Zenith R723 (Chassis 7H04Z2)
AM/FM Table Radio Refurb

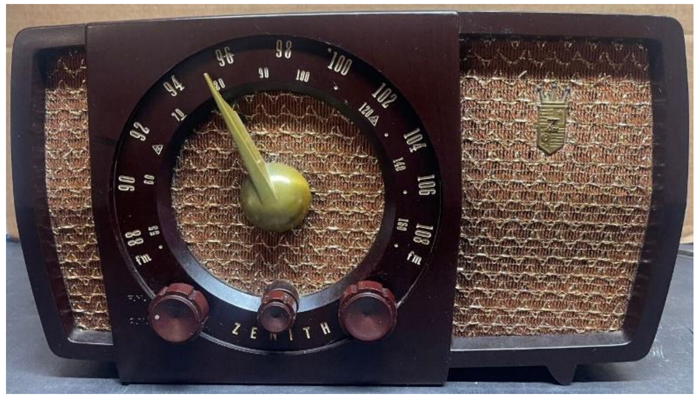

Figure 1 - Zenith table radio Model #R723 – note the white dot to the immediate left of the 100MHz position on the FM dial – more about that later.

One Saturday morning, a gentleman walked into the GCARC Clubhouse, stopping by cold while attending a non-Club-related event elsewhere on the Fairgrounds. He said that he had been directed to me by folks at another club, and then he asked about the possibility of getting an older Zenith table radio refurbished. He stated that the radio would pull in one or two stations (more about this later), but did not say on which band those stations were situated. After a short discussion of his desires and expectations, in which he stated that cost was not a concern, he decided to bring the radio in for the work. He then went home and picked up the unit, and dropped it off at the Clubhouse for the repairs. He understood that it would have to wait its turn to get on the bench, as I am quite busy with repair work at all times.

Figure 2 - Under-chassis view before repairs

I eventually got the radio on the bench and took a good look at it. It turned out to be an AM/FM monaural unit in a handsome maroon Bakelite cabinet, and was in fairly good physical condition for its age. There were minor scuffs on the cabinet top surface, and the speaker grille cloth was frayed in a couple of spots, most noticeably behind the volume control knob. This radio has three front panel controls – a ganged power switch and volume control, a band selector switch, and a tuner control. The tuning indication is by way of a gold-colored pot metal pointer on a shaft that is located in the center of the dial, and that naturally rotates as the tuner knob is turned. One other defect noted was that the surface paint had been worn off the “AM” and “FM” band position legends at the band switch location on the front of the cabinet. This table radio is of a vintage that still had the CONELRAD / Civil Defense (CD) station 640kHz and 1240khz frequency position markings on the dial. This dial, as do the dials on many Zenith radios, also has a small dot just below (to the left of) the 100MHz location on the FM dial. This was to pinpoint the 99.5MHz dial position of a Zenith corporate broadcast FM station, WEFM of Chicago. The company-owned and operated station's call sign reflected the initials of the then chief executive of the company, one *Commander E.F. McDonald.*

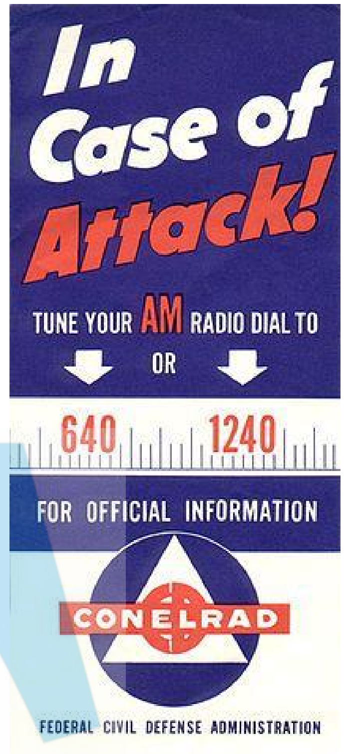

Figure 3 - CD / CONELRAD poster circa 1953

A few words about CONELRAD. The term *"CONELRAD"* is a portmanteau term derived from *"**CON**trol of **EL**ectronic **RAD**iation",* and the associated system provided two discrete frequencies on the AM broadcast band to which the citizenry could tune for official information in the event of a nuclear missile attack on the USA, presumably by the USSR. The station dial positions were usually marked with the Civil Defense stylized round red "CD" in a white equilateral triangle in a blue circle symbol. CONELRAD was introduced in 1951 and was the predecessor of the *Emergency Broadcast System (EBS)*, which replaced CONELRAD in August of 1963, and was itself subsequently replaced by the *Emergency Alert System (EAS)* in January of 1997. While CONELRAD was never intended for use in alerting the populace to natural disasters such as hurricanes, tornadoes, or floods, it was nonetheless used in that regard beginning somewhere in 1957.

