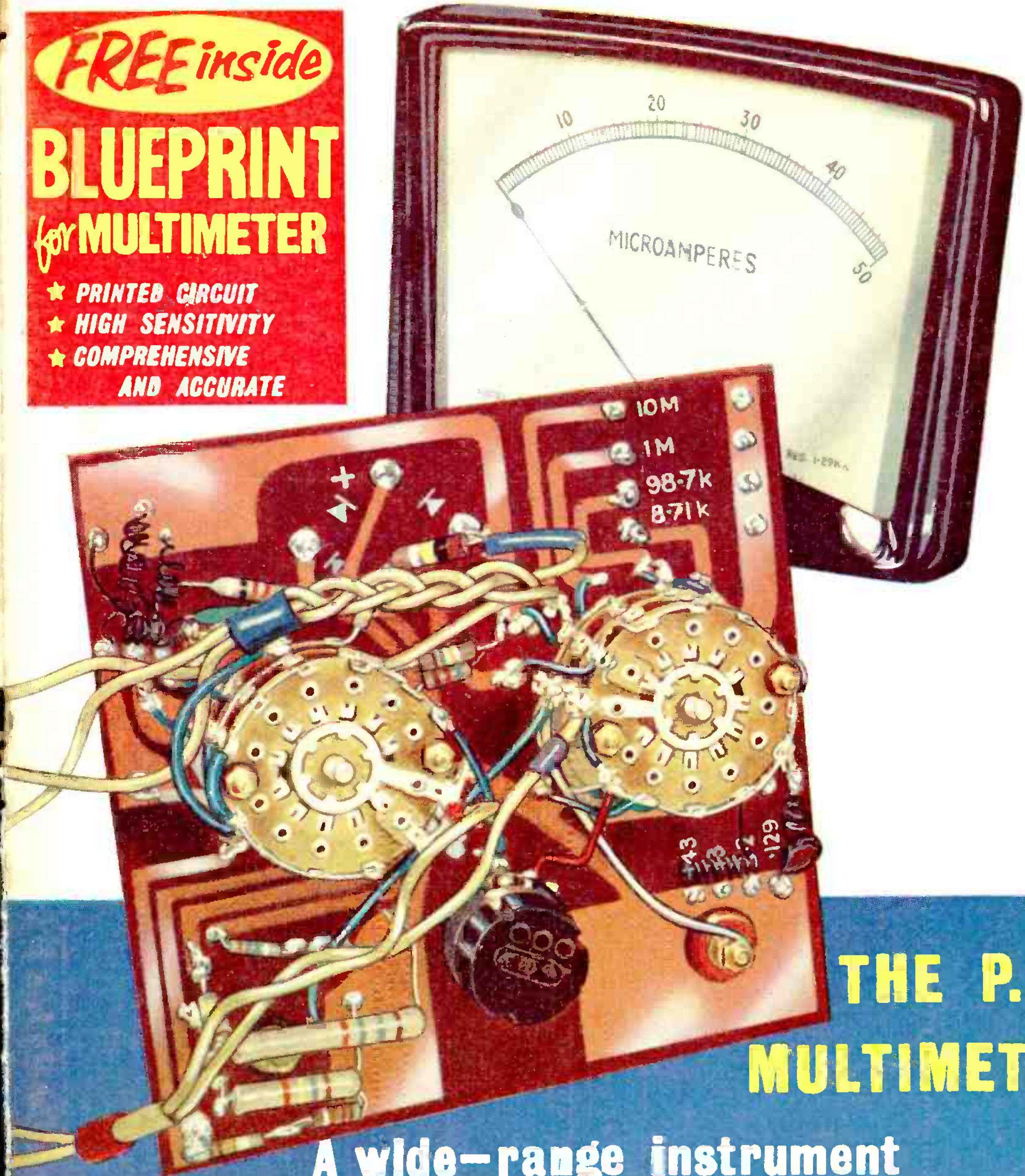
Practical TELEVISION

OCTOBER 1961 1/6

FREE inside

BLUEPRINT for MULTIMETER

- PRINTED CIRCUIT
- HIGH SENSITIVITY
- COMPREHENSIVE AND ACCURATE



THE P.T. MULTIMETER

A wide-range instrument measuring Volts, Amps and Ohms

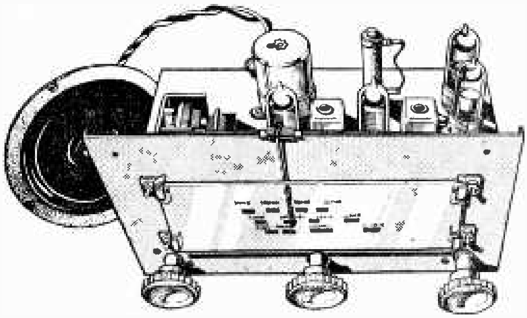
HARVERSON SURPLUS CO. LTD.

CHErrywood 3985/6

83 HIGH STREET, MERTON, LONDON, S.W.19

2 BAND SUPERHET CHASSIS with Speaker

ONLY £5.17.6
Plus 6/6 Post & Packing

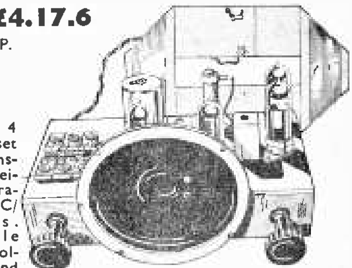


A quality 4 valve AC/DC superhet chassis made by a world famous manufacturer. Long and Medium wave coverage. Fitted with a cord and drum reduction tuning drive and attractive illuminated glass dial (size 6¼ x 2½in.). Controls: Volume on/off, tuning and wave change. The receiver is self-powered, employing a mains dropper and a valve rectifier. Chassis dimensions 6¼ x 9 x 5½in. high. Supplied complete with a good quality 5-inch loudspeaker, valves (UCH42, UAF42, UL41, UY41), AC/DC mains input lead, ivory knobs, etc.

DON'T HESITATE, ORDER NOW! This unbeatable bargain is bound to sell out quickly at only £5.17.6, plus 6/6 post and packing.

4 STATION PRESET CHASSIS with Speaker

ONLY £4.17.6
Plus 6/6 P. & P.



A compact, 4 station preset mains transportable receiver for operation from AC/DC mains. Two simple controls, volume on/off and 4 position station selector. The latter is set to Light Programme (Long Wave). Third Programme, Home Service and Light Programme (Medium Wave), but may of course be adjusted to alternative selections if required. A frame aerial with throw-out extension is supplied, making this receiver ideal as a general purpose transportable set for the home. A fully smoothed power supply is provided from AC/DC mains input by a mains dropper and a valve rectifier. The good tonal qualities are assisted by the provision of a quality 5in. speaker, which is ready-mounted on the chassis (this is easily detachable if alternative positioning is required). Valve line up, UCH, UAF42, UL41, UV41. This chassis (size 9 x 6¼ x 5½in. high) is supplied complete with valves, knobs, mains lead, aerial, etc. It is beautifully made by a famous maker, and is first-class buy at the rock bottom price of only £4.17.6, plus 6/6 post and packing.

THE HARVERSON 6 TRANSISTOR PLUS DIODE SUPERHET KIT

A first class 2 wave band transistor superhet in kit form. ★ Printed circuit panel (size 8⅛ x 2¾ ins.) ★ 3 Pre-aligned IF Transformers. ★ Output Transformer. ★ 5 inch 5Ω Speaker. ★ High gain Ferrite rod aerial. ★ First grade G.E.C. transistors. ★ Push/Pull output. All parts down to the minutest item with simple instructions.

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Cabinet to suit (if available) 15/- extra.

TRANSISTOR AMPLIFIER KIT

A complete kit of parts to build a compact 4-transistor amplifier, with volume control and printed cct. board. Two GT3 driver transistors, transformer coupled. 1 watt output from matched pair GT15. Supplied with output transformer and 2½in. 3 ohm speaker. Ideal for record player, etc. 59/6, plus 4/6 P. & P.

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50 mixed P.F. Condensers and 50 mixed Resistors. An assortment of useful values. All popular sizes—all new—a must for the serviceman and constructor. **ONLY 10/-,** P. & P. 1/-.

THE HARVERSON COMPLETE FM/VHF RECEIVER KIT

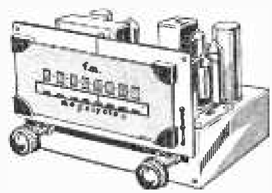
A complete VHF/FM Receiver in Kit Form.

Superb specifications. Everything supplied for **Only £6.19.6,** plus 4/6 P. & P. (See Practical Wireless October 1961 issue page 464 for full details).

20,000 VALVES IN STOCK. Lowest prices ever. See our list in October Practical Wireless, or send for your requirements.

HARVERSON'S F.M. TUNER KIT

At last a quality F.M. Tuner Kit at a price you can afford. Just look at these fine features, which are usually associated with equipment at twice the price.



★ F.M. Tuning Head by famous maker. ★ Guaranteed Non-drift. ★ Permeability Tuning. ★ Frequency coverage 88-100 Mc/s. ★ OA81 Balanced Diode Output. ★ Two I.F. Stages and Discriminator. ★ Attractive maroon and gold dial (7 x 3in. glass). ★ Self powered, using a good quality mains transformer and valve rectifier. ★ Valves used ECC85, two EF80's, and EZ80 (rectifier). ★ Fully drilled chassis. ★ Everything supplied down to the last nut and bolt. ★ Size of completed tuner 8 x 6 x 5½in. ★ All parts sold separately. **£4.19.6,** plus 8/6 P. P. & Ins. Circuit diagram and illustrations, 1/6, post free.

OUTPUT STAGE AND SPEAKER FOR F.M. TUNER

All parts, including speaker, ECL82 valve, and simple instructions to make two-stage output unit for converting F.M. tuner into F.M. receiver. ONLY 59/6, plus 4/6 P. & P.

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U404	8/6
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UB41	12/-
UBC41	8/6
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UBF80	9/-
UBF89	9/6
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UCH81	9/6
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UCL83	19/9
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UF80	10/6
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UF89	9/-
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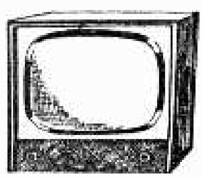

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"I am writing to express my satisfaction at the standard of your kit for your Pocket 4 Transistor set and also to state that it has come up to my expectations in regard to performance."

Mr. R. Belt, Newcastle-on-Tyne.
"I have built your Pocket 4 Transistor set, I am very pleased with it."

Mr. F. Jackson, Ickenham, Middx.
"I have built the Pocket 4 and am more than pleased with the results."

Mr. G. Bamford, Ramsgate.
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Mr. A. J. Simmonds, Welling, Kent.
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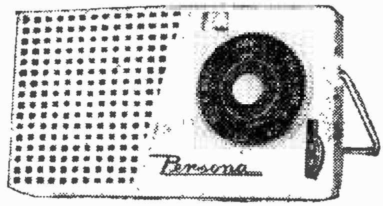

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Practical Television

AND TELEVISION TIMES

VOL. 12, No. 133, OCTOBER, 1961

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Contents

Our Free Blueprint

IN every copy of this issue, is a blueprint for a comprehensive multimeter—the latest PRACTICAL TELEVISION design. This blueprint is the culmination of several months' work on a design which did not employ special parts and would therefore be especially suitable for the amateur radio or television enthusiast. For range selection, two standard 3-pole, 12-way rotary switches are used and the combinations of settings obtainable with these two switches provide 21 ranges. Included in this number are four ranges for the measurement of alternating current—this provision is unusual and is seldom found even in commercial instruments intended for the use of the amateur constructor. Of course, the need to avoid the inclusion of specialised parts has meant that a current transformer could not be used for these ranges and these scales are not linear.

The rectifier used for the A.C. readings is a bridge type made up of four OA70 germanium diodes—a readily obtainable type. This was thought preferable to using a meter rectifier on two counts; firstly, as already mentioned, OA70's are readily available, and, secondly, their use enables the instrument to be employed (for comparison purposes) at R.F.

The series resistors and shunts are described in detail in the text of the article on the Multimeter and no special equipment is needed when adjusting these components to their correct values for the meter movement concerned. In fact, the meter movement is used as the standard in the procedure given.

Although a printed circuit is used as the basis of the construction of the meter, it would be possible to use a conventional method with tag-strips, but the advantage of the actual-size layout given on the blueprint would be lost. Complete information is given on making the printed circuit and no difficulty should be experienced.

This design has been produced to give the amateur the chance of acquiring a comprehensive instrument equal in sensitivity to many expensive designs on the market (20,000Ω/V) and at considerably reduced cost. Next month, we shall give details of a suitable case for the completed instrument together with more information on the calibration, and we are confident that any amateur who makes the meter will be assured of good results.

INCREASED PRICE

AT last the ever increasing costs of production have caught up with us, and it is now a necessity that the price of this magazine should be increased to 1s. 9d. The October issue of PRACTICAL TELEVISION then, is the last at the present price of 1s. 6d. and with the November issue the price will be increased by 3d.

This decision was not one easy to make, but was the inevitable result of a continued rise in cost of paper, printing and many other expenses.

Our next issue, dated November, 1961, will be published on October 20th.

Telenews

Television Receiving Licences

THE following statement shows the approximate number of Television Receiving Licences in force at the end of July, 1961, in respect of television receiving stations situated within the various Postal Regions of England, Wales, Scotland and Northern Ireland.

Region	*Total*
London	1,948,296
Home Counties	1,594,721
Midland	1,723,126
North Eastern	1,846,948
North Western	1,500,582
South Western	976,023
Wales and Border Counties	692,502
Total England and Wales	10,282,198
Scotland	1,034,430
Northern Ireland	168,178
Grand Total	11,484,806

625-Line TV at the Radio Show

TWENTY-ONE of the television receiver manufacturers who exhibited at this year's Radio Show in London had on show TV sets working on the 625-line standard.

This was the first time that commercial exhibitors had shown 405/625-line TV sets in operation at the Radio Show and visitors saw them working alongside standard 405-line receivers.

Continuous daily transmissions of a 625-line monochrome demonstration picture were relayed from the Radio Show control room to the manufacturers' stands, where converters raised the frequency into the UHF band.

Colour Television on a Large Scale

A NEW large screen colour television projector has recently been developed at the Marconi Colour Television Laboratories.

The projector accepts either separate red, green and blue signals, or a composite coded signal, and projects a picture measuring 12ft by 9ft on to a screen 25ft away. Each colour channel has a separate video amplifier with a bandwidth of 10Mc/s, and these amplifiers feed 5in. cathode ray tube projectors operating at 50kV EHT.

The three projectors are mounted side-by-side, and only the centre one is on the normal to the screen. An electronic correction waveform has therefore to be applied to each of the outer cathode ray tubes to avoid "keystone" distortions of the picture.

Microwave Link for Satellite Television Stations

THE British Broadcasting Corporation has awarded a contract to Pye Telecommunications Limited for the supply of four microwave links.

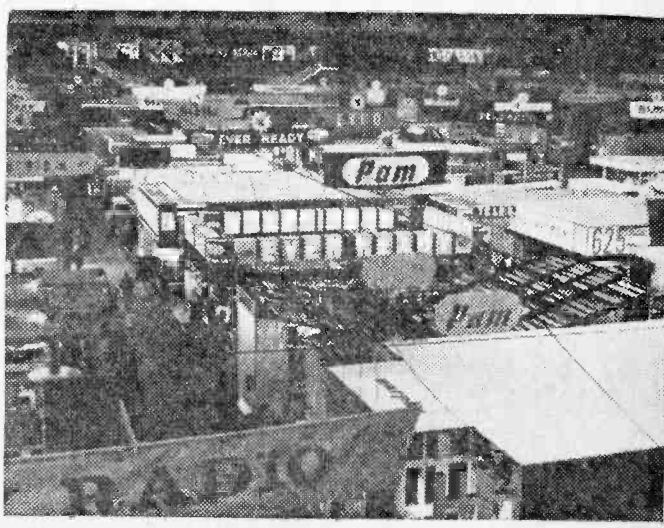
The links will operate in the 7000Mc/s band and each will consist of a transmitting terminal, with two transmitters, and a receiving terminal, with two receivers.

The equipment will be used to convey programmes to certain new low-power satellite television stations which are being set up to extend the coverage of the BBC's television service.

New TV Station for Wales

THE Postmaster-General has approved the ITA's plan for the erection of a station to serve the Flint-Denbigh area of Wales.

As announced in June, a group known as the Wales Television Association, has been selected as the programme company for the combined West and North Wales area which will be covered by three stations, one in Pembrokeshire, a second in the Lleyn Peninsula and this third one for Flint and Denbigh. The total population coverage of the three stations is estimated to be of the order of one million. The Authority has been assured of the



A general view of this year's Radio Show, at Earl's Court, London.

group's intention to broadcast, at good viewing times, programmes of specific interest to the Welsh audience, including regular Welsh-language programmes.

It is hoped that the Pembrokeshire and Lleyn stations will begin transmissions in less than a year's time, with the Flint-Denbigh station coming on the air some months later.

Transmitting Aerials for Five New Stations

THE British Broadcasting Corporation has placed contracts with EMI Electronics Ltd., for transmitting aerials and feeder systems at five new stations in Scotland, Wales, Cornwall, Lancashire and Oxfordshire, which the BBC is building to extend its television and sound services and to improve reception in the fringe areas.

At the station now under construction at Llandrindod Wells in Central Wales, turnstile arrays have been installed on an 80ft section at the top of a 250ft mast.

The stations under construction at Redruth, Cornwall and Beckley, near Oxford, will be equipped with television and VHF sound arrays on 500ft masts later this year. The Morecambe Bay station, to be built near Barrow, will be provided with a television aerial on a 250ft mast, while the Scottish station being built at Ashkirk, near Selkirk, will be equipped with television and VHF sound arrays on its 700ft mast.

All these arrays will be horizontally polarized with the exception of the television array at Ashkirk which will be vertically polarized.

Hospital Operating Theatre has Built-in TV System

THE Queen Elizabeth Hospital, Birmingham, was equipped with a new type of closed circuit television assembly during August. The installation was officially handed over to the Dean of the Faculty of Medicine at the University of Birmingham by Mr. B. R. Greenhead, Technical Controller of A.B.C. Television, which has presented two television camera channels to the University. Both Camera channels have been supplied by EMI Electronics Ltd.

