DISTRIBUTED SCOPE AMPLIFIER

Practical Television

1'6

AND TELEVISION TIMES

SEPTEMBER
1960

CONTENTS

Just Right for your pocket !

THE MULTIMINOR

This splendid AVO Instrument has been developed to meet a definite demand for a sturdy pocket-size multi-range test meter at a modest price, suitable for use on modern electronic apparatus as well as for radio and television receivers, motor vehicles, and all kinds of domestic appliances and workshop equipment. Readings are obtainable quickly and easily on a very open scale, and range selection is by means of a robust, clearly marked rotary switch of the characteristic AvoMeter type. Measurements of A.C. and D.C. Voltage, D.C. Current and Resistance are made by means of only two connection sockets.

19 Ranges

D.C. Voltage: 0-1,000V in 7 ranges

A.C. Voltage: 0-1,000V in 5 ranges

D.C. Current: 0-1A in 5 ranges

Resistance: 0-20,000 Ω, 0-2M Ω.

Pocket Size: 5⅝ x 3⅝ x 1⅜ inches.

Weight: 1 lb. approx.

List Price **£9 : 10s.**

Complete with Test Leads and Clips.
Leather Case if required 39/-.

Sensitivity:
10,000 ohms per volt on D.C. voltage ranges.
1,000 ohms per volt on A.C. voltage ranges.

Accuracy:
On D.C. 3% of full scale value.
On A.C. 4% of full scale value.

To meet special requirements, instruments can be supplied to a higher degree of accuracy for a small additional charge.

Designed and Manufactured by

Telephone: VICtoria 3404 (12 lines)

AVO LTD AVOCET HOUSE · 92-96 VAUXHALL BRIDGE RD. - LONDON · S.W.1

A Member of the Metal Industries Group of Companies

FIRST IN QUALITY - FOREMOST IN ECONOMY

Suffolk's reputation for reliability accounts for the rapidly increasing popularity of Suffolk rebuilt tubes. Now you can obtain "NEW ALUMINA" C.R. Tubes of all types completely rescreened and aluminised—at an exceptionally low price!

12″ **£5.** 14″ **£5.5.** 15″ & 17″ **£5.10.** 21″ **£8.**

Sensational value with the existing range of picture tubes!

12″ **£4.10.** 14″ **£4.15.** 15″ & 17″ **£5.** 21″ **£7.**

Suffolk's FULL 12 MONTH GUARANTEE is your assurance of satisfaction. You get FREE DELIVERY anywhere in the U.K. when you trade with Suffolk, the largest independent tube rebuilders in London.

SUFFOLK TUBES LTD

SUFFOLK HALL, 1-3 UPPER RICHMOND ROAD, PUTNEY, S.W.15

Telephone: VAN 5267, 4304

Practical Television

& TELEVISION TIMES

Vol. 10 No. 120 EVERY MONTH SEPTEMBER, 1960

Editorial and Advertisement Offices:
PRACTICAL TELEVISION
George Newnes, Ltd., Tower House, Southampton Street, W.C.2.

Phone: Temple Bar 4363
Telegrams: Newnes, Rand, London.
Registered at the G.P.O. for transmission by Canadian Magazine Post.

SUBSCRIPTION RATES
including postage for one year

Inland	£1.2.0 per annum
Abroad	£1.0.6 per annum
Canada	19s. per annum

CONTENTS

P.T.V. "Olympic"—Free Blueprint

FOR some time now, our designers have been working on a television receiver circuit which would be suitable for the home constructor. Next month, the first article will appear on the results of their efforts—the P.TV."Olympic". A large blueprint (24in. x 32in.) will be given away free inside every copy of our October issue. (The normal price of the blueprint is 7s. 6d.) We hope that this free offer will enable many constructors to build this receiver which has a number of refinements including "rock-steady" control settings. A prototype will be on show at our stand (No. 117) at the Radio Exhibition where its high standard of performance may be judged.

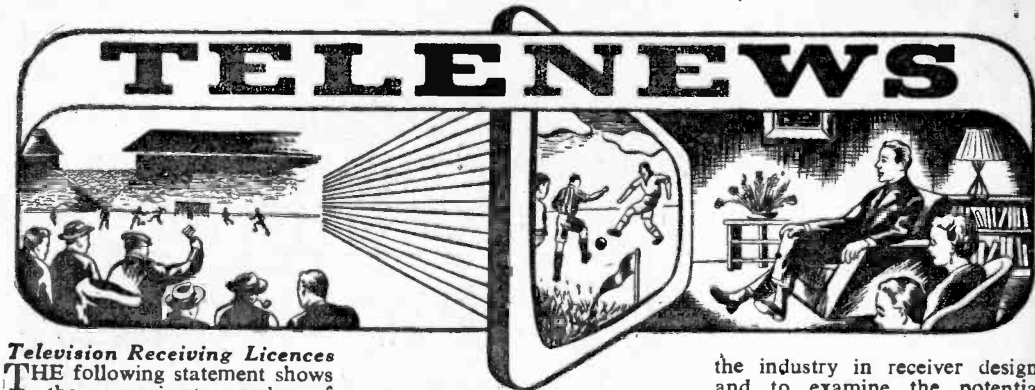
Advertising

IN our Editorial of the July issue we noted the announcement by the Independent Television Authority concerning advertising time. Following complaints that advertising on Independent Television occupied too much of the programme time, it was decided that, while the daily maximum of ten per cent would continue, spot advertising will not exceed 7½ minutes in the clock hour from 12th September and 7 minutes from 24th December. Following this announcement, it has been claimed by programme contractors that the new restrictions would cost them some £5 million per year. Accordingly, the cost of advertising space on television will be increased, and new rate cards have already appeared. From January 1961, increases will be made ranging from 25 per cent for 15 seconds and 64 per cent for 60 seconds. Previous increases in the cost of TV advertising, have, like this increase, been heralded by forecasts of a decline in the demand for space. However, afterwards it has been found that when the cost of advertising space increases, the demand remains stable or indeed increases, and the profits of the contractors rise. It is interesting to note that contrary to most industries, here, increased costs mean more demand.

In the light of previous experience, it is not easy to estimate the probable effects of these increases in charges. Many advertisers have come to regard the 60 second advertising spot as the most effective one for their products—they believe that a more leisurely approach is possible with more time to develop and expand a theme. However, it is on 60 second advertising spots that the largest increase in cost has been made and it may well be that this will make advertisers hesitate in planning their nation-wide campaigns. It is true that, already, the cost of advertising has compelled more effective use to be made of 30 second spots and probably the new rates will bring further improvements in the employment of available time.

Previous increases in advertising rates have been greeted with but vague murmurs of disapproval; the increases have repercussions which affect most members of the community and it is to be hoped that this state of apathy will not continue indefinitely.

Our next issue, dated October, will be published on September 22nd



Television Receiving Licences

THE following statement shows the approximate number of Television Receiving Licences in force at the end of June, 1960, in respect of television receiving stations situated within the various Postal Regions of England, Wales, Scotland and Northern Ireland.

Region	Total
London Postal	1,852,314
Home Counties	1,448,858
Midland	1,617,671
North Eastern	1,735,882
North Western	1,420,587
South Western	894,409
Wales and Border Counties	643,052
Total England and Wales	9,612,773
Scotland	941,400
Northern Ireland	147,958
Grand Total	10,702,131

African Playwright Contest

A CONTEST aimed at discovering Nigerian playwrights has recently been launched by W.N.T.V., Africa's first television network. The best play will receive a prize of £100 and will be produced during the country's Independence celebrations in October. The plays must be at least 45 minutes in length and must be based on contemporary African themes. They must also be written by Nigerians.

A list of hints and instructions supplied by the station to entrants advises them to confine their action to as few sets as possible. Filmed shots without dialogue can be used for transition purposes. The writers are also advised to completely ignore camera movement and angles and to concentrate "on the sense of unity and literary content of the play."

The entries will be judged by the senior television producer at W.N.T.V., a member of the English faculty at University College, Ibadan, and a well-known Nigerian dramatist.

Radio Cabinet-Styling

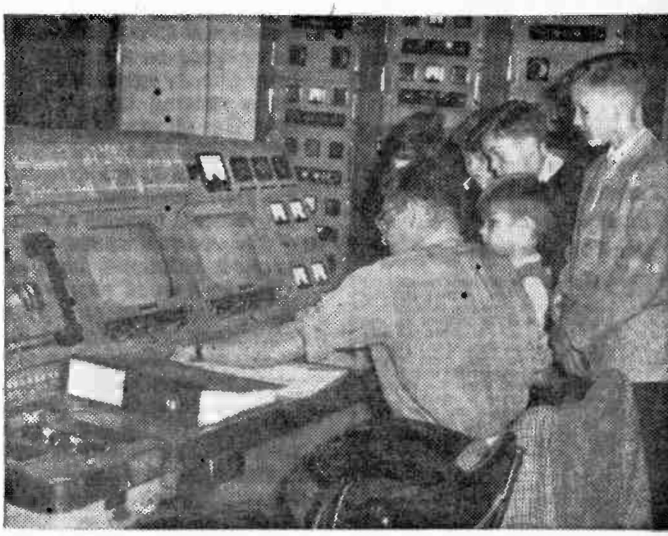
THE fourth cabinet-styling exhibition arranged by the British Radio Equipment Manufacturers' Association will be held on October 4th to October 6th next, at both the north and south halls of the Victoria Halls, Bloomsbury Square, London, W.C.1.

The purpose of the exhibition is to enable suppliers at home and overseas to show radio manufacturers the products materials, techniques and styling currently available, and also under development, for use in the exterior design of radio and television receivers, radiograms, record players and other sound reproducing equipment. The suppliers will be able to form an assessment of the future needs of the industry in receiver design, and to examine the potential market.

Colour TV Unit for Australia

A MOBILE medical colour television unit manufactured by Marconi's Wireless Telegraph Co. Ltd., for Smith Kline and French Laboratories Ltd., was loaded aboard the S.S. "Dunedin Star" at the Royal Victoria Docks on June 27th to begin a three month demonstration tour of Australia.

The mobile colour TV unit, which was commissioned two years ago, has been placed by the owners at the free disposal of medical authorities in this country for use at conventions and other similar functions. It



The BBC recently held an "open day" for the public at the Crystal Palace, South London, transmitting station. Engineers and technicians explained the working of many complicated pieces of equipment. The illustration above shows a BBC Engineer at the Control Desk explaining the working to a group of young visitors.

has been used to televise, in full colour, clinical procedures and intricate operations carried out by surgeons in order to demonstrate their methods to the medical profession.

During its Australian tour, the unit will visit hospitals in Adelaide, Melbourne, Brisbane and Sydney to give colour TV demonstrations. The engineering team who staff the vehicle are provided by the Marconi Company. The unit is expected to arrive back in this country in December.

Granada Contract

AN £80,000 contract has been obtained by Young, Austen and Young Ltd., from Granada Group Ltd.

The Company will install a heating, ventilating and hot water system at Granada's new £500,000 ten-storey office building in Quay Street, Manchester, which is now under construction. Heating for this building and the whole site will be handled from one boiler house, which will eventually contain four Ruston and Hornsby Economic oil-fired boilers. Three of the boilers will have an output of 6,000,000 British Thermal Units, and there will be one of 3,000,000 B.T.U.'s.

The smaller boiler will be used for the domestic hot water system in the summer months.

White City TV Studios

OVER seventy Ekcovision 17in. and 21in. screen receivers were ordered by the BBC from E. K. Cole Ltd. for the new Television Centre at White City, London. They are used in executive offices, board room, conference room, etc. Seventeen 21in. screen chassis have been built into the furniture in the executive suite of offices.

Each receiver is used for live BBC and ITV and VHF radio reception and will also cover the BBC's internal "piped" rehearsal channels.

Thorn Aquires Brimar

AN agreement under which the "Brimar" Valve and Cathode Ray Tube Division of Standard Telephones and Cables Ltd. is acquired by Thorn's, has recently been signed by Thorn Electrical Industries Ltd. and Standard Telephones and Cables Ltd. A new company is being formed under a name including the well known trade mark "Brimar" which will continue all the activities previously carried out by Standard Telephones in this field. (The "Special" Valve Division of Standard Telephones and Cables Ltd is not included in the agreement).

The new, ten-storey, Granada office block in Quay Street, Manchester is now almost completed. The building will house all Granada's administrative departments and the film operation section.

TV Grants

THE Independent Television Company serving central-southern and south-east England southern television, is to make a number of grants to the arts and sciences.

In the first year of this scheme repertory theatres, orchestras, music festivals and universities are to receive sums totalling £8,000. A spokesman of Southern Television said: "It is the company's great desire to support the arts and sciences especially within the region covered by its transmissions.

"Since we first opened almost two years ago we have become part of the way of life in the South and it was felt that we should take our place in supporting cultural development within the South.

"Support has been given to repertory theatres to help develop acting and drama generally and encouragement has been given to good music within the region."

Solder on the Screen

WHILE the emphasis of the Production Exhibited at Olympia was naturally on products and processes rather than on ancillary aids, it is interesting to note that only one stand, that of the Tin Research Institute, took any note of the vast advances that have been made in the industrial applications of closed-circuit television.

To illustrate their research work into the "solderability" of various types of metals, the Institute devised electrical equipment capable of instantaneously heating standard size samples to any desired temperatures. A simple push-button switch operates a transformer bringing down standard main supply to as low as 1·5V, heating the samples after the application of standard fluxes and solder pellets.

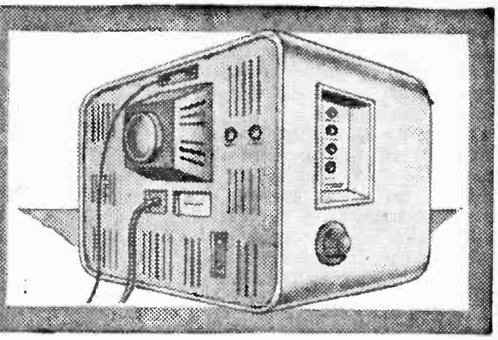
ITA Appointment

THE Postmaster General, the Rt. Hon. Reginald Bevins, M.P., has made the following appointment to the Independent Television Authority:—

Sir John Carmichael, Deputy Chairman from June 22nd, 1960 to July 29th, 1964.

The appointment of Sir John Carmichael, who has been a member of the Authority since January 15th, 1960, fills the vacancy caused by the death of Sir Ronald Matthews on July 1st, 1959.

Servicing Television Receivers



THE FERRANTI 21K6, 21K5.

By L. Lawry-Johns

(Continued from page 557 of the August issue)

AFTER dealing with faults in the tuner and line timebase sections of these receivers we now deal with other sections.

Frame Timebase

This uses a single PCL82 (V13) which is a triode-pentode. The triode section is used as a conventional blocking oscillator, the pentode, of course, being the amplifier or output. Failure to operate will show on the screen as a single horizontal line across the centre. Various conditions could cause this and the first suspect should be the valve (V13) itself. If this is in order a voltage check should be made at the valve base, first at pin 6, then at pin 9. If there is no H.T. at pin 6 (176V) check at pin 7 (about 200V). If there is no H.T. at 6 or 7 R118 will be found open-circuited. If this resistor is charred, check C109 which could be shorted.

If however H.T. is present at pin 7 but not at pin 6, T2 will no doubt be found open-circuited. This is a fairly common occurrence and apart from replacing this transformer there is little which can be done. Quite often however H.T. will be found present at pins 6 and 7 but low at pin 9. This normally indicates an open-circuited T1 blocking transformer winding. The voltage may not be totally absent due to the presence of R116 but it will be very low. About 140V should be recorded when V13 is functioning normally.

When a new transformer is fitted, the windings must be wired correctly in order to promote oscillation. Readers' letters show that this point is not fully realized and quite often a defective transformer is replaced leaving that stubborn white line still glistening across an otherwise dark screen. The answer is to reverse either winding *but not both*, e.g. remove the lead to pin 1 and connect to C106, remove the lead to C106 and connect to pin 1. A welcome buzz should then denote resumed oscillation.

Poor Frame Linearity

Where the bottom of the picture is compressed giving a distorted aspect and a blank space at the bottom when the height is adjusted to keep the top from being excessively extended, this normally denotes

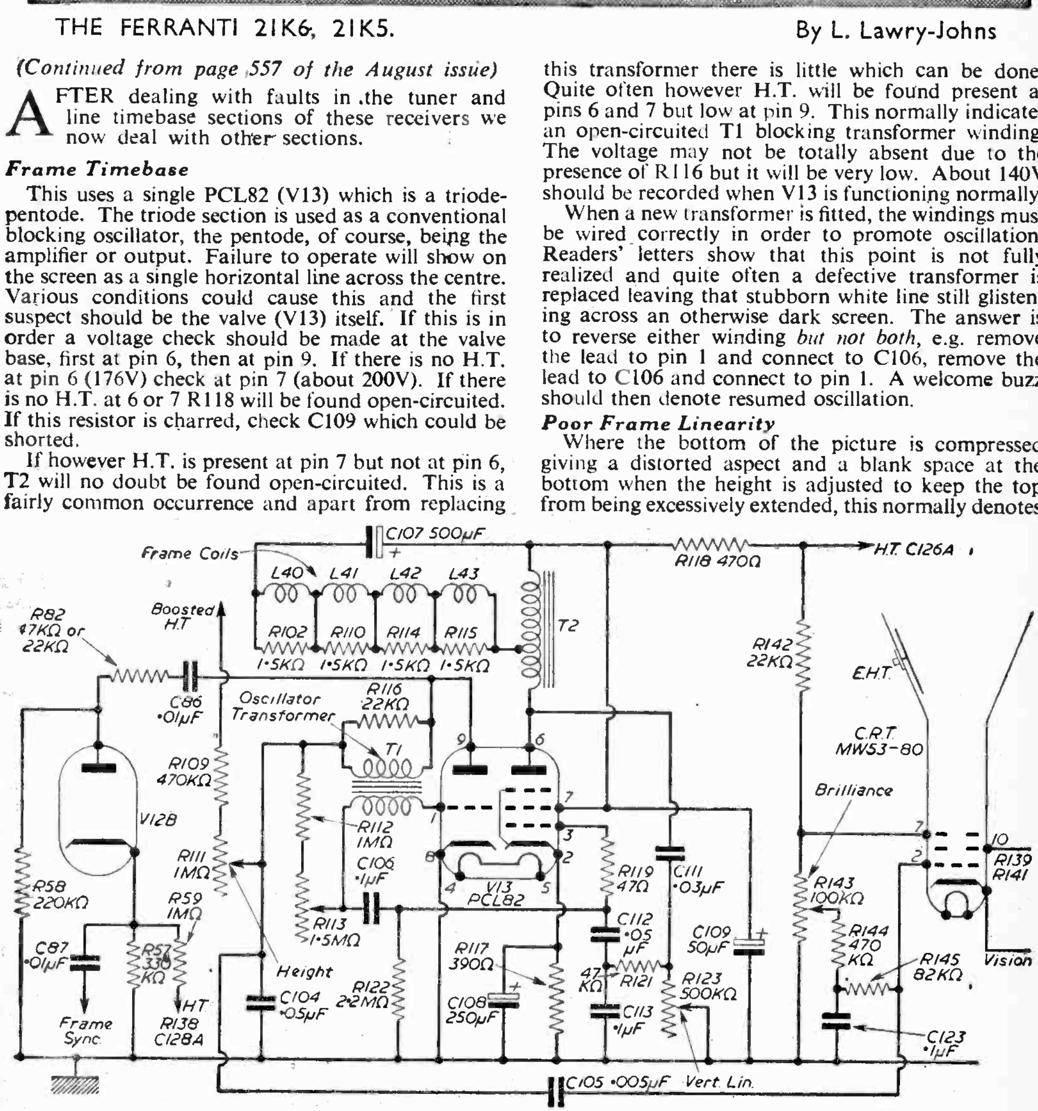


Fig. 3.—The frame timebase and C.R.T. circuit.

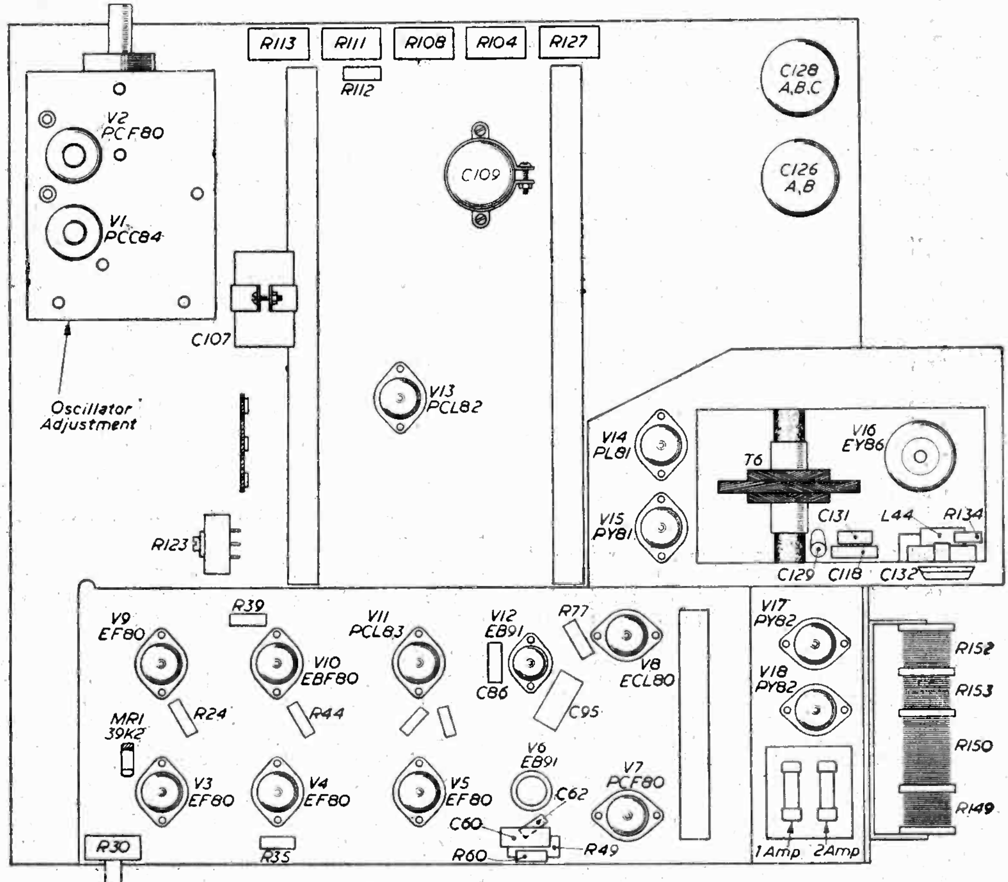


Fig. 4.—Above chassis layout.

a failing PCL82 and a replacement usually puts things right. A faulty valve will sometimes cause top compression, extended centre and inability to lock correctly.

Frame Hold (R113)

Inability to lock need not be due to the PCL82 and if the control is at one end of its travel R112 should be checked. If the picture rolls up and down with no locking position, check V12B and all associated components.

This condition should not be confused with frame bounce which shows as a persistent jitter all the time the picture is locked (or should be locked) which stops when the hold control is set to cause the picture to roll. This could be due to a faulty V13 but a defective component in the V12B circuit could be responsible, causing the line pulses to enter unfiltered into the frame oscillator circuit. However, it may be found that the height and frame linearity controls have an effect on this jitter and, where this is the case, and V13 is not at fault, check by replacement of C111 and C112 (0·03μF and 0·05μF).

