Zenith IF Transformer Can Restoration

As anyone who is the least bit familiar with antique radios will well know, these radios use intermediate frequency transformers as magnetic coupling devices between the various stages of the radio. Depending upon the manufacturer and the particular radio design, these transformers, which are typically enclosed in square metal enclosures known colloquially as *"cans",* may have, in addition to their magnetic devices, capacitors of differing designs. In most cases, there will at least be a capacitor in shunt across each winding. There may be additional coupling (or blocking) capacitors included, again depending upon the specific circuit design needs. In many cases, the cans will have adjustment screws for the capacitors, which are often of the "trimmer" type. Zenith, however, took a different approach with their radios that were produced in the middle 1950's.

Figure 1 - IF can components

A typical Zenith IF can of that vintage will have two windings positioned along a central tube, inside of which the adjustment "slugs" for the windings will reside. Out of design necessity, there will be an "upper" and a "lower" winding (Figure 1). Each winding will have its own slug. Normally, these slugs will be threaded on their exterior surfaces, so as to be able to move vertically inside the central tube as they are turned or "tuned". Tuning the slugs is accomplished by use of a hexagonal alignment tool, with access to the lower slug being gained by passing the tool completely through the upper slug and engaging its hexagonal tip inside the lower slug. The hexagonal tip of the tool is dimensionally wider than its supporting shaft, which is then able to rotate freely inside the upper slug while the lower slug is being adjusted. In these cans, the capacitor(s) are *not* adjustable.

Figure 2 - Mica disc and contact paddles

The capacitor(s) are comprised of paddle-shaped contact pads at the ends of the various transformer terminal pins. Depending upon the specific configuration, each "paddle" will be positioned either directly under or directly over a mica disc, which prevents paddle-to-paddle direct contact and thus preventing short-circuits between the can terminals. The mica disc is the secret to the capacitors inside these cans. Again depending upon the specific configuration of the can, there will be some silver compound applied to the disc, on both surfaces, in various patterns. The combination of the silver coating and the mica disc form a series of silver-mica capacitors in conjunction with the terminal "paddles" that are in direct contact with the silver patches on the disc (Figure 2).

As time goes by, these capacitors become affected by a condition known as *"silver-mica disease"* or *"SMD"*. This condition causes a migration of the silver across the disc, together with carbon traces that form, and end up causing short-circuits both between adjacent silver patches and also over the edges of the disc, effectively short-circuiting the disc from surface to surface. According to Google, ***"Silver mica disease is a degradation issue in some vintage radios where the silver on the mica capacitors inside IF (intermediate frequency) cans corrodes and migrates, especially in humid conditions. This "creeping" of silver causes symptoms like static, noise, and poor radio performance, and it can be difficult and time-consuming to repair by replacing the affected capacitors. It is not a medical condition affecting humans but an electronic component failure."***

Figure 3 - Mica disc with SMD visible

Silver mica disease can and will cause uncontrollable static, and can be especially annoying when it occurs on bands that are normally static-free, such as the broadcast FM band. On the disc pictured in Figure 3, which is from a Zenith 95-1102 third AM IF can from a circa 1954 Zenith 7H04Z2 chassis, the silver-mica disease is clearly visible. This particular can includes a total of three capacitors, as shown in the can schematic in Figure 4. Looking at the Figure 3 disc illustration, the two smaller silver regions, which are heavy with carbon and clearly exhibit migration between the silver patches along the disc edge and center hole, form two 120pF capacitors. The single larger silver patch, between the four o'clock and eight o'clock positions, forms a 180pF capacitor.

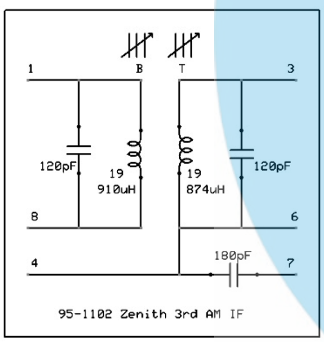

Figure 4 - 95-1102 IF can schematic

In the Zenith 95-1102 IF can schematic at Figure 4, note the locations of the two 120pF capacitors, that of the 180pF capacitor, and the relative difference between the inductances of the two windings, although the DC resistance of each winding is specified as being the same at 19 ohms each. The small numbers near each lead are the can terminal numbers. Zenith IF cans follow a standard terminal numbering scheme in which, starting at the reference "arrow" *witness mark* at one corner of the can, the terminal numbers increment around the can in a clockwise direction when viewed from underneath. It is important to note that each can has eight terminal positions, though not all eight of them may be populated in a given can. The terminal numbers are referenced by the terminal *position* on the can rather than by the actual terminal count. That is why the can schematic shown has no terminal 2 or terminal 5 – those positions are not populated.

So… if silver-mica disease is such a problem, what can be done about it? There are a couple of accepted strategies for remedying this condition during a radio repair, one of which is much better as a long-term fix than is the other.

