Replica Ekco A22T (A22 export model) by Robert Darwent

I first became aware of the existence of the Ekco A22T whilst carrying out research into the different types of dial used on the A22 model a couple of years ago. More recently, my thoughts again returned to this rare export model when I fortuitously acquired a semi-complete A22 chassis and the feasibilty of making a replica version became a much more realistic proposition.

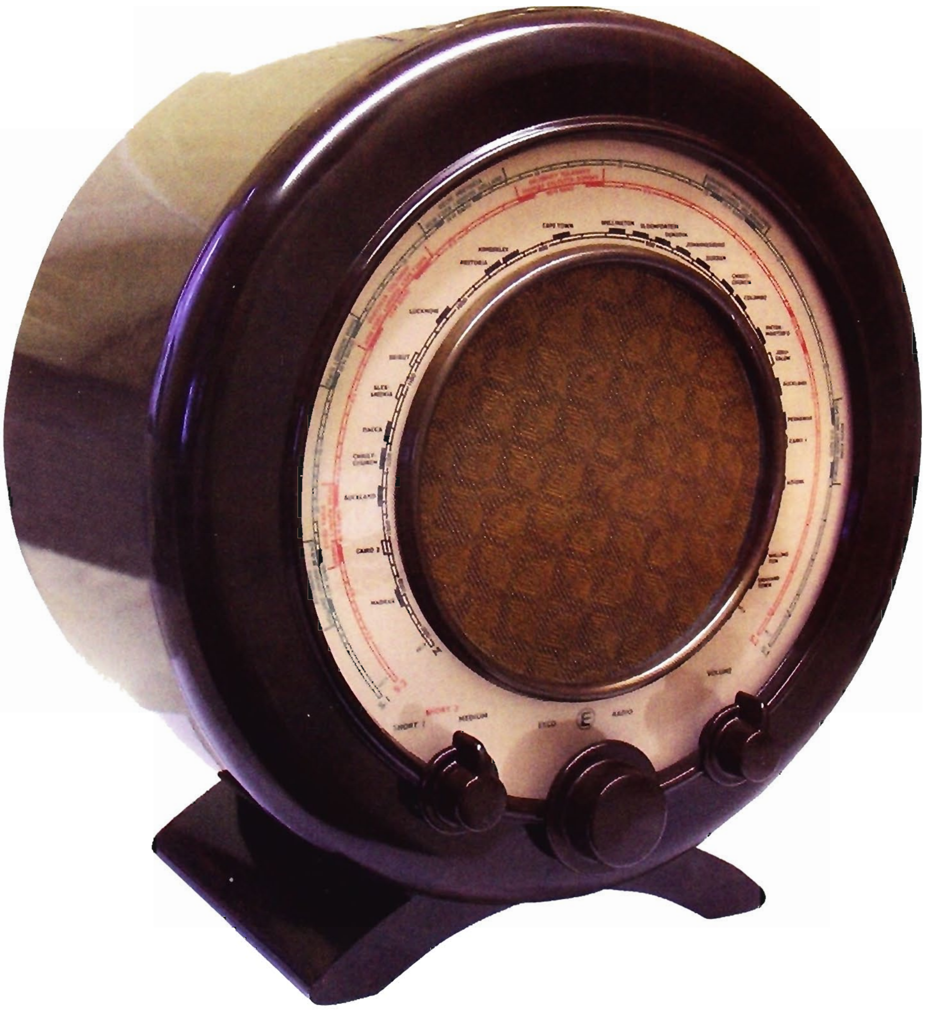


Figure 1: an original brown and bronze A22T

Figure 2: an original black and chrome A22T

Those who have read some of my earlier articles in The Bulletin will not be surprised to learn that I am very keen on the 'round' Ekco's. So much so, that gradually over time not only have I acquired examples of complete models, but have also amassed various useful bits and pieces from the sets as well.

For the A22 model in particular these spares included a walnut brown bakelite case, a couple of back covers, and several control knobs. These parts would finally be utilised to good effect during the course of this project.

In common with all export sets, the model dispenses with the long wave band in favour of additional short wave ranges. Specifically, the wavebands offered on the A22T are - medium wave (M) 550-1550 kHz and two short wave bands, (S2) 3.0-8.5 MHz and (S1) 8.5-23.0 MHz.

Therefore, to successfully build a replica not only would I have to reproduce the correct dial used by the A22T, but calculate and wind the appropriate short wave aerial/oscillator coils required, then carry out a complete rebuild of the coil-pack/band-switching section in order to offer the correct wavebands.

Other than those two major differences, the A22T is virtually identical to the standard A22 model (Figs.1 & 2). The only further minor difference of note, is the additional voltage tap selections found on the mains transformer.

Creating the dial

The dials are such a prominent and attractive feature of the A22 models that without being able to produce a satisfactory reproduction, proceeding with the rest of the project was somewhat pointless. After extensive searches of the internet, I eventually found several images of the A22T suitable to work from.

An auction listing showing a complete image of an original A22T, along with the others accompanying it showing magnified sections of the dial, proved most useful. I was able to combine the segmented images into a collage of an almost complete dial face, good enough to obtain the detail I required to begin attempting a reproduction artwork.

I also came across the website of radio amateur, PY3 CNQ and his Brazil Museum of Radio - Radios Antigos (Ref.1) which has a series of images of the A22T model. Unfortunately too small in size and resolution to be really helpful with anything except overall appearance, but very useful nevertheless.

With reference to my earlier Reproduction Ekco Dials article (Ref.2), I set about producing a reproduction A22T dial using exactly the same techniques and methods I outlined there. I will however, be expanding on that information showing the various steps involved in greater detail that are required to create such a dial from just a set of images, rather than from a scan of an original.

Despite only having a limited number of A22T dial images to work with I could still place the dial legends and details fairly accurately. This was achieved by loading the dial face collage into my graphics software and noting the X,Y co-ordinates of all the major detail; frequency markers, station name positions, and so on.

From this co-ordinate information, and by already knowing the co-ordinates of the exact centre of the dial, I could calculate using trigonometry the angular position of all the dial details to transfer to my reproduction. At this point I assigned an arbitrary colour to each waveband legend, in this case black for MW, red for S2 and green for S1.

The exact shades are not important at this stage, when the artwork is complete the legend colours and the background shade can be varied independently of each other to achieve an acceptable visual colour match that approximates the colours of the original dial.

The reproduction dial artwork is basically created in a series of steps, with each of the main steps broken down further into several sub-steps. Essentially adding layers of detail, a little at a time, until the final artwork is eventually produced (Fig.3 to 10).

Colour–matching the dial

With the detail of the artwork complete, the legend colours and background shade now require modifying to visually approximate those used in an original dial. This introduces the problem of colour variation. It will be appreciated that the exact colour shades displayed by one computer monitor will vary with respect to another. In the same way, the actual colours that are printed by a particular printer will similarly vary with respect to those shown by a monitor.

In order to achieve the correct colour values required I first printed several colour