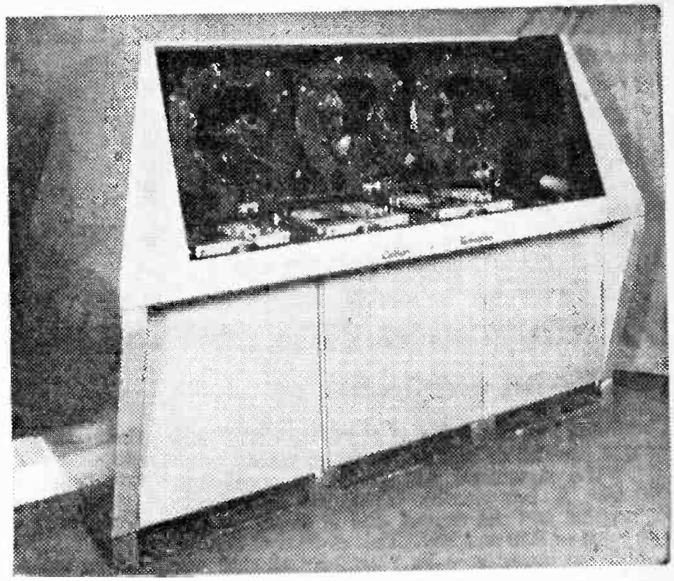
One channel works on the 625-line standard and has been installed in theatre No. 3 of the Queen Elizabeth Hospital and will be used for graduate and post graduate study of surgical operation.

A second portable channel—405-line standard—will be used for microscopy, behavioural research and many other study and research projects in the Medical school.

The EMI camera installed in the operating theatre will enable a large number of students in an adjoining lecture room to watch, on large screen television receivers, operations performed by the tutorial staff.

A two-way microphone talk-back system between the lecture room and the operating theatre will enable surgeons to explain operations step-by-step, and to give an immediate answer to questions raised by the medical students.

The camera, operated by remote control from the adjoining lecture room, is fitted with a motorised zoom lens which will allow for general long shots and detailed close-up study. The camera, in a sterilised housing, is built into the surgical lamp above the operating table. By means of a reflecting mirror the camera will always be centred exactly on the area of surgery, and requires no adjustment by the surgeon or his assistants.



This new colour television projector has been developed at the Marconi Colour Television Laboratories. Three separate red, green and blue projectors are used to produce the full colour picture.

Television Equipment Contract

A CONTRACT for the major equipment required by Grampian Television Limited in their new Studio Centre at Aberdeen has been awarded to Pye T.V.T. Ltd., of Cambridge.

Equipment being supplied by Pye includes three Staticon Telecine channels, three Broadcast Staticon cameras with their associated control and monitoring equipment and a comprehensive master control system designed specifically to meet Grampian's operational requirements.

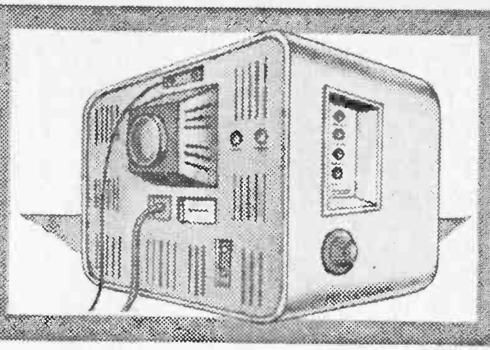
Underwater TV for Russian Tugs

FOLLOWING an order for TV equipment placed by the Finnish shipbuilding firm Valmet Oy, Marconi underwater television cameras will be used for salvage operations by a fleet of seven Russian tugs.

Seven Marconi-Siebe, Gorman cameras and monitors are to be delivered to the Pansio Shipyard, Turku, for installation on board the diesel-driven salvage tugs now being built.

Diving equipment, and underwater cutting and electric arc welding devices, are carried by the tugs. The cameras will enable salvage experts to see work being carried out by divers.

Servicing Television Receivers



No. 72—THE INVICTA 338

By L. Lawry-Johns

(Continued from page 604 of the September issue)

THE method of biasing the frame output valve V11A is unusual and should be noted (see Fig. 3, last month). There are no cathode components and the control grid is biased by the high value of R56 and R57. This method of biasing enables the linearity to be varied by altering the H.T. at V12A (which would normally alter the overall height or vertical amplitude) whilst variation of the screen voltage of V11A, with feedback from T4, alters the height.

The bias of the sound output valves is also unusual since it is derived from the line output valve control grid, the normal (−32)V being divided by R44/R45 to provide some (−7)V to the lower end of the volume control. Decoupling being carried out by C41 (25μF).

Valve Functions

V1 is the usual cascode R.F. amplifier (PCC84) feeding V2 (PCF80) mixer-oscillator. The output of the tuner is taken to the main deck via coaxial cable where it is amplified by V3 (EF85) which is the common vision and sound I.F. amplifier. The output of V3 is split to feed V4 (EF80) vision I.F. amplifier and V8 (EF80) sound I.F. amplifier. The output of V4 is demodulated by V5 (OA70 crystal diode) which is inside the final I.F. coil (T1) can —see Fig. 5 (last month).

The video signal is taken via L6 to V6 PCL84 pentode section where it is amplified before being passed on to the tube cathode and V6 triode which is used as the sync separator. The AGC is derived from the triode grid, the actual applied AGC voltage being controlled manually by a cancelling voltage from the contrast control. The sync pulses are passed by C56 to the line oscillator section of V12 (ECC82) and by R64 to the interlace circuit V11B (PCL82 triode) before the filtered frame pulses are presented to the frame oscillator section of V12 (see Fig. 3).

The line oscillator works in conjunction with the line output V13, i.e., there is no separate oscillator as such and this also applies to the frame timebase where V12 and V11 pentode form the frame oscillator.

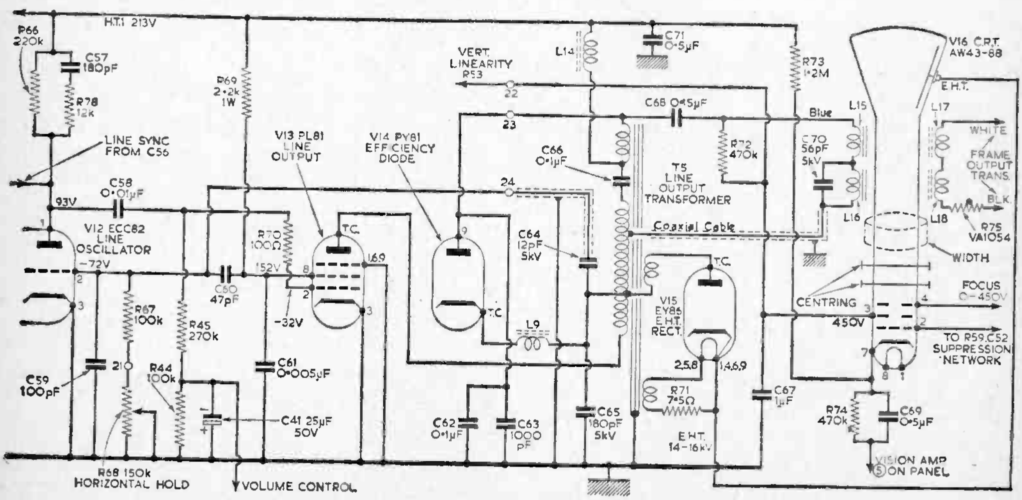


Fig. 6.—The line timebase circuit: note the connection of the volume control to the grid of the PL81, and the boost line feed to the frame linearity control.

The efficiency diode is V14 (PY81) and V15 (EY86) is the EHT rectifier. V8 is the sound I.F. amplifier, the output signals of which are passed to an OA79 crystal diode for detection. The detected A.F. signals are amplified by V10A and then R/C coupled to the volume control for amplification by V10B, the sound output (see Fig. 7).

Fault Symptoms

No signals. Raster on screen when brilliance is turned up, noise from loudspeaker but no vision or sound signals.

Suspect V1, V2 and V3 and check H.T.2 voltage (197). If valves and H.T. are in order, check R4 (5·6k) by the side of the tuner unit—the oscillator H.T. feed resistor. Also check the similar resistor inside the tuner (same circuit). There is another 5·6k in the mixer anode feed circuit, which should be checked.

No Results, Heaters Not Alight (See Fig. 4 last month)

Check the mains input and 1A fuse. Check mains at the large right-hand side mains dropper (black). The 70Ω section (R30) seems to have a habit of going o.c. If this section is found to be o.c., the dropper may be replaced or a 70Ω 10W resistor wired across the tags. When using a neon tester, a glow will be obtained an one tag but not at the other when a section is o.c. *Note:* at all times it should be ensured that the black lead is connected to the *neutral* side of the mains. If a neon tester lights when applied to the chassis the mains leads or plug must be reversed.

If the dropper records mains potential at all tags, it is necessary to check through the heater chain to ascertain which heater is o.c. The heater chain was shown in Fig. 4.

No Picture, Sound in Order

Advancing the brilliance does not produce a raster.

Remove the rear cover and check the line timebase and EHT. If the line timebase is working, the characteristic whistle should be heard varying with the hold control. If the whistle is absent, note the condition of the PL81. If this is red hot internally, V12 (ECC82) may well be at fault or the PL81 itself may be internally shorted. If a new valve restores the line timebase, but the width is reduced or the PL81 still overheats, check R69 2·2k and use a wire-wound resistor as a replacement.

If the PL81 does not overheat but the timebase appears to be dead, check the PY81, and capacitor C66. If the line timebase is working, check EHT at the anode of the tube. If it is absent, suspect the EY86 (V15). If EHT is present, check the voltage at pin 3 of the CRT. If it is low remove the lead from the tag and check the voltage at the lead. If it is now about 450, suspect a 1st anode-cathode short in the tube. Replace the lead on tag 3 and short pin 7 to pin 8 (chassis). This may clear the short. If not, short out R72 (470k) and again short 7 to 8. With R72 out of the circuit the short should be blown clear.

If the EHT and first anode voltages are in order and the cathode voltage is approximately 150 (this depends upon the signal input) check the voltage swing at pin 2 (grid) which should vary from 0-213V. If the voltage at pin 2 remains low check C24 (0·25μF) and C52 (0·05μF).

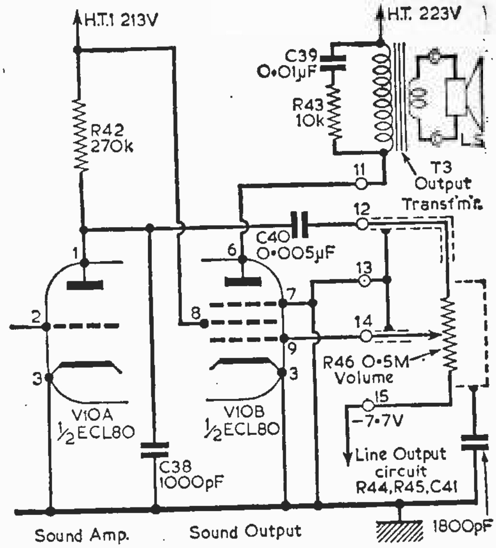
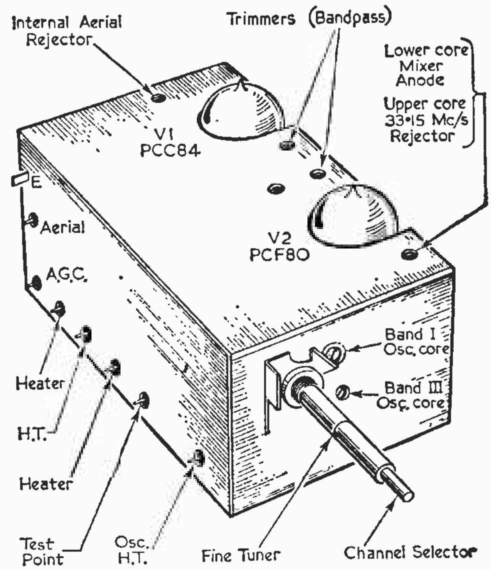


Fig. 7 (above).—The sound output circuit: note the grid bias of V10B.

Fig. 8 (below).—The connections and trimming points of the tuner unit.



Lack of Width

Ensure that the width sleeve on the neck of the tube has not been pushed in too far under the scanning coils. To adjust this sleeve, it may be necessary to slacken the assembly. Do not rotate the sleeve.

(Continued on page 36)

metal rectifiers

CRYSTAL diodes are a form of metal rectifier, and all metal rectifiers may be considered as semi-conductors. That is to say, they conduct a current of electricity with very little resistance in the "forward" direction, while in the "reverse" direction considerably more resistance is offered to the flow of current. The forward and reverse actions, therefore, depend upon which way round the voltage is applied to the rectifier, for, like a battery and electrolytic capacitor, a metal rectifier is polarised.

Characteristics

In Fig. 1 is shown the metal rectifier symbol and its polarising. When the voltage is applied so that current flows in the forward direction, as shown at (a), two things will be observed: one, the current flow is in the same direction as the "arrow" in the symbol and, two, in order to produce a forward flow of current, the positive of the battery or supply source needs to be connected to the negative of the rectifier and the negative of the battery needs to be connected to the positive of the rectifier. If the polarities are matched, as shown in Fig. 1(b), then there is a low reverse current. These points are well worth remembering.

The symbol arrow thus indicates the direction of current in the *forward* direction. The positive terminal is usually colour-coded red and corresponds to the cathode of a rectifier valve, while the negative side corresponds to the anode of a valve rectifier. This means, then, that if the valve in the rectifier circuit of Fig. 2(a) is replaced by a metal rectifier, the rectifier would be connected as shown in Fig. 2(b).

These circuits show one of the outstanding advantages of a metal rectifier against a valve, and that is that no heater power is required. The total efficiency of a metal rectifier is therefore better than a valve rectifier, which is one of the reasons why metal rectifiers are being used more and more by circuit designers.

Rectifier Types

There are four basic materials from which metal rectifiers are made: selenium, copper oxide, germanium and silicon. Copper oxide and selenium rectifiers have been used in the past mainly for power rectification and are formed by a number of elements clamped in series between metal plates or discs which are used for cooling. Germanium and silicon rectifiers, on the other hand, are formed by a single crystal, for which reason they are usually referred to as crystal diodes.

Selenium stacks are extensively used to provide H.T. supplies for domestic radio and television receivers, and of recent years, they have been reduced in size by improvement in design and by utilising the chassis on which the circuit is built as a heat conductor, thereby dispensing with the air-cooling fins or plates. Such rectifiers are called "contact-cooled."

Silicon rectifiers are now being used as power rectifiers, and since the forward and reverse losses are below those of selenium and copper oxide units,

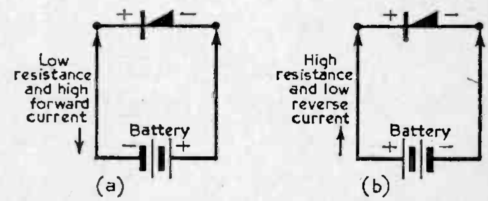
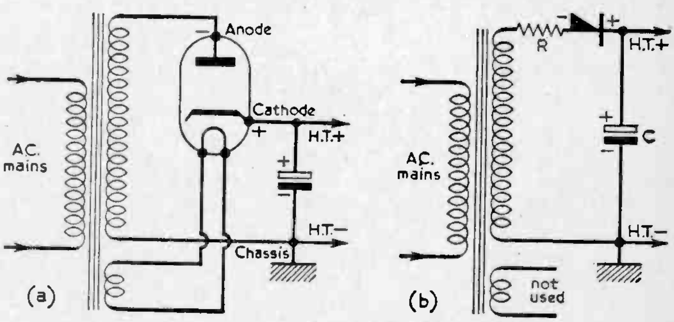


Fig. 1 (above).—When a supply source is connected to a metal rectifier as shown at (a), a high forward current will result in the direction of the arrow. When it is connected as in (b), there will be only a small reverse current.

Fig. 2 (below).—If the valve in the circuit of (a) were replaced by a metal rectifier, it would be connected as shown in (b).



and crystal diodes

THE FUNCTIONS AND METHODS OF OPERATION OF THESE TWO COMPONENTS

By W. Faine

they are more efficient and can be made very much smaller than the older type of rectifier. Indeed, a silicon rectifier designed for 250V r.m.s. and 300mA is no more than ½in. in diameter and a little over ½in. in length and weighs only one-tenth of an ounce. However, because of their higher efficiency they require special treatment in the circuit. (A very useful article on such rectifiers and their uses appeared on page 465 of the June 1960 issue.)

Germanium diodes or rectifiers are used mostly in signal circuits, and because of their low self-capacitance they make very good R.F. detectors and mixers. Crystal diodes generally are produced in three ways. There is the point contact type, which is the direct descendant of the "cat's whisker" crystal detector. This has an extremely low internal capacitance, a low forward current and a relatively low reverse voltage. Then, there is the junction diode which provides a higher forward current and is more of a power rectifier. Finally, there is the bonded diode, which in effect is a low-capacitance version of the junction diode.

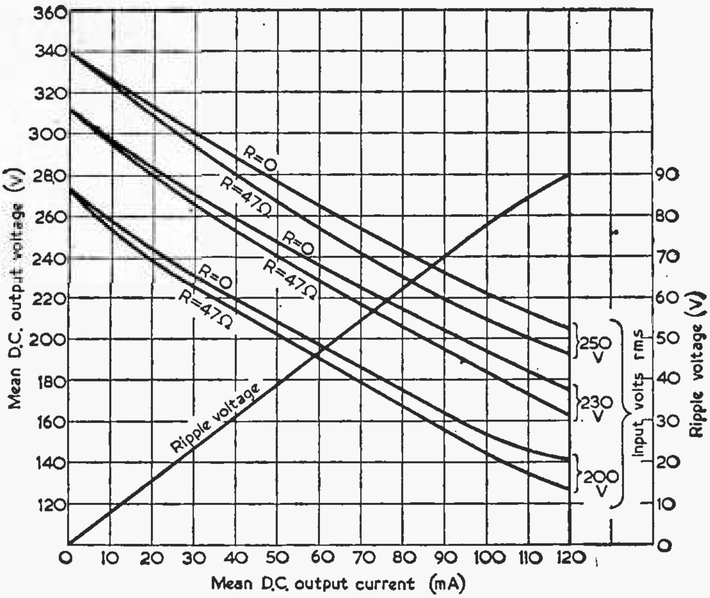


Fig. 4.—The output characteristics curves of a selenium rectifier.

Rectifier Characteristics

If a milliammeter were connected in series with the circuit of Fig. 1(a) and the applied voltage progressively increased from zero, a curve as shown by

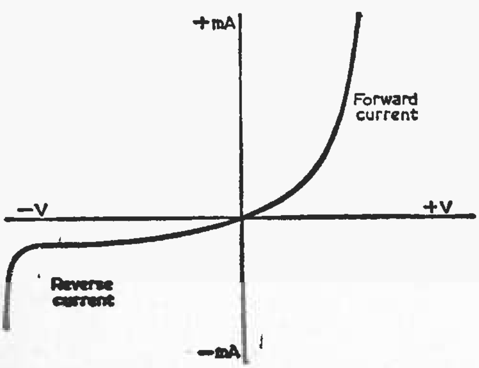


Fig. 3.—The general characteristic curve of a metal rectifier or crystal diode.

the forward current in Fig. 3 could be plotted. Similarly, if the same process were undertaken with the circuit of Fig. 1(b) a curve as shown by the reverse current in Fig. 3 could be plotted. The actual voltages required and the resulting currents would depend upon the type of rectifier under test.

