TELEVISION SERVICING MANUAL

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EDWIN N. BRADLEY

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by

EDWIN N. BRADLEY, A.I.P.R.E.

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PREFACE

The *Television Servicing Manual* has been written in the hope that it will supplement the existing literature on the subject of televisor service work. At the present time there would appear to be no "popular" book on the subject, and so it is the hope of the author and publishers that this Manual will fill a need of the service engineer and experimenter.

It must, of course, be stressed that the inexperienced radio constructor or the beginner in radio should not attempt to repair a faulty televisor. A single mistaken move could cause very serious damage, whilst a working television set, with the E.H.T. circuits exposed, must always be regarded as a lethal machine, capable of killing. Nevertheless, the experienced man can, at least, cure many smaller troubles, but it must always be borne in mind that the guarantee given with a receiver is made void if work is done on the set by any other than an engineer recognised by the manufacturers as capable of performing, and licensed for, the work.

The author and publishers wish to express their very grateful thanks to those British manufacturers whose televisor circuits are shown in this Manual, and who have given such kind and generous assistance in providing servicing data, mechanical details, circuits and general information on their receivers which may all be classed as the foremost types in the field. These receiver circuits and allied information are, in each case, the sole copyright of the manufacturer concerned, and embody patent rights. The circuits and details shown in this Manual are, therefore, for information only, and may not be used for any commercial or constructional purpose.

Manufacturers who have so kindly assisted with material in the preparation of the *Television Servicing Manual* are:—

THE GENERAL ELECTRIC CO., LTD.

INVICTA RADIO, LTD.

KOLSTER-BRANDES, LTD.

MURPHY RADIO, LTD.

PYE, LTD.

THE RADIO GRAMOPHONE DEVELOPMENT CO., LTD.

ULTRA ELECTRIC, LTD.

CHAPTER 1

The Television Receiver in Outline

TELEVISION receiver servicing differs practically at all points from the repair and maintenance of ordinary broadcast receivers. The televisor operates on a very high frequency, the vision channel being tuned (for the London transmissions) to 45 mcs. and the sound channel to 41.5 mcs. and this, apart from any other consideration, means that the receiver has several more valves and stages than an ordinary set for the reason that each stage, at the high frequencies involved, has a relatively low gain.

The receiver proper, therefore, is large and, as will be seen, often complicated, but in the televisor the receiving section—that is, the section comprising R.F. Amplifiers, Frequency Changer, I.F. Amplifiers and Detector, in a superhet, or R.F. Amplifiers and Detector in a T.R.F. circuit, followed in each case by an " Output Stage " for vision, known as a Video Amplifier—is only a part of the whole. There are, in addition, the Power Pack, delivering normal heater and H.T. currents for the receiver as well as the Extra High Tension —E.H.T.—for the cathode ray tube, the two Timebases and the Synchronising Circuits which build up the regular tracery of lines, known as the Raster, on the face of tube, and on which the picture appears, and the Sound Receiver which, though often linked to the Vision Receiver, must be regarded as a separate section.

The operation of the televisor in receiving and reproducing a television picture may be summarised as follows:—

British television transmissions are carried out by amplitude modulated waves. The studio cameras are, broadly speaking, photo-electric devices which give an electrical output depending on the amount of light in the portion of the scene which is being scanned. Scanning is the ordered exploration of a picture—the scene is split up into 405 horizontal lines with 25 complete pictures per second, but to avoid flicker each complete picture is transmitted in two halves, the lines being interlaced. Thus, the first half-picture consists of lines numbers 1, 3, 5, 7, etc., whilst the second half of each picture consists of lines numbers 2, 4, 6, 8, etc. As a complete picture contains 405 lines, the first and last lines are obviously half-lines

The horizontal or Line Timebase thus operates at a speed of 10,125 scans per second, and the vertical or Frame Timebase at a speed of 50 scans per second. The two timebases working together cover the screen of the televisor with the raster of 405 lines every 25th of a second in two half-rasters, each of which takes a 50th of a second to complete. For correct reception the two half-rasters must interlace perfectly, so that the lines fall into their true places, and not one set beside, or over, the other set.

This scanning proceeds both at the transmitter and receiver, and the scanning operation at the receiver must be in exact step, or synchronisation, with that at the transmitter.

The synchronisation is assured by the transmission of sync. signals. A normal modulation pattern on a vision signal may be shown as in Fig. 1. Full or 100% modulation corresponds to the white or brightest parts of the picture, whilst a modulation depth of 30% corresponds to the black or darkest parts of the picture. When the transmission amplitude falls to below 30%, the modulation is then in a part of the band known as "blacker than black." At the beginning of each line the carrier is suppressed by automatic means at the transmitter to zero amplitude for 10% of the line time, the picture modulation being suppressed, before this drop, to the black or 30% modulation level for 0.5% of the line time to prepare the modulating and synchronising circuits for the final drop to zero amplitude. At the end of the drop or pulse the transmission level returns to the black or reference level of 30% for 5% of the line time before the signal modulation recommences, so that in each complete line 15.5% of the line time is taken up by the synchronising pulse and its preparatory and concluding steps of 30% transmission depth, whilst 85.5% of the line is actually concerned with picture transmission proper.

Each line sync. pulse operates circuits within the receiver which ensure that the line timebase "fires" or starts its next scan at the correct instant to agree with the commencement of the new scan at the transmitter.

At the end of each half-picture or frame, the picture content is suppressed for 14 lines whilst 8 pulses, each pulse occupying 40% of the line time, are sent out. These pulses pull the frame timebase into synchronisation through further synchronising circuits. After the 8 pulses the carrier returns to its 30% level for the rest of the suppressed lines, with a drop to zero amplitude at the beginning of each line to keep the line timebase in synchronisation.

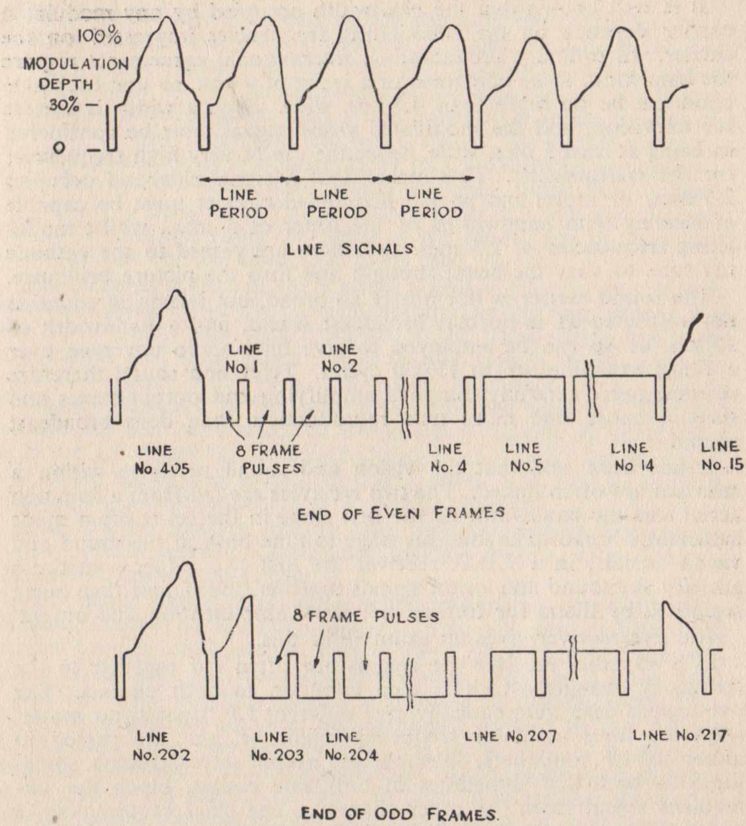


FIG. 1.—The Television Signal

The picture content on each line causes the electron beam of the cathode ray tube to vary in strength in accordance with the amount of light in the scene, so that when the modulation of the carrier is high the beam is strong and causes a brilliant fluorescence on the screen of the tube. When the carrier level falls to 30% the tube should be biased so that very little light, if any, appears on the screen.

It is well known that the bandwidth occupied by any modulated carrier depends on the modulating frequencies impressed on the carrier. In ordinary broadcasting, international agreements require the bandwidth to be contained in a space of 9 kcs., so that each side band can be no more than 4.5 kcs. wide. Such a width is useless for television, and the modulated vision signal must be considered as being at least 5 mcs. wide, hence the use of very high frequencies for the transmission. This means that a signal sideband occupies 2.5 mcs. or more, and so the first tuned circuits must be capable of dealing with bandwidths of the order of 5 mcs., whilst modulating frequencies of 2.5 mcs. and more are passed to the cathode ray tube to vary the beam strength and thus the picture brilliance.

The sound carrier is not nearly so broad, but television sound is not restricted as is normal broadcast sound, and a bandwidth of 30 kcs. or so can be employed to give final audio coverage over a range extending up to 15,000 cycles. Television sound therefore requires more carefully designed amplifying and output stages and gives a better and more true reproduction than does broadcast sound.

It has been said that the vision and sound receivers within a televisor are often linked. The two receivers are fed from a common aerial and the bandwidth of the first stage in the set is often made sufficiently broad to enable this stage to tune both to the sound and vision signals; in a T.R.F. receiver the first two stages sometimes amplify the sound and vision signals together, the signals then being separated by filters for further individual amplification and output

The Pye receiver gives an example of this.

In a superhet receiver the signals are often fed together to the frequency changer which is then common to both circuits. The two signals then automatically give different I.F. signals, no matter what the local oscillator frequency might be, and are passed to individual I.F. amplifiers, detectors and output stages. Filters, sometimes in both and sometimes in only one circuit, block the unrequired signal from the other channel. The chief requirement is to block the sound signal from the broadly-tuned vision receiver.

Not all televisors have the vision and sound channels or receivers linked at the input end with a stage or stages common to each, although this is the most usual arrangement. In some receivers the sound and vision sections are fed through filters from the aerial so that each section can be considered as an entirely separate unit, and it must be remembered that in such a case the filter is actually a matching arrangement and that a length of co-axial cable may be the means of coupling each receiver section to the dipole aerial.

Changing the length of the cable would then upset the whole alignment of the set.

As a general rule it is never safe to run a televisor from any aerial other than a properly cut dipole. The input circuits of the television set are adjusted so that they are correctly loaded and tuned by the dipole and a proper feeder which matches to the dipole's characteristic impedance, and if an attempt is made to run the receiver on any other type of aerial, results are almost certain to be very poor, whilst it is quite likely that interference response will rise sharply. In some cases, when an aerial other than a dipole is used, it is possible to receive only one of the two signals when the set is trimmed, either the vision or the sound, and to make both come in together the dipole has to be used.

The general outline of the modern televisor may be set out as in the block diagram of Fig. 2, remembering, as has been shown, that the input circuit may vary from set to set. The dipole feeds into a common R.F. stage which passes the two signals to another common R.F. stage, in the case of a T.R.F. receiver, or to a common frequency changer in the case of a superhet receiver. The two signals are then separated, the sound signal passing on for further R.F. or I.F. amplification, demodulation and audio amplification, the vision signal also passing through further R.F. or I.F. amplifying stages, a demodulator and a video amplifier.

One or both receiver sections may be fitted with an interference limiter which prevents interference (chiefly ignition) from marring the picture and sound output.

The vision signal, after video amplification, has the D.C. component restored by the D.C. restorer diode or metal rectifier, and is then used to modulate the grid of the C.R. tube, when the feed is not direct from the video amplifier anode. The use of direct feed from the video amplifier makes it possible to dispense with D.C. restoration, and the signal is then generally applied to the cathode of the C.R. tube, the grid of the tube being held at a constant negative potential. The modulation may, of course, be applied either to the grid or the cathode of the C.R. tube; in either case the modulation opposes the bias on the tube and a signal of high amplitude will cause the electron beam to give a brilliant trace on the screen whilst a low amplitude signal will give a faint trace or no trace at all.

D.C. restoration is necessary when the tube is fed from the video amplifier via a capacitor. A capacitive coupling can pass rapid changes of signal amplitude but does not respond to a general slow change in overall signal level. Such a change in signal level corresponds to the general brilliance of a scene, and so if this is neglected the final picture appears to lack modelling and has a uniform character. In D.C. restoration a diode or similar device provides what may be termed a reference level against which the signal

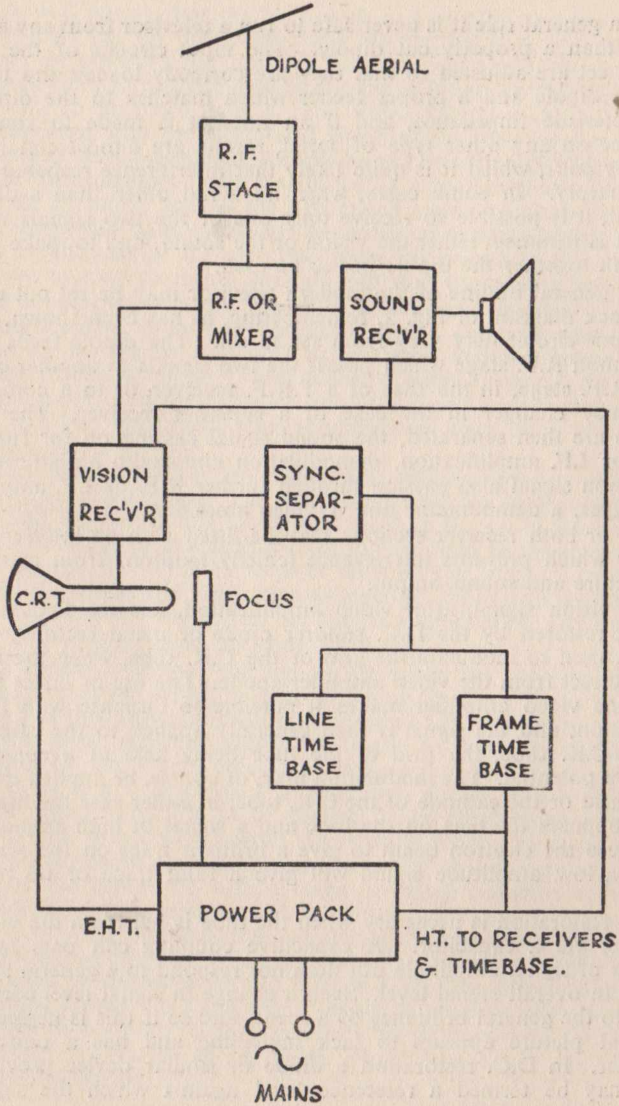


FIG. 2.—The Television Receiver in Block Form

through the capacitive coupling can be compared. The bottom of the sync. pulses, or zero signal amplitude, provide the level against which the overall signal amplitude can be balanced and so corrected automatically.

The video amplifier, besides supplying the vision signal to the C.R. tube, also supplies the signal to a sync. separator. (The sync. separator can appear before the video amplifier, but usually is fed from the anode of this valve.)

The sync. separator, as the name implies, suppresses the video content of the signal and passes only the sync. pulses which appear in an amplified form across the sync. separator anode or load circuit. These pulses are then fed (through some form of filter circuit which depends on the design of the receiver) to the timebases, the line sync. pulses triggering the line timebase and the frame pulses triggering the frame timebase.

The power pack in the modern receiver is usually combined—that is, the one power pack supplies both the receiver normal H.T. and the E.H.T. for the tube, together with all the heater currents required.

Two valves are generally employed, one a full wave rectifier for the receiver H.T. requirements and one a high-voltage half-wave rectifier.

It can be seen, therefore, that the first step in servicing a faulty televisor is to determine that section of the whole receiver in which the fault lies, and the multiplicity of the circuits makes this no light matter. A great deal can be deduced from the appearance of the picture—unless the picture fails to appear at all—though some experience is needed before a fault and its effect on the picture can be connected with certainty, but ordinary test methods, especially when used in conjunction with the service literature issued by the manufacturers of the television receiver under repair, and with the lists of test voltages published in such literature, should enable the practised worker to isolate and remedy faults without too much trouble.

When dealing with faults in an ordinary broadcast receiver, the work can be approached in one of two general ways—if the fault is obvious it can be tackled direct, the rest of the receiver being ignored save for a final check, whilst if the fault is not obvious then a systematic test of the receiver is necessary in order that haphazard working and the waste of time shall be avoided. Depending on the test gear the fault may be traced from the aerial end of the receiver forward to the power pack, or from the power pack back towards the aerial terminal, but in either case the tests are made systematically.

The same system must be used with a faulty televisor, and so the rest of this Manual sectionalises the televisor, describing probable and possible faults in each section, commencing with those parts of the receiver most likely to give trouble.

Before dealing with faults, however, the following chapter on the mechanical handling of a television receiver should be read and noted.

CHAPTER 2

Handling the Televisor

PURELY mechanical adjustments, as well as electrical adjustments, are necessary when televisors are installed and repaired, whilst service work often calls for the dismantling of the C.R. tube or the removal of a chassis from the cabinet. In a television receiver more than in any other type of set such dismantling must be done with the absolute maximum of care and attention.

The C.R. tube is a large evacuated vessel; pressure inside is very low, whilst the glass bulb and neck are supporting normal air pressure on their surfaces. A knock or blow may cause a C.R. tube to " implode "—a word coined to give the impression of an inwards collapse. Unfortunately, the term also conveys the impression that an " implosion " is a fairly docile falling-in, but an imploding tube is very dangerous, since glass and the metal electrodes can scatter just as badly as if the tube exploded from pressure within.

The following points must, therefore, be observed whenever a C.R. tube is dismantled from a televisor:—

ALWAYS discharge E.H.T. capacitors. See next chapter.

ALWAYS handle the tube with the greatest care.

ALWAYS avoid knocking or tapping the tube.

ALWAYS have a padded carton into which the tube can be placed immediately it is removed from the set.

ALWAYS remove the tube from its rubber mask gently.

ALWAYS WEAR GOGGLES WHICH ENCLOSE THE EYES WHILST REMOVING AND REPLACING THE TUBE.

The C.R. Tubes in all modern commercial television receivers are of magnetic deflection and focusing type. The tube electrodes consist of a heater-cathode system, a grid and one or two anodes, the last anode often having its connection brought out through a side cap on the tube. The electron beam is therefore focused by either a permanent magnet system or a ring electro-magnet, in the form of a coil round the tube neck, whilst the deflector coils are wound on formers and a yoke and also placed round the neck of the tube.

The pin or base end of the tube, the focusing coil or magnet and the deflector coils are all secured to a stirrup or mounting. The focusing system is found nearest the base of the tube and the deflector coils nearest the bulb end of the tube neck. Both focusing and deflector systems are mounted so that they may be centred or otherwise adjusted, the yokes and frames of the various coils having slotted holes or being on spring retained fastenings so that they may be moved to the required degree and then clamped in place.

Adjustments to the focusing and deflection unit must always be made with a raster on the screen, and the focus must never be adjusted on a stationary spot. Apart from giving an incorrect focus, a stationary spot, unless the brilliance is turned right down to make the spot barely visible, will cause a " burn " or an insensitive patch on the tube screen.

The focusing and deflection adjustments are, to a degree, interdependent. When a new C.R. tube is fitted to a receiver the manufacturers' instructions should always be carried out, the sequence being somewhat as follows:—

Switch off, and remove the mains plug.

To remove the tube, remove such top chassis components as may be around the tube.

Carefully remove the anode cap connectors and the base socket.

Don goggles and slacken off the screws or bolts which retain the deflector and focusing assembly to the chassis, so that the whole arrangement, on its supporting arm or stirrup, may be drawn from the neck of the tube.

Unhook the springs or straps which hold the tube in its rubber mask, taking care not to allow any spring or sprung webbing to slip and fly back, thus striking the tube.

Withdraw the tube from the mask.

To fit the new tube, this procedure is, of course, reversed, and the televisor may then be switched on and allowed to warm up. The raster on the screen will almost certainly be out of focus and probably also out of place, either high or low or to one side.

The adjusting screws on the focusing and deflecting assembly should be made no more than finger tight, and the adjustments may then proceed.

If a tube is electrically focused, the focusing coil may need no adjustment, since there will be a focusing rheostat to control the current through the coil, but if the focusing is controlled by permanent magnets—as in the Kolster-Brandes CV40, for example—

then all focusing adjustments must obviously be made by the magnet placing bolts.

Adjustment procedure is somewhat as follows (it will be realised that definite instructions to cover every type of televisor cannot be given):—

Set the brilliance control to give slightly more than the normal picture brilliance.

Set the vertical and horizontal hold and the sync. controls to give a steady picture. The adjustments are best made, of course, on a test pattern transmission from the B.B.C. station, but a pattern generator may also be used.

Correct the height and width of the picture to the approximately normal position.

Focus, either by moving the magnets or setting the coil current.

Correct any picture tilt or lack of centring by the deflector assembly adjusting bolts.

Re-correct the width and height of the picture. Manufacturers' instructions should be followed here, as in various sets various effects can be observed if too much scan amplitude is applied.

Re-focus.

Fit the picture exactly to the tube mask. There will probably be found an adjustment which allows the neck of the tube to be moved for this adjustment, besides the adjustments on the deflector coil assembly.

Re-focus.

Set the timebases for proper locking on the sync. signals in accordance with the manufacturers' instructions.

Make any final adjustment for picture centring by the fine adjustment screws sometimes fitted.

Whilst adjustments are being made to the assemblies round the neck of the tube the goggles should still be worn. The adjusting screws should be made no more than finger tight until the picture is exactly correct, when they may finally be tightened up, but in some cases the focusing magnet settings have to be adjusted with a spanner. If this should slip and rap the tube neck there would be a chance of breaking the tube with consequent danger to the eyes.

When the main or top chassis retaining the C.R. tube is to be removed from the receiver, the tube should, in some sets, be removed first before the chassis is taken out, but other chassis—in a console receiver—may be withdrawn without touching the tube. In each case it must be ascertained that the set is switched off and the mains plug is clear of the power socket before the receiver is touched.

All plugs should then be removed from their sockets on the chassis edges—in almost every commercial receiver it will be found that the set is built up in unit form, the units being connected by multi-way plugs and sockets—and the chassis retaining bolts or screws can then be removed and the unit concerned taken out.

Some care should be taken to see that a steel chassis or any steel-cased component or assembly on a chassis is not placed near to a permanent magnet when the chassis is out of the cabinet and on the work bench. A steel member placed accidentally beside a loud-speaker magnet might become magnetised and so exert an influence on the C.R. tube beam when the magnetised component or chassis is replaced in the televisor, so that the deflecting coils would then require quite a large amount of adjustment to correct the resulting picture displacement. In its turn this might lead to picture distortion.

A rear view of a typical television receiver, the R.G.D. 254TR, is shown in Fig. 3, by kind permission of the Radio Gramophone Development Co. Ltd. The use of unit construction is well illustrated, and it will be seen that the C.R. tube, with its focusing and deflecting coils, is mounted in a separate cradle, permitting any chassis to be removed without interfering with the tube. This set contains a small radio unit with a programme selector giving reception of the Light, London Home and Third programmes, this unit being mounted in the top of the cabinet beside the tube. The vision and sound receivers share a chassis, a third chassis contains the timebases and the power pack is mounted, with the loudspeaker, on the cabinet floor.

The handling of the C.R. tube and the precautions necessary whilst doing so, with the adjustment details for focusing and deflection coils, constitute the chief mechanical notes on television receivers, but mention of the valves on the receiving and timebase chassis may also be made.

Midget glass-based valves are rapidly coming into greater use in television sets, whilst normal sized glass-based valves, such as those in the EF50 range, are by now very well known. Care must always be taken when handling glass-based valves to avoid strain and twisting when the valves are being withdrawn from their holders; the valves are extremely robust, but unequal strains and wrong handling can cause breakages. Valve retaining clips are sometimes used, and retaining rings round the EF50 type of valve are not always obvious if a valve is being withdrawn from its socket with the chassis in position and, possibly, in a poor light. Midget glass-based valves fitting B7G holders have contact legs which are slightly flexible in order that the valves may fit more easily into their sockets; care must therefore be taken to avoid bending the legs or pins.

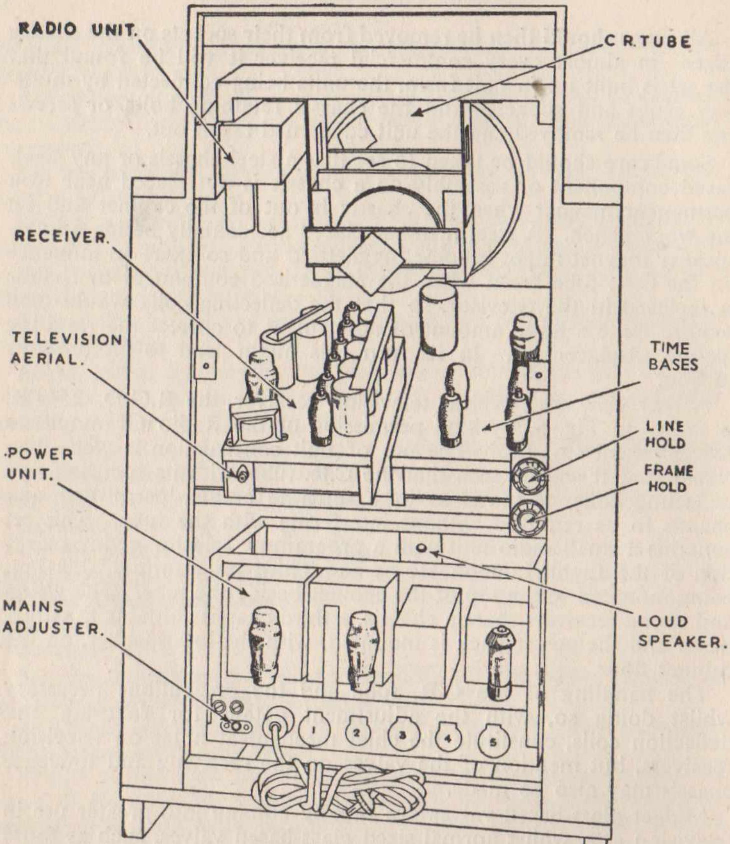


FIG. 3—Rear View of a typical Televisor

A watch should also be kept for fixed adjustments in a televisor, and such adjustments should not have the seals broken until the service literature on the set has been consulted. As an example, the I.F. filter on the Kolster-Brandes CV40 may be mentioned, L18 in the CV40 diagram. The filter is a parallel tuned rejector circuit, which prevents any I.F. from appearing at the grid of the video amplifier, and the iron dust core of the coil is set in the factory and then sealed. If this seal is broken and the core moved the circuit cannot be accurately re-tuned in the receiver.

CHAPTER 3

The Televisor Power Pack and C.R. Tube Network

Remember that the televisor power pack can kill

WHEN working on the power pack of a television receiver care must always be taken to see that the set is switched off, the mains plug is withdrawn so that there is no possibility of the set being switched on accidentally by another person, and that the reservoir capacitors are discharged.

The reservoir and smoothing capacitors of the normal H.T. line feeding the receivers and timebases are usually discharged rapidly through the receiver and timebase circuits, as are the capacitors of an ordinary broadcast receiver, the cathodes of the valves retaining heat and passing current even though the set is switched off, but the capacitor or capacitors across the E.H.T. circuit do not discharge to any great degree in this manner. The C.R. tube passes a very small current, of the order of microamperes, and so is a very poor discharge path, whilst though in all sets there is usually a resistive network or a system of bleeders across the E.H.T. supply the resistance used is very high indeed, and so this discharge path allows the accumulated charge on the E.H.T. capacitors to leak away only very slowly.

It must therefore become a habit for the service engineer to discharge the E.H.T. capacitors whenever he is about to work on the televisor, and it is recommended that this be done by a special tool made for the purpose, and not by a screwdriver or a similar tool picked up from the bench.

Some manufacturers state that a short-circuit can be made across the capacitors, but a tool such as that shown in Fig. 4 is easily made, discharges the capacitors efficiently, and prevents the high voltage spark and heavy surge caused by a direct short circuit.

As can be seen from the diagram, the discharger is merely a 5,000 ohms 1 watt resistor with a Hellerman sleeve slipped over it,

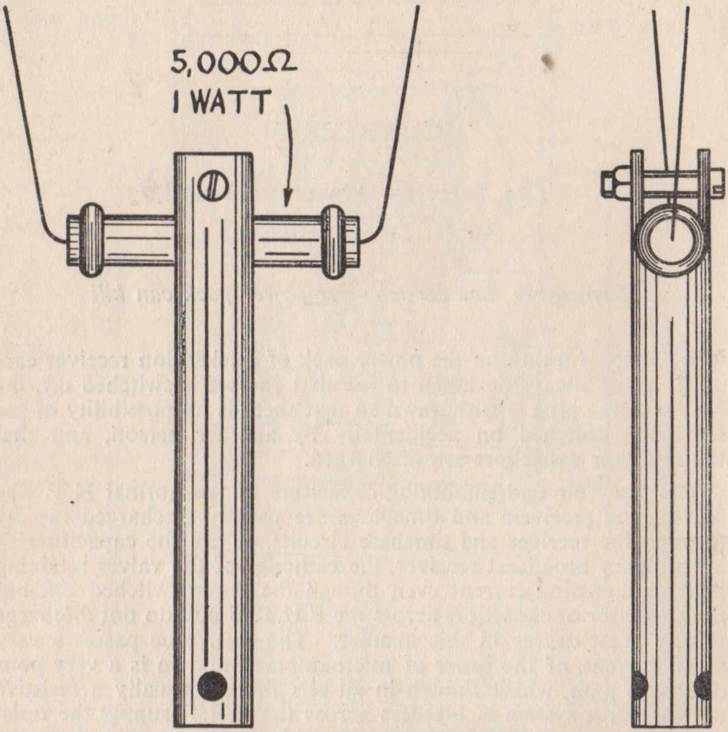


FIG. 4.—The E.H.T. Discharger

the resistor being clamped into a filed-out slot at the end of an ebonite rod which makes the discharger handle. Paxolin tube could also be used, or perspex strip could be softened in hot water and clamped round the resistor to form the insulating handle to the tool.

A hole at the hand end allows the discharger to be hung from its own hook over the test bench, so that it is always ready for use and can easily be seen without hunting for it.

Safety Points

Only when the voltage across the E.H.T. pack is to be measured should work proceed on the power pack with the set switched on and operating, and then every precaution must be taken to avoid contact with the E.H.T. positive line. Unless connections have to be changed over for any reason, the voltmeter should be connected into circuit before the set is switched on, the set then powered from the mains and the E.H.T. voltage read, the set switched off and the capacitors discharged before the voltmeter is touched again but this is not always possible. A good rule to make and observe is to work on the " live " E.H.T. pack, with only one hand, the other hand being kept resolutely in the pocket. It is still possible to get a shock, of course, but the current flow will not be through the body and round the heart, as is the case when a shock between the two hands is received.

The base socket and pins of the C.R. tube may be considered as reasonably safe in a modern televisor, the E.H.T. being taken to the side cap on the tube's bulb. The real point, however, is that modern circuits have the tube heater and cathode at earth potential, the anode being positive to earth by the E.H.T. voltage. Should an old set be received for servicing, however, the E.H.T. circuit should be inspected with great care, for it is possible that the positive side of the E.H.T. pack is earthed, the heater, cathode and associated circuits of the C.R. tube being below earth—that is, negative to earth—by several thousands of volts.

Familiarity with ordinary circuits causes the service engineer to handle cathode and heater wiring as though these were at earth potential. In an old-fashioned televisor, however, touching the cathode circuit and the chassis at the same time might result in a very bad shock.

It must also be remembered that some receivers employing a tetrode tube have the first anode at a potential of something like 400 volts or so positive to the chassis, and the contact to this electrode is usually brought out at the base of the valve.

E.H.T. Power Pack Faults

Apart from the faults associated with normal power packs, the E.H.T. portion of the television receiver power pack is open to a set of faults peculiar to high voltage apparatus. This is by no means due to the use of poor or under-rated components by the manufacturers; indeed, every effort is made to provide trouble-free circuits and the best of components are used. It must be remembered that high voltages not only find flaws, but create them. Dust can be charged and so attracted to the high voltage terminals of the E.H.T. pack with the possibility that a discharge path across wiring or component cases can be gradually laid down by dust, whilst dampness or condensed water vapour on the E.H.T. transformer can provide a leakage path which will eventually pass sufficient current to char the insulating surface and so make a carbon path.

In the event of no picture on the tube the high voltage winding can be an early suspect in the tracing of the trouble.

