Kolster 3D Printed Parts

For the final 15 years before retirement I was involved with 3D electromechanical design. I've been a collector and restorer of radios since 1967 so it may not be surprising to the reader that I've wondered if 3D part printing could be applied in this hobby. Early-on it became evident that the printing technology required long process times on expensive machines and, most importantly, really did not produce parts with adequate strength or smooth surface characteristics to produce convincing replicas.

Over time the printing technology has improved drastically even to the point of being capable of printing metal parts for rocket engines. But these fabulous advances come at a high price…. A price far above what I consider affordable for vintage radio restoration. But this printer technology has captured the fascination of hobbyists to the point that there has been a constant effort to make even the lowest cost filament extrusion printers produce parts with improved strength and surface smoothness.

The original ABS and PLA filament materials for extrusion printers can now be compounded with carbon and glass filaments to make them more rigid. New extrusion heads permit the use of higher melting point materials such as Nylon that can also be compounded with fillers to increase strength or rigidity. Printers designed to work with Nylon filament can be found starting in the $1,500 range.

I have seen many pot metal parts in radios of the 1920s and 30s over the decades that have been rendered useless due to environmental exposure of defectively formulated metal alloys. The challenge for the restorer is to identify parts that can affordably be printed and present the necessary strength and appearance of the original part.

Printed parts could be made more easily if there is no requirement to preserve the original detail dimensions or surface appearance. However, I place a high value in making parts that appear to be identical to the original design. I never want the person viewing the artifact to be distracted from the original intent of the maker. My documentation for the artifact does identify various parts as replicas.

For example, the driver shell of an Atwater Kent Model L horn can be printed on a lower cost machine and will appear OK from the top-side but it will look nothing like the original from the bottom side. Material thicknesses and surface finish cannot be produced with the required strength from printers and materials in this price range. The part would have to be modified drastically and probably incorporate metal plates and flanges to provide the necessary strength.

To date, I have identified only two radio restoration projects that have come to my shop that could be assisted using 3D printed parts. The first is a replacement loudspeaker grill for the Philco 47-204 and internal parts for the 1926 Kolster Model 6D TRF Receiver. This article describes parts for the Kolster.

I have had a model 6D in my house attic for decades. There are pot metal brackets for the Volume rheostat and Sensitivity variocoupler as well as the dial cord drive mechanism that are almost always cracked to the point of being useless. To a lesser degree the dial scale drum can be cracked or warped to the point of being useless.

My design experience told me that it should be possible to model exact replicas of the two brackets and get the 3D files printed in Nylon. The dial drive cord drive bracket cost under $25 to be printed. The identical rheostat/variometer brackets, when printed in two pieces, cost just under $50. You are likely to need two of these bracket part pairs for your radio. Therefore, my total investment for contract 3D printing comes to just under $125.

So why do this? The 2018 market value of a Kolster 6D without tubes is well under $100. This radio is also one of many battery radios of the mid 1920s to have a long multi-conductor battery cable hard wired to the chassis that rarely survives in decent condition. At the 2018 AWA annual conference in Henrietta, NY there was a 6D with pristine cabinet and full-length battery cable in very good condition, audio transformers that checked good AND it was complete with good tubes. In the Saturday morning auction, I was the winner of this set with my $60 bid. With such a great looking set, I hoped that the brackets remained in usable condition but as soon as I removed the chassis, the easy answer was, they are useless.

I took this to be a great opportunity to showcase this whole class of radios totaling at least into the high hundreds of thousands that, today, are fast becoming absent from the historic record of the 1920s American broadcast radio market since collectors see them as very hard to repair with home shop resources.