Refer to the disc illustrated at Figure 5. This is the same disc as in Figure 3 after a thorough cleaning and careful re-installation into the base of the can, properly positioned between the contact "paddles" from the terminals. There are a few important points to be noted from this illustration. The first is that the disc *must* be installed in its original position and orientation if it is going to function properly. There are a few things that will help with

Figure 5 - Cleaned and installed mica disc

this installation. Note the tab on the disc periphery at about the ten o'clock position, and also note that you can just see the arrow witness mark beneath that tab. Next, note that each of the two smaller silver patches is positioned between an upper and lower "paddle" contact. Because we are looking at the upper surface of the can base, the terminal numbering will go counter-clockwise, starting at the arrow witness mark. Thus, we have a 120pF capacitor between the contact paddles from terminals 1 and 8, on either side of the witness mark. This agrees with the Figure 4 schematic, and this capacitor is shunted across the transformer primary winding, which is in this case the lower winding in the can. Next, we have another 120pF capacitor formed by the second small silver patch, and positioned between the upper and lower contact paddles at terminals 6 and 7, again in agreement with the schematic at Figure 4. This capacitor is also in shunt with a winding, in this case the upper or secondary winding. Finally, we have the 180pF capacitor formed by the large silver patch and the upper and lower contact paddles at terminals 3 and 4, once again in agreement with the Figure 4 schematic. What is not visible or evident in this illustration is something that can be inferred from the schematic – that terminals 4 and 6 are connected. This is accomplished by the size and extent of the silver patch on the underside of the mica disc. Whereas the upper surface of the mica disc has three silver patches, the lower surface has only two such patches, with one of them occupying a full two-thirds of the disc. This permits that patch to bridge the gap from terminal 4 around to terminal 6, effectively connecting them to each other.

OK – so we talked about the physical placement of the disc, but we did not talk about the most delicate parts of this job. The task, needless to say, starts with removal of the can from the chassis. A Sharpie® marker can be used to place index marks on the side of the can and on the chassis, adjacent to the mark on the can. This provides for re-installation of the can in the same relative position in the chassis, which is critically important. Take several crystal-clear photographs of the can connections under the chassis, from multiple angles. Verify that the photos clearly show all of the connections to and from the can, including where the opposite end of each connected component and/or wire is routed and attached. Then, carefully de-solder and disconnect each of the connected components and wires. Using a nut driver that properly fits the securing nut, remove that nut from the stud that extends out of the center of the base of the can, and then lift off the bridge that is under the nut. Set them aside for later re-installation.

Again using the Sharpie® marker, draw an arrow along the corner ridge of the can in alignment with the arrow witness mark between terminals 1 and 8, at one corner of the can. This will aid in re-assembling the can later. Before going any further, it is extremely important that *all* solder is removed from each of the can terminals, leaving the terminal surfaces – both of them – clean and smooth. This will permit the terminals to slide out of their slots in the can base block as the can is dis-assembled. Note that occasionally, a terminal will be cemented in place and will therefore not be readily removable. This is usually the case when that terminal does not have a contact paddle formed on the end of the terminal. More about these buggers later – just be aware of them right now.

Using a pair of duckbill pliers – it is best if the pliers <u>*do not*</u> have ridges on the inside of the jaws – carefully work each terminal so that it is straight and true, with no bends or twists. This too is necessary so as to facilitate removal of the terminals from their slots in the can base block.

Using a clean sheet of paper for each can that you restore, note the can part number and then draw a diagram of the underside of the can, always positioning the can so that the arrow witness mark is at the upper left-hand corner. This will then create a standard notation form for the can diagrams that you draw, with the terminal 1 position along the upper surface at the left end, number 2 along the upper surface at the right end, number 3 along the right edge at the upper end, and number 4 along the right edge at the lower end. Terminal number 5 will be on the lower edge at the right end, number 6 on the lower edge at the left end, number 7 on the left edge at the lower end, and finally number 8 on the left edge at the top end. Be sure to note which terminal positions are populated and which are not. This will make it easier to re-assemble the can later. The reason for the clean sheet of paper for each can is so that any and all information for any given can will all be together, and nothing else will be there to confuse things. If so desired, you can easily consolidate the data later for a more permanent record, but for now, while restoring the cans, this is the best way to work things for clarity and accuracy.