The present range of E.H.T. voltages may be taken as around 5,000 volts, but it is evident that new tubes which are on the point of coming into use will require voltages of the order of 8,000 volts, whilst projection receivers which may soon appear for the home—projection receivers are already in use in America—will require E.H.T. supplies of from 25 to 50,000 volts.

These latter supplies will not be obtained from mains transformers, but, in all probability, from R.F. oscillators, which induce high voltages in a winding between two further coupled coils working on a frequency somewhere between about 50 and 300 kcs.

Not all commercial televisors now obtainable use E.H.T. mains transformers. The line timebase, working at 10,125 scans per second, has a very high flyback voltage induced across the primary of the output transformer, and the Kolster-Brandes CV40 provides an example of a receiver in which this high voltage is further stepped up by winding the line scan output transformer primary as an auto-transformer to supply 6,000 volts to the miniature rectifier valve, whose heater also operates from another winding on the same transformer.

Where E.H.T. mains transformers are used they must be well insulated, since between either the E.H.T. winding and the E.H.T. rectifier heater winding, or between the E.H.T. winding and the core a very high potential difference is set up. A 4,000 volts transformer will give an output from the reservoir capacitor of approximately 5,500 volts, since the capacitor charges up to practically the peak voltage, which is 1.414 times the R.M.S. voltage. Half wave rectification is almost always used, and so on the non-conducting periods, when the rectifier anode is negative, the total potential difference across the system is made up of the 5,500 volts across the capacitor with a further 5,500 volts across the valve, making 11,000 volts, the Peak Inverse Voltage. In the basic circuits shown in Fig. 5 the two methods of connection can be seen: in the first the peak inverse voltage exists between the windings on the transformer and in the second it exists between the E.H.T. winding and the transformer core.

If a metal rectifier is used, the heater winding no longer being employed, the peak inverse voltage is reduced to the peak voltage of the system, 5,500 volts, between the E.H.T. winding and core of the transformer.

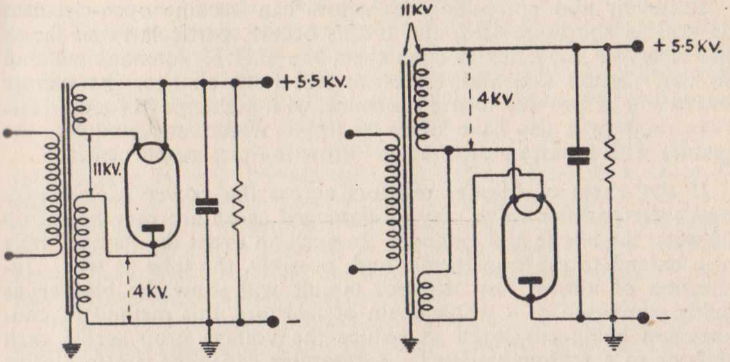


FIG. 5.—Half-wave Power Packs showing Peak Inverse Voltages

Regulation of the E.H.T. power pack must be better than is sometimes thought. The current is very small, and so the reservoir capacitor discharges only slowly, with the result that a low capacitance can be used. Normal values range from 0.005 mfd. to 0.1 mfd. It must be remembered, however, that the current through the C.R. tube, and thus the current drawn from the reservoir, is constantly varying at frequencies which can range from zero to 2.5 Mcs. and higher, and the deflection sensitivity of a C.R. tube depends on the final anode voltage.

Thus if the varying current drawn by the tube causes voltage fluctuations in the anode voltage, the picture will vary in size sufficiently rapidly to affect portions of the scene—a bright patch on the screen means a higher beam current, and so, in a poorly-regulated system, a decrease in anode voltage, which, in turn, means an increase in deflection sensitivity. The bright area would thus be enlarged and the side of the raster in line with the affected area would bulge outwards. Besides this undesirable effect the picture focus would vary.

The internal resistance of the E.H.T. power pack is the chief determining factor on the regulation of the pack, the capacitance of the reservoir being set to give a suitable time constant over the whole circuit, the time constant requiring to be considerably greater than the period of a single frame scan. Thus when reservoir capacitors, bleeder resistors and smoothing resistors are to be replaced care must be taken to replace them with the correct components, and new capacitors or resistors should be obtained from the manufacturer unless the required types are known and to hand.

Reservoir and smoothing capacitors can become open-circuited as well as short-circuited, and if this occurs, particularly so far as the reservoir capacitor is concerned, the E.H.T. potential will fall so that picture size and brilliance will both change, the picture increasing in size and losing brilliance, with a change in focus. The tube anode will also have 50 cycles ripple, which may modulate the picture with a bar, or distort and throw the picture off centre.

If the chain of bleeder resistors across the power pack breaks down the rectifier valve may be damaged as an arc may be set up between the anode and cathode. In such an event the damage may also extend to the transformer and, possibly, the tube as well. Inspection of almost any televisor circuit will show the bleeder as being composed of a whole chain of resistors, this method of construction being employed to reduce the voltage drop across each resistor to a reasonable level. A reservoir capacitor is also always used, but a smoothing resistor in the positive line of the E.H.T. pack, followed by a further high voltage smoothing capacitor, is not always employed.

In Fig. 6, for example, the circuit diagram of the Pye power pack, the E.H.T. positive supply is taken direct from a two-resistance

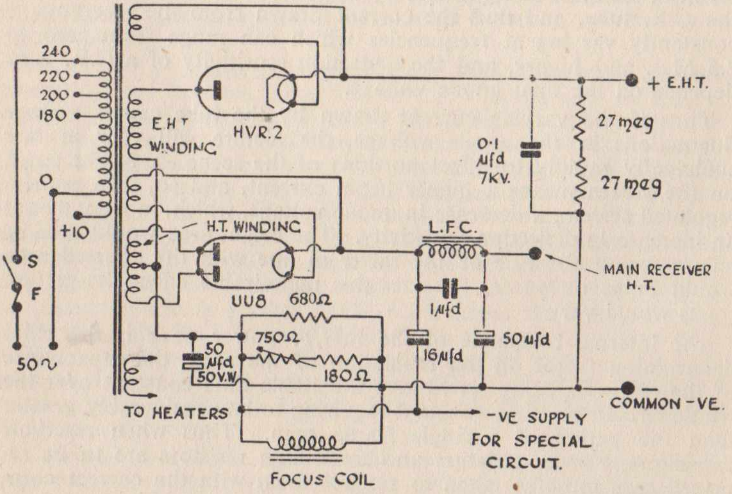


FIG. 6.—The Power Pack of the Pye Televisor

bleeder and an 0.1 mfd. reservoir capacitor with no further smoothing. The first anode of the tube used in the Pye receiver is supplied, along with the main timebase and receiver H.T. line, from the main receiver H.T. line, which is fed from a conventional full wave rectifier. The high value of the smoothing capacitance in this section of the power pack should be noted.

The Pye power pack also provides an excellent example of how the focusing current through the focus coil can be derived from the supply line to the main receiver and timebase circuits. The focus coil, shunted by a resistor network, including a variable resistance as a focus control, is inserted in the main negative line from the power pack to the receiver, the whole network being bypassed by a low voltage—high value capacitor.

Other receivers have a smoothing resistance in the E.H.T. line, whose value can range from 20,000 to 100,000 ohms, whilst other sets have a resistance between the cathode of the E.H.T. rectifier and reservoir capacitor.

Faults in the smoothing or series resistors can cause the picture to vanish from the screen, although there will still be full voltage across the reservoir capacitor if the voltmeter is connected at this point. Faults in the reservoir, or smoothing capacitors, in the E.H.T. pack can have serious consequences; the picture will vanish from the screen, but, presuming the capacitor completely breaks down, the E.H.T. components will probably be damaged.

If, through moisture or components failures, there are arc-overs across the bleeder resistors or within the reservoir or smoothing capacitors, the picture will either appear and vanish intermittently or change in size and brilliance, with focusing changes at the same time.

Poor joints or bad contacts with the E.H.T. pack can also give similar effects, whilst an added effect of bright spots on the picture can also be expected from these sources of trouble.

The method of checking the E.H.T. power pack for the faults mentioned, and for others which may arise, may be summarised as follows:—

Switch off the receiver and remove the mains plug.

Discharge the E.H.T. capacitor/s.

Check over the primary connections to the transformer, from the mains plug through the switch and fuses to the primary voltage regulator taps.

Overhaul the transformer and check the rectifier valve.

Should this be damaged in any way, check the output side of the circuit most carefully for faults and breakdowns before replacing the valve with a new one. If E.H.T. is low and there are no faults in the bleeder-smoother system, check the valve emission.

Check the capacitors and bleeder resistors.

Check the smoothing resistor if fitted and the E.H.T. wiring up to the tube anode.

Connect up a voltmeter to the E.H.T. system and switch on the receiver to check the E.H.T. volts. Check the voltage, both at the reservoir and at the tube anode.

Voltage measurements must, of course, be made with a really high-resistance voltmeter, for nothing like a true reading can be obtained if the E.H.T. voltage is measured with a low resistance meter. The power pack is designed to supply currents of, perhaps, 0.5 mA., and a meter reading 1mA., to give a full-scale deflection on the 5,000 volts range will certainly show a voltage much lower than that actually supplied to the tube. A good valve voltmeter with a high input impedance can be used, or a moving coil voltmeter with a sensitivity of the order of 10,000 ohms per volt can be made up from a 100μA. instrument with a chain of resistors to make up 100 megohms, when the full scale voltage will be 10,000 volts.

The series resistor must, of course, be sectionalised into, say, 10 resistors each of 10 megohms resistance, both for the same reason as the bleeder of the E.H.T. is sectionalised and also to make it possible to obtain the high resistance. The resistors require careful mounting and insulation, for if they were wired on to a tagboard of inferior material the shunt resistance of the insulation could be lower than the total of the components themselves.

If an electrostatic voltmeter can be obtained this is, perhaps, the ideal instrument for measuring E.H.T., as it draws practically no current at all on a D.C. circuit, apart from leakage.

Special E.H.T. Power Packs

R.F. and Flyback power packs have been mentioned, and the service engineer must be prepared to deal with the second type in modern receivers whilst the R.F. type of power pack will probably appear in some receivers in not too long a time.

The basic circuit of the flyback—E.H.T. power pack is shown in Fig. 7. The pentode is the amplifier-output stage of the line timebase, and so is operating at a frequency of 10,125 cycles per second, the anode potential varying as can be seen from oscillograms in the following chapter dealing with timebases. The sawtooth shape of the anode wave means that very high Back E.M.F.'s are set up across the primary of the transformer on the flyback of each scan stroke, although an even higher potential is needed for the C.R. tube anode. The potential set up may be considered as of the order of 2,000 volts; this potential appears across L1. If the diode rectifier were connected directly to the anode of the pentode valve an output of approximately 2,000 volts could be drawn, but about

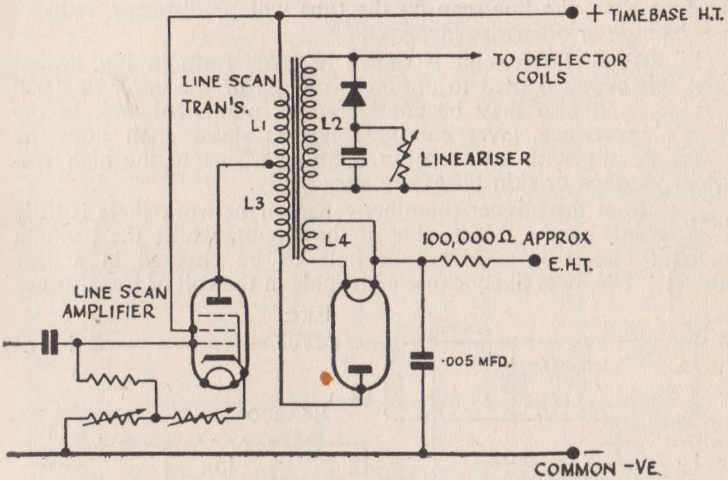


FIG. 7.—The Line Flyback E.H.T. Supply

5,000 volts are required. Thus L3 is wound on the transformer core to act as a step-up winding, whilst L4 is wound on to provide heater current for the rectifier.

The design of the system is complicated as connecting circuits and the additional windings to the original two-winding transformer changes the characteristics of the circuit and compensatory changes in design have to be made. As only one example of the unusual circuit arrangement it may be pointed out that the rectifier heater is supplied not with steady D.C. or sinoidal A.C., but is fed with pulses as is the reservoir capacitor; it is accordingly useless to measure the voltage across the rectifier heater, although a thermo-ammeter in series with the heater can be used to measure the current flowing.

One great advantage of this E.H.T. system is that the high voltage obtained is non-lethal. If the E.H.T. line is accidentally touched a quite bad shock and, possibly, a burn, can result, but the circuit is loaded up on contact and the voltage falls very sharply.

Faults in this type of E.H.T. circuit should be checked and repaired in the same way that faults in mains transformer E.H.T. circuits are cleared. A failure in the transformer supplying the high voltage pulses will, in general, be easily traced, since not only will all the signs of low anode potential on the tube be present, but, at the same time, the line scan on the tube will be distorted, reduced in amplitude or otherwise incorrect.

The R.F. E.H.T. circuit is shown in basic form in Fig. 8, and when this circuit is used to produce voltages of the order of 5,000 volts or so it also may be considered as non-lethal and, in the writer's experience, gives considerably less shock than does the flyback circuit, with no deep burns, though, due to the high frequency, surface or skin burns are very likely.

Apart from the bleeder-smoother-capacitor network there is little to go wrong on the E.H.T. side of the circuit, whilst the pentode oscillator circuit is sufficiently simple to be checked in a few minutes. The most likely cause of trouble in the coil or transformer

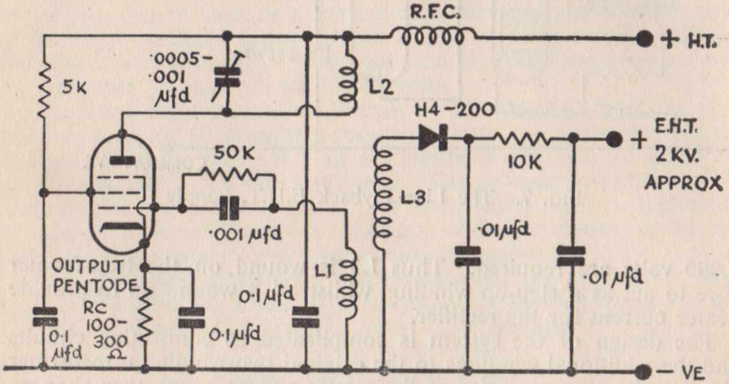


FIG. 8.—The R.F. Oscillator E.H.T. Supply

arrangement is the chance of corona discharge or tracking over the high voltage winding, which is wound in a series of pies or blocks. The high frequency used, 50 kcs. and upwards, makes corona discharges more likely, and dampness on the coils provides a discharge path. Nevertheless, experiment shows the circuit to have great possibilities, and it will probably be found in televisors of the not far distant future.

A totally new method of obtaining E.H.T. voltages from a 350-0-350 volt transformer has recently been patented and announced by the Westinghouse Brake & Signal Co. Ltd. in the "Westeht" unit.

The method of connecting the unit, and its internal arrangement of capacitors and half wave rectifiers, is shown in Fig. 9. The

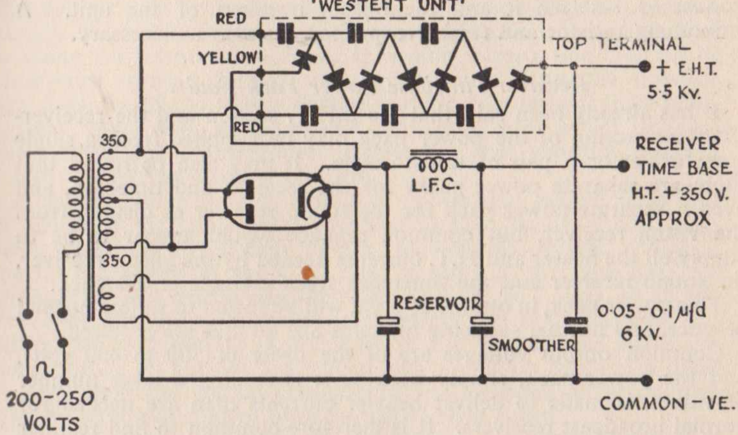


FIG. 9.—The Westinghouse "Westeht" E.H.T. Supply System

circuit is a development from the Cockroft multiplier, first used for the developing of extremely high voltages for atom-smashing.

There is not room here to discuss the complete theory of the unit—the reader is recommended to study the articles on "Television E.H.T. Supply," by A. H. B. Walker, B.Sc. (Hons.), A.M.I.E.E. in the April and May issues of *Wireless World* for 1948 and the manufacturer's literature on the "Westeht" unit—and it must suffice to say that within the unit the capacitors are successively charged to peak voltages, so building up a high output voltage. Regulation, as might be expected, is a little poorer than that of a conventional E.H.T. mains transformer—high voltage rectifier valve system, but is still perfectly adequate for normal viewing purposes.

At the present time the "Westeht" unit is of greatest interest to manufacturers and designers of new television receivers, but it offers a considerable advantage to the service engineer who receives for repair an old television set with a burnt out E.H.T. transformer of an unavailable type. In such a case a "Westeht" could be built into the receiver and connected to the existing normal H.T. transformer and rectifier, and the repair effected both rapidly and efficiently.

It must be noted that the reservoir capacitor, shown as having a value of between 0.05 and 0.1 mfd. with a working voltage of 6 Kv., is the last capacitor in the multiplier chain, and no resistor must be connected between it and the output terminal of the unit. A smoothing resistor and further capacitor are also unnecessary.

Receiver-Timebase Power Pack Faults

It has already been said that the E.H.T. section and the receiver-timebase section of the power pack may be supplied from a single transformer or a pair of transformers. It may also be found that there are separate power packs for the receiver and timebase, and even a separate power pack for the sound receiver as distinct from the vision receiver, but common practice would appear to be to supply all the heater and H.T. currents needed by the vision receiver, the sound receiver and the timebases from a single power pack.

This power pack, in outline at least, will be found to follow normal practice, and normal servicing methods are all that are required.

Common output voltages are of the order of 300 to 400 volts, and the power pack, simply because it is feeding a large number of valves, is made to deliver heavier currents than are needed for normal broadcast receivers. It is therefore common to find rectifier valves of the FW4/500 or the UU8 class in the receiver-timebase power pack, and the pack can, indeed, be identified by such a rectifier valve.

It is apparent from the Pye power pack circuit of Fig. 6 that perfect smoothing in the receiver and timebase supplies is necessary, and in some televisors two or three smoothing chokes and smoothing capacitors may be found, giving individual smoothing for vision, sound and timebases. One of the chokes may well be the field winding of the loudspeaker; in other sets, again, a permanent magnet speaker may be found.

Just as power pack faults in a broadcast receiver are usually obvious, so are they in a televisor. A breakdown in a reservoir capacitor will, if serious, damage the rectifier valve and possibly the transformer, whilst a dried out reservoir will cause hum and a low output voltage.

Similarly a breakdown in the smoothing capacitor will overload the power pack with consequent heating of the transformer and the choke in that H.T. line, or the common choke if only one is employed, and the effects of low voltage will be obvious, whilst a dried out or internally open-circuited smoothing capacitor will cause hum.

A rectifier valve which is losing emission will also cause low voltage effects to be noted, but before replacing an old rectifier the whole H.T. system should be inspected and the capacitors specially checked to ensure that the valve has not been damaged by overrunning due to a faulty component or low-resistance circuit.

Transformer and choke failures are, as usual, quite self-evident. Shorting turns in a transformer will cause the windings to overheat, usually very seriously so that discoloration soon takes place, and touching the transformer almost invariably allows this fault to be discovered without further tests—at the same time the televisor will show the effects of low voltage and the picture may show intermittent faults, too, as more and more turns are caused to short over within the transformer. Remember that shorting turns in a transformer can cause a bad fire.

A broken choke winding would, of course, put the whole set out of action, if the choke were common to both receivers and timebases, and then the E.H.T. circuit alone would operate, giving a spot in the centre of the C.R. tube screen. If the tube has two anodes and the first is fed from the receiver H.T. line, as in the Pye televisor, the spot would, fortunately, go out of focus, but should the spot remain in focus or in fair focus there would be some chance of burning the screen and a spot on the screen must always mean that the set should either be switched off at once or that the brilliance control must be turned right down.

In many sets a cessation of the normal H.T. supply will also mean an unenergised focusing coil with a consequently unfocused spot.

The Effects of Low Voltage and Hum

Low voltage and hum effects on a televisor are easily seen.

If the power pack is common to all circuits, hum will be heard on the sound programme, hum filtering into the timebases will cause the picture to have a waved edge, and hum on the vision receiver line will cause the picture to be at reasonably normal brilliance over one half—possibly the upper half—and quite dark or even blotted out over the other half.

If one of these effects is observed without the others, then it will mean that the H.T. supplies from the pack to the units of the receiver are individually smoothed, and the smoothing circuits of the affected unit can immediately be suspected.

Low voltage, with or without hum effects as well, will also affect either the whole of the set or only part, depending on whether separate power packs are used or whether the low voltage is caused by a leaky smoothing capacitor in an individual hum filter, etc. Low voltage on the sound receiver only will cause the sound volume to drop, whilst low voltage on the vision receiver only will cause the picture brilliance and contrast to fall. Low voltage on the timebases is quite obvious, the picture will shrink so that the edges become visible within the mask, and at the same time picture brilliance will automatically rise, with, probably, a loss of focus.

If the low voltage is caused by a components failure these effects may be accompanied by intermittents—wavering of the picture edges, bright spots on the screen, loss and regain of focus and, of course, crackling from the sound receiver.

Focusing Defects

In electrically focused receivers a sudden complete loss of focus with no other apparent effect on the behaviour of the receiver will almost certainly mean an open-circuited focusing coil or associated resistors. Inspection of Fig. 6 will show that the H.T. return to the mains transformer centre tap from the receiver chassis is not broken if the focus coil winding breaks—there is still a quite low resistance path through the focus control and its associated resistors—and whilst other receivers have different circuit arrangements in many cases the focusing coil can go out of circuit without putting the set out of action. (Note.—The 680 ohms resistor appears only in the Pye model B 16T.)

Gradual loss of focus as the receiver operates over a period of time is unusual but possible, and in this case the focusing coil can be inspected for heating effects, either due to too much current flowing or to heating up from the normal heat of the C.R. tube neck, which contains the heater and cathode. The positioning of the focusing coil relative to this heat source varies with the C.R. tube and the receiver under investigation. It is also possible for a ring or double magnet permanent magnet focusing arrangement to become heated from the C.R. tube neck and distort; this fault, though rare, should be considered as a possibility.

The C.R. Tube Network

The E.H.T. network associated with the C.R. tube has already been discussed., and the remaining control on the C.R. tube is the brilliance control. There are many ways in which this can be connected, but in any well-designed receiver attention will have been paid to the factors affecting tube safety should any part of the televisor fail.

To take a concrete example, the circuit of the Pye brilliance control is shown in Fig. 10. It will be seen that the cathode of the C.R. tube is supplied directly from the anode of the video amplifier —the term " directly," in this context, means that the cathode is not separated from the anode of the last vision stage by capacitance, although resistance does enter the circuit.

The resistance values are such that the cathode of the C.R. tube is held at a voltage which is one-half of the voltage which

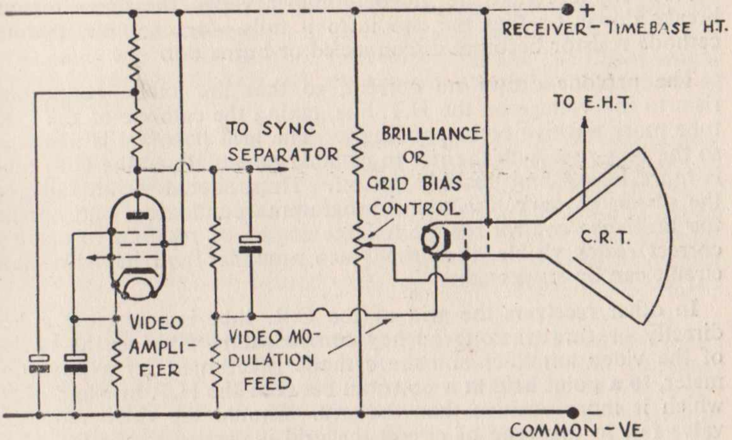


FIG. 10.—The Pye System of Brilliance Control

would be applied were the cathode connected to the anode of the video amplifier direct. The cathode of the tube is thus above earth, i.e., it is positive to earth, and is supplied with video signals from the pentode anode.

The grid of the C.R. tube is returned to a controlling network connected between the H.T. positive line and the chassis of the timebase unit. In Fig. 10 the connections are shown as coming across the H.T. supply of the vision receiver, because the H.T. line of both receiver and timebases is common to both and at the same potential. It must be remembered, however, that should the main connecting plug between the two units fail, the timebase H.T. line would still be powered, and the receiver H.T. line would become "dead."

The cathode of the tube, then, is positive to earth, and the grid of the tube is adjusted to be less positive to earth than is the cathode—that is, the grid of the tube is negative with respect to the cathode by a variable degree, and so the tube is properly biased. Running the slider up the potentiometer would make the grid more positive and thus less negative to the cathode, with the result that picture brilliance would increase; running the slider downwards would make the grid nearer to chassis potential and so more negative with respect to the cathode, so that brilliance would fall and the picture or raster become progressively darker.

Now suppose that the video amplifier valve, for some reason, breaks down, or that the circuit to it fails—for example, that its cathode resistor becomes disconnected or burns out.

The pentode draws no current, so that the anode connection rises to the voltage on the H.T. line, taking the cathode of the C R. tube more positive correspondingly. The grid potential is tied, and so the bias rises with the rise in cathode potential and the C.R. tube is more biased and possibly cut off. Thus, should vision fail and the screen go dark, the sound programme continuing, and should the brilliance control require a large degree of rotation to make a correct raster visible, then the video amplifier and its immediate circuit can be suspected.

In other receivers the grid of the C.R. tube is connected either directly or through a frequency compensating filter to the anode of the video amplifier and the cathode is returned, by a potentiometer, to a point held at a potential between the H.T. line and earth which is more positive than the grid. Should the video amplifier valve fail in this type of circuit the grid is carried to the full H.T. line potential and so immediately becomes more positive than the cathode, thus giving the tube grid a positive bias. The system, therefore, is not so safe as that where the cathode is connected to the video amplifier anode, although from the point of view of picture reception there is nothing to choose in efficiency.

When the C.R. tube circuits are being serviced and the biasing circuits are under investigation the engineer must watch for switched circuits which throw in more bias to the tube as the receiver is switched off. This is sometimes done to prevent the tube's becoming underbiased as the power pack capacitors lose charge and the receiver and timebase H.T. lines fall rapidly in potential. It has already been shown that the potential drop of the E.H.T. pack is very much slower than that of the normal H.T. power pack, and under these circumstances it is sometimes possible for the raster to collapse a moment or so after switching off the set, leaving a spot central on the tube screen at high brilliance. Should this happen the tube would soon have a burnt patch on the screen.

A high resistance is sometimes switched into the C.R. tube's cathode line automatically as the whole set is switched off, to counter this effect, and should this switch section fail, or the high resistance fail in any way, the protective device may go out of action.

A spot on the screen after the set is switched off therefore usually indicates trouble in such a circuit, and trouble which needs immediate remedy. Switching off the receiver at the wall socket without switching off the set by its own mains switch will also produce the same effect and damage the C.R. tube, and this practice is, in any case, bad. For safety both the receiver switch and the mains supply switch should be thrown, but the receiver should be the first to be switched off.

It is also obvious that a failure in the switching of such a protective device could prevent the high resistance being taken out of circuit when the televisor is switched on. A set which refuses to operate even though all appears well with the circuits and power packs and voltage checks show that both the receiver and tube are powered should therefore have its protective devices and their switching investigated before work on other sections of the set proceeds.

Should the protective switch section fail the only symptom would be a dark screen, no picture being obtained with the brilliance control full on. A simple check for this would be to return the brilliance control to its normal or below normal position and to connect a voltmeter between the cathode and its feed point in the receiver or power pack circuits. The voltmeter may or may not indicate; the point is that the protective resistor would be shunted by the voltmeter's resistance, and so the tube should then operate, even if incorrectly.

Such a test may not, of course, suit every televisor with protective biasing devices, and the manufacturer's literature and the receiver circuit should first be consulted.

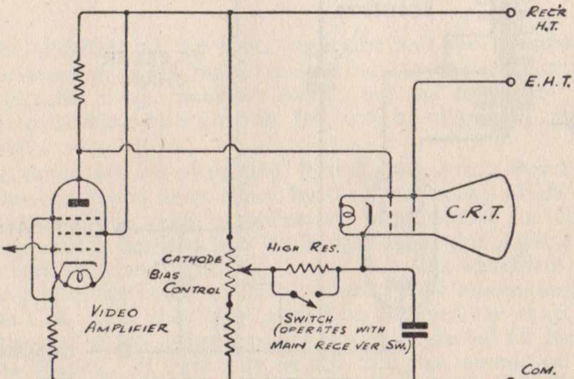


FIG. 11.—Protective Switching to prevent Screen Burning

The basic circuit of such a protective device is shown in Fig. 11.

The engineer must also remember that it is possible to derive the bias voltage from the bleeder chain across the E.H.T. power pack, when the bias changes with a change in E.H.T. potential so that the tube is always protected against a fall in bias. The use of this type of biasing circuit complicates the connection of the tube to the video amplifier by some small degree, and the system appears to be used little, if at all, in modern televisors. It is popular in home-built television receivers, however, and is shown in Fig. 12.

The bias is derived from a variable resistor at the -ve end of the bleeder chain, and sufficient bias must always be provided to make it possible to run the tube to the cut-off condition. Suppose the E.H.T. potential to be 5 Kv. and the tube to be cut-off at —100 volts on the grid (that is, of course, plus 100 volts on the cathode if the grid is earthed), then the bias resistance required will be that which gives one-fiftieth of the full voltage across the power pack, so that

R. Bleeder = 49 R. Bias.

If the whole bleeder chain is to have a total resistance of, say, 25 megohms, then the bias potentiometer should have a resistance

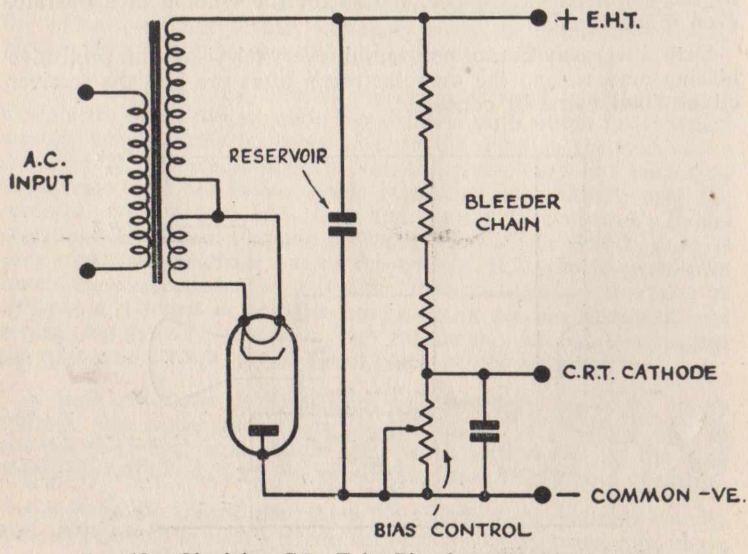


FIG. 12.—Obtaining C.R. Tube Bias from the Bleeder Chain

of 0.5 megohm, the rest of the chain having a resistance of 24.5 megohms.

Note, from the diagrams, that if the signal is applied to the grid of the C.R. tube the cathode must be bypassed to earth, and that if the signal is applied to the cathode, then the grid must be bypassed to earth.

This is because the biased electrode must hold at a steady potential whilst the modulated electrode varies in potential with the signal—without the bypassing an effect would be obtained similar to the negative feedback obtained in an output stage where the cathode bypass capacitor is omitted. The picture quality would suffer and the modulation percentage appear to be down—the effect is difficult to describe, but may be called a lack of "sparkle."

The bypassing of the biased electrode should therefore be checked when picture quality is poor and the receiver appears to be in order.

CHAPTER 4

The Sync. Separator and Timebases

DISCUSSION of the sync. separator and the timebases before discussion of the main receiver may appear to be dealing with circuits in an incorrect order, but the timebases are more likely to develop faults or to fall out of alignment than is the receiver.