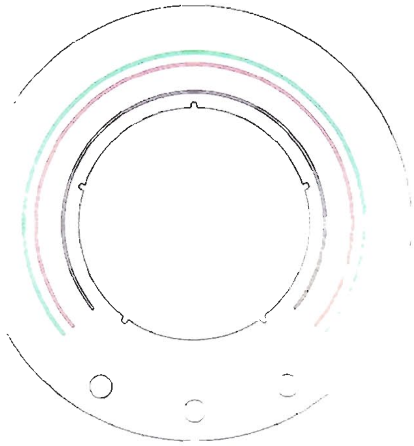


Figure 3: Step 1

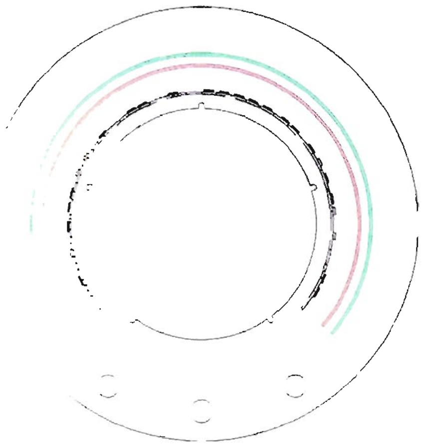


Figure 4: Step 2

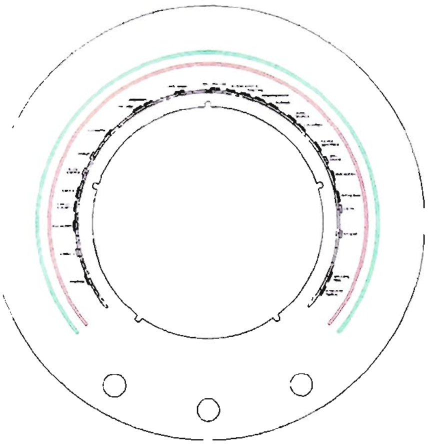


Figure 5: Step 3

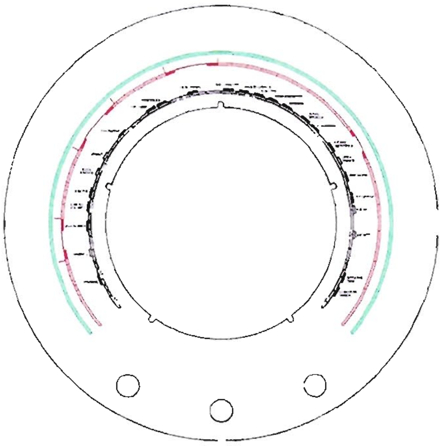


Figure 6: Step 4

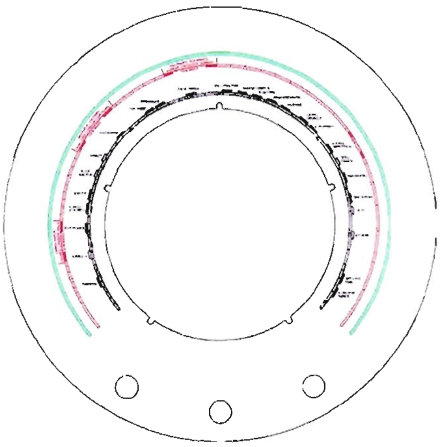


Figure 7: Step 5

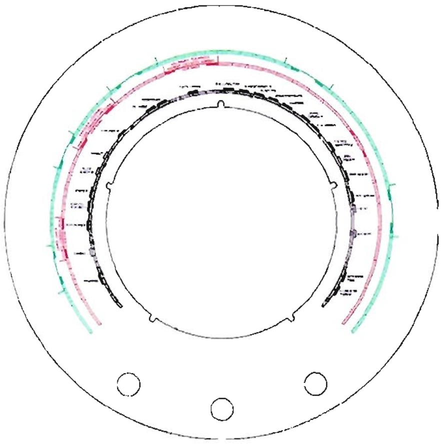


Figure 8: Step 6

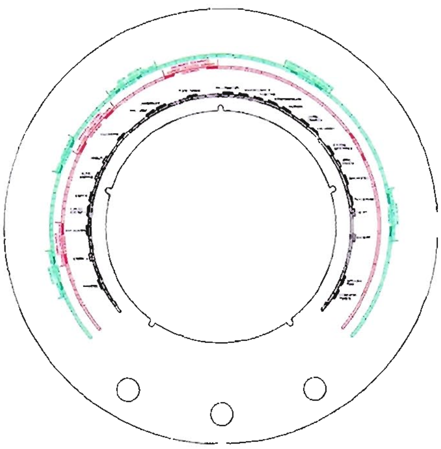


Figure 9: Step 7

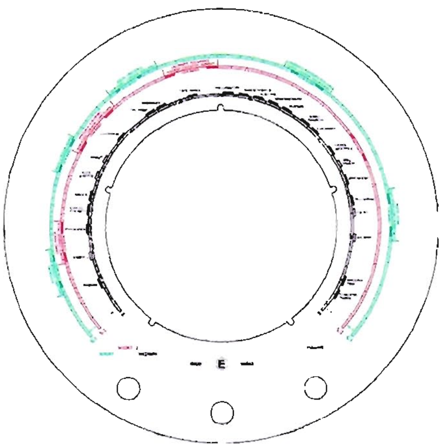


Figure 10: Step 8

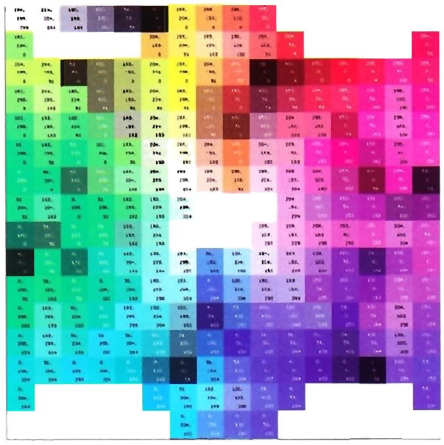


Figure 11. Colour swatch

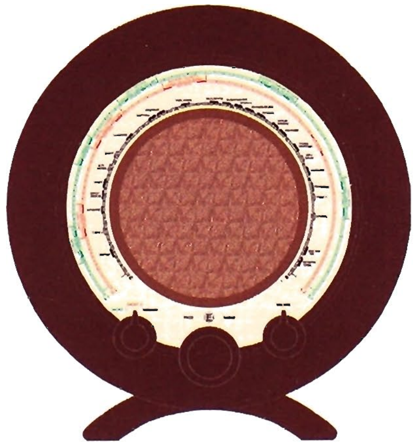


Figure 12: Virtual A22 for testing dial background colours

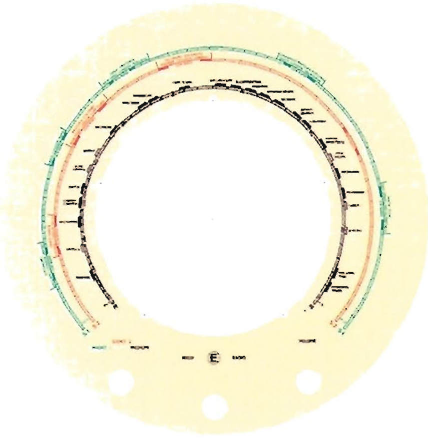


Figure 13: colour matched artwork

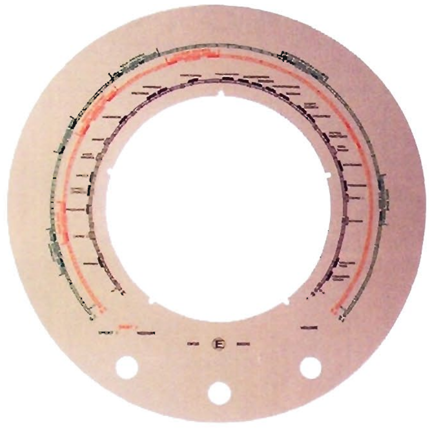


Figure 14: reproduction dial printed

S1 band		Aerial		Oscillator	
Inductor L		0.716 uH		0.646 uH	
Tracker CT		40.43 pF		45.25 pF	
Padder CP		none		none	
Dial kHz	Cv pF	Calc. kHz	Error %	Calc. kHz	Error %
limit	451.7	8394		8795	
8500	433.5	8550	+0.58	8957	-0.08
9000	381.0	9035	+0.61	9481	+0.16
10000	300.9	10035	+0.34	10493	+0.26
11000	243.0	10980	-0.17	11466	+0.00
12000	197.2	11953	-0.39	12463	-0.01
13000	160.6	12948	-0.40	13478	+0.09
14000	131.8	13933	-0.47	14479	+0.09
15000	108.5	14920	-0.53	15474	+0.06
16000	89.2	15918	-0.51	16476	+0.06
17000	73.2	16916	-0.49	17472	+0.03
18000	60.0	17899	-0.56	18445	-0.10
19000	48.8	18882	-0.62	19413	-0.26
20000	38.9	19901	-0.49	20408	-0.27
21000	30.3	20934	-0.31	21409	-0.26
22000	22.6	22010	+0.04	22443	-0.09
23000	15.6	23147	+0.63	23525	+0.25
limit	10.7	24057		24384	