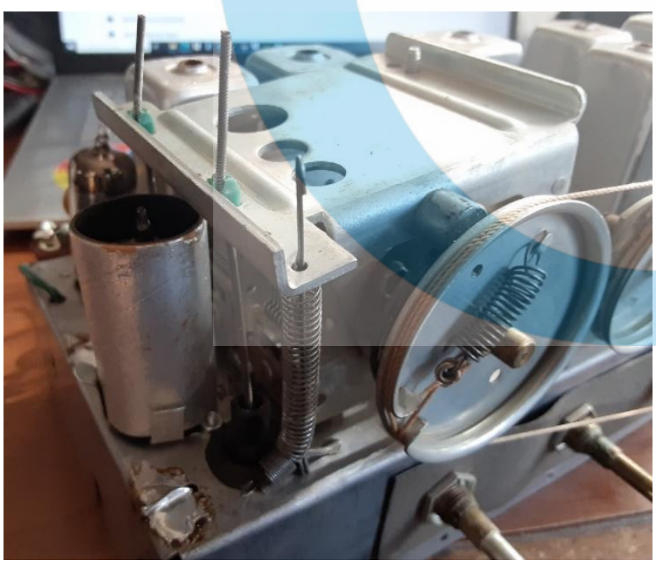
Figure 4 - Tuning mechanism -- capacitor gang is inside enclosure behind the drive pulley and coils are under the green plastic nuts

The receiver is a model R723 using the 7H04Z2 chassis and dating to circa 1954, as nearly as I can tell. Under the skin, this radio uses an interesting tuning mechanism that incorporates both variable inductance and variable capacitance, operating by way of a linked mechanism. When the tuner knob is rotated, the dial string drive causes the dial pointer to rotate at the same time that it causes the air-gap tuning capacitors to open or close, depending upon the direction of the tuner control knob rotation. The tuner capacitor assembly also has a concentrically-mounted cam that of course rotates with the capacitor shaft, which in turn causes a pair of cores to be inserted into or withdrawn from the center of two tuning coils, again depending upon direction of rotation of the tuning control knob. As the dial is moved upscale, the capacitor gang opens and the cores are extracted from the coils; as the dial moves downscale, the capacitor gang closes and the cores are inserted into the coils.

Closing the capacitor gang increases the effective instantaneous capacitance of each of the capacitor sections. That is easy to understand, as the factors that normally affect the capacitance are the amount of surface area of the engaged capacitor plates, the number of engaged plates, the distance between the engaged plates, and the dielectric constant of the insulating material between the engaged plates. Closing the capacitor gang immediately ticks off three out of four of those factors – the number of engaged plates increases, the surface area of the engaged plates increases, and the distance between the engaged plates is immediately halved, as we are effectively inserting a single plate between each and every pair of base plates in the gang.

The coils involved here are the FM RF coil and the FM oscillator coil. These coils serve as coupling transformers. In the case of the FM RF coil (L2), it is used to couple the amplified RF output signal from the RF amplifier vacuum tube on to the FM mixer tube. In a similar fashion, the FM oscillator coil (L3) serves to couple the local oscillator (LO) output signal on to the mixer vacuum tube as well. In the mixer tube, these signals are heterodyned to produce the FM intermediate frequency (IF) of 10.7MHz. Insertion of the cores into these two coils increases the inductance of the coils, which improves the coupling capability of each of these coils

The radio uses a seven-tube circuit, and it has a series string for the tube filaments, with a dropping resistor inserted mid-string to drop an additional nine volts. The vacuum tube complement, as installed in this chassis (but not as listed on the schematic diagram – more about this later), consists of the following tube types:

- V1 – 6BJ6 – 1st FM RF amplifier;
- V2 – 12AT7 – AM/FM mixer and oscillator;
- V3 – 12BA6 – 1st AM/FM IF amplifier;
- V4 – 12BA6 – 2nd AM/FM IF amplifier;
- V5 – 12AU6 – FM limiter;
- V6 – 19T8 – FM discriminator / AM detector, AVC, and AF amplifier; and
- V7 – 35C5 – audio output.

As can be seen, the tube filament voltage values add up to a total of one hundred and eight volts, which is why the dropping resistor is required, so as to drop the remaining nine volts from a nominal AC supply of one hundred and seventeen volts. The schematic calls for a *“special temperature compensating resistor”* that offers 100 ohms of resistance while cold, and falls to 75 ohms when hot. In point of fact, however, a high-wattage 39-ohm resistor was actually installed in the filament string of this chassis.

As would be expected for its era of production, this set uses the almost-standard intermediate frequencies (IF’s) of 455kHz for the AM band and 10.7MHz for the FM band.

As was previously mentioned, the FM is monaural, *not* stereo, which will greatly simplify the post-repair alignment of the set.

It should be noted that this chassis is a variant of the 7H02Z2 chassis, which uses a slightly different tube line-up. In that earlier design, V3 was a second 6BJ6 tube, which then required a higher value filament string dropping resistor, as in that version, it was necessary to account for fifteen volts instead of nine volts as in this chassis variant. I mention this because the only *Sam's Photofact®* schematic set available was for the early chassis, though it did include references to this later chassis variant. However, the circuit was different enough that it prompted me to draw up a complete schematic that was accurate to the chassis at hand, as it was much simpler for me to work from an accurately matching schematic than to mentally change what is on paper to what it should have been. I did so through the use of my favorite schematic software, and then I referred to that schematic throughout the repair process.