The timebases are controlled, through the sync. separator, by the receiver—or, to be more exact, by the sync. pulses which appear in the output of the video amplifier or "output valve for vision," but so long as it is realised that the output from this valve is a waveform such as is shown in Fig. 1, and that this waveform is applied to the grid of the sync. separator as well as the modulating electrode of the C.R. tube, then the connection between the sync. separator and the rest of the vision receiver can be neglected for the purposes of this chapter. It need only be said that this connection is usually made via a resistance to prevent the sync. separator from attenuating the vision signal.

Mention of the phase in which this output waveform appears is, however, very necessary.

If the waveform is applied to the *cathode* of the C.R. tube then it must be as a negative going waveform—the white signals or strongest vision signals must be more negative than the black or weaker vision signals because for a white signal the beam through the C.R. tube must increase to cause a brighter fluorescence, and therefore the cathode must become less positive with respect to the grid of the C.R. tube. In this case the highlight signals may be considered as negative and the black signals as at zero potential with the sync. pulses running positive; in other words, the waveform shown in the first diagram of Fig. 1 may be considered as having "turned upside down" so that it appears as in Fig. 13.

If the output from the video amplifier is applied to the *grid* of the C.R. tube, however, the waveform must be kept in the same phase as the waveform shown in Fig. 1. For the whites the grid must be driven positive, and the blacks may be considered as zero potential, so that in this case the sync. pulses are negative.

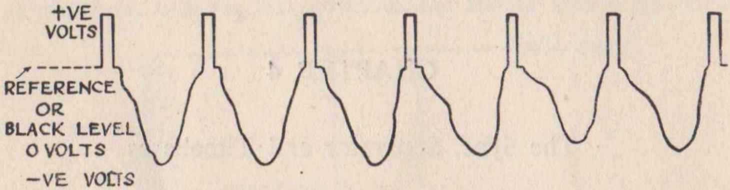


FIG. 13.—" Negative-going " Signal Waveform

(A moment's thought will show that the waveform can be taken in either the positive or negative "sense" from the anode of the video amplifier simply by connecting in the diode detector to the video amplifier in the correct manner. The demodulated output can be taken either from the cathode or the anode of the demodulator or detector diode—a point which does not arise in sound broadcasting where the phase of the signal is of no moment.)

If, as is often the case, the sync. separator is a pentode valve the sync. pulses are required to be in the positive sense for reasons discussed in the next paragraph. When the C.R. tube is modulated through its grid, therefore, a double stage sync. separator is usually employed, the first stage amplifying the pulses and reversing their phase and so supplying them to the grid of the second stage, the separator proper. This is not essential, however, for the signal can be taken from the cathode of the video amplifier where it is, of course, in phase with the signal applied to the video amplifier grid. If the output from the video amplifier anode is positive in sense the waveform at the cathode is in the negative sense and so in the correct phase, with positive sync. pulses, for application to the grid of the sync. separator.

The pentode separator is by no means the only circuit which can separate the sync. pulses from the rest of the video signal content, but it is a commonly used circuit and one which gives good results.

The action of the pentode sync. separator is shown in Fig 14. The vision signal is fed in the negative sense to the grid, which is unbiased, the grid and cathode being returned to earth with no cathode resistance. Accordingly, the positive sync. pulses cause grid current to flow and the valve is biased to an extent dependent on the mean value of the vision signal; the bias is such that no anode current flows during the line picture content. At each sync. pulse, however, the grid passes further grid current, and so anode current flows over the period of each sync. pulse. In the anode circuit of the sync. separator, therefore, pulses of current pass at each sync. signal and thus, with respect to earth, a negative voltage output is obtained.

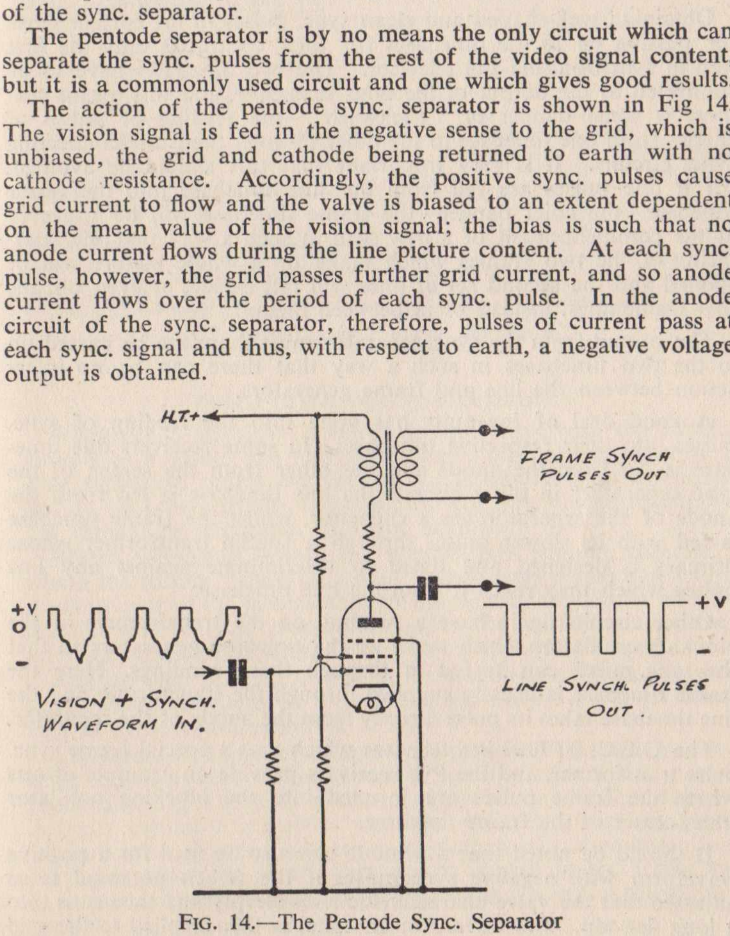


FIG. 14.—The Pentode Sync. Separator

The anode and screen voltages of the valve are kept low, which not only causes the valve to have a short grid base so that the pulses are steep and short sided, but also prevents the valve giving any noise output during the intervals between pulses.

Isolation of the Line and Frame Circuits

Obtaining well-shaped and clean sync. pulses in the correct sense for passing on to the timebases for their control is only the first step in synchronising the televisor. The two timebases have to be connected to the output of the sync. separator, and this means that there is some danger of " backwash "—the feeding of pulses of energy from one timebase to the other through their interconnecting sync. circuits. It is very important that this should be avoided, for if line pulses are fed from the line timebase into the frame timebase—the chief danger—the frame timebase will be triggered at the commencement of a new scan in such a way that the interlacing of the two frames which make up a whole picture will be spoiled and the second set of lines will fall beside, or even on, the first frame lines, instead of in between them.

The output from the sync. separator must therefore be passed on to the two timebases in such a way that there can be no interaction between the line and frame generators.

A good deal of ingenuity has gone into the feeding of sync. pulses into their respective timebases. In some receivers one timebase is fed from the anode and the other from the screen of the sync. separator; in other circuits the line timebase is fed from the anode of the separator via a capacitor, whilst the frame timebase is fed with its slower pulses through a special transformer whose primary is designed and tuned to discriminate against any line pulses which may reach it from the line timebase.

Other circuits again have a winding on the transformers in the blocking oscillators which make up the timebase generators so that the sync. pulses can be fed in through these windings. Here the frame timebase is usually supplied through the transformer and the line timebase takes its pulse directly from the anode of the separator.

The G.E.C. BT7092 is a televisor which uses a special frame sync. pulse transformer, and the Pye receivers provide an example of sets where the frame pulses are injected into the blocking oscillator transformer of the frame timebase.

It should be noted that a pentode can also be used for a positive waveform with negative sync. pulses if the screen potential is so adjusted that the valve characteristic rises steeply and then runs into a long flat top. The waveform or signal is then applied to the grid of the pentode so that all the video content of the signal runs the anode current into the flat top of the curve, with no corresponding change of anode current and thus anode potential, whilst the negative sync. pulses are the only sections of the signal which cause a change in anode potential by reducing the anode current.

The valve characteristic necessary, and the action of negative sync. pulses, are shown in Fig. 15.

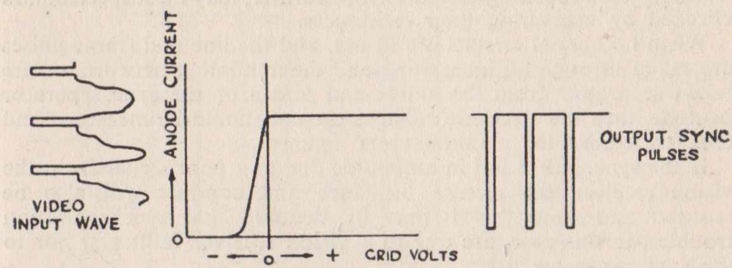


FIG. 15.—Valve Characteristic to give Sync. Pulse Output from a "Positive-going" Signal Waveform

Faults in Pentode Sync. Separators

Whenever a televisor develops a fault involving the timebase circuits as a whole, the first inspection should always start at the sync. separator, unless the breakdown is obviously in a timebase, and in no other circuit—the complete collapse of the raster or of the vertical or horizontal scan, for example.

Where interlacing is lost, the picture lines running together, or where the picture "pulls on whites" when lines containing a bright or white part of the picture shift to the right-hand side, or when the picture fails to lock properly in either the vertical or horizontal direction, the sync. separator can always be the first suspect.

Another sign of sync. trouble is the wobbling or flickering to the left of the top few lines of the picture; and picture slip is yet another sign of sync. separator faults.

The screen and anode voltages on a pentode separator, as can be imagined, are often critical, and if for any reason the electrode potential changes then the action of the valve may well be impaired. A faulty capacitor or resistor would be sufficient to put any pentode separator out of action. At the same time, a loss of emission in the valve has much the same effect, and it is wise to try a new valve in the sync. separator position before testing the rest of the separator circuit.

When interlacing is lost this may show that line timebase energy is filtering through into the frame timebase—an oscilloscope is a most valuable instrument for all timebase and sync. tests and will show if backwash is present. If the oscilloscope shows interference from the line generator with the frame synchronisation, then any special filtering circuits such as the special sync. transformers or windings on a blocking oscillator transformer, may be suspected, and checked by measuring their resistances.

When no special circuits are in use, and the line and frame pulses are taken through an integrating and differentiating network, or are taken separately from the anode and screen of the sync. separator pentode, then the electrode voltages present should be measured and checked against the manufacturers' figures.

If the sync. pulses fall in amplitude due to a poor signal from the vision receiver the picture brilliance and contrast will also be reduced and from this it may be deduced that synchronisation troubles, in this case, are due to a vision receiver fault and not to the sync. separator.

In some cases of sync. separator failure a bright line runs horizontally or vertically across the screen, the line direction indicating that the trouble is chiefly affecting the frame or line timebase respectively. If such a line appears it is indicative of a fault in the network of resistors and capacitors which should therefore be tested for open circuits, internal shorts, etc.

A valve which has worked loose in its socket can cause a good deal of trouble in a television receiver. In a sound receiver such a fault causes the receiver to go dead, but should a sync. separator work loose so that the heater, for example, draws no current, the reception of the sound and vision would be unaffected but synchronisation would be poor or non-existent and the picture would slip badly or be no more than an unresolved jumble.

A check for correct valve seating should always be made, therefore, whenever a televisor is serviced.

Diode Sync. Separators

The pentode separator is often found in televisors, but so is a diode separator, and in many receivers a pentode and diode work together to separate and isolate the line and frame pulses.

A common type of diode separating circuit is shown in Fig. 16. The cathode of a double diode is connected directly to the anode of the video amplifier, to which also is connected the grid of the C.R. tube. The signal is therefore presented to both the tube and the diode cathode in the positive sense with negative sync. pulses.

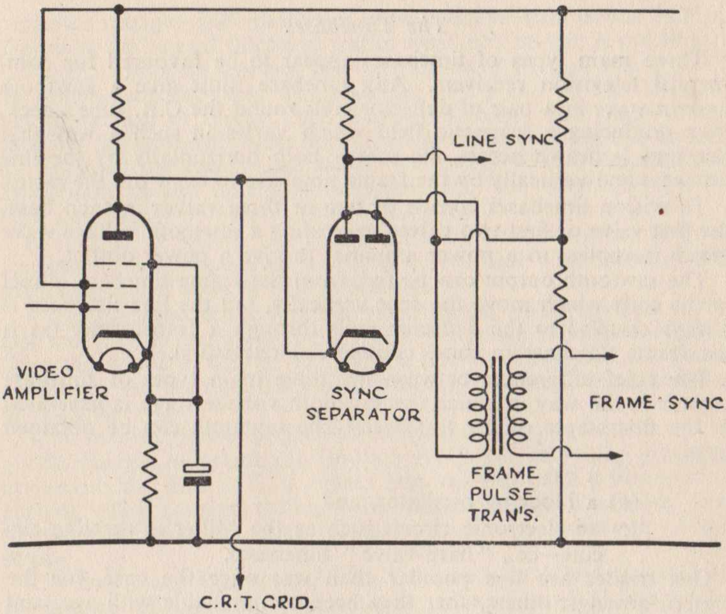


FIG. 16.—Typical Diode Sync. Separator

The diode anodes are biased either from a network across the H.T. supply and chassis or through an automatic circuit which holds the diode anodes positive to the sync. pulses and negative to the vision content of the signal. Thus the diodes conduct only during the sync. pulses, and the line pulses can be taken from one diode anode whilst the frame pulses are fed through a special transformer, as already described, the two timebases therefore being effectively isolated.

Various receivers use differing sync. separator circuits. Faults in a diode separator are similar to those in a pentode separator; the anode voltages on the diode anodes must be maintained correctly whilst loss of emission will give obvious results on the screen. When a pentode and diode are combined, as in the special Pye circuit, the diode may have a particular function to perform, and the manufacturer's literature should be consulted.

The Timebases

Three main types of timebases appear to be favoured for commercial television receivers. Any timebase must give a sawtooth current wave in a pair of deflector coils round the C.R. tube's neck, thus producing a magnetic field which varies in such a way that the spot is drawn across the screen both horizontally by the line timebase and vertically by the frame timebase to draw out the raster.

Television timebases consist of two or three valves in each base, the first valve or first two valves generating a sawtooth voltage wave which is applied to a power amplifier to give a power output.

The sawtooth output can be fed, from the frame timebase, direct to the coils which move the spot vertically, but the line timebase is always coupled to the deflector coils through a transformer (as is the frame timebase in some commercial televisors).

The chief differences between the three main types of timebase circuits is the way in which the sawtooth voltage wave is generated in the first stages of the timebase. The sawtooth can be obtained from

(*a*) a gas triode,
(*b*) a blocking oscillator, and
(*c*) an electronic circuit such as the Miller integrating circuit—i.e., " hard-valve " timebases.

Gas triodes are less popular than was once the case, for the reason, amongst others, that they become unreliable with age, and apt to fire erratically. At the present time the blocking oscillator would appear to be the most popular of the generator types; circuits like the Miller Integrator will probably gain steadily in popularity.

In any timebase the sawtooth voltage wave is derived either from the slow charge and rapid discharge, or the slow discharge and rapid charge, of a capacitance.

In a gas triode (or, more popularly, a " thyratron ") timebase, the capacitor is discharged rapidly through the thyratron; in the blocking oscillator the capacitor is charged rapidly by a strongly oscillating circuit to such a degree that the oscillator valve is run into cut-off conditions when the capacitor slowly discharges until the oscillations recommence.

In Miller Integrator and other hard-valve non-oscillating circuits the charge and discharge of the capacitor are controlled in various ways.

In any type of timebase some compensation for the loss of linearity in the charging or discharging is necessary, and this is obtained in various ways; negative feedback may be used or an amplifying circuit may have a factor of distortion which is just sufficient to counteract the non-linearity in the original sawtooth. A capacitor charges and discharges expotentially—that is, the rate of charge or the rate of discharge varies with time and so is not linear.

Various timebase circuits can be examined in the diagrams of the commercial receivers which appear at the end of this Manual, but the action of typical commercial timebases, with oscillograms showing the sawtooth wave with the various correction curves and the effect of the sync. pulses are shown in Fig. 17 and Fig. 18. The description of the timebase operation, and the diagrams, are by kind permission of Messrs. The G.E.C., Ltd.

In Fig. 17 is shown the frame timebase of the G.E.C. BT7092 receiver. The components numbers correspond with those of the main diagram at the rear of this Manual.

V7 is the sync. separator, the video signal being applied to its grid from V6 in the main circuit. The line pulses are supplied direct from the anode to C29 in Fig. 18, the line timebase, and the frame pulses are fed through TR3 to the frame timebase which consists of V23 and V24.

With no sync. pulses applied the timebase works as follows: —

C96 charges expotentially through R112 and its rising potential applied to the grid of V24 causes that valve to pass an increasing current. The current through the deflector coils therefore also increases, causing the trace to move from top to bottom of the screen.

The negative-going potential on the anode of V24 is applied to the grid of V23 and, with the cathode potential on V23 applied by R117 and C95, holds that valve at cut-off for the duration of the scan. Near the bottom of the scan the potential across C96 rises sufficiently to cause V23 to conduct, and C96 discharges through V23, so that the anode potential of V23 rapidly decreases. This drives V24 to the cut-off point and the trace flies back from the bottom to the top of the screen. The consequent positive-going potential on the V24 anode is fed back to the V23 grid to complete the process of making that valve conduct, so accelerating C96's discharge and the flyback.

When sync. pulses are applied, these arrive as positive-going pulses on the grid of V23 and so determine the moment when V23 commences to conduct.

R117 controls the frequency of the timebase and so acts as a Vertical Hold Control, biasing V23 correctly for synchronisation to be properly applied.

The non-linear rise of potential across C96 is corrected by the resistive-capacitive combination R113, R114 and C98, whilst R118, the Vertical Form Control, by varying the bias on V24 varies the curvature at the bottom of the valve characteristic to balance out any non-linearity still present.

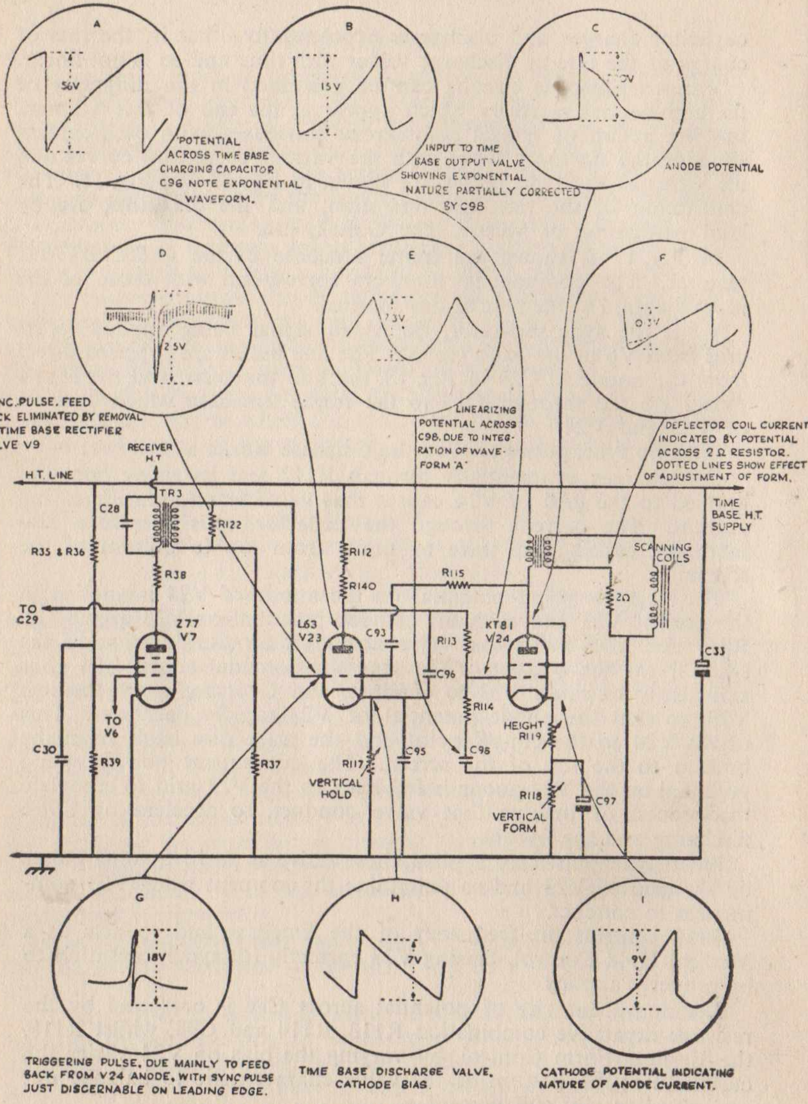


FIG. 17 OSCILLOGRAMS OF FRAME TIME BASE OPERATION. TAKEN ON A G.E.C. MINISCOPE TYPE M860B.

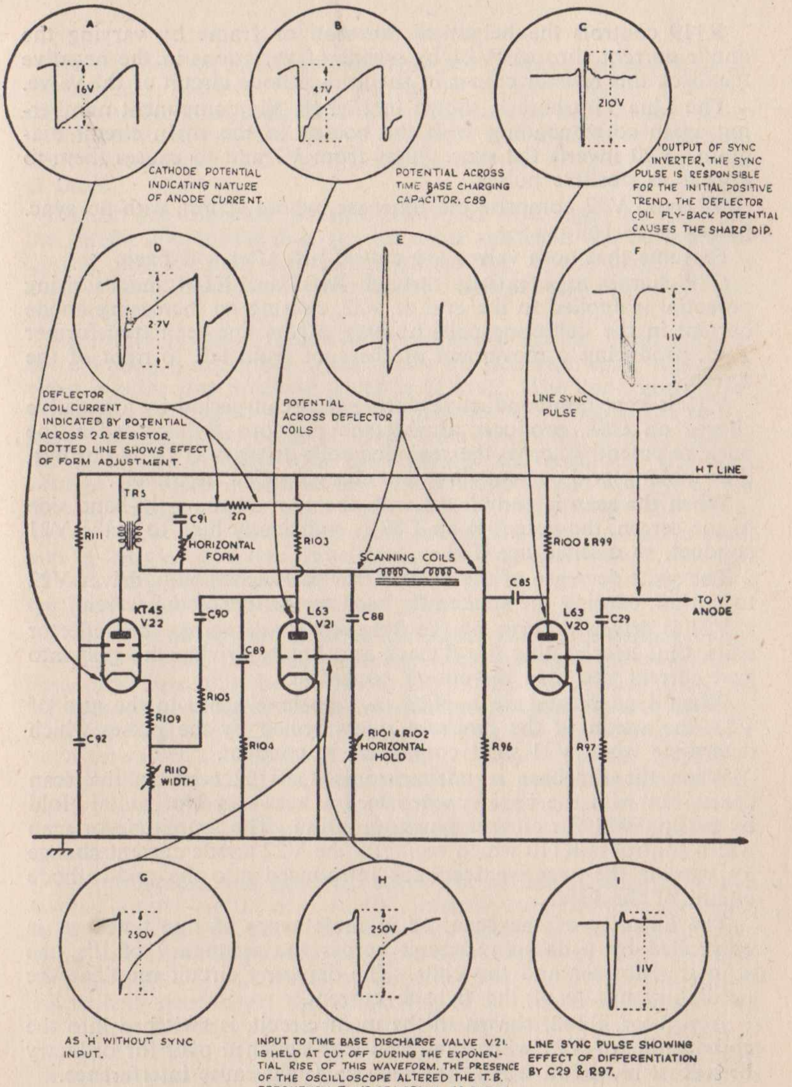


FIG. 18 OSCILLOGRAMS OF LINE TIME BASE OPERATION. TAKEN ON A G.E.C. MINISCOPE TYPE M860B.

R119 controls the height of the scan or frame by varying the anode current through V24 by means of variations in the negative feedback this resistor causes in the grid-cathode circuit of the valve.

The Line Timebase is shown in Fig. 18, the component numbering again corresponding with the coding in the main circuit diagram. V20 inverts the sync. pulses from V7 and so causes them to appear as positive pulses.

V21 and V22 comprise the timebase, whose action, with no sync. pulses, is as follows:—

Presume that both valves are cut-off just after a flyback.

C89 charges expotentially through R103 and R104 and its rising potential is applied to the grid of V22, causing an increasing anode current in the deflecting coils by way of the line scan transformer TR5, producing a movement of the spot from left to right of the screen.

V21 is kept non-conductive during the scan period by a negative charge on C88, produced during the previous flyback when the positive potential across the scanning coils drives V21's grid positive, thus making grid current flow and charging C88 negatively.

When the scan is completed, with the spot on the right-hand side of the screen, the potential on C89 is sufficiently high to make V21 conduct, so discharging C89.

The swift decrease of the V21 anode potential rapidly drives V22 to cut-off, causing the spot to fly back to the left of the screen.

V21 is driven positive by the flyback voltage across the deflector coils, thus accelerating the flyback and finally driving the grid into grid current and then the cut-off condition.

When sync. pulses are applied in a positive sense to the grid of V21, the action of the timebase is controlled by the pulses which determine when V21 shall commence to conduct.

When the timebase is unsynchronised, R102 controls the scan speed, but with the base synchronised it acts as a Horizontal Hold by biasing V21 for correct synchronisation. The amplitude or scan width control is R110 which regulates the V22 anode current change by varying the negative feedback introduced into the grid-cathode circuit of the valve.

The linearity of the scan, as in most types of line timebase, is controlled by a damping circuit across the secondary of the line scan transformer and the coils. The damping circuit modifies the oscillatory nature of the flyback current.

A resistor, R142, shown in the main circuit, is switched into the cathode line of V21 when the receiver is switched over for ordinary broadcast reception when the timebase might cause interference.

This resistor puts the timebase completely out of action.

Timebase Faults

Synchronisation and timebase faults are in some respects difficult to separate. Certain raster defects, as already shown, are due entirely to the sync. separator, but in the case of component failure at the point of entry of the sync. signals into the timebases, both the timebase scan and the synchronisation of the picture may be at fault.

Should one timebase go completely out of action, the effect on the screen is unmistakable, for the other timebase will be left producing only a bright line across the screen. If the bright line is vertical then, of course, the horizontal timebase is out of action, and vice versa.

Fault-finding on a broken-down timebase should commence at the coupling transformer which feeds the deflector coils, especially when it is the line timebase which is at fault. The line transformer, as already mentioned in the power pack section, is subjected to flyback voltages of the order of 2,000 volts across the primary due to the Back E.M.F. effect over the windings and coils, and this high voltage can cause a breakdown. The voltage is also applied to the timebase output valve, and cases are on record where the valveholder has broken down under the potential strain; in such a case, and in the case of a line transformer breaking down under the high flyback voltages, the picture will probably give some warning before the final collapse by flickering or jumping.

If there is no obvious fault in the transformer and deflector coils —whose winding resistances can be checked against manufacturers' data—the tests must be carried to the valves and a check made of all operating voltages. Some manufacturers specify that the timebase amplifier should be tested by removing the sawtooth generator valve or valves and injecting an audio frequency into the amplifier's grid circuit, checking the electrode voltages under working conditions. Low voltages, or a loss of valve emission, can cause serious timebase defects, although the base should not completely fail to operate.

A more rapid and practical check on the amplifying valve and overall output circuit of a faulty timebase can, however, be made by tapping the grid pin of the amplifier with a screwdriver or other metal object, taking every precaution to keep well clear of high-voltage lines. If the timebase amplifier and output circuit are in reasonably good order the contacting of the metal to the grid pin will cause the line left on the tube screen by the other timebase to jump or deflect. If this effect can be obtained, then attention can be given to the timebase generator proper, and the amplifier ignored at least for the time being.

With transformers and coils in order and the valves drawing approximately the correct currents, then the circuit components must be checked, the capacitors first. Timebase capacitors work under arduous conditions, and if leaks or partial short-circuits develop then the whole circuit can be put seriously out of alignment.

As with the sync. separator, it is often a valuable check to try the effect of plugging-in a new valve if the timebase is operating poorly. Like the capacitors, timebase valves operate under wearing conditions. A new valve should not, of course, be inserted if the trouble seems serious or if the timebase stops working altogether for the new valve may be damaged by some component fault; the substitution should be tried as a first measure only when the timebase is giving a short scan, or has lost linearity or has some other reasonably slight defect.

Cramping of the picture to one side or other of the screen indicates a loss of linearity, and the effect may be due to a fault in the main circuit of the base or to a component collapse in the linearising circuit connected across the deflector coils.

With both timebases out of action a spot will appear centrally on the screen, and the brilliance control must be rotated until the spot is blanked out. The two bases ceasing together would be indicative of a power failure or a break at some point in the circuit, and, should this fault occur, testing might well commence at the inter-unit plugs and connectors.

Poor connections can affect any section of a televisor, but they can cause considerable trouble in the timebases. They are generally shown by intermittent working, however, the picture spreading across the screen, then collapsing alternatively.

When timebase circuits are under test the potentiometer controls must not be omitted from the inspection. A control where pitting or burning on the track has occurred can completely ruin the picture by intermittent changes in resistance—the picture might not hold, for example, and periodically turn into a jumble of lines, then pull back into scan but off sync. so that the picture is split across or down the screen.

The picture shrinking in one direction whilst maintaining its full size in the other direction would indicate either loss of H.T. or a loss of emission in the timebase affected.

The picture can also show faults which are due not to breakdowns in the timebases or to components failures, but simply to incorrect settings of the timebase controls, and there is always the possibility that the engineer will be called to inspect a faulty televisor, giving a distorted or non-linear picture, where the only trouble is that the pre-set timebase controls have been put out of adjustment by explorations on the part of the set owner.

Common picture faults which can be traced to incorrect timebase settings are a shadow effect at the left-hand side of the picture produced by too great a line amplitude, further increases in amplitude giving a " fold-over " effect, together with general distortion and, in some cases, a reduction in the height of the picture.

Distortion at the top of the picture, along the first few top lines, can also be caused by too great an amplitude from the frame timebase.

Incorrect settings of the line hold or frame hold are self-evident. If the setting is only slightly off the correct position the picture will be " sensitive "—changes in picture content may cause the picture to shift or roll so that the frame slips up or a number of the horizontal lines slip to one side. A more incorrect setting will cause the frame to roll steadily or the picture to dissolve into a jumble of lines and bars, and in either case the effect must be distinguished from poor synchronisation.

Hum on the timebases has already been mentioned in connection with the power pack. The effect cannot be mistaken and in any case if hum is present in the timebases it is generally present, too, in the rest of the receiver, giving hum bars on the picture or hum on the sound, or both.

If hum occurs on only one timebase—not a usual occurrence—the effect is perhaps not so obvious, especially when the frame base only is affected, for then the hum interferes with interlacing and the lines are displaced or distorted by thickening. The writer has seen a hum effect on the edge of the picture and extending across the screen, giving an unpleasant slow sway or ripple to the scene, which appeared to be due to the transmitter. A portable transmitter, presumably powered from 50 cycles mains, was in use on an outside broadcast, and some testing on the televisor took place until the studio transmission was resumed when the hum magically cleared.

CHAPTER 5

The D.C. Restorer

IT has already been said that D.C. restoration is necessary in a televisor only when the D.C. content of a signal has been lost by a capacitive coupling either between the detector—that is, the demodulator—and the video amplifier, or between the video amplifier and the C.R. tube modulating electrode, whether this is the cathode or grid.

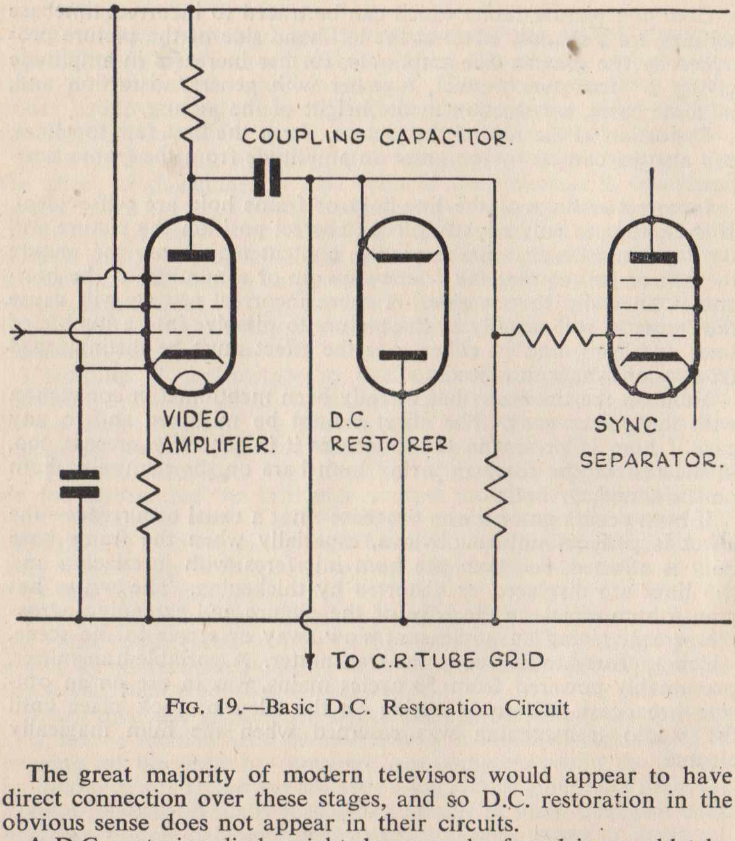


FIG. 19.—Basic D.C. Restoration Circuit

The great majority of modern televisors would appear to have direct connection over these stages, and so D.C. restoration in the obvious sense does not appear in their circuits.