Hum Bars

Sometimes a poor picture is displayed, much darker at the top than the bottom or vice-versa. This could be due to a heater-cathode short or leak in almost any vision valve or a floating control grid, but the writer has found that the PCF80 (V7) video amplifier AGC triode, is most often at fault and a replacement usually restores normal conditions.

No Picture Signal

Check V4, 5, 6 and 7 and the voltages to each base. If these are in order check the video choke to pin 2 of the video amplifier, V7.

No Sound

Where no sound at all is received, V11 is most often responsible, this being a PCL83. If the valve is in order, check the voltage to pin 6 as the sound output transformer T3 may be defective or perhaps disconnected.

If a hum is present denoting that the V11 stage is working, check V10 EBF80 and V9 (EF80) and the voltage supplies to each.

This symptom should not be confused with incorrect tuning where a high background noise is audible with perhaps a loud vision buzz. This denotes incorrect alignment of the oscillator coil core, or frequency drift, perhaps caused by a faulty PCF80 (V2).

Oscillator Alignment

Remove the tuner knobs (pull off) set fine tuner midway, insert a non-metallic trimming tool and trim core for *maximum sound.*

Adding Vision AGC

CIRCUITRY AND MODIFICATIONS

By K. Royal

A HIGH resistance voltmeter will read about 20-30 volts negative when it is connected between the control grid of the sync separator valve and chassis of a working receiver. This voltage will decrease when the signal level falls, and increase when the signal level rises. It will also tend to decrease when the picture changes to a dark scene and increase when it changes to a bright scene. This latter effect is most in evidence during a morning test transmission when the vision modulation is switched on and off. When this happens there might well be change in voltage of almost 50 per cent. However, during an ordinary programme, the brightness level of a picture is maintained fairly constant and will be seen not to change very much, provided there is no fading of the signal.

Operation

This voltage is ideal for vision AGC since it is negative with respect to chassis. It can thus be applied to the R.F. valve and the vision I.F. valves as a control bias. Under average signal conditions, the bias should be adjusted to give the required stage gain, so that when the signal fades the bias will decrease and the stage gain will rise, and when the signal increases the bias will increase and the stage gain will fall. A means is thus available for an automatic control of the gain of the vision channel as dictated by the signal strength at the aerial. It will be appreciated that gain variations will also occur as the result of changes in picture brightness, given by the vision modulation, but since these changes are relatively small they detract from the general efficiency of the system by only a small amount, and for normal application they can be discounted. This method of vision AGC is now used extensively in new receivers. At one time very complicated arrangements were adopted, whereby the black level of the vision signal was sampled to provide vision AGC reference which was unaffected by changes in picture. Such arrangements, although very effective, had little practical advantage in domestic receivers over the simple arrangement described above. Nevertheless, they are still sometimes used and are essential when the receiver is required to give pictures of technical perfection, for there is some slight cramping of the contrast ratio by the use of the simple arrangement.

Video Coupling

Early receivers of the single-channel and five-channel variety are mostly without vision AGC, and are consequently susceptible to variations in overall brightness of the picture as the result of fluctuations in signal strength. This was countered to some small degree, especially so far as aircraft flutter was concerned, by making the coupling between the video amplifier valve and the picture tube cathode or grid partly direct and partly AC. Direct coupling is, of course, required for optimum results.

Old sets such as these are still in use, and many are being adapted by their owners for multi-channel reception. Without vision AGC, however, there is always the inconvenience of having to re-adjust the contrast and sensitivity controls on changing from one programme to another It is thus well worthwhile to extend the adaption to bring these old sets further in line with current development by adding vision AGC of the simple type described. This is not difficult, and most experimenters with a fair knowledge of circuitry should be able to handle the job in a couple of evenings.

Modification of Existing Contrast Control

The method of contrast control adopted on the earlier receivers is no longer possible when vision AGC is used, as the AGC system would tend to maintain a constant overall gain and thus detract completely from the normal operation of the contrast control. Manual gain control is possible, however, by arranging for the contrast control to vary the AGC bias about its mean level.

In addition to the contrast control, some of the early sets also featured a sensitivity control. This serves exclusively to vary the gain of the R.F. amplifier stage to cater for the applied aerial signal without cross-modulation. This control should not be altered or removed, as even with vision AGC it will allow the signal strength to be adjusted to provide optimum auto control. In normal or low reception areas, the control should always be set for maximum gain so as to maintain the best possible signal-to-noise ratio. Some turret tuners have a lead-out wire or tag for con-

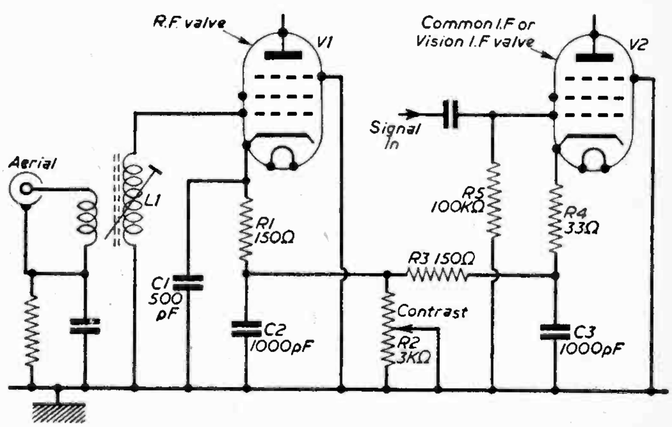


Fig. 1—Typical contrast control circuit.

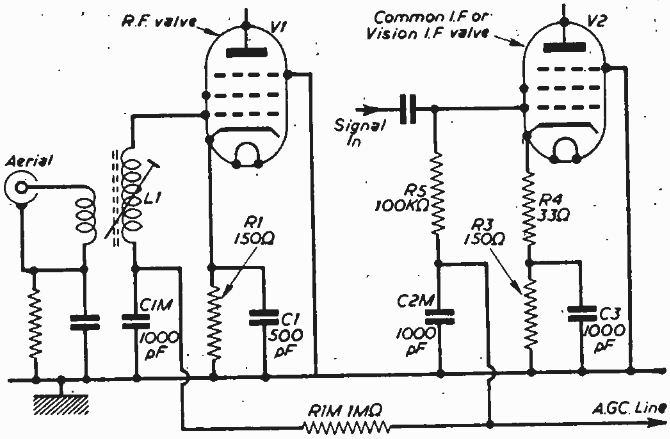


Fig. 2—Eliminating the contrast control from Fig. 1 and rearranging the circuit for an AGC line.

necting a sensitivity control. In some cases this is in addition to the normal AGC lead-out wire or tag.

In Fig. 1 is shown a typical contrast control circuit as may be found in the type of set under discussion. There may be slight differences, but all circuits feature the basic elements of Fig. 1. Two valves are usually controlled; the R.F. amplifier, V1, and either the common I.F. or vision I.F. amplifier V2. The grid circuit of each valve is returned to chassis—V1 via L1 and V2 via R5. The cathode circuit of each valve is also tied to chassis via fixed resistors and the contrast control R2. Each cathode is, therefore, positive with respect to each grid owing to the voltage drop across the resistive elements in the cathodes. This means that each grid is negative with respect to each cathode, and in this way the valves are biased.

Feedback

The negative bias on each valve increases as the contrast control is adjusted to give greater resistance in the cathode circuits. In this way the stage gain is decreased, or increased by rotating the control to give less resistance. It will be noticed that R1, R2 and R3 are bypassed by capacitors C1, C2 and C3. This is to prevent unwanted feedback in the stages. However, R4 is not bypassed, and the reason for this is that it introduces a small degree of negative feedback which holds the input capacitance of V2 reasonably constant as the bias on the valve is altered. Without this resistor, a marked change in input capacitance is likely, and this would tend to detune the stage as the contrast control is adjusted.

It will also be seen that each suppressor grid is connected to chassis. This means that this grid is also biased negatively, which helps provide a greater range of gain control with variation in bias. The control grid is sometimes returned to the junction of two resistors in the cathode circuit, instead of direct to chassis. This arrangement allows for the change of bias on the control grid to be less than the change of bias on the suppressor grid, and this also helps in keeping the input capacitance constant over the range of the contrast control. These special arrangements should not be elimininated when adding vision AGC.

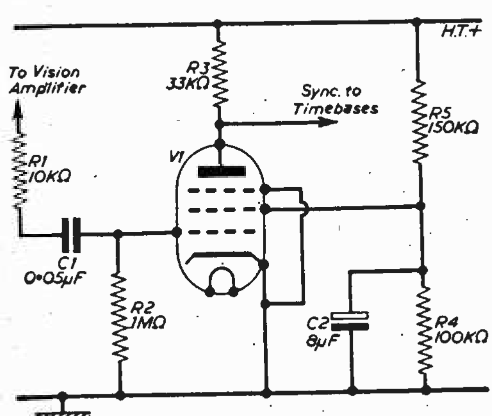


Fig. 3—Typical sync separator circuit.

Biasing

In Fig. 2 is shown how the contrast control is eliminated and how the circuit is altered to cater for an AGC line. Each valve is now given a fixed bias of minimum value as would have been obtained in Fig. 1 with the contrast control set for maximum gain. This, of course would only happen when the AGC line is returned to chassis. As shown in Fig. 2 it is "floating", as the control grid of V1 is isolated by C1M and the control grid of V2 is isolated by C2M, both being additional components along with the AGC decoupling resistor R1M.

If some method were available of varying the negative voltage on the AGC line of Fig. 2, then a normal means of contrast control would again be available. The next step, then, is to take a suitable control bias from the sync separator stage and also arrange for this section to provide a form of manual control to enable the contrast to be adjusted correctly in the first place.

Obtaining the Control Bias

Fig. 3 shows a typical sync separator stage. The voltage which is suitable as a control bias occurs across resistor R2 in the control grid circuit, but before this can be fully exploited for AGC the circuit requires slight rearrangement and the addition of a contrast control.

Fig. 4 shows the circuit in modified form. Here R2 is eliminated and its place taken by R1M, R2M, R3M and R4M. The negative voltage is thus developed across R1M and R2M in series, and approximately half of it is used as control bias, as it is taken from the junction of R1M and R2M and applied to the AGC line through R5M.

(Continued on page 611)

USING THE WOBBULATOR

METHODS USED TO SWEEP THE FREQUENCY, AND TO CALIBRATE THE DISPLAY

By R. Brown

ANYONE who has had the task of aligning a wide band I.F. amplifier with the aid of a signal generator and an output meter has felt the need for something better. This task is one we all seem to come across sooner or later, and it is one which frequently ends in frustration and a bady finished job. It is here that the frequency swept oscillator, or wobbulator, really proves its worth. Using this instrument, with an oscilloscope, even the most complicated of I.F. strips can be accurately aligned in a very short time.

Curve Display

With a wobbulator we can display, on the oscilloscope screen, the response curve of the amplifier. Any adjustments we make to the trimmers in the amplifier, will alter the response curve, and this change can be seen immediately.

The basic arrangement for displaying the response curve is shown in Fig. 1. The timebase voltage from the oscilloscope is fed into the wobbulator sweep circuit, where it sweeps the frequency of the oscillator across the pass-band of the I.F. amplifier. The output from the I.F. amplifier is detected, and taken to the "Y", or vertical, plates of the oscilloscope. The "X", or horizontal, deflection will thus be proportional to frequency, while the "Y" deflection will be proportional to the I.F. amplifier gain.

Sweep Circuits

There are three methods which are normally used to sweep the oscillator frequency. One method is to vary mechanically the capacitance of the tuning condenser. This can be achieved by rotating the rotor using an electric motor, the motor being driven by the timebase. Alternatively, a small mechanically variable capacitor can be constructed, and connected in parallel with the main tuning condenser. The capacitance of this unit can then be varied by some form of vibrator—the voice coil of a loudspeaker makes an excellent vibrator.

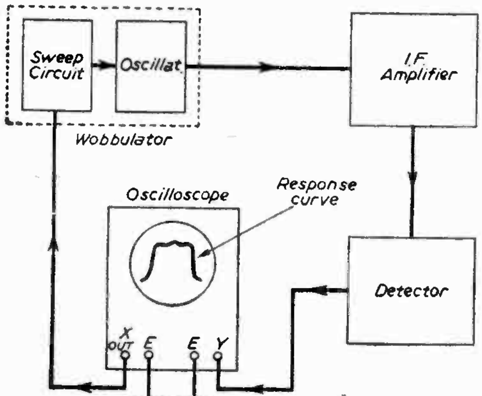


Fig. 1—Displaying the response curve of an I.F. amplifier.

The fault with this type of sweep circuit is that it is very difficult to vary the sweep width—a disadvantage which considerably reduces the usefulness of the instrument. The other two methods of sweeping the frequency are electronic, and do not suffer from this disadvantage.

The first of these electronic sweep circuits is the reactance valve modulator. This is a single valve circuit which is connected across the oscillator tuned circuit. To the tuned circuit it appears as a variable capacitor—a capacitor the value of which varies in step with the oscilloscope timebase.

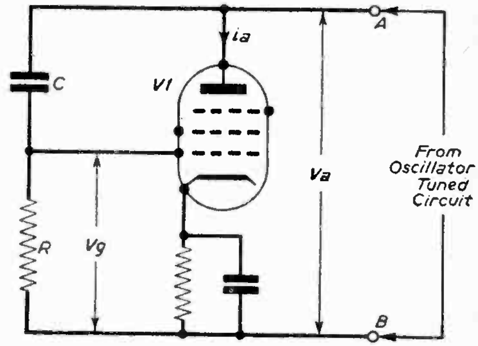


Fig. 2—A reactance valve sweep circuit.

Operation

The circuit of a reactance valve is shown in Fig. 2. When this is connected across the tuned circuit, an oscillating voltage, Va, from the tuned circuit, will appear across A and B, and, therefore, across C and R in series. The value of C is chosen so that, over the frequency band in which the modulator works, its impedance is very much greater than the resistance of R. The current which flows through C and R thus leads the voltage, Va, by almost 90deg. The voltage, Vg, which is developed across R, will be in phase with this current. Vg is the input voltage to the grid of the valve, and the anode current, Ia, produced as a result of Vg will be in phase with it. Thus the oscillating anode current Ia will lead by 90deg the oscillating voltage, Va, which produced it. Thus, as was said earlier the valve looks like a capacitive reactance.

The valve actually looks like a capacitor the value of which is given by CRgm. Thus by varying gm we can vary the value of this capacitor, and, therefore, the frequency of the oscillator. This is done by first choosing a variable-μ valve for V_1, and then applying the sweep voltage to the grid of the valve.

The reactance valve is particularly suitable for narrow sweep working. For large sweep/widths a ferrite modulator can be used. This consists of a small ferrite core, which carries an R.F. winding forming part of the oscillator circuit inductance. The ferrite core is placed in the gap of a Ni-Fe core, which carries the sweep voltage winding and a D.C. polarising winding. This is shown in Fig. 3. How the modulator works can best be seen with the aid of Fig. 4. This shows the upper portion of the B/H curve of the ferrite core.

Calculation

Supposing we first of all apply the D.C. polarising voltage, and let it have a value such that it produces a field strength of 10 oersteds. From Fig. 4 it can be seen that this will produce a flux density of 1020 gauss. The permeability of the ferrite core is given by B/H and is 1020/10=102.

Suppose now we apply an alternating sweep voltage such that it causes the field strength to vary continuously from 7 to 13 oersteds. The flux density will now vary, along the line ABCDA. When the field strength is 6 oersteds, point C, the flux density will be 1180 gauss. This gives a permeability (B/H) for the ferrite of 1180/7=168. When the field strength is 13 oersteds, point A, the flux density will be 1380 gauss. Which gives a permeability of 1380/13=106. Thus the effect of connecting the sweep voltage has been to cause the permeability of the ferrite core to vary continuously from 106 to 168. But the inductance of the R.F. winding is directly proportional to the permeability of the ferrite core. Hence the sweep voltage varies the inductance of the R.F. winding, and as this forms part of the inductance of the oscillatory circuit the oscillator frequency will vary.

Calibrating the Display

Useful as is the display produced by the set up shown in Fig. 1, it does only give us the approximate shape of the response curve. If work of any accuracy is to be done some means of calibrating the frequency and amplitude scales must be provided.

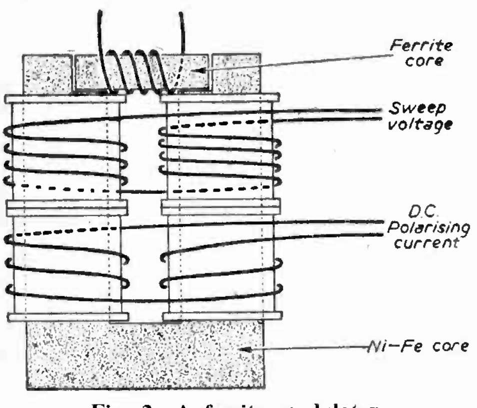


Fig. 3—A ferrite modulator.

There must first of all be some means of determining the position on the display which corresponds to zero output from the I.F. amplifier. It will not always be possible to view the frequencies at which the I.F. amplifier response has fallen to zero, so this cannot be relied upon to provide us with a datum line. The usual practice is to pulse-modulate the oscillator in such a way that it is switched off on alternative scans of the oscilloscope. In this way the oscilloscope will show the I.F. amplifier response on one scan, but on the next scan the oscillator will be switched off, and the

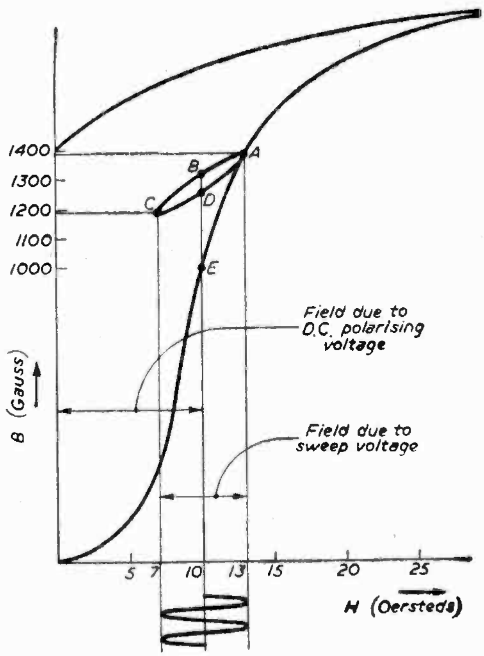


Fig. 4—Hysteresis loop of ferrite core with sweep voltage and polarising fields.

oscillator will show a straight line—a straight line which corresponds to zero output from the I.F. amplifier. A rough estimate of the relatives amplitudes of the various points on the response curve can now be made from this display.

The graticule of the oscilloscope can, however, be calibrated much more accurately if the wobbulator is fitted with an attenuator, or, if an external attenuator is fitted between the wobbulator and the amplifier. This can be carried out in the following way. A line is first drawn on the graticule through the points corresponding to maximum output from the I.F. amplifier. Then the attenuator is used to reduce the wobbulator output by 1dB. A line is then drawn through the new position of the top of the displayed response curve. The output from the wobbulator is reduced in further steps of 1dB, and a line is drawn at each step. The wobbulator output is then restored to its maximum value, and the relative amplitudes of the various points on the display can be measured using the series of 1dB lines that have been drawn.

(To be continued)

Grid Dip Aerial Testing

USING A G.D.O. FOR CHECKING RESONANCE

By F. G. Rayer

WHEN making up aerials, it is not always easy to be sure that the elements are of such a length that they are correct for the channel required. With a standard type of aerial, erected in free space, it is possible to follow specifications giving element length, etc, but when experimenting with indoor aerials, circular loops, picture-frame aerials, and similar pick-up devices, no exact information may be available. In such cases, a grid dip meter will provide a convenient means of checking frequency, and showing whether the aerial resonates above or below the required frequency. Such a meter also shows if a tuned circuit is adjusted to a frequency higher or lower than that required, and is thus very useful when winding or adjusting tuning coils.

A suitable grid dip meter circuit is shown in Fig. 1. The actual form of construction is of little importance, provided all wiring to coil, valve, tuning condenser and bypass condensers is as short as possible. A valve such as the 955 acorn will be most suitable, though other valves can be used if operation on frequencies above 70Mc/s is not required. The 955 has a 6·3V, 0·15A heater, with a maximum anode rating of 180V at 7mA. Current can thus be obtained from a small convertor type transformer and metal rectifier. The exact value of components in the power-supply part of the circuit is unimportant.

Grid Dip Operation

The meter should have a full scale reading of 1mA or 0·5mA, and the potentiometer controlling the anode current is adjusted so that a convenient meter reading is obtained. This reading will not remain constant through the whole tuning range, but this is of no importance, and if the pointer tends to go off the scale, the 100k potentiometer can be adjusted.

The aerial to be checked is coupled to the meter coil by means of a 1 or 2-turn loop, as shown in Fig. 2. As the meter is tuned to resonance with the aerial, power is drawn by the latter, and the grid current falls. Correct tuning is thus the lowest reading, or maximum grid current dip, on the meter.

Initially, coupling can be fairly tight, so that an indication is easily obtained. Coupling should then be reduced, by moving the loop away, until tuning is more critical, and a dip found only exactly on resonance.

For tuning coil adjustment, the meter coil is positioned near the tuning coil, and the dip in grid current then indicates resonance with the coil. If the coil cannot be reached, a feeder with 1 or 2-turn loop each end can be coupled to the meter coil and receiver coil. The receiver should not be switched on.

When the meter is calibrated, it will show if the circuit to which it is coupled is resonant at a frequency higher or lower than that required. It is thus easy to cut down aerial elements, or lengthen them, and adjust or modify coils, until the meter shows resonance on the desired frequency.

Calibration

The meter tuning can be calibrated by coupling the coil to resonant circuits of known wavelength. A standard aerial will serve as a means of calibration, so that loop, picture-frame, or other aerials can be made to the same frequency.

Coupling the meter coil to tuned circuits in a receiver, which are already tuned to known frequencies, will give more calibration points. The meter can also be calibrated from an absorption wavemeter, if this is available. The absorption wavemeter is set to various frequencies, the grid dip meter tuned as described, and the scale marked.

If no such means at all are available, the meter can be calibrated from Lecher wires. This is relatively simple for the very high frequency bands, but becomes awkward for lower frequencies, due to the length of the Lecher wires.

To make a Lecher wire line, two stout wires (say 14swg) are strained between supports so that they are parallel and about 1in. apart. The frequencies to be covered should be transposed into wavelengths, and the line should be a little over one wavelength long, for the lowest frequency required. It is simplest to make measurements directly in centimetres, decimetres and metres, to avoid conversion from inches. One end of the Lecher line is provided with a hairpin or 1-turn loop, and the grid dip meter is coupled to this as explained. The Lecher line is then shorted by a metal straight-edge held at right angles to the wires, and bearing on both. This shorting bar is moved along until a dip is found in the grid dip

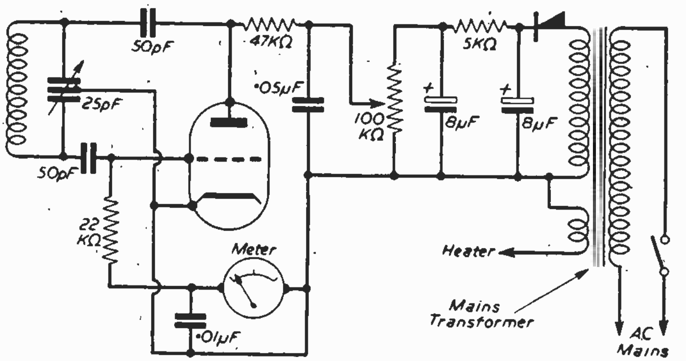


Fig. 1.—The circuit diagram of the grid dip meter.

meter tuning. The shorting bar position should be accurately marked with a slip of tape or similar means. The bar is then moved on along the line until a second dip is encountered. This distance between the bar and original marked position is then one-half wavelength. A number of points are calibrated in this way, and marked on the meter tuning scale, as they are found.