Among certain other changes, the most visible difference between this chassis and the 7H02Z2 earlier version is that this chassis does not use a tone control or a front-panel pilot lamp. Of course, the tube complement difference is also there. However, the structures of the 6BJ6 and the 12BA6 tubes are very similar, with the most obvious physical difference being an apparent swap of the cathode and the suppressor grid pin number assignments. As used in the circuit, both of these elements are held at chassis ground potential, so that is a moot point, making the two tubes effectively interchangeable apart from the difference in filament voltages, which we already discussed.

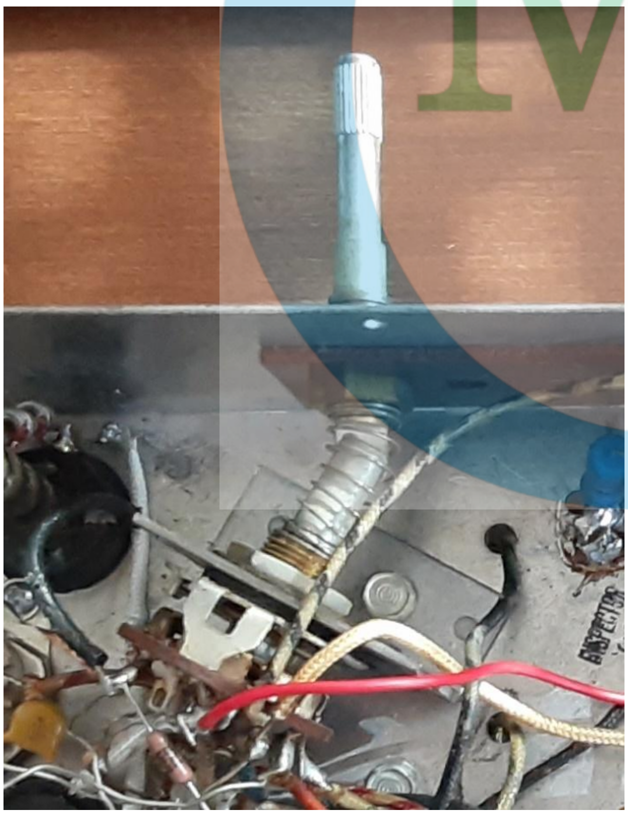
Figure 5 -Band switch arrangement

This radio has one side of the incoming AC power tied directly to chassis ground via the power switch. The power cord on this radio, as presented for repair, had a lever-type replacement plug installed to it, which was a non-polarized plug. This sets up a potentially unsafe condition in which the line side could be connected to chassis rather than the neutral side being connected there. The radio uses a rear-panel disconnecting interlock that breaks incoming power from the chassis when the rear panel is removed, and it clearly is polarized in that it utilizes two different diameter pins as its inter-connecting features. This indicates that the manufacturer intended for polarization to exist and to be carried through into the set. For that reason, one of the first items slated for replacement was the power cord, so that a cord with a proper molded and polarized plug could be installed.

Figure 6 - Interlock pins, clearly showing size difference that indicates polarization was intended

A very unusual methodology is evident in the band switch mechanism. In this chassis, the band switch is situated at an angle to the front of the chassis proper, and a flex joint is used to transmit the rotation of the knob and shaft to the switch itself. This can be seen in the photos of the chassis, and I am hard put to figure a reason for this complicated system. It is possible that it was done to keep lead lengths at a minimum in that portion of the circuit, but the same could have been accomplished without the need for an angle-drive switch shaft. The flex joint consists of a short knob shaft with a flatted end, which in turn fits into a slot in the switch shaft. The junction of these two shafts is enclosed inside the tubular structure of a coil spring, which keeps the shafts from disengaging. The switch itself is a six-pole/two-throw rotary type, mounted to an angle bracket secured to the underside of the chassis top surface. Switch rotation is about 30° between the two band positions.

Figure 7 - Exploded tubular wax-and-paper capacitor – note blackened chassis under capacitor

I pulled all seven tubes and tested them using my CONAR 224 emission-type and Hickok 352 transconductance-type tube testers. All of the tubes tested out to be in good – in fact very good – condition. I set the tubes aside and began to explore the unit more deeply.

Upon removal of the chassis from the cabinet, several things were immediately apparent. There were failed components evident in several locations throughout the under-chassis. The failures were so widespread that it was hard to understand how this set received any stations at all. I began to suspect that the damage had in part been caused by the owner's attempt to "try the radio out" with leaky capacitors and/or off-specification resistors.

The first thing that I did, as I had with the intact overall set before any work began, was to take numerous photographs of the under-chassis, showing the placement and connection of the many components found there. Of course, some of these photos also clearly showed the damaged condition of some of the components. These photographs would be of great utility later during the component replacement phase of the repair.

The loudspeaker installed to this chassis is a 5-1/4” dynamic unit of the permanent-magnet moving voice-coil type. The speaker cone was in great shape. It was pliable and had no cracks or tears. The motion was free and easy with full range of movement evident. Similarly, the audio output transformer, mounted on top of the loudspeaker rear frame, measured out to be in line with the values provided in the *Photofact*® set. I put them aside as serviceable, and protected the speaker against damage while I worked on the rest of the set.

