CAMs.

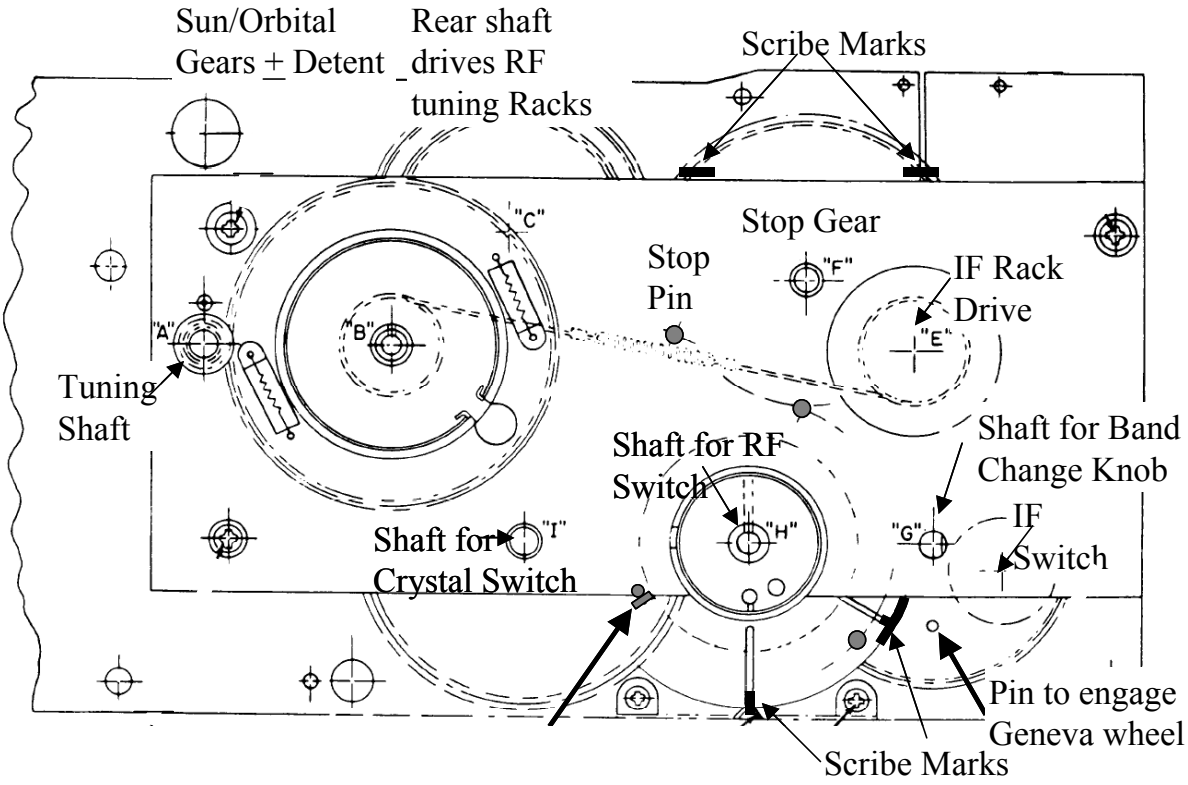
Pull Cord:

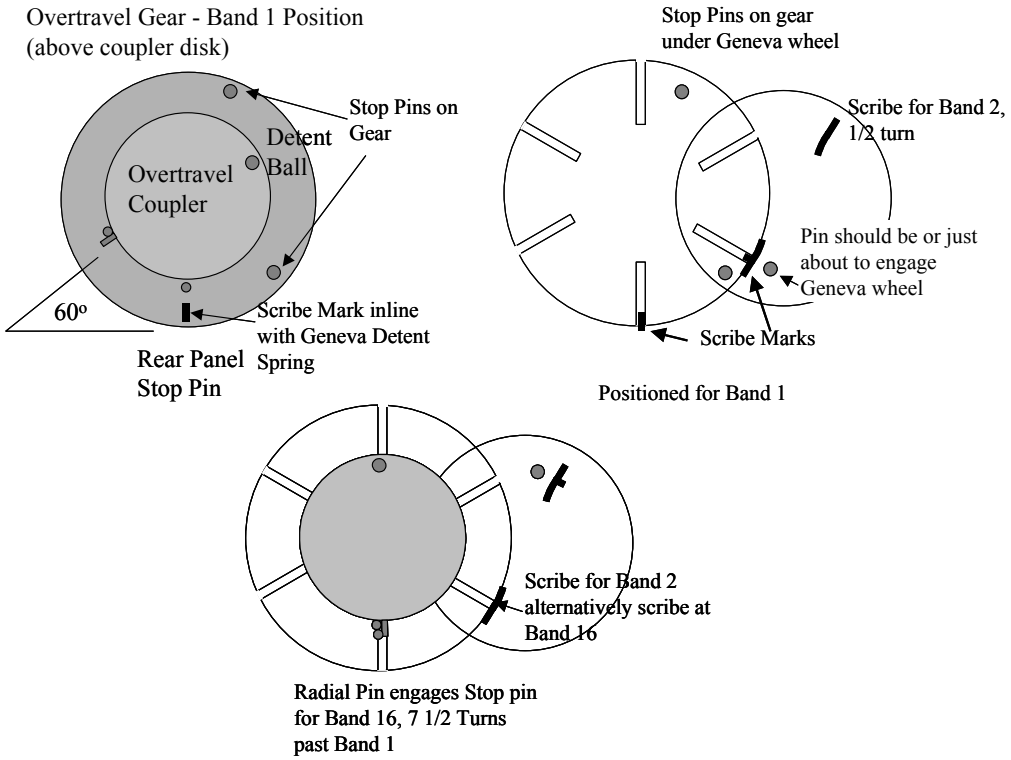
If you want to replace the nylon-coated wire on the pull cord in the gearbox do so while the gearbox is disasembled. If you were unable to pull the pin on the front gear then you need to be very careful with the length of cord used on the pulley behind this gear as you will be unable to make any adjustments as to its postion. You will only be able to adjust tensioning with the pulley on the right hand side. The cord for the left hand side pulley, needs to be long enough that when it is fully wrapped on its pulley that the loop and its crimp do not wind on to the pulley. Make the length of the loop as short as possible. If you crimp the loop with a sleeve, make sure the sleeve is as close to the end of the loop as possible. If you don't, the sleeve could end up winding on to the pulley. This will result in unevenness in the feel of the tuning and possibly an audible click as well if the sleeve rubs against the side of the pulley.