If the forward current rating of the rectifier were exceeded, the rectifier would fuse, and in the case of a selenium or copper oxide stack, severe overheating would first occur, probably accompanied by flashing between the elements and a very unpleasant smell.

Similar symptoms would result by overrunning the rectifier in the reverse current sense. From Fig. 3 it will be noticed that the reverse current increases gradually up to a certain point where there is a rapid increase in current. The voltage at which this rapid increase in current occurs is called the "reverse turnover voltage," and the resulting current will destroy the rectifier.

With power rectifiers, this turnover voltage is of the order of 400V, while with smaller diodes it is considerably less. When selenium or copper oxide rectifiers are connected in series, the turnover voltage (sometimes termed peak inverse voltage) is increased, and this is the reason why two or more rectifier stacks are connected in series in certain power units. It should be noted, however, that copper oxide rectifiers are not generally suitable for mains power supply units.

Applications of Power Rectifiers

When a metal rectifier is used as shown in Fig. 2(b) there are three factors to be considered: the rectifier shall be capable of supplying the required current; the maximum input voltage (r.m.s. A.C.) should not be in excess of the rectifier rating; the maximum peak inverse voltage should not be exceeded.

When the A.C. voltage at the negative terminal of the rectifier in Fig. 2(b) swings positive, a very heavy current flows from the power source through the rectifier to charge the reservoir capacitor C. This current is limited only by the resistance of the power supply and rectifier and can rise to a

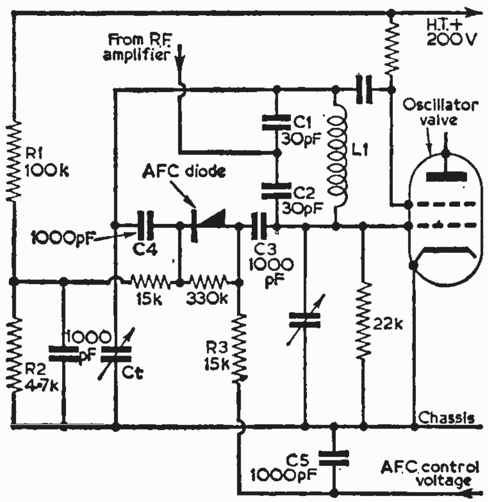


Fig. 5.—An AFC circuit.

value many hundreds of times the working current when a large value reservoir capacitor is used. With silicon rectifiers such a heavy initial current could cause immediate failure since the current is much larger with this type of rectifier owing to its lower forward resistance. To avoid this and to hold the current to a reasonable level a surge limiting resistor R must be included in the circuit, as shown.

A similar resistor is usually also recommended with selenium stacks to minimise ageing which could be aggravated by heavy peak currents. Generally speaking, however, a selenium stack can withstand an almost unlimited instantaneous peak current, though this is not the case with silicon units. Typical values of R are 25Ω for a silicon rectifier and 22Ω or 47Ω for a selenium stack, depending upon the number of elements.

Higher H.T.

Normally, owing to the greater efficiency of a silicon rectifier, when such a unit is used to replace a valve or selenium rectifier, the resulting H.T. voltage is somewhat in excess of that originally obtained. Thus, to avoid exceeding the ratings of associated components it may be found necessary to reduce the output voltage, either by using a surge limiting resistor of slightly larger value, or by increasing the value of the smoothing or H.T. feed resistor, or both.

When the A.C. voltage at the negative terminal of the rectifier in Fig. 2(b) swings negative, there occurs a reverse voltage across the rectifier equal to the positive voltage across C together with the peak voltage of the A.C. If the applied r.m.s. A.C. is, say, 200V, then the peak value will be 280V (peak voltage=1·4 x r.m.s. voltage). The voltage across the reservoir capacitor under this condition may be 230V, thereby giving a peak inverse voltage across the rectifier of 510V. This may be as high as 2·8 times the applied r.m.s. voltage in some circuits, having a low load.

In Fig. 4 is given the output characteristics of a well-known selenium rectifier stack (STC Type DSM2/3) with an 8μF reservoir capacitor. This shows the output voltage and input voltage over a wide range of load currents with, and without, a surge limiting resistor. The ripple voltage is also given and, as is common to all rectifier circuits, this increases with increase in load current. With a larger reservoir capacitor, a larger output voltage is obtained for a given input voltage and the ripple voltage is also smaller. However, by reducing the ripple voltage the time over which the diode conducts is also shortened, which means that the charge of the reservoir capacitor has to be restored during the small intervals at the peaks of the positive-going waves, and this requires current pulses many times in excess of the mean current load.

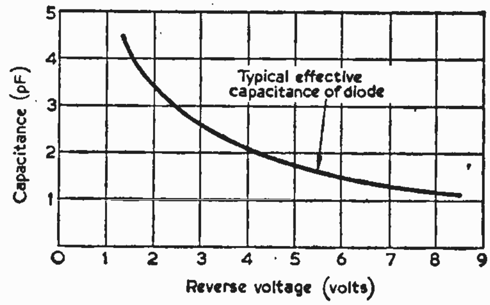


Fig. 6.—This graph shows how the capacitance of a germanium diode varies with a change in reverse voltage.

Diode as Variable Capacitor

The self-capacitance of silicon and germanium rectifiers is not constant but is dependent on the reverse voltage. For instance, as the reverse voltage increases, so the capacitance decreases.

This effect is exploited for automatic-frequency-correction of local oscillators in television and VHF-FM receivers. The diode is connected in such a way across the oscillator tuned circuit that it represents a part of the tuning capacitance. Thus, the frequency of the oscillator may be altered within a small amount by varying the diode bias voltage.

Oscillator Tuning

In Fig. 5 is shown such a circuit. The main capacitance across the oscillator coil L1 is that made by C1 and C2 in series. Also in parallel with L1 is the AFC diode. C3 and C4 simply give DC isolation and are of such large value that they have negligible effect on the diode capacitance. Ct is the oscillator tuning capacitor.

The diode is biased from a standing bias of about (−4)V obtained from the potential divider, R1 and R2, across the H.T. supply. The control voltage is obtained from a discriminator circuit, which gives either a positive or negative control voltage depending to which side of the tuning point the oscillator has drifted. Thus, if the oscillator tends to drift off frequency, the control bias automatically brings it on tune again.

This circuit is based on the S.T.C. Type GD14 germanium point-contact diode, and the diagram in Fig. 6 shows how its capacitance varies with reverse voltage.

(To be continued)

Uncommon CRT faults

SOME PECULIAR FAULTS WHICH MAY NOT, AT FIRST, BE ASSOCIATED WITH THE PICTURE TUBE

By D. P. Samuel

THERE are many tube faults which are very well known, such as obvious low emission, causing a dim picture which may go negative, or black on whites, when the brightness is turned up; shorting electrodes, causing just a blank raster or uncontrollable brightness; open-circuit heater—and other similar faults and their tell-tale effects.

On the other hand, there are tube faults resulting in symptoms which appear to be unrelated to the tube itself and, conversely, there are receiver faults whose symptoms sometimes mislead the experimenter into suspecting tube trouble.

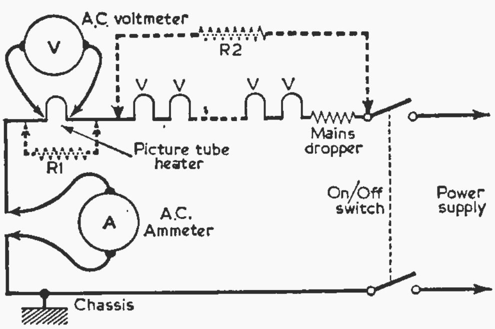


Fig. 1.—A typical heater chain circuit of a television receiver, showing ways of measuring voltage and current, and of fitting compensating resistors.

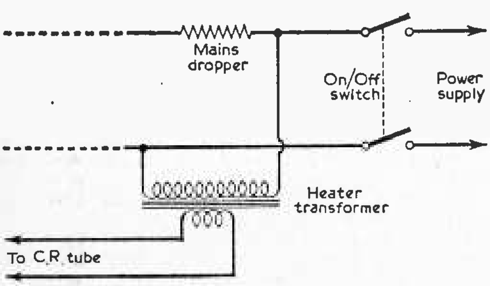


Fig. 2.—The correct method of wiring a heater transformer for the CRT. The resistor R1 of Fig. 1 should be included to balance the heater chain.

Shorting or Ageing Heater

Normal low emission symptoms are caused by the electron-emitting substance on the tube cathode deteriorating with age. This means that there are fewer electrons—and fewer electrons impinging on the screen results in a loss of brightness.

However, the quantity of electrons emitted also depends on the temperature of the cathode, and since it is the heater which raises the cathode to the temperature which produces most electrons, it can be understood that a low-emission system *may* be caused by a faulty heater and not by a worn cathode.

The heat produced by the heater depends on the power that it consumes and, in almost all modern sets, this power is extracted from the heater chain current (see Fig. 1). A heater is rather like a small electric fire the power loading of which is related to the resistance of the element and the voltage applied across it.

Let us take an ordinary picture tube heater rated at, say, 6·3V and 0·3A (typical figures). When such a heater is *hot* and has 6·3V across it, then its current will be 0·3A (or should be). The wattage loading of the heater is equal to the voltage multiplied by the current which, in this case, is 1·89W. This simply means that the tube manufacturer has discovered that the heat produced by a loading of 1·89W is sufficient to bring the cathode in the tube to the optimum emitting temperature. Theoretically, if the loading is greater, no more electrons will be emitted and if the loading is smaller fewer electrons will be emitted.

Now, the tube heater is placed in series with the heaters of all the other valves in the receiver which, like the tube heater, all require 0·3A. The resistive elements of the heater circuit are, in fact, adjusted in relation to the supply voltage so that exactly 0·3A will flow in each heater.

Loading

Assuming that the tube heater is in good order, exactly 6·3V will be developed across it and the heater will load at the optimum 1·89W. However, this will happen only if the resistance of the tube heater is correct and the same as it was when new. The optimum resistance for the heater can easily be found from Ohm's law by dividing the heater voltage by the current, e.g., 6·3/0·3, which is equal to 21Ω. This is the "hot" resistance, of course, for when the heater is cold its resistance will be smaller —this is why thermistors are used in series-connected heater circuits. The resistance of a thermistor is high when cold and low when hot, and thus cancels out the opposite effect of the heaters.

It sometimes happens that the resistance of a heater becomes less as it ages. Let us suppose that it falls to 15Ω from its optimum 21Ω. Now, since the current in the heater chain is controlled (the very small decrease in resistance of the whole chain will have no significant effect on the current), the current in the tube heater will remain at 0·3A, but the voltage across it will now be 0·3 multiplied by 15 (Ohm's Law), which works out to 4·5V. The heater loading will have changed from 1·89W to 1·35W (i.e., 4·5 x 0·3), which is a drop of 0·54W.

This means that even if the emitting properties of the cathode are in order, it will be unable to provide the full quota of electrons for a picture of normal brightness.

Heater Short

Exactly the same thing happens if a part of the heater short-circuits. The resistance of the heater will be less than optimum, the voltage across it will

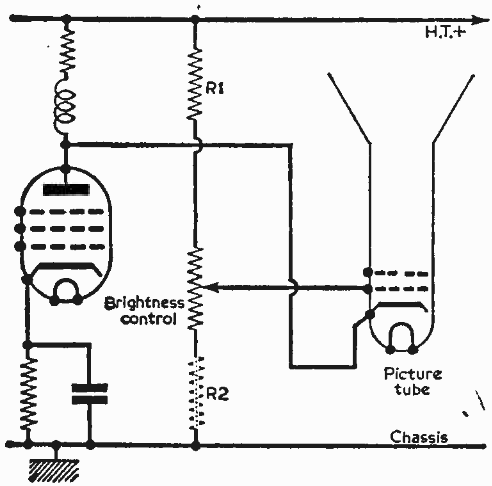


Fig. 3.—Occasionally, when using reconditioned tubes or if there is a change in the tube characteristics, the resistors R1 and R2 may require a different value to compensate.

fall, the current will remain essentially normal and the wattage loading will be reduced. It must be remembered that this happens only because the heater chain current is little affected by the change in the resistance of the tube heater. If the tube heater were fed from a transformer, then matters would be entirely different. The voltage across the lower resistance heater would hold at 6·3V and the current would rise. In the case formerly illustrated, the current would rise to 6·3/15, which is a little over 0·4A. The wattage loading would also rise to 6·3 x 0·4 which is a little over 2·5W—0·61W more than it should be.

A heater transformer provides a constant *voltage* supply, while a series-connected heater chain provides a constant *current* supply, which is the reason for the two effects described. The effect on the heater itself is that an aged or partially shorting heater in a constant voltage circuit will glow far brighter than normal and in a constant current circuit will be dimmer than normal. These points are well worthwhile observing during the course of diagnosing for tube trouble.

The use of a Constant Voltage Supply

Provided the emission of the cathode is fairly reasonable a tube with an aged or partially shorting heater can usually be made to produce a picture of good brightness by removing it from the constant current supply and connecting it in a constant voltage circuit.

Before this procedure is adopted, however, one must be sure that the heater is, in fact, to blame. This can be proved with an A.C. multimeter. First, it should be ascertained that the heater chain current is 0·3A by connecting an A.C. ammeter in *series* with the tube heater, and then an A.C. voltmeter should be connected in *parallel* with the heater. Alternatively, the heater voltage of several valves in the chain could be measured — if the reading is correct (usually 6·3V), the heater current may be taken as correct. If the current is correct and the voltage across the heater of the tube is low, then the heater is responsible. If the current is low, the voltage across the heater will also be low even if the heater is in good condition. Such trouble would indicate that the mains dropper is set to an incorrect value.

A constant voltage for the tube heater can be obtained from a 6·3V heater transformer. The tube should be disconnected from the heater circuit and a resistor (R1 in Fig. 1) having a value equal to the heater resistance should be connected in place of the heater (in the example given it would be 21Ω rated at 3W or 5W). A heater transformer should be wired into the circuit as shown in Fig. 2. The primary of the transformer should suit the power voltage and should be connected across the receiver side of the on/off switch, so that the switch will also switch on and off the tube heater.

Overloading

As we have already seen, a constant voltage applied across a low resistance heater will increase the loading above normal. Most heaters can stand this, but it must be remembered that the heater is then being overloaded so that the improvement obtained may only be for a short while, as the heater may eventually become open circuited.

This same set-up can, of course, be used to enhance the emission of a tube with a worn *cathode.* In this event, however, the heater transformer secondary should deliver about 7 or 8V as the process is one of raising the temperature of the cathode in order for it to " boil off " more electrons. This may or may not be successful, depending on the condition of the cathode. It may also result in almost immediate heater failure. Nevertheless, if the tube is otherwise useless, there is nothing to lose.

A tube with a heater-to-cathode short, or intermittent short of this kind, can be subjected to similar treatment, but in this case the heater transformer must be of the low-capacitance variety to prevent the higher frequency video signal components from being lost in the low-impedance heater circuit and mains supply.

An alternative method of passing more current through a low resistance heater is to bypass all the heater chain, except the tube heater, by an additional resistor (R2 in Fig. 1). The value of this resistor should really be adjusted until the voltage across the tube heater rises from its low value to its normal value.

(Continued on page 22)

Variable Voltage Stabilised Power Supply

By R. Brown

MAKING A SIMPLE UNIT FOR WORKSHOP EXPERIMENTAL PURPOSES

(Continued from page 596 of the September issue)

WE can now fix the minimum output voltage. This must be such that the valve, V2, has sufficient anode voltage. Under the conditions in which it is being worked, an anode voltage of as low as about 30V is sufficient, and this fixes Vout at about 200V.

The Circuit Diagram

The complete circuit diagram was given in Fig. 5. A number of additional components have to be added to the basic circuit, in order to ensure optimum conditions in a practical unit.

A capacitor C3 is connected across the neon V4. This has the value of 0·1μF and its purpose is to reduce the effects of random noise in the neon stabiliser, which otherwise would be present in the output voltage. With the basic circuit, the gain to the 100c/s ripple voltage is the same as the gain to ordinary mains variation and the load variations, and the ripple is considerably reduced by the stabiliser. The gain to the ripple can, however, be considerably increased by connecting a capacitor, C5 of 0·25μF, across the potentiometer R1 (Fig. 1). This acts as a short circuit to the ripple voltage and prevents the reduction in gain introduced by R1 and R2 of the basic circuit operating at ripple frequencies.

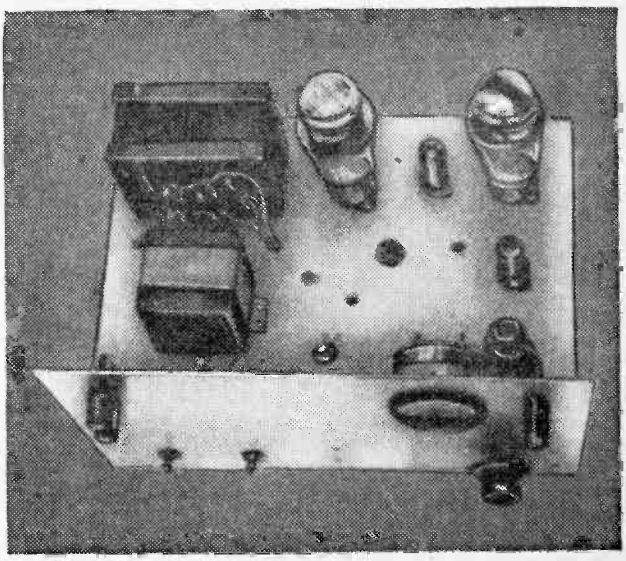
The single potentiometer R1 of the basic circuit is replaced by two potentiometers R8 and R9, and a fixed resistance R7. This allows finer control of the voltage and the pre-set potentiometer R8 is used when setting up the power supply to ensure that R9 controls the output voltage over the desired range of 200V/300V.

A large capacitor C6 of 0·5μF is connected across the output terminals. This serves to reduce any residual noise and ripple voltages. The value of the output voltage is indicated by a moving coil meter M1. This can be any of the small moving-coil milliammeters available on the surplus market. A one milliamp movement was suggested in the components list, but this is not critical. The resistance R11 should have a value such that, with an output voltage of 300V the meter gives full scale deflection. With a 1mA meter, R11 should be 300k. This will ensure that 300V does give full scale deflection. The meter scale can now be calibrated to indicate 0—300V.