A D.C. restoring diode might, however, be found in an old televisor, and also in a home-constructed receiver, and the basic circuit will in all probability follow the lines of Fig. 19. Note that the sync. separator must also be supplied with a signal whose D.C. component has been restored. This is for the reason that the sync. pulses must all be on the same level—Fig. 20a shows a signal where the D.C. component has been lost in a capacitive coupling, and it can be seen that the signal centres itself about the reference or zero line according to the signal content.

In Fig. 20b the same signal with the D.C. component retained or restored is shown; obviously the second waveform is the one which

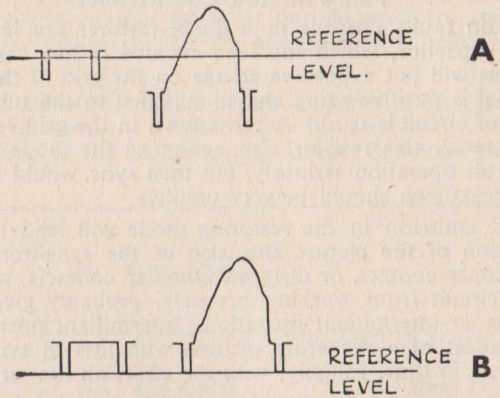


FIG. 20.—D.C. Restoration Waveforms

must be supplied both to the tube for a correct picture and to the sync. separator for correct operation and separation of the pulses from the picture content. A sync. separator can, however, act as its own D.C. restorer, grid and cathode performing as a diode.

In the basic D.C. restorer circuit of Fig. 19 the diode cathode is coupled in with the tube and the sync. separator, its anode being connected to the earth or negative line. The signal is presented to the circuit in the positive sense, and so throughout the vision period of each line the cathode of the diode is driven positive and the valve fails to conduct. On the arrival of a sync. pulse, however, the cathode drops the positive potential and goes negative with the result that the diode conducts and charges up the coupling capacitor between the diode cathode and the anode of the video amplifier, and the charge depends on the picture content. The picture content determines how the signal " centres itself on the zero line " and so a bright or highly-lighted scene will produce a high charge on the coupling capacitor, because the sync. pulse after such a line drives the diode cathode far into the negative; a dark scene leaves little charge on the capacitor because the sync. pulse will drive the cathode so much less negative (see Fig. 20).

The final charge on the capacitor due to the diode conduction is positive, so assisting in making the diode non-conductive, and the charges counteract the loss of D.C. component through the capacitor. The bottoms of the sync. pulses are thus brought approximately to the same level.

Faults in the Diode Restorer

The main faults possible in a diode restorer are leaking in the coupling capacitor, which must be avoided in any case as a poor component will put a positive charge on the grid of the C.R. tube. (The signal is positive-going and so supplied to the tube grid when this type of circuit is used.) A breakdown in the grid resistor of the sync. separator, this resistor also acting as the diode load, would upset circuit operation seriously, but then sync. would also be lost; such a breakdown should be very unlikely.

Loss of emission in the restoring diode will lead to a gradual deterioration of the picture and also of the synchronisation, and loss of proper contact, or dirty valveholder contacts, will also prevent the circuit from working properly, probably giving no D.C. restoration or intermittent operation. Intermittent operation would give the effect of a flickering picture, with loss of sync. or partial loss of sync. in time, roughly, with the effect on the screen.

The advantage of a circuit where D.C. restoration is employed is that the C.R. tube can be isolated, by capacitance, from the receiver H.T. line and so safeguarded against valve and circuit breakdowns; nevertheless, there is still the possibility of a capacitor breakdown which would drive the C.R. tube grid positive with the likelihood of consequent damage.

Modern Circuits

Coupling the tube direct to the video amplifier anode renders a D.C. restorer unnecessary, but the video amplifier must have a wide frequency range. The lowest frequency in a vision signal may be taken as 25 cycles per second (the highest, as has been said, being of the order of 2.5 or 3 mcs.), but for perfect reproduction and the retention of the D.C. component, the video amplifier should have a frequency response running down to zero—that is, to D.C.

Decoupling in the video amplifier circuit, as well as resistance and capacitance in the cathode bias circuit of the valve, affects the performance at low frequencies. The decoupling circuits can be made with components of such values that they have no effect on the anode potential down to about 25 cycles, but after that the anode potential will tend to rise with a further decrease in frequency. The Pye televisor gives an interesting example of how this can be combated in a circuit which can be likened to a D.C. restoration device.

The circuit of the Pye video amplifier is shown in Fig. 21. The anode potential of the video amplifier increases as the frequency falls below 25 c.p.s. in accordance with the time-constant of the anode decoupling circuit, R1, C1, and at zero frequency the anode potential is double its normal value for normal working conditions as the anode load resistance, R2, and the decoupling resistance are equal.

The time-constant of R3 and its bypass capacitor, C2, is, however, made to be about the same as that of the decoupling circuit, with R3 equal in value to R4. As a result, changes in anode potential

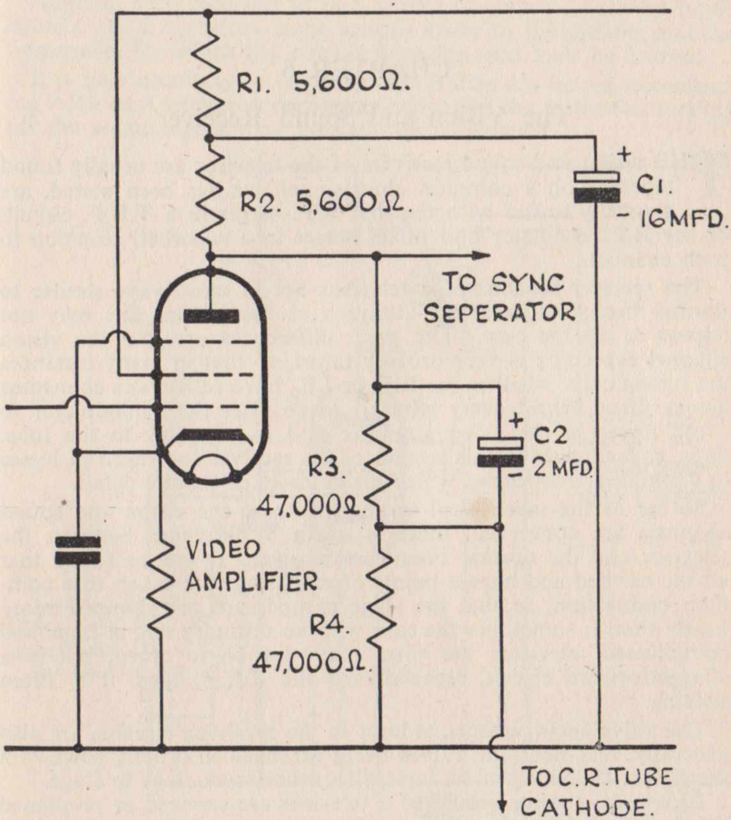


FIG. 21.—The Pye Video Amplifier and Compensation Circuit

due to frequency reduction are neutralised, and variations in the C.R. tube cathode voltage, as the frequency falls below 25 cycles, are avoided.

In such a circuit there is, clearly, little, if anything, to go wrong. The electrolytic capacitors are working under normal conditions, and the resistors are adequately rated, so that trouble from this compensating network should be very rare.

CHAPTER 6

The Vision and Sound Receiver

THE vision and sound receivers of the televisor are usually found together on a common chassis, and, as has been stated, are generally linked with the first R.F. stages in a T.R.F. circuit, or the R.F., oscillator and mixer stages in a superhet, common to both channels.

The receiver sections of a televisor are in most ways similar to normal broadcast receivers although at first glance this may not appear to be the case. The great differences are that the vision channel especially is very broadly tuned, so that in many instances the tuning coils, whether for R.F. or I.F., have resistances connected across them, whilst every effort is made after the demodulator to avoid losses in the video amplifier and its coupling to the tube. Stray capacitances in this section of the receiver can result in losses in the higher frequencies which mean losses of picture detail.

So far as the mechanical arrangements of the vision and sound channels are concerned, there is again a difference between the televisor and the normal broadcast receiver. It will be found that all the earthed and bypass points of each stage are taken to a common connection, so that the stage components are grouped more neatly than is sometimes the case with an ordinary set; in large and complicated televisors the effect may not be so noted, but in a straightforward circuit, especially of the T.R.F. type, it is often striking.

The valve arrangements, at least in the receiving circuits, are also generally very neat, the valves being arranged in orderly rows with the circuit following on in logical sequence from stage to stage.

Before the tuning circuits of a televisor are serviced or re-aligned the manufacturers' instructions must be consulted. All types of receiver drift out of alignment with age, and it is fortunate that televisors give less trouble on this account than do ordinary broadcast sets for the reason that the circuit response is broad and so much less affected by a small frequency drift. At the same time, most superhets are stagger-tuned—that is, some of the I.F. transformers are set to the central I.F., some to one side of the central frequency and some to the other side of the central frequency, to give an even response for the whole I.F. amplifier over the required band of frequencies—whilst some T.R.F. sets are also stagger-tuned to some degree.

Aligning such receivers to one central frequency in all the tuned circuits would therefore cause serious losses in the picture, and the frequencies for which the circuits were designed must be known.

It is also necessary to have the circuit diagram before commencing work on a television receiver in order that the method of tapping off the sound signal may properly be understood.

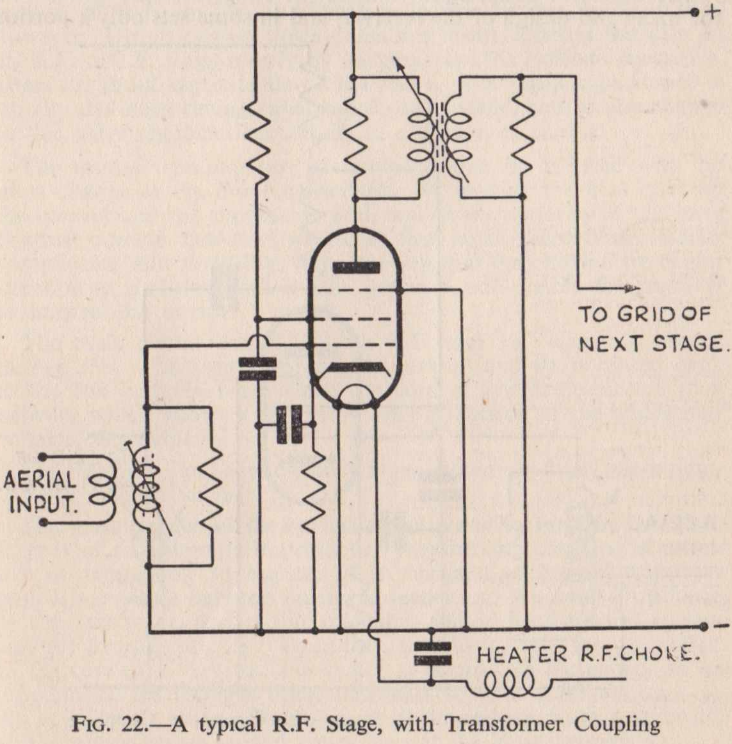


FIG. 22.—A typical R.F. Stage, with Transformer Coupling

Typical Stages

THE R.F. STAGE

A typical R.F. stage is shown in Fig. 22, with the aerial coupled in to the grid coil. The coil may or may not have a resistor parallel-connected with it, but resistors across the inductances are commonly found in all televisor stages.

The anode load of the R.F. stage may be resistive or inductive. The popular type of stage coupling now appears to be transformer coupling, one or both coils being tuned by adjustable cores, but resistance loads in R.F. amplifier anode circuits are still found, the signal being passed on via a capacitance to a tuned grid winding in the next stage. Such a coupling is shown in Fig. 23a, and is still popular in home-constructed sets.

The degree of coupling in transformer coupled stages varies with the make and design of the receiver, and in some sets only a portion

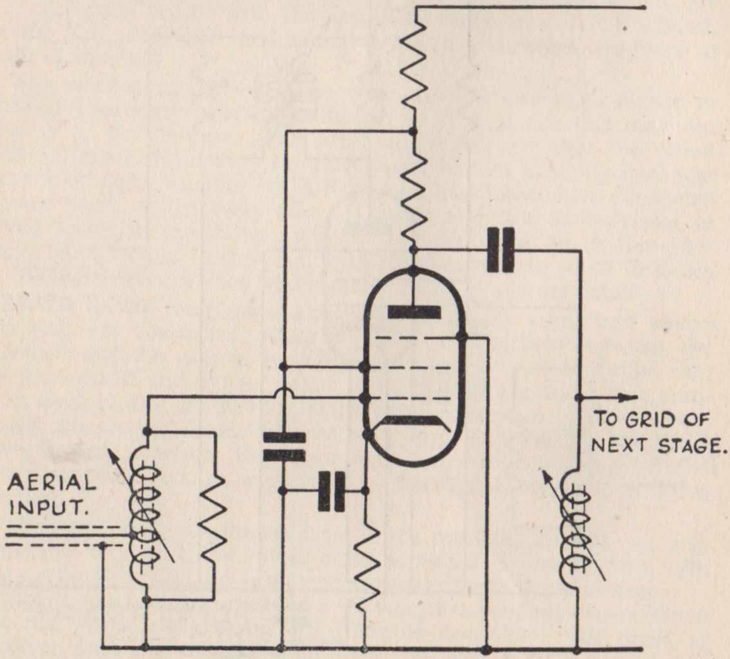


FIG. 23A.—A typical R.F. Stage, with Capacitive Coupling of the whole secondary transformer winding is coupled to the primary.

Valve heaters are often bypassed or filtered for R.F. to prevent inter-stage coupling, and heater chokes are sometimes found. as well as heater bypassing capacitors connecting directly from the heater sockets to the chassis.

The Contrast Control in practically any televisor works either in the R.F. stage or in the I.F. stages if the receiver is of the superhet type. Contrast is controlled by varying the R.F. gain of the receiver, and the control may therefore be likened to the R.F. gain control of an ordinary set or the I.F. gain control of a communications receiver.

The simple circuit used in broadcast frequency receivers for the control of R.F. or I.F. amplification is not suitable for televisors, however. Unless certain precautions are taken, altering the gain of an R.F. or I.F. stage merely by varying, say, the cathode resistance, alters the input capacitance of the valve. The input capacitance is usually the main tuning capacitance of the stage, and so any change in this valve characteristic results in a change of tuning.

The mutual conductance of the valve can be reduced with no great change in the input capacitance by varying the bias on both the control and the suppressor grid, and so the majority of sets have contrast control networks which, at first sight, seem unnecessarily complicated and unwieldy; remembering that they have a particular function to perform, with a little patience, will enable the engineer to unravel the circuit.

The basic circuit, found in both R.F. and I.F. stages, is shown in Fig. 23b. The suppressor grid is earthed and so is biased back to the full cathode bias, whilst the control grid is connected to a network which allows it to receive only a fraction of the whole bias voltage obtainable.

The resistance and capacitance values shown are fairly representative for modern valves.

The maintenance of the correct aerial coupling into the first R.F. stage is of considerable importance. Whether the coupling is inductive or tapped on to the coil it is designed to provide a proper impedance match between the aerial feeder and the input impedance of the first stage, and if this matching should be disturbed in any way the transfer of energy from the aerial to the receiver will suffer. In the case of a very bad mis-match it is possible for energy to be reflected at the receiver input terminals so that it travels back to the aerial, only to be reflected once again and so cause a "ghost" on the screen on its second appearance at the input terminals.

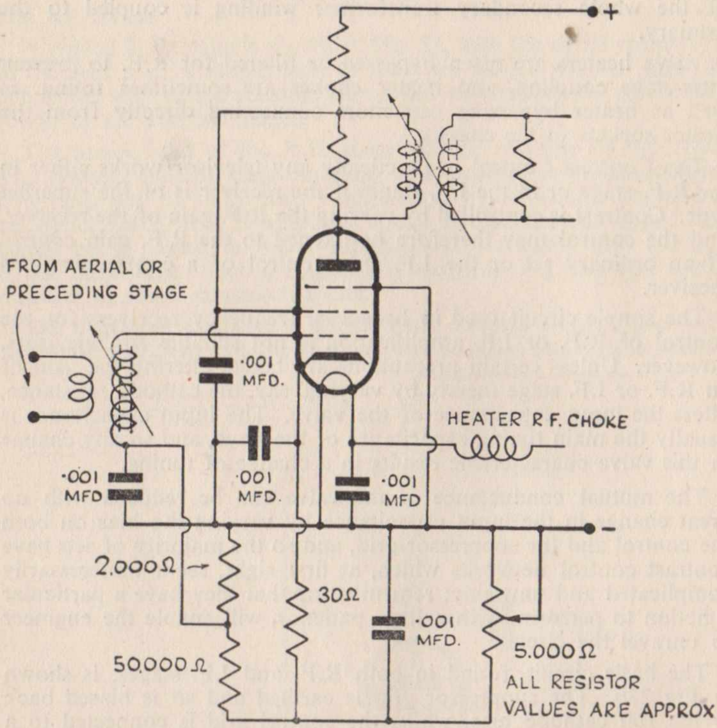


FIG. 23B.—Typical Contrast Control for an RF or IF Stage

There would be, of course, no point in deliberately mis-matching the aerial to the receiver, but the matching can suffer through an accidental use of the wrong kind of feeder, or by trying to operate the set from the wrong type of aerial.

THE T.R.F. SET

The T.R.F. receiver consists of a number of R.F. stages, all basically similar to one or other of the stages so far shown, feeding one into another and finally into the detector or demodulator. The Contrast control may operate over only one of the stages, though more than one stage may be controlled, whilst the total number of R.F. stages is generally of the order of four.

Of these four stages probably the first two are common to both sound and vision, the sound signal being tapped off from the cathode of the third R.F. stage. Ideally, of course, the Contrast control should have little effect on the sound signal, and so the first stage of such a receiver is often left running at full gain, the Contrast control taking effect on later stages.

The sound signal may be taken from the composite signal by one of several ways. The second coupling transformer may have a third winding tuned for sound, the rest of the vision circuit being fed through a sound frequency filter, and the full circuit diagrams can be consulted for examples of the manner in which the sound and vision signals are separated. In the Pye receiver, for example, the first two R.F. stages are common to both channels, the sound being removed by a tuned circuit providing part of the cathode load of the third R.F. stage. Such a tuned circuit also acts as a rejector, and so the stage passes on the vision signal for further amplification with none (or extremely little) of the sound signal remaining.

The circuit rejects the sound signal from the stage simply because it is tuned to the sound frequency and so provides heavy negative feedback over the valve's cathode-grid circuit at this frequency. Over the vision band the feedback is far smaller—it may be taken as non-existent in a well-designed filter—but for the sound frequencies the filter presents a greatly increased impedance, sound frequency voltages build up across the rejector, and not only do these provide the feedback, thus clearing the sound from the vision channel, but they are also available for passing on to the further amplifiers in the sound channel. The sound rejector is shown in Fig. 24.

A great number of commercial televisors now have the output stage and loudspeaker mounted on the same chassis as the power pack, so that the last sound stage on the main receiver chassis is the diode demodulator. Diodes will be found as detectors in both T.R.F. and superhet receivers, and very often a double diode is used in each case, one section of the valve acting as the demodulator and the other as an interference limiter.

The demodulator and interference limiter of a T.R.F. receiver follows much the same design as does that of a superhet, so that these stages, as well as the video amplifier, can be discussed under the heading of superhet receivers.

SUPERHET RECEIVERS

A superhet will be found to have an R.F. stage before the mixer, even if the set is intended to have high gain and requires an attenuator between the aerial and the input circuit. An R.F. stage has a much higher signal-to-noise ratio—that is, the stage introduces little noise into the circuit whilst giving good sensitivity—whilst the frequency changer or oscillator-mixer of a superhet is a relatively noisy circuit. The signal therefore needs amplification before the mixer.

Noise may be described as random signal. A receiver with a poor signal-to-noise ratio would operate very inefficiently at distances far removed from the transmitter, whilst the picture obtained from such a set would not compare with the brighter, cleaner picture given by a televisor with a high signal-to-noise ratio.

The R.F. stage is coupled either by a transformer or a capacitive coupling into the frequency changer section of the set, and it is quite general practice to use a normal triode-hexode as the oscillator-mixer. Some receivers use separate oscillators with pentode mixers, but in any case the efficiency over the whole mixer stage is never great and it is generally thought advisable to make the frequency conversion as simple and stable a circuit as possible, leaving amplification to the I.F. stages of the set.

A typical triode-hexode frequency changer is shown in Fig. 25. The single coil oscillator circuit should be noted—this variation on

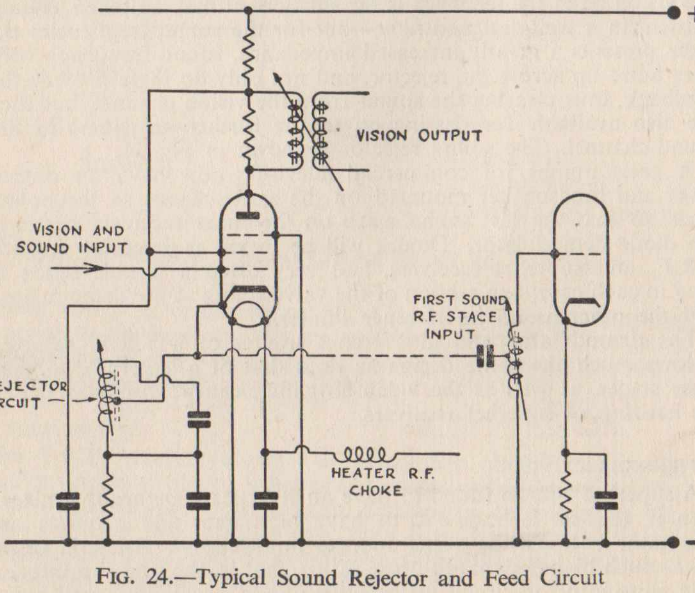


FIG. 24.—Typical Sound Rejector and Feed Circuit

the Colpitts oscillator is commonly used. The amplitude of oscillation depends on the coil diameter, the grid capacitor and the grid leak, and should any of these components need replacement at any time some care must be taken to use the correct values. A replacement coil, if needed, should of course be obtained from the manufacturer of the televisor.

The central I.F. of a televisor is chosen with great care to give efficient working and also to avoid interference by short-wave transmitters; the I.F. is high, usually of the order of 10 to 13 mcs., and so open to short-wave interference around the 30 metre band, so that careful screening is necessary.

Separation of the vision and sound channels at the frequency changer is therefore relatively simple. Presume the oscillator to be working at a frequency of 55 mcs. (a higher frequency than the carrier frequency is sometimes used to lessen the chances of interference); in this case the vision I.F. will be 54-45 m/cs. or 10 m/cs. The sound I.F. will be 55-41.5 mcs., or 13.5 mcs., and the two I.F. signals can be separated by tuned circuits.

A quite common method of picking up the sound I.F. is shown in Fig. 25. A double winding transformer directly in the anode

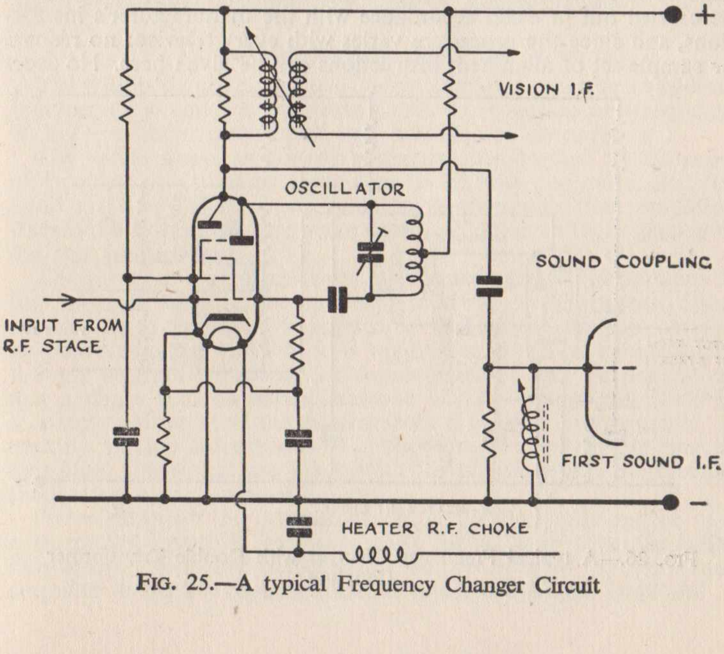


FIG. 25.—A typical Frequency Changer Circuit

circuit of the hexode passes on the I.F. carrying the vision signals and a single winding transformer is tuned to the sound I.F. The coupling capacitance is very small—usually of the order of 4 to 10 pfs.—so that the loading on the vision circuit is light. The sound I.F. amplifier is then transformer-coupled into the sound demodulator.

Some receivers also use two transformers in the hexode anode line, when the basic circuit takes on the form of Fig. 26.

The chief advantage of the superhet over the T.R.F. circuit for television is the greater gain possible in the I.F. stages over the gain obtained when the same types of valve are used as R.F. amplifiers, whilst filtering the sound from the vision signal is, perhaps, a rather simpler matter. Modern valves have, however, reduced the advantages of the superhet over the T.R.F. receiver, and a comparison of two representative televisors under working conditions will show that so far as the final results are concerned there is nothing to choose between the circuits.

When either type of televisor is being re-aligned the work must be carried out with the aid of a good signal generator which will tune up to 50 mcs., and a reliable output meter. Re-alignments must be carried out in exact accordance with the manufacturer's instructions, and since the procedure varies with every televisor no résumé or sample set of alignment instructions can be given here. No short

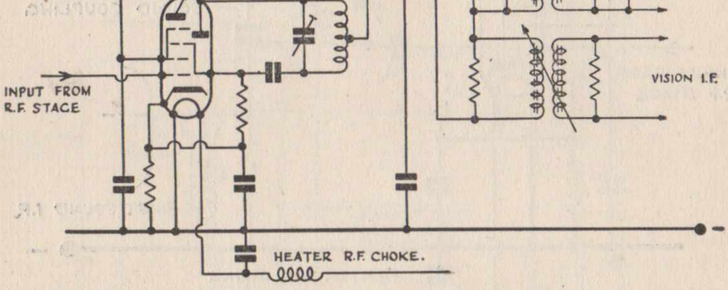


FIG. 26.—A typical Frequency Changer with Double Transformer Coupling

cuts are possible in televisor alignment, and if the printed instructions for the set in hand are not available, then in the writer's opinion the work should not be attempted.

Fortunately, the need for re-alignment of the tuned circuits rarely arises, for the bandwidth is so broad that even the replacement of a valve often has no visible effect on the picture or, using instruments, on the tuning as indicated by a signal generator and output meter. The one control which may be corrected, on some superhets, without the alignment procedure and without the use of instruments, is the oscillator tuning capacitor. If sound is weak, or the sound and picture appear to be unbalanced in any way, then a careful and gradual change of setting of the oscillator tuning is often beneficial.

Many receivers have temperature compensating capacitors in the oscillator circuit to correct automatically for any tendency to drift, with heating, of the oscillator frequency. In the event of a breakdown in the oscillator circuit which necessitates a component replacement, such capacitors must be noted and replaced with the correct types, as well as values.

A typical television I.F. amplifier is shown in Fig. 27, with Contrast control on the I.F. valves. Note that control of both control and suppressor grid is still employed to prevent detuning.

The Vision Demodulator and Video Amplifier

The vision demodulator and video amplifier must be considered together as a unit for the reason that the coupling between them is, in the modern receiver, of very considerable importance.

The whole stage, as already explained, has to deal with a range of frequencies extending from zero to 2.5 mcs., or more, and this band must be demodulated, and the video signals then amplified, linearly, with no high frequency losses or phase shifts or gain over the low frequencies.

The avoidance of phase shift is of much greater importance in the televisor than in the ordinary receiver. It has already been shown that if the signal is applied to the grid of the tube it must be positive-going, whilst if it is applied to the C.R. tube cathode it must be negative-going ; in consequence, it will be understood that a phase shift on either electrode of 180 degrees will result in a complete reversal of the picture from a positive to a negative A negative picture corresponds to a photographic negative in that all highlights and whites are black with the blacks white, intermediate shades also being reversed.

Phase shifts of 180 degrees would not in any case appear over a capacitive coupling, but some shift would arise over the lower frequencies were the demodulator to be coupled to the video amplifier through a capacitor and so direct coupling is employed

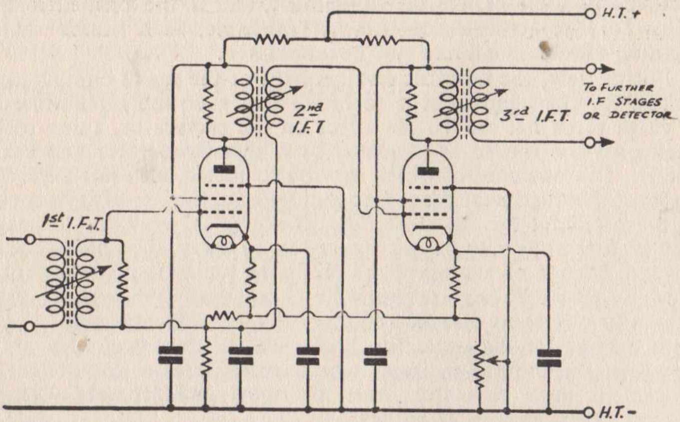


FIG. 27.—A typical I.F. Amplifier for the Vision Frequencies, with Contrast Control

At some point in the video amplifier circuit there must be compensation for unavoidable high frequency losses. As the frequency rises in any valve amplifying circuit the losses increase for the simple reason that the impedance presented to the signal by the valve's input and, especially, output capacitances, is reduced. The gain over the circuit therefore falls as the frequency rises.

To counteract this effect the circuit must be given a characteristic which supplies greater gain over the higher frequencies, the increase in gain being balanced as exactly as possible against the losses introduced, and over the same range of frequencies. The losses are caused by capacitance ; the extra gain is obtained by inserting at some point in the circuit an inductance. The impedance of the inductance rises with frequency, so that greater signal voltages are set up across the inductance by high frequencies. At one time it was common to find such an inductance or " peaking coil " forming a part of the video amplifier's anode load, but the peaking coil now appears often to be connected into the video amplifier grid circuit. In theoretical diagrams the peaking coil must not be confused with the choke coil often used in the coupling between the demodulator and the video amplifier. The choke coil is tuned to the signal frequency to block any stray R.F. still present on the demodulated signal ; in the T.R.F. receiver the choke coil will therefore operate at 45 mcs. and in a superhet it will resonate over the intermediate frequency band.

When capacitors are used to bypass the R.F. choke to earth their values are usually very low, since there must be no chance of by-passing the signal frequencies as well (e.g., C1 in Fig. 28 = 4.7 pfs.).

A typical demodulator and video amplifier circuit is shown in Fig. 28 with an interference limiter also shown. The circuit is that used in Pye receivers, and is described by permission of Messrs. Pye, Ltd.

The second half of the double diode is the interference limiter. The signal at the video amplifier anode is negative-going, i.e., the whites and highlights are negative, and so the diode conducts only on the highlights, and C2 is normally discharged. If a pulse of interference passes, the anode of the video amplifier runs much more negative than for a normal highlight. Under normal conditions the time-constant of C2 and R1 is adjusted to suit the television signal, but on interference the time-constant is such that C2 will not discharge sufficiently rapidly and so each interference pulse drives the grid of the video amplifier negative through C2 and so reduces the gain of the amplifier whilst the interference persists. The effect of interference — and particularly ignition interference (white splashes)—on the picture is therefore considerably reduced.