	1	2	3	4	5	6	7	8
1	X							
2		X						
3			X					
4				X				
5					X			
6						X		
7							X	
8								X

Figure 6 - Resistance record table

Now it is time for some measurements that we will make to validate things for later on. On your note sheet for the can, draw a table similar to the one shown in Figure 6. Next, make resistance measurements using your multimeter between the various terminal pairs, recording the measured values in the appropriate blocks. For example, when measuring between terminals 1 and 2, enter the value in either the 1 column and the 2 row, or vice-versa. Either way is OK. Do this for each and every terminal pair. Remember, that for some terminal pairs, the result will be “open” or “infinity”, indicated on some DMM’s as *“0L”* or *“overload”*, while for others it may be “shorted”, usually indicated by a 0.000Ω (or nearly so) reading. Take for example the 95-1102 IF can discussed above. If the resistance measurement is made between terminals 4 and 6, the result should be at or near zero ohms. If the measurement is between terminals 1 and 8, the result should be somewhere low, in the area of twenty ohms. The same result would be expected between terminals 3 and 6. Note too that the DC resistance between terminals 6 and 7 should be infinite *after a short period of low resistance being indicated.* This is because the 180pF capacitor is all that is connected between these two terminals. Once the capacitor is fully charged, current flow ceases and the resistance reading goes to infinite as a result. The terminal 1 & 8 pair and the terminal 3 & 6 pair will also exhibit a short(er) period of very low resistance, but it may not be noticed due to the brevity of the period and the basically low resistance of the windings involved. The short-term low-resistance readings in these terminal pairs is, of course, due to the presence of the 120pF capacitor in shunt across each of the connected windings.

Recording these resistance measurements will prepare you as to what to expect regarding internal connections when the can is finally opened up and disassembled. As the can is disassembled, it will become readily apparent which terminal is connected to which winding. The capacitor connections will not be quite so evident at the outset, as the disc will be very difficult to read clearly before it is cleaned.

The connections to the windings are comprised of *extremely* light-gauge wire, which is very easily broken off the terminals with anything except the most delicate of handling methods and procedures. ***Be warned!*** While there is usually sufficient excess wire length to permit *one* re-connection process, that is all that there is. It is best to avoid breaking the wires at all rather than to have to go through the re-connection process. OK – we have skirted the issue long enough. Now it is time to open up the can and to get down to what lies inside.

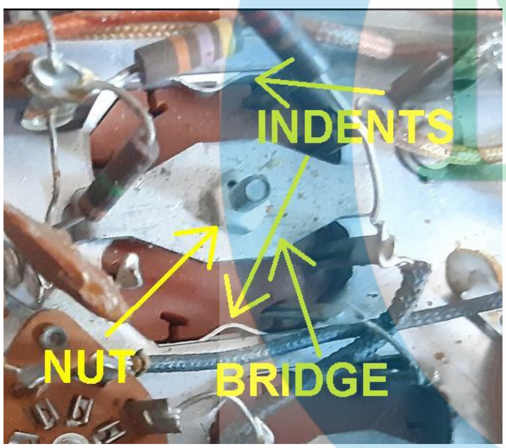

Figure 7 - IF can bottom view

Refer to the photo at Figure 7 and take a good look at the underside of the can again. This photo shows the installed bridge and retaining nut. Pay special attention to the edge of the can enclosure at the center of each edge of the can, where you will see an indent bent into the edge of the can enclosure material. Note that only two of the indents are visible in the photo. The other two are mostly hidden underneath the bridge. These four indents retain the enclosure onto the can base block and ensure that the central tube remains in place in the opening at the top of the can.

Using the duckbill pliers again, carefully straighten each of these indents, re-aligning them with the enclosure side surface. Straightening the indents usually takes no more than a simple squeeze of the pliers on the indent, flattening it back into its original condition before the indent was made. Now… before going any deeper into this, ***carefully review the can diagram that you made, including the populated terminal positions, and make sure that the arrow witness mark on the can base has an aligned arrow marked on the can corner.***

Using the nut driver again, remove the nut that secures the base block onto the center stud. Set the nut aside safely for re-installation upon re-assembly of the can later on.

Now, gently slide the can enclosure off the internals, while holding securely onto one of the terminals. Set the can enclosure aside as you did the two nuts and the bridge. Place the removed internals carefully onto another clean white sheet of paper, and then take several clean and clearly focused photographs of the internals, making sure that the locations and positions of the contact paddles are shown in the photograph(s). The clean white paper provides a clean background for the photographs. Having already removed the nut from the stud, you should be able to gently separate the base block from the round upper base disc that sandwiches the mica disc and the contact paddles. Separate the base block and the upper base disc by only about an eighth of an inch or so at this point. Doing so will make it easier to photographically record the positions and orientations of the contact paddles (Figure 8). It should now be evident which contact paddles are between the base block and the mica disc, and also which contact paddles are between the mica disc and the upper base disc. It should also be evident at this point that the tab on the periphery of the mica disc is aligned to the arrow witness mark on the base block. The arrow witness mark is repeated on the upper surface of the base block. A careful look at the Figure 8 photograph will help you to recognize the mica disc as it sits between the contact paddles.