A further capacitor C4 was found to be necessary. This is a 20pF capacitor, connected between anode and grid of V3. It was found that in certain circumstances the unit became unstable. This is an effect common in negative feedback systems and was cured in this case by using C4 to reduce the high frequency gain of the system. It may well be found with some units that C4 is not in fact necessary and the unit is stable without it. However, it is a small cheap component and is well worth having. It is conceivable that instability could occur even with C4 in place, although this effect has not been met with in practice. If instability should occur then it can be cured by increasing the value of C4. It is most unlikely that instability will occur with C4 in place, and it is worth keeping the value of this component to a minimum, for the reduction in high frequency gain it causes increases the high frequency noise in the output from the unit.

The resistances R6 and R4 are grid stoppers included to prevent any tendency for parasitic oscillations to build up.

The value of R2 could be chosen to give a convenient value of screen voltage for V2, but it



An above-chassis view of the unit.

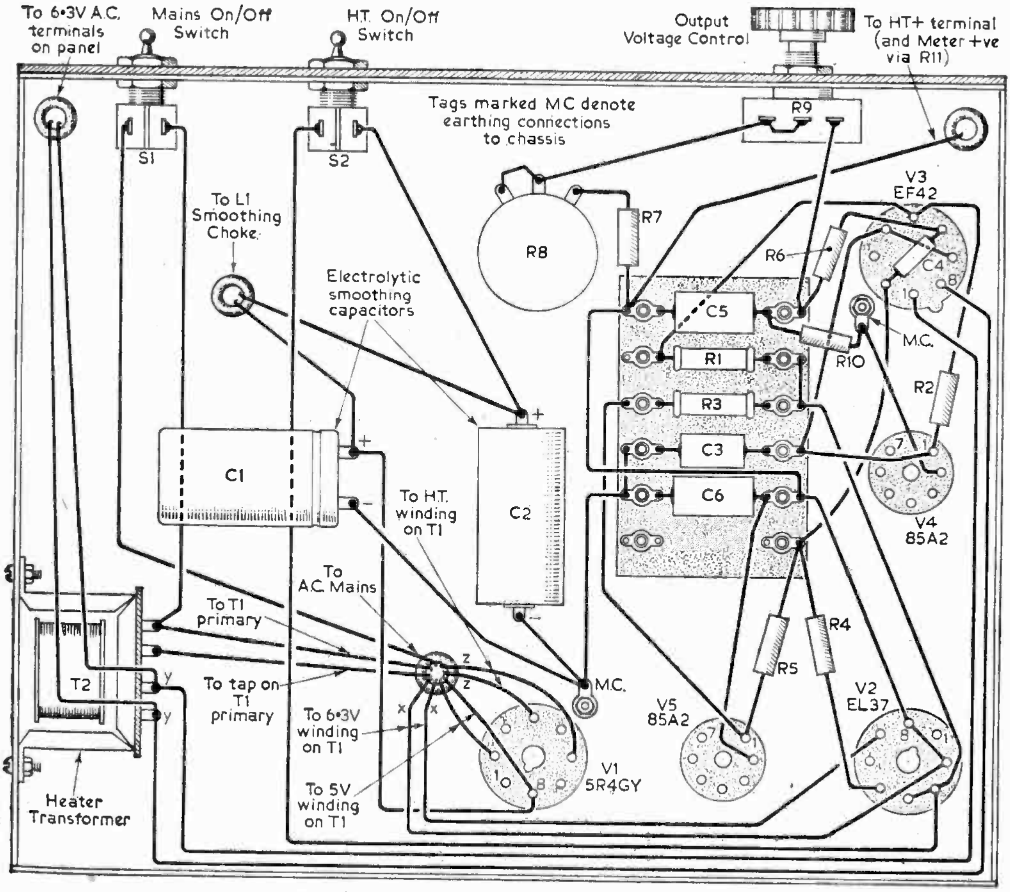


Fig. 6.—The underchassis layout of components and wiring diagram.

can, if carefully chosen, also assist in the stabilisation. In fact it will increase the stabilisation through screen feedback quite considerably, provided it has a value equal to μ2.g2.rV4; where μ2.g2 is the amplification factor between g1 and g2 in V3 and rV4 is the A.C. resistance of V4. In the case of the EF42, the value of μ2.g2 is about 85 and the value of rV4 for the 85A2 is 300Ω. A more realistic value for μ2.g2 is 65, and this gives a value for R2 of 23·5k; 22k is a suitable value for this position.

The H.T. Supply

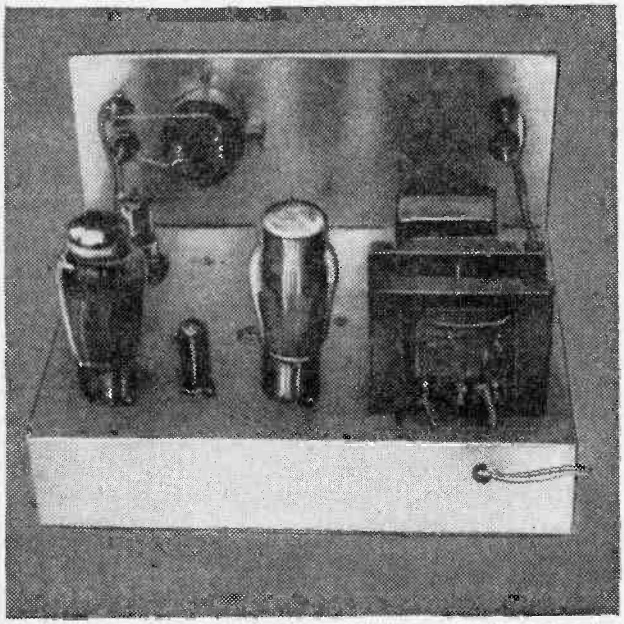
The H.T. supply unit is of quite conventional form, the valve used being a 5R4GY—quite a large valve for this application, but it does leave something in hand for any future increase in the output. Two transformers are shown, one providing 350-0-350V, 60mA for the H.T., 5V for the 5R4GY, and 6·3V for the EL37. The other transformer provides 6·3V for the EF42, and 6·3V output on the front panel. There is no technical reason for using a separate 6·3V filament transformer like this, and a single mains transformer could be used. It is, however, essential to have two 6·3V filament windings, because one of the 6·3V windings has to supply the EL37, and it should be strapped to the cathode of this valve: this means that it will be between 200V and 300V positive with respect to earth, and so it is not suitable for feeding the EF42 and the front panel output. When looking for a suitable transformer it was found that it was cheaper to buy a standard domestic mains transformer with one 6·3V winding and buy a second filament transformer to provide the other 6·3V supply.

Two on/off switches are used. One is a single-pole single-throw mains switch for switching the whole unit on and off. This is connected in the primary circuit of the transformer T1 and T2. The other is similar to the first, and is used to switch off the H.T. supply, while keeping the valve filaments on.

The filter uses a 5H smoothing choke, a 32μF electrolytic input capacitor, and an 8μF smoothing capacitor—all quite conventional.

Constructional Details

The construction and layout of the unit can be seen from Fig. 6. The layout is not at all critical, the only important point being that the grid lead to V3 should be kept short, so as to minimise any hum pick-up. The chassis is of a box form about 12in. × 10in. × 2½in., with a front panel 12in. × 7in. The layout of the power supply section will depend to some extent upon the transformer and choke used, and in the unit constructed by the author both the transformer and the choke are of the chassis mounting type, and are on top of the chassis. The smoothing choke did not have any fixing holes, and so is held in place by a strip of metal strapped around it, and fastened to the chassis. The small filament transformer is fixed underneath the chassis, being bolted to the side panel near to the back. The electrolytic capacitors fit under the chassis—their actual fixing depending upon the type of component used.



Another view of the power supply.

The two on/off switches are fixed through the front panel and the front of the chassis.

A six-way tag board is used to hold many of the components in the stabiliser circuit, and this is mounted to one end of the chassis to one side of the line of valves. Five components are mounted upon it, the sixth tag serving as an anchor point for the resistors R4 and R5. The voltage control potentiometer, R9, is mounted at the end of the chassis. The pre-set potentiometer, R8, is mounted underneath the chassis with the shaft upwards. The meter is fixed to the front panel—its actual method of fixing will depend upon the meter chosen. H.T. and 6·3V output terminals are fitted on either side of the meter on the front panel.

Wiring

As has been mentioned, the wiring is, with one exception, not critical. The one exception is that the grid lead to V3 should be kept short. If the layout shown in Fig. 6 is followed, then this will be achieved. The only point about the remainder of the wiring is that it should be kept reasonably neat.

Setting Up

Having constructed the unit the only setting up required is the adjustment of the pre-set potentiometer R8. This should be adjusted until the potentiometer R9 permits the output voltage to be varied from 200V—300V.

The working range of the instrument is nominally 200V—300V, 5mA—50mA for a mains variation of ±6%. Somewhat higher output can, however, be obtained at lower output currents. From Fig. 2 (last month), operation is possible anywhere below the line of the −2V grid bias limit; thus it is possible to have an output of 400V, provided the current is 10mA or less, and an output voltage of 350V can be obtained at currents of less than 24mA. It will be necessary to use both R8 and R9 to obtain these higher voltages.

It is also possible to operate below the 200V lower limit at all current levels. Below 200V, however, the gain of V2 falls off rapidly, and the stabilisation provided by the unit becomes very poor. Down to about 175V it is, however, still better than the results obtained from a simple H.T. power supply, and it may well be useful for some purposes. The −2V grid bias limit is drawn for the mains 6% low condition, and when it is known that the mains are normal or high this limit can be moved up, and higher voltages and currents taken from the unit.

Thus the basic trouble-free operating range of the unit is 200V—300V, 5mA—50mA; but provided one is prepared to study and understand the load diagram of Fig. 2, and to keep the diagram handy, the operating range can be usefully extended. ■

An Unusual Cause of Hum

An unusual cause of hum was encountered during the fitting of a 2V booster transformer to the heater of a CRT fitted in an Ekco T164.

The 25% booster transformer was fitted on the roof of the cabinet and the heater leads taken down to the tube base. A prominent buzz was heard from the rear of the receiver that had not existed before. The scanning coils were examined as was the laminations of the newly fitted transformer and during these tests the buzz faded and returned erratically. In the glare of the bench light the outline of the flex leads from the boost transformer seemed blurred. They were strongly vibrating and causing a mechanical buzz against the focus assembly. When pulled away from the region of the focus magnet, they ceased to buzz. The heavy current flowing in the flex (over 1A) produced a magnetic field that reacted with the powerful focus-magnet field sufficient to vibrate the wires at the mains frequency. Dressing back the flex from the magnet stopped the buzz.

TRACING TV FAULTS

By G. J. King

(Continued from page 618 of the September issue)

LAST month, the need for logical step-by-step location of faulty parts in TV receivers was stressed and a general description of TV circuitry given. This month a specific type of fault will be examined.

Signal Paths

Referring again to Fig. 2, it will be seen that the directly related stages of the signal paths follow a definite pattern. This applies particularly to those stages concerned with I.F. signals, for in order to ensure optimum stability, the designer has to arrange the layout of the stages so that the stray inductances and capacitances of the inter-connections are as small as possible. This means, of course, that adjacent stages have to be placed as close as possible together.

This was illustrated in Fig. 1, from which it may be seen that the signal from the tuner (stage 3) goes direct to the common I.F. stage (stage 4), and that stage 4 goes direct to stages 5A and 5B, and that stage 5B goes direct to stage 6B and so on.

This necessary pattern assists considerably in stage identification. In most cases, the various stages, as shown in block form in Fig. 1, can be picked out without too much trouble simply by examining the top of the chassis, with the back cover removed from the cabinet. It may be necessary to establish certain valves in terms of function and type, but this is not difficult with the help of a valve data booklet. In some cases, however, it may be necessary to remove the bottom cover from the cabinet, or slip the chassis from the cabinet in order to examine the stage continuity from underneath, but this should be avoided if possible (unless the inspection cover at the base of the cabinet may be removed easily) for the disturbance in removing an awkward chassis may introduce other faults before the original fault is found, when it is undertaken by an inexperienced operator. Nevertheless, later on in the process, it may be necessary to remove the chassis.

In most cases, it will be unnecessary fully to identify all the stages. For example, if now we go back to the fault lack of sound detailed earlier, and assume that there is no residual hum from the loudspeaker and no crackle when the volume control is turned, all we need find out first of all is the location of the loudspeaker. This, of course, is simple enough, as also is tracing the wires from the loudspeaker to the sound output transformer. At this stage the fault may be found —it may well be a wire disconnected from the speaker circuit.

Tracing in Greater Detail

On the other hand, the speaker leads may be intact. The next stage, then, would be to locate the sound output valve. Again, this should not be difficult, as the loudspeaker is connected to the output transformer and the output transformer is connected to the ouput valve (see Fig. 2). Moreover, we should now have some idea of the type of valve used as output.

Having located the valve, the receiver should be switched on and the heater of the valve observed. If this is alight then, at least, we know that the valve is receiving heater current and that the heater of the valve is good (two more observations as to what is *not* wrong). Now give the set time to warm up properly (five to ten minutes) and test the temperature of the valve with the hand. If the valve is taking a fairly reasonable anode current, as it should do, the temperature of the envelope will be such that the hand (or finger) cannot be held in contact for more than a couple of seconds. Take care to avoid electric shock when delving inside a television set with the power switched on. There is always a risk of shock, and this a hazard that the experimenter has to accept, but if due precautions are taken, such as ensuring in the case of A.C./D.C. type receiver that the chassis is connected to mains neutral (use a neon tester). Also take care that earthed objects, such as other electrical appliances and the like, are outside the range of contact when dealing with the inside of a " live " set, and that the hand is steered clear of E.H.T. and H.T. points.

If the valve is hot, it is passing H.T. current. If it is warm, then it is possibly being warmed up by its heater alone. If it is excessively hot, and glowing red hot internally, then there is trouble in the associated circuit. This would possibly be the case with the symptom under discussion; a red hot screen grid and no residual hum from the speaker would indicate without doubt that the output valve is running without anode voltage. The screen grid would then pass very much more current than it should and would thus become red hot.

In nine cases out of ten, lack of anode voltage here is caused by an open-circuited sound output transformer primary winding—the winding which is connected between the anode of the valve and H.T. positive. There are other possibilities, but they are somewhat remote, such as a short-circuit in a tone-correction capacitor connected between anode and chassis. Normally, however, such a capacitor is connected in series with a resistor across the primary winding of the transformer, so a short, although cutting out sound (or most of it) would not starve the anode of H.T. voltage.

Lack of H.T. Voltage

If the valve is only warm to the touch, the trouble would be caused either by a low-emission valve or by lack of current in the valve. In the latter instance, either the screen grid feed resistor or (if fitted) the main resistor supplying H.T. voltage to the output valve would be suspect.

In Fig. 3 is shown the sound output stage of the receiver under discussion, and the valves tie up with those marked in Fig. 2. It will be seen that the anode of the output valve (the pentode section of V9) connects to one terminal of the output transformer T1 and the other terminal is connected to the H.T. positive line via resistor R78. Failure of this resistor would cut off H.T. voltage, and the valve would be just warm, as described. C63A could have developed a short-circuit which would overload R78 and possibly cause it to burn out. This would be seen by inspection. R79 is the screen grid H.T. feed resistor, and would fail likewise with the same symptom should C63B develop a short. Another cause of the trouble could be open-circuiting of the bias resistor, R81. This would possibly " blow " C64, which would then have considerably higher voltage across it than its working rating provides.

To check these latter possibilities it would have been necessary to graduate from pure observation to practical servicing. However, the fault may have been discovered long before this time from observation alone. For example, the speaker wires may have become disconnected; the output transformer primary may have been open-circuited as indicated by the symptom of a glowing screen grid; R78 or R79 may be obviously burnt, indicating a short in C63A or C63B. At some stage in the exercise, V9 itself may have been tested in a dealer's shop on a valve tester. This would have given one more important positive or negative fact which would govern the subsequent action.

Output Stage Normal

We must now assume that the initial tests of operating the volume control and listening closely in the speaker indicated that the output stage was in order. We will suppose, therefore, that residual hum could be heard from the speaker, but that there was no apparent crackling when the volume control was operated.

This latter factor should not be rated too highly, since the volume control may be in good order and not produce crackles when turned. Nevertheless, we must be sure that the output stage and sound amplifier are working before continuing with the diagnosis, bearing in mind still that the fault must be somewhere in stages V8 and V9 (Fig. 3) as we proved in the very first place.

It may now be necessary to remove the inspection cover from the bottom of the cabinet or, at least, gain access to the volume control itself, which may be possible without removing anything more than the back cover.

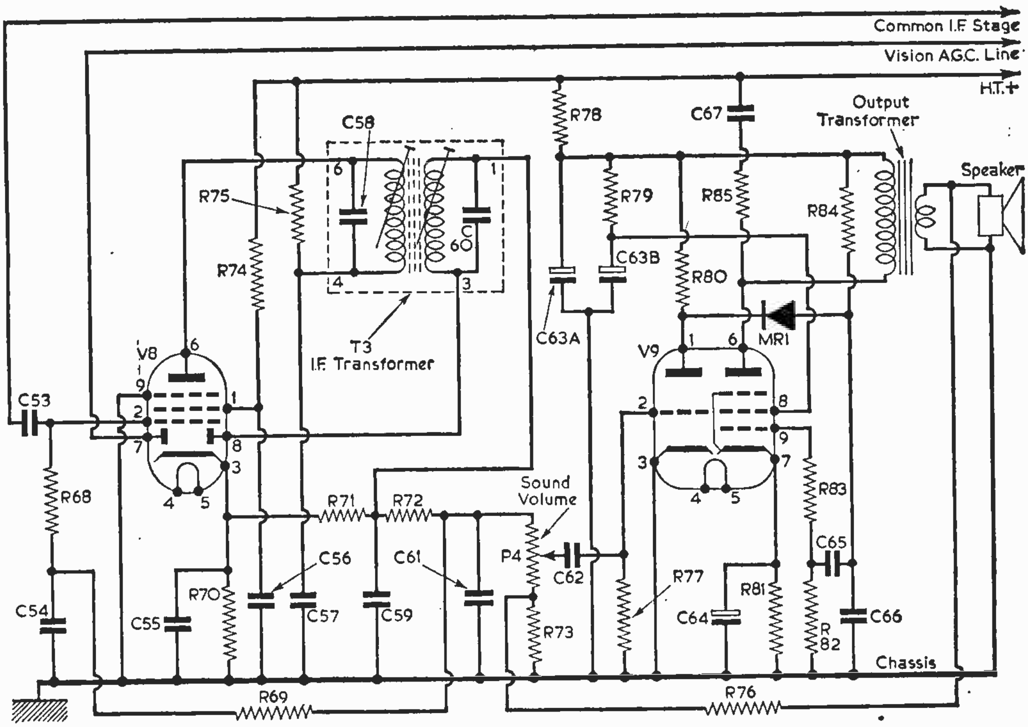


Fig. 3.—The circuit diagram of the sound section of a receiver. This should be compared with the block diagram of a complete receiver which was given in Fig. 1 on page 616 of the September issue.

