GENERAL SERVICING

An occasional series by LES LAWRY-JOHNS chatting this time on—

3-VALVE RADIOS

Valved radios are still great favourites with many people. The main reason is economy, as a mains operated transistorised set large enough to provide the same bass response tends to be expensive whilst battery operated sets are either too small to sound good or are too expensive to run, bearing in mind the fact that a PP9 battery, for example, is now over 50p. In addition to this, some people have a sentimental attachment to their valve radios. We are quite fond of an old couple in their nineties, who have a 1933 Ultra! We will not go into the servicing of this type of set, however! Suffice to say that we have kept it going for them for more years than we care to mention.

Transformerless

Valved radios generally fall into two types, the heavier type having a mains transformer and parallel-fed valve heaters and the lighter ones with no transformer and series heaters. The latter is more commonly encountered and we will consider this type first.

With no transformer to provide low voltage supplies, the normal 240V mains has to be adapted to provide the HT and heater requirements. If we accept that one of the mains supply leads, preferably the neutral, can be connected directly to the chassis or metalwork, the design can be simplified so that all that is necessary is a means of reducing the mains voltage to that required by the total number of valve heaters in series. This is usually done by inserting a wirewound resistor in the top end of the series chain to drop the voltage to that required. A tapping on this resistor can be used to supply the HT rectifier, which is usually a valve, and the current drawn by the HT must be added to that drawn by the valve heaters when calculating the value of the dropping resistor. The arrangement is shown in Fig. 1 except that a dial lamp and shunt resistor have been inserted into the chassis return to neutral (or one side of the mains at any rate).

The advantage of using a valve rectifier is twofold. First, the valve warms up slowly with the rest and therefore the HT builds up slowly as the rest begin to draw current. Therefore the HT is rarely more than, say, 200V. This takes the strain off all the capacitors on the HT line and leads to greater reliability. Secondly, the voltage drop across the rectifier heater in addition to that of the other valves reduces the rating of the dropper so that the heat concentration is reduced in this area. Obviously the higher the total voltage of the valve heaters the lower the value of the dropper. This is why nearly all European radios of this type used 100mA valves of the "U" series (UY85, UL84, UCL82 etc.). Countries with a low mains voltage (say the US) of about 110V used a different range of valves taking more current and dropping less voltage. Some years ago it was quite common to find a series chain of 0·3A valves (25Z4, 25L6 etc.), or a 0·2A chain (CY31, CL33 etc.), a 0·15A chain or even a 0·16A would you believe! Also a 0·1A chain which is the most likely line-up to be found in sets of more recent origin.

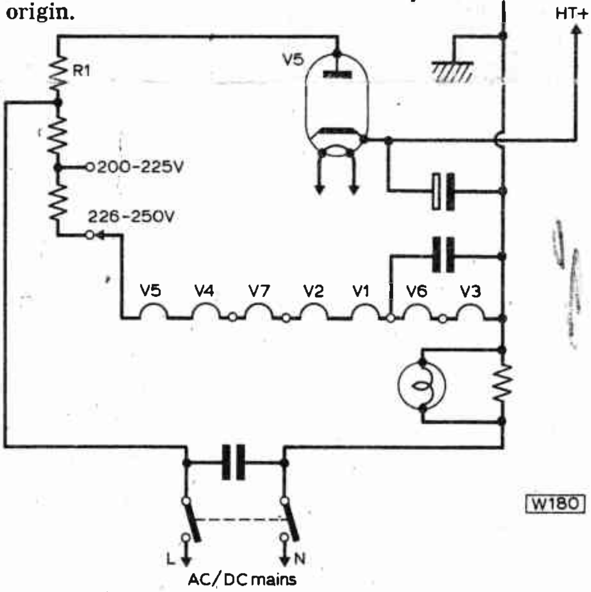

Fig. 1 In AC/DC receivers the heater chain and HT supply were generally of this type.