Figure 15. S1 band table

S2 band		Aerial		Oscillator	
Inductor L		5.792 uH		4.895 uH	
Tracker CT		34.17 pF		39.62 pF	
Padder CP		none		3400 pF	
Dial kHz	Cv pF	Calc. kHz	Error %	Calc. kHz	Error %
limit	451.0	2972		3434	
3000	437.8	3012	+0.40	3475	+0.27
3500	313.5	3497	-0.09	3961	-0.11
4000	231.4	3984	-0.40	4453	-0.27
4500	172.2	4496	-0.09	4971	+0.12
5000	130.9	4998	-0.03	5479	+0.25
5500	101.0	5489	-0.20	5973	+0.13
6000	77.4	5998	-0.03	6483	+0.27
6500	59.7	6489	-0.17	6971	+0.07
7000	45.6	6980	-0.28	7454	-0.14
7500	33.3	7513	+0.17	7974	+0.10
8000	24.0	8010	+0.12	8451	-0.16
8500	16.0	8525	+0.29	8942	-0.26
limit	10.8	8920		9311	

Figure16: S2 band table

swatches (Fig.11). Each square of colour has its RGB values printed on it, and when printed by your printer will give you a permanent reference chart so you can determine exactly how your own printer will produce a specific colour combination. It is necessary to print on exactly the same sort of paper and with the same printer settings as those intended to print the artworks with or the resulting colour chart will be invalid.

The problem of colour-matching is not only confined to the differences between what a particular monitor displays and what a particular printer actually produces. The human eye perceives colour hue and saturation differently in response to contrast

Put in terms of colour matching a reproduction dial, if a dial artwork is viewed

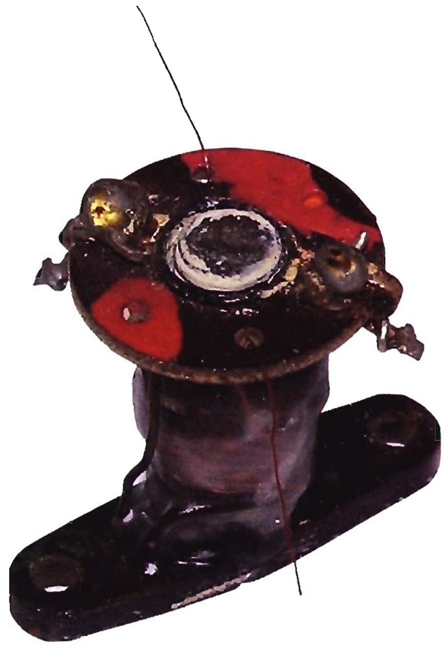


Figure17: Coil winding

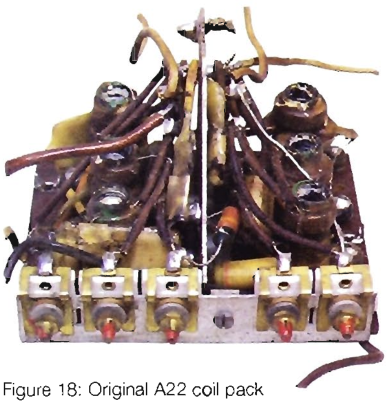


Figure 18: Original A22 coil pack

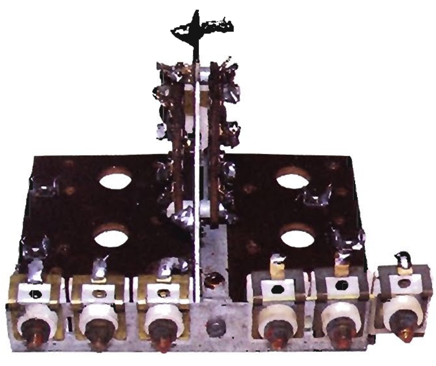


Figure 19 Stripped coil pack

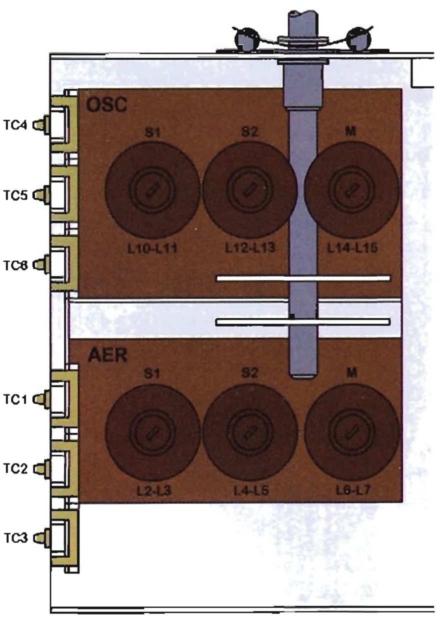


Figure 20: Layout of coil pack

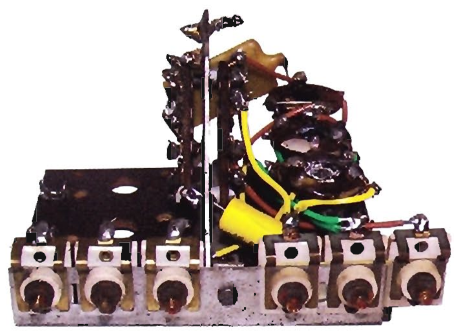


Figure 21: Rebuilding coil pack

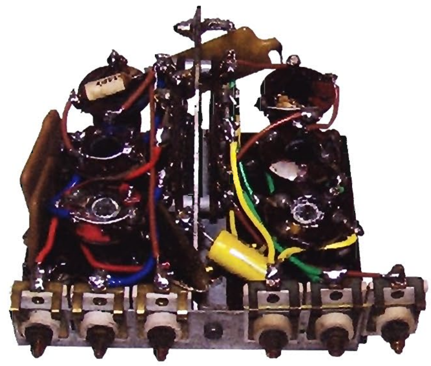


Figure 22: Finished replica A22T coil pack

against a light backdrop then the shade used for the background of the dial will appear darker than if the same artwork is viewed against a dark backdrop.

I had not realised just how striking this effect can be until I began experimenting with printing my reproduction dials a couple of years ago. Often the background shade of the artwork that came out of the printer looked too dark against the white of the photo paper I was using, until I trimmed and test fitted it into an actual bakelite case when the same dial background then looked too light.

To overcome this problem I created a graphic version of a bakelite A22 case (Fig.12) that I could test fit the artworks into 'virtually' before physically printing them out. This method is not perfect, but what it does do very well is give a close 'ball-park' figure for the RGB colour values of the required background shade. It is then a case of 'tweaking' this value until a final shade is found that is visually pleasing and acceptable (Figs.13 & 14).

Calculating the LC tank components

I began with the standard equation, found in many text books, for calculating resonant frequency from a specified inductor and capacitor. For convenience modified to accept values in kHz, pF and uH.

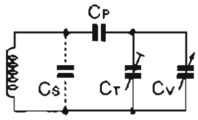
$$F = \frac{1}{2\pi\sqrt{LC}} = \frac{159155}{\sqrt{LC}}$$

However, it is not as simple as rearranging the equation and entering the upper and lower frequency limits to read off the required inductance. The range of frequencies covered in a practical LC tank circuit is determined by the capacitance ratio of the particular variable capacitor being used. This often results in the tuning band extending well outside of the required range.

Ideally what is needed is only the desired tuning band to be covered and for it to be spread out over the full rotation of the variable capacitor. Not surprisingly then, this circuit technique is termed - 'bandspreading'.

The tuned circuits commonly used in superhet designs make use of combined parallel and series bandspreading, by including a parallel 'tracker' (usually an adjustable trimmer) and a series 'padder' (usually a fixed capacitor) to modify the main variable capacitor's capacitance range.