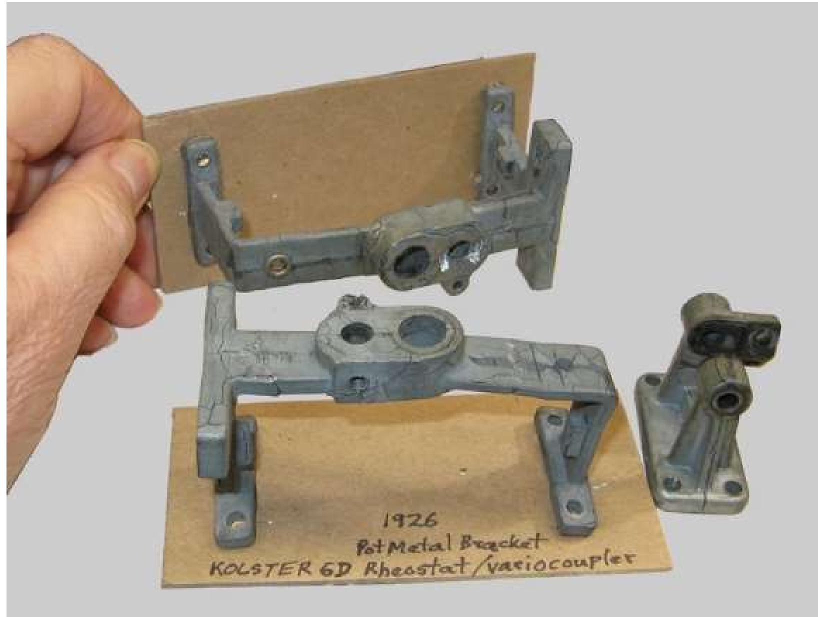

Figure 1- Broken brackets epoxied back together but still useless because of extreme warping.

This class of printed part is not going to be ready to drop into your vintage radio. The surface and sharp edges need light sanding. The original part is likely to have both inside and outside corners that have small radiuses. The inside radius usually can be printed and look OK, but the outside radii are best left to forming manually with a sanding block.

These parts have holes for steel and brass shafts. Holes are likely to be printed to no better than +/- 0.015" diameter tolerance with this technology. The best practice is to print holes 0.02 to 0.03" undersize. For holes 0.188" or larger, the holes are enlarged to finished diameter using straight flute reamers. Using twist drills in filament extruder plastics is an extremely risky business for large holes! Holes under that size do not present the same risk and can be carefully enlarged with ordinary sharp twist drills in a drill press. Never try to do this with a hand-held power drill.The bracket

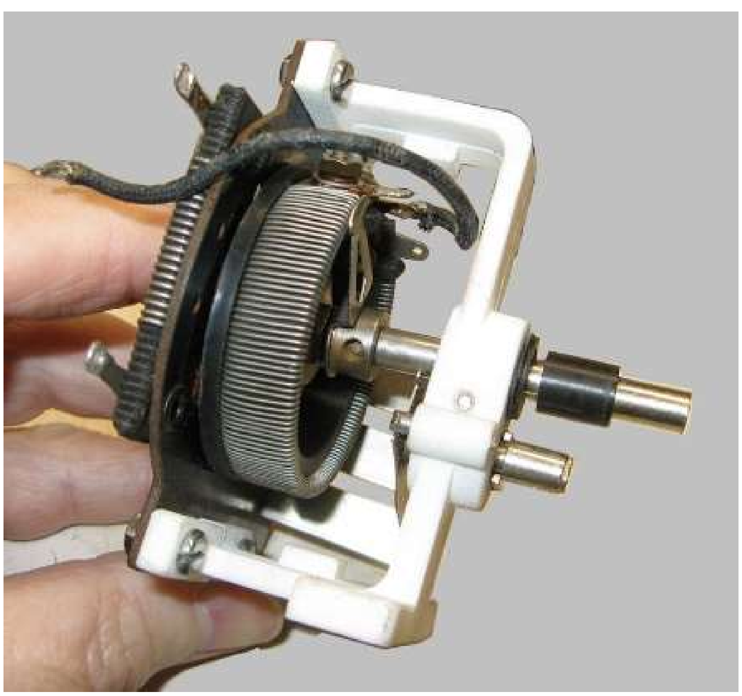

Figure 2 - Part printed in natural Nylon and being checked for proper fit and finish before painting.

dimensions for the rheostat and variocoupler presented some problems unique to the filament extrusion printing technology. If the bracket had been printed as a single piece, it would have been necessary for the printer to have also printed a support structure for elevated horizontal surfaces or angled surfaces less than 45 degrees from horizontal. There are several techniques that can do this, but it takes time to print these structures and post-process time to remove the structures and touch up the attachment points. In the case of this bracket, it was much faster to print it as two parts that could be pinned and glued together.

Figure 3 - Extra fill added for rigidity.

In the case of the dial drum drive bracket, it was necessary to build a thick portion up from the base to support a robust angled feature for two idler wheels. It was easy to cut away the excess material to better match the appearance of the original part. Here again reamers were used to provide accurate holes.

This type of Nylon can easily be painted to look like the original pot metal casting. The rheostat/variocoupler bracket is used to make an electrical contact from a switch arm to the receiver chassis. It was an easy task to cut a strip of phosphor bronze shim stock and glue it along the side of the Nylon bracket to complete the circuit.

Figure 4 - Drum incorporates counterbalance weight; would have to be a separate lead part mounted inside a 3D printed plastic version.