The number of valves used could vary but the minimum was usually four including the rectifier, this line-up being, for example, UCH81 frequency changer, UBF89 IF amp, detector and AGC, UCL82 audio amplifier and output, and a UY85 rectifier. A variation on this theme was a UCH81 as above with another UCH81 as an IF amplifier and audio amplifier with a UL84 output, using two crystal diodes for detection and AGC. The one advantage with this system was the possibility of changing over the two UCH81s if the one in the FC stage was reluctant to oscillate (which is something they often did, or didn't!).

The main disadvantage of series-heated valves is the fact that rectifier and output valves are well up the live mains end with only the dropper and perhaps the dial lamps (some designs) at a higher potential. This means that there is increased stress between the heater and the cathode of the valve with the consequent risk of breakdown, and induced hum in the case of the output valve. It comes as no surprise therefore to find the fault of "no valves glowing" is often due to the heater of the rectifier being open circuit. It is not that the heater just feels like failing, it is most often blown due to the failure of insulation, the high potential AC on the heater suddenly finding itself provided with a short cut via the main electrolytic capacitor and chassis. The rectifier heater is thus treated to an extremely gay life of somewhat short duration. If there are dial lamps in the way, these will probably fail also. A similar short in the output valve may or may not blow the heaters, only cause them (rectifier and output only) to glow brightly.

Common faults

Now let us consider a few of the more common complaints and their cures. One of the most common is hum. Tackling this in a set with series heated valves is a little different from a set with parallel heaters. In the latter case one tends to reach for an electrolytic capacitor of adequate voltage rating, usually 350V or more, and connect this across the HT line in one of two places, reservoir section to chassis or smoothing section to chassis, to see which section is at fault. The series heated chain does add the probability of heater-cathode leakage so that although the test electrolytic capacitor can still be tried, one is not surprised if there is no difference. The next step is to see if the hum continues with the volume turned down. If it does, it is reasonable to suspect that the output valve (probably a UL84 or UCL82) has heater-cathode leakage or is drawing grid current, the net result being the same. So change the valve.

If the receiver uses a printed panel, there is the added possibility of leakage across the surface of the panel or through it. The affected area will usually

—one common complaint is hum—

—set manufacturers often seem more concerned with appearances—

be blackened and a little cutting away of the plastic, perhaps combined with replacing the affected tracks with wire, may have to be resorted to. Set manufacturers seem often more concerned with appearance than efficiency and mount resistors close up to the panel with the leads cut short. Replacements should be made with longer leads so that the resistors stand well up off the panel, however ugly this may appear. Resistors, like politicians, should be open and above board!

Do not omit to check the grid resistor of the output valve which sometimes goes high particularly if the valve has been drawing grid current. A grid leak resistor of say 1MΩ or 470kΩ can often rise to many megohms leaving the grid floating and humming away to itself. Quite often the hum varies with the volume control setting and this means we have to look back to the preceding stages. Usually either the IF amplifier, say UF89, or the frequency changer (UCH81) is at fault and the latter, being more expensive of course, is usually the culprit!

No results

One of the most common complaints is that the valves light up but there is precious little other activity. The usual reason is that the smoothing resistor has failed but one must not assume this. The output transformer could have an open circuit primary or there may be no supply to the rectifier due to an open circuit surge resistor (R1 in Fig. 1), perhaps little Johnny has moved or unscrewed the internal loudspeaker muting devices on the external speaker panel (you did it, but blame Johnny anyway).

So we must proceed logically. If there is a fine upstanding dropper it is no trouble to check all sections with a neon when the set is on or an ohmmeter when the set is off (if you're too lazy to switch the meter to the AC range and check the voltages on the dropper tags with the set on). Many sets did not use a single dropper however and the surge limiter may be a separate wirewound resistor mounted in a more inaccessible position. If the value cannot be read it can be assumed to be in the region of 100Ω. If a printed panel is used, the resistor may be intact but it could have parted company with its print beneath.