In the generalised LC tank circuit - CV represents



$$C_{NET} = \frac{(C_V+C_T)C_P}{C_V+C_T+C_P} + C_S$$

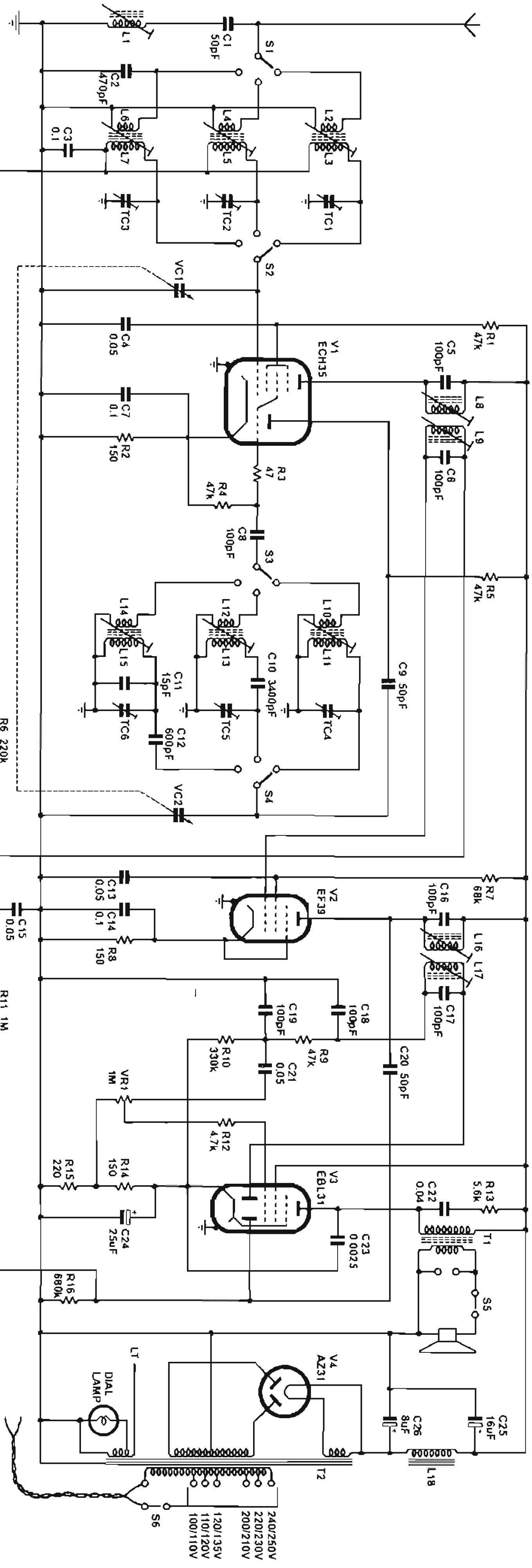
the variable capacitor, CT the tracker (trimmer), CP the padder and CS is any stray circuit capacitance present. Combining all these components gives an overall 'net' capacitance with which the inductance is tuned to resonance.

If you are interested in delving deeper into the subject of bandspreading, paying a visit to Robert Weaver's excellent website - Bob's Electron Bunker (Ref.3) is well worth your time. I referred extensively to the in-depth explanation of the mathematics involved and made use of the on-line resonance calculators available.

Normally a LC tank circuit is designed to cover a desired tuning range, once built a tuning dial is then made to tally with specific frequency points. Unfortunately, my problem was the exact opposite. I already had the dial with specific frequency points marked on it, for which I needed to design LC tank circuits to track those points with a high degree of accuracy.

To begin to solve the problem, I temporarily fitted a test print of my A22T reproduction dial to the chassis and rigged up a suitable power supply for the illuminated tuning arm. Whilst accurately placing the tuning cursor on the major frequency markers on the dial, I noted down the corresponding capacitance reading from a digital LC meter I had connected across the main tuning capacitor. Repeating this procedure for both short wave ranges, I obtained the specific capacitance value that produced a known frequency at many points across the dial.

I now needed to try, by trial and error, various values for inductance, tracker and