Hum Test

The volume control should be turned to maximum and, with the set switched on, the blade of a screwdriver should be brought into contact with the centre tag on the side of the control (but be sure that contact is not made with any of the tags on the mains on/off switch at the back of the control, as an electric shock or a mains short-circuit may result). If the screwdriver is being held by the insulated handle a finger should then be brought into contact with the blade. If the sound amplifier and output stages (V9 in total) are working, then a very loud hum will be heard from the loudspeaker.

If this does not happen, the screwdriver should be brought into contact with the control grid of the pentode section (pin 9—Fig. 3). If the output stage is working, which it should be in view of the build up to this stage, a lesser hum will occur from the loudspeaker.

Anode Load Resistor

If all is according to the plan; that is if hum is present at the control grid of the pentode but not at the centre tag of the volume control, the sound amplifier (triode section of V9) stage is at fault. Apart from the valve itself, the most likely and possibly only cause is open-circuit of R80, the triode anode load resistor.

Now we must assume that hum occurs at the volume control, but the symptoms still remain. The trouble must now be somewhere in the sound detector or sound I.F. amplifier stage (V8 of Fig. 3). It is unusual for much to happen to the sound detector as it does not carry H.T. power and possesses only a few components. However, if the circuit features a semiconductor diode, this is best tested by substitution before going any more deeply into the problem.

The sound I.F. valve should, as before, be observed for heater glow and tested for temperature with the fingers. This valve will not get as hot as the output valve, but should run at a fairly reasonable temperature, which after 20 seconds or so should become uncomfortable to the touch.

A valve which is only slightly warm will indicate emission failure or lack of H.T. current. The former may be proved by a valve test or subsitution test, while the latter really requires a test-meter of some kind.

The H.T. voltage on the anode, screen grid and cathode should be measured. The actual voltage is not highly important at this stage, since the symptom is one of complete failure and there is bound to be a complete failure of some component or other, which would almost certainly have caused H.T. failure in the I.F. amplifier, assuming that it had been necessary to follow the exercise right through to the stage now being described.

The most likely cause would be a short-circuit in the screen decoupling capacitor, C56, resulting in R74 overloading and possibly burning out. Again, this would be seen from close examination of the associated components around the valve-holder of V8.

The complete process of logical stage-by-stage testing for the symptom of no sound (vision normal) has now been described. The exercise has been one to reduce the number of operations to a minimum by observing the behaviour of the set when the controls are operated, and then concentrating on those sections of the circuit in which the fault is most likely to be present, after first eliminating those sections which are obviously working correctly. In most cases the fault will be discovered long before the game is played right out, and in some cases the faulty part may be found by pure observation and without having to put a meter to the circuit or even take the chassis from the cabinet.

(To be continued)

Uncommon CRT faults

(Continued from page 16)

This is accomplished, of course, by injecting more current through the heater via the resistor. For instance, if an extra 50mA is required to bring the voltage back to normal, then the resistor should have a value equal to the power voltage divided by the extra current required. If the mains voltage is, say, 250, the resistor should be 250/0·05, which is 5,000Ω.

The power rating of the resistor is important, since it is called upon to drop almost 250V at 0·05A, which works out to 12·5W. In practice a 15W wire-wound, component would be employed. This should be mounted in a well ventilated position so that its heat will not affect any of the other parts.

Altered Tube Characteristics

With certain reconditioned tubes and with normal tubes as they age, the characteristics sometimes differ from these of new tubes. This may show up in one of two ways: it may be found impossible to black out the screen completely by turning down the brightness and contrast controls; or it may be found impossible to secure sufficient brightness to secure the correct contrast ratio by turning up the brightness control—resulting in a picture which is too black and white.

The former symptom would mean that the tube requires a larger negative bias on its grid for beam current cut-off than is normal. In practice a cure can usually be effected by increasing the value of the resistor connected between the brightness control and the H.T. line (R1 in Fig. 3). This makes the grid less positive at minimum brightness setting (e.g., more negative with respect to cathode).

The latter symptom would mean that the tube requires a smaller negative bias on its grid for beam current cut-off than is normal. This is best handled by introducing a resistor at the earthy end of the brightness control, as shown by R2 in Fig. 3. Sometimes resistor R2 may already be fitted. In this event, its value should be raised by about 5k to 10k to give the required range of brightness control adjustment. ■

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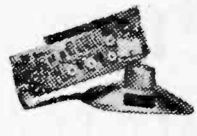

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A Precision Wobbulator

By N. Mears

(*Continued from page 615 of the September issue*)

THIS VERSATILE WIDE-RANGE INSTRUMENT WAS DEVELOPED AROUND A MODERN SEMICONDUCTOR JUNCTION DIODE

THE power supplies for the unit were not included with the main circuit (Fig. 4, last month) and are given in Fig. 7 on the next page. They are conventional in the supply of H.T., and 6·3V A.C. at about 3A. The H.T. value of 140V may seem somewhat low, but the reason for this is that if the supply is stabilised by a neon lamp there is plenty in hand. It is essential to remove all hum from the H.T. supply—the aim should be to have not more than 0·1V ripple—and in the construction of the unit care must be taken to keep heater supplies well away from high-impedance grid points. For this reason, grid impedances are kept as low as practicable throughout. Here and there values of 2·2M have to be employed however, and these are the points at which to avoid 50c/s pick-up. Smoothing by a 200+200μF condenser is employed in the prototype, with a resistance of 4·7k in a 250V A.C. supply to the rectifier. A metal rectifier produces least heat in use and is recommended.

The Schmitt trigger circuits are reasonably stable with regard to frequency, provided stabilised H.T. is used. Multivibrators are inherently sensitive to H.T. variation, however, and if the supply is not stabilised it will be necessary to bring out the 200c/s circuit speed control to the front of the panel. There is the advantage in this in any case that the number of markers may be varied at will from about 5 to as many as 20, if desired.

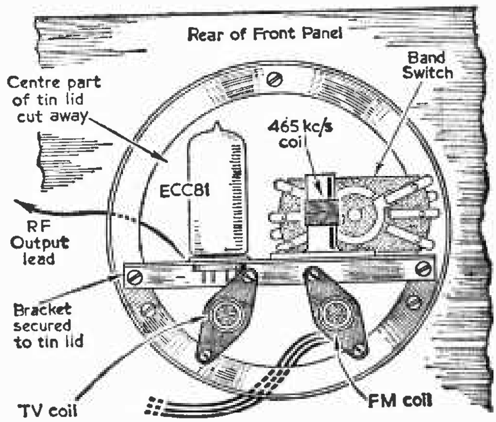


Fig. 5.—The layout inside the oscillator screening can.

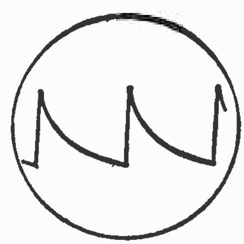
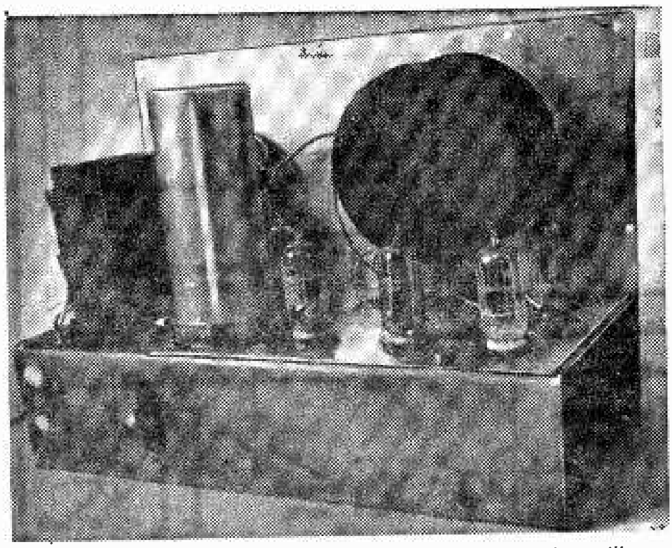
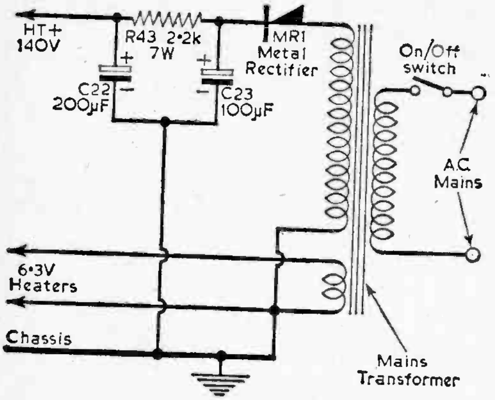


Fig. 6.—Sawtooth sweep wave.



A rear view of the wobbulator without the cabinet. Note the oscillator screen (see Fig. 5).

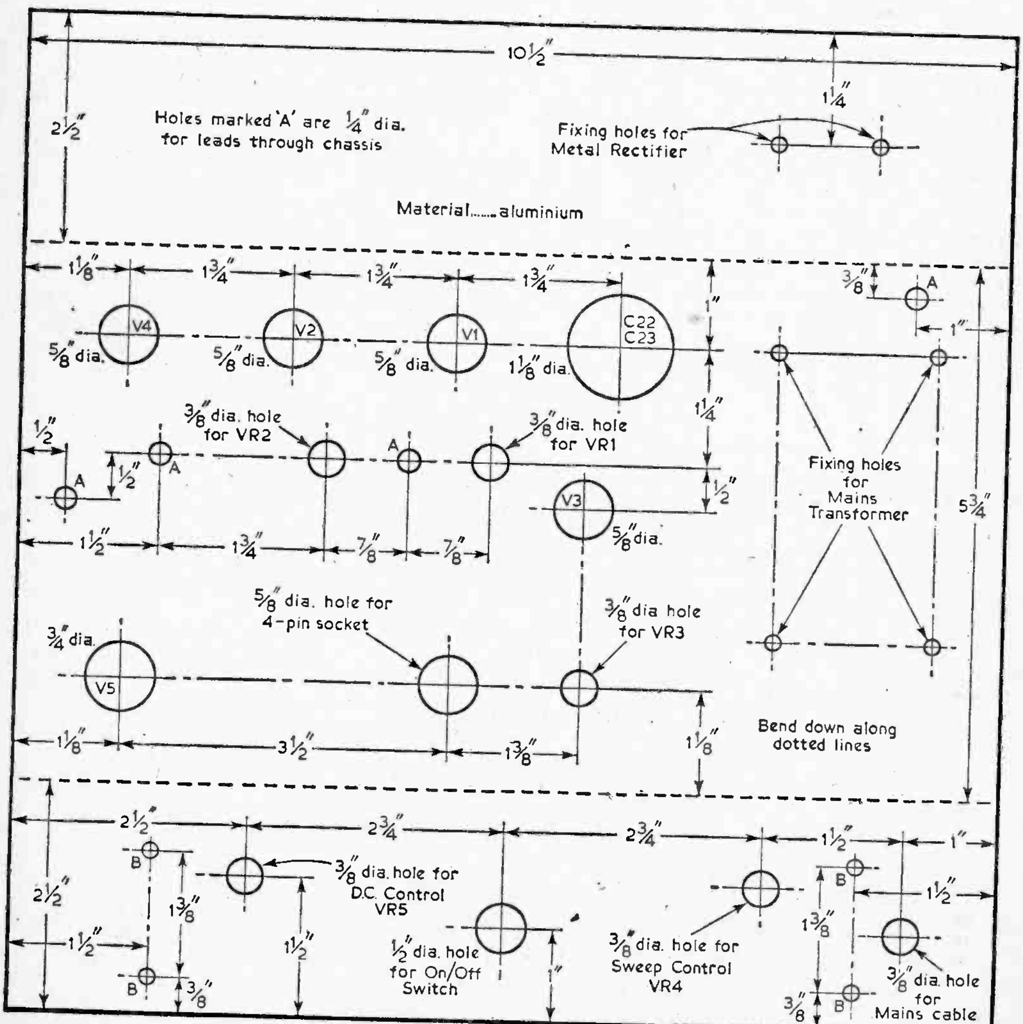


Screening

The oscillator section is very carefully screened. Unless the output from any kind of signal generator is to be transferred to the receiver in a rough-and-ready fashion, radiation or induction field must only be allowed to escape from the case at one point, namely the coaxial output point. Otherwise an unknown, and usually large, amount of field escapes and may find its way into the receiver at almost any point. This is no way to conduct experiments! A reader's recent letter remarking that he could receive sound ITV on the broadcast band of his set indicated that the ITV signal was leaking in very easily, only requiring H.F. parasitics in either

Fig. 7 (left).—A suitable power supply circuit.

Fig. 8 (below).—The chassis drilling details.



Holes marked 'B' are for bolts securing chassis to front panel

COIL WINDING DATA

10·7 Mc/s — *50 turns, tapped at 18t from the earthy end, 32s.w.g. enamelled wire; close-wound.*

34-38 Mc/s — *18 turns of 24s.w.g. enamelled wire; spaced by the diameter of 32s.w.g. wire (wires wound together, cemented, and when dry the 32s.w.g. winding is stripped out). It is tapped at 7 turns from the earthy end.*

465 kc/s — *900 turns of 42s.w.g. enamelled wire, scramble wound and tapped 200 turns from the earthy end. If this coil is too much to wind, use 400 turns of 38s.w.g. enamelled wire tapped 150 turns from the earthy end and tune to 1 Mc/s or near, so avoiding the I.F. range and injecting signal into the aerial only. This gives equally good results.*

All the above coils are on ¼in. diameter formers, fitted with iron dust cores on the 465 kc/s and 10·7 Mc/s ranges and with an iron dust core for 34-38 Mc/s or brass slug for 40-65 Mc/s range, if preferred. Harmonics of this range can be picked up in Band III, and so the overall response curve of a receiver obtained. Naturally, recalibration of the marker pulses will be needed if measurements are to be made.

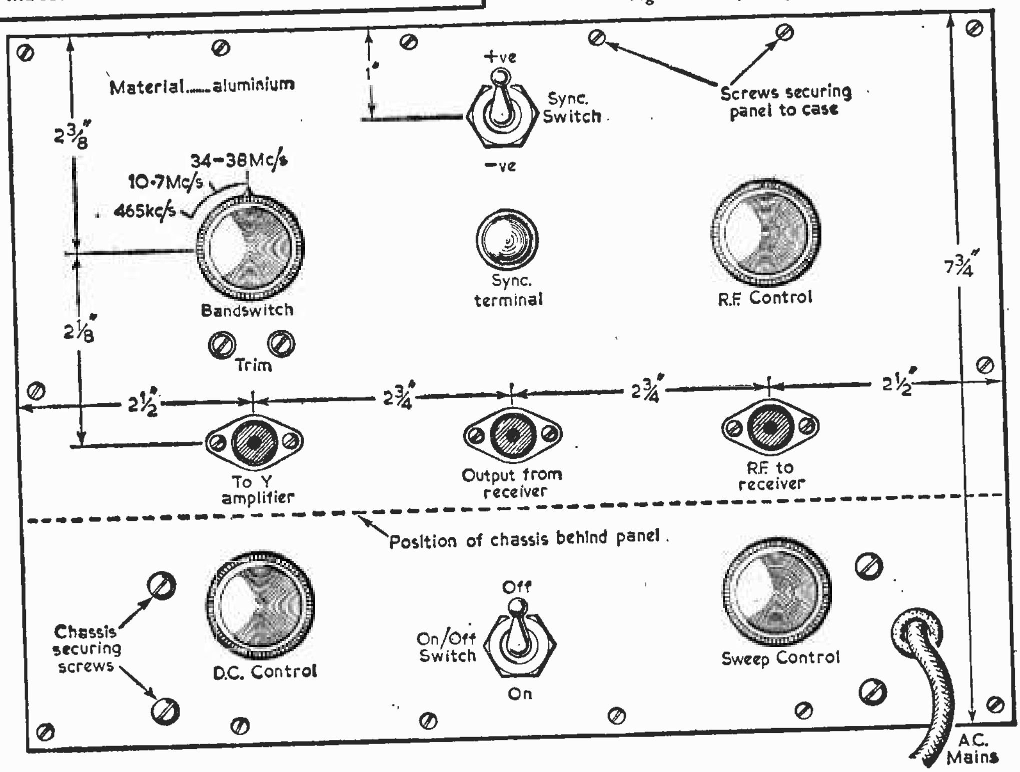
R.F. oscillator or audio stages (probably the latter) to render its presence all too obvious.

Correspondingly, thorough decoupling of the oscillator within its screen is needed. Both H.T. and L.T. leads are decoupled, together with the leads carrying D.C. and sweep voltages to the SVC1 diode.

In the prototype, the oscillator screening can consist of an empty cold-cream "tin" of aluminium 3½in. in diameter and 2½in. deep. A small chassis is constructed to fit into this, and on the chassis is built the complete oscillator. The lid of the tin is fixed to the front panel of the instrument, the centre portion of the tin having been cut out with a sharp penknife, and the chassis is mounted at right angles to it in such a position that, when everything is in place, the tin can be screwed into the lid. Leads are brought out between the lid and the panel—the aluminium is sufficiently ductile to permit this—and when the tin is screwed into place, the whole is firmly held and effectively screened. Slots are cut in the tin for ventilation; ideally they would be covered with wire gauze, but this has proved unnecessary since the instrument is built into a complete metal container a double screen is afforded which gives very good reduction of external field. In the prototype, the mains leads are also decoupled by means of 100-turn chokes and 2000pF capacitors; the only leakage of R.F. field is from the centre spigot of the coaxial connector and the ¼in. trimming holes cut in the front panel.

(To be continued)

Fig. 9—The front panel drilling.



Practical Television MULTI

IN designing a multi-range meter for home construction, a number of requirements, some conflicting, have to be kept in mind. Firstly, the manufacturer not only has access to the scale of the meter, but has the technical facilities for graduating all of the several scales he will use. If the home constructor tries this he usually produces a rather unsightly job—and can seldom work to better than 5% accuracy in handmarking the scales.

Then, the home constructor is seldom able to obtain the special switches that make such a reliable job of the commercial meter. Shunts, too, present a problem, as difficult to solve as the production of a current transformer—without which the scales on A.C. measurement are necessarily non-uniform.