Assuming the rectifier is receiving its supply however, there should be HT on at least one of the main electrolytic capacitor tags. If there is a good voltage on one but not the other the smoothing resistor (or choke if it's an older set) could well be open circuit. The value of this will depend upon whether it has to pass the total HT current. Quite often, the output transformer primary is directly connected to the rectifier and therefore the anode current of the output valve does not pass through the smoothing resistor. In this case the value may be quite high, say about 3kΩ. If the voltages are ok at both the smoothing tags, check the voltage at the anode of the output valve. If output transformers have a bad habit it is that they go open circuit on the winding which feeds the anode! This means a new transformer. If an exact replacement is not to hand an alternative can be used, the important thing being that the correct impedance matching is maintained. Very generally speaking, a small battery output valve requires a high impedance, the normal type of valve encountered in mains operated sets a medium impedance, whilst a low impedance is only required for more high powered amplifier type valves (and output triodes if you can remember that far back).

—a hefty charge which can tickle you pink—

Don't forget that if there is no discharge path through the HT line, the reservoir capacitor can be left with a hefty charge which can tickle you pink if you let it! The capacity is not that used in TV receivers (about 100 to 300μF) which can really cause a spark but even a 32μF on a 300V line can pack a punch which is not to be sneezed at!

The Thorn group made a large number of models with the "U" series of valves on a printed panel where not only the smoothing resistor had a habit of becoming O/C but also parted company with its print, as did the surge resistor to the UY85 anode. These were fairly small wirewound resistors and serve as an illustration of what we have been going on about in the above text.

The audio amplifier

Having checked the HT supply and output stage, and ensured the latter is operating under the correct conditions, with the cathode bias components in order (resistor the right value and the capacitor doing its job) check the output grid to ensure there is no positive reading. If there is such a reading, the valve could be drawing grid current, highly likely, or the coupling capacitor from the audio amplifier anode could be leaking, less likely but still a strong possibility. We then turn to the preceding stage which is normally either a separate triode section in the output valve or the triode section in a valve like a UABC80 (three diodes and a triode in one envelope). The only component likely to require attention is the anode load resistor which is normally about 220kΩ. This does tend to "go high" producing loss of volume and a peculiar form of distortion (stressing the sibilants, you could say). This is no trouble as the voltage at the anode will be very low and this itself suggests the resistor is the primary subject.

A low voltage need not be due to the resistor and if this proves to be of correct value, attention should be directed to the control grid. This is normally biased by a high value resistor of up to 10MΩ. If the coupling capacitor (the charge on this determines the bias with the resistor) is leaky, the bias is cancelled and the valve draws too much current. The voltage drop across the anode load is therefore excessive and is responsible for the condition. Some receivers do use cathode bias, and where this is so the cathode capacitor could be shorted, or the grid coupler could still be leaky, but most receivers have the cathode directly coupled to chassis as this simplifies the design.

Most sets have the volume control feeding the control grid and if the coupling capacitor is leaky the position of the control will vary the distortion to an extent. Which of course brings us to the vexed subject of noisy controls. Usually a squirt of cleaning fluid into a convenient gap in the housing will bring the control to heel but it is sometimes difficult to find or make a gap. The construction of the control either makes this operation very easy or very difficult and it is sometimes necessary to partially strip it or replace it completely. The control itself is not always responsible however and associated capacitors should be checked for leakage as control tracks do not take kindly to the passage of DC current. This is particularly so in the case of some makes of unit audios and radiograms of more recent origin but since these are transistorised this thorny subject will not be pursued further.

The IF stage

The detector and AGC circuitry in valved receivers very rarely gives trouble so we may be forgiven for nipping smartly past these and delving into the IF stage. Once again this can be quite simple, with the cathode chassis connected and the control grid biased from the AGC line. Note that valves are always reversed biased, i.e. the control voltage pushing the valve toward cut-off and is therefore negative-going. The HT supply to the anode and screen is via a decoupling resistor of some 1kΩ with a capacitor to chassis of from 0·047 to 0·1μF. This decoupling point can be the screen pin of the valve base with a short lead to the IF transformer primary, or to the latter point with a short connection to the screen pin.