Several capacitors had fractured, and one of the standard ceramic discs had evidently been replaced at some point with a spark-gap type of disc capacitor. One of the tubular paper and wax capacitors had exploded. The two-section can-type filter capacitor had expressed electrolyte through its lower seal. There were resistors that had broken off their leads or lead connections, and one tube socket had a broken pin connector tab, which showed evidence of arcing. One mica capacitor had a broken lead right at the body of the capacitor. The wax coatings on all of the capacitors so equipped, both tubular and disc, had melted mostly off, leaving wax puddles in the chassis lower shield tray. This was evidentiary of high heat inside the chassis at some point in time.

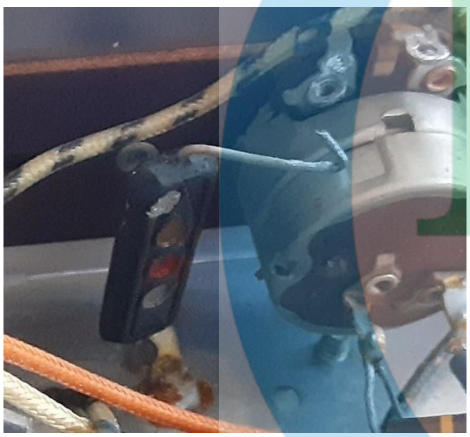

Figure 8 - Resistor masquerading as capacitor - note the lead broken off its connection point

I isolated the intact resistors throughout the unit and found that most of them were considerably out of tolerance. This was *not* unexpected, given the age and type of resistors installed in the set. The older carbon-composition resistors are known to be prone to moisture absorbency, which causes the resistor to exhibit a change in its through resistance. On the other hand, continuity checks of the transformers showed that all of them were intact, and their resistances measured almost exactly in line with those listed in the *Photofact*® dossier.

I decided that all of the resistors and all of the tubular and disc capacitors were to be replaced. In addition, two of the mica capacitors warranted replacement, one for its broken lead, and the other for a crack in the capacitor body. The dual capacitor across the incoming power connection was also to be replaced by a pair of 0.01μF X1-440V/Y2-300V safety capacitors.

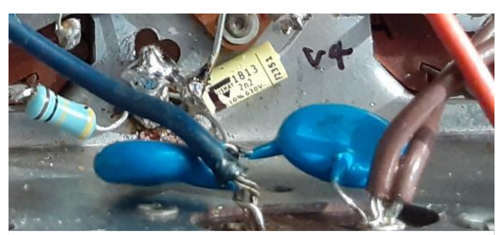

Figure 9 - Safety capacitors installed at power entry point

As an interesting side note, there were three resistors in use in this set that I at first took to be capacitors, because they looked physically like molded mica capacitors *and <u>they were actually marked with the “Micamold” brand name.</u>* They were also marked as being *Type 800* devices, which through research, I discovered to actually be high-power-rated resistors. I chose five-watt, five-percent tolerance metal-oxide resistors as replacements for these, and all of the remaining resistors were replaced with two-watt or 500-milliwatt resistors (depending upon their use in-circuit) at five-percent tolerance, in metal film types.

The wax-and-paper tubular capacitors were all replaced by axial metallized polyester film capacitors in various voltage ratings, meeting or exceeding the ratings of the original capacitors. In some cases, however, slight value changes were necessary due to the changes in standard values between the 1950's and the present day. For example, 0.05μF devices were replaced by 0.047μF types. The common tolerance factors of the older capacitors were much wider than those of the devices that I used, so I did not anticipate any problems there. Other value substitutions included 0.022μF for 0.2μF, and in one case, I installed two 0.0015μF and one 0.001μF types in parallel to replace an original 0.004μF capacitor. These three capacitors together occupied much less space than did the original single tubular capacitor.

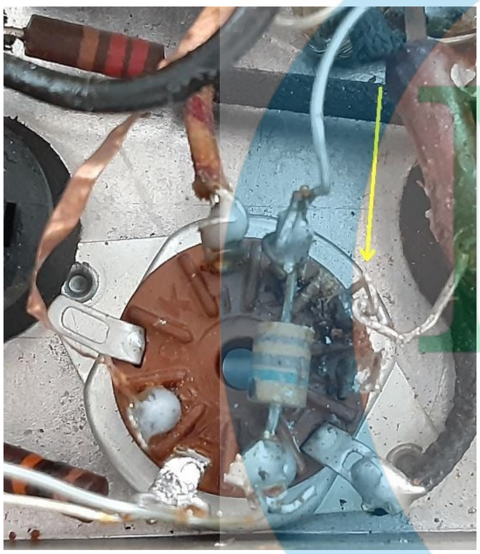

Figure 10 - Broken connector tab on tube socket (at arrow) - note the arc damage to the surrounding area and the solder melted off the joint

That theme carried through the entire refurbishment. As a rule, the modern components are much smaller than their same-value and same capability devices of an earlier era. As a result, there is much more empty space under the chassis now than there was originally. It almost looks like parts are missing, because there is so much empty space now. This can readily be seen in the "before" and "after" chassis photographs.