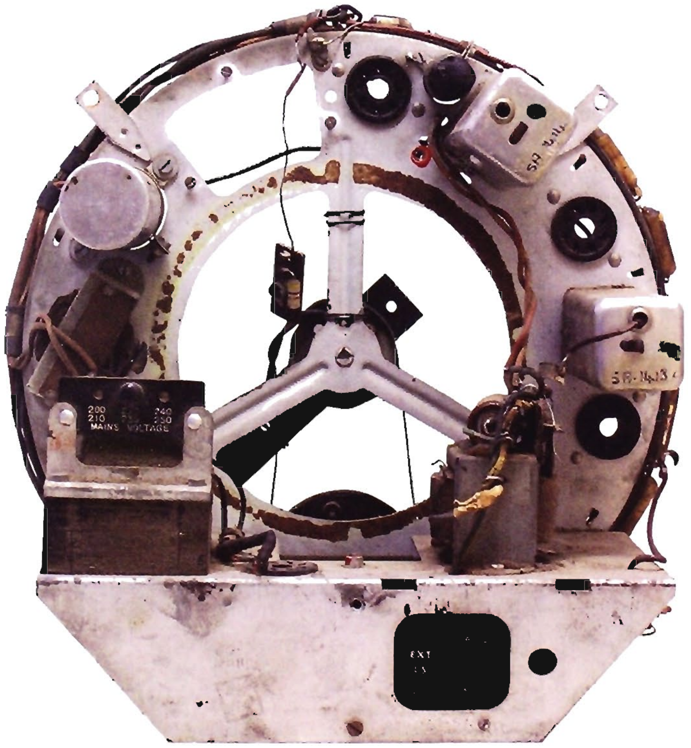


Figure 23: Untouched rear of chassis

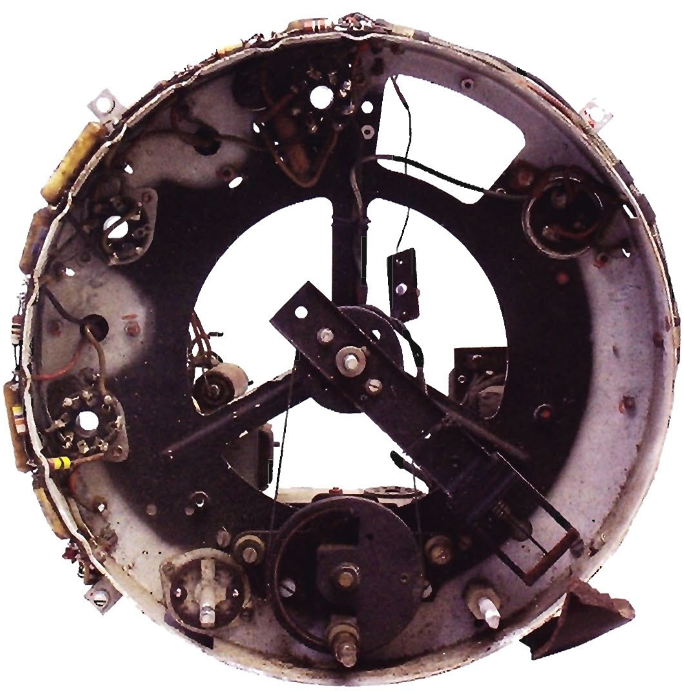


Figure 24: Untouched front of chassis

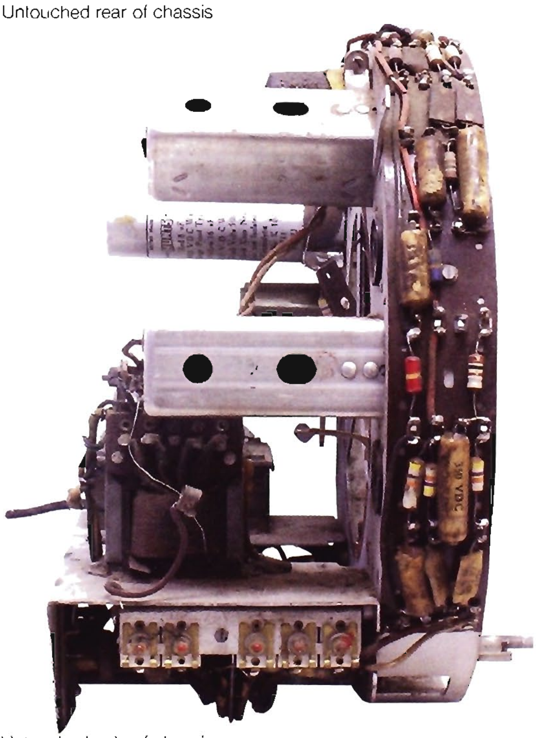


Figure 25. Untouched side of chassis

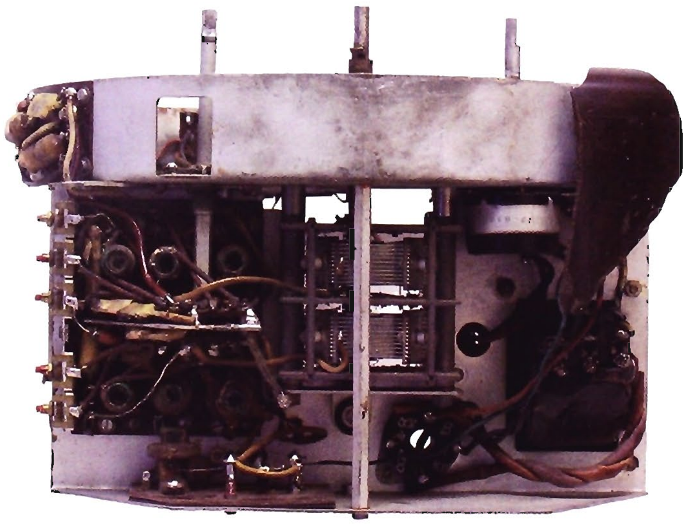


Figure 26: Untouched bottom of chassis

padder that best matched all of the required frequency points as accurately as possible using the previously stated equations. It will be appreciated that many combinations of values needed to be searched through. To do so by hand with only a pocket calculator would have taken a very long time, instead I wrote a small computer program to do the 'number-crunching' for me. Even so, it still took the computer several hours of continuous calculations for each short wave range to arrive at the best match having the lowest error difference between required frequency and calculated frequency.

Surprisingly, the final values found produced a maximum error of a fraction of one percent across all required frequency points for both aerial and oscillator tank circuits on both short wave ranges. More than accurate enough for my purposes, even allowing for the inevitable errors involved in positioning the tuning arm accurately on a dial frequency point and in the accuracy of measurement of capacitance by the LC meter. The final results are presented in tabular form (Fig.15 & 16).

Note; in both tables the calculated frequency values under the 'Oscillator' heading are higher than the specified 'Dial' frequency points or the calculated frequency values under the 'Aerial' heading due to the addition of the 465 kHz intermediate frequency.

At first glance some of those frequency errors may seem quite large, for example; the largest error on the S1 Aerial table is at the 23000 kHz point which actually comes out at 23147 kHz in the calculations. In reality the 147 kHz difference amounts to no more than the thickness of the tuning pointer shadow produced by the illuminated tuning arm, so more than acceptable in practice.

Winding the SW coils

Fortunately I had a head start when it came to making the four 'new' coils required. I already had many reclaimed parts from stripped down Ekco A23 and A28 sets, the A28 chassis in particular was most useful having several bandspread short wave ranges and sixteen coils in its coil-pack. The coils are of the same overall size and shape as those used in the A22, so it was possible to use some of those as

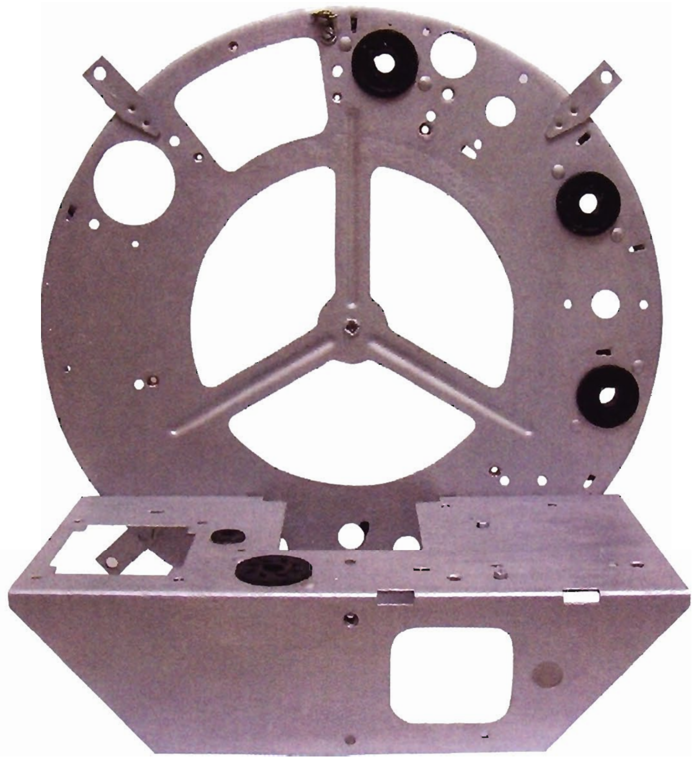


Figure 27: Rear of chassis during restoration

Figure 28: Front of chassis during restoration

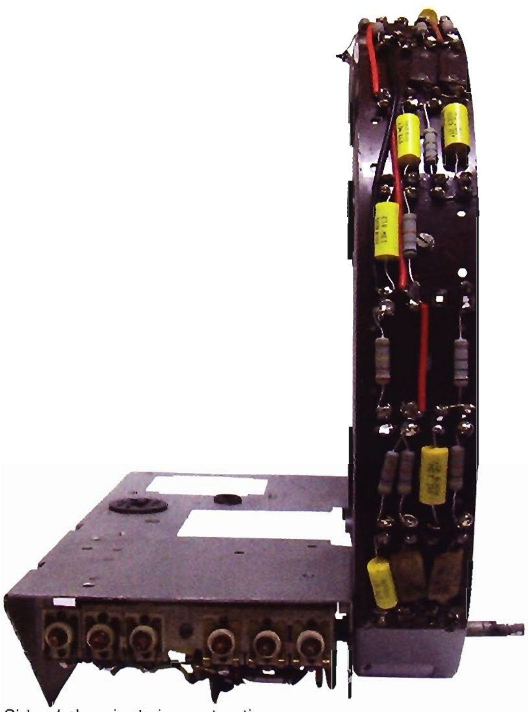


Figure 29 Side of chassis during restoration

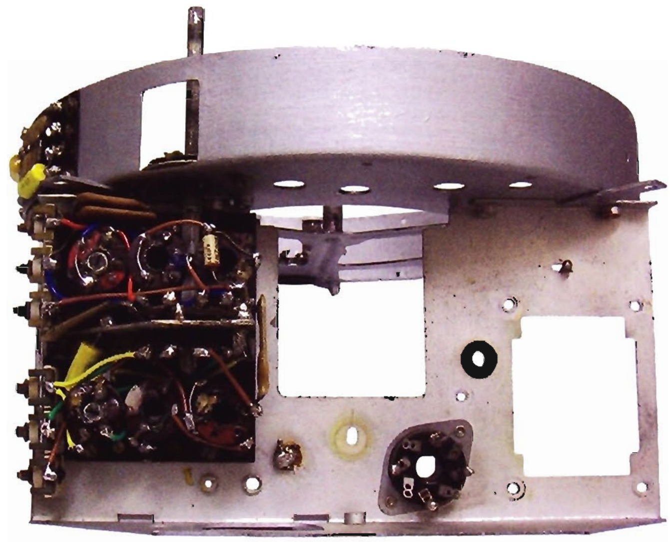
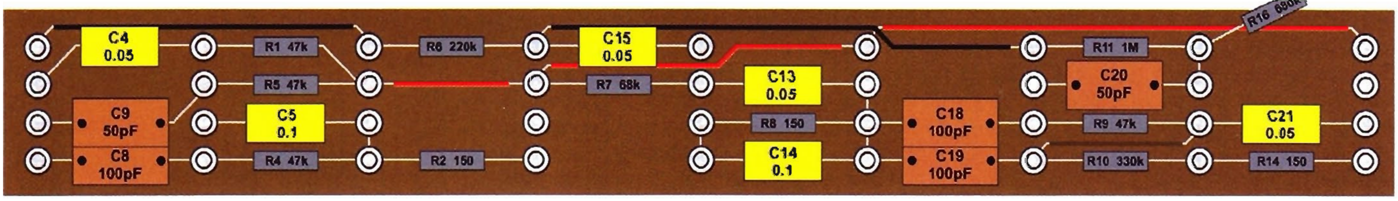


Figure 30: Bottom of chassis during restoration



Component layout on the tag-board

'donor' coils rather than start completely from scratch with a bare coil former.

