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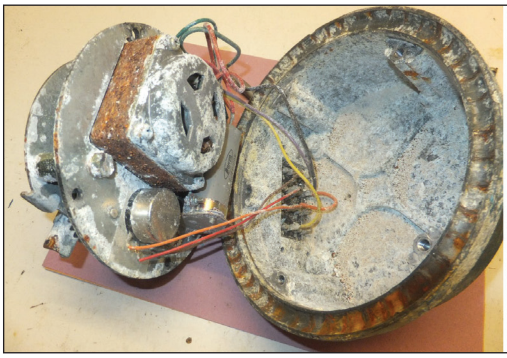
Jet-Spray Repair of an Old Daiwa Rotator

Jonathan Hare G1EXG describes how he managed to bring an old antenna rotator back to life. The lessons learned could well be applicable to many PW readers.



The rusty rotator opened up.

After cleaning, priming and painting - like new!

Over the years, I have had antenna rotators seize-up on me. This is partly because I live by the sea and the saltwater attacks the aluminium casing and partly because the rotators sometimes don't get used for a while. Believing that the rotten casing and parts were too far gone to repair, I had simply thrown them away. A friend at the local radio club recently give me an old seized Daiwa rotator, suggesting that it might not be too far gone to get working again.

The rotator was a Daiwa DR7600a and on the outside it looked to be in a bad way. It still had some of its original green metallic paint but overall the case was blistered with oxide and it was seized up and wasn't turning. The four securing bolts around the middle may have been stainless steel but because they went into the rotator's aluminium body, the combination of water and sea air had cemented them in very effectively and they were difficult to remove. I sheared one of the bolt heads trying to remove it and they all needed a bolt/stud remover tool to free them.

On opening up the casing, it was obvious that water had got in and had caused problems for quite a while. All the parts were covered in a fine dusting of white aluminium oxide and there were piles of the stuff, including iron rust (mainly from the ball bearing races) covering the floor of the box. There are two sets of about thirty 8mm ball bearings in the unit, **Fig. 1**. Both needed replacing. Luckily, they are easily available on eBay for just a few pounds. The good news was that the internal parts looked restorable. A proper refurbishment job would require each part to be removed, cleaned-up and reassembled but this was something that would take too long given my current lack of spare time. I thought, therefore, that I would try a short-cut approach, which I describe here and which I hope might be of interest to readers, whatever rotator you use.

Jet Spray Cleaning

I first removed all the ball bearings and dismantled the rotator into its basic parts – upper and lower case, the large driving cog, two microswitches and the motor unit (more on all these later). I then used a vacuum cleaner and fine brush to carefully remove as much as I could of the fine powdery layer of aluminium oxide that was covering everything.

Next, I filled a bucket with warm water and washing detergent and submerged all the parts for 20 minutes. My 'secret weapon' for this quick fix was my neighbour's power jet spray, the sort of thing you use to wash down walls or to clean your car wheel hubs. After soaking, I jet-sprayed all the parts (including the motor, switches, pots, all the gears and so on) to remove every last bit of oxide and rust. I then poured away the detergent and repeated this process twice with clean water just to make sure I had removed all the detergent. It was a very hot day so I drained the equipment and left it to dry in the sun. I was surprised how clean and new everything looked after this treatment. I used a hair dryer on the switches and motor to make sure they were completely dry and then sprayed these parts with WD40. I was disappointed, however, that I could barely move the motor shaft by hand. Then I remembered that there might be a locking device to prevent movement until power is applied so my next job was to check all the rotator's electrical parts.

I wired up the rotator motor connections (via the panel of screw connections on the side of the rotator box) to a 24V AC transformer via a Variac and slowly raised the voltage. The motor spun! I added some more WD40 and it whizzed around faster.

The AC motors used in these rotators have two coil sets with a capacitor to get the correct phasing. The two windings share a common ground connection. Applying power from the 24V AC transformer between the common and one of these coil windings will cause the motor to turn. Swapping over to the other coil windings will reverse the motor direction. In my case, changing over to the other motor coil set made the motor reverse direction. My repair attempt was looking good.

There are also two microswitches that go to these two sets of motor wiring coils. These switches are normally ON and only come into play (turning the motor coils off) when the rotator is at the extremes of its rotation movement. Looking at typical rotator controller circuit diagrams, the

Fig. 1: The second set of greased ball bearings in place before fitting the middle securing ring.

motor switches (or relays) are usually wired to stop you energising both coil sets at the same time. The microswitches disconnect power to the motor at the extreme positions but are located in the box in such a way that you can always apply power to the other (reverse) set of coils to make it go back the other way. Checking them with a meter, the microswitches gave good low resistance continuity.

The motor has a small cog attached to its shaft that joins the multitude of other cogs in the rotator drive assembly. These drive a large outer cog that is just smaller than the inside of the rotator housing. This large cog sits in slots and when it turns, it drives the top relative to the bottom and the rotator turns.