One situation where the component size did not change was in the replacement of the can-type dual filter capacitor. The original component was a two-section 80μF■/40μF▲ three-tab capacitor with a one-inch diameter and three-inch length. I had absolutely no success in locating an exact replacement for this part. Note that the geometrics after the values above are standard indicators used on filter capacitors to identify the various sections of the device. They are marked both on the device label and on the end surface adjacent to their respective connector lugs. Fortunately, I remembered a source that I had used in the past for Collins radio parts, and I reached out to him. He happened to have in stock a filter capacitor used by some 75-series Collins units, which is a 40μF/40μF/40μF unit. This worked out nicely, as the replacement is the same physical size as the original (albeit just a little bit shorter in length) and its three sections would lend themselves perfectly to my needs. I would take two of the sections in parallel to produce the 80μF section, and the remaining section would stand pat as a 40μF section. A fortuitous find, as it solved the problem immediately. This vendor, by the way, is Mark Olson at *Nationwide Radio and Equipment Sales, LLC*, who maintains a web storefront presence at https://ke9pq.com/.

Replacement of the filter capacitor was straight-forward after de-soldering the twist tab from the chassis, which required the use of my 140-watt Weller soldering gun, as the chassis purely sucked up the heat. The new capacitor, being of the same form factor, fit in perfectly, and I then used buss wire to connect two of the three separate 40µF sections into a parallel combination to yield the desired 80µF capacitance for the first (■) section. The remaining (third) 40µF section stood as the second (▲) section of the working capacitor.

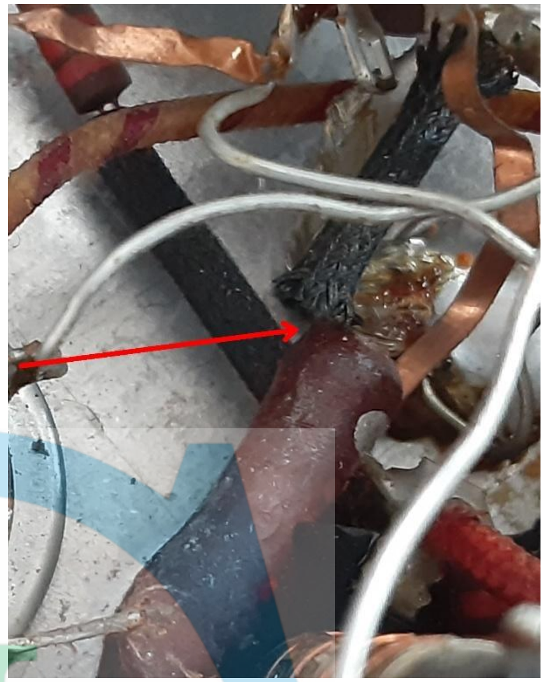
Figure 11 - Mica capacitor with a lead broken off

Sourcing of the remaining parts was fairly routine. I had much of the needed materials in stock, and those items that I did not have on hand, I was easily able to locate at either www.mouser.com or at www.digikey.com, two of my go-to suppliers. I even sourced the tube socket through Digikey, though it was what they term a *"Marketplace Item"* and was therefore drop-shipped directly from the wholesaler, incurring a little bit of additional shipping cost.

In preparation for the arrival of the new tube socket, I drilled out the rivets securing the original socket. This socket was for the 12AT7 tube V2, which happened to be a bottom-mount miniature nine-pin socket and was equipped with a shield retainer above the chassis. My plan was to secure the new tube socket to the chassis using two sets of stainless steel 2-56 x 1/4" machine screws, lock washers, and hex nuts. That vacuum tube, when installed, is surrounded by a metallized carboard shield tube, obviously due to its proximity to the tuning coils and the air-gap tuning capacitor gang.

Power rectification is performed by a selenium rectifier rated at 80mA through or forward current. This rectifier is mounted outboard of and to the rear face of the chassis, but is securely inside the cabinet when the chassis is installed.


Figure 12 - Electrolyte leaking from filter capacitor

The tedious process of replacement of the individual components then began, and this took a bit longer than I had anticipated, mostly because I was going to great lengths to do no damage to any of the remaining structure of the set, especially to the coils, transformers, and tube sockets. This chassis has numerous punched tabs that extend down into the under-chassis area to serve as chassis ground tie points. Because of the number of connections and the amount of solder on some of them, they too required the use of the 140-watt soldering gun in order to desolder them. Considerable use was made of the pre-repair photographs in validating component placements during this phase of the repair process. In two locations, component leads are simply passed through holes in the chassis upper surface, and then bent over and soldered to the top side of that surface.

Figure 13 - Wax-and-paper capacitors with "outside foil end" marked

An interesting note here is the placement of the tubular wax-and-paper capacitors in the chassis, specifically as regards the stripe on one end of each of the tubular capacitor bodies. Back in an earlier era, it was commonplace for capacitor manufacturers to identify one end of a non-polarized capacitor with a stripe or other prominent marking, often adding the adjacent label *“outside foil end”* to the body of the capacitor. This end of the capacitor was normally connected to the lowest-impedance side of the circuit in which the capacitor was installed. The capacitor body would often serve as both an antenna, picking up nearby RF, and as a shield, shunting that RF off to ground. Equipment manufacturers relied upon that marking as an aid in the assembly process, so that they could properly place the capacitor in such a manner that it would in fact act as that shunt path. This was done as a means of reducing hum pickup and passage within the radio, and it was quite effective. Installing one of these capacitors in the opposite direction would often cause considerable hum to be present in the delivered audio.