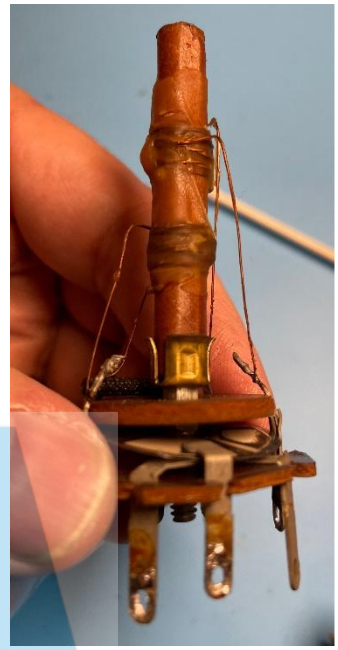

Figure 8 - Zenith IF can internals

	Wires yes/no	Wires Winding top/bot	Paddle yes/no	Paddle Locus top/bot	Paddle Aligned yes/no	Notes
1						
2						
3						
4						
5						
6						
7						
8						

Figure 9 - Terminal configuration table

Now it is time to go back to the sheet of paper upon which we are making our notes about the can. Draw another table, this time similar to that shown in Figure 9. Examine the can internals, entering the appropriate data for each terminal into its designated cell in the table. For example, lets suppose that for a given can, terminal 1 has a wire attached and that wire connects to the bottom winding, there is a paddle at terminal 1 which is above the mica disc, and there is a paddle from terminal 8 positioned directly beneath the terminal 1 paddle. With that set of conditions, the terminal 1 row of the terminal configuration table would read, from left to right, ***"yes" "bot" "yes" "top" "yes"*** and possibly, the row may be closed out with some notes that were deemed important.

If we are going to use directional position-indicating terms, we must have a standard as to the specific meaning of each term. The generally-accepted practice is to identify the various parts and pieces with respect to their position and orientation in the *installed* device. Therefore, when we indicate that a winding or a contact paddle is the *"top"* one, it means that the part is in the top or upper position or location in the can when it is viewed with respect to its normal upright position in the chassis. This is important to remember, mostly because of the fact that when we work inside the IF can, we are actually working from the underside of the can, where "down" has suddenly become "up". Although it may seem confusing at first, we generally follow this procedure because it is the scheme utilized by the schematic and service literature authors, and you should remember that *they* would be looking at the chassis with the cans installed and upright.

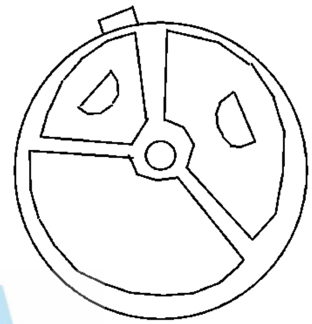

Figure 10 - Disc drawing

We can now separate the base block from the upper base disc, which will then allow the removal of the mica disc from between these elements. Because only the upper surface of the mica disc can be readily seen at this point, we will make a careful sketch of that surface on your note sheet for this can. Begin by drawing a circle about an inch in diameter, and then add a “tab” at about the eleven o’clock position on the edge of the circle. Now, hold the can internals, terminals down in one hand with the arrow witness mark at the upper left corner. Looking under the upper base disc as necessary to fully visualize the silver patch pattern on the disc, transfer what you see on the disc to the drawn circle on your note sheet. While it does not need to be one hundred percent accurate, the drawing does need to adequately represent on paper what exists in silver on the disc. For example, if a silver patch on the disc extends from twelve o’clock around to about four o’clock, just draw a similar pattern in the circle that represents the disc, as shown in Figure 10. To finish up the disc sketch, add in contact paddle outlines at the proper locations. Doing all of this will allow for the accurate re-assembly of the can after cleaning. Cleaning of the disc will, if done correctly, remove almost all indications of where the contact paddles had been in place against the silver patches on the disc, so this drawing is your best means of properly identifying the correct assembly positions. It can be as crude as you would like, so long as it represents the patch and contact positions fairly accurately.

Removal of the mica disc from the can internals involves first sliding the terminals out of their respective slots in the base block. At the same time, slip the base block off the center stud, and then simply lift the mica disc off the upper base disc, taking special care *not* to bend the disc sharply.

This is the point in the process where a decision must be made as to whether to repair or replace the capacitor system in the can at hand. Earlier I said that there were two generally-accepted methods of dealing with silver-mica disease in these IF cans. Those two methods are to either a) repair the disc by cleaning it and then reinstalling it into the can, or b) discarding the mica disc and installing discrete silver-mica capacitors of appropriate values in place of the disc. That is the decision that must be made.

If the mica disc or its silver patches are fractured, then there is not much choice in the matter, and replacement is the better way to proceed. Also, if the disc fails to clean up adequately, then replacement is also advised. A third factor would be the longevity factor. The discrete capacitor option is a more permanent fix than is the cleaning process. My usual approach is to replace the disc with discrete silver-mica capacitors, but I will describe the clean-up process first so that the reader can make an informed decision on this matter.

The mica disc is quite fragile and especially susceptible to cracking if flexed too far. In addition, the silver coating patch can also crack without an accompanying fracture of the underlying mica, which will effectively render the silver patch useless unless the contact paddle happens to fall directly on and thus can bridge the crack in the silver coating.