While the gearbox is disassembled, you can check to ensure that the left hand side cord is long enough by afixing the cord to its pulley and
- turn the tuning shaft fully CCW so that the cable is at maximum extent
- turn the tuning shaft fully CW and wind the cord on to the pulley

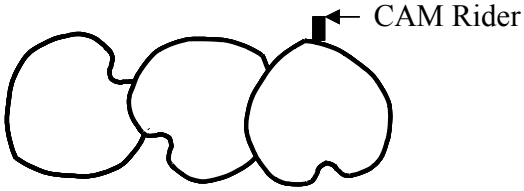
Once the tuning shaft reaches its stop, the sleeve/loop should not be in contact with the pulley. Make sure you have applied enough tension to the cord while winding to keep the cord stretched. You may wish to reassemble the gearbox with just the two pulleys to check that the cords are correct.

During re-assembly of the gearbox, I leave the cords unattached and I leave off the retaining ring on the right hand side pulley. Once all the gears are synchronized I assemble the pulley cord. Turn the tuning shaft fully CCW (or is it CW) so as the cord is at its full extend. Run the cord from the left hand side pulley through the gearbox according to the diagrams in the manuals. Bring the end of the cord up to the top of the gearbox, attach the spring and attach the loop from the right hand side cord. Disengage the right hand pulley from the any gears (the retaining ring on its shaft needs to be off). Turn the right hand side pulley so the cord winds onto the bottom of the pulley as per the manual diagram. To tension the spring use a flat screw driver to push against the gear teeth. You may leverage the screwdriver off the top right hand stand off. Set the spring length to what was measured prior to disassembly. Use another screwdriver to push the gear back against the rear panel so it engages its mating gear. Once you are satisfied with it apply the retaining ring.

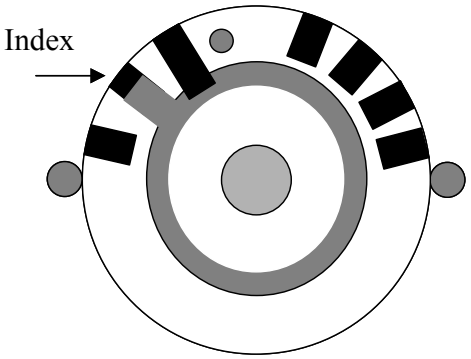

Sun/Orbital Gears + Detent
Rear shaft drives RF tuning Racks
Scribe Marks
Stop Gear
Stop Pin
IF Rack Drive
"A"
"B"
"C"
"E"
"F"
Tuning Shaft
Shaft for Band Change Knob
Shaft for RF Switch
"G"
"H"
"I"
IF Switch
Shaft for Crystal Switch
Pin to engage Geneva wheel
Scribe Marks


Overtravel Gear - Band 1 Position
(above coupler disk)
Stop Pins on Gear
Detent Ball
Overtravel Coupler
60°
Scribe Mark inline with Geneva Detent Spring
Rear Panel Stop Pin
Stop Pins on gear under Geneva wheel
Scribe for Band 2, 1/2 turn
Pin should be or just about to engage Geneva wheel
Scribe Marks
Positioned for Band 1
Scribe for Band 2 alternatively scribe at Band 16
Radial Pin engages Stop pin for Band 16, 7 1/2 Turns past Band 1

Position of CAMs, Band 30

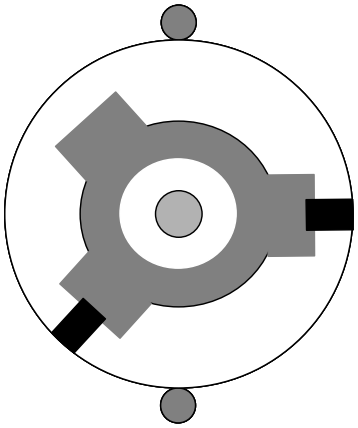


Crystal Switch, Band 1



Remove cover from crystals to see it

IF Switch, Band 1



Band Switch, Band 1