Megacycles (Mc/s) may be converted to metres by dividing into 300. For example, Band III (174-216Mc/s) is approximately 1·8 to 1·4M. Calculations for required markings should be to at least 3 decimal places, though less accuracy would still be useful.

Coils

The tuning condenser should be a low-loss butterfly VHF type, but the actual capacity is not very critical, and 15pF will easily suffice for the VHF bands. The coils are best made from stout wire, self-supporting. Layout and stray capacity will influence the coverage, but a 7-turn coil ½in. in diameter should usually serve for about 45 to 90Mc/s, with a 2½-turn coil for 70 to 150Mc/s, and a 1-turn coil for up to about 250Mc/s. With the very small coils, extremely short wiring is essential, as mentioned, or the valve will cease to oscillate.

It is recommended that aerial tests should be made outside transmission hours, because the meter can cause interference to an adjacent receiver.

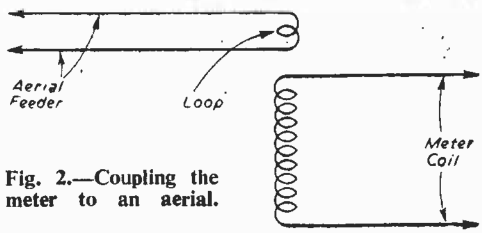


Fig. 2.—Coupling the meter to an aerial.

ADDING VISION AGC

(*Continued from page 607*)

A potential divider between H.T. positive and chassis is formed by R3M and R4M in series, and since R3M is the contrast control and R2M is returned to its slider, the control bias can be adjusted from a maximum as determined by the ratio R1M and R2M (with the slider at the chassis side of the control), to a minimum (with the slider at the H.T. side of the control). It will be appreciated, of course, that as the contrast control's slider approaches the H.T. side of the control, the control bias decreases owing to the positive potential partly cancelling the negative potential.

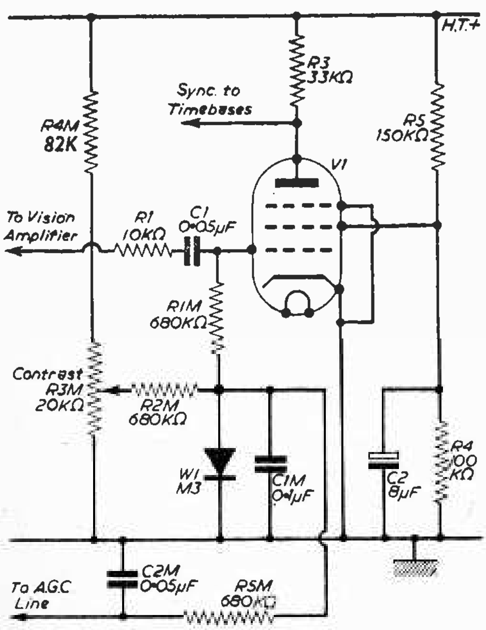


Fig. 4—Obtaining an AGC bias from the sync separator stage and including a manual contrast control.

A means is now available of varying the gain of the two controlled stages manually and, irrespective of the gain setting, the gain is also controlled automatically in the event of signal fades.

Components C1M, C2M and R5M serve to decouple the AGC line and rid the line of picture and sync pulses which are definitely not required in this section of the circuit. Rectifier W1 (type M3) prevents the AGC line from ever going positive, which could otherwise happen in the event of failure in transmission of the vision signal. A positive AGC line would tend to counteract the standing bias on the controlled valves and quickly render the valves useless.

If the original R.F. valve in the receiver is made redundant by the installation of a multi-channel tuner, that section of the AGC line connected from R1M to the junction of C1M and L1 (Fig. 2) should be connected to the AGC wire or tag on the tuner—which is usually the green wire in the case of Cyldon turret tuners.

BOOKS RECEIVED

"Basic Electricity" (five volumes: 12/6 nett per volume or 55/- nett per complete set of five volumes).
"Basic Electronics" (six volumes: 12/6 nett per volume or 66/- nett per complete set of six parts). Published by the Technical Press Ltd., 7 Justice Walk, Lawrence Street London, S.W.3.

These eleven volumes form a complete course in electricity and electronics. "Basic Electricity" was published in January 1959 and is an adaptation to British usage at R.E.M.E. Training H.Q., Aborfield, from a course originally devised for training technicians in the United States Navy. "Basic Electronics" was published in December 1959 and like "Basic Electricity" is a British adaptation of an American course.

The chief features of these volumes are a basic approach from first principles, clear language and expression and a large number of illustrations. Style does not follow the usual form to be found in conventional textbooks, rather does it savour of the American method of "learning through pictures and personality." In the first part electrons are pictured with smiles on their faces and similar personification is adopted throughout the book. To many British readers this method of presentation will be a source of prejudice against this course, as readers may feel that the authors are "talking down" to them.

On the whole, it is difficult for technical readers to judge the quality of the books, and it should be pointed out that non-technical members of our staff have derived some elementary knowledge of the subjects covered merely by reading through the first two or three chapters.

Feeder Cables

TRANSMISSION LINE THEORY AS IT AFFECTS THE CONSTRUCTOR

By F. A. Palmer

(Continued from page 528 of the July issue)

BOTH in television transmission and reception it is necessary to make use of matched transmission lines for optimum transfer of signal. A receiving aerial can be thought of as a generator—it has a current induced in it by the incoming signal. It has its own impedance (about 72Ω at the centre of a normal dipole). Therefore, a cable having this value as its characteristic impedance is used to obtain the maximum transfer of power from dipole to the cable. Fig. 9 shows the scheme.

At the receiver end we must terminate the line with its characteristic impedance and here is a snag. The input impedance of the first stage is somewhat larger than the impedance of the line. How then can we effect a match?

The answer lies in the transformer. It is well known that a transformer will convert low voltages into higher voltages. This is accomplished by making the secondary winding have more turns than the primary winding. If the ratio of primary to secondary turns is 1:2, then double the voltage

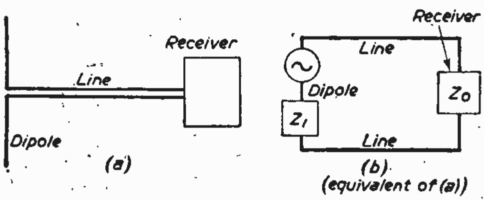


Fig. 9.—Normal television aerial feed and its equivalent circuit.

that is put into the primary will be obtained from the secondary. If 100V is applied to the primary then 200V will appear at the secondary.

Not only does the transformer transform voltage, but it will also transform impedance. The voltage ratio of a transformer is equal to the turns ratio.

The *impedance ratio* of a transformer is equal to the *square of the turns ratio.*

A transformer which has a turns ratio of 1:2 will, therefore, have an impedance ratio of $1:2^2=1:4$.

The condition is shown in Fig. 10. Zb is an impedance of 400Ω; Za is an impedance of 100Ω. Now, if we look into the input circuit of Zb (i.e. towards CD) we shall see an impedance of 100Ω stepped up four times, i.e., 400Ω.

If we look into the circuit from Za (via AB) we see an impedance of 400Ω stepped down four times, i.e., 100. Za is therefore exactly matched to Zb and vice-versa.

In practice we use a simple transformer in the input circuit of the receiver, either by tapping the tuning coil or by using a separate winding.

We have now a matched dipole to line, and line to load, and maximum transference of power will take place from the aerial to the televisor.

Standing Waves

Having dealt with the maximum transference of power, there is another very important reason for correctly matching the aerial, line and receiver input. It is that if a line is not terminated with its characteristic impedance, reflections will occur and *standing waves* will exist along the length of the line.

The net result is the appearance of "ghost" pictures.

There are three cases to consider: (a) a line which is open-circuited at its distant end; (b) a line which is short-circuited at its distant end; (c) a line which is terminated with an impedance other than its characteristic impedance.

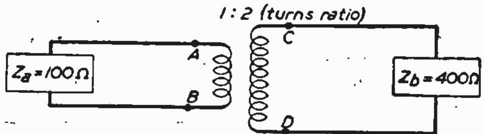


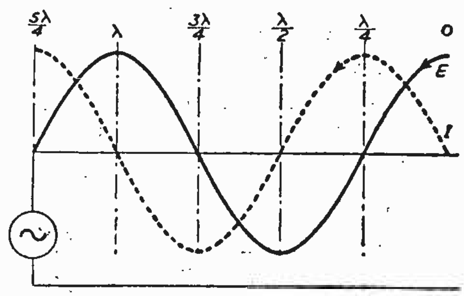
Fig. 10.—Effect of a transformer on the total impedance of a circuit.

Case (a)

Imagine energy applied at the generator end of a line which is open-circuited at the far end. A certain amount of time will elapse before the energy applied at one end appears at the other. The voltage and current travel down the line together, but when they come to the open circuit the current will collapse to zero, as there is no path for it.

Now energy cannot just disappear; the collapsing current and consequent collapsing field generates fresh currents and voltages which immediately begin to travel back to the beginning of the line. In other words, the current and voltage are reflected back to their source, and return like an echo. The current at the distant end, which is open circuited, is zero; the voltage however is maximum and the reflected voltages and currents will therefore be 90 deg out of phase with each other (90 deg means one-quarter of a wavelength). Fig. 11 shows the conditions.

When current and voltage are reflected back to the load the result is the appearance of standing waves of current and voltage displaced from each other by λ/4 along the whole length of the line. At points where the standing voltage wave is at



Reflected voltage and current from open circuited line
Note: Current and voltage waves shown in one line only for clarity

Fig. 11.—Voltage and current distribution on a line.

zero it is termed a voltage *node*, and where it is at maximum it is termed a voltage *antinode*.

The same terminology is applied to standing waves of current, though in this case the points are termed current nodes and antinodes (Fig. 12).

Case (b)

When the line at the distant end is short-circuited, then when the voltage and current wave, travelling from the generator, meet the short-circuit the voltage will collapse to zero and the current will be at a maximum. The result is similar to that in case (a), i.e. current and voltage waves are reflected back to the source, and standing waves will exist along the line.

There is, however, an important difference: the phase relationship between voltage and current will be reversed. This time the voltage starts the return journey at zero and the current at maximum. This condition is shown in Fig. 13.

It should be noted that at the generator end the phase relationship between reflected voltage and

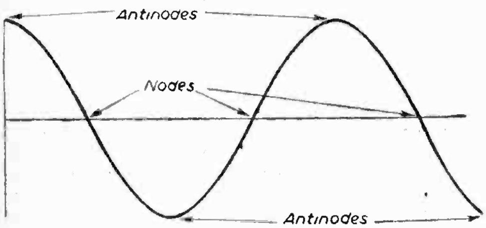


Fig. 12.—Nodes and antinodes in a standing wave.

current for open-circuited lines is opposite to that for short-circuited lines.

Case (c)

Where the line is neither open-circuited nor short-circuited and yet is not terminated with its characteristic impedance, a certain amount of current and voltage will be reflected according to the value of the terminating impedance, and the phase relationship between the two will also be determined by this value. The reflected currents and voltages arriving back at the generator can be reflected once again and travel back to the load. If both generator and load are badly matched to line (such as can be caused by a high-resistance joint at some critical point), then a series of reflections will take place, each reflection being attenuated to some degree on each journey.

The practical result of these reflections is the appearance of " ghost " images on the picture tube. A " ghost " image is a second picture on the tube slightly displaced to the right of the main picture.

It is important not to confuse ghost images caused by aerial reflection with those due to mismatched transmission line. Aerial reflections can occur when the signal is " bounced " back on to the aerial by some nearby object such as a hill or large metal surface such as a gasometer. The cure for this trouble is to reorientate the aerial.

The importance of the production of ghost images cannot be over-emphasised where first-quality pictures is the aim. It is quite easy to have slight reflection where the reflected image comes almost on top of the existing image. The result is an out-of-focus effect which cannot be overcome by adjustment of the focus control.

Standing Wave Ratio (SWR)

The " goodness " of a line can be measured by taking the ratio of maximum, to minimum current at both ends of the line. This is called the *standing wave ratio* (SWR).

If the line is perfectly matched, then the current absorbed by the load (the receiver) will be equal to the current transmitted by the generator (the aerial), and the ratio will therefore be unity.

As the current ratio is determined by the impedance ratio we can calculate the SWR on this basis:

$$\text{SWR} = \frac{Zr}{Zo} \text{ or } \frac{Zo}{Zr}$$

where SWR = Standing Wave Ratio.
Zo = Characteristic impedance of the line.
Zr = Terminating Impedance.

The usual practice is to put the larger figure (either Zo or Zr) on top so that the result is always greater than 1.

Table I given below shows the dB losses to be expected for various SWRs using ¼in. overall diameter coaxial cables. The figures are approximate and will, therefore, vary slightly with the manufacture of the cable.

TABLE I

SWR	dB loss
2	0·35
3	0·9
4	1·5
5	2·0
6	2·4
7	2·75
8	2·95
9	3·2
10	3·5
15	5·0
20	6·0

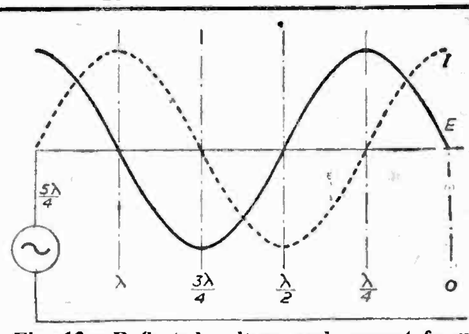


Fig. 13.—Reflected voltage and current from short-circuited line.

As an example, supposing that the centre impedance of a dipole due to length and position of reflector and director is 40Ω, and that 80Ω coaxial cable is used to connect it to the receiver, then

$$\text{SWR} = \frac{Zo}{Zr} = \frac{80}{40} = 2$$

From table I the dB loss for an SWR of 2 is 0·35dB—an amount which would be unnoticeable in the picture.

Now, supposing the centre impedance were 10Ω, then the SWR would be $\frac{80}{10} = 8$ and from Table I we see that this represents a loss of 3dB—a considerable loss for the fringe area viewer and offsetting to a marked degree the gain obtained by the additional reflector and directors.

Matching Stubs

There is another peculiarity of transmission lines which is of practical importance. Let us take the case of an open-ended line first.

At the end of the line (Fig. 14) we have zero current and maximum voltage. This end can therefore be represented as a very high impedance.

(a) At $\frac{1}{8}$ wavelength the reflected waves show a rising voltage and falling current (looking at it from the generator's point of view). This is the condition in a charging capacitor. If the line were therefore cut at this point it would exhibit *capacitative reactance* of which the reactance is $X_C = Z_O$.

In other words a transmission line which is $\lambda/8$ long could be used in place of a capacitative reactance.

(b) At $\lambda/4$ we have exactly the reverse conditions to that at the end of the line. Here the current is at maximum and the voltage at minimum. The line at this point, therefore, exhibits a very low impedance.

(c) At $3\lambda/8$ we have a rising current and a falling voltage, which is a condition similar to that in an inductance. The line at this point would therefore exhibit inductive reactance whose value $X_L = Z_O$.

(d) At $\lambda/2$ we have the same conditions as at the end of the line; the current is zero and the voltage at maximum. The impedance is therefore high and can be represented as a series resonance.

The various conditions are shown in Fig. 15.

Short-circuited Line

A short-circuited line behaves in a similar manner, though the conditions are reversed, as at the short-circuit the current is maximum and the voltage zero. Fig. 16 shows the conditions.

All the conditions enumerated above are repeated from $\lambda/2$ to λ. It will be seen that an open-circuited or short-circuited line up to $\lambda/4$ long can be made to simulate any kind of reactance required.

This useful feature can be employed to "tune out" inaccuracies in matching. A simple practical method is to attach a length of coaxial cable, about 6ft long, in parallel with the existing aerial socket on the televisor. The receiver should be previously adjusted for best results; at first the picture contrast will deteriorate. Now, cut off an inch at a time

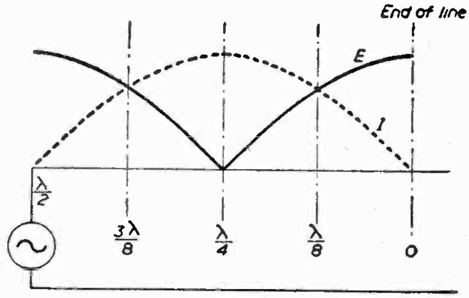


Fig. 14.—Voltage and current distribution at the end of an open-ended line.

from the end of the 6ft length of cable without leaving the ends short-circuited; cutting is finished as soon as the best picture is obtained. Employment of this method will enable the fringe viewer to obtain the best possible performance from his installation.

Matching Transformers

When reflectors and directors are added to a dipole the centre impedance of the dipole falls from its normal 72Ω to a figure dependent upon the number and spacing of the parasitic elements. It can fall as low as 3Ω in certain cases.

Such an aerial can be matched to an 80Ω line at the aerial by employing a "T" match, or double and triple folded dipoles, or some other method. A $\lambda/4$ length of transmission line can, however, be employed as a matching or impedance transformer. If a $\lambda/4$ length of line is terminated at the far end by an impedance Za, then the input Zb impedance to the line will be

$$Zb = \frac{(Zo)^2}{Za}.$$

therefore $Zo = \sqrt{Za \times Zb}$

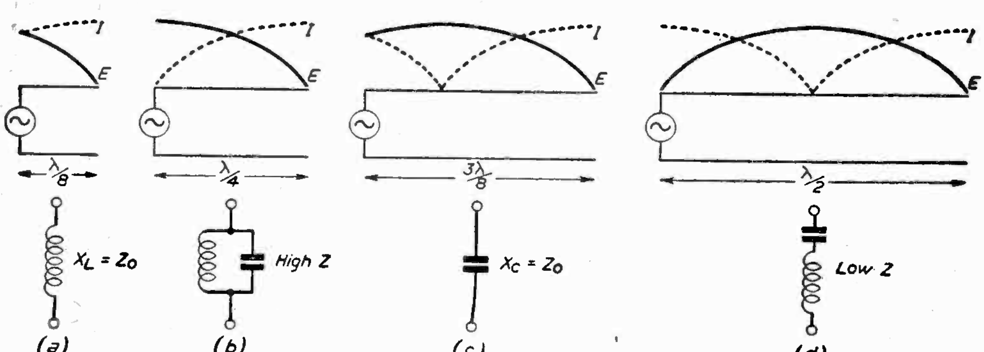
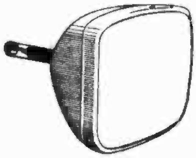


Fig. 15.—Voltage and current distribution at the end of lines of various lengths.

ANOTHER BARGAIN FROM DUKE & CO. JUST LOOK AT THIS!

17" TV's COMPLETE 19 Gns.

Cash or Terms over 20 weeks (NO interest charged). Initial payment £1.0.7 and 19 weekly payments of 19/11. Carr. and Ins. 30/-. ITV/BBC. Beautifully styled polished cabinets. These are table models with the option of contemporary legs fitted (2 gns. extra). 17in. rectangular tube guaranteed for 12 months. Valves and chassis guaranteed for 3 months. (Chassis salvaged but reconditioned.) Where possible personal collection is preferable.



REPLACEMENT, REBUILT

TV Tubes

12 Months Guarantee

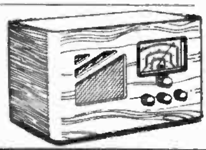
TERMS AVAILABLE OVER 20 WEEKS
Carr. and Ins. 15/6.

21in. TUBE . . £8.10.0
17in. TUBE . . £7.10.0
£2 allowed on old tube

12, 14, 15in. TUBES £5.10.0
£1 allowed on old tube

HOME RADIO 79/6
A.C. MAINS

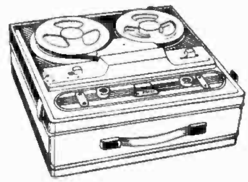
5 valve octal superhet. 3 w/band receiver. In attractive polished cabinet. Dimensions 9¾ × 18½ × 11¾in. Carr. and Ins. 4/6. Terms available.



29 Gns. NOW ONLY 18 Gns.

COMPLETE TAPE RECORDER

UNREPEATABLE VALUE!



Famous Manufacturer. Huge purchase allows us to offer at this amazing price. Beautifully styled, rexine covered cabinets, colours—RED, GREY, BLACK. Storage space for 4 tapes, Mike and Lead. Incorporating the new B.S.R. Tape Deck.

LOOK AT THESE EXPENSIVE FEATURES. Controls. Record/Playback switch and re-wind with interlocking device to prevent accidental erasure. Tone and volume controls. Super impose and electronic eye. Ample power output 3.5 watts. Small overall size—14¼ × 14¼ × 7½in. Lightweight, only 21 lb. Playing time 1½ hours. 5¾in. standard tape. Microphone 27/6 extra. Tapes 19/9. Terms available. Carr. & Ins. 12/6.

SEND FOR FREE CATALOGUE

DUKE & CO. (London) LTD. Dept. E.9, 621/3 Romford Road, Manor Park, E.12. ILF 6001/3

REGUNNED TV TUBES

Supplied from stock and despatched by British Railways, same day. COMPLETE NEW MULLARD or SUPERIOR ELECTRON GUNS fitted in every tube, and fully guaranteed for 12 MONTHS FROM DATE OF INSTALLATION.

Mullard AW AND MW types available.

	Mullard	Mazda
12 in. -	£5.0.0	£5.0.0
14 in. -	£5.0.0	£5.0.0
15 in. -	—	£6.0.0
17 in. -	£6.0.0	£6.0.0
21 in. -	£8.0.0	£8.0.0

Carriage & Insurance 10/- extra.

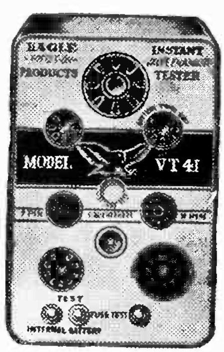
Other types available; Brimar, E.E., G.E.C. etc. C.W.O. to:—

CLARKSONS (Tube Distributors)
120 Commercial Road, LEEDS 5

Multi-Purpose

VALVE FILAMENT TESTER

Model VT41



- Pocket size
- Battery operated

GIVES INSTANT CHECK OF:

★ All TV and Radio Valves and Fuses
★ All pilot lamps.
★ Circuit Continuity.
★ Built-in 7 and 9 pin valve straighteners.
★ Built-in Battery Test.

With this revolutionary instrument you can test all current Valves, Fuses, Continuity and other radio parts. All components tested are shown "good" or "faulty" on panel indicator.

Finished in black hammer case with gold front panel. **30/-** Complete with internal batteries full instructions, and ready for use.

From your local dealer or if in difficulty order direct:

EAGLE PRODUCTS (Dept. P.T.6.)
EAGLE WORKS, COPTIC ST., LONDON, W.C.1.