The best cleaning tools for the mica disc happen to be 99.9% isopropanol (isopropyl alcohol or *"IPA"*), some cotton swabs, paper towels, and one of those ubiquitous pink pencil erasers. Begin by giving the disc a rinse with the IPA, and then blot it dry with a paper towel. Next, very carefully and gently scrub the upper surface of the mica disc with the pencil eraser. This will require several passes, with the eraser being cleaned back to a bright pink appearance between subsequent passes over the disc. Continue this process of scrubbing the disc and cleaning the eraser until all traces of carbon tracking and silver migration have been removed from the disc surface upon which you are working.

The next step is to thoroughly clean the just-erased surface with the IPA, removing any stubborn marks with an IPA-soaked cotton swab as necessary. Blot the disc dry with a paper towel. If the surface of the disc is acceptably clean, with no traces of carbon or silver migration remaining, flip the disc over and repeat the full process on the second surface. When properly completed, the disc will be completely transparent except at the locations of the silver patches, which will have clearly defined margins and absolutely no silver migration evident. If the disc is properly cleaned, it is ready for re-installation into the can internals.

Identify the upper surface of the mica disc by comparing the silver patch patterns on the two sides until you identify the one that matches the disc drawing that you made earlier. To install the mica disc, it must very carefully, so as not to damage it, be placed back into position between the contact paddles, with the mica disc upper surface facing towards the upper base disc and the tab aligned with the arrow witness mark on the base block. Once you have the disc positioned correctly, begin to slide the terminals back into their correct slots in the base block, working a little bit at a time on each terminal until the terminals are fully seated. Once you have fully seated the terminals in the base block, make sure that the center stud is completely inserted through the base parts, and then install the first tin nut onto the stud, tightening it securely with the nut driver.

Now take a good look at the assembled can internals, and then compare what you see to the photographs that you took earlier. Is each and every paddle in its correct position and located on its correct side of the mica disc? Are all of the winding wires still attached to their terminals? Is every terminal in its correct terminal position slot in the base block? Are the resistances as originally measured? If all of these questions can truthfully be answered *"yes"*, then the can internals are assembled properly and continuation with the assembly is the next step. However, if it turns out that any one of those questions gets a negative response, the problem noted must be corrected before moving forward. That would, of course, require at least partial disassembly of the can internals again to correct the issue. Be patient and take your time doing this so as to avoid damaging anything. Work at it until the assembled can internals match the photographs and notes properly.

Once you have the internals ready to move forward, it is time to install the internals back into the enclosure. This is actually quite simple. Start by holding the internals by a terminal with one hand, and with the arrow witness mark at the top and towards you. In your other hand, hold the can enclosure with the drawn arrow at the top and towards you, and the open end towards the internals. Gently slide the internals into the can, and then turn the can – still holding onto one of the terminals – so that you can look into the hole in the top end of the enclosure. While looking into that hole, guide the internals into the can, adjusting the angle of the internals to bring the central tube into alignment with the hole in the can top. When the central tube aligns, push the internals in so that the central tube seats in the hole and the base block seats in the can's open end. Verify that the arrow witness mark is aligned with the drawn arrow on the can corner. If they are aligned, you can continue with the assembly. If they are not aligned, slip the internals out just enough to rotate the parts to align the marks, and then re-seat the internals, once again guiding the central tube into the hole in the can top. If the assembly is correctly aligned, continue by re-forming the indents that secure the can enclosure to the can base. This is best done by simply placing the round shank of a small screwdriver against the indent strip and then bending that strip towards the can center by pushing sideways on the screwdriver shank. Repeat for all four indent locations. The IF can is now repaired and ready for installation back into the radio chassis.

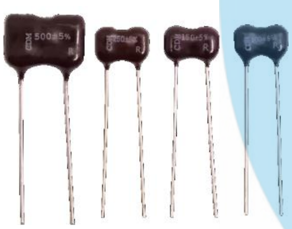

Figure 11 - Discrete radial dipped silver-mica capacitors

OK – so let's talk about repair option two – the idea of replacing the mica disc with discrete radial dipped silver-mica capacitors (Figure 11). Up to the point where the mica disc is removed from the can internals, the procedure is identical to the first method. However, an important aspect of this repair, something that we were not really concerned with during the cleaning process, is the design capacitance of each of the capacitors that are formed within the cans by the contact paddles, the mica disc, and the silver patches. We did not really care about specific values before because the same disc, providing the same capacitance values, was going back into the can. Now however, we are eliminating the disc completely, so we *must* have some idea of the capacitances provided by the disc.

Refer to Table 1 for information about the design capacitances of the common Zenith IF cans that were used during the middle 1950's and up into the 1970's on some chassis. Note that this table shows only those terminals to which capacitors are connected.