Sensing Potentiometer

The large cog also drives a separate cog that goes to a 500Ω potentiometer (pot). This pot tells the controller where the rotator is in its (nearly) 360° rotation. It doesn't have a stop like a standard volume control, so it can move around and around. The resistor track covers most of this rotation (roughly 350°) but there is a dead zone of 10° or so where the connections are.

A quick check of the pot showed that the wiper wasn't making reliable contact and needed attention. I took the pot out, carefully opened it up, cleaned it with Servisol (Aero Klene 60) and used a fine brush to remove accumulated dirt and green copper oxide. I then gave it a quick spray of WD40, reassembled it and put it back into the rotator. The three wires from the pot go out to the side connections on the rotator. In principle (ignoring cable loss), if you put 3.6V and 0V (ground) on the two ends of the pot track and measured the voltage between the wiper connection and earth, you would get 10mV for every degree of rotation, equating to 0V = 0°, 1.8V for 180° and 3.6V for 360°.

Painting

I cleaned up the two outer parts of the rotator case and the aluminium securing ring using a wire brush and circular wire attachment on a power drill. This removed most of the old paint and white aluminium oxide. I then washed all the parts in detergent and clean water and dried them. I coated all the surfaces with a special metals primer (Hammerite in my case), **Fig. 2**. I then gave the three parts two or three coats of Hammerite smooth silver metal spray paint. After this treatment, the rotator looked like new.

Assembling

After oiling and running the motor for a while, I reassembled everything and greased all the cogs with heavy grease. I then loaded the first set of ball bearings, greased these and carefully did the same for the second set. There is an aluminium ring that goes on the outside that contains this last set of ball bearings. Four bolts clamp it to the main housing.

Setting Up the Sensing Pot

The next challenge is to make sure the sensing pot is correctly set up so that back in the radio shack you know what the rotator is doing. You need to set the pot correctly when you put the large cog back in place. If you simply put everything together without thinking about this, the pot position won't mirror the rotator position properly. In fact, you may get the situation where part of the rotator movement is taking place while the pot wiper is moving through the dead zone. Ideally, you want the wiper to be at the correct end of the pot when the rotator is fully turned. What I did was to assemble the rotator and power up the motor so that the rotator went completely anticlockwise until the microswitch turned off the motor. I then reversed it slightly so that the stopping

Fig. 2: The three outer parts of the rotator wire brushed, de-greased, treated with 'special metal primer' before being sprayed with a couple of coats of silver Hammerite.

microswitch was just disengaged (you can't readily reassemble it with the microswitch engaged).

After this, I took everything apart, noted the position of the large cog, carefully took it off and adjusted the pot by hand until the wiper gave a low resistance on the ohmmeter to the zero end of the pot. Having done so, I carefully reassembled everything while making sure that I got the main cog in the same place. I connected up the ohmmeter between the wiper and one end of the pot via the outside connection and powered up the motor. The wiper of the pot now mirrored the movement of the rotator.

I need to point out at this stage that there is a chance that you might adjust the wiper to the wrong end of the pot. If so, as soon as you start the motor moving, instead of the resistance rising from zero, the wiper actually starts going through the dead zone and disconnecting. If this happens, you need to repeat the procedure but then turn the pot by hand so that the wiper is in the other extreme position. I had to do this a few times to get it right. Finally, though, I got a reading of 32Ω for 0° (fully anticlockwise) and 490Ω for 360° (fully clockwise) rotation. The result is that I now have a working rotator and a pot set up correctly so that it will track the rotator position.

Another method that I didn't try but might be easier, would be to run the rotator motor back and forth a few times until you know that the rotator is exactly halfway (180°) around its path. Then take everything apart and set the pot for mid-way along the track and reassemble.

Controller

The simplest controller arrangement is to wire up a three-way switch (anticlockwise, OFF and clockwise) to a 24V transformer and send the two sets of AC wiring from the switches up to the rotator motor connections. A few volts DC can then be applied to the ends of the pot and a meter connected to the wiper connection. The meter will read close to zero for fully anticlockwise and the meter sensitivity can be set to read full scale when the rotator is fully clockwise. The meter can then be marked N, E, S and W as appropriate.

A PIC Controller

I plan to use a PIC microcontroller to record the pot voltages and let the PIC control the relay switches to control the rotator motor. An LCD or LED display will show the beam heading. Beacon positions and favourite beam headings could be programmed in. Many rotators have the 'stop' in the South position. In my location, my best path for VHF propagation is to the south so if I want to work someone in Brittany and then another person in Belgium, it means turning the rotator almost 350° to go around via the north. In the past, I have simply fitted the rotator with the stop to the North and relabelled the rotator controller. However, if I use a PIC to control the rotator, I can arrange for the stop to be north and work out the correct display of the headings in software.

Preventing Rotator Seize-Up

If I use a PIC to control the rotator, I can also easily set up the system to automatically move the rotator once a week. I hope this will help to stop the rotator seizing up over time, which can happen to aluminium rotators if you forget to move them occasionally.

My thanks to **Phil G4UDU** for giving me the rotator and to **Norman 2E0RKO** who managed to remove the four securing bolts so that the rotator could be opened.