The video amplifier is connected to the C.R. tube in the manner already described, so far as the Pye demodulator and video amplifier stage is concerned, and, in other receivers, in some manner allowing for frequency compensation and the correct reproduction of the D.C. component of the signal.

In some receivers full-wave demodulation may be used, both halves of a double-diode being employed for the purpose, but this,

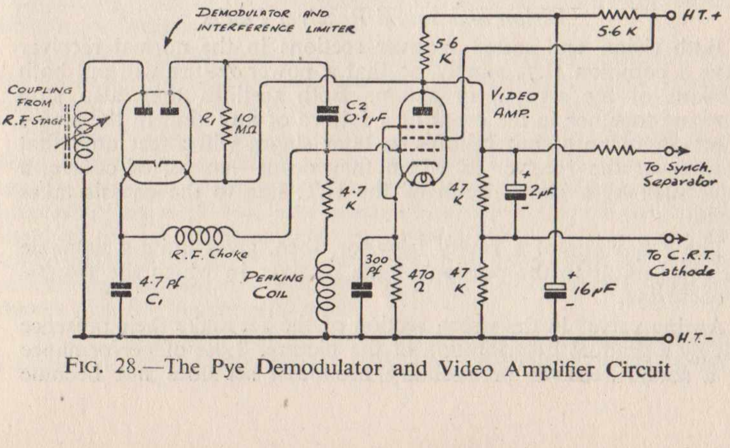


FIG. 28.—The Pye Demodulator and Video Amplifier Circuit

of course, is more usual in a superhet, and in any case single diode —that is, half-wave—demodulation appears to be more common.

The Sound Receiver

The only unusual feature of a televisor sound receiver, the separating circuits or filters which allow the sound signal to share the first stages of the receiver with the vision channel, have already been discussed, and the rest of the sound receiver follows normal practice to such a degree that special treatment of these stages is not needed.

There are, usually, two further amplifying stages after the separating filters, then a diode demodulator and interference limiter, the demodulator sometimes being a full-wave but more generally a half-wave circuit.

In some receivers there are two controls on the sound receiver, one an R.F. or I.F. gain control arranged in the same manner as the vision Contrast control to avoid detuning of the stages involved, and the other an ordinary volume control operating in the grid circuit of the sound output stage—the Pye receiver is an example of a televisor where both controls are incorporated. In other sets a volume control only is employed.

The sound interference limiter generally works in much the same manner as the vision limiter—in any case a diode or metal rectifier is used in one of two basic circuits. The first type of limiter " by-passes " the interference, the other type of limiter becomes non-conductive to interference pulses and acts as a series-connected device.

Vision and Sound Receiver Faults

Both vision and sound receiver sections in the normal receiver have a common H.T. supply, so that a power failure will put both sections of the set out of action. Both sections may also stop working together in the event of a failure of any kind in the stages common to both, but failures in later stages will affect only that portion of the receiver in which they occur—unless, of course, a fault such as a short-circuit of the H.T. line to the chassis takes place.

The behaviour of a faulty televisor, then, gives quite a valuable set of clues as to the portion of the receiver in which the trouble is occurring.

Ageing valves in the vision section of the set make their presence felt by a gradual deterioration of the picture. Loss of performance in a sound receiver or ordinary broadcast set does not become apparent for some time as the ear is very accommodating, but picture quality is more easily judged and, generally speaking, the eye is a more critical organ. A loss of picture quality—depth and tone—may be due to an ageing valve ; some televisor valves work under rather strenuous conditions and so if no more serious fault is apparent a substitution of new valves for old may be tried. The video amplifier is one stage in which the valve may age before those in other stages since the video amplifier is often running at full gain with low bias voltages, but fairly low bias voltages are quite common throughout the vision receiver.

It may be said at this point that it should not be forgotten that the C.R. tube can age, too ; the modern tube is less prone to faults and has a longer life than was once the case with cathode ray tubes, but the screen is still, generally speaking, the first part of the tube to show signs of wear and tear. If a dull picture is the trouble, it is worth while comparing the centre of the screen with the edges of the fluorescent material shielded by the mask from external light and on which the picture does not fall. In an old tube a very noticeable difference will be found, the screen centre will be discoloured and yellowed whilst the screen edges will still be a creamy white. Such a tube is in all probability due for replacement, when the picture detail and sparkle will be renewed.

The tube screen and safety glass window should be cleaned regularly.

Instability in a vision receiver is the cause of some very noticeable effects on the picture. Should the R.F. or I.F. stages actually go into oscillation the picture may vanish from the screen, leaving a flare of white, whilst varying degrees of instability will have varying " modelling " effects on the picture, sometimes similar to the effect known as " plastic."

Instability can be caused by a failure in a bypass capacitor, by the breaking—perhaps through handling—of the contact to a valve's metallised coating, or through a fault in a tuned circuit.

" Plastic " is the effect caused by an improper or inadequate low frequency response, and so can be the result of a failure in a D.C. restorer, though in the modern receiver the only likely cause is an incorrectly adjusted oscillator placing the vision I.F. off the tuned band of the I.F. transformers. A " plastic " picture shows loss of tone—detail is perfectly clear and sharp and the edges of objects are properly shown, but the tone or shade of the objects tends to merge with the background tone.

" Flare," especially with an out-of-focus effect, is due to the exact reverse of the last-mentioned fault and, therefore, to an over-amplification of the low frequencies. It would probably be due. in the modern set, to the failure of a compensating capacitor in the output network of the video amplifier, such as C2 in Fig. 21.

By " flaring " is meant the spreading of all objects on the right-hand side, each part of the picture " tailing-off " instead of being properly shaped.

Incorrect coupling transformer tuning, or a mis-setting of the oscillator tuning, can cause the effect known as " black after white " in which, on the right-hand boundary of white or light objects, a black line appears, very slightly separated from the object and following its shape. If the object is dark, or black, then the boundary or following line is white. In a very bad case of mis-tuning there can be several lines, one following the other, but one, or in some instances two, lines are more generally seen when the trouble arises.

A very careful use of the effect can enhance the apparent detail on the screen and it has been used with effect by the writer in home-constructed apparatus; in the commercial televisor it should not appear, however, and indicates that either the oscillator or the R.F. or I.F. couplings are out of trim.

In the case of an indeterminate fault where there are no outstanding effects or clues, and especially when the picture is poor with the sound working well, a careful voltage check on all the vision valves should be made. Loss of voltage in the I.F. amplifier for any reason can soon cause a poor picture and even non-reception, whilst loss of voltage on the frequency changer can put this stage right out of action—in this case the sound would also be affected, of course, unless a totally separate sound receiver is in use.

When voltages are being checked the heater line should not be forgotten. In a televisor the heater supply is not so direct and straightforward as in the ordinary set, since heater bypassing and choking circuits are employed, and a quite simple fault in a heater line could cause a considerable amount of trouble in the tracing if these circuits are overlooked.

It must also be remembered that simple mechanical faults, such as valves loose in their sockets, can also cause trouble, though in this case the symptoms will usually be those of an intermittent fault, the picture appearing and vanishing at random, possibly with accompanying effects in the sound. For any such fault, a quick mechanical check should always be the first thought of the engineer.

CHAPTER 7

The Aerial and the Input Attenuator

THE need for perfect matching of the aerial has already been mentioned, in order that energy feed into the first stage of the televisor may be correct with no reflections which, if they do not cause " ghosts " will result in poor operation.

Besides this matching, however, the transfer of energy from the aerial to the televisor must be so adjusted that the first stage of the receiver may not become overloaded. A television receiver has to be designed and made so that it is suitable for operation at any point within the service area of the transmitter, and this means that sensitivity, bearing in mind the bandwidth covered, is high.

A receiver used near to the transmitter can thus be overloaded, giving the effect, on the screen, known as " soot and whitewash," where the blacks are dense, the highlights intense, and the whole picture glaring and lacking in tonal value.

The use of a less efficient aerial is no remedy for the effect for it is still necessary to use a dipole properly matched into the televisor. An attic aerial might be used in place of an outdoor aerial, but the usual method of correcting the too great input to the set is by the use of an attenuator. In some receivers attenuators are built in, giving variable and selectable sensitivities—see the G.E.C. circuit for an example—and for other receivers attenuators can be obtained from the manufacturers for insertion between the feeder and the televisor's input terminals.

It must be borne in mind that a simple resistance is not a suitable attenuator. The aerial impedance—73 ohms approximately for the normal dipole—must still be matched correctly into the receiver, and a simple resistance, though reducing the input, will upset the matching between the feeder and set.

The attenuator must therefore be a network which presents equal input and output resistances whilst giving a loss over the system. For co-axial feeders a T-section attenuator is suitable ; for two-wire feeders the H-section attenuator should be used.

Attenuators must be carefully made so that stray inductances and capacitances are cut to the minimum.

The two sections are shown in Fig. 29, and attenuators can be made up, if desired, using the following formulæ:—

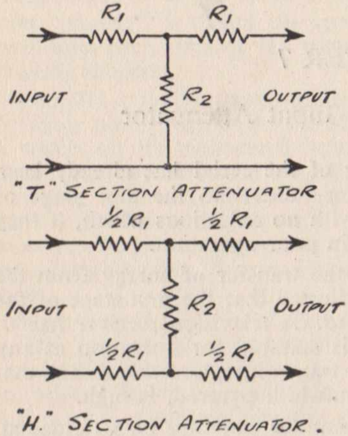


FIG. 29.—
Televisor Input Attenuators

$$R1 = \frac{R\,.\,(A - 1)}{A + 1}$$

$$R2 = \frac{R\,.\,2A}{(A - 1)\,.\,(A + 1)}$$

where R1 and R2 are the resistors shown in the figure and A is the ratio of the input to the output voltage, with R the input and output resistance.

Supposing, therefore, that it is required to reduce the input voltage to the televisor by 5, then A becomes 5 and the resistances calculate out to

R1 = 49 ohms approx. and R2 = 30.4 ohms.

when R, the aerial and input impedance, is taken as 73 ohms.

Provided that the aerial and its feeder line are of reputable make there should be no chance of faults arising in these sections of the whole receiving system. The weakest part of the aerial is at the junction of the feeders with the two halves of the dipole ; in a good aerial these joints will be both highly insulated and well protected from the weather. The aerial, especially if mounted well above the roof, should also be provided with a static discharger connected by as direct a route as possible to earth; the Belling-Lee aerial embodies all these points and can be highly recommended.

Aerial type and location will be decided upon when the televisor is first installed, and some attention should be given to situating the aerial in such a position that it is out of any interference field which may exist—at the rear of the house, for example, if the house fronts on to a busy road—yet does not require a long and circuitous feeder line which will introduce losses.

The aerial must also be situated so that there is no chance of "ghosts" caused by reflection of the transmitted wave from large buildings, gasholders, etc. Ghosts caused by mismatching of the feeder to the receiver are, or should be, rare, but ghosts caused by double reception of the signal, once by a direct path and again, a fraction of a second after, by an indirect path, are not so rare and must be avoided.

Both interference and ghosts can be eliminated to a great extent first by testing out several aerial positions and choosing the best, and secondly by using an aerial with a reflector which improves gain from the forward direction and practically blocks out any signal from the rear.

If the receiver is far from the transmitter an aerial with a reflector will in any case be a necessity.

The reflector is a plain metal rod with no central break, such as that employed in the dipole proper, and the reflector length is usually made a little more than the dipole length by approximately 5%. The reflector is situated behind the dipole, so that the aerial is in line with the reflector and transmitter, and the spacing is such that the distance between the aerial and reflector is between about one-quarter to three-quarters of a wavelength.

The aerial is, of course, mounted vertically, because the transmitter aerials are vertical and the transmitted wave is therefore vertically polarized; nevertheless, at considerable distances from the transmitter the polarization of the wave can shift, and it may be advisable to swing the aerial a few degrees off vertical to see if any improvement in the signal can be obtained by so doing.

CHAPTER 8

Broadcast Receiver Units and Televisor Switching

SOME televisors are fitted with broadcast receiver units—the modern trend would seem to have these units switched and pre-tuned to two or three main stations—so that the whole receiver serves both for the television and also for the Home, Light and Third programmes; sometimes only the Home and Light programmes are tuned.

The broadcast unit is generally small and mounted on a separate chassis, as shown in Fig 3, for example, but in some cases the unit is not pre-tuned and acts as a normal receiver over the Long, Medium and Short waves, as in the G.E.C. BT7092.

Whether the unit is small or, as in the case of the G.E.C. receiver, very comprehensive and operated through push-buttons, it is serviced, if required, in the same way as any other ordinary receiver. The usual circuit arrangement has a frequency changer as the input stage, followed by an I.F. amplifier and demodulator, the output stage being common to both the broadcast unit and the television sound.

So far as service work is concerned, the switching of the broadcast unit is probably the most important section of the receiver. This switching will put the C.R. tube out of action, as well as the timebases and, possibly, the vision receiver, and a failure in the switch leaves may be difficult to trace and remedy. In every case the manufacturers' instructions will be required; some receivers have rotary switches and some push-button switching, and each switch leaf may control many circuits, throwing in resistors and opening feedlines. The function of the switches in the G.E.C. receiver is analysed in the components list accompanying the circuit diagram of the BT7092 as an example.

In the event of a failure in the broadcast receiver unit a quick and rough check of the seat of the trouble can be made by switching on the television receiver. If vision and sound operate correctly it may, in most cases, be taken that all is well with the power supply to the broadcast unit, whilst it will also be known that the output stage is in order. Switching back to the broadcast unit, a click test can be made over the I.F. stage—tapping the grid and anode connections of the I.F. valve with a screwdriver, or shorting them to earth through a capacitor—to check the I.F. amplifier and demodulator, and the fault further located. Testing the electrode voltages could be the next step, or, of course, a signal tracer might be used.

As much care for personal safety must be taken when the broadcast unit is under test as if it were the E.H.T. power pack. The high tension circuits may not be switched out when the broadcast unit is in operation, or, even if they are, a faulty switch section may have brought them in. In any case the capacitors may be charged, and work on the broadcast unit may bring the hand into close proximity with a high voltage connection.

Safety precautions, such as removing the E.H.T. rectifier before switching on the set, as well as discharging the E.H.T. capacitors, must therefore always be taken.

APPENDIX A

Some Televisor Faults and their Causes

Fault	*Possible Cause or Check Point*
No vision, no sound, no raster.	No mains supply. Check wall plug, cable, switches, receiver fuse, voltage adjustment. Check transformer/s primary.
Raster, no vision, no sound.	Check aerial connection. H.T. supplies to receiver faulty. Check power pack, interconnecting plugs. Check for break over control and input circuits. Check frequency changer.
Sound, no vision, no raster.	Check power pack for heater and E.H.T. supplies to C.R. tube. Check tube for damage or failure. Check for no H.T. on vision channel and timebases.

Fault	*Possible Cause or Check Point*
Sound, raster, no vision.	Check through vision receiver. Loose valves, broken or open circuit contrast control, low voltages. Check for earthing on valve metallising, especially over earthing clips if used.
Vision, no sound.	Check over sound receiver, and at points where sound is filtered from vision. Check connection between demodulator and output stage. Check output stage and loudspeaker. Check for H.T. on output stage.
Good raster, poor vision and sound.	Check aerial and input connection. Check for attenuator being used accidentally. Check H.T. line throughout receiver. Check valve operating voltages. Check valves for age and seating in sockets. Check oscillator tuning.
Vision, distorted sound.	Check for overloading in sound R.F. or I.F. stages, and check sensitivity control. Check connections to output stage, check for leaky coupling capacitor. Check output stage bias, and for open-circuit volume control.
Good sound, but vision faults:—	
Picture too contrasty.	Aerial input too great. Vision Contrast Control too far advanced.
Picture flat. (Dull, no contrast.)	Aerial input low. Vision Contrast Control not advanced sufficiently. Fault in video amplifier coupling. C.R. tube ageing. Oscillator or tuned circuits out of trim.
Flare, or black after white.	Vision tuning circuits out of alignment. L.F. compensation out of order.
Flicker at picture edge, or stray modulation on picture in bands. Effect varies with the sound.	Sound signal leaking through to vision circuits. Check sound traps and filters.

Fault	*Possible Cause or Check Point*
Bars across picture or wavering edge.	Hum, on vision circuits to give bars, on timebases to affect edges.
Focus poor.	Focus control requires resetting. Receiver taking too much or too little current through coil. Permanent magnet losing strength. Fault in focus coil, such as shorting turns. Fault in focus control rheostat. Leak in smoothing capacitor.
Focus lost.	Focus control faulty. Focus coil open-circuited / short-circuited.
Varying focus.	Focus circuits smoothing capacitor open-circuited.
Poor interlacing.	Sync. separator faulty, or line pulses feeding through to frame timebase.
No sync.	Sync. separator valve or feed circuits at fault.
Sync. only in one direction, horizontal or vertical.	Sync. feed transformers between Sync. separator and timebases at fault. Sync. isolating circuits or diodes at fault.
Sound and vision receivers found to be in order, but no picture or spot on tube.	Check tube and supplies. Check high bias on C.R. tube cathode, if protective circuit is fitted.
Unfocused spot, central.	Check H.T. to timebases.
Vertical trace only.	Line timebase out of action.
Horizontal trace only.	Frame timebase out of action.
Insufficient width.	Check line timebase for low H.T. Check deflector coils. Check line output transformer. Check line amplifier valve.
Insufficient height.	Check frame timebase for low H.T. Check deflector coils and transformer if used. Check frame amplifier valve.

Fault	*Possible Cause or Check Point*
Portion only of picture, or jumble of lines.	Timebases running too quickly. Check both timebase circuits and controls.
More than one picture, picture with black edges.	Timebases running too slowly. Check both timebase circuits and controls.
Timebase Speed correct but picture too large.	Timebase H.T. too high. E.H.T. low. Check amplitude controls for correct settings.
Timebase Speed correct but picture too small.	H.T. voltage too low. E.H.T. high.
Loss of linearity, frame or line.	Check deflector coils. Check linearising circuits. Check insulation of timebase capacitors, especially main charging capacitor.
White line at top or side of picture.	Check components, especially capacitors, in timebase circuits. Check sync. separator.

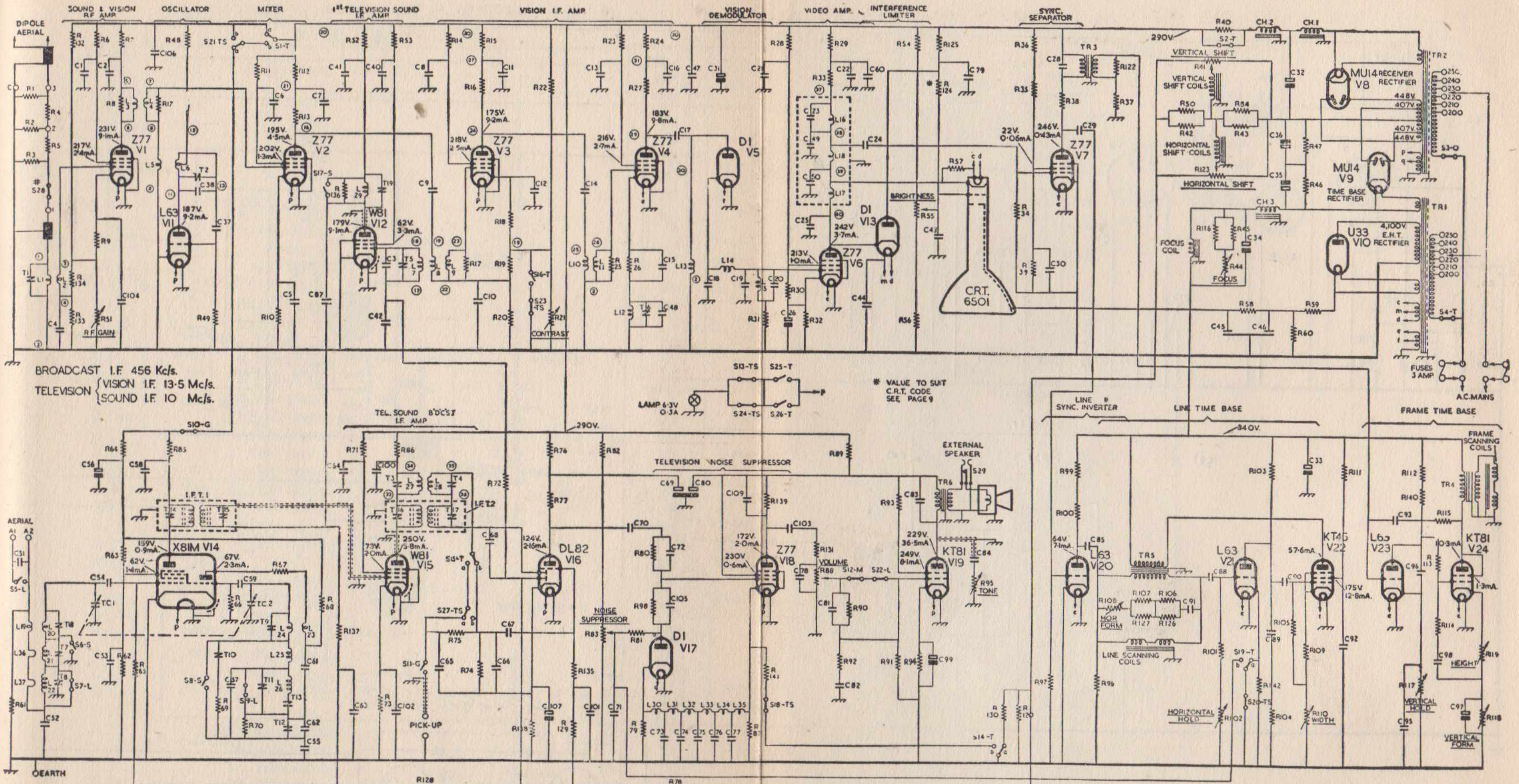
APPENDIX B

RECEIVER SECTION

Some Typical British Televisor Circuits

All Diagrams, Lists,
and Information by
kind permission
of :—

THE GENERAL ELECTRIC CO. LTD.
INVICTA RADIO, LTD.
KOLSTER-BRANDES, LTD.
MURPHY RADIO, LTD.
PYE, LTD.
THE RADIO GRAMOPHONE DEVELOPMENT CO. LTD.
ULTRA ELECTRIC, LTD.



CIRCUIT INDICATES CONDITIONS WHEN TELEVISION BUTTON IS DEPRESSED.

SWITCHES ARE LETTERED WITH THE INITIALS OF THE BUTTONS OPERATING THEM.

\# S28 IS OPENED WHEN THE TELEVISION AERIAL PLUG IS INSERTED IN AERIAL SOCKET 1.

ALL RANGE BUTTONS SWITCH ON S3

POTENTIAL & CURRENT VALUES TAKEN WITH R.F. GAIN & CONTRAST CONTROLS AT MAX.

ENCIRCLED NUMBERS SHOW THE CIRCUIT CONNECTIONS OF THE SIMILARLY MARKED POINTS IN FIG. 16.

FIG. 30.—The G.E.C. BT7092 Televisor

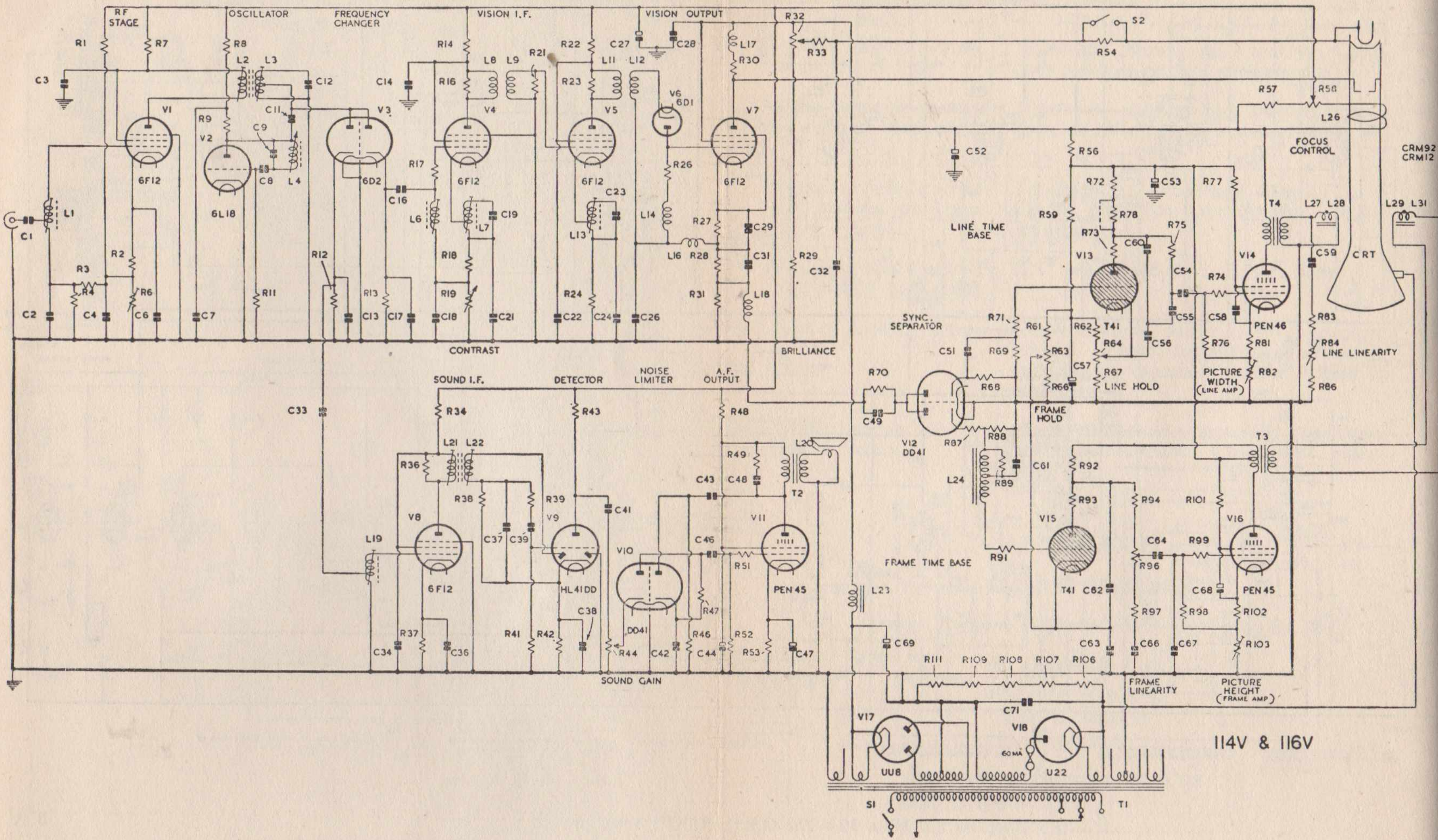


Fig. 35.—The Murphy V114 and V116 Televisors

PARTS LIST FOR THE G.E.C. BT 7092 *Fig. 30
RESISTOR VALUES

No.	Resistance	Rating Watts	Tol. ±%
R1	68 ohms	¼	10
R2	150 ohms	¼	10
R3	100 ohms	¼	10
R4	330 ohms	¼	10
R5	150 ohms	¼	10
R6	22,000 ohms	½	10
R7	4,700 ohms	1	10
R8	15,000 ohms	¼	5
R9	150 ohms	¼	10
R10	680 ohms	¼	10
R11	47,000 ohms	½	10
R12	10,000 ohms	½	10
R13	6,800 ohms	½	5
R14	22,000 ohms	½	10
R15	4,700 ohms	1	10
R16	4,700 ohms	1	5
R17	6,800 ohms	¼	5
R18	150 ohms	¼	10
R19	1,000 ohms	¼	10
R20	27,000 ohms	¼	10
R21	22,000 ohms	Contrast	
R22	47,000 ohms	2	10
R23	22,000 ohms	½	10
R24	4,700 ohms	1	10
R25	4,700 ohms	¼	5
R26	150 ohms	¼	10
R27	4,700 ohms	1	5
R28	10,000 ohms	1	10
R29	4,700 ohms	1	10
R30	47,000 ohms	1	10
R31	3,900 ohms	¼	10
R32	330 ohms	¼	10
R33	3,900 ohms	1	10
R34	1 meg.	½	20
R35	47,000 ohms	½	10
R36	56,000 ohms	1	10
R37	56,000 ohms	½	10
R38	10,000 ohms	½	10
R39	12,000 ohms	½	10
R40	180 ohms	3	10
R41	220 ohms	Vertical Shift	
R42	68 ohms	½	10
R43	150 ohms	½	10
R44	10,000 ohms	Focus	
R45	3,300 ohms	½	10
R46	150,000 ohms	½	10
R47	150,000 ohms	½	10

* Fig. 30 appears on page 80a.