Table 1 - Zenith IF can capacitor values

IF Can #	Typical Function	Capacitor 1	Capacitor 2	Capacitor 3	Capacitor 4
95-1102	3rd AM IF	T1-T8 – 120pF	T6-T7 – 120pF	T3-T4/T6 – 180pF	
95-1150	1st, 3rd FM IF	T5-T8 – 24pF	T2-T4 – 24pF		
95-1153	FM Discriminator	T2-T3/T1/T6 – 24pF	T1/T3/T6-T7 – 68pF	T1/T3/T6-T8 – 68pF	T4-T5 – 24p
95-1250	1st AM IF	T4/T6-T7 – 120 pF	T3-T6 – 180pF	T1-T8 – 120pF	
95-1251	2nd AM/FM IF	T5-T8 – 50pF	T4-T5 – 68pF		
95-1920	FM Ratio Detector	T3-T4 – 43pF			

Simply for purposes of familiarity and comparison, we will explore re-capping the Zenith 95-1102 3rd AM IF transformer can in this section of the article, which is the same IF can that we worked with earlier. The term *"re-capping"* as used herein refers to the process of replacing existing capacitors with new ones. In this case, there will be three capacitors installed, two of which are of 120pF capacitance, while the third one is of 180pF capacitance. These should be familiar values, as these were the values afforded by the disc that we cleaned up in an earlier part of this article.

As has already been mentioned, the mica disc will be removed from the can internals and not re-installed. This leaves us with an untenable situation, in that the contact paddles that formerly were separated by the mica disc are now going to be able to come into direct contact with each other, creating a short-circuit at each terminal pair involved. This cannot be allowed to happen, so we must find an acceptable means of prevention of these short-circuits. There a few options from which to choose:

- removal of the contact paddles from the terminal assemblies;
- covering the contact paddles with insulating material such as electrical tape;
- covering both surfaces of the mica disc with an insulating layer; and
- installing a new blank mica disc between the contact pads.

Let's explore each of these methods, one at a time, and think about the pros and cons of each method.

Starting with the removal of the contact paddles, we have here the most permanent method of the four. This method involves using a pair of end-cutting pliers to simply snip off the paddle-shaped contact pad from the terminal, leaving sufficient material in the plane of the paddle to permit gripping of the terminal by the upper base disc, so that the terminal will be held solidly on place. The pros include the fact that this is a positive method of preventing contact between the paddles, as the paddles will no longer exist. It is an easily implemented method. The cons include the fact that there is no going back once the contact paddles are removed. We are committed to the current course of action.

Next, we have the method of applying an insulating coating to each of the contact paddles. There are several products that can be used for this purpose, including standard black electrical tape, Kapton tape, liquid brush-on solder mask, and so forth. This method is a bit more labor-intensive than the first method discussed, which is one of the cons. Additional cons include the potential for insulation breakdown resulting in subsequent short-circuits, the possibility of the coating coming off the contact paddles, and the fact that the coating must be applied to both of the contact paddles in a terminal pair. Falling into the pros list is the fact that this method is clearly reversible, so we could, if necessary, go back to the original design, provided that a suitable silver-mica disc is on-hand to be installed.

Next is the option of covering both surfaces of the mica disc with an insulating layer. Perhaps the best material for this task is Kapton tape. Ideally, we should use tape that is wide enough to cover the entire disc in a single pass. Be sure to clean the disc with IPA before applying the tape to help the tape to adhere properly. Among the pros of this methos is its ease, its reversibility, and its effectiveness. The cons, however, include such points as the possibility of the tape lifting from the disc surface, the need to trim the tape exactly to the disc contours, and the need to make a hole in the center of the tape coatings without damaging the mica disc.

That brings us to the final method, the installation of a blank mica disc in place of the original silver-mica disc. This method has a certain simplicity, and with mica discs readily available online, it is rather easily deployed. Among the pros is the ease of installation, the ability to reverse the process if necessary, and the effectiveness of the mica disc as an insulator. The cons for this method include the propensity for carbon tracks to form on the mica disc, leading to unstable device operation, and the cost and lead time on obtaining the necessary mica discs.

The is another drawback to both the second, third, and the fourth methods that has not yet been considered. The placement of an insulating layer between the contact paddles actually forms a capacitor of some unknown value at each of these terminal pair locations. That is probably best avoided. As a result, my method of choice is the removal of the contact paddles from the terminals.

In the task description that follows, it is assumed that the instruction provided earlier regarding the preparations for disassembly of the IF can have been accurately and completely followed, and that an adequate quantity of clear and illustrative photographs have been taken of the can internals. It is further assumed that a terminal diagram has been made and annotated, that the terminal resistances have been recorded in a table such as that shown at Figure 6, and that a terminal configuration table such as that in Figure 9 has also been made accurately. All of this is necessary to ensure proper positioning and orientation of the terminals during reassembly of the can,

It will also be *very* helpful to be able to identify each of the terminals as to its terminal slot position before or as the terminals are removed, which we will be doing shortly. One method that works is to take a Sharpie® marker with a very fine tip and make a hash mark series on each terminal that relates to that terminal's slot position. For example, on terminal 1, make one single hash mark, while on terminal 4, there would be four hash marks made on the terminal, and so forth through all of the existing terminals. Make sure that whatever method you use, the terminals are clearly marked.