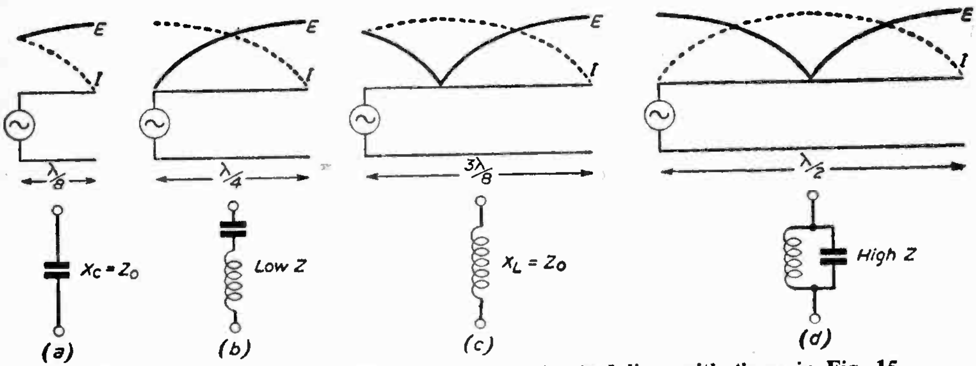


Fig. 16.—Compare these curves, of a short-circuited line, with those in Fig. 15.

In other words a $\lambda/4$ length of line will couple two impedances together (Za and Zb) so that the two will match, the $\lambda/4$ section acting as an impedance transformer.

Example

Suppose we wish to match a 70Ω cable to a 40Ω dipole, then

$$Zo = \sqrt{Za \times Zb} = \sqrt{70 \times 40} = \sqrt{2800} = 50\Omega \text{ (approx.)}$$

therefore a $\lambda/4$ section of 50Ω cable will effect a practically perfect match.

TABLE II

Type of Transmission Line	V Factor
Open wire lines 400-600Ω	0·975
Coaxial cable air insulated	0·95
Coaxial cable 50Ω	0·66
Coaxial cable 75Ω	0·66
Twin lead 300Ω (balanced)	0·82
Twin lead 150Ω (balanced)	0·77
Twin lead 75Ω	0·68
Rubber insulated	0·56
Twisted pair (lamp flex)	0·65

In all the foregoing it should be remembered that throughout we have been dealing with *electrical wavelengths* and not the physical wavelength. To find the electrical wavelength of a cable its physical wavelength should be multiplied by the velocity factor "V" of the cable.

For those who would like to experiment, the V factors of various types of transmission lines are given in Table II.

Choosing Transmission Cables

There are two types of transmission line in common use in television practice. They are balanced twin and coaxial cable. The actual type will be determined by the design of the input to the televisor. If the input is balanced then a balanced twin feeder will have to be used, and if the input is unbalanced coaxial cable must be used.

It is possible to feed either cable into either type of input by using a matching transformer.

Cables for television are supplied with various characteristic impedances and it is wise to choose one whose impedance matches the input impedance of the televisor. Any slight mismatch at the aerial end will have no noticeable effect; as we have seen in previous paragraphs, a mismatch giving an SWR of 2 will only cause a loss of 0·25dB.

Cables are also subdivided into two classes—local and fringe. Fringe cables have a much lower attenuation factor than local types, and are therefore more expensive. The principle used in the construction of low-loss cables is to make the dielectric between the conductors to consist mainly of air. As attenuation increases with increasing frequency, it is usual to give the dB loss at varying frequencies.

New Low-Power Station

THE BBC announces that the low-power television station at Sheffield now under construction will be ready for service in the autumn. It is intended to give improved reception in parts of Sheffield where reception of Holme Moss on Channel 2 is difficult on account of ghost images and interference.

The station is located at Tapton Hill, about two miles west of the City Centre, and will use Channel 1 with horizontal polarization. It will work unattended, and will relay the television signals from Holme Moss.

The station is already working on reduced power and it will continue to do so throughout the normal hours of transmission until it is ready for full-power service. Some viewers in Sheffield who have difficulty in receiving Holme Moss but are favourably placed to receive the new station may find it worth while to change their aerials now and tune to Channel 1. Local dealers will be able to advise them whether this is likely to result in an improvement; if there is any doubt, it would be better to wait until the Sheffield station is working on full power.

Replacing C.R. Tubes—II

SOBELL RECEIVERS

By H. Peters

(Continued from page 566 of the August issue)

THE previous article concluded with the general considerations involved in tube changing in models TPS180 (covering T278, T24, SC24, SC270).

Unboxing

Remove the card back and the moulded cover on the control and loudspeaker panel. This is held in place by two spring clips at the front and two turn-buckles at the back which can be swung forward by pressing a finger on them down the cabinet side. The panel will then hinge out forwards. Pull off the channel selector and fine tuner knobs.

Next remove the front screen, which is held by four screws around the edge. The top two of these are beneath the top escutcheon and may be reached by removing the two screws securing the handle and escutcheon.

Lay the set face down on a soft cloth, bearing in mind that the tube face will now take the whole weight of the set. Remove the four screws holding the chassis to the cabinet base and lift the cabinet off the chassis and CRT assembly.

Replacing CRT

Disengage the chassis from the CRT assembly. As mentioned above, this unclips at the top and slides out of two pegs at the bottom. The following leads will also need to be disconnected: CRT base, EHT lead, two scancoil leads. These unplug at the line and frame output transformers. The loudspeaker lead is fairly long and unless inconvenient may be left attached. "Older hands" will note with relief that there is no ion trap magnet on a 110deg tube.

Next remove the deflector coils, having noted which way is top, and note the position at which the tube is clamped by the metal strap. Unscrew the bolts holding the metal strap around the tube bowl and lift the tube cradle off the tube. Reassemble in reverse order.

Variations (T24)

To remove side panel first pull off channel selector and fine tuner and then unscrew the one screw retaining the channel indicator. When laying the set face down on a soft cloth, first provide beneath the cloth a large block or some books about an inch high which will fit inside the mask, and support the entire weight of the set on the tube face. Unless this is done the whole chassis will fall downwards on to the tube face upon release of the last chassis fixing bolt. In addition to the four bolts at the chassis bottom also release the two thumb nuts from the inside of the cabinet top and swivel the two strips to clear the bolts.

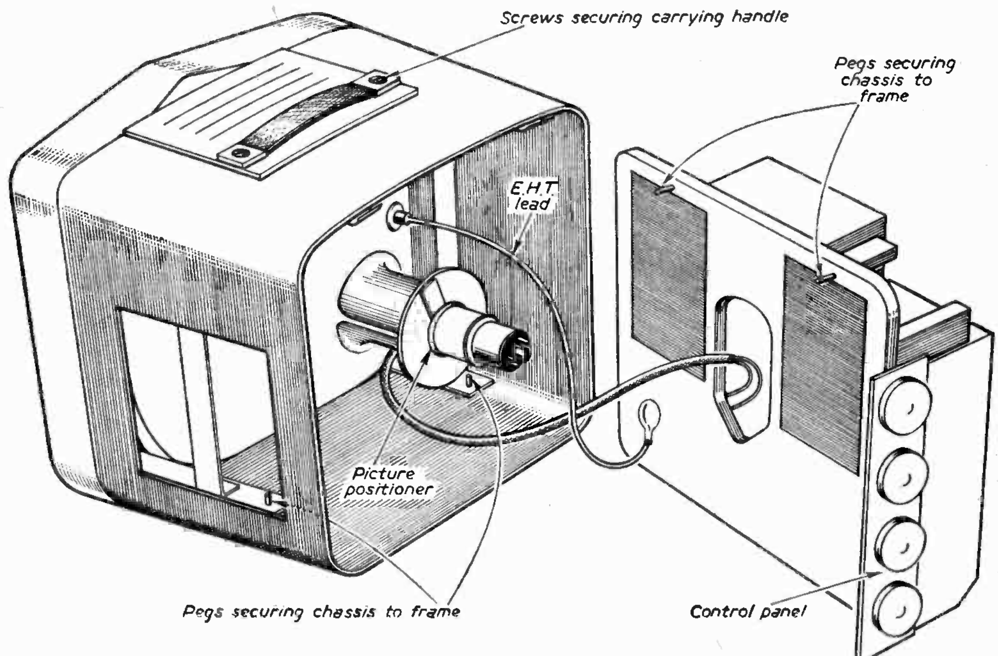


Fig. 3.—A view of model TPS180 showing how the chassis detaches from the main frame.

Having lifted the cabinet clear, disengage the chassis and remove the scancoils, stand the tube cradle back upright and remove the glass window by peeling back the mask (the warmer the better). Note the position of the tube in the mask, lay the unit face down again, slacken the two screws on the CRT clamp and lift off the cradle and mask.

Variations, SC270, SC24 Consoles

Close the doors at the beginning, remove fine tuner and channel selector knob and then the control panel which is held by four screws. Free the tuner unit and control panel by removing the four self-tapping screws and secure it to the main chassis by the parking clip and bracket provided. Remove the four bottom screws provided and unsolder the lead from the left-hand speaker. The chassis withdraws backwards from the cabinet and the tube change is then as for the relevant table model.

Setting Up

With automatic focus and no ion trap the setting up is simple. Press the scancoils well forward and clamp them tight when the picture has been levelled. Rotate the two picture shift magnets for a central picture.

Line Linearity

This adjustment is made by two shorted turns of foil in a paper ring under the scancoils. If the setting of this device has been disturbed it should be re-adjusted by the bakelite ring by sliding it in and out of the scancoils for optimum linearity with the index on the bakelite ring at "3 o'clock". If pressed too far in, width will also be reduced.

Earlier Models T121, T122, T143, T144, TS145, T224, T274, T277, T174, T174C, etc.

These are very similar in principle to the TS17 which can be regarded as a basic model. Unboxing follows the same lines, i.e. remove the back, control knobs, four base screws, and slide the chassis out.

To detach the tube, unplug the base connector and EHT cap, remove the ion trap, slacken off the clamping band and withdraw the tube forward. Some receivers are fitted with the multi-channel adaptor EX1 (external) or IN1 (internal) which plug into the sockets previously occupied by the RF and frequency changer valves of the single channel version. The tube change is made easier if these units are removed first.

Screen Cleaning, All Models

(Except the TS17, the TPS173 and 180, the T23 and T178.)

To clean the screen of all models it is necessary to unbox them. On the five receivers mentioned above the window detaches easily. The makers recommend the use of a silicone furniture cream when cleaning the screen and window.

McMICHAEL EQUIVALENTS

Apart from variations in cabinet design the foregoing notes may be used to assist the replacement of tubes in many McMichael sets, as set out in the following list.

McMichael Model	*Nearest Sobell equivalent*	*See Model*
MP18	TPS180	TPS180
M74T	T278	TPS180
M74HFC	SC270	TPS180
M274HFC	SC24	TPS180
MP17	TPS173	TPS173
M72T	T178	TPS173
M72HFC	T178	TPS173
MP14	TPS147	TPS147
MP14DL	TPS147DL	TPS147
M17T	T171	T171
M14T	T347	T171
M17TLC	T171C	T171

BANNER EQUIVALENTS

Some receivers have been issued under the Banner label and their approximate Sobell counterpart is as follows:

Banner	Sobell
B112	T225
B114	T145
B117	T175
B117C	T175C
B412, 414, 416, 436, 124	T143 series

ELECTRON MICROSCOPE AT THE NEW YORK FAIR

At the British Exhibition in New York A.E.I. demonstrated their electron microscope with image intensification, which enabled visitors to see on a television screen minute particles magnified more than a million times.

Television audiences in Great Britain had already seen on their screens the smallest of basic organisms magnified to this degree, but at the New York Fair it was possible to see actual experiments in progress.

Recording

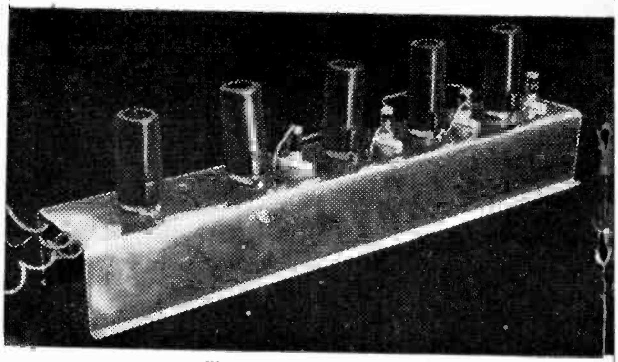
The conventional electron microscope provides a highly magnified image which is viewed by means of a fluorescent screen mounted within the vacuum system of the microscope. The method of recording is generally by means of photographic plates or films, which are also inserted into the vacuum and which register the electron beams which fall directly on them. Direct viewing is necessarily restricted to the few observers who can look through the window of the microscope.

The image has to be focused, and the field of view adjusted by direct viewing of the fluorescent screen and consequently the intensity of the electron beams must be sufficient to make the image easily visible. At the same time, in order to preserve specimens against radiation damage from the electron beam, a very low beam intensity is desirable. A compromise between these conflicting conditions is usually made by operating the microscope in the dark and the operator's eyes have to become dark-adapted. The new image intensifier method enables a TV camera to view the image and enables the audience to be large.

A DISTRIBUTED AMPLIFIER FOR FAST PULSES

A WIDE-BAND CIRCUIT WHICH PERMITS OBSERVATION OF SYNC PULSES

By D. R. Bowman



The completed amplifier.

DURING recent experiments in the development of an accurate timebase generator for television, the writer found he had need of an amplifier to enable a 2V synchronising pulse from the broadcast television waveform to be seen on an oscilloscope. The amplifier here described was devised and built, and proved useful enough to be worth passing on to experimenters as a possible addition to their equipment. A few calculation methods are given also, so that variations may be made if desired to suit particular requirements.

Lack of Distortion

It was especially important that the amplifier was able to show a relatively undistorted sync pulse. Because of this, the band of frequencies amplified had to be very large, and the amplification had to be effected with negligible phase distortion. The ordinary video amplifier, as used in a television receiver is not capable of this; its purpose is to amplify R.F. signals and sync signals within a bandwidth of 3Mc/s only, and this is ample for the British television transmissions. Moreover, a little overshoot or "ringing" when a sharp change from black to white (or vice versa) occurs may even be a slight advantage.

The rise time of the sync pulses is specified as being not greater than 0·25μs at its fastest (the beginning of the line-pulse). It can be materially faster—perhaps down to 0·2μs. Since bandwidth is inversely proportional to rise time, an amplifier to reproduce this pulse edge accurately has to have a bandwidth of at least 2·5Mc/s. In general it needs to be able to do much better than this, and it was considered necessary to design the amplifier to have a bandwidth of at least 15Mc/s, since it would be used for other purposes also.

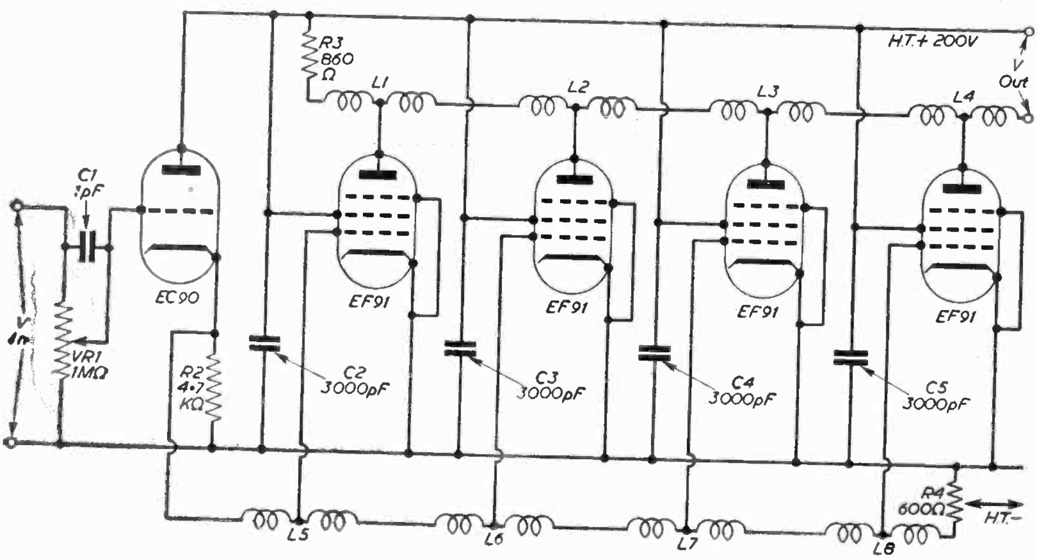


Fig. 1.—The circuit of the amplifier.

Calculations

Using television R.F. pentodes with low anode resistance is one way of attacking the problem. Remembering that, because of the likelihood of introducing phase distortion it is not desirable to use compensating inductances in the anode curcuit, an expression can be obtained for the load resistance as follows.

If the output capacitance is Cout, and the anode load resistance is R_L, the cut-off frequency (3dB down) is given when X_C, the reactance of Cout, is equal to R_L.

$$X_C = \frac{1}{2\pi fC} = R_L$$

If f=15Mc/s, and Cout is 15pF the value of R_L becomes 700Ω.

Using a valve of the type 6AM6 (EF91) this enables a stage gain of 5·2 to be achieved, as the mutual conductance (gm) is about 7·5mA/V. This amplification is hardly enough, and if, as is usual in an oscilloscope, direct coupling is employed from the anode of the video amplifier, the output capacitance might well be much greater than 15pF. With the more likely 40pF. hardly any gain from the stage could be expected as the load resistance would have to be reduced to about 200Ω.

An improvement can be obtained by using a cathode follower as a buffer stage but still no more gain than 5 or so can be expected.

Cascade

If two valves are used in cascade, the bandwidth is narrowed by the process, and each valve must have a bandwidth of $\sqrt{2}$ or 1·414 times the 15Mc/s aimed at, or 25Mc/s. The anode load resistance then has to be reduced still further. In addition, the input capacitance of the second valve adds to the output capacitance of the first, requiring a further lowering of the gain. A short calculation shows that making practical assumptions about circuit capacitances, the first valve can have only 560Ω in the anode circuit. This results in a gain of 4 only. If a cathode follower buffer stage is again used between the gain stages the situation is once more improved, and an overall amplification of 25 is obtained. Four valves are however required, because a cathode-follower output is essential. Moreover, the output voltage obtainable is only 11 for a very simple reason: the output valve has a load resistance of 700Ω. Assuming a 6AM6 can still operate linearly with a minimum anode current of 2mA, and a maximum current of 20mA this corresponds to a grid voltage variation of 2·4 which is reasonable about a working point of (—2)V. The grid voltage variation can be 4V peak to peak at least, but this results in the anode load resistance failing to supply the output voltage required. Since V=IR, R=700Ω and the change of anode current is 18mA the corresponding change of output voltage is only 12·6; this is the maximum it can deliver, whatever happens in the grid circuit. The amplification of a cathode follower is 0·9, so the output actually achieved is only 11V.

LIST OF COMPONENTS
VR1 1M—C1 1pF L1-8 see text.
R2 4·7k—C2 3000pF.
R3*860Ω—C3 3000pF.
R4*600Ω—C4 3000pF.
(590 + 10)—C5 3000pF.
* Values selected from the constructor's stock to be as near as possible to these.

This is hardly enough for an oscilloscope, if a reasonable deflection is to be obtained.

Power Valve

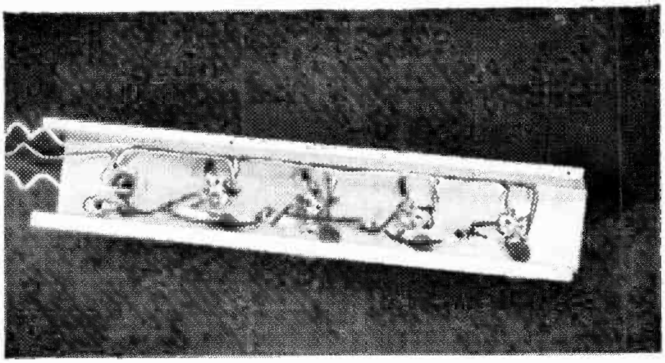
A larger output valve could be used, such as a 6CH6, but, in this case, the increased anode current is obtained at the expense of extra output capacitance, and the designer is, infuriatingly, in the position of having to reduce its anode load resistance still further, and with it the gain. The idea of using a large power valve to drive a small cathode follower is not very elegant, and in general the design is hardly practicable. The distributed amplifier provides a convenient solution to this *impasse*.

The theoretical diagram of the amplifier is given in Fig. 1. It will be seen that the circuit is very simple, and although a total of five valves is used, the unit can be made cheaply because the valves are obtainable easily at attractive prices from advertisers in this journal, and very few other parts are needed. The inductances represent an hour's work at most, and the whole construction can be carried out in an evening.

Operation

The method of operation is as follows; the first valve, EC90, is a cathode-follower input valve, used for reasons to be given later. It applies a signal to L5 at the correct impedance, and it may be assumed that this signal is in fact a rectangular wavefront.

This signal passes right along the inductances L5, L6, L7 and L8. It does not do this instantaneously however. Certain other components exist in invisible form in the diagram, namely the grid-cathode capacitance of the valves, and these together with the inductances, form a delay line. As the signal arrives at each grid in turn it



The underchassis wiring.

energises the valve, and a pulse of anode current appears. The grid signal finally arrives at R4, and if R4 has been properly calculated it matches the delay line exactly. The signal is then absorbed completely in R4. If R4 were omitted, the signal would be reflected at the open end of L8, would travel back along the line and cause further energising of the grids in reverse order, so interfering with the anode signal (which is next to be considered).

When the grid of the first gain stage receives the pulse, an anode pulse is generated. This divides, half going to the "right" and half to the "left" in the diagram. Similarly, when the grid of the second valve is pulsed, a further anode pulse divides into the anode circuits. If the anode inductances have been properly proportioned, having regard to the anode-earth capacitance of each valve, a delay line exists in the anode circuit. The pulse from V1, travelling to the "right", arrives at V2 at the precise moment when another pulse is being generated at V2, thus doubling the effect, and similarly for the remaining valves. The result is that an augmented pulse appears at the output terminals.

That part of each anode pulse which has travelled to the "left" is absorbed completely in the resistance R3, which matches the anode delay line, thus preventing any reflection which would upset matters.

The output terminals have to work into an impedance equal to R3, otherwise reflections occur which upset the proper functioning of the amplifier especially at the higher frequencies.

Termination

If the unit is to feed into a transmission line of characteristic impedance equal to R3 (860Ω) this line must be properly terminated to prevent reflections. If the amplifier is connected direct to a high impedance circuit, such as the input to a cathode follower or the Y plates of a cathode ray tube, an additional resistor of 860Ω must be connected across the output terminals.

Another way of looking at this amplifier is to consider that all the valves—the gain stages—are connected in parallel, thus quadrupling the mutual conductance. This does not give improved results normally, because if valves are connected in parallel the input and output capacitances are also paralleled. With the distributed amplifier, however, the inductances between the valves just tune out the capacitances which are inevitable and enable more gain to be achieved.

Chassis

The amplifier is constructed on a deep and narrow channel of aluminium, so that the minimum coupling takes place between output and input. The illustrations show the general layout, which is seen to be very simple and straightforward. Wires and components are well separated from each other and the chassis, and heater and H.T. leads taken well out of the way into a corner of the chassis. Decoupling of the heater leads has not been found necessary, but the screens of the pentodes have an R.F. by-pass condenser straight to chassis to ensure that no R.F. circulates in the H.T. leads. If desired, 220Ω decoupling resistors might be added, but these are not recommended because the L.F. decoupling depends on the H.T. smoothing condenser and resistances will "stand off" the screen from it at I.F. Small chokes would be much better, each consisting of 150 turns of wire, pile-wound on 0·27in. diameter Aladdin formers—but, again, they have not been found necessary.