In the design described, the aim has been to offer an instrument which affords the best compromise for the home experimenter. Expense has been kept in mind, as has the fact that readily obtainable components have to be used.

The Meter Instrument

The instrument used as the basis of the test assembly is a Taylor, model 60, "Vista", which reads from 0 to 50μA in 0·5μA steps. With this instrument, reading to 1% accuracy is simple. Its internal resistance is about 1,300Ω. The actual value of resistance is quoted on the meter itself. Its internal damping is very high. This latter is actually a slight disadvantage. It can readily be shown that the most rapid reading is obtainable on an instrument which is not dead-beat but which has about 10% overshoot. This instrument reads quickly enough on voltage ranges, but current and resistance take an appreciable time to reach a steady reading. This is, however, offset by the high accuracy obtainable and—important for a portable instrument—the needle cannot be made to swing about wildly if handled incautiously. Thus damage is prevented and accuracy maintained.

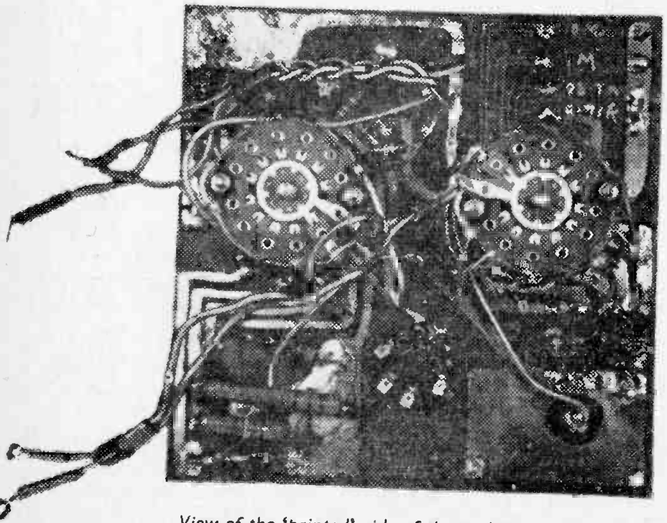
Nomenclature

It should be noted that in this article, references are made to "A.C. current" and "D.C. current"; "A.C. voltage" and "D.C. voltage". Although these terms may appear repetitious—Alternating Current current, for example—it is felt that they are in general use and readily understood.

The Switches

Two 3-wafer rotary switches of good construction and low contact resistance are specified. For most certain results, these ought to interlock so that only one at a time can be brought into use. However, this has been rendered less essential in the present design by arranging the switching so that even if a totally incorrect combination of settings is switched, the meter remains undamaged. This does not mean, of course, that the meter cannot be damaged by careless use.

The meter instrument is so arranged in the circuit that at least one lead is disconnected whenever a switch is rotated; when shunts are in use the probability of damage to the movement is high if the meter remains in circuit while switching takes place. Of course, the careful experimenter will always disconnect a meter when changing ranges—or nearly always—but the possibility of an accident cannot be completely excluded.



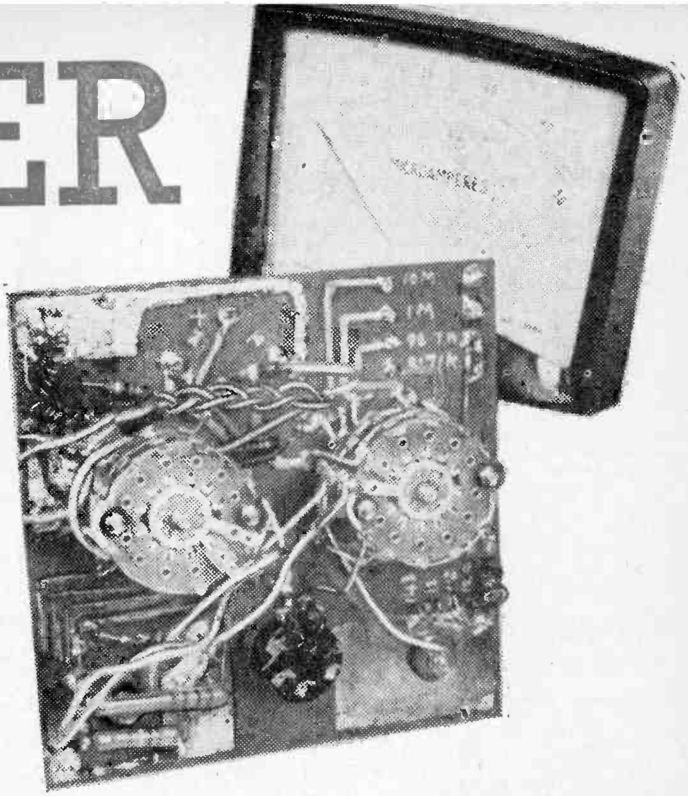
View of the 'printed' side of the multimeter wiring.

To make D.C. measurements, the switch S2 is moved so that the pointer knob indicates "D.C.", while for A.C. measurements the other switch is moved to the "A.C." position. For resistance measurements the following procedure is adopted:

(1) set the zero-adjusting knob to the minimum position (fully anti-clockwise),
(2) set the appropriate switch to the resistance range required,
(3) set the other switch to "Resistance";
(4) short-circuit the instrument leads,
(5) adjust the meter to full-scale reading by means of the zero-adjusting knob,

METER

By D. R. Bowman



(6) connect the leads to the component of which the resistance is required.

It should be noted that for simplicity a single adjustable shunt does duty for all three resistance ranges. It would be more foolproof to have a separate adjustable shunt for each range, because if step (1) above were omitted and the range were changed, the meter might be much overloaded when zero is set.

Making the "Printed Circuit"

A "resist" material should be made up by dissolving ½oz of shellac in about 4oz of methylated spirit. This will take some while to dissolve, and is conveniently left overnight to complete the process. If some sealing-wax is added at the same time, or a little mahogany spirit dye, the resist solution will be found more visible when applied.

In use, this "resist" solution is used to cover the parts of the copper surface which are not to be removed during the etching process.

A water-colour brush is used to apply the solution which should be reasonably "thick" or else it may run where not desired. A steady hand is needed, and some practice is essential; this may well be carried out on a sheet of glass or paxolin. All parts which are to be conducting must be covered. These parts are shown *unshaded* in the drawings on the blueprint. The only parts not covered are those which are to be etched away.

Mistakes can be corrected by a plug of cotton wool damped (not saturated) with methylated spirit; the plug should be turned frequently so that all traces of the resist are removed from the area concerned. Thorough cleaning is essential and is not easy, so mistakes are best avoided. When it is decided that all is in order, the resist coating is gone over again to thicken it. Finally, the prepared board is left overnight to dry.

A solution of ferric chloride, $FeCl_3$, is made up by dissolving 4oz ferric chloride in 6oz water, adding 1oz concentrated hydrochloric acid—HCl. (Commercial "spirit of salts" is suitable.) This will form a very deep orange clear solution which is corrosive and must be kept in a well-corked, labelled bottle well out of the way of food and out of the reach of children. For use, the solution is poured into a flat container such as a photographic dish, and the laminated board immersed in it.

Etching will take a little while to accomplish; about an hour should be allowed but it may take longer, depending on the temperature. When the copper is completely removed, where required, the board should be removed from the solution, washed for a few minutes in running water, and dried with a soft cloth.

All necessary holes should now be pierced. For most holes, a $\frac{1}{32}$in. drill will be adequate, but where thick wires have to be anchored, a larger drill will be required. Of course, larger holes will be needed for the switches and the wires to the terminals, and where several wires will be anchored at one point, a hole of large diameter will be needed. It is not strictly necessary to drill at all points where connections have to be made; if a connection is carried through the board a hole will of course be needed.

The Ranges.

Twenty-one ranges are available as follows:

(a) Voltage

D.C. 0·5V, 0—5V, 0—50V, 0—500V

A.C. 0—1V, 0—10V, 0—100V, 0—500V

(b) Current

D.C. 0—50μA, 0—500μA, 0—5mA, 0—50mA, 0—500mA, 0—2A

A.C. 0—10mA, 0—100mA, 0—1A, 0—1·5A

(c) Resistance

0—15k, 0—1M, 0—10M — *using internal batteries.*

Construction

Although the use of the printed circuit is not absolutely essential, it is recommended as being very convenient and more reproducible than normal wiring. If not used, the meter shunts must be mounted on tag strips, and adequate insulation provided, especially at points where voltages may be high. Assuming that the printed circuit is to be used, one or two practical points need to be observed during construction.

The first is that the width of conducting strip—left after etching—must be adequate. A width of 1/16in. should be the aim, and this applies, of course, only to the main connecting conductors. The copper areas connected to the shunts (B, P and N, together with U, V, W and X, H, J, K, L and M, all shown on the blueprint) should be as specified, or as near as posible. These areas are made as large as possible for two reasons: firstly, so as to radiate heat effectively, and secondly, so as to offer as low resistance as possible. To improve the second, and so to minimise both heat developed and voltage drop, certain areas should be covered with solder. The areas concerned are H, J, K, U, V, W, B-B1-B2, and the area N-N1-N2-N3-N4. This is best carried out by cleaning the surfaces concerned with kitchen scouring powder, *lightly*, so as not to damage the surface too much, and then laying on the surface here and there small pieces of Multicore solder—about ¼in. long—snipped from a strand of the solder used. A hot soldering iron is then passed rapidly over the area, melting the small pieces and spreading the solder as evenly as possible. If an instrument-type soldering iron is used, some auxiliary heating—for example a gas-ring—may be needed. If this operation is carried out with moderate skill, the effect achieved is similar to dip-soldering. Care must be exercised, of course, so that excessive heating does not take place, otherwise the copper sheet may lift from the insulated board.

The Shunts

For current measurement, the shunts are made as compact as possible, and are of material best suited to the range concerned. Carbon resistors are employed for the low-current ranges, but for higher currents. Eureka resistance wire is specified. Eureka has the advantage of ease in soldering, but at the same time it has a high thermoelectric effect with copper. Thus it is essential to wait until

LIST OF COMPONENTS

One 6in. square of copper-clad laminate (Bakelite grade DH74)
Two 3-pole, 12-way switches; non-shorting type (Specialist Switches Ltd)
One 5k wire-wound variable resistance
Two insulated terminals—one red, one black (Belling and Lee)
One 0-50μA meter (Taylor Electrical Instruments Ltd., "Vista" model 60)
Four OA70 diodes (Mullard)
Resistors (all carbon and of 1W rating except the adjusting resistors which are ¼W, and the others as stated)

1—for the D.C. voltage ranges
- one 10M 1%
- one 1M 1%
- one 100k 1%
- adjusting resistors as required (10%)

2—for resistance measurement
- one 150k 10%
- one 15k 10%
- one 1·5k 10%

3—for D.C. current ranges
- one 150Ω ½W (selected, or adjusted, to be 143Ω)
- two 27Ω ½W (selected to be 26Ω each; wired in parallel)
- one 10Ω and an adjusting series resistor to give 13Ω total

4—for A.C. voltage ranges
- one 10M 1%
- one 1·65M (1·5M 1% with series adjusting resistor of 150k 10%)
- one 150k 1%
- one 11k (10k 1% with series adjusting resistor of 1k 10%)

5—for A.C. current ranges
- one 33Ω 1% (or resistors in series to give the exact value)

Eureka resistance wire:
- one yard of 24s.w.g.
- one yard of 30s.w.g.

Shunts required:

R5	0·033Ω	Four 2·65in. lengths of 24s.w.g. Eureka in parallel
R6	0·13Ω	2·65in. of 24s.w.g. Eureka
R7	1·3Ω	8·4in. on 30s.w.g. Eureka
R8	13Ω	10Ω carbon with 1ft 7·4in. 30s.w.g. Eureka in series
R9	143Ω	carbon
R14	0·1Ω	2·05in. 24s.w.g. Eureka
R15	0·2Ω	4·1in. 24s.w.g. Eureka
R16	3·0Ω	1ft 7·4in. 30s.w.g. Eureka
R17	33Ω	carbon

Note:—24s.w.g. Eureka has a resistivity of 0·588Ω/ft.
30s.w.g. Eureka has a resistivity of 1·859Ω/ft.

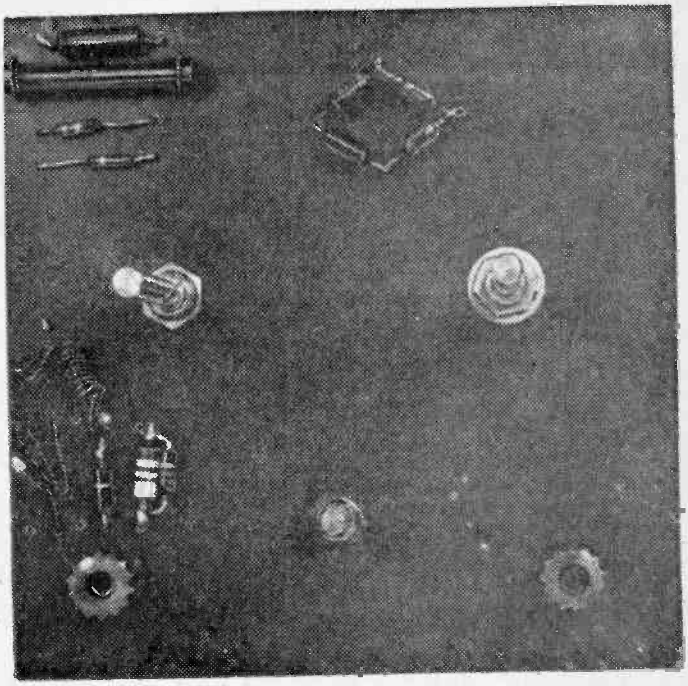
From the above, resistance wire lengths can be calculated for any series adjusting resistor needed—for example, R8 can be made up of a 12Ω carbon resistor with a series adjusting resistor of 6·5in. of 30s.w.g. Eureka.

All the above lengths of resistance wire are the lengths of effective wire between the wrapped and soldered ends. The actual wire cut should be ½in. longer before preparation, and, if the shunts are to be adjusted in situ, 1in. longer than the above.

complete cooling has taken place, after soldering, before any adjustments are made to shunts; otherwise misleading deflections of the meter will vitiate the results. Manganin is on the whole a better material, but it has to be hard-soldered.

After the shunts have been made and secured to the printed circuit board, they should be coated liberally with shellac varnish to protect them from atmospheric oxidation.

The shunts are prepared as follows. The exact length should be exceeded by ¼in. at each end, and the ends cleaned up by very light and careful sandpapering. Then some tinned copper wire is wrapped round the cleaned end so as to leave the precise length of resistance wire between. The gauge of wrapping wire should be appropriate to that of the resistance wire—the same or a size or two smaller will do well. When this has been done the copper wrapping, and the resistance wire on which it has been wound are soldered together. Care must be taken that solder does not intrude on the resistance wire between the two ends. Fig. 1 shows the procedure. When carried out carefully, this procedure can give correct resistance to better than 2% accuracy by measurement of length alone, using standard gauges of resistance wire. When soldering these shunts into position care is needed to ensure that the conditions are not altered.



The rear of the printed panel—the bridge rectifier can clearly be seen together with several resistors.

Wire Gauge

In order to cater for reasonably accurate measurement of length, the actual length of wire used must not be too short. This means that a reasonably small gauge of wire is needed. For the highest direct current range, four lengths of wire in parallel are employed; thus the shunt is not too small physically and its current-carrying capacity is improved.

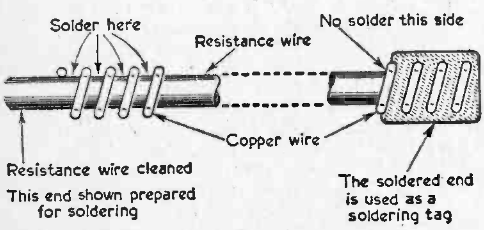


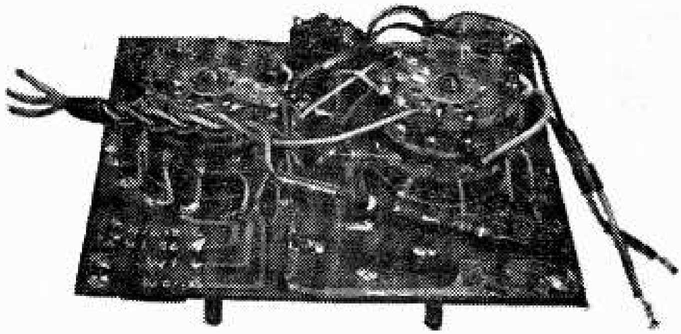
Fig. 1.—Preparation of the shunts: tinned copper wire is wrapped round the cleaned ends of the wires so as to leave the precise length of resistance wire effectively in circuit. (The text describing this operation is above.)

For lengths of resistance wire exceeding four or five inches, it is useful if non-inductive winding is arranged. It is not essential in this meter, but if it is intended to adjust shunts *in situ* for purposes of calibration the non-inductive winding has advantages. All that is necessary is to fold the length of bare wire in half, first coating all but the centre inch with shellac varnish, and wind the shunt on the shank of a 3/16in. drill as a temporary former. The shunt adjustment can then be carried out on the unvarnished centre inch of wire, which now conveniently protrudes at the end of the shunt remote from the circuit board.

Adjustment

Adjustment of the shunt is then carried out as follows. First lightly clean the adjustment loop with sandpaper, having cut the shunt wire about ¼in. longer than the specified length. Then, passing a known current through the instrument, slowly but very firmly twist the wires together until the correct reading is *nearly* but not quite achieved. Next solder the twisted portion, observing the meter reading. If not quite accurate, twist a very little more and again solder. Repeat as necessary. If this is done carefully a precise calibration can be obtained. The reader is reminded of the need to avoid thermoelectric effects.

The shunts specified for this instrument relate to the particular meter used in development, and if a meter with an internal resistance differing from 1,290Ω is employed, slight variations will be needed. As an alternative, the meter resistance may be made up to, say, 1,500Ω by a suitable length of Eureka wire, and shunts calculated accordingly. Unfortunately, the switch contacts also have resistance which is part of the shunt; practical values of switch resistance have been taken into account in designing the circuitry, and good accuracy should be obtained without shunt adjustment on the lower current ranges, but on the higher ranges adjustment is strongly advised.



Another view of the multimeter.

Series Resistors (D.C. Ranges)

The tolerance of the resistors for the series multipliers should be 1%. This is actually practicable only for the resistors of higher value — 10M down to 100k; with these, the resistance of the meter movement can be neglected compared with the series resistance. However, for the lower values of series resistor it is necessary to choose such a value that the total resistance, including that of the meter movement, is of the required amount. It is actually preferable to correct the 100k resistor in this way.