I found three donor coils that gave the inductance values I had calculated simply by rotating the alignment slug in or out, the value needed being comfortably within the coil's existing range. For the fourth, the best match I had was a donor coil that was slightly higher in inductance, but by removing a couple of turns of wire from its winding I brought the value down into the required range.

It was a simple matter to remove most of the wax sealing the coil winding with a soldering iron, unsolder one end and take off a couple of turns. I was careful to ensure that enough wax was left on the winding to keep the other turns firmly in place whilst carrying out this operation.

Each of the four coils now needed a coupling winding adding over the main inductance winding. From unwinding a spare coil, I determined that this coupling winding consisted of approximately five to six turns evenly spaced on top of the main winding.

Using a similar gauge enameled copper wire, I carefully added this coupling winding. Each end of the winding was terminated

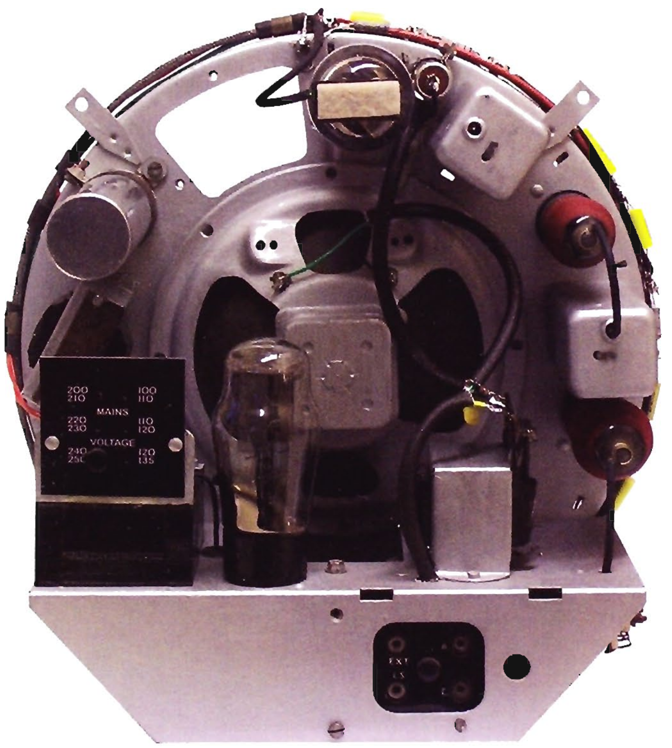


Figure 31: Completed rear of chassis

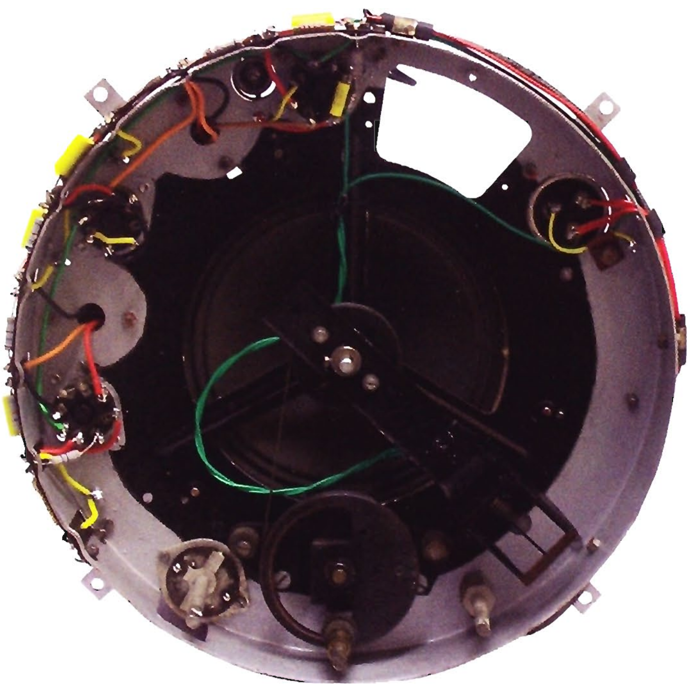


Figure 32: Completed front of chassis

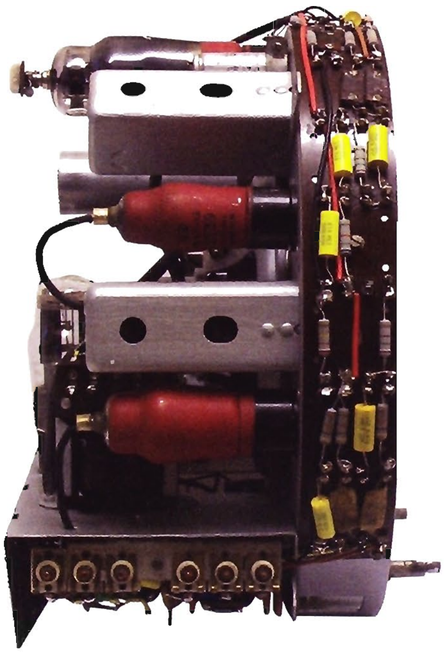


Figure 33: Completed side of chassis

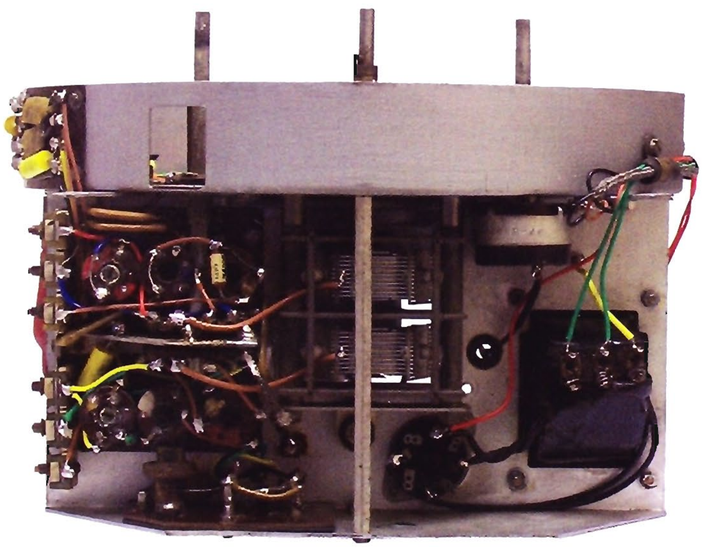


Figure 34: Completed bottom of chassis

by feeding through unused holes in the top of the former (Fig.17). After securing the ends to solder-tags to provide a connection point, the coil was resealed with wax to keep everything stable.

Rebuilding the coil-pack

Next came the task of stripping the existing A22 coil-pack (Fig.18). After careful removal of all the components I added an extra trimmer capacitor to the stripped board (Fig.19). This was necessary due to all three coils in the aerial section requiring a tracking trimmer. As the coil-pack in an original A22T also has this sixth trimmer, I adopted the same layout (Fig.20).

I found that I could modify the mounting arrangement used by the group of two existing trimmers to securely hold it in place. This leaves the trimmer standing a few millimetres higher than the others and off of the end of the board, but since its fixing was mechanically sound I considered it acceptable.

I began the rebuild with the slightly less complicated 'Aerial' side of the board, adding the three coils one at a time and soldering the required connections between the bank of trimmers running down the side and the band-switching wafer mounted in the middle (Fig.21).

Continuing in similar fashion, I rebuilt the 'Oscillator' side of the coil-pack. This section was more difficult due to having to accommodate the additional large padder capacitors in the limited space available.

Note: the two large 6800 pF 1% mica capacitors on the left hand edge. These are connected in series to make-up the calculated 3400 pF padder value required for the S2 oscillator range (Fig.22).

I should add that none of the original coils and padder capacitors were used in the rebuild and have been carefully saved, even the medium wave coils used were reclaimed components. Therefore, these coil-pack modifications are completely reversible should it be so desired.