Resistor R3 may have to carry a steady current of up to 40mA together with peak current from the valves of as much again. A 2W component at least is required: it may run a little hot, but a 5W type has rather a high capacitance to earth and is not really needed. R4 can be ¼W type, and again must be stood well away from the chassis. The performance of the amplifier depends largely on R3 and R4 being close to the specified values; a tolerance of 5 per cent is reasonable and anything much closer only gives marginal improvement..

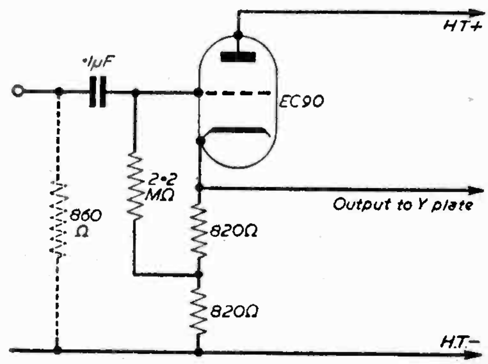


Fig 2.—Output circuit to oscilloscope.

Inductances

The inductances in the grid line are all the same, and are calculated on the assumption of valve and circuit capacitance of 15pF. Those in the anode delay line are again all the same, and have been calculated for anode and circuit capacitances of 10pF.

The grid inductances consist of 22 turns of 24s.w.g. enamelled wire, close-wound on Aladdin formers 0·27in. in diameter. They are centre-tapped. The anode inductances consist of 30 turns of the same wire on the same former, also centre-tapped. The wire is held in place by tape or cellulose cement. The grid coils are mounted in line on the underside of the chassis, and the anode line is mounted between the valves on the upper surface of the chassis. This prevents interaction between anode and grid circuits.

The first valve is an input cathode follower. This is necessary because signals are hardly ever generated at the input impedance of the amplifier —600Ω—but usually at something around 5k. The valve selected, EC90, together with the cathode resistor is working at such a point on its slope that the cathode impedance is about 600Ω, and thus it behaves as a matching device to couple the signal to the amplifier. If it is desired to use any other type of valve, the circuit will have to be redesigned. Not all valves can be used in this position and valves of high mutual conductance are especially unsuitable.

Output

The output should be applied direct to one of the Y deflector plates of the oscilloscope tube if the tube is of low capacitance. If it is not, and many in use (especially the older ones) have a capacitance of over 25pF, a cathode follower output valve will be necessary.

This may consist of almost any valve, with reasonably small input capacitance, triode-connected. Since the EC90 can be obtained very cheaply, this will serve well. The amplifier should be capacitance-coupled to it, using a condenser of about 0·1μF with a grid leak of 2·2M. The cathode resistor is divided into two parts. The resistance nearest the cathode should be 820Ω and the "earthy" end of the grid lead should be connected to the junction of this and a further 820Ω resistor which goes to chassis. The suggested circuit is shown in Fig. 2.

Bandwidth

The amplifier, built according to the foregoing specifications, has an effective bandwidth of 30Mc/s. It is not very suitable for use as a D.C. amplifier and if the cathode follower output is used not only is amplification zero at D.C. but also there is appreciable sag below 15c/s. The maximum voltage output for this bandwidth is 30 which provides a workable deflection on the usual kind of oscilloscope.

Apart from the simple construction involved, it is necessary to set up the amplifier by adjusting the inductances if best results are to be achieved. If the coils have been wound carefully it should be sufficient to insert a purple-coded dust core in each anode coil to its full depth. If a signal generator and some kind of low capacitance resonance indicator are available, the following method can be used.

Alignment

Couple the signal generator very loosely to each coil in turn, first unsoldering the end leads but retaining the centre-tap soldered to the grid or anode pin of its valve. Connect one 5 per cent tolerance capacitor of value 100pF to the two leads and attach the resonance indicator, which is, best of all, a valve voltmeter. Set the signal generator to 7·1Mc/s for the grid coils and 5·8Mc/s for the anode coils. Screw in the dust core until resonance is achieved. Re-connect the coils in circuit, and the amplifier is ready for use.

In Fig. 1 it will be noted that provision for grid bias is made by means of a tapping on R4: the portion between H.T. negative and chassis carries very nearly all the cathode current for all the valves, some 60-80mA, and the voltage dropped is applied to the valves via the grid line inductances. About 1V is required. Only a very small amount of degeneration takes place across this resistor. It can therefor be made up from 590Ω with a 10Ω ¼W resistor in series, H.T. negative being connected to the junction.

If it is inconvenient not to have the chassis earthed, bias provision can be omitted with little effect. The grid line is arranged to have a low impedance, and, because signal voltage is supplied at this low impedence, the grid being driven a little positive does not have very much effect on the performance of the amplifier.

Design Data

The following equations are given for those who wish to alter the bandwidth to suit their own purposes.

fc = Cut-off frequency for the amplifier.
fn = Bandwidth of amplifier and upper frequency at which phase distortion is negligible.
R_G = Characteristic impedance of grid circuit.
R_A = Characteristic impedance of anode circuit.
(R_G and R_A are also the values of the terminating resitors).
La = Value of inductance in Henries of each coil in the anode delay line.
Lg = Value of inductance in Henries of each coil in the grid delay line.
Ca = Output capacitance (Cak + strays) of each valve.
Cg = Input capacitance (Cgk + strays) of each valve.
A = Total gain of the whole amplifier.
gm = Mutual conductance of each valve.
N = Number of stages.

The following equations hold;

$$fc = \frac{4fn}{3} \qquad \ldots\ldots(1)$$

for grid line:—

$$fc = \frac{1}{\pi\sqrt{(Lg.\,Cg.)}} \text{ or } Lg = \frac{1}{\pi^2 fc^2 Cg} \qquad \ldots\ldots(2)$$

for anode line:—

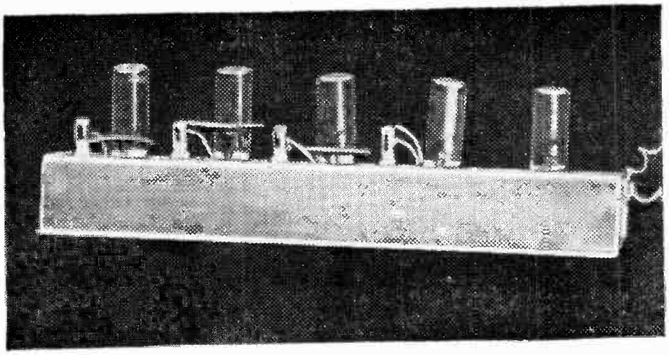
$$fc = \frac{1}{\pi\sqrt{(La.\,Ca)}} \text{ or } La = \frac{1}{\pi^2 fc^2 Ca} \qquad \ldots\ldots(3)$$

$$R_G = \sqrt{\left(\frac{Lg}{Cg}\right)} \qquad \ldots\ldots(4)$$

$$R_A = \sqrt{\left(\frac{La}{Ca}\right)} \qquad \ldots\ldots(5)$$

$$A = \frac{N.\,gm.\,R_A}{2} \qquad \ldots\ldots(6)^*$$

* Note that the factor (½) has to be applied to the usual gain formula, since half the anode current changes are wasted in the load resistance R_A.



Another view of the amplifier.

VALVE TESTING FOR BEGINNERS

FAULT FINDING TECHNIQUES

By H. Peters

FROM the advice given to readers in "Your Problems Solved" it is apparent that the majority of faults are caused by valves, and that in any case it is always advisable to check the valve of the stage concerned first of all.

Checking the valve is a simple matter in urban areas. It is removed from the set, taken along to the local dealer—usually to the one who caters for the home constructor—who tests it, and if faulty, replaces it. In country districts the cost of the journey to such a shop is usually greater than the replacement price of the valve.

Three simple tests can be applied to a valve at home. You can change it (known technically as substitution), look at it (visual inspection), or hit it (disturbance testing), and if you are fortunate enough to have a meter you can also measure the voltages and currents around the base.

Changing it

Substitution by a new valve known to be good is by far the most satisfactory way of checking a valve. Unfortunately it is more easily said than done, as it assumes the availability of a good stock of valves. Most radio dealers will confirm that one of each type is not enough to constitute a good stock especially of triode pentodes, as the fitting of a faulty new valve off the shelf can be very misleading, and wastes a lot of time if another new one is not available as a double check. At home, the television receiver itself is the best source of supply of spare valves, and a systematic interchange of suspected valves with those of the same type may provide enough information reliably to condemn a particular valve. Note the word "systematic". Always make a note of the valves you change and move only a pair at a time. What you are expecting to happen is that the fault will either (a) stay where it is (b) move to another part of the set—where it may take a different form (c) disappear. The interpretation of (a) is usually that you have changed the wrong pair, though it can sometimes mean that they are both as bad as each other (especially with triode pentodes). If the answer is (b) you have located your faulty valve. Condition (c) is a little perplexing at first, but happens when the faulty valve is moved into a less critical stage. An example of this is when the frame output valve, which was low in emission and producing foldover or cramping, is exchanged with the sound output valve. Unless the set is run at high volume levels, the shortcomings of the former frame valve are unlikely to be noticed.

Other examples of exchanges of this description are: video amplifier into sync separator; line oscillator into local oscillator; flywheel sync discriminator into noise limiter/AGC clamp. There is one well known instance of the reverse of this effect, and that is in certain 13-channel Ferguson receivers. Here the EF80 at the rear of the chassis near the mains plug, which is in the AGC circuit, is held non-conductive for the major part of its working life. It develops cathode poisoning but if it is changed over with one of the EF80's in the sound or vision strip, its emission is soon restored to normal. The symptoms—in case you think you have this trouble yourself—are that the contrast control has insufficient range.

Exchanges where a movement of the fault into another stage can be observed are as follows: sound I.F. amplifier with vision I.F. amplifier, frame oscillator with line oscillator, the exchange of double triodes and double diodes.

Looking at it

Visual inspection can tell you more than may be supposed. It falls into two groups (1) observation of the valve in operation, (2) close scrutiny of it when it is cold. In the first group a "soft" valve will show up by glowing bright purple as soon as H.T. is applied. This appearance should not be confused with the

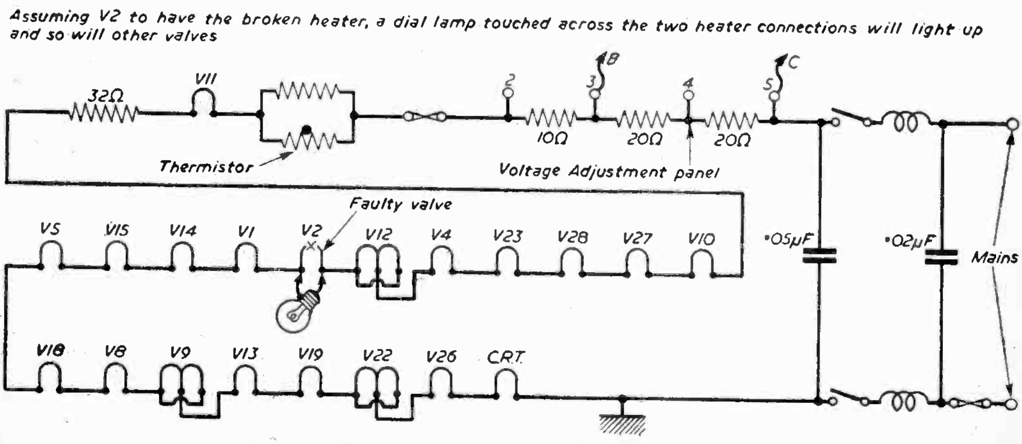


Fig. 1.—Typical example of a 0·3A heater chain (Pye V4).

small areas of a blue glow which are seen on output pentodes particularly around gaps in the anodes, or with the light blue haze which appears inside an EHT rectifier as it warms up. These, they tell me, are normal characteristics.

Valves which *do* glow purple should immediately be removed from the set, especially rectifiers which will surely ruin the rest of the power unit if left running for any length of time.

Red-hot Electrodes

Inter-electrode leakages sometimes cause small bright spots of light inside the valve, and a flaking cathode will produce spasmodic flashes, particularly inside rectifiers during the warming up period. A red hot anode denotes the passage of excessive current, and the grid coupling condenser (if any) from the previous stage should be suspected of leakage. Red hot anodes on efficiency diodes mean an H.T. short in the line output stage, or if the valve does not cool down when the top cap is lifted, heater-cathode breakdown of the valve itself.

Red hot grids can also be noticed. The grid which glows is usually the screen grid and the inference to be drawn from this symptom is that the anode voltage is either low or absent. The commonest grid to glow is the screen grid of the video amplifier and this is by way of being a "red herring", for the valve itself is generally not faulty but merely overloaded by the signal. This nearly always happens when a line timebase failure occurs on a set with gated AGC. Removing the aerial plug will return the valve to normal until the rest of the set is working again, but it is always advisable to check that the cathode bias resistor, grid stopper resistor and vision detector diode have not been damaged in the process.

Getter

A close examination of the valve when cold can be rewarding. Look to see if the "gettering" is intact. This is the metallic patch on the inside of the glass which is produced in manufacture when the getter is fired to burn up any gases left inside the sealed envelope of the valve.

If the gettering is transparent or milky white, the valve has lost its vacuum.

Examine the valve pins and scrape the scale off wire pins carefully using a pen knife or fine sandpaper. On older valves, such as the octal range, check that all the pins are soldered properly and check also that the top cap itself is not "dry joint". A bad connection here may cause intermittent gain or noisy operation.

Cathode flaking can be observed by laying the valve on its side and gently tapping it. Any emissive substance which has left the cathode will settle at the bottom of the envelope, looking like cigarette ash. This symptom, common in power valves and rectifiers, usually makes the valve candidate for replacement and may account for previous fuseblowing.

Hitting it

The quickest test for microphony, sagging grids, and other similar defects is a gentle tap on its side. Results may be observed on the screen, by the loudspeaker or inside the valve itself. A suitable tool is a plastic knitting needle pushed into a rubber stopper. In a number of cases faults can be cleared by this means, and inter-electrode shorts on cathode ray tubes may be located similarly.

Removing Old Valves

Removing old valves can sometimes result in their destruction if they are pulled out by the envelope. Top caps particularly can break off and it may be better to clip off the lead than try to remove the top cap. The spring clip around the shield of B8A holders should be lifted from its groove, and these valves and octals may be pressed out from underneath by a rod applied to the spigot. Octal base valves tend to part from their base and can be raised intact by pressing on the spigot with a pencil from below or levering between the valve and its holder whilst gently easing them out.

Heater Chain Faults

As the majority of modern receivers employ a series heater chain, failure of one heater will prevent any of them from lighting. Bitter experience has proved that the very last thing to do is to pull each valve out in turn and test it. Apart from wasting time (for the faulty valve is usually the last one to be tried) it is quite possible to insert a fault which would not otherwise have existed. The pins of valves which become very hot in use tend to become brittle and oxidised, and one or two will prefer to stay in the valveholder rather than be extracted with the valve.

Fortunately the modern receiver generally provides quick access to the underside of the chassis and this enables a very quick check to be made. All that is required is a 6·3V, 0·3A or 0·45A radio dial bulb. Any voltage will do but 6·3V is commonly used. Solder two thin flexible wires to it, or use an MES lampholder if you prefer. Bare the insulation off the flexibles to expose ¼in. of wire at the free ends and

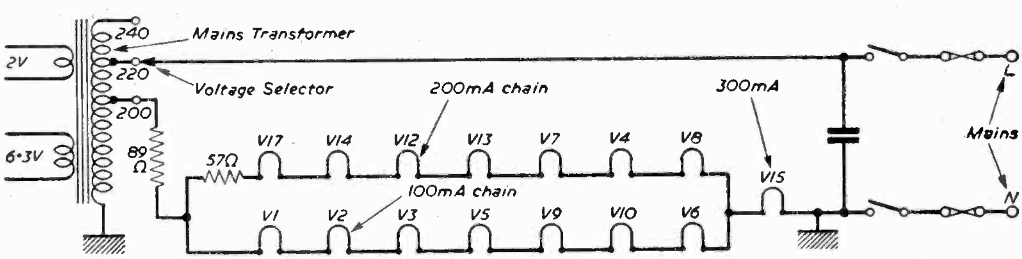


Fig. 2.—A conventional series/parallel arrangement with the small mains transformer which supplies the CRT heater voltage also used as a voltage selector ballast. "Cold" meter checks on one chain are easier if one valve from the opposite chain is removed (Ekco T161).

apply these two ends across each valve's heater pins in turn, with the set, naturally, switched on. When you come to the faulty valve the bulb will light and so will the other valves. If the bulb lights brilliantly and then blows you may conclude that either the faulty valve or the one next to it in the heater chain has a heater-cathode short, or that you have selected the wrong two pins.

Heater Pins

On B9A valves the heater pins are usually 4 and 5, with pin 9 as the centre tap on some double triodes. B7G valves except battery types have pins 3 and 4 as heaters, and B8A use pins 1 and 8 which are adjacent to the marker pip. International octal valves normally use pins 2 and 7, and Mazda octals 1 and 8. Do not forget to include the CRT (heater pins 1 and 12) in your checking and also any odd stages tucked well out of the way, such as the spot wobble unit or preamplifier. At the "top" of the heater chain, will be the ballast resistor and thermistor. The former is generally a cement coated tapped wirewound unit mounted at the back in a well ventilated position and associated with the voltage selector panel. The thermistor is usually between this resistor and the top valve in the heater chain, and should be replaced if the wire ends are at all loose. Thermistors become very hot when working and their leadout wires should be kept as long as possible when they are replaced. Faults on the ballast resistor and thermistor can be tackled with the dial bulb in the same way, as can faults on heater chains using 100mA and 200mA valves instead of the 300mA chains which are common nowadays.

Examples of these earlier types of heater chain are found in receivers using Mazda "10" and "20" series valves such as Murphy, Ekco and Ultra, and those which used the Mullard range "U" such as the early Philips. Here more than one heater chain will be found, sometimes in very complicated arrangements which look rather like an examination problem on Kirchoff's Laws. The symptoms are usually that some of the valves will light and others will not, and those which do light will be brighter than usual. The same technique of fault-finding may be employed, but the dial bulb should not be expected to light up quite as brightly.

Using a Meter

Readers who are fortunate enough to own a meter may use it on the 250V range in place of the dial bulb, but if they do they should expect to read the supply voltage across the pins of the faulty valve, and the remainder of the chain will not light up.

It is advisable to perform these checks as quickly as possible in order not to over-run the valves which are still lit, or alternatively to remove one of the lit valves as a safeguard. Even so, there is a risk of heater-cathode breakdown on the "upper" valves in the chain.

Do not confuse a break in a multiple heater chain such as those just mentioned with heater-cathode breakdown of a valve in a single (300mA) chain. The symptoms are the same, i.e. only some of the valves light and they are all too bright, but the fault in this case is a heater-cathode short in either the last lit valve or the first unlit valve reading from the ballast resistor end of the chain. Check the cathode bias resistor of the faulty valve when replacing failures of this kind.

EHT Rectifiers

The heaters of these valves are usually supplied from a special winding on the line output transformer, so if the EHT rectifier does not light up, it is just as likely to be due to a line output stage fault as to the valve itself. The heaters can be easily tested using a 2V battery for U25 and 26 and a 6V battery for EY51 and EY86. If such batteries are not handy use a single 1·5V torch cell (U2) for the U25 and 26, and a 4½V flat battery for the EY51 and EY86. If the valves are good they may even be run off these batteries for short periods and many readers use this method to check their line output stage, suspending the battery temporarily on an insulated thread, or in a polythene bag.

Checks for EHT may be made using the screwdriver method, and in case you have not attempted it before and are apprehensive, this is how it is done: place one hand in your pocket (or out of the way) and hold the *plastic handle* of a screwdriver in the other. Do not use one with a coil of fusewire or neon inside. Approach the tip of the screwdriver blade to the anode of the EHT rectifier (this is the single wire or top cap end). You should see a purple spark about ¼in. long jump across to your screwdriver. You should feel nothing.

Repeat the test at the heater end. You should not see any spark unless it is very dark, but you should hear ticking noises as the blade approaches the wires. You should feel nothing. These two tests denote that A.C. and D.C. EHT are present at their respective ends of the rectifier and those of you who desire more spectacular indications may attach a flexible lead from the chassis to the screwdriver blade.

IMPORTANT. None of the foregoing applies to sets with mains EHT. These are extremely dangerous to handle and should be treated with the greatest respect. Should you make a mistake you are seldom afforded the opportunity of trying again.

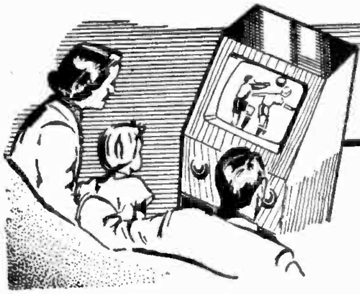
Valve Testers

The results of having a valve checked on a tester cannot always be relied upon, especially where timebases are concerned. Intermittent faults seldom show up except after a prolonged "soak", and very few testers have facilities for checking valves working horizontally, as they do in the modern upright chassis.

The majority of R.F. pentodes in the I.F. strips will read "low" if they are of any age, but need not be replaced unless the set is in the "fringe" area. A useful comparison of "goodness" can, however, be obtained by testing and this is particularly helpful when a critical stage is in need of a specially good valve (like a multivibrator timebase in need of a triode-pentode).

For the average handyman who is only interested in fifteen to twenty valves at the most (the ones inside his set) a valve tester is not a particularly good investment. Much more benefit can be derived from the purchase of a good high-resistance multimeter, and the service manual of the receiver in question.

(To be continued)



UNDERNEATH THE DIPOLE

TELEVISION PICK-UPS AND REFLECTIONS

By Iconos

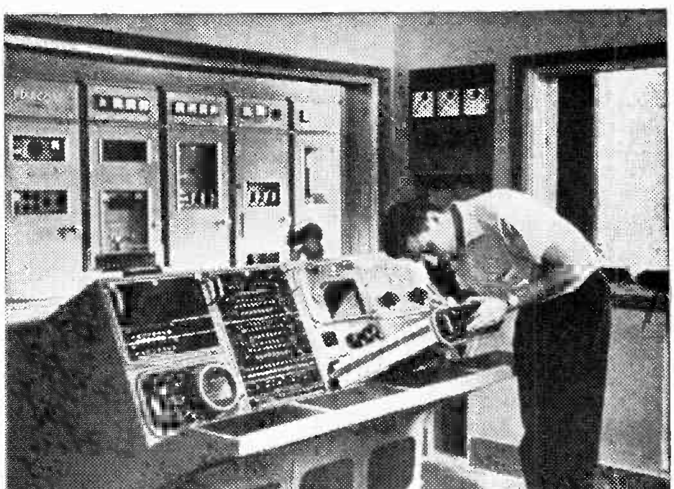
NEW year is the customary time for reviewing progress during the preceding twelve months in most arts and industries. However, so far as radio and television go, I have always felt that mid-summer—or just after—is a more appropriate time to survey the immediate past. Holidays are on, viewers are turning their attention to the landlady's television set, while the television industry is bracing itself for the annual ballyhoo of radio exhibitions, autumn programmes and advertising rate cards. What, in fact, has been achieved during the last twelve months? In my opinion, it has been the greatest year of progress yet—a period of tremendous achievement artistically and technically in the TV studios, of growth of studio stages in both size and numbers, of the associated technical facilities, including all types of equipment. Thanks to the healthy competition between the three main British manufacturers, British television cameras and much associated equipment are again the best in the world.