The prototype meter movement had an internal resistance of 1,290Ω. Thus, the 100k total series resistance, for reading 0-5V D.C., had to be reduced to 98·7k approximately. In the prototype, this value was selected from stock, but an equally good way would be to shunt the 100k 1% resistor with 7·6M, made up of two 10% resistors in series perhaps. The fact that the adjusting resistor is so much larger in value than 100k means that its "accuracy" can be a good deal worse than 1% without introducing appreciable error. Similarly the resistor R4 (the 0—0·5V D.C. multiplier) must be 8·71k; in the prototype, a resistor of the correct value was selected from the 8·2k stock. A 10k 1% resistor could just as well be shunted by a 680k 10% resistor.

Calculation

If a meter differing from 1,290Ω in resistance is supplied, the formula for calculating the adjusting resistor (R_A) is

$$R_A = \frac{R_S \times [R_S - R_M]}{R_M}$$

where R_S is the total series resistance required and R_M is the resistance of the meter movement. Thus if $R_S = 100k$ and $R_M = 1{,}290\Omega$,

$$R_A = \frac{100{,}000 \times [100{,}000 - 1{,}290]\Omega}{1{,}290}$$

$$= 7 \cdot 6M.$$

Thus, if a 100k 1% resistor were used for the multiplier on the 0—5V D.C. range, with a meter resistance of 1,290Ω, a 7·6M 10% could be connected in parallel to obtain the correct series resistance (as was quoted above).

A.C. Ranges

A large increase of diode resistance when the impressed voltage is small is characteristic of all semi-conductor diodes—including the copper oxide rectifier. Consequently the scale readings on A.C. do not correspond with those on D.C., and the scale is non-linear. This disadvantage can be overcome to a large extent by reducing the meter sensitivity from, say, 20,000Ω/V to about 1,000Ω/V, so requiring a much larger current from the rectifying unit. Also, by the use of transformers, a more constant voltage can be offered to the rectifiers at the expense of reduced frequency range. Other devices can be used to improve scale linearity as well as constancy of scale "law" for different voltage and current ranges.

R.F. Tests

This instrument, however, is designed to offer as little difficulty as possible to the amateur, and it is also arranged so that comparisons at R.F. can be made—a valuable feature not met with in some quite expensive instruments. Consequently the simple device of a "universal" shunt on alternating current ranges has been employed. This does not improve the linearity of the scale but preserves the scale "law" for the different current ranges.

Alternating voltages, except the lowest, require the same scale law. The lowest range requires a modified scale, because the series resistance is not very large compared with the meter resistance plus rectifier resistance.

The printed scales to be given next month will be found accurate on A.C. ranges to about 5%, provided full scale reading is adjusted to be correct. Voltage readings, using the proper value of series multiplier, will be equally accurate without such adjustment. With current ranges, however, accuracy depends also on the resistance of switch contacts so that for the higher current ranges (50mA and over) this needs to be taken into account. Consequently, for the higher current ranges (on both A.C. and D.C.) scales are only correct if the full-scale reading is adjusted to be correct.

Calibration

Provided 1% tolerance resistors are employed, or accurate values selected from stock, calibration on the D.C. voltage ranges is unnecessary. Calibration of the D.C. current ranges presents only the minor problem of shunt adjustment, already described. Assuming a standard instrument can be borrowed, the technique is merely to pass the same current through both instruments; adjust the current—which is best provided by an accumulator —by means of a rheostat of suitable value, and adjust the shunt to obtain the correct full-scale reading.

(Continued on page 51)

PC97 Beam Triode

(from "Mullard Outlook," August 1961 issue)

A NEW VALVE FOR TV TUNERS

THE PC97 is a new frame-grid triode intended for use as an R.F. amplifier in television tuners. The use of a single triode in place of the usual double-triode cascode stage has the advantages of reduced cost and simpler circuitry. It is therefore likely to be encountered in future receivers.

The noise factor of a PC97 R.F. stage is of the same order as a PCC89 cascode stage. The gain however will be somewhat less than for a triode used in a cascode arrangement, but in television tuners high gain is not always an advantage, and it may be more satisfactory to increase the I.F. sensitivity of the receiver by using the frame-grid pentodes EF183 and EF184.

A frame-grid construction in the PC97 enables a mutual conductance of 13mA/V to be obtained at an anode current of 11mA. The PC97 is designed for an anode potential of 135V, which enables the high slope to be achieved but only at the expense of cross-modulation. However, by operating the valve from a 200V line with a suitable series resistor, the cross-modulation curve is improved and the valve will handle signals of up to 100mV quite satisfactorily.

Beam Triode

In the U.S.A., where the use of the cascode stage is not as popular as in the U.K., triodes and tetrodes are commonly used in the R.F. stage of VHF tuners. The triode is inherently less noisy than the tetrode, but has the disadvantage of a high value of anode-to-grid capacitance. The advent of a beam triode, however, has offset this disadvantage to a large degree, and has thus made a single triode stage an attractive alternative to the cascode arrangement of a double triode.

In a conventional valve the grid support rods are the main contributing factors to the anode-to-grid capacitance. The method employed to reduce this anode-to-grid capacitance in the PC97 beam triode is illustrated in Fig. 1. The anode is formed by two plates specially shaped so that only the "active" areas are close to the grid. A shield is placed between each support rod and the anode and these, together with the action of the anode, divide the electron stream into two main beams. The plates forming the shield are brought out to a separate base pin which is normally earthed. Two cathode pins and a special arrangement of the cathode leads also give improved input damping.

By the above means an anode-to-grid capacitance of the order of 0·5pF, has been achieved which may be compared with 1·5pF for a typical R.F. triode. This low anode-to-grid capacitance simplifies the problem of neutralising.

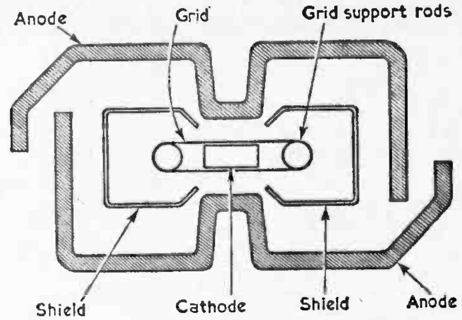


Fig. 1.—Cross-section of the PC97.

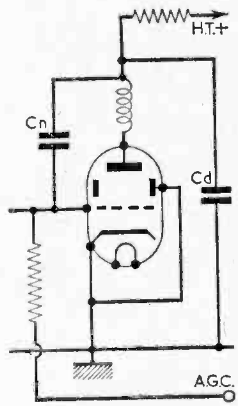


Fig. 2.—Theoretical neutralising circuit.

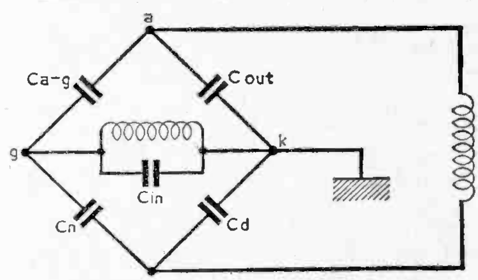


Fig. 3.—The bridge neutralising circuit.

Neutralisation in VHF Tuners

In a VHF tuner the anode-to-grid capacitance provides a feedback path from the output to the input.

The phase relationship of the voltage feedback is such that it causes the input signal to be reduced, thus affecting the selectivity of the tuner. It also produces phase distortion of the signal. This feedback can be neutralised by introducing another voltage equal to the instantaneous value of the anode-to-grid voltage, but 180° out of phase with it.

The neutralising voltage may be developed across a capacitance Cn, which is usually connected between the anode and grid to form one arm of a bridge network. The anode-to-grid capacitance Ca-g of the valve makes up the adjacent arm. The remaining two arms of the bridge include the output capacitance Cout of the valve, and a capacitance Cd connected between the H.T. end of the anode load and the cathode of the valve (Fig. 2). The neutralising bridge network for this circuit is shown in Fig. 3.

When the bridge is at balance there is no current flowing in the centre arm. For the bridge to stay in a balanced condition the alternating potential at the point "g" must always be equal to the alternating potential at the point "k". Therefore, under this condition the voltage across the neutralising capacitor will always be equal to the anode-to-grid voltage.

Hence if the capacitance of the neutralising capacitor is chosen so that the bridge is balanced, then the network will be correctly neutralised. The only voltage developed across the centre arm (that is between the grid and the negative H.T. line) will be the input signal. There will be no phase distortion caused through anode-to-grid feedback and no reduction of the input signal.

Neutralising the PC97

There are numerous types of neutralising bridge network and one especially suited to the PC97 is shown in Fig. 4. This neutralising circuit utilises the capacitance between the beam plates and the grid, and has the advantage that one side of the neutralising capacitor is earthed. The input capacitance of the valve should not be included in the ratio arms of the neutralising bridge. This capacitance varies with the anode current, and therefore if AGC is applied the stage will not be correctly neutralised. The inductance of Cd must be extremely low as complete neutralising can only be achieved if the capacitor is purely capacitive.

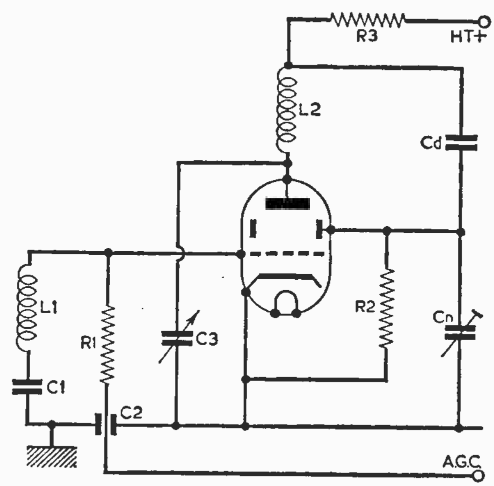


Fig. 4.—The form of a practical circuit for the PC97.

One important feature of the circuit in Fig. 4 is that the value of neutralising capacitance will be small. This is a direct consequence of the low anode-to-grid capacitance of the PC97, the special construction of which makes the valve very suitable for VHF applications. ■

Servicing Television Receivers

(Continued from page 11)

Correct width is obtained when the sleeve is withdrawn far enough from the scanning coils to permit about ½in. overlap at each side of the picture. The line linearity should be correct at this point. If the sleeve is pushed in too far it will cause not only lack of width but also overheating of the scanning coils. The sleeve is about correct when ¾in. is protruding. If the sleeve has not been altered, check the line timebase valves V12. V13 and V14 and R69.

Loss of Line Hold

This is nearly always due to loss of emission in V12 (ECC82) but on occasions it may be necessary to check associated circuitry (perhaps V13 and R69).

Fuse Blowing Immediately upon Switching On

Check C25, and for signs of flash-over in between the metal rectifier plates. If the fuses blow as the set warms up check the PY81 and if this becomes red-hot prior to the fuse failing, check C65. Check the PY81 for internal shorts.

Frame Distortion

If the top or bottom of the picture is compressed, check the setting of R53 (adjusted through printed panel, Fig 1—vert. Lin). If this does not help, check V11 (PCL82) and R52 (820k). If the picture is also dark, check C67 for leakage.

Frame Hold

Check V12, R48 and R51 if the hold control is over one way and the picture continues to roll. If the sync is poor and the frame can be made to roll in either direction, but will not lock securely, check R63.

Oscillator Tuning

Maximum sound on whichever channel is selected should occur at approximately the mid position of the fine tuner. Should this position change it may be necessary to retune the relevant oscillator coil core. The position of the cores is shown in Fig. 8 and these are accessible when the station selector and fine tuner knobs are removed. Care must be exercised when tuning and the use of a larger tool than required can result in damage particularly to the Band I coil which easily becomes loose, thus leading to persistent oscillator drift. If the coil or core is loose, the chassis should be removed and the coil and core secured by adhesive or wax. ■

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EAF42	9/6	EM81	10/6	PX25	12/6
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ECC81	8/-	EZ80	7/-	PY82	7/-
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ECC83	9/-	FC13	5/-	UAF42	9/6
ECC84	10/-	GZ32	11/6	UBC81	11/4
ECC85	9/6	HL42DD		UCC84	10/11
ECF80	12/-		10/-	UCH42	9/6
ECF82	10/6	OZ4	4/6	UCL82	11/6
ECH42	9/6	PCC83	13/6	UCL83	16/-
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Underneath the Dipole

A MONTHLY COMMENTARY

By Iconos

WHEN I heard that Granada was going to put on "The Dumb Waiter", another play by that much-praised playwright, Harold Pinter, I made a special note not to miss it. Granada TV plays for "Television Playhouse" are always presented in the most polished and professional manner and invariably strike a new note. Here was a play that was commended by some of the theatre critics when produced on the live stage last year; a play with a reputation for building up tension, having you sitting breathless on the edge of your seat as the drama proceeded between two professional gunmen awaiting their next assignment.

Alas! If the Pinter stage play had tension and the kind of macabre atmosphere one expects of an Alfred Hitchcock thriller, these qualities were missing in its television form. The gunmen in the basement argue about irrelevances and talk inconsequently as they wait, interrupted from time to time by a noisy dumb-waiter lift which arrives with written messages or by the whistle from an adjacent speaking tube, through which verbal instructions (unheard by viewers) are given. That was all. For the ordinary viewer who is possibly a bit of a "square" so far as *avant garde* plays are concerned, it meant very little. By the time the sudden climax arrived at the end, few of them, including me, cared anyway. It seemed a pity that the good acting of Roddy McMillan and Kenneth J. Warren as the gunmen, and the fine production values of sets by Stanley Mills and direction by Paul Almond, should be expended upon such a peculiar and puzzling script.

Video Tape

Like nearly all TV plays these days on both BC and ITV, "The Dumb Waiter" was recorded on magnetic video tape. There must be over a hundred of these machines installed in television studios and centres in various parts of Britain alone. This must represent a capital investment of over £2,000,000 upon which no import duty is payable, because magnetic television tape recorders have not been made in Britain since the BBC's original and ingenious (but not very practical) Vera tape recorder was abandoned. The video tape machines now in use here are mainly manufactured by Ampex, though recently a number of tape machines by R.C.A. have been imported from America and are proving highly satisfactory.

Outwardly, the main difference between the R.C.A. and Ampex equipment is that the current models of the former are rack mounted, while the latter make favours the console. Both systems work to the same standards, however, allowing tape recorded on either make to be played off on the other. A Japanese television tape recorder which has proved highly successful, is non-compatible with either of the American machines, since the scanning is on an entirely different concept and in certain respects is said to be an improvement. However, newer models of the rival American makes are coming along in different shapes and with numerous refinements which will make the existing equipments look a bit old-fashioned! I hate to think of the high annual depreciation percentage the television accountants have to deduct from the capital asset value of these tape recorders!

Long-Life Magnetic Heads

One of the biggest headaches of the video tape operation is the short life of the magnetic head assembly, which wears rapidly and requires renewal after about 200 hours use (or less). Ampex have brought out a new type ferrite head equipment which, it is claimed, will last ten times as

So much electricity was used by television and radio receivers and other electrical appliances at the New Horticultural Hall, Westminster, where the "New TV Show" was held, that extra power was supplied from these mobile generators parked outside.

long. R.C.A. have designed a new, much simplified type machine which uses transistors in many of its circuits and has a very easy tape threading facility. Both makes have electronic interlocking systems to permit rapid switching from live studio or O.B.'s to tape playoff, without flashing or rolling of the picture. And so the systems progress, following the usual pattern of refinement after refinement until an entirely new method of television recording is evolved. That is already on the horizon in the U.S.A.—thermo-plastic recording —which puts a visible picture on a special tape, thus enabling cutting and editing to be carried out as with cinema films.

Television Debates

Sound radio had its great days of talks and debates, especially when there was no alternative Light or Third Programme. In these days, the most popular use of sound radio seems to be for pumping out a continuous flood of music, which transistorised receivers deliver to picnic parties, the beach, the railway compartment and (literally) to the man-in-the-street. It is not easy to plant yourself in a deck chair very far away from rival portable transistor sets or gramophones, each adding its quota of pop and plug to drown the soothing noises of the waves and seagulls. The best sound radio debates seem to have moved into television in a big way. I suppose the BBC TV's "Tonight" started it all, though this in itself was really a television development of the almost ancient "In Town Tonight". John Freeman's famous interviews had their own startling flavour and the American Ed Murrow's interviews had an eye- and ear-arresting quality. Now the ITV companies are occasionally getting off the band waggon and indulging in startling debates. "Under Fire" probably led the way, and now "Head On" carries on the controversial note, by taking a celebrity and having a panel discuss his merits and demerits in his presence. It is, in fact, another method of presenting "This is Your Life" but tempering the praise with a good deal of criticism. The first victim in this series was Randolph Churchill, whose reactions to both praise and criticism were revealed in close-up. "Head On" must have required a great deal of research. The film interpolations of early incidents in Mr. Churchill's life were excellent.

"Appointment with——"

Another highly successful interview series has been "Appointment with ——" in which Malcolm Muggeridge ranges over a wide variety of current topics with a well-known personality or public figure. Sir Charles Snow and J. B. Priestley have appeared in this series, in which points of view are often exchanged with uncompromising frankness. One has the impression at times that the producers of this programme, Peter Plummer and Patricia Lagone, were putting the viewer in the position of an eavesdropper listening to a private conversation between Mr. Muggeridge and his interviewee. I don't always agree with Mr. Muggeridge's point of view, but his easy, smiling manner and his relaxed questioning undoubtedly draws out his "victims" in a manner which is disarming. This again is first-class television debate material which make good entertainment.

Black Spots

The television public is becoming more critical of the quality of pictures in fringe areas and in the black spots where only the highest of multi-element aerials will bring in a picture at all. In some places, pictures are ruined by freak interference between transmitters geographically hundreds of miles distant from one another, which are using the same frequency. Channel Nine, London, for instance, has interfered with local station Channel Nine reception in a few places many miles from London. The BBC have made great strides with small unmanned local transmitters called "translators," a typical example of which is at Folkestone, where signals are received on Channel Two and are rebroadcast on Channel Four on very low power. Similar installations at Sheffield, Ipswich, Barrow, Scarborough, Swindon and Caernarvon, amongst others, will greatly benefit local viewers. The ITA have now embarked on a similar scheme and I expect that quite a number of ITV black spots will, before long, be receiving a really good signal. It seems fairly easy to reach about 85 per cent of the population of the country with a good, strong signal. But there are pockets of population in small towns and villages in the remoter areas which have tolerated pictures full of snowstorms of interference for a long time. It is this last 15 per cent of the population which presents both BBC and ITA engineers with problems that are difficult to solve.

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Letters to the Editor

The Editor does not necessarily agree with the opinions expressed by his correspondents.