In this 6D receiver, the 4” diameter tuning dial drum (Fig. 4) is still in good enough condition to work. Cracks around two set screws attaching the drum to the ¼” diameter steel shaft of the tuning condenser rotors were reinforced by wrapping the hub area with #22 gauge stainless steel wire and then saturating with epoxy resin. This part is relatively large, and I suspect that the cost of getting it printed would be in the $75 to $100 range. I think there is a fair chance

that this repaired part will remain serviceable because it is likely to stay in an area of relatively low humidity and stable temperature. I did, however, take the opportunity to measure the part and generate a 3D model.

Again, while the original dial drum is a single casting, I determined that a relatively low-cost Nylon part would need to be printed in two parts. It would also require a simple aluminum bushing with two tapped holes to securely index the drum on the condenser rotor shaft. For long term stability of the part, the printed part needs radial ribs with fillets to support the dial scale not seen in the original part. In addition, there is a large mass of pot metal in the part that serves as a counter balance for the brass condenser rotor vanes. A properly operating 3D printed part will need to have a separate lead counter weight attached. The good news is that these alterations to the original part dimensions cannot be seen when the chassis is in the cabinet.

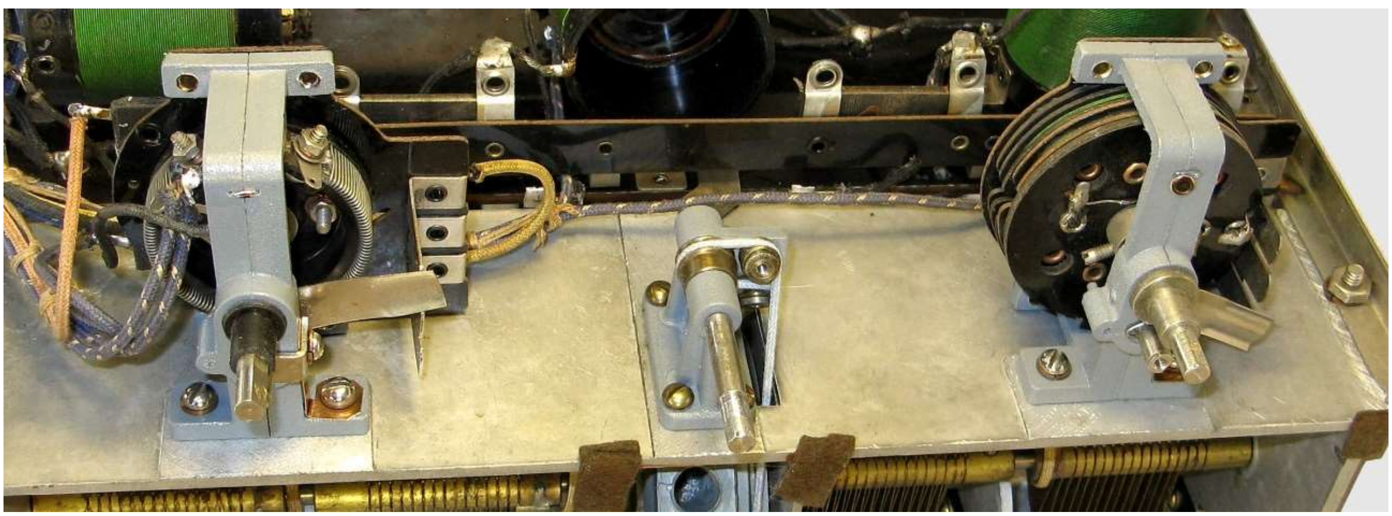

Figure 5 - 3D Printed Parts installed. Left, rheostat bracket - Center, Drum drive, Right, Variometer bracket.

Conclusions

As I see it, the take away from this restoration exercise is this: Technology exists to make exact appearance and performance replicas in modern materials but only at very high cost for the hobbyist. Affordable printed parts will likely solve only a few restoration challenges you are likely to encounter in this hobby thus making it hard to justify investing in a 3D printer of your own. The learning curve towards proper design and 'tuning' of the printer to produce the most accurate parts possible is considerable. If you have ever attended a *Maker Faire* or visited a *Hackerspace* you will know that the use of low-cost 3D printers has inspired

thousands of people to make application of their printed parts serve many uses. The learning exercise can be great fun for folks that want new challenges, but for the next several years, affordable printer technology is not likely to prove anywhere near as useful as a soldering iron, drill press, lathe or milling machine to the vintage radio enthusiasts with modest financial resources.

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