Separate supplies are often used so that the screen grid of the IF amplifier can be connected to the same electrode on the frequency changer base and two resistors are often used as a potentiometer to hold the screens steady, typical values being say 22kΩ from HT to the valve base with a 47kΩ to chassis. As the majority of the current passes through the upper resistor, 22kΩ, this is often the one to change value and thus drop the applied voltage. This is sometimes the cause of the complaint, "My radio has been getting weaker and weaker and now you can hardly hear it".

Instability is another common disorder and this can vary from whistles and screeches to non-operation due to the paralysing effect of the AGC being overloaded by the instability. This can be a trifle tedious to overcome and the normal remedies are not always effective. The usual first step is to try bridging the decoupling capacitors with a test 0·05μF or similar. Bridging from screen to chassis may stop all complaints right away and you then go on your way rejoicing. But more extensive checking around may have to be resorted to, bridging other capacitors associated with the IF and frequency changer stages, the AGC line and the HT line. If none of these efforts produce results, check the alignment of the IF transformers, the valves, earth contacts (especially if these are riveted) and the main electrolytics.

Frequency changer stage

For AM reception this is usually a conventional triode heptode such as a UCH81. The complaint of no normal reception with, perhaps, some background mush is often the result of the valve becoming defective and refusing to oscillate (triode section). When it is oscillating there should be a negative voltage on the triode grid. If this is absent a new valve will usually put things right. If it doesn't, a general check up on the capacitors and resistors, comparatively few in number, associated with the section will usually restore signals. A defective coil is sometimes difficult to locate if it is suffering from shorted turns but with a bit of luck the trouble may be the result of a badly soldered lead-out or even an open circuited lead-out which can be repaired.

The mixer section is similarly wired to the IF amplifier and the same remarks apply regarding resistors changing value, leaky decoupling capacitors and the like. It varies in the arrangement of the control grid which is blocked from the aerial coils as a rule with a fairly low value capacitor, say 100pF, and with a fairly high value resistor connecting to the AGC line.

The aerial circuit may consist of a ferrite rod on which is mounted the tuning coils with leads to the tuning gang, the wavechange switch and chassis, but there are infinite variations on this theme. If there is no ferrite rod (the design is older) there is usually a cluster of coils around the wavechange switch and an open circuit on one may result in the others being put out of action. They are probably slug tuned for padding with separate trimmers for lining up the high frequency end of the scale. Where ferrite rods are fitted the actual rod is the slug and the position of the coils on the rod is varied for padding on the low frequency end of the scale.

VHF-FM

Receivers with these facilities have a separate section due to the higher frequencies involved. The aerial input can conveniently be a half-wave dipole made simply by opening up a piece of twin flex to the required length and stapling this in the cabinet. This is all very well in some areas but if serious listening is demanded a more elaborate system is needed with the correctly matched down lead, 75Ω coaxial on most UK stuff, 300Ω balanced twin on imported, as a rule. We will not go into the pros and cons of these different inputs here as they are pretty well known and have been discussed at length in previous issues.

The aerial input is taken to the tuning coils and thence to the first section of a double triode, as a rule, say a UCC85. The second half functions as an oscillator. Nine times out of ten replacement of this valve will restore normal signals if these fail suddenly, the tenth time being the result of defective resistors or capacitors. The actual tuning may be carried out by separate sections on the gang capacitor or by varying the position of the slugs in the aerial and oscillator coils. The output of this usually small section is fed to the IF stages, there may be more than one, through separate transformers to a ratio detector. The two diodes involved in this latter operation may be in a valve envelope (as in the UABC80 for example) or separate germanium or silicon diodes if the valve line-up does not include such a valve.