SPECIAL NOTE: Will readers please note that we are unable to supply Service Sheets or Circuits of ex-Government apparatus, or of proprietary makes of commercial receivers. We regret that we are also unable to publish letters from readers seeking a source of supply of such apparatus.

A SERVICING HINT

SIR,—In the hope that the following will be of interest to other readers, I should like to give details of a servicing fault which I had. The symptoms were those of a failing tube. The customer said the tube had gradually become darker, and, when I tried it, the picture was there, but very faint. Turning up the brilliance gave a very slight improvement, but without producing a negative picture which I expected with a faulty tube. I tested all the usual points, H.T., EHT etc., without finding anything wrong. It was when I went to remove the tube base for testing that the fault became revealed. The flex lead carrying the signal to the tube had frayed all but one strand, and that was on the point of breaking. Apparently the extremely high resistance of that single fractured strand was just sufficient to carry some intelligence to the screen, and the breaking of the wires one by one had given the gradual reduction in signal strength. When cleaned, retinned and soldered back the results returned to normal and I have heard nothing in the way of a complaint since. The moral seems to be, take nothing for granted, but test systematically.—G. BORDEN (Paisley).

CHANGING TV DATA

SIR,—I feel that it is time for somebody, either the P.M G. or some Parliamentary body to come down to earth and make one final decision regarding television. At the Radio Show I was confronted with all sorts of statements from various stands, and it would appear from what I was told that the industry is indeed in a sorry plight. How many lines, colour or black and white, and actual frequency, are all in the air, and the poor viewer doesn't know whether he will have to scrap his existing aerials and buy new ones, or whether, if he keeps his present equipment, he will soon be lagging behind his neighbours. Why can't someone make a firm decision for the benefit of both the general public and the Trade?—F. F. GREGORY (Hammersmith).

TRANSISTORISED TV

SIR,—Now that some manufacturers have successfully made a commercial receiver utilising the ubiquitous transistor I would feel it time for one of your technical writers to provide those of us who find our main enjoyment in experimenting with some data to enable us to go ahead. I have designed a successful receiver section, for both vision and sound. I believe the manufacturers I mentioned above make use of both an American circuit and American transistors, but have been unable to confirm this. I trust, therefore, that we shall shortly see some really practical data on this aspect of TV.—R. PALMERSTON (Leeds).

CANNIBALISM

SIR,—I read in a daily paper some time ago that a store in London advertised sets for cannibalising, and I thought that the following data might be of interest. I had a Pye set which had given up the ghost, and had been relegated to the loft owing to being unable to dispose of it anywhere. I bought a set advertised for the cannibalising process, and to my surprise it was the same Pye model which I had put away. I got them both out and on making the usual tests I found that the components which had gone wrong were a mains transformer on one and a line output transformer on the other. I changed the line output transformer on the faulty set and it worked satisfactorily. I then looked at the remaining faulty set, which now had a faulty line and mains transformer, and on visiting the junk shops managed to pick up both of these items for a mere song, and as a result I have two working sets, both of which I have been able to give to O.A.P.'s, as I bought a new set when the first went wrong. I am sure that if one understands the technical aspect thoroughly, there are many odd pieces from sets which can be utilised to get a set to function after a break-down, without having to rely upon the special type of original component.—F. RATHBONE (W.6).

CHANNEL CHANGING

SIR,—I sympathise with Mr. Olivant (P.T. August) and his trouble. It is one I experienced in an acute form. This is due to being able to receive the BBC on four channels and ITV on three, any pair of which may be best on any given evening, depending on co-channel interference, Continental stations butting in, or just plain weakness. I solved the problem by using two turret tuners, one Band I and the other Band III. A simple change-over switch or relay (I use one on a remote control unit) gives two channels with a minimum of fiddling with fine tuners and the like, yet does not restrict choice.—R. G. YOUNG (Peacehaven).

ITA Station in South-East England

The estimated coverage of the mast.

THIS map, issued by the Independent Television Authority, shows the coverage of the Dover station.

The transmitter, which went on the air on 31st January, 1960, has a highly directional aerial system that radiates a maximum power of 100kW a little South of West, 25kW to the North and East but only 1kW to the South. This special radiation pattern was designed to avoid creating any interference with television services on the Continent.

Within the primary service area (see map) most viewers, unless they are situated in particularly unfavourable positions, should receive a consistently satisfactory service.

In the secondary service area, a substantial proportion of viewers should receive a satisfactory service, but in a few unfavourably situated places reception may be poor.

In fringe areas acceptable reception should be secured in many locations although this service may be subject to some interference from time to time.

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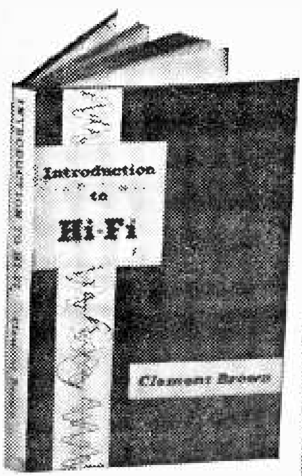

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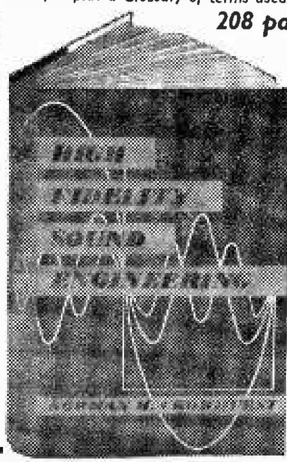

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Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from p. 51 must be attached to all Queries, and if a postal reply is required a stamped and addressed envelope must be enclosed.

EKCO T221

There is no raster and no sound; the only valves lit are those in the sound strip, and the 20P4, U301, and 20L1, these latter three being excessively bright. Sparking occurs inside the U301. The following valves are in order: three 20D1's, 20S2 and 20P5. I have no service sheet.—W. Wells (Sunderland).

The symptoms indicate a heater-cathode leak in the " 20 " series heater chain. In your case these are the 20L1 line and frame oscillator and the 20F2 sync separator.

PYE VT4

The picture enlarged and went out of focus, and the screen went blank. After a few seconds, the picture returned. This happened two or three times at about quarter-hour intervals, but, eventually, the picture failed to return. The sound is unaffected.—A. Long (Holmrook).

A faulty EY51 EHT rectifier is the probable cause of the symptoms. In view of the intermittent nature of the fault, we suggest that you try re-soldering the EY51 heater wires before you replace the valve.

FERGUSON 204T

The sound is rather harsh and a little distorted. I have replaced the PCL83 with no improvement.—G. Brigg (Ipswich).

Replace the 30pF capacitor connected to pin 6 of the PCL83. If the trouble persists, replace the 0·01μF capacitor connected to pin 1 of the same valve.

McMICHAEL MP18

The frame is extended at the top and the bottom of the picture is folded over. I have changed the ECC82 with little or no results. — C. G. Scoll (Rotherhithe).

You should replace the PL84 frame output valve. If there is no improvement, check the 0·01μF linearity capacitors associated with its valve base.

SOBELL T171

The picture takes a long time to appear, and is then about 2in. short all round. It gradually enlarges until the screen is filled apart from a small space at the bottom of the picture. I have replaced the PY32, but with no effect. — C. F. A. Snook (Taunton).

If the PY32 is not at fault, we would advise you to check the appearance of the valve heaters during the warming up period. If these are very dim for the first few minutes, you should check the thermistor (VA1015) wired adjacent to the PY32 valveholder. Check also the rear centre PCL83, the right side PY81 and PL81 valves is necessary. If the bottom compression persjsts, check the 100μF capacitor (25VW) next to the PCL83 (on top of the chassis connected through to pin 7 of the valveholder).

DECCA DM14

From time to time, the picture becomes displaced in bands according to the picture detail, at the same time, sound on vision occurs. This fault can be produced or rectified by a sharp tap on the cabinet. —G. Powell (Marden).

The fault is probably caused by a blob of solder lodged between two tags promoting a short which is cleared by sharp vibration. We cannot be sure of this and you should trace the fault methodically, by first checking the effect of tapping each valve, ensuring that all are fitted, then turning the receiver on its side, take off the bottom cover and probe the valveholders, tag-strips, etc., to ascertain the exact point of the short.

ALBA T356

The line hold control will not quite lock the picture, leaving broken lines at the top and bottom of the screen and sometimes a wedge-shaped piece across the middle. The frame hold is good and so is signal strength.—P. J. Sanders (Taunton).

In most cases which we have investigated involving symptoms such as you describe, the trouble has been traced to the aerial which is receiving reflected signals. Resiting the aerial has restored normal line sync in most instances. If you find that the aerial is not at fault, and there is no sign of ghost images, check D1, disconnect D2, check C80 and C27.

K.B. MV100

Generally, this set gives a clear picture, but at times the picture breaks up and will not lock.—W. L. Dallow (Durham).

If the effect is most noticeable on camera changes or more on some scenes than others, check the aerial. If the break-up is complete, necessitating resetting of the line hold, check by replacing the rear right side 12AU7 (ECC82) valve and check the 220k resistor wired from the hold control to chassis.

FERRANTI T1002

The chanel selector switch is " noisy " and a second fault is that the picture has been slipping down to about half size and gradually righting itself. Recently, it has been slipping more rapidly, and takes longer to right itself. — J. J. Davies (Wrexham).

First turn the receiver on its side; remove the bottom cover, free one end of the tuner unit lid, and lift out of the slots at the other. This exposes the turret contacts. Thoroughly clean all the silver plated studs, rotating the channel selector switch to expose eath pair of biscuits in turn. No further action is really necessary, but a light film of "Vaseline" or MS4 silicone grease can prevent further tarnishing.

For the second fault, replace the 30PL1 valve (PCL83) in the centre of the chassis.

PETO SCOTT 1712

It takes 2 minutes for the sound and 5 minutes for the picture to appear. When the picture first appears, it is weak and ragged. — B. Evans (Brighton).

You should replace the PZ30 H.T. rectifier valve. This should restore the normal warming up period. The irregular edges which slowly fill out are the result of loss of emission in the tube. Advancing the brilliance fully will help straighten the edges more quickly.

MARCONIPHONE VT157

This set works perfectly for about five minutes. The vision then disappears leaving a weak picture and loss of line hold accompanied by an increase in volume of the sound which is rough with a hum. —C. H. Griffiths (Garnant).

An extremely common fault in these receivers is for one of the vision coils on the top right side (as viewed from the rear) to become open-circuited at one end. These coils should therefore be checked. Normally, this does not affect the sound in any way and on this account, we would be more inclined to check the 8μF capacitor to the left of the mains dropper on the left side power board.

G.E.C. BT1252

A barretter 305 is fitted to this set which burns out every five months of normal use, together with either the line output valve PL81 or the sync separator PCF80 (L2319) whichever seems the weakest.—E. Whitehouse (Birmingham 24).

Check that the voltage tapping, especially the heater one, is in correct position. Suspect V329 for intermittent heater-cathode shorts or in fact any of the first seven valves in heater chain after the barretter.

SOBELL T171

There is a raster but no picture or sound on this set. The line whistle is very prominent and sounds a little rough. The raster is not at full brilliance even when the control is advanced. I have replaced the tuner valves with no result; also I have tried another PL81 but this made no difference. The raster is not steady but looks as if being viewed through water which has been disturbed.—J. Bowman (Wallsend).

Check EF80 common sound and vision I.F. amplifier and the valve base voltage to pins 7 and 8. If these are in order check the 0·005μF decoupling capacitor (pin 8 to chassis). Next check the H.T. supply to the tuner unit (blue lead) and follow the supply to pin 1 of the PCF80 (and contact nearest fine tuner) via the 6·8k and 3·3k resistors, both of which should be checked.

MARCONIPHONE VT53 DA-TRF

This television receiver is for the London area and is in good working order. Is it possible to alter this set for Wenvoe?—R. Barnes (Aberdare).

It is possible to alter the coils to receive Channel 5 but this involves a great deal of modification, coil rewinding etc. A more satisfactory solution would be to fit a turret tuner of the P38H (Cyldon) or 35S (Brayhead) type and feed the output of this to the V2 (Z77) stage, altering the coils to produce a 34-38Mc/s I.F. i.e., tune sound coils from 41·5Mc/s to 38Mc/s and the vision coils to 35Mc/s approx. The receiver would then behave as a superhet. Even this is no easy modification if a signal generator circuit is not available.

ALBA MODEL?

I have recently come into possession of this 12/14in. receiver which I believe is three years old. When the set has been switched on for about 20 minutes to half an hour, there appears along the bottom of the picture a black bar about 1in. wide. This shortens the picture. Use of the vertical hold does only a little to reduce this before the picture starts to roll. There are ten valves in the set and I would like your advice on remedying the defect. Apart from this fault the picture is good. — P. Norman (Aubourn).

You should change the frame output valve, probably an ECL80 or PL82. As you give us no idea of the model number of the receiver or any description of it we cannot be of greater assistance.

BAIRD 2117

When I turn the brightness or contrast up the faces of the people on the screen glisten on the light parts of their features then the picture becomes negative. The picture is not very bright but I can draw a good long spark from the EHT rectifier. There is also another fault. When the timebases are running free, the whole screen is scanned but when I turn up the contrast the picture is about three inches short at the top with stretching at the top of the screen and cramping at the bottom. When the titles come up on the screen the bottom halves are out of sight, below the screen. The frame linearity controls will fill the screen but they only make the stretching and cramping worse. The voltages on the frame amplifier seem to be correct and the feedback components seem to be in order. I have the circuit for this set. — F. Fawton (Oldham).

The first fault described is most certainly due to a failing tube. The second fault is due to a low ECL80 V12 and the picture should be properly centred when this valve has been replaced.

BUSH TV22

I have just replaced a PL38 in this set but neither this nor adjustment to horizontal hold cured lines across the screen. Thinking this valve might not be seating on its socket I pushed on it and the EY51 burnt out. There is quite a bit of buzzing etc. on the sound.—K. Wagstaff (Sevenoaks).

We are not sure of what is meant by the EY51 burning out. If the heater of this valve has failed

(Continued on page 51)

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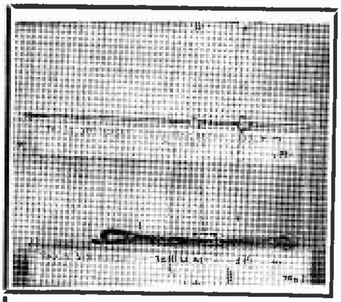

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(Continued from page 48)

it should of course be replaced. Pushing in the PL38 would hardly have caused this. You should retune the station tuner knob to the right of the aerial terminals or if the input is excessive use an aerial attenuator.

PHILIPS 1768U

Although the sound is perfect, there is no raster. I have changed the EHT rectifier and all the line output valves. The ion trap has been checked and found to be in order. The line whistle is audible and there is spark when the EHT lead is advanced to the chassis. I shorted the grid to the cathode of the CRT, but with no result. I have a circuit of this model.—W. Burtonshaw (Croydon).

When the EHT clip is advanced to the chassis the resulting spark should be vigorous and quite long. A weak or subdued spark should direct attention to the EY86 valve inside the transformer housing, ensuring that the heater is glowing visibly. If you are satisfied that the EHT is satisfactory, check the heater voltage across pins 1 and 12 of the CRT base (6·3V) and the voltages applied to pins 2, 10 and 11. Since you have already partially checked the 2 and 11 potentials by shorting the tags together, attention should be directed to pin 10. If this potential is low check the boost line decoupling capacitor; 18,000pF on early models, 27,000pF on later models.

BUSH TV 53

Three months ago I fitted a regunned tube to this set and, until a few days ago, the picture was quite good. Now however, the picture is rather dim and the brightness control has little effect. Advanced or retarded from about the mid position, this control causes the raster to become black. The picture is at one moment reasonably bright and the next is almost black. The width of the picture also seems to vary with the brightness content. When the brightness control is advanced, the picture is brought well into focus. The sound is quite all right. I have a service sheet. — K. F. Gorman (Cudworth).

First ensure that the ion trap magnet on the rear neck of the tube is correctly adjusted for maximum brightness. If there is little or no improvement, you should change the EY51 (EY86 in later models) on top of the line output transformer. Check the ECC82 and P181 if the width is inadequate.

K.B. LVT50

After having checked the aerial, cleaned the biscuit contacts and springs, fitted new PCC84 and PCF82 valves in the tuner unit and cleaned all the valve pins on this set, the following faults still prevail. On ITV the resolution of the picture is good, as is the contrast, but the whole of the picture is covered with a " crawling " effect. There is also a deal of background noise. On BBC only a dim ragged picture is obtained and the "crawling" effect is noticeable. The sound is in order. I have a circuit diagram of this set.—C. Bradford (Buxton).

The trouble most certainly appears to be due to a faulty aerial system. Another receiver should be tried with the aerial to test it. If the aerial is not at fault note the effect of disconnecting the AGC (remove the 6AL5) and connecting a 4·5V battery—positive to the chassis, negative to the anode pin of the AGC diode anode (the junction of 0·1μF, 1·5M, 150k, and 220k components). If there is an improve ment although the contrast is inoperative, check the AGC system thoroughly; 6AL5, 0·5μF, 0·25μF, etc. If there is little difference check the 10k triode anode load resistor of the PCF82 (pin 1), and the 100k resistors of the PCC84 (pin 2). Check the 6AM6 decoupling capacitor—0·001μF.

Practical Television MULTIMETER *(Continued from page 32)*

Alternative Method

If, however, a standard instrument is not available, good results can be obtained, if care is exercised, by the following method:

1. Using a 90V dry battery, or a stable source of H.T. voltage of about 100V, insert in series with this and the meter a resistor of about 2M. By putting a little more resistance in circuit, or reducing the series resistor a little, adjust the meter to give precisely full-scale reading on the 0—50μA range. A hand lens should be used to ensure an accurate reading.
2. Switch to the 0—0·5mA range. The reading should now be exactly 5. If not, adjust the shunt a little, as necessary, until an exact reading is obtained. The hand lens will be needed again.

Accuracy

The above procedure can be repeated for the next range (0—5mA) without much loss of accuracy. However, proceeding in this way the errors are cumulative, and unless a check against a standard can be obtained too much reliance should not be placed on the higher current readings.

In calibrating A.C. current ranges in this way it is possible to use the 6·3V heater supply from a mains transformer for the higher current ranges. For the lower current ranges, the shunts are larger in value and switching from one range to another causes enough variation in total resistances to alter the current appreciably. Hence, when the 10mA and 100mA ranges are being calibrated, the full 230V mains supply should be used, together with a series resistor of suitable value to limit the current. Since on the A.C. ranges a "universal" type shunt is used, it is necessary to do all shunt-adjusting progressively, beginning with R14 and proceeding in turn to R15, R16 and R17.

(To be continued)

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