PARTS LIST FOR THE G.E.C. BT 7092 Fig. 30 *(continued)*—

No.	Resistance	Rating Watts	Tol. ± %
R48	4,700 ohms	1	10
R49	100,000 ohms	½	10
R50	68 ohms	½	10
R51	22,000 ohms	R.F. Gain	
R52	10,000 ohms	2	10
R53	68,000 ohms	1	10
R54	56,000 ohms	½	10
R55	250,000 ohms	Brightness	
R56	100,000 ohms	½	10
R57	100,000 ohms	½	10
R58	150,000 ohms	1	10
R59	10,000 ohms	½	10
R60	6×1 meg.	1	10
R61	10,000 ohms	½	10
R62	22,000 ohms	½	10
R63	15,000 ohms	1	10
R64	22,000 ohms	2	10
R65	1 meg.	½	20
R66	100,000 ohms	½	10
R67	470 ohms	½	10
R68	22,000 ohms	½	10
R69	68 ohms	½	10
R70	10,000 ohms	½	10
R71	120,000 ohms	½	10
R72	1 meg.	½	20
R73	270 ohms	½	10
R74	47,000 ohms	½	10
R75	1 meg.	½	20
R76	22,000 ohms	½	10
R77	47,000 ohms	½	10
R78	470,000 ohms	½	10
R79	10,000 ohms	½	10
R80	470,000 ohms	½	10
R81	2·2 meg.	½	20
R82	68,000 ohms	1	10
R83	50,000 ohms	Noise Limiter	
R84	150 ohms	½	10
R85	68,000 ohms	½	10
R86	6,800 ohms	½	10
R87	10,000 ohms	½	10
R88	100,000 ohms	Volume	
R89	680 ohms	2	10
R90	220,000 ohms	½	10
R91	330,000 ohms	½	10
R92	150,000 ohms	½	10
R93	100 ohms	½	10
R94	91 ohms	½	10
R95	55,000 ohms	Tone	

PARTS LIST FOR G.E.C. BT 7092 Fig. 30 (*continued*)—

No.	Resistance	Rating Watts	Tol. ±%
R96	10,000 ohms	½	10
R97	22,000 ohms	½	10
R98	150,000 ohms	½	10
R99	22,000 ohms	2	10
R100	15,000 ohms	1	10
R101	150,000 ohms	½	10
R102	250,000 ohms	Horizontal Hold	
R103	470,000 ohms	½	10
R104	3,300 ohms	½	10
R105	220,000 ohms	½	10
R106	1,800 ohms	2	10
R107	1,800 ohms	2	10
R108	1,000 ohms	Horizontal Form	
R109	68 ohms	½	10
R110	1,000 ohms	Width	
R111	10,000 ohms	2	10
R112	1 meg.	½	20
R113	220,000 ohms	½	10
R114	100,000 ohms	½	10
R115	100,000 ohms	½	10
R116	3,300 ohms	½	10
R117	100,000 ohms	Vertical Hold	
R118	10,000 ohms	Vertical Form	
R119	1,000 ohms	Height	
R120	18 ohms	½	5
R121	8,200 ohms	¼	5
R122	10,000 ohms	½	10
R123	220 ohms	Horizontal Shift	
R124	0—68,000 ohms	½	10
R125	150,000 ohms	½	10
R126	1,800 ohms	2	10
R127	1,800 ohms	2	10
R128	1 meg.	½	20
R129	1 meg.	½	20
R130	27 ohms	½	10
R131	10,000 ohms	½	10
R132	47,000 ohms	2	10
R133	27,000 ohms	¼	10
R134	1,000 ohms	¼	10
R135	1 meg.	½	20
R136	33,000 ohms	½	5
R137	470,000 ohms	½	10
R138	1,000 ohms	½	10
R139	22,000 ohms	2	10
R140	470,000 ohms	½	10
R141	330 ohms	½	10
R142	470,000 ohms	½	10

CAPACITOR VALUES G.E.C. Model BT7092 Fig. 30

No.	Value	Type	Volts Working
C1	0·05 μF.	Tubular	350
C2	0·05 μF.	Tubular	350
C3	10·0 pF.	Close tolerance	500
C4	0·05 μF.	Tubular	350
C5	0·05 μF.	Tubular	350
C6	0·05 μF.	Tubular	350
C7	0·05 μF.	Tubular	350
C8	0·05 μF.	Tubular	350
C9	500·0 pF.	Moulded mica foil	350
C10	0·05 μF.	Tubular	350
C11	0·05 μF.	Tubular	350
C12	0·05 μF.	Tubular	350
C13	0·05 μF.	Tubular	350
C14	500·0 pF.	Moulded mica foil	350
C15	0·05 μF.	Tubular	350
C16	0·05 μF.	Tubular	350
C17	500·0 pF.	Moulded mica foil	350
C18	18·0 pF.	Close tolerance	500
C19	10·0 pF.	Close tolerance	500
C20	13·5 pF.	Close tolerance	500
C21	1·0 μF.	Tubular	350
C22	1·0 μF.	Tubular	350
C23	13·5 pF.	Close tolerance.	500
C24	0·1 μF.	Tubular	500
C25	10·0 pF.	Close tolerance	500
C26	25·0 μF.	Electrolytic	25
C28	0·02 μF.	Tubular	750
C29	100·0 pF.	Moulded mica foil	350
C30	1·0 μF.	Tubular	250
C31	32·0 μF.	Electrolytic	450
C32	16·0 μF.	Electrolytic	450
C33	8·0 μF.	Electrolytic	500
C34	50·0 μF.	Electrolytic	50
C35	16·0 μF.	Electrolytic	450
C36	16·0 μF.	Electrolytic	450
C37	47·0 pF.	Protected silver mica	350
C38	47·0 pF.	Close tolerance	350
C40	0·05 μF.	Tubular	350
C41	0·05 μF.	Tubular	500
C42	0·05 μF.	Tubular	350
C43	0·1 μF.	Tubular	500
C44	0·01 μF.	Tubular	1,000
C45	†0·1 μF.	Metal can	6,000
C46	†0·1 μF.	Metal can	6,000
C47	0·05 μF.	Tubular	500
C48	680·0 pF.	Close tolerance	350

CAPACITOR VALUES G.E.C. Model BT7092. Fig. 30 (*continued*)—

No.	Value	Type	Volts Working
C49	2·0 pF.	Cer.	500
C50	15·0 pF.	Close tolerance	500
C51	22·0 pF.	Protected silver mica	350
C52	0·003 μF.	Close tolerance	750
C53	0·05 μF.	Tubular	500
C54	100·0 pF.	Moulded mica foil	350
C55	3,950·0 pF.	Close tolerance	750
C56	16·0 μF.	Electrolytic	450
C57	39·0 pF.	Protected silver mica	350
C58	0·05 μF.	Tubular	500
C59	100·0 pF.	Moulded mica foil	350
C60	1·0 μF.	Tubular	350
C61	0·005 μF.	Tubular	1,000
C62	100·0 pF.	Protected silver mica	350
C63	0·05 μF.	Tubular	500
C64	0·05 μF.	Tubular	500
C65	200·0 pF.	Moulded mica foil	350
C66	15·0 pF.	Close tolerance.	500
C67	0·02 μF.	Tubular	750
C68	22·0 pF.	Protected silver mica	350
C69	*4·0 μF.	Electrolytic	450
C70	0·01 μF.	Tubular	1,000
C71	0·1 μF.	Tubular	500
C72	10·0 pF.	Close tolerance	500
C73	100·0 pF.	Moulded mica foil	350
C74	100·0 pF.	Moulded mica foil	350
C75	100·0 pF.	Moulded mica foil	350
C76	100·0 pF.	Moulded mica foil	350
C77	100·0 pF.	Moulded mica foil	350
C78	500 pF.	Moulded mica foil	350
C79	0·05 μF.	Tubular	500
C80	*8·0 μF.	Electrolytic	450
C81	500·0 pF.	Moulded mica foil	350
C82	1,500·0 pF.	Moulded mica foil	350
C83	0·005 μF.	Tubular	1,000
C84	0·05 μF.	Tubular	500
C85	0·005 μF.	Tubular	1,000
C87	100·0 pF.	Moulded mica foil	350
C88	47·0 pF.	Close tolerance	500
C89	0·001 μF.	Moulded mica foil	350
C90	0·005 μF.	Tubular	1,000
C91	0·01 μF.	Tubular	1,000
C92	1·0 μF.	Tubular	500
C93	0·005 μF.	Tubular	1,000
C95	0·1 μF.	Tubular	500
C96	0·05 μF.	Tubular	500

CAPACITOR VALUES G.E.C. Model BT7092 Fig. 30 (*continued*)—

No.	Value	Type	Volts Working
C97	32·0 μF.	Electrolytic	150
C98	0·05 μF.	Tubular	500
C99	25·0 μF.	Electrolytic	25
C100	0·05 μF.	Tubular	500
C101	0·5 μF.	Tubular	500
C102	0·05 μF.	Tubular	500
C103	0·05 μF.	Tubular	500
C104	0·5 μF.	Tubular	350
C105	50·0 pF.	Moulded mica foil	350
C106	0·05 μF.	Tubular	500
C107	25·0 μF.	Electrolytic	25
C109	500·0 pF.	Moulded mica foil	350

*** C69 and C80 have a common negative connection.**

† C45 and C46 have a common connection.

VARIABLE CONTROL RESISTORS

G.E.C. Model BT7092 Fig. 30

No.	Resistance	Watts Rating	Function
R21	22,000 ohms	2 watts	Contrast control
R41	220 ohms	1 watt	Vertical shift
R44	10,000 ohms	2 watts	Focus control
R51	22,000 ohms	2 watts	R.F. gain
R55	250,000 ohms	½ watt	Brilliance control
R83	50,000 ohms	2 watts	Noise suppressor control
R88	100,000 ohms	½ watt	Volume control
R95	55,000 ohms	½ watt	Tone control
R102	250,000 ohms	½ watt	Horinzontal hold
R108	1,000 ohms	4 watts	Horizontal form
R110	1,000 ohms	3 watts	Width control
R117	100,000 ohms	½ watt	Vertical hold
R118	10,000 ohms	3 watts	Vertical form
R119	1,000 ohms	2 watts	Height control
R123	220 ohms	1 watt	Horizontal shift

COILS AND TRANSFORMERS

G.E.C. Model BT7092 Fig. 30

No.	Description	Resistance in Ohms	Inductance
TR1	E.H.T. Transformer		
	Primary—0—250 V.	22·3	
	Secondary—E.H.T.	7,500.0	
	—Heater : V10 ..	0·074	
	—Heater : V9 ..	0·053	
	—Heater : c, m, d	0·26	
	—Heater : e, frame	0·056	
TR2	H.T. Transformer		
	Primary—0—250 V.	6·42	
	Secondary—H.T. Total ..	117·5	
	—H.T. tap-tap ..	110·0	
	—Heater : V8 ..	0·067	
	—Heater : a, frame	0·102	
TR3	Sync. Transformer		
	Primary—Inner	475·0	0·2 Hy.
	—Outer..	940·0	0·2 Hy.
	Secondary	4,750·0	7·4 Hy.
TR4	Frame Time Base Transformer		
	Primary	1,975·0	33·0 Hy.
	Secondary	6·2	0·27 Hy.
TR5	Line Time Base Transformer		
	Primary	280·0	3·0 Hy.
	Secondary	6·2	0·15 Hy.
TR6	Output Transformer		
	Primary	430·0	
	Secondary	0·49	
CH1	Smoothing Choke	150·0	5 Hy.
CH2	Smoothing Choke	150·0	5 Hy.
CH3	Smoothing Choke	490·0	12 Hy.
	Focus Coil	510·0	
	Deflector Coils		
	Line Pair	9·5	6·0 mH.
	Frame Pair	26·5	24·0 mH.
	Shift Coils		
	Each Set	90·0	
	Speaker Speech Coil	2·3	
IFT.1	Broadcast I.F. Transformer		
	Primary and Sec.	7·0	1·1 mH

No.	Description	Resistance in Ohms	Inductance
IFT.2	Broadcast I.F. Transformer		
	Primary and Sec.	4·0	0·47 mH.
	Television Aerial Transformer		
L1	Primary	0·1	
L2	Secondary	0·01	0·95 μH.
	Television R.F. Transformer		
L3	Primary	0·16	2·04 μH.
L4	Secondary	0·1	0·86 μH.
	Television Oscillator Coil		
L5	Primary	0·01	
L6	Secondary	0·05	
	Sound and Vision I.F. Transformer		
L7	Sound Secondary	0·9	5·45 μH.
L8	Primary	1·5	10·0 μH.
L9	Vision Secondary	2·5	19·55 μH.
	Vision I.F. Transformer		
L10	Primary	2·4	21·15 μH.
L11	Secondary	1·5	9·15 μH.
L12	Sound I.F. Rejector Coil ..	0·02	5·0 μH.
L13	Vision I.F. Output Coil	1·4	11·18 μH.
L14	Video Filter Coil	9·0	358·0 μH.
L15	Video Filter Coil	4·5	116·0 μH.
L16	Video Filter Coil	4·5	116·0 μH.
L17	Video Filter Coil	9·0	358·0 μH.
L18	Video Filter Coil	9·0	358·0 μH.
L19	SHORT W. Aerial Primary ..	0·18	
L20	SHORT W. Aerial Secondary ..	0·06	1·51 μH.
L21	MEDIUM W. Aerial Secondary	2·8	204·9 μH.
L22	LONG W. Aerial Secondary ..	19·5	2·28 mH.
L23	SHORT W. Oscillator Anode ..	0·32	
L24	SHORT W. Oscillator Grid ..	0·06	1·41 μH.
L25	MEDIUM W. Oscillator Grid ..	3·4	104·6 μH.
L26	LONG W. Oscillator Grid ..	7·7	443·2 μH.
	Sound I.F. Transformer		
L27	Primary	1·3	8·13 μH.
L28	Secondary	1·4	10·0 μH.
L29	Sound I.F. Coil	1·0	4·38 μH.
L30	Delay Coil	62·0	5·0 mH.
L31	Delay Coil	92·0	10·0 mH.
L32	Delay Coil	92·0	10·0 mH.
L33	Delay Coil	92·0	10·0 mH.
L34	Delay Coil	92·0	10.0 mH.
L35	Delay Coil	62·0	5·0 mH.

TRIMMING CAPACITORS G.E.C. Model BT7092 Fig. 30

No.	Capacity	Function
T1	50–130 pfs.	Aerial trimmer
T2	3·5–13·5 pfs.	Oscillator trimmer
T3, T4, T5	3.5–30 pfs.	Sound I.F. trimmers
T6	75–250 pfs.	Sound rejector trimmer
T7	3·5–30 pfs.	Medium-wave aerial trimmer
T8	40–80 pfs.	Long-wave aerial trimmer
T9	3·5–30 pfs.	Short-wave oscillator trimmer
T10	3·5–30 pfs.	Medium-wave oscillator trimmer
T11	40–80 pfs.	Long-wave oscillator trimmer
T12	150–425 pfs.	Medium-wave padder
T13	150–425 pfs.	Long-wave padder
T14	50–130 pfs.	Broadcast I.F. trimmer
T15	50–130 pfs	Broadcast I.F. trimmer
T16	150–425 pfs.	Broadcast I.F. trimmer
T17	150–425 pfs.	Broadcast I.F. trimmer
T18	3·5–30 pfs.	Shortwave aerial trimmer
T19	3·5–30 pfs.	Television sound I.F. trimmer

SWITCH FUNCTIONS IN THE G.E.C. MODEL BT7092 Fig. 30

No.	Button	Function
S1	Television	B/C-Tel. R.F., H.T. changeover
S2	Television	H.T. compensation. R40 shorted
S3	OFF	Mains on-off Sound
S4	Television	Mains on-off vision
S5	Long	Aerial coupling shorted
S6	Short	Medium-wave aerial coil shorted
S7	Long	Long-wave aerial coil shorted
S8	Short	Medium osc. coil shorted
S9	Long	Long osc. coil shorted
S10	Gram.	B/C. R.F. H.T. on-off
S11	Gram.	Pickup
S12	Medium	Treble boost
S13	Tele. sound	Dial lamp
S14	Television	A.G.C. delay. Bias changeover
S15	Television	Diode load changeover
S16	Television	H.T. compensation. V3 cath. shorted
S17	Short	Tele. sound muted
S18	Tele. sound	Noise suppressor
S19	Television	Line timebase. Noise suppressor
S20	Tele. sound	Line timebase. Noise suppressor
S21	Tele. sound	B/C/Tele. R.F. H.T. changeover
S22	Long	Treble boost
S23	Tele. sound	H.T. compensation on V3
S24	Tele. sound	Dial lamp
S25	Television	Dial lamp
S26	Television	Dial lamp
S27	Tele. sound	Diode load changeover
S28		Aerial attenuator
S29		Internal speaker muting

COMPONENTS LIST FOR THE INVICTA T101 TELEVISOR Fig. 31
RESISTOR VALUES

No.	Resistance	Rating Watts	
R1	4,700 ohms	1 watt	
R2	2·2 megohms	⅓ watt	
R3	47,000 ohms	⅓ watt	
R4	470 ohms	⅓ watt	
R5	470 ohms	⅓ watt	
R6	470 ohms	⅓ watt	
R7	470 ohms	⅓ watt	
R8	470 ohms	⅓ watt	
R9	470 ohms	⅓ watt	
R10	250 ohms	4 watts	Wirewound
R11	4,700 ohms	1 watt	
R12	10,000 ohms. preset	4 watts	Sound sensitivity
R13	47,000 ohms	⅓ watt	
R14	470,000 ohms	⅓ watt	
R15	10,000 ohms	⅓ watt	
R16	10,000 ohms	⅓ watt	
R17	10,000 ohms	⅓ watt	
R18	470 ohms	⅓ watt	
R19	10 megohms	⅓ watt	
R20	22,000 ohms	⅓ watt	
R21	10,000 ohms	⅓ watt	
R22	10,000 ohms	⅓ watt	
R23	1 megohm variable	Volume control	
R24	47,000 ohms	⅓ watt	
R25	22 ohms	⅓ watt	
R26	2,000 ohms	1 watt	
R27	15,000 ohms	⅓ watt	
R28	150 ohms	⅓ watt	10%
R29	1,000 ohms	⅓ watt	
R30	2·2 megohms	⅓ watt	
R31	47,000 ohms	⅓ watt	
R32	220 ohms	⅓ watt	
R33	33 ohms	⅓ watt	
R34	470 ohms	⅓ watt	
R35	33 ohms	⅓ watt	
R36	470 ohms	⅓ watt	
R37	33 ohms	⅓ watt	
R38	470 ohms	⅓ watt	
R39	33 ohms	⅓ watt	
R40	220 ohms	⅓ watt	
R41	2,700 ohms	⅓ watt	
R42	470 ohms	⅓ watt	
R43	6,800 ohms	Wirewound	
R44	470 ohms	⅓ watt	

COMPONENTS LIST FOR THE INVICTA T101 TELEVISOR, Fig. 31 RESISTOR VALUES (*continued*)—

No.	Resistance	Rating Watts	
R45	470 ohms	⅓ watt	
R46	470 ohms	⅓ watt	
R47	1,000 ohms	1 watt	
R48	10,000 ohms. preset	4 watts	Contrast control
R49	5,000 ohms	4 watts	Wirewound
R50	1,000 ohms	⅓ watt	
R51	50 megohms	1 watt	
R52	5,000 ohms	4 watts	Wirewound
R53	470,000 ohms	⅓ watt	
R54	47,000 ohms	⅓ watt	
R55	100,000 ohms	1 watt	
R56	5,000 ohms. preset	4 watts	Picture height
R57	680,000 ohms	⅓ watt	
R58	4,700 ohms	⅓ watt	
R59	270,000 ohms	⅓ watt	
R60	6,800 ohms	⅓ watt	
R61	1,000 ohms	4 watts	Wirewound
R62	1,000 ohms	4 watts	Wirewound
R63	500 ohms	4 watts	Wirewound
R64	330,000 ohms	⅓ watt	5%
R65	1,000 ohms	⅓ watt	
R66	10,000 ohms	⅓ watt	
R67	10,000 ohms	⅓ watt	
R68	220,000 ohms	⅓ watt	
R69	500 ohms. preset	4 watts	Focus control
R70	5,000 ohms. preset	4 watts	Line linearity
R71	120 ohms	1 watt	
R72	390,000 ohms	⅓ watt	
R73	120,000 ohms	⅓ watt	5%
R74	82,000 ohms	½ watt	10%
R75	47,000 ohms	⅓ watt	
R76	250,000 ohms	⅓ watt	
R77	680,000 ohms	⅓ watt	
R78	250 ohms. preset	4 watts	Picture width
R79	1,000 ohms	⅓ watt	
R80	10,000 ohms. preset	4 watts	Line hold
R81	2·2 megohms	⅓ watt	
R82	1,500 ohms	½ watt	
R83	390,000 ohms	⅓ watt	10%
R84	4,700 ohms	⅓ watt	
R85	2·7 megohms	⅓ watt	
R86	100,000 ohms	⅓ watt	
R87	10,000 ohms. preset	4 watts	Frame hold
R88	15,000 ohms	⅓ watt	

All resistors 20% tolerance unless otherwise stated.

COMPONENTS LIST FOR THE INVICTA T101 TELEVISOR Fig. 31
CAPACITOR VALUES

No.	Capacitance	Volts Working
C1	0·005 mfd.	
C2	0·001 mfd.	500 v.w.
C3	0·1 mfd.	500 v.w.
C4	0·01 mfd.	500 v.w.
C5	2 pfs.	
C6	0·001 mfd.	500 v.w.
C7	0·001 mfd.	500 v.w.
C8	0·03 mfd.	
C9	0·001 mfd.	500 v.w.
C10	0·001 mfd.	500 v.w.
C11	0·001 mfd.	500 v.w.
C12	0·001 mfd.	500 v.w.
C13	0·001 mfd.	500 v.w.
C14	0·001 mfd.	500 v.w.
C15	0·01 mfd.	500 v.w.
C16	0·05 mfd.	500 v.w.
C17	0·01 mfd.	500 v.w.
C18	47 pfs.	
C19	50 mfds.	Electrolytic. 12 v.w.
C20	10 pfs.	
C21	680 pfs.	
C22	2 mfds.	Electrolytic
C23	22 pfs.	
C24	0·001 mfd.	500 v.w.
C25	0·001 mfd.	500 v.w.
C26	0·001 mfd.	500 v.w.
C27	47 pfs.	
C28	0·001 mfd.	500 v.w.
C29	0·001 mfd.	500 v.w.
C30	47 pfs.	
C31	0·001 mfd.	500 v.w.
C32	0·001 mfd.	500 v.w.
C33	47 pfs.	
C34	0·001 mfd.	500 v.w.
C35	0·001 mfd.	500 v.w.
C36	47 pfs.	
C37	0·001 mfd.	500 v.w.
C38	0·001 mfd.	500 v.w.
C39	0·001 mfd.	500 v.w.
C40	0·001 mfd.	500 v.w.
C41	10 pfs.	
C42	500 pfs.	5%
C43	50 mfds.	Electrolytic. 12 v.w.
C44	0·1 mfd.	7,000 v.w.
C45	16 mfds.	Electrolytic. 450 v.w.
C46	0·1 mfd.	500 v.w.

COMPONENTS LIST FOR THE INVICTA T101 TELEVISOR

CAPACITOR VALUES Fig. 31 (*continued*)—

No.	Capacitance	Volts Working
C47	50 mfds.	Electrolytic. **50 v.w.**
C48	32 plus 16 mfds.	Electrolytic
C49	0·002 mfd.	450 v.w.
C50	47 pfs.	
C51	0·01 mfd.	500 v.w.
C52	100 pfs.	
C53	0·1 mfd.	500 v.w.
C54	0·1 mfd.	500 v.w.
C55	0·1 mfd.	500 v.w.
C56	0·1 mfd.	500 v.w.
C57	0·05 mfd.	500 v.w.
C58	220 pfs.	
C59	32 plus 16 mfds.	Electrolytic
C60	2 mfds.	Electrolytic
C61	0·1 mfd.	500 v.w.
C62	0·005 mfd.	5%. 700 v.w.
C63	0·001 mfd.	500 v.w.
C64	0·02 mfd.	450 v.w.
C65	50 mfds.	Electrolytic. 12 v.w.
C66	2 mfds.	Electrolytic
C67	8 mfds.	Electrolytic
C68	16 plus 8 mfds.	Electrolytic. 450 v.w.

Capacitors 350 v.w. unless otherwise marked.

TRANSFORMERS, COILS, VALVES, Etc.

W1, W2, WX6	Westectors
T1	Sound output transformer
T2	Mains transformer
T3	Line output transformer
T4	Line oscillator transformer
T5	Frame output transformer
T6	Frame oscillator transformer
L1, L2	Sound R.F. coils
L3, L4, L5, L11 ..	Vision R.F. coils, anodes
L6	Vision aerial coil
L7	Sound aerial coil
L8, L9, L10	Vision R.F. coils, grids
L12	Filter coil
L13, L14	Smoothing chokes
L15	Line scan coils

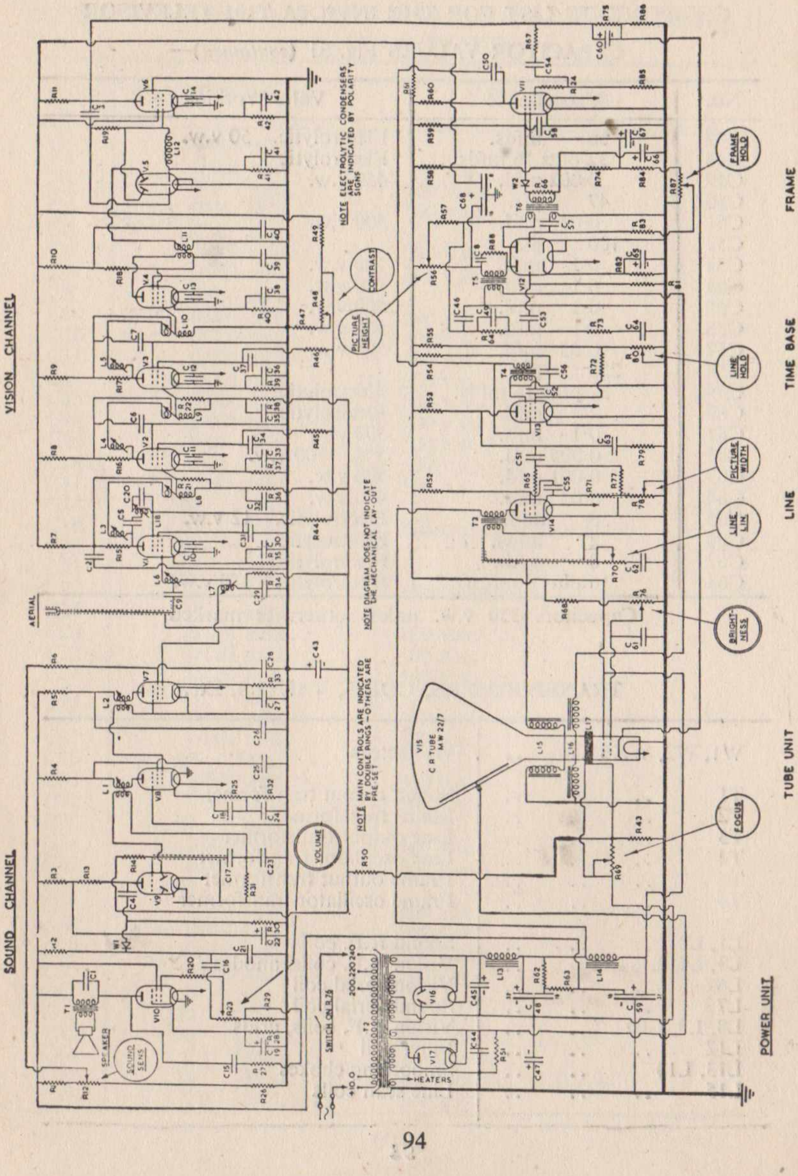


FIG. 31.—The Invicta T101 Televisor

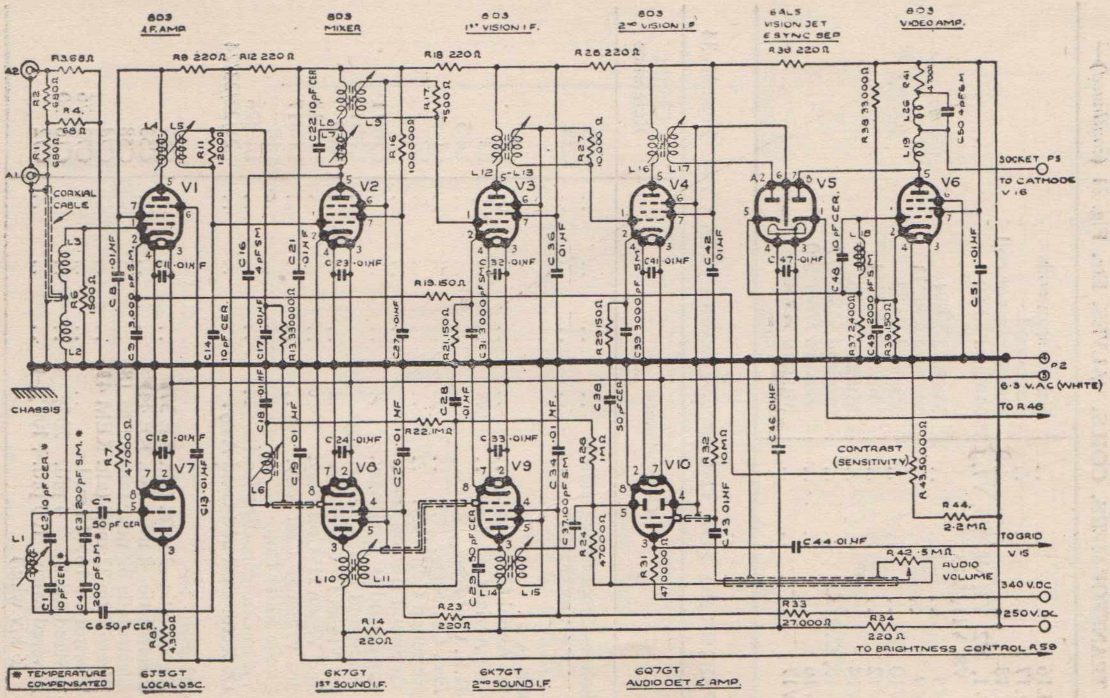


FIG. 32.—The Kolster-Brandes CV40 Televisor. Vision and Sound Receiver Section

TRANSFORMERS, COILS, VALVES, Etc. Fig. 31 (*continued*)—

L16	Frame scan coils
L17	Focus coil
L18	Sound rejector coil
V1, V2, V3, V4, V6, V7, V8, V11, V13	Mullard EF50
V5	Mullard EB91
V9	Mullard EBC33
V10	Mullard EL33
V12	Mullard ECC34
V14	Mullard EL38
V15, C.R.T.	Mullard MW22/7
V16	Mullard FW4/500
V17	Mullard HVR2

PARTS LIST FOR THE KOLSTER-BRANDES CV40 Figs. 32–34

Components	Circuit Reference
Chokes—Smoothing (audio)	L20
—Smoothing	L25
Coils :—	
1st Aerial Coil Assy.	L2
2nd Aerial Coil Assy.	L3
H.F. Coil Assy.	L4/5
Osc. Coil Assy.	L1
Rejection Coil Assy.	L7
1st Sound IF Coil Assy.	L6
2nd Sound IF Coil Assy.	L10/11
3rd Sound IF Coil Assy.	L14/15
1st Vision IF Coil Assy.	L8/9
2nd Vision IF Coil Assy.	L12/13
3rd Vision IF Coil Assy.	L16/17
Diode Filter Coil	L18
Video Compensating Coil	L19/26
Deflector Coil and Lead Assy.	L21/22/23/24
Condensers :—	
Electrolytic 2 mfd. (alt. KE 37)	C67
Electrolytic 8 mfd. (alt. KE 44)	C53
Electrolytic 32 mfd. (alt. KEM 18)	C58
Electrolytic 32 mfd. (alt. KEM 41)	C74
Electrolytic 16×16 mfd.	C73, 76
Silvered Mica 4 pfd. 20%	C16, 50
Silvered Mica 100 pfd.+100%–0 (5 k/v wkg.)	C72

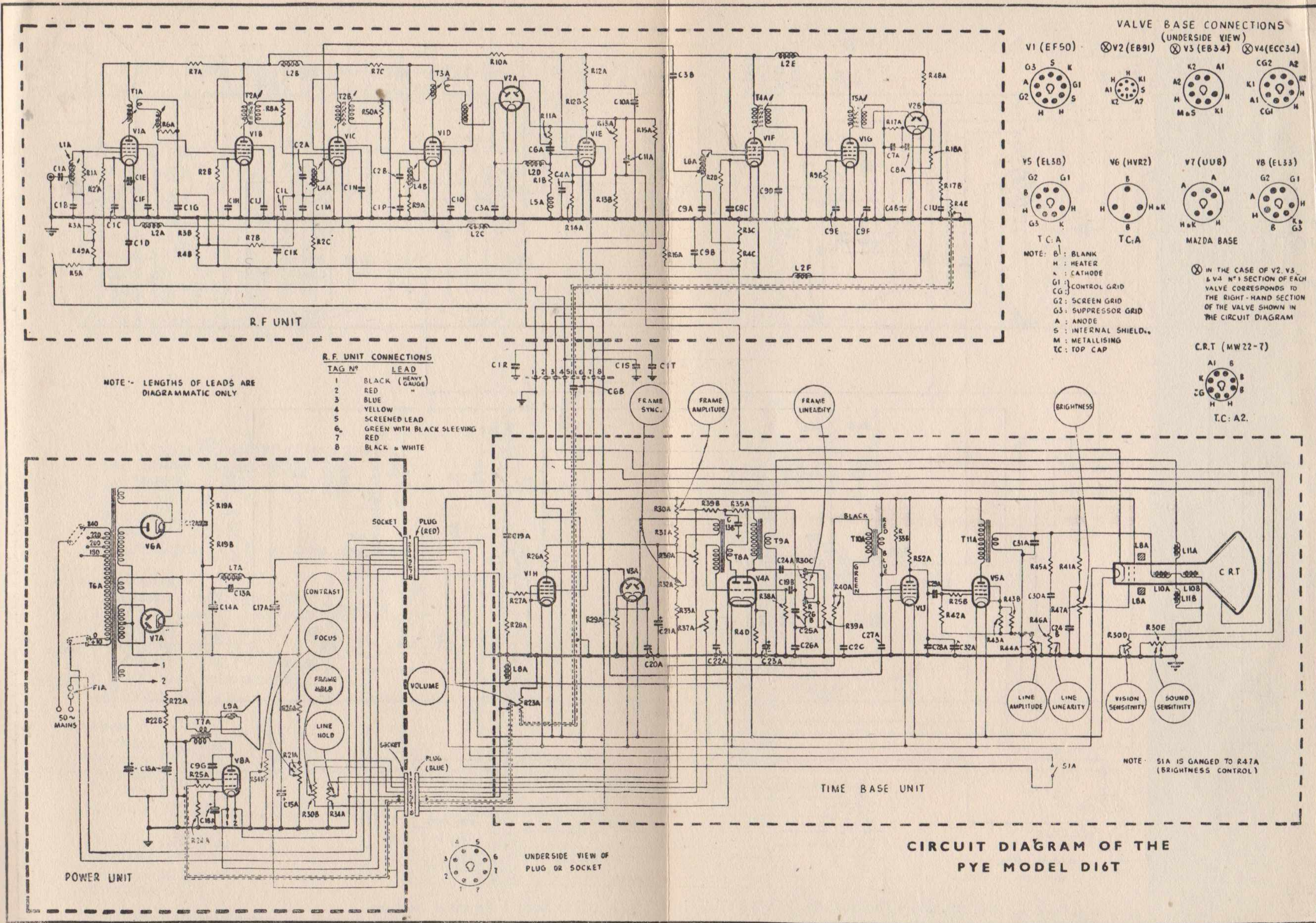


FIG. 36.—The Pye D16T Televisor

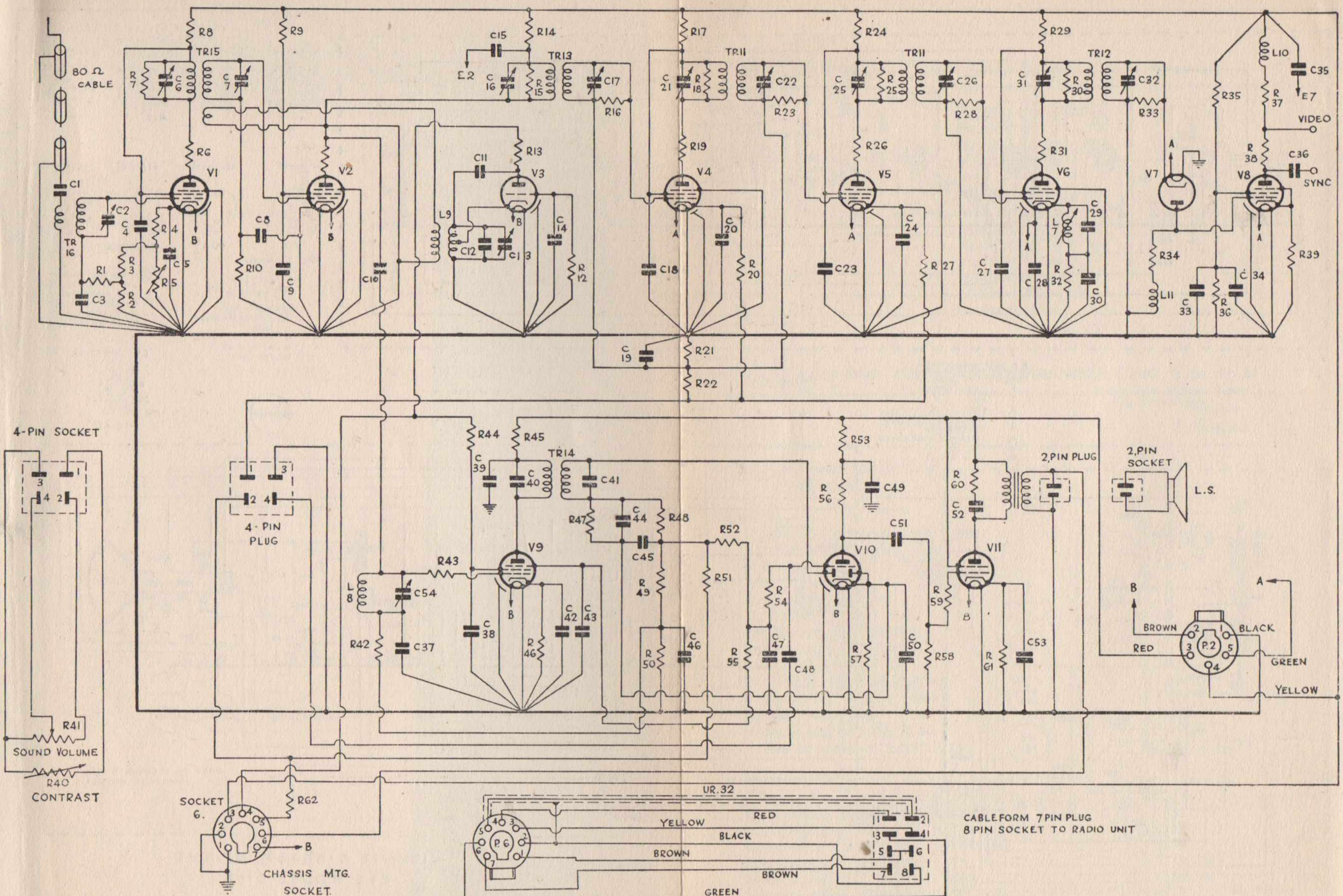


FIG. 37.—The R.G.D. 2547TR Televisor. Vision and Sound Receiver Section

PARTS LIST FOR THE KOLSTER-BRANDES CV40.