Confidence

A HUGE studio 5 at Wembley and the colossal BBC plant at Shepherd's Bush open up a new field of possibilities which, in the course of time, will make the ordinary local cinema look like an ancient monument. The facilities available at both of these centres are far in advance of present requirements, but are a valuable indication of things to come, paving the way for large scale TV spectaculars in colour—" live ", on film or on tape. However, I hate to think of the huge production costs that will inevitably arise from the use of such colossal stages. The fact that both the BBC and Associated Rediffusion boldly embarked upon their construction and staffing is the clearest possible indication of their confidence in the continued development of television in Britain.

O.B's

IMPROVED facilities, expanding staffs and consequent increased costs are not confined to the " home ground," the studio centres of the BBC and the Independent Television contractors. Quite large O.B. units now play "away"—sometimes many miles away—from their base. The BBC possess dozens of mobile control rooms, large and clumsy vehicles built in the days when relatively large amounts of equipment and power supplies were necessary. These vehicles seem to carry everything except the kitchen stove—though I have a shrewd suspicion that kettles can be boiled without much trouble, and they still perform yeoman service on the more ambitious and complicated outside broadcasts. The BBC have recently sent a complete fleet of huge O.B. vehicles to Belfast, including videotape equipment, microwave links and towers. It would appear that the local flavour that Ulster Television have so successfully added to the ITA programmes has spurred the BBC to show the flag in Northern Ireland. And they have done it literally in a big way, with a large mobile control room as the main vehicle. Like great battleships these M.C.R.'s can tackle immense royal and national events in their stride, sometimes supported by "cruisers" in the form of two or three-camera trucks or by "destroyers" in the shape of single-camera light trucks. But so far as O.B. trucks are concerned, lightness and speed of operation are a first



The complete studio and television equipment for a new Television Station at Recife in Brazil, has been supplied by Marconi's. Test transmissions are now in progress and live transmissions will commence shortly.

objective with A.R., who are undertaking experimental work on portable hand-held television camera equipment — complete with microwave transmitters for sending the picture back to the main O.B. truck or mobile control room. Most of the other programme contractors follow the same policy, calling their O.B. vehicles "scanners" for some unknown reason. The utilisation factor of these expensive outside broadcast units is low; two or three jobs a week being the maximum that their large, enthusiastic and expensive crews can accomplish. No wonder the newer and less opulent programme companies are thinking twice before indulging in such luxuries.

Armchair Theatre

THERE are times when an armchair seems an inappropriate piece of furniture from which to view ABC's "*Armchair Theatre.*" At any rate, many viewers must have sat on the very edge of their chairs when the gripping spy story "*Flight from Treason*" was on the home screen. This was the first television play script written by James Mitchell and adapted from his novel "Away Back"—which I have not yet read, but now intend to do so! The play revolved around an international adventurer who was blackmailed into taking part in the stealing of defence plans in a government factory. One of the gang is killed, turning the plot into a murder mystery. Special Branch of Scotland Yard are called in, and a smooth, sardonic detective, played by John Gregson, has a great deal of quiet fun in "sorting out" the local factory management, workers and police in his steady unravelling of the mystery. Stated so baldly, the story sounds routine, but as played on television it was anything but routine. Thanks to a taut script, fine direction by Dennis Vance, excellent settings, superb camera work and lighting by the ABC technicians at Teddington, and to perfect recording on videotape, this play was one of the best I have seen. "*Armchair Theatre*" has long been a "must". It would be unfair not to mention the superb contribution to their thriller made by John Gregson as the detective, Ian Hendry as the blackmailed crook, Robert Brown as a local police inspector and Avril Angers as his sister, whose love for the crook provided an unexpected twist to the story. But top credits really go to Dennis Vance, past master of television play technique, and his Teddington technicians.

The Theatre on TV

TV presentation of stage productions has become more or less outmoded, especially for dramatic subjects played on a real stage before a live audience. The larger the theatre, the louder the artistes seem to be shouting. However, all the disadvantages seemed to have been overcome when "*Flower Drum Song*" was put on by ATV as a Sunday night peak-time presentation. The delightful music, dancing and spectacular production scenes came over perfectly, in spite of the lack of colour, which adds so much to the public presentation at the Palace Theatre. There was a nobility in the camera work which was quite unusual for this type of production.

Spoof

THOSE viewers who complain that they are being cheated by the television producers of both programme and advertising items might like to ponder over further skullduggery in which they are being spoofed of the real thing. The authorities are inclined to be strict about fire scenes being enacted in studios. Besides, it would be rather inconvenient if a theatrical conflagration got out of hand and burned the studio down. Therefore, burning coals in fireplaces, more dramatic flames in houses on fire, smoke, explosions and bomb flashes all have to be simulated in various ways. Large and dramatic jets of flame can be produced with a special burner around which is a container of lycopodium dust. Air blown into this container (via a flexible hose) ejects some of this dust into the air, and it promptly catches alight. The air is usually provided by a property man blowing into a rubber tube. The moment he stops, the flame dies. Thus, really good photographic flames, having little heat value can be kept well under control. Nevertheless, it is advisable to have extinguishers and fire hoses nearby. Bomb flashes are made with photographic magnesium flash powder packed loosely around a fuse wire in a container rather like a sardine tin. Distant anti-aircraft flashes are produced by pushing fuse wire alone through holes in the backcloth. The operative circuit to blow the fuses in each case are connected to dry batteries with push-button controls. Smoke is provided by igniting chemical drain testers (not very controllable and most unpleasant when used inside the studio—but good on exterior OB's); also by spraying oil on to a hot-plate (specially scented oil is preferable) or by dripping hydrochloric acid on ammonia (acrid fumes, which can be softened by passing through perfumed water).

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.

TV Dx

SIR,—Your correspondent E. W. Ezzard (June issue), is incorrect in assuming that reception of French TV in this country is "freak." There are many areas in Eastern and Southern England where daily reception is possible, particularly coastal districts. When such reception occurs farthur inland it is due to fine, settled weather conditions.

In order to receive the French TV picture properly, an 819-line receiver is required. As British sets are designed to operate on the 405-line system, this would seem to explain the two side-by-side pictures received. In addition, a wider bandwith is needed to accommodate the higher quality French picture, so it follows that the sound channel must be several Mc/s lower in frequency than our own, hence the need to alter the channel selector switch to hear the sound. Incidentally, French TV sound is amplitude modulated like our own.

Two of several French TV stations receivable in this country are Mont Pinçon near Caen (the sound channel of which can interfere with BBC Crystal Palace) and Lille (Bouvigny).

According to Mr Ezzard's letter, however, it appears that he must have received one of the low power stations as neither Caen or Lille operate on the Channel 7 frequencies.

If Mr. Ezzard cares to write to me care of the Editor, I shall be pleased to forward details to help him to identify the station in question.—A. H. UDEN (Buckinghamshire).

SOUND QUALITY

SIR,—I read your editorial in the April issue of Practical Television concerning sound quality in domestic TV receivers with great interest. You may be interested to know, however, that at least one British manufacturer has used the techniques you advocate in their home market models for some time with great success. One receiver in particular, produced about two years ago, used two bass and mid-range speaker units mounted on either side of a table cabinet, with a small front-facing speaker designed to favour the middle and high frequencies. When placed across the corner of a room this model gave very good sound reproduction indeed.

The same technique is applied here in Bermuda, too, for quite a few of the higher-priced American TV receivers, sometimes coupled with a good quality push-pull audio amplifier system.

Several Dutch and German receivers use the same multiple-speaker techniques in their small table and "lowboy" cabinets, too, and one Dutch company carries this one step further, in several of their models, by having separate bass and treble audio amplifiers, fed through filters. The bass amplifier feeds a speaker with a heavy magnet, mounted on the side of the cabinet. The main part of the mid-range and the high frequencies are fed to a high efficiency front-facing speaker system from their own amplifier. The total effect is very pleasing indeed in spite of the fact that the local TV station, which operates on the American 525 line system, has a treble cut-off frequency on its sound of around 5kc/s.—RODERICK BALLARDIE (Pembroke, Bermuda).

TELEVISION COMPONENTS

SIR,—Reading the letter from B. Ladyman (June issue) and feeling pretty much the same as this writer from Boreham Wood, and considering your reply, I think it would be very helpful to those of us who are at the initiation stage, if put through in a manner accompanied by the diagram on page 480, June issue, "Curing Difficult Faults," by L. E. Higgs, if what the various blocks contain, viz. vision I.F., detector, sync separator, etc. This would be of great help at grasping the basic circuits. This article by L. E. Higgs was just up my street—many thanks.—T. McPAKE (Stirling).

[*Suitable articles are in the course of preparation.—Ed.*]

SIR,—I should like to join Mr. Ladyman in his request which was printed in the June issue. There are many of us who have only recently entered the field of television, and such terms as blocking oscillator and multivibrator do leave us a little in the dark. By the way, would it be possible for an amateur, especially one with little practical experience (I, for instance, am only 15 and have only just left school) to make such things as scanning coils, etc.? I look forward with interest to your compliance with Mr. Ladyman's request.—F. G. BENTMORE (York).

USING DIODES

SIR.—In looking through many commercial television receiver circuits, I am struck by the number of triode sections of multiple valves which are used in conditions which, to my mind, could conveniently be filled by a simple crystal diode or similar half-wave rectifier. It seems to me that when a triode section of a triode-pentode, for instance, fails, it is expensive to replace a whole valve when only one small part (and the simplest part at that) is needed. Is this a valve-maker's racket, or is there some more specific reason for the use of such triodes? I have in mind such items as interference limiters, sync clippers, sound detector, etc. — D. BRADLEY (Twickenham).

Your Problems Solved

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. 636 must be attached to all Queries, and if a postal reply is required a stamped and addressed envelope must be enclosed.

PORTADYNE 179

The picture is fine for a time then a black line begins to show on the left hand side and the middle turns dark leaving the top and bottom bright. The picture then seems to give a "woodgrain" effect and the sound becomes blurred. This set is only a few months old.—L. Underwood (Leytonstone).

There is undoubtedly a high degree of hum voltage rippling the vision (and sound) signal. The first suspect is a faulty valve. This could be a tuner unit valve, possibly the PCF80 (V2) but check V1 PCC84 and V3 common sound and vision (EF85?) amplifier if replacement of the PCF80 does not cure the fault.

REGENTONE 143T

This is a second-hand set and I wish to replace the contrast valve. I also wish to replace the two-gang potentiomenters behind the right-hand controls. What are their values?

When I turn the left hand control to bring in the other programme there is a loud hum on the loud-speaker, about midway between the two stations. How can I correct this please? — W. Morrison (Bristol 4).

The contrast-volume control is a ganged 1·5k-1M with D.P. switch. Radiospares code No. V100 is available from most radio dealers. The vision hum experienced as the tuner is rotated is normal and is to be expected. We are not sure what you mean by a contrast valve. Check rear right PCC84 valve.

EKCO 141

The top half of the screen is slightly lighter than the bottom and the bottom is superimposed on the top. There is no black line across the middle. The sync separator valve has been changed and all associated components have been checked. According to the circuit later models have a 2μF condenser for screen decoupling on V7 SP61 (sync separator) so I changed the 0·1μF for the above without results. — S. Darnell (Hammersmith).

The 6K25 could easily cause the trouble you are having but if its replacement does not help matters, check the SP61 frame output valve next to it and the coupling and feedback condensers which connect the two stages together.

MURPHY V178C

I am using a T.R.S. Band III convertor with this model. A new tube has been fitted and reception is very good, both on BBC and ITV with the exception of long distance shots. These appear to be out of focus, although close-ups are very clear, adjustment of the focus control makes no difference. I am wondering if the metal rectifier is becoming weak. No ion trap magnet is fitted and I would like to know if it would be in order to fit one to the set. No adverse effects have been noticed without it.—C. B. Underwood (Stroud).

The V178 uses a bridge rectifier. Murphy's reference is MR1 but we believe it is either a 14A100 or a 14A124 Westinghouse. Focus can be corrected by moving the focus magnet up and down the tube neck with the three picture positioning screws. If this movement is not sufficient the band around the tube bowl can be moved in and out until focus is obtained. The Mazda CRM123 does not require an iron trap magnet, which would only distort the picture if fitted.

K.B. KV35

I purchased a Brayhead tuner for this set to convert it to ITV. I do not have the adaptor for this unit and would be obliged if you can give me instructions for fitting it. — J. McMullan, N. Ireland).

Remove the R.F. valve V1 and across tags 4 and 5 on the valveholder connect the grey and brown heater leads to the tuner. Disconnect the oscillator coil and associated components from tag 1 of the frequency changer valveholder V2 and connect between this tag and chassis a 100Ω ¼W resistor. Across this resistor connect the tuner output lead, the screen to chassis. In place of the 22k resistor in series with V2 screen (tag 7) connect a 1k ½W resistor. Connect to this tag an 0·001μF capacitor and connect the other end to chassis. Connect the black tuner lead to receiver chassis and the red lead to the set H.T. line of the set.

H.M.V. 1845

The tube is an Emiscope type 5/2 and has been in use for four years. I fitted a booster transformer owing to failing brightness which resulted in a good picture. The voltage across the heater is 15½. The picture has now gone back to its original dimness after 6 hours. A second increase in boost makes no difference. Can you give me the equivalent to this tube.—R. Bacon (Chesterfield).

The tube will have to be replaced. Use the original type 5/2 or change the base and use a Mullard AW36-21.

BUSH T36

On switching on there is a dull glow in the tube for about a minute, before the picture comes on.

There is a blue glow in the EY51 during this period. Another time when I switch on there is no glow or light in EY51, no voltage on EHT connector when taken off tube anode, no voltage on EY51 anode, no pulse voltage on anode of PL81, or PY81. These valves have been changed and all heaters are in order. I suspect an intermittent fault in the time transformer or the scanning coils. —E. Hoskins (Neath).

The intermittent absence of EHT may be due to a defective line output transformer but the line oscillator stage (EF80) should be checked and also the horizontal form control which may be shorting to chassis. Check 0·2μF boost capacitor.

PHILCO 1251L

The picture has a 1in. wide black strip along the bottom and is also cramped towards the top.—A. C. Brooks (Welling).

We would advise you to check the front left side ECL80 valve and the associated components (if necessary). Trace the linearity components, 0·05μF from pin 6 of ECL80 bar to 150k resistor (brown-green-yellow). Change to 100k if necessary.

BAIRD P167

Every month I have to renew VR6 (2k) which keeps burning out. I have replaced various condensers and resistors in that part of the circuit but to no avail.—E. Middlemies (Hartlepool).

Use a higher wattage 2k control or change to 1k and add a 1k wire wound resistor in series. If hold cannot be obtained, remove 1k resistor and use 500Ω.

INVICTA 237

This set is about 14 months old. Recently a fault has developed. There was a sudden complete loss of picture down the centre of the screen about 1½in. wide. By switching on and off I managed to lose this, but now it is consistently present. My dealer has said that he cannot cure it. The parts of the picture that are left are very distorted, and there is also a crackle on sound when the volume control is operated. — W. M. Hancock (Abertillery).

Your letter states that there is a 1½in. black band down the centre, the parts of the picture on either side of this being distorted. This denotes loss of line hold. The V14 PCF80 should be replaced (this is on the centre at the rear just behind the mains dropper), and if necessary, its associated components checked. The volume control requires cleaning or replacement.

ETRONIC ECV 1523

This set has the following faults: continuous frame slip, horizontal white line across the screen, picture very faint, tube too brilliant even when brilliance control is at minimum. Occasionally it seems to work properly but it then goes wrong again.—A. Barnes (Wirral).

It would appear that the anode load resistor of V6 the video amplifier 6AM6 is at fault. This resistor is connected to pin 5 and should have a value of 6·8k.

MARCONI VO55A

This is an old set and used to work quite well, but now I cannot obtain a raster.—H. F. Edwards (Dagenham).

You should check the left side EL38 valve, the EY51 in the screened box and all associated capacitors and resistors if the EHT is absent. If the EHT is present, check the tube itself, particularly the heater.

G.E.C. B.T. 5147

I cannot obtain full picture width on this set. The horizontal form is in order. The width control takes the picture to within ½in. of the vertical edges of the screen and then the picture width decreases slightly as the slider continues in the same direction. This is with Test Card "C". When the programme is received there is a gap of ½in. on both sides of the screen.—J. Collier (Sutton Coldfield).

Check the H.T. at C71—200μF. Reading should be 200V. If low, change metal rectifier. RM4 is replacement. Also suspect V12 and V13 (Z77 and KT36).

ARGOSY TV 1412

This is a console model which has been converted. Sometimes the picture is perfect, sometimes "foggy" and on occasions there are wide bands across the screen which appear to be "foggy". This occurs when using the converter and also when it is disconnected for BBC.—R. Squires (Leeds).

The tube has a heater-cathode short or partial short and you should fit a 2V heater isolating transformer to supply the tube heater independently of the main transformer.

FERGUSON 988T

This set has no raster or sound. The line whistle is audible and a spark can be drawn from the anode of the EHT rectifier. The EHT rectifier glows blue. Sometimes a "howl" accompanied by noise is heard from the speaker. — P. R. Anderson (Cowes).

If this set suddenly ceased to work and exhibited the symptoms mentioned, then we feel that a fault has developed somewhere in the R.F. frequency changer and common I.F. circuits. The associated valves should first be checked (V1, V2 and V3) and replacements made if necessary. If the valves are in order, a test of voltage at the various electrodes should reveal a faulty resistor or capacitor.

STELLA ST. 8314U-45

The mains ballast broke blowing the house fuse as well as the set fuse. I have replaced mains ballast also valve EY51 but all the other valves light up except this one. I cannot obtain sound or vision. I have had all the valves tested and they

were in order so it seems that there is no H.T.—W. Burton (Smethwick).

Check the mains supply to all tags of the ballast resistors (both). The one on the rear edge is the heater circuit dropper which is working but apparently the supply is not connected to, or the current is not flowing through, the lower sections of the second dropper.

PHILIPS PROJECTION 1800

I have a somewhat obscure fault on this receiver. At first I could obtain a picture with uncontrollable brilliance. I proved that this was not a tube fault by removing the whole optical box complete with tube, etc., and trying it on a friend's receiver (1800). In the meantime the line timebase has gone out of commission ruining the tube with the usual burn line. I tested for voltage on the brilliance control to find that I have about (—30V) on both ends.—W. Buckly (Leicester).

Check voltage at CRT cathode which with a normal signal input should be about 150. This also is the voltage of the PL83 anode. If absent, check V17 UB41 and H.T. feed to PL83. The (−30V) at the brilliance control seems to denote normal operation when the tube projection circuit is in order. This however, is not confirmed by the burn on the tube caused by failure of the line timebase. Check UL41—UY41—resistors on top of the line output transformer and the transformer itself. Check tube cathode and PL83 anode voltages.

VIEWMASTER

This set receives BBC only and has given excellent service for the past four years. The set works perfectly for about half an hour, then a dark, half moon shaped, patch appears on the right hand side of the tube and the picture becomes over-bright and fuzzy with lack of detail. Shrinkage also takes place and corners of the picture "creep in". If the set is switched off momentarily, say for half a minute, the picture reappears normally only to repeat the fault about half an hour later. Main and EHT rectifiers have been renewed without success. Voltage readings are on all bias resistors normal. I have not tested whilst the fault is on, as, by the time I make connections and take readings it would probably have cleared itself.—H. Hill (Liverpool).

From your description we suspect that a fault may have developed in the CRT which is causing a heavy current drain, thereby putting the picture out of focus. If your CRT is a type fitted with an ion trap magnet, then it is possible that this has become intermittently faulty.

MARCONI VT69DA

This set uses an Emiscope 4/15G 13V tube. I have to replace this tube and want to use a 6·3V type and run the heater from a separate transformer. Perhaps you could mention one that would fit both electrically and physically. Is an ion trap magnet necessary? Would the beam shift ring used on the 4/15G still be necessary with other tubes?—W. Anson (Northfleet).

There is no direct equivalent to the 4/15G. A Mullard MW43-64 or MW43-69 can be used (there is no need for a 6·3V transformer as the current (0·3A) remains the same in a series circuit), with a change of base and the addition of an ion trap magnet (IT9). The beam shift ring is not necessary. The Brimar C17FM is similar.

FERGUSON 968T

On this set the picture is losing height and there are light patches and shadows around the figures on the screen.—T. Lloyd (Enfield).

For loss of height, check the ECL80 valve (V13) which is situated in the far left-hand corner of the chassis when viewing from the rear of the cabinet. Also check the 470k resistor connected to the centre of the height control. Replace if high in value.

The poor picture may be aggravated by a worn picture tube and this should be suspected if the tube is the original.

KOLSTER-BRANDES KV35

On the above set I cannot obtain sound, picture or raster. When I first switch on all the valves light up except V16 and there is no light at the gun end of the tube. If I switch off and then switch on again when the glow in the line output valve has disappeared, I sometimes obtain picture and sound. Once on it remains there. Sometimes it takes between 6 to 20 minutes switching on and off to obtain a picture.—J. Wilkie (St. Helens).

If you remove the rear cover you will see that there are two rows of valves. Note which come on and those that do not (carefully). If the heater of the tube (V7) does not come on but all other heaters do, (except V16) suspect a heater cathode short in V10 (6AL5). If the heater of the tube can be made to light by replacing the defective valve but V16 still fails, check V13, V14, V15 and, of course, V16 itself. If there is no sound or vision even with all heaters (except V16) lighting, check the RM4 metal rectifier.

QUERIES COUPON

This coupon is available until SEPTEMBER 22nd, 1960, and must accompany all Queries sent in accord with the notice on page 632.

PRACTICAL TELEVISION, SEPTEMBER, 1960.

Published on the 22nd of each month by GEORGE NEWNES, LIMITED, Tower House, Southampton Street, London, W.C.2, and printed in England by WATMOUGHS LIMITED, Idle, Bradford; and London. Sole Agents for Australia and New Zealand: GORDON & GOTCH (A/sia), Ltd. South Africa and Rhodesia: CENTRAL NEWS AGENCY, LTD. Subscription rate including postage for one year: Inland £1.2.0, Abroad £1.0.6 (Canada 19s.). Registered at the General Post Office for the Canadian Magazine Post.

FOR ..Your Career
..Your Own Business
..An Absorbing Hobby

A NEW-PRACTICAL WAY of UNDERSTANDING

Radio · Television Electronics

Including: Transistors; VHF/FM; Hi-Fi equipment; Computors; Servo-mechs; Test Instruments; Photo-electrics; Nucleonics, etc.

Radiostructor—an organisation *specialising* in electronic training systems—offers a new self-instructional method using specially designed equipment on a "do-it-yourself" basis. You learn by building actual equipment with the big kits of components which we send you.

You advance by simple steps, performing a whole series of interesting and instructive experiments—with no complicated mathematics! Instructional manuals employ the latest techniques for showing the full story of electronics in a practical and interesting way—in fact, you really have fun whilst learning! Fill in the coupon below, for full particulars.

RADIOSTRUCTOR

LEADS THE WORLD
IN ELECTRONICS TRAINING

POST NOW

TO RADIOSTRUCTOR (DEPT. G.40)
READING, BERKS.

Please send brochure, without obligation to:

★Name .... ★ BLOCK CAPS PLEASE
Address ....
....