One marking method that works very well and is not at all ambiguous is to take a short length – an inch or so long – of solid hook-up wire, like 22AWG or 24AWG wire, in a light color, say yellow or white, and use that length of wire as a marker tag. Strip off the insulation from about 3/8" at one end of the wire, and on the wire insulation, make the appropriate number of hash marks for the wire position on the can base block. Make one such wire tag for each terminal that the can uses. Then, immediately after the terminal is removed from the can base block, the stripped end of the wire is to be inserted through the hole in the terminal end and then twisted to keep it in place. This tag will remain on the terminal right up to the point where the terminal is about to be re-inserted into the can base block.

When you are ready to begin, and have your wire markers made and ready to use, begin by carefully removing each terminal that has a contact paddle from the can base block one at a time, installing the proper marker tag (based on the terminal's slot position) to each terminal as soon as it is slid out of the can base block. Terminals without contact paddles may be cemented into place in the base block, and are best left in place there. Such terminals may have wires attached, though, so care must be taken not to break any such wire connections. The cemented terminals are not secured by the upper base disc, but instead are held in place purely by the cement.

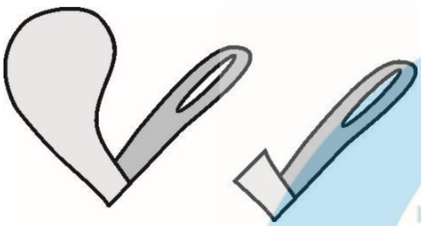

Figure 12 - Terminal before and after cutting

Once the terminals have been removed, each contact paddle can be cut off the terminal using a pair of end-cutting pliers. The *"before"* and *"after"* representations of the trimmed terminals can be seen in Figure 12. Note that the contact paddle could actually be "flagged" in either direction, depending on whether the contact paddle was below or above the mica disc in its original placement. Once the terminals have had their contact paddles removed, the terminals are ready for re-insertion into the can base block.

After insertion back into the can base block, it is important to recognize that *all* of the terminals are then to be captured flat on the can base block by the upper base disc, with everything held together by the nut installed onto the center stud and secured tightly against the can base block. One by one, remove the wire marker tag from a terminal and then insert that terminal into the appropriate terminal slot position, based on the legend on the tag. Once all of the terminals have been inserted, slide the can base block down to capture the terminals in place against the upper base disc, and install and tighten the nut to keep it all together.

Once the can internals are reassembled and the nut is secure, compare the assembled can internals to the photographs, notes, and drawings that you made earlier. If it is all correct, you can move on to the next step. However, if anything it out of place, the can internals must be at least partially disassembled so as to correct the discrepancy, and then must be secured together again. Following a final check of the internals, we will move on to the next step, which is the installation of the discrete capacitors.

Hopefully, before this whole job began, the time was taken to identify and source the various values of discrete radial dipped silver-mica capacitors would be needed, and in what quantities.

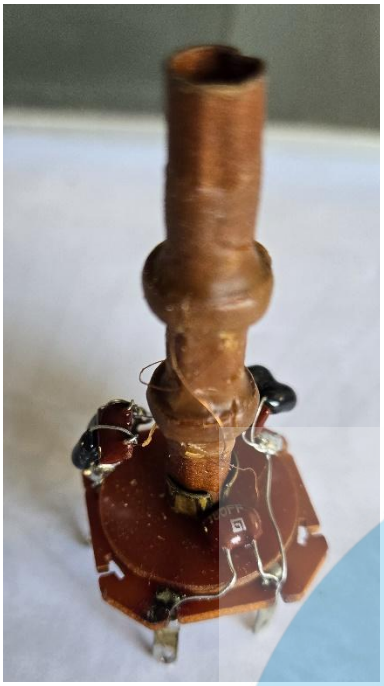

Figure 13 - Discrete capacitors installed

Still using the 95-1102 IF can as our working example, we will need two 120pF capacitors and one 180pF device. The 120pF capacitors will be installed between terminals 1 and 8 and between terminals 6 and 7, respectively. The 180pF capacitor will be installed between terminals 3 and 4, with the lead that attaches to terminal 4 also continuing around to terminal 6. This is because the terminal 4-to-terminal 6 bridge connection that was originally made by the silver patch on the mica disc must be recreated, and this is one way of doing that. If, for some reason, the capacitor lead is not long enough to make that connection, a length of 24AWG hook-up wire can be used in place of the capacitor lead.