Figure 14 - Replacement capacitors with my markings on outside foil end – note the three tubular capacitors installed in parallel to achieve desired value (at left side)

Modern capacitors are not marked in this manner any more, and many technicians are certain that it makes no difference in which direction a non-polarized capacitor is connected. Electrically, that is correct, but in terms of hum reduction, it is patently incorrect, especially on older equipment where such capacitor placement was a part of the equipment manufacturer’s hum reduction scheme. So… the question is… how can a technician identify which end of a modern capacitor is the outside foil end? It just so happens that a while back, I built an instrument whose sole purpose is to locate and identify the outside foil end of a capacitor. A device with a similar function can be seen online at https://www.youtube.com/watch?v=BnR_DLd1PDI&t=972s. There are several follow-on videos to that one, with increasing complexity and utility, but I will leave it to the reader to explore that detail. In any event, I my newly-arrived non-polarized film capacitors and, using my device, identify and mark the outside foil end of each capacitor. It takes just a few seconds for each capacitor, but it pays definite benefits in performance later, when using those components in repairs. Once identified, I simply make a stripe around the outside foil end with a Sharpie® marker. The capacitor end markings can clearly be seen in both, the before-repair images, and then later on the new devices in the after-repair photographs.

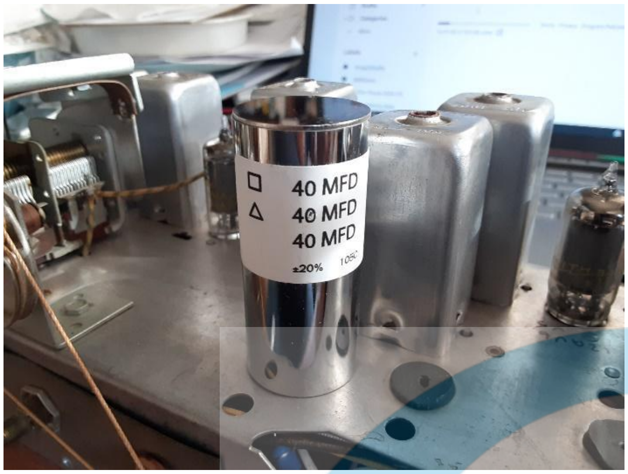

Figure 15 - Replacement filter capacitor installed

I was curious about the fact that Zenith, in the original production of this chassis, specified two different part number capacitors having the same value and working voltage ratings at two different locations in the set. This is in reference to capacitors C16 and C28, both of which are 0.05µF/200V tubular wax-and-paper-style capacitors. Capacitor C16 carried a Zenith original part number of 22-829, while C28, as installed had a Zenith factory part number of 22-1158C. This difference was borne out by the capacitor identifications in the *Photofact*® set. There is no indication on the capacitors themselves as to what the difference may be. They are physically the same dimensionally, and in all outward ways they appear to be identical. The difference may well be that one of them was of a tighter tolerance than was the other, but I could find no information online to verify that possibility. However, the suggested replacement part numbers offered in the *Photofact*® packet were the same for both capacitors, so who knows? One of them, C16, is in the AM loop antenna circuit, while the other, C28, is in the audio amplifier circuit. Neither circuit would appear to have any need of a tight tolerance capacitor.

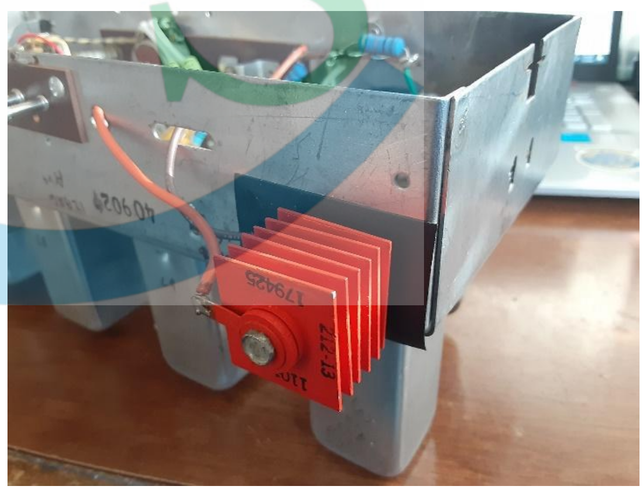

Figure 16 - Selenium rectifier mounting on chassis rear edge

Once all of the replacement components had been installed, the loudspeaker and audio output transformer were re-installed. Then, it was time for some basic testing, a good warm-up, and then a complete alignment of the set. As has already been indicated, I fortunately had the *Sam's Photofact*® folder (Set 178, Folder 17) that covered this receiver, which means that I had full and complete alignment instructions. As an informative bit, the *Sam's Photofact*® series is still available in either digital (.PDF) or print format (in most cases), directly from *SAMS Technical Publishing* via their official online presence, https://www.samswebsite.com/. Purchased documents can be downloaded, very often immediately, or else delivered in hardcopy via the postal system. This is useful for those who do not have service libraries from which to pull. In this case, I chose to purchase this folder, as I did not have it readily available.