(We do not employ representatives)

REGUNNED TV TUBES

12 MONTHS' GUARANTEE from date of installation

Despatched same day
ALL types available:

Mullard, Mazda, G.E.C., Emiscope Brimar, E.E., etc.

12 and 14-inch	...	£4.15.0
15 and 17-inch	...	£5.15.0
21-inch ...	...	£7.15.0

Carriage and Insurance 7/6.

Cash with order to:

DIRECT ELECTRONICS
44 WEST PARK ROAD
LEEDS, 8

Unrepeatable Offer

COSSOR 10" TUBE 108K — BRAND NEW

Twelve months' guarantee
NOT A RE-GUN
—we have a few only

15/- each

10/- Packing, Postage and Insurance

HARVERSON SURPLUS LIMITED
83 High Street
MERTON, S.W.19
CHERRYWOOD 3985/6/7

SETS & COMPONENTS

REBUILT TELEVISION TUBES—12in. **£5**; 14in. **£5/10/-**; 17in. **£6/10/-**. Twelve months' guarantee. 10/- carr. **BRAYHEAD TURRET TUNERS**—**£6/19/6.** Carriage paid. State coils. All types **BBC** and **ITA AERIALS. AIRSPACED COAXIAL CABLE** from **6d.** per yard. **TELEVISION SPARES AND EXACT REPLACEMENTS.** The latest **BSR, UA14** four-speed Changer **£9/10/-**. Carriage paid. All leading makes of **TAPE RECORDERS, TAPES, AMPLIFIERS, TAPE DECKS, RECORD PLAYERS, TELEVISIONS** and **RADIOS.** All new goods on Easy Hire Purchase Terms. **TRANSISTORS RED SPOT 5/6. TRANSISTORS WHITE SPOT 5/6** each. **GERMANIUM DIODES 1/-** each. Stamped addressed envelope please. **for inquiries and callers are welcome.**

DEVIZES TELEVISION SERVICE
29-30, The Nursery, Bath Road, Devizes, Wilts. Tel.: Devizes 1100.

RECLAIMED VALVES. All tested and perfect; modern and obsolete; huge stocks; all one price. 5/-, plus 6d. postage each, delivered by return. LEWIS, 46, Woodford Avenue, Ilford, Essex.

Tubes-Spares-Tubes

Mail Order Service

Best Northern Component Service

STAMP BRINGS LISTS

L. ANDREWS

67 ST. MARK'S ROAD, LEEDS, 6

"HEATHKITS" can now be seen in London and purchased on easy terms. Free brochure. DIRECT TV REPLACEMENTS LTD., Dept. PT/19/8, 138, Lewisham Way, S.E.14. Tideway 6666.

Television Tube Shop

now stock

Tubes for every make of set

for example:

12 inch, Mullard type	£4. 5.0
12 inch, Mazda type	£4.15.0
14 inch, Mullard type	£5. 5.0
14 and 15 inch, Mazda type	£5.15.0
17 inch, All types	£7. 0.0
17 inch, Slim line 110°	£7.10.0
21 inch, All types	£8.10.0

Also **G.E.C., BRIMAR, E.M.I. types**

Add 12/6 for delivery to your door within 48 hours, or 7/6 via B.R.S.

All Tubes Carry 12 months' guarantee.

A few shop-soiled tubes available. Good picture. Fully guaranteed, from 50/-.

Spare-time Service Engineers—send for details of our rebate scheme.

TAPE RECORDERS

Latest Collaro "Studio" 3-speed Tape Deck, complete	£13.17.6
Fitted to Motor Board, with 1,200 feet E.M.I. tape, knobs, etc., to fit into your own cabinet	£15.15.0
5.3 watt Amplifier, specially designed for the "Studio" complete with power pack, knobs, etc.	£10.10.0
Complete job in beautiful cabinet, with 2 speakers 8 x 5, usually £50	£39.10.0

E.M.I. sealed tape 1200 ft usually 35/-, at 27/6

VALVES

A very wide range at 50% off list price. Send for complete price list of these and other Bargains.

48 Battersea Bridge Road, LONDON S.W.11. *BAT* 6859. Open Saturdays.

RATES: 4/- per line or part thereof, average five words to line, minimum 2 lines. Box No. 1/- extra. Advertisements must be prepaid and addressed to Advertisement Manager, "Practical Television," Tower House, Southampton St., London, W.C.2.

SETS & COMPONENTS *(continued)*

New Tubes

	2 Years' Guarantee	1 Year Guarantee
12in. MW31-74	—	£5.5.0
14in. MW36-24	£10.10.0	£6.6.0
17in. MW43-64/69	£12. 0.0	£8.0.0
17in. CRM	£13.10.0	£9.0.0

SPECIAL AW43-80 £6.6.0
Carriage 7/6

LINE OUTPUT TRANSFORMERS

Direct Replacements for 500 sets.

Baird, T29, T163	53/-
T164, T167, T172, 2014, 1712	60/-
Bush, TV 11A, B; 12A, B; TVF 12A TUG 12A, B; TRG 12A, B	45/-
TV12AM; TV22, 24; TRG24, TUG24	60/-
Cossor, 930, 931, 933, 943, etc.	60/-
Ekco, TS46; TS113-114; T161, 164; T222, 231; TSC311, etc.; 948	55/-
Ferguson, 841, 2, 3; 941 to 945	55/-
990T-998T; 103-145T; 203-246T	66/6
Ferranti, 14T3, 17K3, 17T3	45/-
14T2, T1205, T1215, T1225, T1325, T1405, T1415, T1425, T1505, T1825	65/-
G.E.C. and H.M.V. mostly 55/- to	60/-
Invicta, T101-104; T108 to T110	52/-
T114-126; T133-142	60/-
Murphy, V114C, V116C, V118C	45/-
V120C, V180, V178, V200, V202C	57/6
Philips, 1114 UF/UM, 1115 U, 1437 U, 1446 U, 1726 U, 1746 U, 1747 U	65/-
383A, 463A, 563A, 663A	60/-
Pye, LV30, 16T, CS17, etc.	50/-
CTM4, V4 VT4; V7, VT7; VT17	60/-

Add 2/6 post. S.A.E. with enquiries.

NEW 17" TV CABINETS (less glass) only 30/-. (Carr. 7/6).

Westway Radio

5 WESTWARD WAY, HARROW, MIDDX.

TELEVISIONS.—Satisfaction guaranteed. 14in., 13 channel from **£10**; 17in., 13 channel from **£20**. All in perfect working order. Sets for the engineer from **£2** each, all complete. RELYON RADIO 439, Katherine Rd. Forest Gate, E.7.

BOURNEMOUTH

NATIONAL RADIO SUPPLIES

66 HOLDENHURST RD.

Tel.: 25232

14in., 15in., 17in., Round & Rectangular Television Tubes. 12 month written guarantee **£6.19.6** and 10/- allowed on your old tubes. Carr. paid. 3 Element ITV and BBC dipole combined wall fixing, 34/6 and 4/6 carr. Complete range of capacitors, resistors. Hi-Fi radiogram chassis, amplifiers motors and pick-ups, stereo and mono.

Bournemouth's Hi-Fi and constructors' centre.

NATIONAL RADIO SUPPLIES BOURNEMOUTH

SETS & COMPONENTS *(continued)*

TV SPARES

LARGEST RANGE OF NEW AND USED SPARES

Line Outputs our Speciality. Used from **£1**. New from **45/-**. Also breaking hundreds of TVs for Spares. All Coils, Transformers, Chassis, Valves, etc. Send S.A.E. for immediate Quote.

NEW and USED VALVES. Used from **2/6** each. Please state type required.

TV BARGAINS
Working from **£5.** Chassis from **50/-**
Callers Welcomed.

Television Consumer Services

LTD.

28 BROCKLEY CROSS, S.E.4
Phone: TIDeway 5394

and at **112 CAMBERWELL ROAD, S.E.5**
Phone: RODney 7917

Telephone Orders Sent Same Day C.O.D.

GUARANTEED VALVES from **6d.** List 3d. HAMILTON RADIO (T), 237, Sedlescombe Road N., Hastings.

TUBES — AERIALS — VALVES

Regunned tubes, guaranteed one year, prices from **£5**, allowance on old tube. Revacuumed tubes, all sizes, **50/-**; guaranteed 4 months. Full range of aerials at trade prices, double five costs only **56/-**. Full range of valves, example PCC84 costs **8/-**. ITV pre-amplifiers, **£3.15.0**, self-contained in case. ITV converters, **£5.** Brayhead tuners, **£4.12.6.** New TV sets and transistor radios supplied, ask for quotation. Low loss co-axial, **1/1** yd.; Standard **6d.** yd. Diplexers, **8/8** each. All items carriage extra. S.A.E. for lists.

G. A. STRANGE
BROADFIELD, NORTH WRAXALL, Nr. Chippenham, Wilts. Tel. Marshfield 236

TELEVISION TUBES! Rebuilt, new guns, 12 months' guarantee. 12/14., **70/-**, 17in., **79/6.** Quantity discounts. 3, Pank Ave., New Barnet. BAR 3185.

TELEVISION PICTURE TUBES

Manufacturers' Guarantee

Twelve Months

Tubes for All British made Sets

10 inch	**£4. 0.0**
12 inch	**£5. 0.0**
14 inch	**£5.10.0**
15 inch	**£7. 0.0**
16 inch	**£7. 0.0**
17 inch	**£7. 0.0**
21 inch	**£8.15.0**

Credit terms arranged

Carriage 12/6.

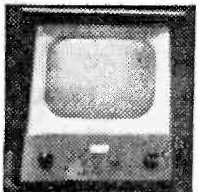
Despatched British Railways Passenger to give a fast delivery and a 48-hour service from:

Cathode Ray Tube Service

35 BROOMWOOD ROAD
ST. PAUL'S CRAY, KENT
Orpington 21285

SETS & COMPONENTS *(continued)*

C. EDWARDS
1070 HARROW ROAD
LONDON, N.W.10
LADBROKE 1734



Offers S/H TV in First-class Condition,
12in. £5.0.0
14in. £7.10.0
17in. £13.10.0
(all 5 channel) +15/- carriage.

Guaranteed VALVES
10F1, 10/-; 10C2, 10/6; 20D1, 6/-; 6F1, 5/-; SP61, 7/-; 6K25, 8/-; 20P1, 10/-; PZ30, 8/-; PL33, 7/-; ECL80, 8/-; EB91, 6/-; Plus 6d. post.
S/H. 12in. Tubes, 50/- plus 7/6 post.

FERGUSON, EKCO

BRAYHEAD TURRET TUNERS for any area. Will convert over 600 models. Complete with fitting instructions. State set, model and two channels when ordering. 110m/c models 95/-, 16m/c and 35m/c 120/-. External cabinet (if required) 24/-. Carriage paid. CWO or C.O.D. DURHAM SUPPLIES, 175, Durham Road, Bradford 8, Yorkshire.

TV TUBES from stock. 17in., new gun £4/15/-, new gun and guaranteed, £5/15/-, 12 months' guarantee. TV ELECTRIC & CYCLE CO., 1, High Street, Chalvey, Slough, Bucks. Tel.: Slough 21860.

TV TUBES, factory rebuilt (regunned), fully guaranteed, 14in., £5, 17in., £6, p and p 10/-. 24, Bristol Road, Brighton.

MULLARD TUBES, reclaimed, 6 months' guarantee. 9in., 30/-, 12-14in., 59/6, 17in., 79/6. All picture tested. FITTED FREE. Picture shown to callers. Other makes, types, cheap. Salvaged spares for modern and obsolete sets. Prices from: LOT 17/6, FOT 7/6, Osc. Tr. 6/-, Mains Tr. 10/-. Valves: 1,000 types in stock. EF91, EB91, 6J5, 2/6, EF80, 10F1, UF42, 3/6. Save money. Send a S.A.E. with enquiries or for free list. "ST. JOHN'S RADIO." 156, St. John's Hill, S.D.11. (BAT9838).

17 INCH tubes £5, new guns, all sizes available, guaranteed. STAR TUBES, Brief Street, Bolton.

H.P. on Regunned C.R.T.S.
At No Extra Charge
12 Months' guarantee

12" & 14"	..	£3.10.0
17"	..	£4.10.0
21"	..	£5.10.0

Phone or Call only:
Rod 7778
P. J. F. Andrews
61-63 ROSEMARY RD.
LONDON, S.E.15

SETS & COMPONENTS *(continued)*

REBUILT TV TUBES
Fully Guaranteed
12 months
All makes—12" to 21"

Blane & Martin Electronics
Sandown Lane, Liverpool
DETAILS ON REQUEST. Tel. SEF. 3428

FOR SALE

VALVE CARTONS at keen prices. Send 1/- for sample and list. J. & A. BOXMAKERS, 75a, Godwin Street, Bradford 1.

100 BAYS of brand new adjustable steel shelving. 72in. high x 34in. wide x 12in. deep, stove enamelled, dark green, sent unassembled, six-shelf bay. £3/15/-. Sample delivered free, quantity discounts. N. C. BROWN LTD., Eagle Steelworks, Heywood, Lancs. Tel.: 69018.

TELEVISIONS
All sizes including Projections. Require attention from £3. In working order:—
12in. BBC from £5.
12in. and 14in. BBC/ITA from £10.
Regunned CRT £6 extra, 17in. from £25.
Send for Lists. Carriage Paid.

CADMANS
SERVICE DEPARTMENT
BRYAN STREET, HANLEY
STOKE-ON-TRENT

SERVICE SHEETS; also Current and Obsolete Valves for sale. JOHN GILBERT RADIO, 20 Extension, Shepherd's Bush Market, London W.12. (Phone: SHE3052).

1,000 TELEVISIONS, all makes, from £3 working, 10/- not. Callers only 9 till 6 including Sats. 39, Whitehorse Lane, Stepney, London.

2,000 COMPONENT BOXES each with 10 adjustable compartments 2in. x 1½in. x 1½in. and press on lids. Ideal for nuts, screws, etc., 3/11 each, 6 for £1, post free. JERVIS, 16, Manor Rd., Brampton, Chesterfield.

S/Vision Strip, 2/9. **"Plessey" I.F.'s**, 10.5 Mc/s sound, 14 Mc/s vision, 8 v/holders. Size: 8½ x 5 x 4½in. Circuit inc. (valves not incl.). P. & P. 2/6.
Germanium Crystals, 9d. each or 6/- doz. Brand new, long wire end. Post on one, 4d., post on one dozen, 9d.
Ronette Hi-Fi Crystal Cartridge, 19/6. L.P. and Standard stylus. Replaces Studio O, B.S.R. Ful-Fi, will fit almost all types of pick-up heads. P. & P. 9d.
P. P. COMPONENTS LTD.
219 ILFORD LANE, ILFORD, Essex
Stamp for FREE Catalogue

WANTED

NEW VALVES WANTED. — EY51, ECL80, PCC84, PCF80, PCL83, PL81, PCL82, PY81, R19, U801, 30P4, etc. Best Cash prices by return. DURHAM SUPPLIES, 175, Durham Road, Bradford 8, Yorkshire.

WANTED, Service Sheets. No quantity too large or too small; highest prices paid. SULTAN RADIO, 29, Church Road, Tunbridge Wells, Kent.

A PROMPT CASH OFFER for your surplus Brand New Valves, Speakers, Components, Test Instruments, etc. R.H.S., 155, Swan Arcade, Bradford 1.

BEST PRICE paid by return for new Valves and equipment. STAN WILLETTS, 43, Spon Lane, West Bromwich, Staffs. Tel.: WES. 2392.

NEW TV VALVES WANTED. Send valves, cash by return to: P. J. F. ANDREWS, 61-63, Rosemary Road, London, S.E.15.

WANTED—VALVES. Modern TV and radio types. Large or small quantities. Box No. 22.

SERVICE SHEETS

SERVICE SHEETS, Radio, T.V., 5,000 models. Lists 1/-. S.A.E. enquiries. TELRAY, 11, Maudland Bk., Preston.

SERVICE SHEETS.—Huge stock at 4/- ea. List 1/-. Immediate delivery. GLOBE SUPPLIES, 33, Fairfield Close, Sidcup, Kent.

SERVICE SHEETS for sale, all types from 1/- each, with free fault-finding guide. 125 Radio/TV Service Sheets, covering 370 popular models 20/-. S.A.E. lists/enquiries. HAMILTON RADIO (T), 237, Sedlescombe Rd. N., Hastings.

SERVICE SHEETS. — We have the largest stock of Radio and TV Sheets in the country for sale at 4/- ea. 1960 Radio and Television Service Sheet List Now Ready. 1/-. Also Manuals for sale or hire. List 9d. S.A.E. please. Mail Order Only. S.P. DISTRIBUTORS, 11, Old Bond Street, London W.1.

SERVICE SHEETS. TV 2/6 each, radio 2/- each. Post free. DARWINS, 45, Shaw Street, St. Helens, Lancs.

SERVICE SHEETS. TV 4/- ea. Radio 3/- ea. List 1/-. All orders dispatched on day received. C.O.D. if required. Also manuals for sale and hire. SULTAN RADIO, 29 Church Road, Tunbridge Wells, Kent.

SERVICE SHEETS. Largest stock Radio and TV Service Sheets North London. 4/- each with S.A.E. State make and model no. Circuit diagram only 2/6. Also Manuals for sale or hire. Radios over 20 years our speciality. All enquiries S.A.E. please. WYNDSOR TELEVISION, St. Albans Road, Barnet, Herts.

FAULTFINDER FILES (TV) showing common faults that each receiver is prone to and other useful servicing information 2/- each. List 9d. plus postage. S.P. DISTRIBUTORS, 11, Old Bond Street, London, W.1.

(continued overleaf)

EDUCATIONAL

INCORPORATED Practical Radio Engineers home study courses of radio and TV engineering are recognised by the trade as outstanding and authoritative. Moderate fees to a limited number of students only Syllabus of Instructional Text free. "The Practical Radio Engineer," journal, sample copy 2/-, 6,000 Alignment Peaks for Superhets, 5/9. Membership and Entry Conditions booklet 1/-, all post free from the SECRETARY, I.P.R.E., 20, Fairfield Road, London, N.8.

Radio Television & Electronics

Learn at home with the world's largest home study organisation. Brit. I.R.E.; City & Guilds; R.T.E.B., etc. Also Practical Courses with equipment. No books to buy.

Write for FREE prospectus stating subject to

I.C.S.

Intertext House, Parkgate Road, (Dept. 516), London, S.W.11.

"HOW AND WHY" of Radio and Electronics made easy by a new, non-maths. practical way. Postal instructions based on hosts of experiments and equipment building carried out at home. New courses bring enjoyment as well as knowledge of this fascinating subject. Free brochure from Dept. 12, P.T. RADIOSTRUCTOR, 40, Russell St., Reading.

NEW!

LEARN

RADIO & TV SERVICING and ELECTRONICS

and how to make and build your own equipment—using an exciting new practical apparatus course. Ideal for starting your own business or as a fascinating hobby.

FREE Brochure, without obligation from

RADIOSTRUCTOR Dept. G78

READING, BERKS.

Britain's leading radio training organisation.

RADIO AND TV SERVICING all aspects from basic principles. Guaranteed Coaching for City and Guilds, R.T.E.B. Cert., Brit. I.R.E., etc. Study at home under highly qualified tutors. No books to buy. Write for FREE Prospectus stating subject to I.C.S., Intertext House, Parkgate Road, (Dept. 516A), London, S.W.11.

SITUATIONS VACANT

A few excellent vacancies for men who can learn a skilled trade in today's R.A.F.

You can learn a trade worth having, in today's R.A.F. Your training is very thorough and gives you a skill at your fingertips for life. Pay compares very well with the equivalent jobs outside, and, if you are single, there's nothing out of your pay-packet for food or rent. Leave is a month a year, you get the chance to travel and you work with a fine lot of people.

Radar or Wireless Mechanics. Suitable candidates are now being accepted for thorough training on the latest radar and wireless equipment and its maintenance, fault-finding and repair.

Electrical or Instrument Mechanics. There are vacancies for suitable applicants to be trained in the skilled trades of electrical and instrument maintenance.

For full information write to:

Central Recruiting Office (PTN 728), Victory House, Kingsway, London, W.C.2.

TODAY'S TOP JOB IS THE R.A.F.

DID YOU KNOW COYNE'S NEW TROUBLE-SHOOTING SERIES TAKE HEADACHES OUT OF ALL SERVICING PROBLEMS!

Pin-Point

TV troubles in 10 minutes

Find the exact sound or picture trouble in ANY TV set from 700 possibilities! 300 pages; 300 diagrams, check charts! 31/6. Postage 1/-.

Pin-Point

Transistor troubles in 12 minutes

Trouble-shoot every type of circuit in ALL transistorized equipment! 525 pages; hundreds of illustrations; 120 check charts. 47/6, postage 1/4.

Simple Check Chart System Saves Time

These amazing practical handbooks with **ENTIRELY NEW METHOD** show you how to find the trouble in ANY TV, or transistor circuit FAST! Index tells you where to look: famous Check-Charts help you to pin-point the exact trouble in minutes! Those on-the-job books quickly pay for themselves in profitable new business and valuable time saved!

SEND NO MONEY

Just mail coupon for free trial. After 7 days send only low price or return books and pay nothing! If you keep both books send only £1 after 7 days and £1 a month until 79/-, plus 1/- postage is paid. If ordering one book, pay one half after seven days and the other half in 30 days.

FREE TRIAL OFFER Mail Coupon Now!

Mail Order Division, SIM-TECH BOOK COMPANY, Gater's Mill, West-End, Southampton, Hants.

- ☐ Rush 2-book PIN-POINT Series for 7-day FREE TRIAL per offer.
- ☐ I do not require both books, please send me the following book as per offer.
- ☐ TRANSISTORS, 47/6, plus postage.
- ☐ TV TROUBLES, 31/6, plus postage.

Name ....

Address ....

City.................. County............

☐ Check here if enclosing full price; we pay postage same. 7-day money-back guarantee.

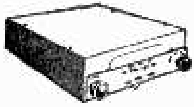
EDDY'S (Nottm.) LTD.

172 ALFRETON ROAD, NOTTINGHAM

TRANSISTORS. Red Spot, 3/11. White Spot, 4/11. Post 6d.
NIFE ACCUMULATORS. Size 3 x 2¾ x ⅞in. 7 amp hrs. 1.25 v., weight 13 ozs., 1/11 ea. P. & P. 1/6, one only, add 9d. each cell.
HEADPHONE CORDS. High quality 6ft lengths, 1/11 pair. Post 6d.
GERMANIUM DIODES. 8d. ea., 7/- doz. Post 6d.
·0005 mfd **VARIABLE CONDENSERS.** Small, twin gang. Built-in slow motion drive, 8/11. Post 1/6.
THROAT MIKES, 1/- ea. Post 6d. Could be used for electrifying musical instruments.
2000 mfd **CONDENSERS.** 3 v., working, 1/6. Post 6d.
JACK PLUGS. Standard. 1/11. Post 6d.
All Above are NEW and Guaranteed

Build your own CAR RADIO!

★ 7 Transistors ● Long and Medium Waves ● Two Watts Output ● R.F. Stage and Automatic Gain Control



10½ Gns.

P & P 5/- extra

6 or 12 volts (state which)

Supplied with full instructions

Size 7¾ x 7¼ x 2½in.