Figs. 32-34 (*continued*)—

Components	Circuit Reference
Silvered Mica 100 pfd. 20%	C37
Silvered Mica 200 pfd. 2% .. .. .. (Temperature Compensating)	C3, 4
Silvered Mica 400 pfd. 15%	C70
Silvered Mica 660 pfd. 5%	C63
Silvered Mica 1,000 pfd. 15%	C69
Silvered Mica 2,000 pfd. 15%	C49
Silvered Mica 3,000 pfd. 15%	C9, 31, 39
Paper Tubular ·003 mfd.	C56, 64,71
Paper Tubular ·005 mfd.	C59
Paper Tubular ·01 mfd.	C8, 11, 12, 13, 17, 18, 19, 21, 23, 24, 26, 27, 28, 32, 33, 34, 36, 41, 42, 43, 44, 46, 47, 51, 54
Paper Tubular ·01 mfd. (1 k/v wkg.)	C57
Paper Tubular ·05 mfd. 10%	C66
Paper Tubular ·1 mfd.	C62, 68
Paper Tubular ·5 mfd.	C52
Ceramic 50 pfd. 10%	C6, 7, 29 38, 61
Ceramic 10 pfd. 10%	C14, 22, 48
Ceramic 10 pfd. 5% (—ve temp. co-efficient) ..	C1, 2
Potentiometers :—	
·5 megohms 20% ½ w. (log)	R42
·5 megohms 20% ½ w. (with SPST switch) ..	R59
·5 megohms 20% ½w.	R71
·25 megohms 20% 1½ w.	R73, 82
150 ohms 10% 4 w. (wire wound)	R91
50 K 10% 4 w. (wire wound)	R43
1,000 ohms 20% ½ w.	R51
Resistors ;	
68 ohms 5% ½ w.	R3, 4
100 ohms 10% 1 w.	R89
150 ohms 20% ½ w.	R19, 21, 29, 39
150 ohms 20% 1 w.	R94
220 ohms 20% ½ w.	R9, 12, 14, 18, 23, 28, 34, 36
270 ohms 10% ½ w.	R77
330 ohms 5% 1 w.	R63
390 ohms 10% ½ w.	R49
680 ohms 5% ½ w.	R1, 2

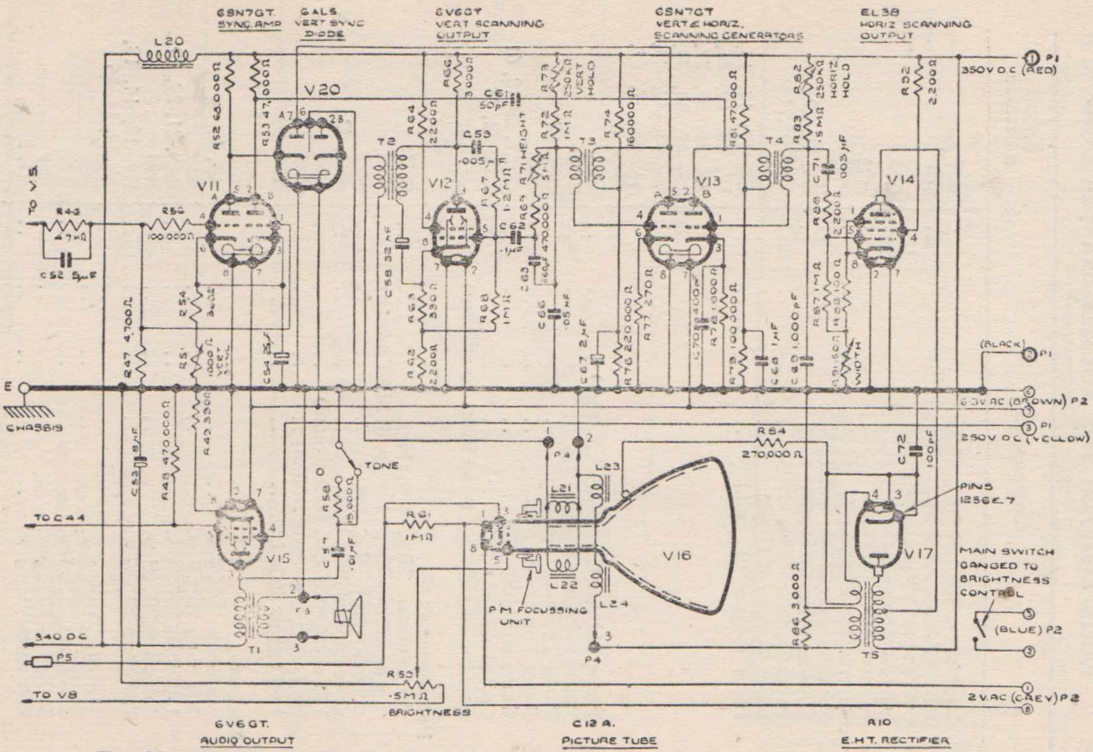


FIG. 33.—The Kolster-Brandes CV40 Televisor. Timebase, Tube and Sound Output Section

PARTS LIST FOR THE KOLSTER-BRANDES CV40.
Figs. 32-34 (*continued*)—

Components	Circuit Reference
1 K 20% ½ w.	R51,54
1 K 10% Res. Dub. AB1	R93
1·2 K 5% ½ w.	R11
1·5 K 5% ½ w.	R6
1·8 K 5% ½ w.	R78
2·2 K 20% ½ w.	R64,88
2·2 K 20% 1 w.	R92
2·2 K 10% 3 w.	R62
2·4 K 5% ½ w.	R37
3 K 5% 5 w. (wire wound)	R66, 86
3·3 K 10% ½ w.	R47
4·3 K 20% 1 w.	R8
4·7 K 5% 3 w.	R41
7·5 K 5% ½ w.	R17
10 K 5% ½ w.	R27
15 K 20% ½ w.	R58
22 K 20% 1 w.	R53
27 K 20% 1 w.	R33
33 K 20% 3 w.	R38
47 K 20% 1 w.	R52
47 K 5% 1 w.	R81
47 K 20% ½ w.	R7, 24
100 K 20% ½ w.	R57, 16
100 K 10% 1 w.	R79
160 K 5% 1 w.	R74
220 K 10% 1 w.	R76
270 K 20% ½ w.	R84
330 K 20% ⅓ w.	R13
470 K 20% ½ w	R48, 56, 69, 31
·5 M 5% 1 w (high stability)	R83
1 M 20% ½ w	R61, 68, 87, 22, 26
1 M 5% 1 w. (high stability)	R72
1·2 M 10% ½ w.	R67
2·2 M 20% ½ w.	R44
4·7 M 10% ½ w.	R46
10 M 33⅓% ½ w.	R32
Thermistor	R96
Transformer Mains	T6
Transformer—Audio Output	T1
Transformer—Line Output Assy.	T5
Transformer—Frame Output Assy.	T2
Transformer—Line Oscillator Assy.	T4
Transformer—Frame Oscillator Assy.	T3

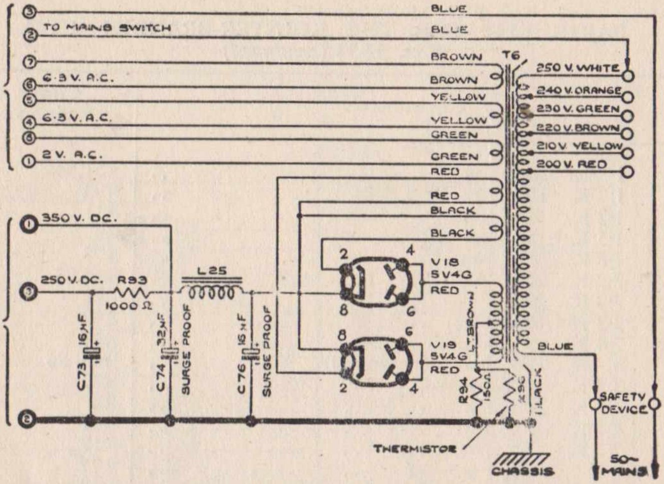


FIG. 34.—The Kolster-Brandes CV40 Televisor. Powerpack Section

PARTS LIST FOR THE KOLSTER-BRANDES CV40.

Figs. 32-34 (*continued*)—**VALVES**

V_1, V_2, V_3	8D3	V_{11}, V_{13}	6SN7GT
V_4, V_6		V_{12}, V_{15}	6V6GT
V_5, V_{20}	6AL5	V_{14}	EL38
V_7	6J5GT	V_{16}	C12A (C.R. Tube)
V_8, V_9	6K7GT	V_{17}	R10
V_{10}	6Q7GT	V_{18}, V_{19}	5V4G

PARTS LIST FOR THE MURPHY TELEVISOR

Models V114 and V116 Fig. 35

RESISTORS

No.	Resistance	Watts Rating
R1, R36, R39	47,000 ohms	½ watt
R2, R18, R24, R27, R37, R73	150 ohms	½ watt
R3	3,900 ohms	½ watt
R4, R59, R68	68,000 ohms	½ watt
R6	10,000 ohms, variable	
R7, R14, R22, R34	3,300 ohms	½ watt

PARTS LIST FOR THE MURPHY TELEVISOR Models V114 and V116

RESISTORS *Fig. 35 (*continued*)—

No.	Resistance	Watts Rating
R8	2,200 ohms	½ watt
R9, R11, R23, R43, R69, R78	22,000 ohms	½ watt
R12, R13, R16, R33, R51, R61, R89	10,000 ohms	½ watt
R19	5,000 ohms, variable. Contrast control	
R21, R26	6,800 ohms	½ watt
R28, R31, R49, R62, R71	4,700 ohms	½ watt
R30, R77	10,000 ohms	1 watt
R32	50,000 ohms, variable. Brilliance	
R38, R75, R97	100,000 ohms	½ watt
R41	2·2 megohms	½ watt
R42	680 ohms	½ watt
R44	50,000 ohms, variable. Volume control	
R46	470,000 ohms	½ watt
R47, R54, R70, R106, R107, R108, R109, R111	4·7 megohms	½ watt
R48	220 ohms	½ watt
R52	1 megohm	½ watt
R53, R92, R102	180 ohms	½ watt
R56	1,500 ohms	4 watts
R57	1,800 ohms	4 watts
R58	1,000 ohms, variable. Focus	
R63	3,000 ohms, variable. Frame Hold	
R64	1,000 ohms, variable. Line Hold	
R66	1,800 ohms	½ watt
R67	390,000 ohms	½ watt
R72	120,000 ohms	½ watt
R74, R91, R99	470 ohms	½ watt
R76	470,000 ohms	½ watt
R81	91 ohms	½ watt
R82	200 ohms, variable. Picture Width	
R83, R86	220 ohms	1 watt
R84	400 ohms, variable. Line Linearity	
R87, R88, R101	33,000 ohms	½ watt
R93	330 ohms	½ watt
R94	270,000 ohms	½ watt
R96	100,000 ohms, variable. Frame Linearity	
R98	1·8 megohms	½ watt
R103	500 ohms, variable. Picture Height	

*Fig. 35 appears on page 80B.

PARTS LIST FOR THE MURPHY TELEVISOR Models V114 and V116

Fig. 35 (*continued*)—CAPACITORS

No.	Capacitance
C1, C2, C29, C55, C67	0·001 mfd.
C3, C7, C28, C31, C54	0·0005 mfd.
C4, C18, C21, C24, C36, C38, C39, C42, C48	0·01 mfd.
C6, C14, C22, C34, C46, C56	0·005 mfd.
C8	47 pfs.
C9	39 pfs.
C10, C13, C26	10 pfs.
C12	2·2 pfs.
C16, C19, C23, C33	0·0001 mfd.
C17	4·7 pfs.
C27, C44	16 mfds. Electrolytic
C32, C66	0·05 mfd.
C37	15 pfs.
C41, C63	0·1 mfd.
C43, C59	0·02 mfd.
C47	50 mfds. Electrolytic
C49	0·5 mfd.
C51	56 pfs.
C52, C69	32 mfds. Electrolytic
C53, C68	8 mfds. Electrolytic
C57	25 mfds. Electrolytic
C58, C62, C64	0·25 mfd.
C61	0·002 mfd.
C71	0·1 mfd. 5 KV.

VALVES

V1, V4, V5, V7, V8	6F12
V2	6L18
V3	6D2
V6	6D1
V9	HL41DD
V10, V12	DD41
V11, V16	Pen 45
V13, V15	T41
V14	Pen 46
V17	UU8
V18	U22

PARTS LIST FOR THE MURPHY TELEVISOR Models V114 and V116

Fig. 35 (*continued*)—**COIL AND TRANSFORMER RESISTANCES**

T1	Primary	4·5 ohms
	H.T. Sec.	18 plus 25 ohms
	E.H.T. Sec.	5,000 ohms.
T2	Primary	320 ohms
	Secondary	0·5 ohm.
T3	Primary	900 plus 620 **ohms**
	Secondary	0·7 ohm.
T4	Primary	80 ohms
	Secondary	0·7 ohm.
L11, L12, L21, L22		0·6 ohm
L14		33 ohms
L16		3 ohms
L17		11 ohms
L18		1·6 ohms
L20		2 ohms
L23		70 ohms
L24		35 ohms
L26		1,600 ohms
L27/28		1.3 ohms
L29/31		1·3 ohms

C.R. TUBE

C.R. Tube	Model V114 Model V116	CRM92 CRM124

COMPONENT LIST FOR THE PYE TELEVISOR, MODEL D16T

*Fig. 36

CONDENSERS Specification

C1A–U	0.001 μF	±20%		500 v.
C2A–C	70 pF	± 2%		500 v.
C3A & B	4·7 pF	±10%		500 v.
C4A & B C5A	300 pF	±10%		350 v.
C6A & B	0·1 μF	±20%		350 v.
C7A	33 pF	±10%		500 v.
C8A	0·01 μF	±20%		500 v.
C9A–G	0·002 μF	±20%		500 v.
C10A	16 μF	+50% −20%	Electrolytic	375 v.
C11A	2 μF	+50% −20%	Electrolytic	150 v.

*Fig. 36 appears on page 96A.

COMPONENT LIST FOR THE PYE TELEVISOR, MODEL D16T

CONDENSERS Fig. 36 (*continued*)—

C12A	0·1 μF	±20%		7,000 v.
C13A & B	1 μF	±20%		350 v.
C14A	16 μF	+50% −20%	Electrolytic	450 v.
C15A	50 μF	+50% −20%	Electrolytic	50 v.
C16A	16+16 μF	+50% −20%	Electrolytic	350 v.
C17A	50 μF	+50% −20%	Electrolytic	350 v.
C18A	25 μF	+50% −20%	Electrolytic	50 v.
C19A & B	0·1 μF	±20%	" Low leakage "	350 v.
C20A	250 pF	± 5%		350 v.
C21A	8 μF	+50% −20%	Electrolytic	125 v.
C22A	0·01 μF	±10%		350 v.
C23A	50 μF	+50% −20%	Electrolytic	25 v.
C24A & B	0·1 μF	±10%		350 v.
C25A	0·02 μF	±10%		350 v.
C26A	0·05 μF	±10%		350 v.
C27A	100 pF	±10%		
C28A	700 pF	± 2%		350 v.
C29A	0·01 μF	±20%	" Low leakage "	1,000 v.
C30A	0·007 μF	±10%		750 v.
C31A	500 pF	±10%		750 v.
C32A	50–350 pF		Trimmer	

INDUCTANCES Specification

L1A	Input Coil (Vision)
L2A–F	R.F. Choke
L3A	
*L4A & B	Sound Filter Coil
L5A	V.F. Compensation Coil
L6A	Input Coil (Sound)
L7A	H.T. Smoothing Choke
L8A	Focus Coil
L9A	Loudspeaker Speech Coil
L10A & B	Line Scan Deflector Coil
L11A & B	Frame Scan Deflector Coil

COMPONENT LIST FOR THE PYE TELEVISOR, MODEL D16T

Fig. 36 (*continued*)—**VALVES** Specification

V1A–J	EF50	R.F. Pentode	(Mullard)
V2A & B	EB91	Double Diode	(Mullard)
V3A	EB34	Double Diode	(Mullard)
V4A	ECC34	Double Triode	(Mullard)
V5A	EL38	A.F. Output Pentode	(Mullard)
V6A	§HVR2	4 v. Heater E.H.T. Rect.	(Mullard)
V7A	UU8	H.T. Rectifier	(Mazda)
V8A	EL33	A.F. Output Pentode	(Mullard)

C.R. TUBE, FUSE AND SWITCH Specification

C.R.T.	M.W.22–7 Tetrode	(Mullard)
F1A	Fuse 1·5 amp.	
‡S1A	Mains On/Off Switch	

RESISTORS

No.	Resistance	Tol. ±
R1A & B	4,700 ¼ watt Insulated	5%
R2A–D	150 ¼ watt Insulated	10%
R3A–C	47,000 ¼ watt Insulated	10%
R4B–E	2,200 ¼ watt Insulated	10%
R5A	56,000 2 watt Non-insulated	10%
R6A	15,000 ¼ watt Insulated	5%
R7A–C	330 ¼ watt Insulated	20%
R8A	2,000 ¼ watt Insulated	5%
R9A & B	220 ¼ watt Insulated	10%
R10A	330 ½ watt Insulated	20%
R11A	10 Meg. ¼ watt Insulated	10%
R12A & B	5,600 2 watt Non-insulated	10%
R13A & B	47,000 ½ watt Insulated	10%
R14A	470 ¼ watt Insulated	10%
R15A	10,000 ¼ watt Insulated	20%
R16A	100,000 1 watt Non-insulated	10%
R17A & B	33,000 ¼ watt Insulated	10%
R18A	1 Meg. ¼watt Insulated	10%
R19A & B	27 Meg. 1 watt Non-insulated	33⅓%
R20A	180 2 watt Non-insulated	10%
R21A	750 6 watt wire-wound Potentiometer	10%
R22A & B	1,500 6 watt wire-wound	20%
R23A	250,000 1·5 watt Potentiometer	20%

COMPONENT LIST FOR THE PYE TELEVISOR, MODEL D16T

Fig. 36 (*continued*)—**RESISTORS**

No.	Resistance	Tol. ±
R24A	150 ½ watt Insulated	20%
R25A & B	100 ¼ watt Insulated	20%
R26A & B	10,000 ¼ watt Insulated	10%
R27A	47,000 ¼ watt Insulated	20%
R28A	4·7 Meg. ¼ watt Insulated	20%
R29A	220,000 ¼ watt Insulated	10%
R30A–E	10,000 6 watt wire-wound Potentiometer ..	20%
R31A	27,000 2 watt Non-insulated	10%
R32A	5,000 6 watt wire-wound Potentiometer ..	20%
R33A & B	1,000 ¼ watt Insulated	10%
R34A & B	3,000 6 watt wire-wound Potentiometer ..	20%
R35A	680,000 ¼ watt Insulated	10%
R36A	82,000 1 watt Non-insulated	10%
R37A	1·5 Meg. ¼ watt Insulated	10%
R38A	2·2 Meg. ¼ watt Insulated	20%
R39A & B	100,000 ¼ watt Insulated	10%
R40A	560,000 ¼ watt Insulated	10%
R41A	470,000 ¼ watt Insulated	10%
R42A	680,000 ¼ watt Insulated	20%
R43A & B	330 ½ watt Insulated	10%
R44A	150 6 watt wire-wound Potentiometer ..	20%
R45A	2,000 6 watt wire-wound	10%
R46A	1,000 6 watt wire-wound Potentiometer ..	20%
‡R47A	250,000 1·5 watt Potentiometer	20%
R48A	2·2 Meg. ¼ watt Insulated	10%
R49A	3,300 ¼ watt Insulated	10%
R50A	2,200 ¼ watt Insulated	5%
R51A	680 1 watt Non-insulated	10%
R52A	470,000 ¼ watt Insulated	5%

TRANSFORMERS Specification

T1A	Band-Pass Transformer (Vision)
*T2A & B	Single Peak Transformer (Vision)
T3A	Detector Band-Pass Transformer (Vision)
T4A	Single Peak Transformer (Sound)
T5A	Detector Single Peak Transformer (Sound)
T6A	Mains Transformer
T7A	Sound Output Transformer
T8A	Frame Scan Oscillator Transformer
T9A	Frame Scan Output Transformer
T10A	Line Scan Oscillator Transformer
T11A	Line Scan Output Transformer

COMPONENT LIST FOR THE PYE TELEVISOR, MODEL D16T

Fig. 36 (*continued*)—

* Coil and Transformer wound on common former.

‡ S1A ganged to R47A.

§ Receivers Serial Nos. 1101–1200 are fitted with a Mains Transformer, Reference No. 770007, having a 2-volt E.H.T. Rectifier Heater winding and V6A on these receivers is a 2-volt Heater HVR2A Mullard Valve. Reference No. 860021.

D.C. Resistance of Windings

Mains Transformer (T6A) : Prim. (between " 240 " and " +10 ") : 7 ohms.
H.T. Sec. (total winding) : 112 ohms.
E.H.T. Sec. : 7,300 ohms.
H.T. Smoothing Choke (L7A) : 92 ohms.
Focus Coil (L8A) : 133 ohms.
(102 ohms when R51A omitted.)
Deflector Coils : Line Scan Coils (L10A and L10B) (total for both coils) : 8.4 ohms.
Frame Scan Coils (L11A and L11B) (total for both coils) : 7·7 ohms.
Line Scan Oscillator Transformer (T10A) : Screen grid winding : 9 ohms.
Control grid winding : 60 ohms.
Line Scan Output Transformer (11TA) : Prim. : 90 ohms.
Sec. : 5·5 ohms.
Frame Scan Oscillator Transformer (T8A) : Anode winding : 186 ohms.
Control grid winding : 660 ohms.
Sync. winding : 250 ohms.
Frame Scan Output Transformer (T9A) : Prim. : 1,340 ohms.
Sec. : 2.5 ohms.
Sound Output Transformer (T7A) : Prim. : 500 ohms.
Sec. : 0·37 ohms.
Video Frequency Compensation Coil (L5A) : 4·6 ohms.
Loudspeaker Speech Coil (L9A) : 2·5 ohms.

Note—Tolerance on above winding resistances : ±10%.

COMPONENTS LIST FOR THE R.G.D. 2547TR RECEIVER

*Fig. 37 **RESISTORS**

No.	Resistance		Watts Rating
R1	47,000	ohms	½ watt
R2	75,000	ohms	½ watt
R3	3,000	ohms	¼ watt
R4	110	ohms	½ watt
R5	10,000	variable	R.F. gain control
R6	10	ohms	¼ watt
R7	2,500	ohms	¼ watt
R8	3,900	ohms	½ watt

*Fig. 37 appears on page 96B.

COMPONENTS LIST FOR THE R.G.D. 2547TR RECEIVER.

RESISTORS Fig. 37 (*continued*)—

No.	Resistance		Watts Rating
R9	200,000	ohms	½ watt
R10	1	megohm	¼ watt
R11	10	ohms	¼ watt
R12	47,000	ohms	¼ watt
R13	39,000	ohms	½ watt
R14	10,000	ohms	½ watt
R15	2,000	ohms	¼ watt
R16	2,000	ohms	¼ watt
R17	3,900	ohms	½ watt
R18	2,000	ohms	¼ watt
R19	10	ohms	¼ watt
R20	110	ohms	½ watt
R21	75,000	ohms	½ watt
R22	5,000	ohms	¼ watt
R23	2,000	ohms	¼ watt
R24	3,900	ohms	½ watt
R25	2,000	ohms	¼ watt
R26	10	ohms	¼ watt
R27	110	ohms	½ watt
R28	2,000	ohms	¼ watt
R29	1,000	ohms	½ watt
R30	2,000	ohms	¼ watt
R31	10	ohms	¼ watt
R32	150	ohms	¼ watt
R33	3,000	ohms	¼ watt
R34	3,500	ohms	½ watt
R35	8,000	ohms	2 watts
R36	20,000	ohms	1 watt
R37	1,500	ohms	½ watt
R38	2,200	ohms	1 watt
R39	50,000	ohms	½ watt
R40	10,000	ohms, variable	Picture contrast control
R41	0·5	megohm, variable	(Log. law). Sound volume
R42	47,000	ohms	¼ watt
R43	10	ohms	¼ watt
R44	25,000	ohms	¼ watt
R45	5,000	ohms	¼ watt
R46	110	ohms	½ watt
R47	47,000	ohms	¼ watt
R48	100,000	ohms	¼ watt
R49	1·8	megohms	¼ watt 5%
R50	120,000	ohms	¼ watt 5%
R51	100,000	ohms	¼ watt

COMPONENTS LIST FOR THE R.G.D. 2547TR RECEIVER.

RESISTORS Fig. 37 (*continued*)—

No.	Resistance		Rating Watts	
R52	1	megohm	¼ watt	
R53	100,000	ohms	¼ watt	
R54	2·2	megohms	¼ watt	
R55	20,000	ohms	¼ watt	
R56	47,000	ohms	½ watt	
R57	470	ohms	¼ watt	
R58	500,000	ohms	¼ watt	
R59	5,000	ohms	¼ watt	
R60	10,000	ohms	½ watt	
R61	180	ohms	½ watt	10%
R62	100,000	ohms	¼ watt	

All resistors 20% tolerance unless otherwise stated.

CAPACITORS

No.	Capacitance		Type
C1	20	pfs.	Silver mica
C2	7·5	pfs.	Trimmer
C3	0·001	mfd.	Metallised mica
C4	0·001	mfd.	Metallised mica
C5	0·002	mfd.	Metallised mica
C6	7·5	pfs.	Trimmer
C7	7·5	pfs.	Trimmer
C8	0·001	mfd.	Metallised mica
C9	0·001	mfd.	Metallised mica
C10	4	pfs.	Cer. 10%
C11	30	pfs.	Silver mica 5%
C12	20	pfs.	Silver mica
C13	15	pfs.	Variable
C14	50	pfs.	Cer. 10%
C15	0·001	mfd.	Metallised mica
C16	7·5	pfs.	Trimmer
C17	7·5	pfs.	Trimmer
C18	0·001	mfd.	Metallised mica
C19	0·001	mfd.	Metallised mica
C20	0·002	mfd.	Metallised mica
C21	7·5	pfs.	Trimmer
C22	7·5	pfs.	Trimmer

COMPONENTS LIST FOR THE R.G.D. 2547TR RECEIVER

CAPACITORS Fig. 37 *(continued)*—

No.	Capacitance	Type
C23	0·001 mfd.	Metallised mica
C24	0·002 mfd.	Metallised mica
C25	7·5 pfs.	Trimmer
C26	7·5 pfs.	Trimmer
C27	0·001 mfd.	Metallised mica
C28	0·01 mfd.	Metallised mica
C29	0·001 mfd.	Metallised mica
C30	0·002 mfd.	Metallised mica
C31	7·5 pfs.	Trimmer
C32	7·5 pfs.	Trimmer
C33	8 mfds.	Electrolytic. 350 v.w.
C34	0·01 mfd.	Metallised mica
C35	0·002 mfd.	Metallised mica
C36	0·1 mfd.	Paper tubular 350 v.w.
C37	0·001 mfd.	Metallised mica
C38	0·01 mfd.	Metallised mica
C39	0·001 mfd.	Metallised mica
C40	7·5 pfs.	Trimmer
C41	7·5 pfs.	Trimmer
C42	0·1 mfd.	Metallised mica
C43	0·01 mfd.	Metallised mica
C44	0·0001 mfd.	Metallised mica
C45	50 pfs.	Cer.
C46	0·05 mfd.	Paper tubular 250 v.w.
C47	0·1 mfd.	Paper tubular 350 v.w.
C48	0·01 mfd.	Paper tubular. 350 v.w.
C49	8 mfds.	Electrolytic. 350 v.w.
C50	50 mfds.	Electrolytic. 12 v.w.
C51	0·05 mfd.	Paper tubular. 250 v.w.
C52	0·01 mfd.	Paper tubular. 350 v.w.
C53	50 mfds.	Electrolytic. 12 v.w.
C54	7·5 pfs.	Trimmer

VALVES AND COILS

V1, 2, 4, 5, 6, 8, 9 ..	Mazda SP41
V3	Mazda P 41
V7	Mazda D1
V10	Mazda HL.42.DD
V11	Mazda Pen 45

COMPONENTS LIST FOR THE R.G.D. 2547TR RECEIVER.