Figure 17 - Under-chassis with replacement components all in place

The preliminary testing, well before power-up, includes the measurement of specific point-to-point resistances within the set, in accordance with those values listed in the *Photofact*® package. The literature provides the expected resistance value(s) for each pin of each vacuum tube usually to chassis ground, with specific instructions as to whether the set is switched to the AM or the FM band. Several of the resistance measurements are to be taken from the referenced vacuum tube pin to the output or DC (cathode) side of the selenium rectifier, M1. Prior to making the resistance measurements, it was necessary to re-install the loudspeaker and audio output transformer. These components must be in place for both the resistance testing and the alignment, so as much as I did not to risk any damage to the speaker, it had to go back in at that point. Upon performing the resistance testing, it was found that all values were within about ten percent of the table values provided.

The alignment instructions detail the equipment needed and the specific procedure to be followed in order to perform a full factory-level alignment of the set. Sometimes, all that is needed post-repair is a touch-up or tweaking of the coils, but with the wholesale replacement of components that I did, a full alignment was the best alternative.

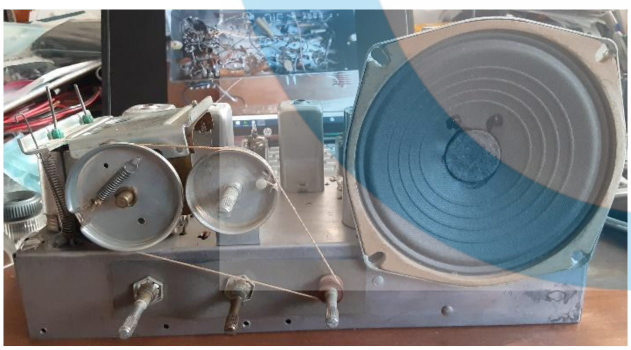

Figure 18 - Chassis ready for alignment

The equipment required for this procedure included, as its first item listed, an isolation transformer. As I have mentioned in other places, I regularly utilize my *"safety trinity"* of isolation transformer, VARIAC®, and dim-bulb current limiter when powering up equipment of this type. The isolation transformer provides some level of personal safety for the technician by keeping the equipment electrically segregated from the power line. The VARIAC® or variable AC transformer allows the supply voltage to be brought up slowly while checking for short circuits or excessive current draw, and the dim-bulb current limiter serves as a visual indicator of that current draw. If conditions are normal within the equipment, the dim-bulb indicator will first illuminate brightly on initial power-up, and then will settle down to a dimmed condition. If the bulb's illumination remains bright, or becomes bright again, a short-circuit and/or excessive current draw is indicated.

There are three areas of alignment that must be attended to in this receiver… the AM IF stages, the FM IF stages, and the FM RF stage. There are two IF stages, and in each stage, a common vacuum tube is shared between the AM and FM bands. However, each band has its own transformers, so there are a multitude of adjustment points – a total of 16 to be exact – in this set. Adjustment points A1 through A7 are related to the AM band, and A8 through A16 are related to the FM band. The complicated aspect of the alignment procedure is that although there are separate transformers *electrically* for the two bands, some single functions, *e.g.,* the 2nd AM and the 2nd FM IF transformers will have the related coils housed in a single shielding "can", stacked vertically. Even in the single-purpose transformer cans there are dual (upper and lower) slugs to be adjusted. Therefore, the alignment procedure has the technician reaching into the can either for the upper or the lower adjusting slug when making the adjustments. Because there are two IF stages for each band, there are three IF transformers used to couple the signal through these stages and on to the limiter (FM) or detector (AM) stage. Note that the alignment procedure calls for aligning the FM IF stages *before* aligning the FM RF stage, which is actually the last set of adjustments made in the process. The FM RF stage adjustments are made external to the coils, at the FM RF coil and the FM oscillator coil. In these adjustments, the technician must make any corrections by twisting the coiled cable that pulls and pushes the cores into and out of the coils. These cables are spiral-wrapped, like tightly-coiled springs, and are threaded into plastic nuts that are mounted into the hinged cam-follower plate that serves to provide the motion of the cores. Changing the relative positions of the cores to the plate changes their static positions within their respective coils.

Figure 19 - Signal input area of chassis

Heading back to the test equipment used for the alignment process, there are some options available to the technician. The AM band is aligned through the use of a modulated AM signal generator and an audio power meter. The audio power meter is not an absolute requirement. In the case of no dedicated audio power meter being available, a standard VOM such as the Simpson 260 or the Triplett 630-NA will do the job nicely. These instruments have an *"Output"* jack which is actually an input via a capacitor, making the meter responsive only to AC inputs while disregarding any DC at the measured point. Using the *"Output"* and the *"Common"* jacks, and connecting the meter across the voice coil as instructed, the instrument becomes a serviceable AC voltmeter than can be used as an audio output indicator. Setting the AM signal generator as instructed and inputting the signal as instructed sets the unit up for the AM IF adjustments. There are three steps to this portion of the process. Perform them in sequence, and go back through them as often as may be required until no further improvement is realized.