SPEAKER, extra 17/11

New or Surplus Valves, Guaranteed and Tested, by Return Post

DAF96	6/11	OZ4	4/11	3Q5GT	8/6
DF96	6/11	P61	2/-	3S4	6/3
DK96	6/11	PCC84	7/3	3V4	7/-
DL96	6/11	PCF80	7/-	5Z4G	7/6
EB91	3/6	PCL82	7/6	6A7	10/11
ECC40	19/11	PCL83	11/3	6AG5	4/-
ECC81	5/3	PEN36C	8/6	6B8G	2/11
ECC83	6/6	PL36	11/6	6BA6	5/11
ECC82	5/11	PL81	8/9	6BE6	5/11
ECL80	7/6	PL82	7/3	6BG6G	12/3
ECF82	9/6	PL83	7/3	6BJ6	5/11
ECH42	8/3	PY31	8/3	6C4	4/3
EF36	3/-	PY80	6/11	6C6	3/3
EF37	8/3	PY81	6/-	6C9	9/3
EF37A	7/11	PY82	7/-	6F1	5/9
EF40	13/3	PY83	7/3	6J7G	5/-
EF42	7/3	UBC41	7/6	6K7G	1/11
EF50	1/9	UF42	7/-	6K8G	5/6
EF86	9/9	UY41	6/3	6SG7M	4/9
EF89	7/3	UY1N	10/11	6SN7GT	4/3
EF91	3/6	1A7GT	11/9	12AH7GT	6/6
EL41	7/3	1C5GT	10/6		
EL84	6/6	1D5	7/6	12AT6	7/6
EL85	10/6	1H5GT	9/6	12K7	5/6
EL91	4/6	1L4	3/6	12Q7	5/6
EY51	8/6	1N5GT	9/6	25A6G	6/11
EY86	7/11	1R5	6/-	25Z4G	7/11
EZ40	6/6	1 S5	4/9	35Z4	5/3
				90AV	3/6
EZ80	6/-	1T4	3/11	954	1/6
EZ81	7/-	3D6	4/11	955	3/6
GT1C	6/11	3Q4	7/-	956	2/6

All parcels insured against damage in transit for only 6d. extra per order. All uninsured parcels at customers' risk. Postage and Packing 6d. per valve extra. Over £3 Free. C.W.O. or C.O.D. only. C.O.D. charge 3/- extra.

S.A.E. with enquiries.

DOMINATOR

17 WATT TREMOLO AMPLIFIER

A top quality instrument designed for the professional who needs the best. The "Dominator" embodies all the tried and trusted features of the earlier models with detailed improvements made possible by the continuing research of Musical Designers. Natural quality of tone to suit the most discerning player. Generous valve line-up and circuit efficiency ensure ample volume and some to spare for all occasions together with the brilliant and sparkling attack associated with "Darwins" Amplifiers. Twin 12,000 line 10in. speakers drive in a cabinet geometrically angled to give maximum sound dispensation and directional treble impact. Comprehensive control panel is flush mounted for safety in transport and features: Four inputs. Two volume controls. Two tone controls. Tremolo Speed control. Tremolo Depth control. Jewelled pilot light. Tremolo is operative on two of the four inputs and is flash-controlled for on/off by foot switch on wander lead. Tremolo speed and depth controls provide "Full Compass" tremolo pulse combinations. Acoustically designed luxury cabinet, presented in two-tone leather cloth with gilt trim completes the striking and exclusive appearance.

Price £40.0.0 *(Heavy quality waterproof cover 27/6d.)*

A.C. MAINS 200-250 v. **DOMINATOR** Non-Tremolo model. **Price £35.0.0.**

DARWINS

19 GEORGE STREET, ST. HELENS, LANCS. *Phone:* St. Helens 4246.

RES/CAP. BRIDGE 38/-

p. & p. 2/-

Checks all types of resistors, condensers
6 RANGES
Built in 1 hour. Direct reading
READY CALIBRATED
Stamp for details of this and other kits.

RADIO MAIL (Dept. CV)
Raleigh Mews, Raleigh Street, Nottingham

TRANSFORMERS

Suppliers to B.B.C., I.T.A. and leading radio manufacturers, single or long runs, prompt delivery, home and export.

Rewinds to all makes.

H.W.FORREST(Transformers)Ltd.
Shirley, Solihull, Warwickshire
Tel.: SHirley 2483

RADIO SERVICING

Vol. 6—
Specimen Answers to City and Guilds Questions 1955/1959 (Final). By A. R. Bailey and E. C. Bell. These specimen answers cover five years of questions in Radio Service Work (Final) set by the City and Guilds of London Institute. 8/6. Postage 6d.

TELEVISION EXPLAINED by W. E. Miller Rev; by E. A. W. Spreadbury. 12/6. Postage 1/-.

FUNDAMENTALS OF SEMI-CONDUCTORS by M. G. Scroggie, 23/-. Postage 1/-.

A BEGINNER'S GUIDE TO TELEVISION by F. J. Camm. 7/6. Postage 6d.

TELEVISION SERVICING HANDBOOK by G. J. King. 30/-. Postage 1/3.

MODERN OSCILLOSCOPES AND THEIR USES by J. H. Ruiter, Jr., 40/-. Postage 1/3.

RADIO VALVE DATA 6th ed., Compiled by "WW". 5/-. Postage 9d.

NEW 1960 CATALOGUE 1/-.

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKISTS of British and American Technical Books

19-23 PRAED STREET, LONDON, W.2

Phone: PADdington 4185
Open 6 days 9-6 p.m.

Factory Rebuilt . . . Super

TELEVISION TUBES

All types fitted with New Gun Assembly. Fully guaranteed 12 months.

Mullard, Mazda, etc.:

12 inch	£5.0.0
14/15 inch..	£5.10.0
17 inch	£6.0.0

Carriage and insurance 10/-
C.W.O., C.O.D. or Credit terms available. S.A.E. for all enquiries.
Allowance on old tube.

K.V.A. ELECTRONICS (Dept. P/1)
3B Godstone Rd., Kenley, Surrey

SPECIAL VALVE OFFER

For Limited Period

EB91	4/-	UF42	7/-	6L1	8/-
ECL80	7/6	UL41	7/-	6L18	9/-
ECL82	9/-	UL44	7/6	6P25	6/6
EF80	5/-	UL46	7/6	6LD20	7/6
EF91	4/-	UBC41	7/6	6SN7GT	5/6
EL38	10/6	UCH42	7/6	7Q7	6/-
EY83	7/6	[illegible]	8/6	10F1	6/-
GZ32	8/-	SP61	2/6	10P13	8/6
KT33C	6/6	3D6	2/6	10P14	8/6
KT36	8/6	6AT6	6/6	12AT7	6/-
PL33	8/-	6CH6	7/-	20D1	7/6
PL82	7/6	6BG6G	10/6	20F2	8/6
PL83	7/6	6F1	6/-	N37	8/-
PY80	7/-	6F13	6/-	ECC83	9/6
PY82	7/-	6F14	6/-	807	6/-
PZ30	11/-	6F15	6/-	PY31	7/6
UAF42	8/6	6J5GT	5/-	1625	6/-

Postage 4d. per Valve.

Coaxial Cable, 75 ohms, 6d. yd. Ion Traps 5/-; Midget 2 Gangs, 6/6; New 7 x 4 P.M Speakers, Large or Small Magnet, 16/-.

TV AERIALS: We carry large stocks send S.A.E. with your requirements and we shall reply and send leaflets by return.

MAIL ORDER ONLY — NO CALLERS

Terms: C.W.O. or C.O.D., minimum C.O.D 3/-; postage, packing, other than valves under £2, 1/6; under £5, 2/-; aerials, 2/6.

ELECTRO SERVICES & CO.

221 BATTERSEA PARK RD., S.W.11

Mac. 6833/4

C.R.T. ISOLATION TRANSFORMERS

TYPE A. OPTIONAL 25% and 50% BOOST. 2 V. *OR* 4 V. *OR* 6.3 V. *OR* 10.8 V. *OR* 13.3 V. MAINS INPUT. 12/6

TYPE A2. HIGH QUALITY, LOW CAPACITY, 10/15 pF. OPTIONAL BOOST 25%, 50%, 75%. MAINS INPUT. 16/6

TYPE B. MAINS INPUT, MULTI OUTPUT 2, 4, 6.3, 7.3, 10 and 13 VOLTS. BOOST 25% AND 50%. LOW CAPACITY. 21/-

TRIMMERS, Ceramic. 30, 50, 70 pF, 9d.; 100 pF, 150 pF, 1/3; 250 pF, 1/6; 500 pF, 750 pF, 1/9. **RESISTORS.** Preferred values. 10 ohms to 10 meg., ¼ w., 4d.; ½ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-. **HIGH STABILITY.** ½ w., 1%, 2/-. Preferred values 100 Ω to 10 meg. Ditto, 5%, 100 Ω to 5 meg. Ω, 9d.

WIRE-WOUND RESISTORS 25 ohms—10,000 ohms: 5 watt 1/3; 10 watt 1/6; 15 watt 2/-

PLASTIC RECORDING TAPE

Long Play	7in. reel, 1,700ft.	32/6	Spare Plastic Reels 3/- ea.
	5¾in. reel, 1,200ft.	22/6	
	5in. reel, 850ft.	19/6	
	3in. reel, 225ft.	7/6	
Standard	7in. Reel. 1,200ft	21/-	
	5¾in. reel, 850ft.	17/6	
	5in. reel, 600ft.	15/-	

"Instant" Bulk Tape Eraser and Head Defluxer, 200/250 v. A.C., 27/6. Leaflet, S.A.E.

O.P. TRANSFORMERS. Heavy Duty 50 mA, 4/6. Multiratio, push-pull, 7/6. Miniature, 3S4, etc., 4/6. Push-pull 10 w., 15/6. **L.F. CHOKES** 15/10 H. 60/65 mA. 5/-; 10 H. 85 mA. 10/6; 10 H., 150 mA. 14/-.

MAINS TRANSFORMERS 200/250 v. A.C.

STANDARD, 250-0-250, 80 mA, 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a. 5 v. 2 a. or 4 v. 2 a. ditto, 350-0-350 .. 22/6
MINIATURE 200 v. 20 mA. 6.3 v. 1 a. .. 10/6
MIDGET. 220 v. 45 mA. 6.3 v. 2 a. .. 15/6
SMALL. 220-0-220, 50 mA. 6.3 v. 2 a. .. 17/6
STD., 250-0-250, 65 mA. 6.3 v. 3.5 a. .. 17/6
HEATER TRANS. 6.3 v. 1½ amp. .. 7/6
Ditto, tapped sec. 2, 4, 6.3 v., 1½ amp. .. 8/6
Ditto, sec. 6.3 v. 3 amp. .. 10/6
GENERAL PURPOSE LOW VOLTAGE. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v., 2 a. .. 22/6

ALADDIN FORMERS and core, ¼in., **8d.**; ⅜in., **10d.** 0.3in. **FORMERS 5937/8** and Cans **TV1/2.** ⅝in. sq. x 2⅝in. and ⅜in. sq. x 1¾in., **2/-** ea., with cores.
TYANA.—Midget Soldering Iron, 230 v. 40 w., **16/9.**
REMPLOY Instrument Iron, 230 v. 25 w., **17/6.**
MAINS DROPPERS. 3in. x 1¼in. Adj. Sliders, 0.3 amp., 1,000 ohms, 4/3. 0.2 amp., 1,000 ohms, 4/3.
LINE CORD. 0.3 amp., 60 ohms per ft., 0.2 amp., 100 ohms per ft., 2-way, 6d. per ft., 3-way, 7d. per ft.
LOUDSPEAKER P.M. 3 OHM. 5in. Rola, 17/6. 8in. Plessey, 19/6. 6in. x 4in. Rola, 18/-. 6½in. Rola, 18/6. 10 x 6in., 27/6. 10in. Rola, 30/-. 4in. Hi-Fi Tweeter, 25/-. 12in. R.A., 30/-.
STENTORIAN HF 1012 10in. 3 to 15 ohm, 10 w., 95/-. 12in. Baker 15 watt 3 ohms, or 15 ohms, 105/-.
CRYSTAL DIODE G.E.C., **2/-**. **GEX34, 4/-**.
HIGH RESISTANCE PHONES. 4,000 ohms, 15/- pr.
MIKE TRANSF. 50 : 1, 3/9 ea.; 100 : 1, Potted, 10/6.
SWITCH CLEANER. Fluid squirt spout, 4/3 tin.
TWIN GANG TUNING CONDENSERS. 365 pF miniature 1in. x 1¼in. x 1⅝in., 10/-. 0.0005 Standard with trimmers, 9/-; less trimmers, 8/-; midget, 7/6.
SINGLE, 50 pF, **2/6**; 75 pF, 100 pF, 160 pF, **7/-**. Solid dielectric 100, 300, 500 pF, 3/6.
SPEAKER FRET. GOLD CLOTH. 17in. 25in., 5/-. 25in. x 35in., 10/-. **Tygan** 4ft. 6in. wide, 10/- ft.; 2ft. 3in. wide, 5/- ft. Samples S.A.E.

New and Boxed VALVES 90-day Guarantee.

1R5	7/6	6K8G	7/6	EABC80	8/6	HABC80	12/6
185	7/6	6L6G	10/6	EB91	6/-		
1T4	6/-	6N7M	6/6	EBC33	8/6	HVR2A	6/6
2X2	3/6	6Q7G	8/6	EBC41	8/6	MU14	9/-
3S4	7/6	6SA7	6/-	EBF80	10/-	P61	3/6
3V4	7/6	6SJ7M	6/6	ECC84	9/6	PCC84	9/6
5U4	7/6	6SN7	6/6	ECF80	9/6	PCF80	9/6
5Y3	7/6	6V6G	6/6	ECH42	10/6	PCL82	11/6
5Z4	9/6	6X4	7/6	ECL82	10/6	PEN25	6/6
6AM6	5/-	6X5	6/6	EF39	5/6	PL82	10/6
6B8	5/-	12AT7	8/-	EF41	9/6	PY80	7/6
6BE6	7/6	12AU7	8/-	EF50	5/6	PY81	9/6
6BH6	9/6	12AX7	8/-	EF80	8/6	PY82	7/6
6BW6	9/6	12BE6	8/6			SP61	3/6
6D6	6/-	12K7	6/6	EF91	5/-	UBC41	9/6
6F6G	7/6	12Q7	6/6	EF92	5/6	ECH42	9/6
6H6	3/6	35L6	9/6	EL32	5/6	UF41	9/6
6J5	5/6	35Z4	7/6	EL84	8/6	UL41	9/6
6J6	5/6	80	9/6	EM81	9/6	UY41	8/6
6J7G	6/6	807	5/6	EZ40	7/6	U22	8/6
6K6GT	6/6	954	1/6	EZ80	7/6	VR105	9/6
6K7G	5/6	EA50	1/6	E1148	1/6	VR150	9/6

TELEVISION REPLACEMENT

LINE OUTPUT TRANSFORMERS

70/- ea. from stock.

For Makes and Models

Argosy: T2, CTV517. **Decca:** D17 & C. **Defiant:** TR1753. **RGD:** 6017T, 7017C, C54. **Regentone:** 17C, 17T, 17 Comb.

Argosy: T3. **Decca:** D14. **Defiant:** TR1453T. **Regentone:** 14T. **RGD:** 6014T.

Marconi: VT63DA.

Baird: 2014, 2017, 2114, 2117.

Cossor: 930 & T, 931, 933-4-5, 937, 938 & A. & F. 939 & A & F, 943T, 946.

H.M.V. 1824 & A, 1825 & A, 1826 & A, 1827 & A, 1829 & A, 1865, 1869.

Marconi: VT68DA, VT69DA.

Sobell: TS17, T.346.

Ferguson: 306T, 308T.

Other makes available (7 days). S.A.E. with all enquiries.

LINE BLOCKING TRANSFORMERS, 10/- to 16/6.

FRAME BLOCKING TRANSFORMERS, 13/6 to 21/-

FRAME OUTPUT TRANSFORMERS, 27/6 to 39/-. Most makes available (7 days). S.A.E. with all enquiries.

TV and RADIO SERVICE SHEETS. 1,500 models. Send **2/6,** your Model No. and S.A.E.

HIGH GAIN TV PRE-AMP KITS BAND I BBC

Tunable channels 1 to 5. Gain 18dB. ECC84 valve. Kit price **29/6** or **49/6** with power pack. Details **6d.** (PCC84 valves if preferred.)

BAND III ITA—Same prices.

Tunable channels 8 to 13. Gain 17dB. ECC84 valve. (PCC84 valves if preferred.)

CRYSTAL MIKE INSERT by Acos, precision engineered. Size only ¾in. x 3/16in., 6/6.

ALUMINIUM CHASSIS. 18 s.w.g. undrilled. With 4 sides, riveted corners and lattice fixing holes. 2½in. sides, 7 x 4in., 4/6; 9 x 7in., 5/9 11 x 7in., 6/9; 13 x 9in., 8/6; 14 x 11in., 10/6; 15 x 14in., 12/6; 18 x 16 x 3in., 16/6.

TELETRON "TRANSIDYNE" MIDGET SUPERHET PORTABLE 6 x 4 x 1¾in. 6 transistors, printed circuit, Ferrite aerial. All parts and cabinet. 9 gns. **We include Ediswan Transistors for maximum performance.** Details 9d.

BBC TRANSISTOR RADIO. Med. and Long Wave. Two transistors and diode. Complete kit, 32/6, phones 7/6 extra. Deaf Aid Earpiece with Special Lead 15/-. Details 6d.

GARRARD RECORD PLAYERS

AUDIO PERFECTION

Designed to play 16, 33, 45, 78 r.p.m. Records 7in., 10in., 12in. Lightweight Xtal pick-up. GC8 plug-in head. Stereo Wired.

SINGLE PLAY TA MK II £8-8.
TRANSCRIPTION 4HF £18.
AUTO CHANGER 210 £10-10-0
(Stereo heads £2 extra.) Leaflets, S.A.E.

Volume Controls Long spindles. Guaranteed 1 year. Midget 5K ohms to 2 Meg. No Sw. 3/-; D.P. Sw. 4/9. Linear or Log Tracks.

80 ohm CABLE COAX Post 1d. per yard extra. Semi-air, spaced. ¼in. dia. Losses cut 50%. **6d.** yd. Fringe Quality Air Spaced. **1/-** yd.

COAX PLUGS .. 1/- **LEAD SOCKET** .. 2/-
PANEL SOCKETS 1/- **OUTLET BOXES** .. 4/6
BALANCED TWIN FEEDER yd. 6d. 80 or 300 ohms.
DITTO SCREENED per yd. 1/6. 80 ohms only.
WIRE-WOUND POTS, 3 WATT. Pre-set Min. TV Type. All value 25 ohms to 25 K., 3/- ea. 30 K., 50 K., 4/-. (Carbon 30 K., to 2 meg., 3/-.)
WIRE-WOUND 4 WATT. Pots Long Spindle Values, 100 ohms to 50 K., 6/6 100 K., 7/6.
CONDENSERS. New Stock. 0.001 mfd. 7 kV. T.C.C., 5/6; Ditto, 20 kV., 9/6; 0.1 mfd., 7 kV., 9/6; Tubular 500 v. 0.001 to 0.05 mfd., 9d.; 0.1, 1/-; 0.25, 1/6; 0.5/500 v., 1/9; 0.1/350 v., 9d.; 0.01/2,000 v. 0.1/1,000 v., 1/9; 0.1 mfd., 2,000 volts, 3/6.
CERAMIC CONDS. 500 v., 0.3 pF to 0.01 mfd., 9d.
SILVER MICA CONDENSERS. 10% 5 pF to 500 pF. 1/-; 600 pF to 3,000 pF. 1/3. Close tolerance (±1 pF) 1.5 pF to 47 pF., 1/6. Ditto 1% 50 pF to 815 pF., 1/9; 1,000 pF to 5,000 pF, 2/-.

I.F. TRANSFORMERS 7/6 pair

465 Kc/s Slug Tuning Miniature Can. 2¼in. x 1in. x 1in. High Q and good bandwidth. By Pye Radio. Data sheet supplied.

WEARITE M800. Miniature, 12/6 pair.
WEYMOUTH, Standard size, 12/6 pair.

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350v.	2/-	50/350v.	5/6	8/500v.	3/-
2/450v.	2/3	100/25v.	2/-	16/500v.	4/-
4/450v.	2/3	250/25v.	2/6	32/350v.	4/-
8/450v.	2/3	500/12v.	3/-	100/270v.	5/6
8/500v.	2/9	8+8/450v.	4/6	2,500/3v.	4/-
16/450v.	3/6	8+8/500v.	5/-	5,000/6v.	5/-
16/500v.	4/-	8+16/450v.	5/-	32+32/350v.	4/6
32/450v.	5/6	8+16/500v.	5/6	32+32+32/350v.	7/-
25/25v.	1/9	16+16/450v.	5/6	50+50/350v.	7/-
50/25v.	2/-	16+16/500v.	6/-	64+120/350v.	11/6
50/50v.	2/-	32+32/350v.	4/6	100+200/275v.	12/6

LATEST EMI. 4-SPEED SINGLE RECORD PLAYER. Acos 73 hi-fi stereo and normal crystal pick-up. Silent motor, heavy turntable. **Special offer, £6.19.6.** Post 3/6.

RECTIFIERS SELENIUM 300 v. 85 mA. 7/6.
CONTACT COOLED 250 v. 50 mA, 7/6; 60 mA, 8/6; 85 mA, 9/6; 200 mA, 21/- 300 mA, 27/6.
COILS Wearite "P" type, 3/- each. Osmor Midget "Q" type adj. dust core from 4/-. All ranges.
TELETRON. L. & Med. T.R.F., with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 8/9; M. & L., 12/6.
T.R.F. COILS A/HF, 7/- pair. **H.F. CHOKES,** 2/6.
FERRITE ROD, 8in. x ⅜in., dia., 2/6.

JASON F.M. TUNER COIL SET, 26/-. H.F. coil, aerial coil. Oscillator coil. Two I.F. trans. 10.7 Mc/s. Ratio Detector and heater choke. Circuit book using four 6AM6, 2/6.
COMPLETE JASON F.M. KIT, FMTI, 5 gns. Set of 4 valves, 20/-.

FULL WAVE BRIDGE SELENIUM RECTIFIER: 2, 6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ amps., 15/6. 2 amps., 17/6; 4 amps., 22/6. Circuit included.
VALVE and **TV TUBE** equivalent books, 5/-.
TOGGLE SWITCHES. S.P. 2/-. D.P. 3/6. D.P.D.T. 4/-
WAVECHANGE SWITCHES
5 p. 4-way 2 wafer long spindle 6/6
2 p. 2-way, or 3 p. 2-way short spindle .. 2/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way long spindle 3/6
3 p. 4-way, or 1 p. 12-way long spindle .. 3/6
VALVEHOLDERS. Pax Int. Oct., 4d. EF50, EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6 and 7 pin. 1/-. **MOULDED MAZDA** and Int. Oct., 6d. B7G, B8A, B8G, B9A, 9d. B7G with can., 1/6. B9A with can., 1/9. **CERAMIC** EF50, B7G, B9A. Int. Oct., 1/-. **S/CANS** B7G, B9A, 1/- ea.

RADIO COMPONENT SPECIALISTS

OUR ONLY ADDRESS
337 WHITEHORSE RD., WEST CROYDON

Post and Packing 1/- over £2 free. (Export post Extra.) C.O.D. 1/6. (Wed. 1 p.m.) THO 1665 Buses 133 or 68