VALVES AND COILS Fig. 37 (*continued*)—

L7	Sound rejector coil
L8	1st sound I.F.
L9	Oscillator coil
L10	Anode load coil
L11	Diode load coil
TR11	I.F. transformer
TR12	Detector I.F. transformer
TR13	1st I.F. transformer
TR14	2nd sound I.F. transformer
TR15	Mixer coil
TR16	Aerial coil

COMPONENTS LIST FOR THE R.G.D. 2547TR TIMEBASE Fig. 38

RESISTORS

No.	Resistance		Watts Rating	
R1	0·5	megohm	½ watt	
R2	470	ohms	¼ watt	
R3	100,000	ohms	¼ watt	
R4	10,000	ohms	½ watt.	10%
R5	1,000	ohms, variable	Sync. control	
R6	140	ohms	¼ watt	
R7	150,000	ohms	½ watt.	10%
R8	39,000	ohms	½ watt.	10%
R9	2,000	ohms	¼ watt	
R10	6,000	ohms	½ watt.	10%
R11	18,000	ohms	2 watts	
R12	47,000	ohms	½ watt.	10%
R13	5,000	ohms	¼ watt	
R14	0·5	megohm	½ watt	
R15	1,700	ohms	½ watt	5%
R16	56,000	ohms	1 watt.	5%
R17	10,000	ohms	½ watt.	10%
R18	47,000	ohms	½ watt.	10%
R19	150,000	ohms	½ watt.	10%
R20	150,000	ohms	½ watt	
R21	50	ohms	½ watt	
R22	270	ohms	½ watt	
R23	270,000	ohms	¼ watt	
R24	270,000	ohms	¼ watt	
R25	270,000	ohms	¼ watt	

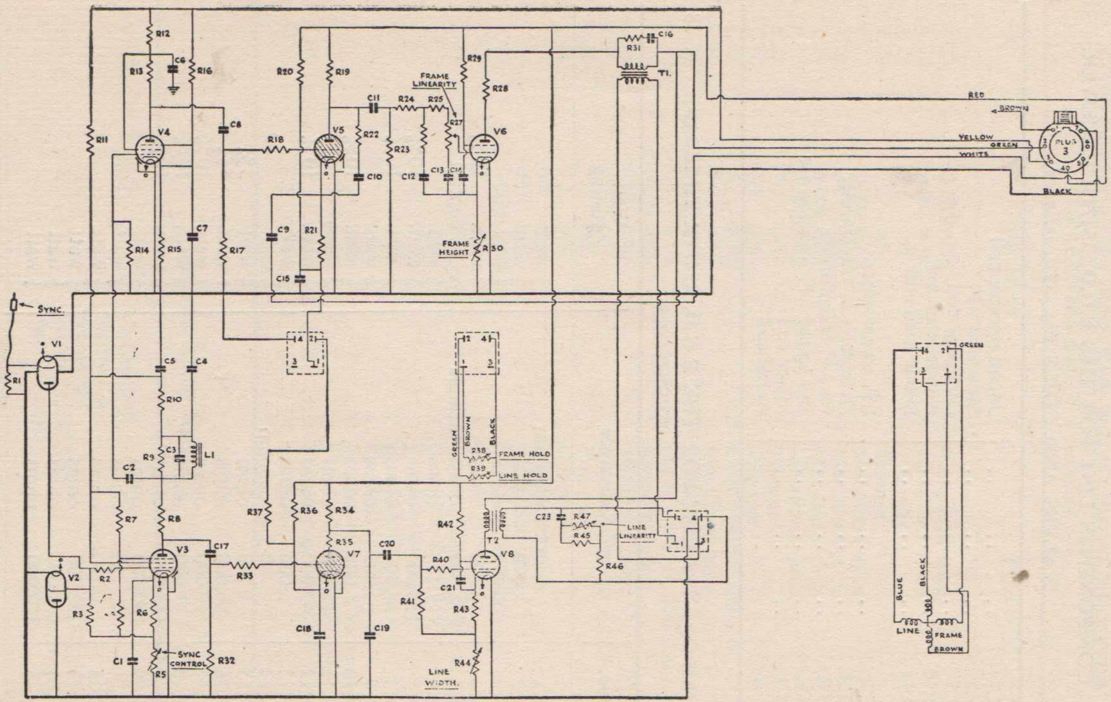


FIG. 38.—The R.G.D. 2547TR Televisor. Timebase Section

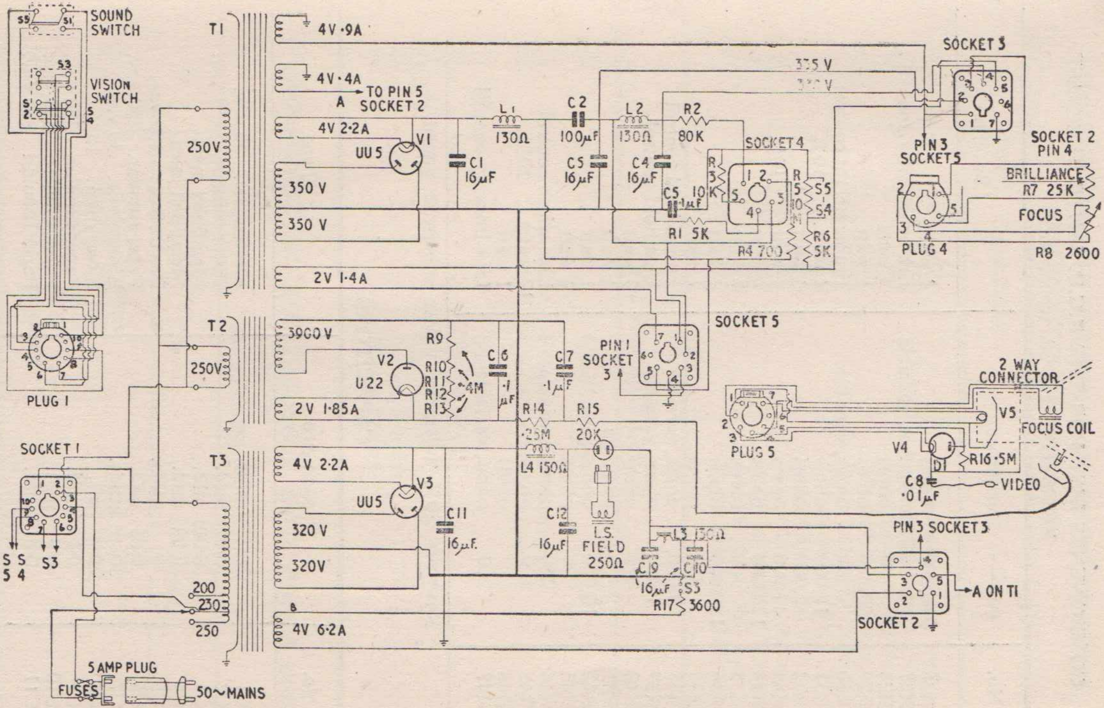


FIG. 39.—The R.G.D. 2547TR Televisor. Power and C.R. Tube Section

COMPONENTS LIST FOR THE R.G.D. 2547TR TIMEBASE.

RESISTORS Fig 38. (*continued*)—

No.	Resistance	Watts Rating
R26	270,000 ohms	¼ watt
R27	0·25 megohm, variable	Frame linearity control
R28	50 ohms	½ watt
R29	20,000 ohms	¼ watt
R30	1,000 ohms, variable	Frame height control
R31	15,000 ohms	½ watt. 10%
R32	2,000 ohms	¼ watt
R33	47,000 ohms	½ watt. 10%
R34	120,000 ohms	½ watt
R35	100 ohms	½ watt
R36	150,000 ohms	½ watt
R37	300 ohms	½ watt
R38	3,000 ohms, variable	Frame hold control
R39	1,000 ohms, variable	Line hold control
R40	470 ohms	¼ watt
R41	0·5 megohm	½ watt
R42	10,000 ohms	1 watt
R43	90 ohms	½ watt
R44	220 ohms, variable	Line width control
R45	100 ohms	12 watts. 10%
R46	27 ohms	1 watt
R47	200 ohms, variable	Line linearity control

Resistors 20% tolerance unless otherwise stated.

CAPACITORS

No.	Capacitance	Type
C1	30 mfds.	Electrolytic. 30 v.w.
C2	0·02 mfd.	Paper tubular. 750 v.w.
C3	0·001 mfd.	Metallised mica
C4	0·005 mfd.	Metallised mica
C5	8 mfds.	Electrolytic. 350 v.w.
C6	0·05 mfd.	Paper tubular. 250 v.w.
C7	30 mfds.	Electrolytic. 30 v.w.
C8	20 pfs.	Silver mica. 10%
C9	0·1 mfd.	Paper tubular. 350 v.w.
C10	0·5 mfd.	Paper tubular. 350 v.w.
C11	0·5 mfd.	Paper tubular. 350 v.w.

COMPONENTS LIST FOR THE R.G.D. 2547TR TIMEBASE.

CAPACITORS Fig. 38 *(continued)*—

No.	Capacitance	Type
C12	0·05 mfd.	Metallised paper. 500 v.w.
C13	0·05 mfd.	Metallised paper. 500 v.w.
C14	8 mfds.	Electrolytic. 350 v.w.
C15	50 mfds.	Electrolytic. 12 v.w.
C16	0·02 mfd.	Paper tubular. 750 v.w.
C17	20 pfs.	Silver mica. 10%
C18	4 mfds.	Electrolytic. 50 v.w.
C19	0·007 mfd.	Paper tubular. 500 v.w.
C20	0·02 mfd.	Paper tubular. 750 v.w.
C21	8 mfds	Electrolytic. 350 v.w.
C23	0·25 mfd.	Paper tubular. 350 v.w.

VALVES AND COILS

L1	4 Millihenrys
T1	Frame output transformer
T2	Line output transformer
V1, V2	Mazda D1
V3	Mazda SP42
V4	Mazda SP41
V5, V7	Mazda T41
V6	Mazda Pen 45
V8	Mazda Pen 46

COMPONENTS LIST FOR THE R.G.D. 2547TR POWER UNIT

Fig. 39

RESISTORS

No.	Resistance	Watts Rating
R1	5,000 ohms	¼ watt
R2	80,000 ohms	½ watt
R3	10,000 ohms	½ watt
R4	700 ohms	1 watt
R5	10 megohms	½ watt

COMPONENTS LIST FOR THE R.G.D. 2547TR POWER UNIT.

RESISTORS Fig. 39 (*continued*)—

No.	Resistance		Watts Rating
R6	5,000	ohms	¼ watt
R7	25,000	ohms variable	Brilliance control
R8	2,600	ohms, variable	Focus control
R9	4	megohms	½ watt
R10	44	megohms	½ watt
R11	4	megohms	½ watt
R12	4	megohms	½ watt
R13	4	megohms	½ watt
R14	0·25	megohm	¼ watt
R15	20,000	ohms	¼ watt
R16	0·5	megohm	½ watt
R17	3,600	ohms, wirewound	

TRANSFORMERS

T1	Timebase transformer	350–0–350 v.
T2	High voltage transformer	3,900 v.
T3	Receiver transformer	320–0–320 v.

CAPACITORS

No.	Capacitance	Volts Working
C1	16 mfds. Electrolytic	500 v.w.
C2	100 mfds. Electrolytic	40 v.w.
C3, C4	16 plus 16 mfds. Electrolytic	450 v.w
C5	0·1 mfd. Paper tubular	350 v.w.
C6	0·1 mfd. Paper tubular	600 v.w.
C7	0·1 mfd. Paper tubular	600 v.w.
C8	0·1 mfd. Paper tubular	350 v.w.
C9, C10	16 plus 16 mfds. Electrolytic	450 v.w.
C11	16 mfds. Electrolytic	500 v.w.
C12	16 mfds. Electrolytic	500 v.w.

COILS AND VALVES

L1	5 Henrys, 180 mAs.
L2, L3	3 Henrys 65 mAs. plus 4·5 Henrys 35 mAs.
L4	5 Henrys 180 mAs.
V1, V3	Mazda UU5
V2	Mazda U22
V4	Mazda D1
V5	12 in. C.R.T. CRM121

COMPONENTS LIST FOR THE R.G.D. 2547TR BROADCAST RECEIVER UNIT Fig. 40

RESISTORS

No.	Resistance	Watts Rating
R1	100,000 ohms	¼ watt
R2	27,000 ohms	½ watt. 10%
R3	220 ohms	¼ watt. 10%
R4	47,000 ohms	¼ watt
R5	47,000 ohms	½ watt
R6	6,800 ohms	½ watt
R7	100,000 ohms	¼ watt
R8	27,000 ohms	½ watt. 10%
R9	270 ohms	¼ watt. 10%
R10	47,000 ohms	¼ watt
R11	1 megohm	¼ watt
R12	1 megohm	¼ watt
R13	100,000 ohms	¼ watt
R14	100,000 ohms	¼ watt

All resistors 20% tolerance unless otherwise stated.

CAPACITORS

No.	Capacitance	Type
C1	0·05 mfd.	Metallised paper. 500 v.w.
C2, C3	15–45 pfs.	Double trimmer
C4	75 pfs.	
C5	150 pfs.	Silver mica. 10%
C6	500 pfs.	Silver mica. 10%
C7	0·05 mfd.	Paper tubular. 500 v.w.
C8	0·1 mfd.	Metallised paper. 350 v.w.
C9	220 pfs.	Silver mica. 2%
C10	220 pfs.	Silver mica. 2%
C11	100 pfs.	
C12	100 pfs.	
C13	0·1 mfd.	Metallised paper. 350 v.w.
C14	100 pfs.	
C15	50 pfs.	Silver mica
C16, C17	15–45 pfs.	Double trimmer
C18	250 pfs.	Silver mica. 10%
C19	0·05 mfd.	Metallised paper. 500 v.w.
C20	0·1 mfd.	Metallised paper. 350 v.w.
C21	0·1 mfd.	Metallised paper 350 v.w.

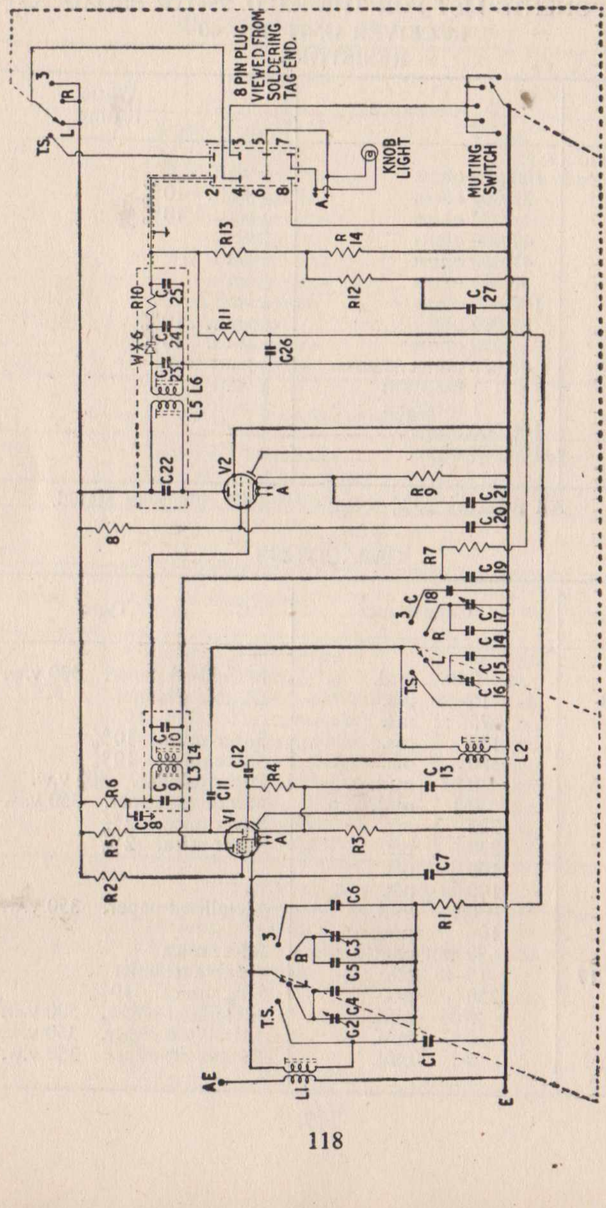


FIG. 40.—The R.G.D. 2547TR Televisor. The Broadcast Receiver Unit

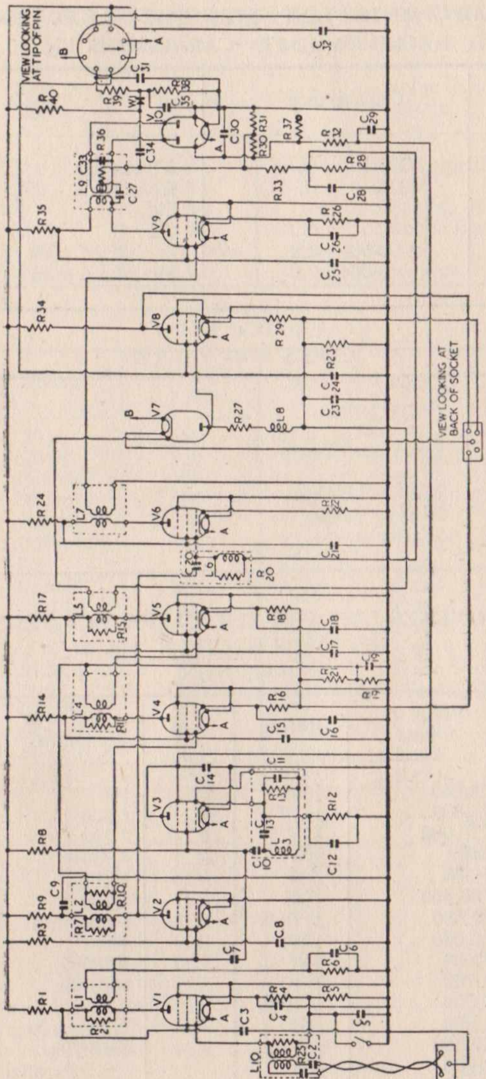


FIG. 41.—The Ultra V470 Televisor. Receiver Section

COMPONENTS LIST FOR THE R.G.D. 2547TR BROADCAST RECEIVER UNIT. CAPACITORS Fig. 40 (*continued*)—

No.	Capacitance	Type
C22	220 pfs.	Silver mica, 2%
C23	220 pfs.	Silver mica. 2%
C24	100 pfs.	Cer.
C25	100 pfs.	Cer.
C26	0·001 mfd.	Metallised mica
C27	0·001 mfd.	Metallised mica

COILS AND VALVES

L1	Aerial voil
L2	Osc. coil
I.F.T.1, 2	I.F. transformers
V1	Mazda TH41
V2	Mazda VP41
WX6	Westector

COMPONENTS LIST FOR THE ULTRA V470 TELEVISOR RECEIVER SECTION Fig. 41

RESISTORS

No.	Value in Ohms	Rating	No.	Value in Ohms	Rating
R1	22,000	$\frac{1}{2}$ W.	R22	150	$\frac{1}{4}$ W.
R2	33,000	1/10 W.	R23	1,000	$\frac{1}{4}$ W.
R3	220,000	$\frac{1}{4}$ W.	R24	2,200	$\frac{1}{2}$ W.
R4	240	$\frac{1}{4}$ W.	R25	4,700	1/10 W.
R5	7,500	$\frac{1}{4}$ W.	R26	150	$\frac{1}{4}$ W.
R6	100,000	$\frac{1}{4}$ W.	R27	4,000	$\frac{1}{4}$ W.
R7	47,000	1/10 W.	R28	1 megohm	$\frac{1}{4}$ W.
R8	56,000	$\frac{1}{2}$ W.	R29	47	$\frac{1}{4}$ W.
R9	5,600	$\frac{1}{2}$ W.	R30	100,000	$\frac{1}{4}$ W.
R10	4,700	1/10 W.	R31	100,000	$\frac{1}{4}$ W.
R11	4,700	1/10 W.	R32	2.2 meghoms	$\frac{1}{4}$ W.
R12	4.000	$\frac{1}{4}$ W.	R33	2.2 megohms	$\frac{1}{4}$ W.
R13	51,000	$\frac{1}{4}$/10 W.	R34	Two 10k.	$\frac{1}{2}$ W.
R14	2,200	$\frac{1}{2}$ W.		Parallel	$\frac{1}{2}$ W.
R15	4,700	1/10 W.	R35	2,200	

COMPONENTS LIST FOR THE ULTRA V470 TELEVISOR

RESISTORS Fig. 41 (*continued*)

No.	Value in Ohms	Rating	No.	Value in Ohms	Rating
R16	150	$\frac{1}{4}$ W.	R36	18,000 type 16	$\frac{1}{4}$ W.
R17	2,200	$\frac{1}{2}$ W.	R37	100,000 type 16	$\frac{1}{4}$ W.
R18	150	$\frac{1}{4}$ W.			
R19	75,000	$\frac{1}{4}$ W.	R38	2.2 megohms	$\frac{1}{4}$ W.
R20	39,000	1/10 W.	R39	39,000	$\frac{1}{4}$ W.
R21	5,600	$\frac{1}{4}$ W.	R40	1 megohm	$\frac{1}{4}$ W.

CAPACITORS

No.	Capacity	Working Volts	No.	Capacity	Working Volts
C1	120 pf	350	C18	.01 mfd	500
C2	120 pf	350	C19	.01 mfd	500
C3	.001 mfd	500	C20	5 pf	
C4	.001 mfd	500	C21	.01 mfd	350
C5	.001 mfd	500	C23	22 pf	350
C6	.001 mfd	500	C24	.01 mfd	500
C7	4 pf		C25	.01 mfd	500
C8	.01 mfd	500	C26	.01 mfd	500
C9	.01 mfd	500	C27	100 pf	350
C10	100 pf	350	C28	.01 mfd	500
C11	15 pf	350	C29	100 pf	500
C12	.01 mfd	500	C30	100 pf	500
C13	22 pf	350	C31	.001 mfd	500
C14	.01 mfd	500	C32	.01 mfd	500
C15	.01 mfd	500	C33	50 pf	350
C16	.01 mfd	500	C34	.01 mfd	350
C17	.01 mfd	500	C35	270 pf	

No.	**Coil**	No.	**Valve**
L1	R.F.	V1	6F12
L2	Vision I.F.I	V2	6F12
L3	Oscillator	V3	6F12
L4	Vision I.F.2	V4	6F12
L5	Vision I.F3	V5	6F12
L6	Sound I.F.1	V6	6F12
L7	Sound I.F.2	V7	D1
L8	Peaking Coil	V8	6F14
L9	Discriminator	V9	6F12
L10	Aerial	V10	6D2
		W1	Westector Type W.

COMPONENTS LIST FOR THE ULTRA V470 TELEVISOR TIMEBASE AND C.R. TUBE SECTION. Fig. 42

RESISTORS

No.	Value in Ohms	Rating	No.	Value in Ohms	Rating
R41	120,000	¼ Watt	R70	91	½ Watt
R42	120,000	¼ Watt	R71	250 Pot.	
R43	4,700	¼ Watt	R72	50 Pot.	
R44	2,200	¼ Watt	R73	10	¼ Watt
R45	1,200	¼ Watt	R74	33	¼ Watt
R46	8,200	¼ Watt	R75	2,200	3 Watt
R47	1 Megohm	½ Watt	R76	1,000 Pot.	
R48	10,000 Pot.		R77	1,200	½ Watt
R49	33,000	¼ Watt	R78	1,200 Pot.	
R50	100,000	1 Watt	R79	50,000	¼ Watt
R51	470	¼ Watt	R80	22,000	¼ Watt
R52	270,000	¼ Watt	R81	82,000	1 Watt
R53	18,000	½ Watt	R82	100	¼ Watt
R54	47,000	½ Watt	R83	1,000	¼ Watt
R55	68,000	¼ Watt	R84	5,000 Pot.	
R56	50,000	¼ Watt	R85	100,000 Pot.	
R57	270,000	¼ Watt	R86	470,000	¼ Watt
R58	120,000	½ Watt	R87	3,300	3 Watt
R59	4,700	¼ Watt	R88	2,200	3 Watt
R60	22,000	¼ Watt	R89	100	¼ Watt
R61	50,000	¼ Watt	R90	180	½ Watt
R62	82,000	1 Watt	R91	500 Pot,	
R63	100	¼ Watt	R92	10,000	¼ Watt
R64	2,700	¼ Watt	R93	10,000	¼ Watt
R65	2,000 Pot.		R94	39,000	1 Watt
R66	1,200	¼ Watt	R95	10,000 Pot.	
R67	470,000	¼ Watt	R96	22,000	½ Watt
R68	4,700	¼ Watt	R97	15,000	¼ Watt
R69	4,700	2 Watt			

CAPACITORS

No.	Capacity	Working Voltage	No.	Capacity	Working Voltage
C41	.1 mfd	350	C51	.01 mfd	350
C42	.01 mfd	350	C52	.1 mfd	350
C43	.1 mfd	200	C53	.1 mfd	350
C44	200 pf	350	C54	.005 mfd	500
C45	400 pf	350	C55	22 pf	250
C46	.1 mfd	200	C56	1 mfd	350
C47	22 pf	250	C57	.5 mfd	350
C48	.005 mfd	350	C58	.05 mfd	350
C49	.05 mfd	350	C59	32 mfd	350
C50	.007 mfd	350	C60	.01 mfd	350

COMPONENTS LIST FOR THE ULTRA V470 TELEVISOR TIMEBASE AND C.R. TUBE SECTION. Fig. 42 (*continued*)—

VALVES

No.	Valve	No.	Valve
V11	6F12	V15	6P28
V12	6F12	V16	PEN45
V13	T41	V17	CRM92
V14	T41		

NOMENCLATURE OF CONTROLS	NOMENCLATURE OF COILS
R84—Vertical Hold.	L10—Compensating Coil.
R95—Vertical Shift.	L11—Horizontal Deflection Transf.
R85—Vertical Form.	L12—Horizontal Deflection Coil.
R65—Horizontal Hold.	L13—Horizontal Form Coil.
R72—Horizontal Shift.	L14—Focus Coil.
R76—Horizontal Form.	L15—Vertical Deflection Coils.
R91—Height.	
R71—Width.	
R78—Focus.	
R48—Contrast.	

COMPONENTS LIST FOR THE ULTRA V470 TELEVISOR POWER SUPPLY SECTION Fig. 43

RESISTORS

No.	Value in Ohms	Rating	No.	Value in Ohms	Rating
101	27,000	1 W.	*110	540	
102	330	2 W.	111	5 megohms	½ W.
103	12,000	½ W.	112	5 megohms	½ W.
104	1 megohm	½ W.	113	5 megohms	½ W.
105	1 megohm	¼ W.	114	5 megohms	½ W.
106	160	½ W.	115	5 megohms	½ W.
107	50,000	1 W.	116	27,000	¼ W.
108	47,000	1 W.		* Focus Drift	
109	10 megohms	¼ W.		Resistor.	

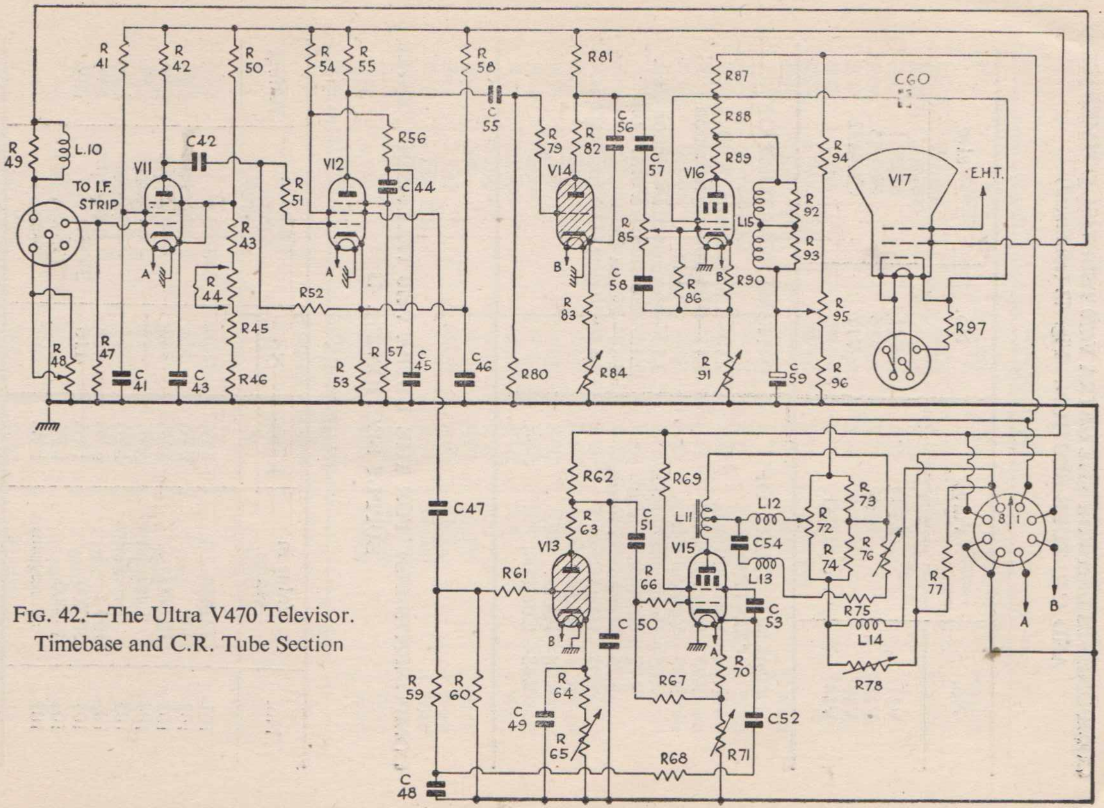


FIG. 42.—The Ultra V470 Televisor.
Timebase and C.R. Tube Section

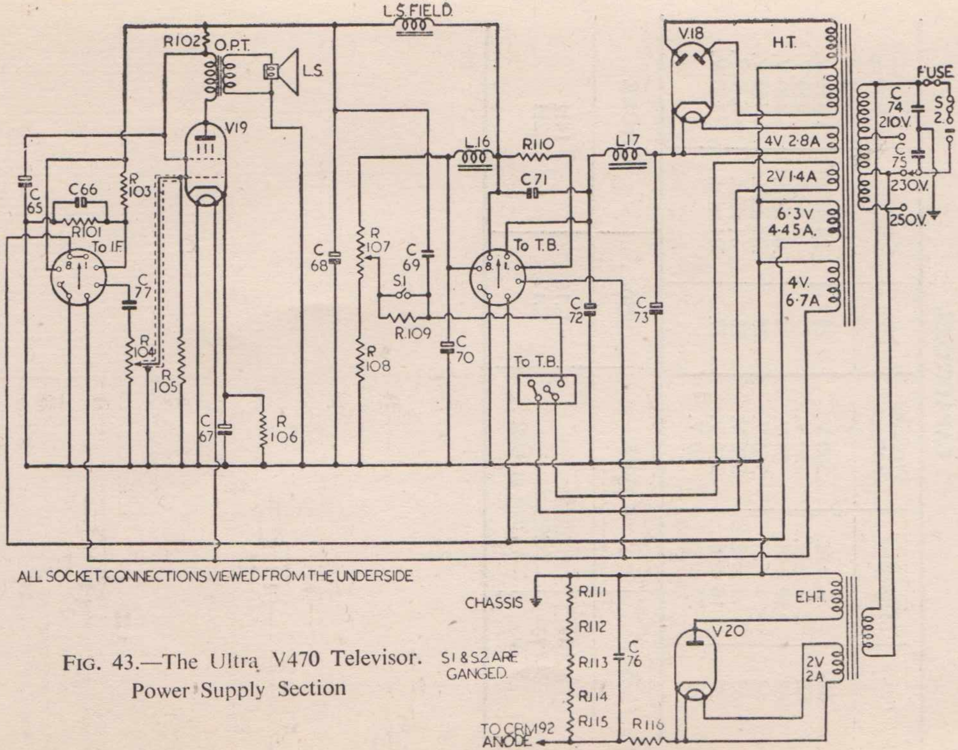


FIG. 43.—The Ultra V470 Televisor. Power Supply Section

COMPONENTS LIST FOR THE ULTRA V470 TELEVISOR POWER SUPPLY SECTION Fig. 43—(*continued*)

CAPACITORS.

No.	Capacity	Working Voltage	No.	Capacity	Working Voltage
65	8 mfd.	350 V.	72	24 mfd.	450 V.
66	4 mfd.	350 V.	73	16 mfd.	450 V.
67	50 mfd.	25 V.	74	.01 mfd.	450 V.
68	24 mfd.	350 V.	75	.01 mfd.	450 V.
69	.5 mfd.	350 V.	76	.1 mfd.	6.K.V.
70	16 mfd.	350 V.	77	.01 mfd.	350 V.
71	25 mfd.	50 V.			

No.	**VALVE**	No.	**CHOKE**
V.18	UU8	L.16	14H
V.19	PEN45	L.17	2H
V.20	V916 or U22		