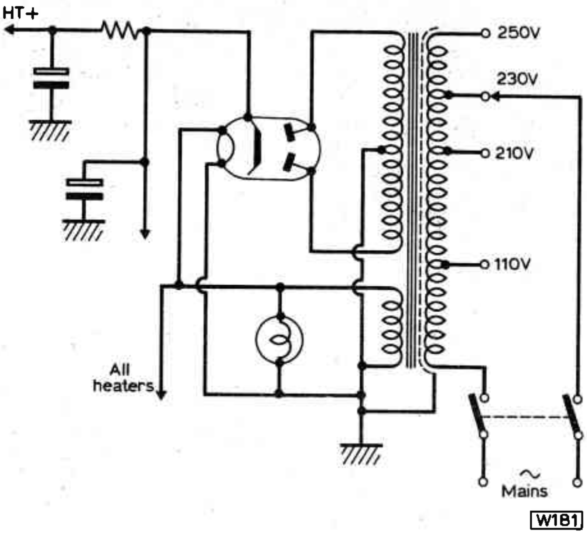

Fig. 2. AC-only sets have the conventional mains transformer with the valve heaters in parallel.

AC-only sets

The advantage of using a mains transformer is that the valve heaters can be wired in parallel (all at the same low potential) so that the stress between the cathode and heater is largely removed, and that the chassis can be isolated from the mains. Note we said, "can be." Some receivers sacrifice this advantage on the grounds of economy. Some transformer supplied sets use a series chain of heaters but this is all a matter of design considerations.

Some pretty weird and wonderful sets were imported some years ago using difficult valves which did tax one's resources but this is a story of its own which we may relate on another occasion. The average type of AC mains set which is likely to be encountered and which is probably worth renovating will have a transformer supplying a full wave rectifier and valves having 6·3V heaters (possibly 5V for the rectifier heater). The rectifier may have between 250 and 350V applied to its anodes from a centre tapped winding, the centre tap being chassis connected. The output of the rectifier is taken to the reservoir capacitor which may have a value of between 8 and 32μF. The circuit is then much the same as that previously described, using a smoothing resistor, a choke or part of the output transformer before the smoothing capacitor. The rectifier valve may be directly heated (cathode is the heater) which has a very fast warm up or indirectly heated (separate cathode) which warms up and becomes operative with the other valves. The latter imposes less stress on the capacitors, Fig.2.

—old timers which really need tracking down—

If a rectifier valve is difficult to obtain and it is decided to wire a couple of silicon diodes across the base, this stress must be recognised as the switch-on surge may be greater than the rating of the capacitors, To avoid this the inclusion of a thermistor between the rectifier output and the reservoir capacitor will add to the long term reliability of the receiver.

Valves such as the EZ80 and EZ81 are still generally available and should be used whenever possible. Older types such as the EZ40 and the like need a bit more finding but it is the old timers like the 5Z4 and 5Y3 which really need tracking down and it is here that the diodes may have to be used.

Little need be said about the other stages. They follow the lines already discussed but one is more likely to find different output stages in higher priced radiograms etc. For example, a cheaper type may use a single EL84 (or ECL86, for example) for each channel if the instrument is stereo whilst higher quality grams which are more likely to be worth saving may have four such valves, two in push-pull for each channel. The complication arises not only in the output transformers but in the drive from the audio stage to the output pair. An output transformer primary may have five lead outs, HT to the centre tap, a tap for each screen (this provides a degree of feedback) and the outer taps for the anodes.

Valves in push-pull need differing grid drives so that some form of phase splitter is necessary. A common method is to use a triode suspended midway between the HT line and chassis with one output valve driven from the anode and the other from the cathode (when the anode is positive going, the cathode is negative thus providing the "I push, you pull" requirement). This in turn means that the grid of the triode is returned to cathode at a fairly high potential. There are so many variations on this theme that detailed description is impractical, at least in this article, so that one should not be surprised if the voltages in the driver stages appear abnormal. Stereo does at least supply us with a ready made comparison circuit so that if one side is working well we know what to expect in the side which isn't. Get the voltages right and most else falls in line. Where they are wrong, check the resistors for correct value and the capacitors for leakage. Then suspect the valves.