Chassis restoration

As stated earlier, the A22 chassis which forms the basis of this project was acquired semi-complete. Most notably it

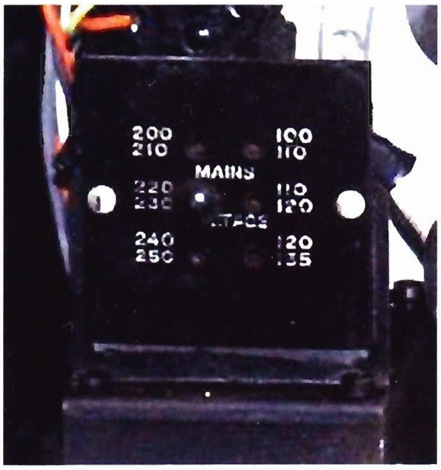


Figure 35: Original A22T voltage selector

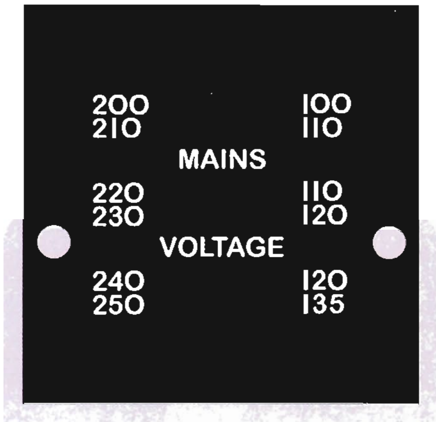


Figure 36: Graphic of A22T voltage selector

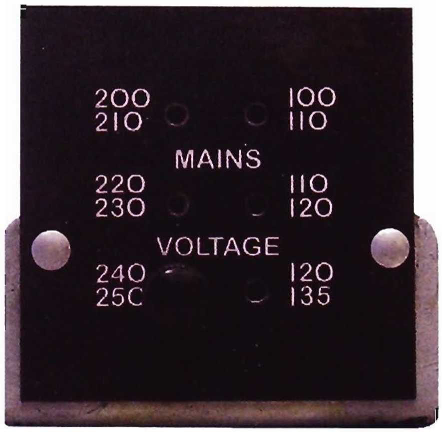


Figure 37: Reproduction A22T voltage selector

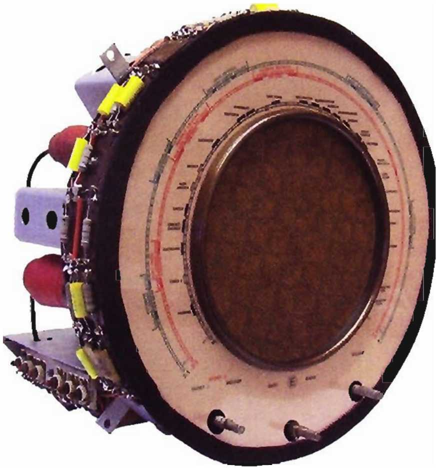


Figure 38: Reproduction dial fitted to chassis

March 1947 advertisement

was minus a dial, loudspeaker and a set of valves. However, I was fortunate that the metal trivet that mounts the dial and speaker cloth was still present. Less so with the bronze speaker ring that covers its circumference, which was absent.

Generally the chassis was dirty and the wiring had obviously seen better days, but was otherwise complete (Fig.23 to 26). It even had a chunk of its original broken bakelite case still attached!

I adopted the same approach that I followed in my Ekco A22 rebuild article (Ref.4), which was to completely strip the chassis and undertake a full restoration. All the important wiring connections were first labeled and marked for each of the major components before they were removed.

Working steadily and methodically in this way, I quickly had the chassis completely stripped whilst being certain of exactly how everything was originally connected.

I could now begin the task of cleaning and painting the two major sections of the chassis. After a thorough clean and the removal of any flaking original paint, each part received a coat of silver or black smoothrite paint, as appropriate (Fig.27 & 28).

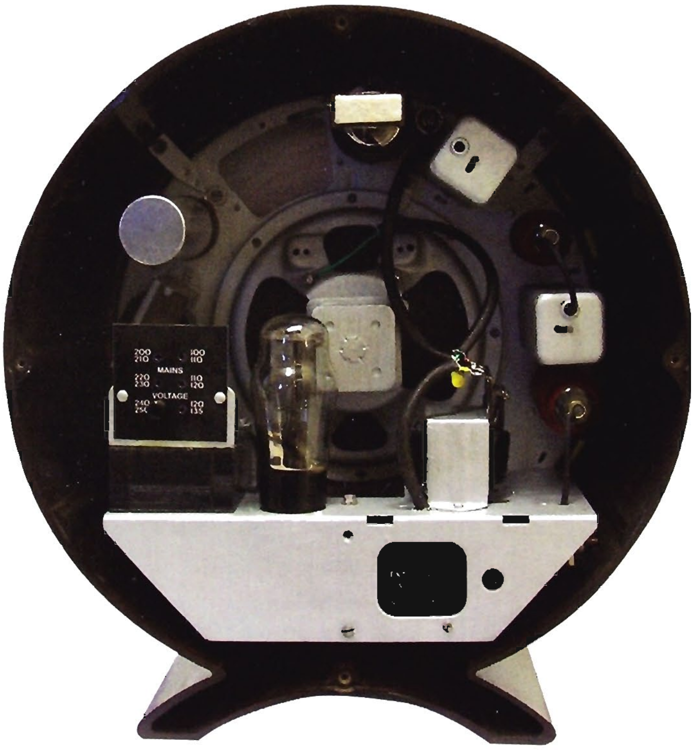
I also began the replacement of all the resistors and the wax type capacitors used on the tag-board that attaches around the edge of the circular chassis. Renewing with modern 2W carbon resistors because of their similar dimensions to the originals, and yellow 630V rated polypropylene capacitors (Fig.29).

An unforeseen problem was encountered when I attached the rebuilt coil-pack board and tried to insert the band-switching spindle. I found that the medium wave oscillator coil was fouling the clean rotation of the spindle (Fig.30 - upper right with the capacitor across it).

After a number of attempts at repositioning the coil and wiring, I eventually solved the problem by the inclusion of several small washers under the two mounting bolts that secure it. The washers raised the height of the coil a few millimetres which proved just enough to clear the spindle.

Continuing, I renewed all the wiring between the major components mounted on the circular chassis and the tag-board and then fully rebuilt the chassis (Fig.31 to 34).

Fortunately, the original screening



braid which carries the wiring between the tag-board and volume control was in good condition and could be reused, it was just a case of carefully threading the new wiring along its hollow centre.

Regarding a replacement for the missing loudspeaker. I was fortunate to already have a 6.5 inch diameter, 3 ohm speaker amongst my previously mentioned spares. Although not from an A22, it originally came from a related Ekco model, it was exactly the type required.

> Although not necessary in terms of making the set work, I felt the cosmetic modifications worthwhile.