Occasionally, it may be necessary or desirable to use a pair of capacitors in parallel to achieve the desired total capacitance for a given location. The illustration of the 95-1102 can internals with the discrete capacitors installed at Figure 13 is a good example of this. In this situation, a 68pF and a 51pF capacitor are installed in parallel at each of the 120pF locations, between terminals 1 and 8 and between terminals 6 and 7. Once the capacitors have been placed, they must be soldered into place at each involved terminal, and the excess lead length must be clipped short. When placing the capacitors, care must be taken once again to avoid damaging the ultra-fine coil winding wires that also connect to the terminals. In addition, care must be taken to ensure that the capacitors and their leads are inboard of the edge of the can base block, so that the enclosure will fit back in place and also so that no capacitor leads will come into contact with the can enclosure.

Figure 15 - IF can top view

Installing the internals back into the can enclosure is the same as was described previously. Start by holding the internals by a terminal with one hand, and with the arrow witness mark at the top and towards you. In your other hand, hold the can enclosure with the drawn arrow at the top and towards you, and the open end towards the internals. Gently slide the internals into the can, and then turn the can – still holding onto one of the terminals – so that you can look into the hole in the top end of the enclosure. While looking into that hole, guide the internals into the can, adjusting the angle of the internals to bring the central tube into alignment with the hole in the can top. When the central tube aligns, push the internals in so that the central tube seats in the hole and the base block seats in the can's open end (Figure 14). Verify that the arrow witness mark is aligned with the drawn arrow on the can corner. If they are aligned, you can continue with the assembly. If they are not aligned, slip the internals out just enough to rotate the parts to align the marks, and then re-seat the internals, once again guiding the central tube into

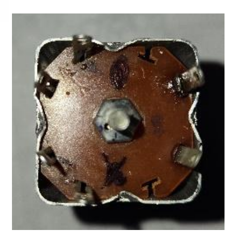

Figure 14 - IF can bottom view

the hole in the can top. If the assembly is correctly aligned, continue by re-forming the indents that secure the can enclosure to the can base. This is best done by simply placing the round shank of a small screwdriver against the indent strip and then bending that strip towards the can center by pushing sideways on the screwdriver shank. Repeat for all four indent locations (Figure 15). The IF can is now repaired and ready for installation back into the radio chassis.

Install the IF can by first aligning the index mark drawn earlier with its mating mark on the chassis, and then seat the can on the four corner lips that are formed on the chassis. Drop the bridge onto the center stud, engaging its two side tips into the provided holes in the chassis. Install the nut onto the center stud, securing it using the nut driver. Finally, reconnect all of the external connections to the IF can's terminals, physically attaching them and then soldering them properly.

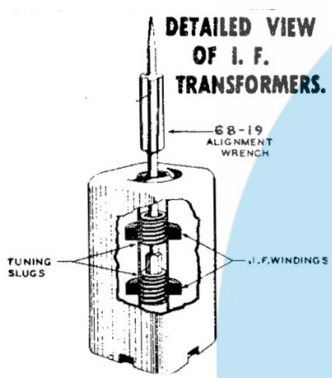

Figure 16 - IF can cutaway view

To round things out here, we will spend a few minutes going back over the IF can adjustment method. Refer to Figure 16 as you follow along with this description. Inside the IF can, as you are now well aware, there are two windings installed at separate positions along the length of a central tube, and all held in place normally with wax. Inside the tube, with a space in between them, are two ferrite or pressed powdered iron tuning slugs, which are externally-threaded forms with a hex opening that extends longitudinally through each slug. As each slug passes through the center of its associated winding, it changes the magnetic condition of the winding. Because the two windings share a common center axis, their magnetic fields overlap and interact, permitting the two coils to operate as a transformer and therefore pass a signal magnetically from one winding to the other. The specific adjustment of the slugs within the coils peaks the magnetic fields, thus increasing the magnetic coupling between the windings.

Adjustment, as was already explained, is accomplished through the use of an alignment tool that has a hexagonal tip connected to the tool handle by a narrow-diameter shank. The hex is sized to fit inside the hexagonal openings of the slugs, while the shank is sized to be able to rotate freely when inside a slug. Thus, by inserting the tool just enough to engage the upper slug, the top winding can be peaked, and then by inserting the tool more deeply, passing it through the upper slug and inserting its hex tip into the lower slug, the lower coil cand be peaked without changing the adjustment of the upper winding.

However, the adjustment of each winding's slug will affect the peaking of the opposite winding, so the alternating adjustments must be made repeatedly until no further improvement can be realized.

Restoration of the mid-1950's Zenith IF transformers is a tedious process, but it is one that pays huge benefits in radio performance when properly accomplished. Take your time, and be careful not to damage any of the coil windings as you work. Make good notes that will allow you to properly assemble the cans as you restore them. Select the restoration method that will give you the most desirable results. If complete originality is important or desired, then disc cleaning may be the route that you choose. However, if permanence of the restoration is your goal, then capacitor replacement is the better choice. Only you – or the customer – can make that decision effectively, and the customer does not always know what is best.