Next up is the series of FM IF adjustments, for which four steps are required. There are two alternate test equipment sets described – either an AM signal generator and a vacuum-tube voltmeter (VTVM), or an FM signal generator and an oscilloscope. Either method will work. In the first method, the VTVM serves as the output indicator, with the needle sweep being the actual indication sought. In the second method, the oscilloscope is the output indicator, and specific waveforms are the output indications sought. In either method, the output indicator is connected in turn to each of three indicated test points labeled as test point A, B, or C, each of which is identified on the schematic by the appropriate letter in a square-on-point symbol. These points are, respectively, the discriminator signal input, the discriminator signal output, and the limiter signal input, and are used as the output indication source in each of the first three steps of the FM IF alignment process in sequence. Once again, perform the steps in the order described, and again go back through them as often as may be required until no further improvement is realized.

Figure 20 - Antenna connections - note looped wire antenna for AM; FM uses the two input terminals

Finally, the last part of the alignment involves the FM RF stage alignment. In this case, instead of coupling the signal generator output into the radio via a 0.05μF capacitor (I actually used a 0.047μF 600V capacitor), a 270Ω carbon resistor is placed in series with the signal generator output and then that combination is connected across the FM antenna terminals. In this adjustment, the VTVM is used as the output indicator, and it is connected as in the first of the FM IF stage adjustments. Because this is a single adjustment, there is no need for any repetition, so long as the best adjustment possible is achieved.

Once the alignment was completed, it was time to start on the cabinet. Some cleaning and polishing, followed by the application of some white paint from a paint pen to the raised band legend on the front panel, made the cabinet as good as it would get without replacing the grille cloth, which the owner decided not to do. Next, it was a simple matter of assembling the chassis bottom panel to the chassis, and then slipping the chassis back into the cabinet. I secured the chassis in place, and then installed the antenna panel to the rear of the cabinet, followed by replacing the back panel onto the cabinet. Placement of the knobs and pointer back onto their respective shafts completed reassembly.

Now that all is said and done, it is time for a few words about the overall condition of this set as received from its owner. Very often, with older equipment such as this receiver, the capacitors are well past their "best by" dates, and it can be very destructive to power up the set. In any event, it should *never* simply be powered on to full AC supply line voltage. If the decision is made to power the set up and see if it works, that should be done under controlled conditions using the *"safety trinity"* both for protection of the user *and* the equipment. By bringing up the supply voltage slowly, the risk of immediate capacitor failure is reduced, and sometimes even tired and leaky electrolytics will recondition themselves enough to be able to test the operation of the set. In this case, damage did result, as is evidenced by the many failed capacitors found. It is impossible to determine just when this damage occurred, only that it did. The extent of the damage is rather puzzling, however. Finding failed capacitors is *de rigueur,* as is finding that older carbon composition resistors have strayed in their values well beyond tolerance. What is *not* so common is to find resistors with broken leads, and physically damaged mica capacitors. The fact that so many leads were broken in this set tends to suggest that somebody had been poking around under the chassis, yet there was no immediate evidence that the set had been opened recently. As stated earlier, though, is the fact that one of the disc capacitors had been replaced with a spark-gap disc type. There would be no need for a spark-gap capacitor in this application, and I am lost as to just why it was installed. The fact that it was installed, however, is clear evidence that the set had been worked on at some point *after 1985,* which was the apparent date code on the spark-gap capacitor. What is certain is that powering up a radio such as this one, as was done, can only be destructive and should generally be avoided.

Figure 21 - Chassis rear view - note handwritten markings by various technicians, as well as factory stamps

One other note of interest, also as previously mentioned in passing, was the extensive melting of wax from the capacitor coatings onto the lower base shield of the chassis. This could have happened in storage, if the unit been stored in an exceptionally warm or downright hot environment. It takes considerable heat to melt that wax, as it was intended to coat components that would be exposed to some heat in operation. However, it is equally possible that this wax-melting heat buildup occurred during operation of the receiver. I have no way to know which is the correct answer here, but it is something that must be considered. With the decrease in ohmic value of some of the resistors that was evident, excessive current could well have resulted, and that could have been the cause of the melting of the wax coatings. Shorted capacitors would have the same potential effect, dependent upon their specific locations in the circuit. At best, they could and would have caused DC voltages to be off-specification in the signal paths in which they are found. In this situation, the capacitors would serve as DC blocking

Figure 22 - Spark-gap capacitor

and signal coupling points between adjacent stages of the receiver, and any such capacitors that were shorted or leaky would cause the DC voltages to mingle and thus vary.

This was an enjoyable unit to work on, and the plentitude of failed components found is somewhat typical of consumer-grade equipment of the age of this set. Every job can be a learning experience, and this one was no exception. I learned, for example, that there are resistors that look just like mica capacitors. I also saw the extensive use of punch-tabs as chassis ground tie points, something I have seen before, but never to the extent that is seen on this chassis. Finally, this is the first time that I have come across the particular tuning mechanism used in this set, wherein both induction and capacitance are varied simultaneously to tune the set, as well as the angle-drive for the band switch.

Figure 23 - Close-up of dial section showing the 99.5MHz WEFM locator dot on the dial.