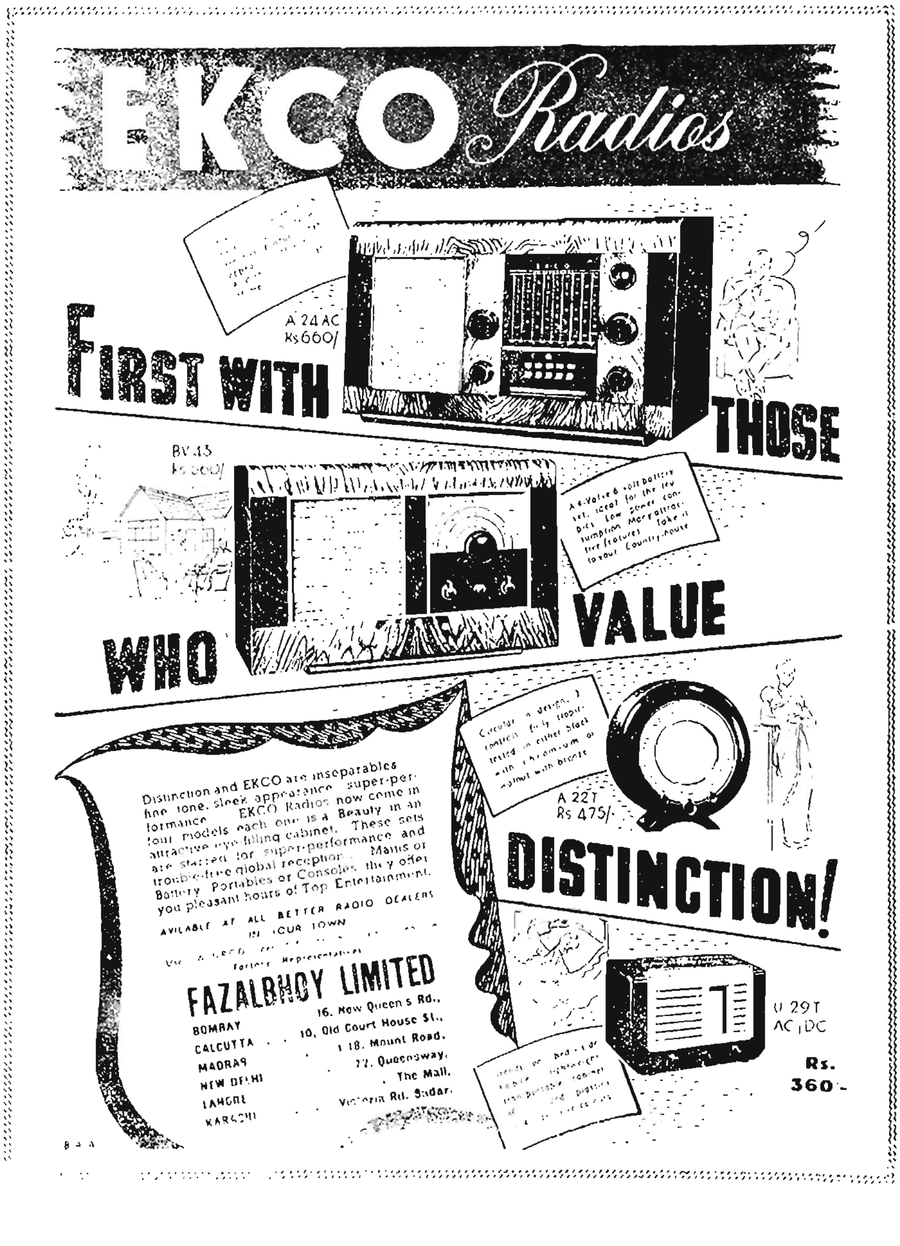
The bronze speaker ring was more problematical. I didn't have one and a number of possible solutions were contemplated during the course of the several months this project took to complete. None proved really satisfactory, then quite unexpectedly an original bronze A22 ring was listed and purchased via eBay. The final missing piece of the jigsaw had been found!

Modifying the mains transformer

A standard A22 has three tapping points on its mains transformer to select different voltage ranges, the A22T being an export set has an additional three. The body and size of the two types of transformer are identical, the A22T just has a much larger voltage selector panel fitted.

Obviously I couldn't replicate the additional three lower voltage tappings, but I could replicate the appearance by making an appropriate reproduction A22T voltage selector fascia and fitting the existing A22 selector panel to its rear.

This would involve extending the existing



wires between the transformer winding and the selector panel and rotating the selector itself from the horizontal and refitting vertically in the centre of the new fascia.

The reproduction voltage selector consisted of two parts, the existing paxolin panel which the tap selector was attached to and a graphic of the A22T selector fascia, printed and laminated several times to achieve an appropriate thickness, fitted in front.

The 'U' shaped metal bracket that forms the front of the transformer, mounting the selector panel with two rivets, had to be fitted the opposite way around in order to provide the clearance required from the transformer windings.

The rivets were carefully released using a modellers drill and a burr tool. This enabled them to be reused to secure the new selector panel. Observant readers will note that they have been refitted a little lower and should actually be in-line with the middle voltage taps. This was a necessary compromise due to the 'U' bracket used being approximately a quarter of an inch shorter in height than the one used in an original A22T (Fig.35 to 37).

Although not necessary in terms of making the set work, I felt the cosmetic modifications worthwhile. The voltage selector panel along with the dial are the only two things that visually differentiate the A22T from the A22, so I thought it important to try and reproduce them both for the sake of authenticity.

Initial testing

The time had finally arrived to switch the set on! After double-checking everything I connected a temporary aerial and applied power via a lamp limiter with the set switched to the medium wave range. No indications of anything amiss from the lamp and twenty seconds or so later I'd got a definite background hiss from the loudspeaker. Switching out the limiter and tuning around brought in several stations loud and clear.

I'd expected this of course, or rather hoped. The cores of the medium wave coils and the two IF transformers had been untouched, so providing my component and wiring renewal was carried out correctly the set should have worked on this band. But what of the two 'new' short wave ranges.

Trying the S2 range first produced little until I reached the 10 o'clock position on the dial, when suddenly a foreign language station came booming out of the loudspeaker! Further careful tuning found several fainter stations as well. Switching to the S1 range produced very similar results. Clearly both ranges were working, which was something of a success in itself. Whether they were in the correct band of frequencies was unclear at this point, but I was very encouraged by what had already been achieved.

Alignment

Adopting the alignment procedure outlined by Ekco in their service data for the A22 as a guide, I began with the I.F. alignment. Using a signal generator coupled to the grid (top cap) of V1 (ECH35) via a 0.1 uF capacitor, I injected a modulated signal at 465 kHz. As instructed, the set was switched to the medium wave range and the tuning capacitor was fully meshed.

I don't have an audio output meter, so the adjustments were simply gauged by ear. Working backwards from the second I.F. transformer, cores L17, L16, L9 and L8 in that order, were each peaked for maximum audio output. As expected, the I.F. alignment was pretty much perfect already and no significant adjustments needed to be made.

Next came the I.F. filter consisting of L1 and C1. Injecting a 465 kHz into the aerial socket, the core of L1 was adjusted for minimum audio output. Again the alignment was close to ideal already, as L1 had also not been disturbed.

Then the adjustments for calibrating the three tuning ranges. To begin with, the physical position of the dial needs adjusting so that when the tuning capacitor is fully meshed the shadow of the pointer on the illuminated tuning arm coincides with the calibration spot just under 'M' on the lower right of the dial. I had already ensured this was the case when fitting the dial earlier (Fig.38).

S1 range (8.5-23.0 MHz) - Dial tuned to and signal injected at 22.0 MHz, adjustment of oscillator trimmer TC4, followed by aerial trimmer TC1 - Dial tuned to and signal injected at 9.0 MHz, adjustment of the core of oscillator coil L10/11,

In the final analysis, I considered the extra effort made early on in the project was well worthwhile. It made the sense of achievement in completing this replica all the more satisfying and special.

followed by the core of aerial coil L2/3.

S2 range (3.0-8.5 MHz) - Dial tuned to and signal injected at 8.0 MHz, adjustment of oscillator trimmer TC5, followed by aerial trimmer TC2 - Dial tuned to and signal injected at 3.5 MHz, adjustment of the core of oscillator coil L12/13, followed by the core of aerial coil L4/5.

MW range (550-1550 kHz) - Dial tuned to and signal injected at 1500 kHz, adjustment of oscillator trimmer TC6, followed by aerial trimmer TC3 - Dial tuned to and signal injected at 600 kHz, adjustment of the core of oscillator coil L14/15, followed by the core of aerial coil L6/7.

All the adjustments were made for maximum audio output and repeated until no further discernible improvements could be made. The medium wave range needed little adjustment because it had not been disturbed, and surprisingly the two short wave ranges were close to their optimum settings as well.

I attributed this to the fact that I had carefully adjusted the coil inductances and trimmer capacitances as accurately as I could with a digital LC meter during the rebuilding of the coil-pack board, setting them to their calculated values.

Using the signal generator to inject various frequencies on both short wave ranges confirmed that they were accurately operating within the required band of frequencies. Tracking was as good as I had hoped for, with all frequency points matching the dial markings to within a couple of widths of the tuning pointer shadow.

Conclusion

This project pushed me further than any other restoration I had previously undertaken. I broke into new ground in terms of calculating/ making the coils and rebuilding the coil-pack for this set, something I hadn't even contemplated attempting before. In the final analysis, I considered the extra effort made early on in the project was well worthwhile. It made the sense of achievement in completing this replica all the more satisfying and special.

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