INSIDE! Blueprint for the 'Olympic' TV Set

Practical Television

AND TELEVISION TIMES

1'6

OCTOBER 1960

FREE!

7'6 BLUEPRINT for the 'OLYMPIC' 17" TV SET

OUTSTANDING FEATURES OF THE CIRCUIT

HOME-BUILT FRONT END
ATTRACTIVE CABINET DESIGN
100 PER CENT INTERLACE
"ROCK-STEADY" CONTROL SETTINGS
HIGH EFFICIENCY SILICON H.T. RECTIFIERS
GOOD FREQUENCY STABILITY ON BOTH BANDS—NO FINE TUNER

LASKY'S RADIO

MAKER'S SURPLUS COMPONENT BARGAINS

WIDE ANGLE 38 mm.

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Ferrox-cube cored Scanning Coils and Line Output Trans., 10-15 kV. EY51 winding Line Trans. with width and linearity controls, circuit dia., pair	50/-
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Frame or line block osc. Transformer	4/6
Focus Magnets Ferrox-core	19/6
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300 m/a Smoothing Chokes	10/6

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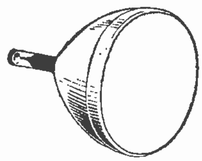
Frame or line blocking oscillator Transformer	4/6
Frame Output Transformer	7/6
Focus Magnets: Without Vernier	9/6
With Vernier	12/6
200 m/a Smoothing Chokes	7/6



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FERRANTI 9in., T9 3, 4 v. heater, or 12in., T12/44 and T12/54 4 volt heater.
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17in. rect.	£6 19 6	12/6
21 in. rect.	£7 19 6	21/-

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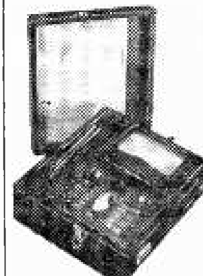

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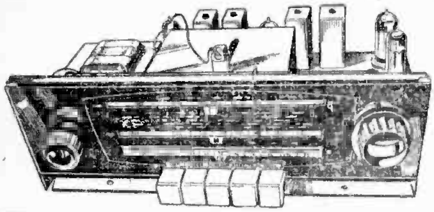

Tapped input 220-225 v. and 226-250 v. A.C. ONLY. Chassis size 15 x 6½ x 5½in. high. New manufacture. Dial 14½ x 4in. in gold and black. Pick-up. Extension Speaker. Ae., E., and Dipole sockets. Five "piano" push buttons—OFF, L.W., M.W., F.M. and Gram. Aligned and tested. With all valves & O.P. Transformer. Tone-control fitted. Covers 1,000-1,900 M.; 200-500 M.; 88-98 Mc/s. Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85. Speaker & Cabinet to fit chassis, 47/6. 10 x 6in. ELLIPTICAL SPEAKER, 20/-. **TERMS:**—(Chassis) £4.16.8 down—10/- carr.—and 6 Monthly Payments of 30/-, or with Cabinet & Speaker £5.9.2 down and 7 Monthly Payments of 32/-.

A FEW CHASSIS, DUSTY AND TARNISHED THROUGH STORAGE at £10 (10/- P. & P.). Working and unused but only 3 months' guarantee.

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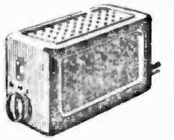

Separate gain controls. Valves PCF80 and PCC84. Switch positions ITA (1)—ITA (2)—BBC. Bakelite moulded cabinet 8½ x 4 x 6in. £5.5.0. P. & P. 3/-.

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Mullard and Mazda, all types. 12 months' guarantee. First grade guns.

14 inch **£5.0.0**

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Carriage and Insurance 12/6.

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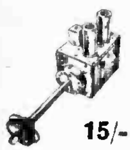
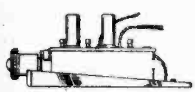
13-CHANNEL INCREMENTAL TUNER



I.F. 34-38 Mc/s complete with valves PCF80 and PCC84. Removed from chassis but in working order. or 16-19 Mc/s.

15/- (2/6 P. & P.) Knobs 2/6 extra. Some tuners less valves 7/6.



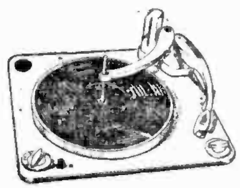
NEW ITA AND BBC TUNER. By well-known manufacturer for superhet TVs with 35-38 Mc/s I.F. For all areas; covers all 13 channels. Switch gives BBC and two ITA selections. Suits G.E.C. sets BT4543, 4544, 5146, 5147, 5543, 5642 and 6641 without alteration. Easily adapted as aerial converter, and instructions can be provided free. Has ITA and BBC co-axial sockets and separate gain controls.

WITH VALVES PCF80 and PCC84, 22/6 (P. & P. 3/-).

Some without valves at only 12/6 (P. & P. 3/-).

PERSPEX UNSCRATCHED. (Post 2/- each or 6 post free.) 16½ x 14½ x 3/16in., 7/6; 12½ x 9½ x ⅛in., 4/6. **Armoured Plated Glass** 16½ x 14 x 3/16in., 7/6.

AUTOMATIC RECORD CHANGERS, COLLARO CONQUEST with manual play also. Turnover crystal pick-up, 4-speed, A.C. mains 200-250 v. see illus.



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B.S.R. 4-speed U.A.8, auto-changer **£6.10.0** or STEREO **£6.12.6** (5/- carriage).

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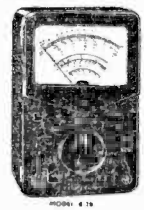


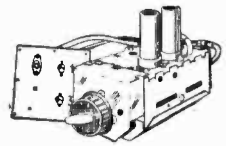
In moulded case. Prices include Test Prods., Batteries, Instruction Book. FULLY GUARANTEED. Also measure db. Accuracy: A.C., 3 per cent D.C., 2 per cent.

A-10 **£4.17.6**

B-20 **£6.10.0**

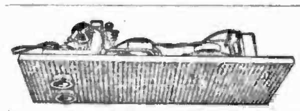
A-10—2K ohms/v. on A.C. and D.C. volts (10, 50, 250, 500 and 1000 v.); 10K and 1M ohms; ½ mA. 25 mA and 250 mA, D.C. Size: 5½ x 3½ x 1½in. Weight 17 ozs.
B-20—10K ohms/v. on 0.5 v. and 2.5 v.; 4K ohms/v. on 10, 50, 250, 500 and 1000 v., A.C. and D.C. Resistance, 2K, 200K, 2M and 20M-ohms; D.C. current, 100 microA, 2.5 mA, 25 mA, 250 mA. Size: 5½ x 3½ x 2½in. Weight 24 ozs.

THE BRAYHEAD TURRET TUNER, £7.7.0 post free. Complete with booklet and fitting instructions. State set and model number when ordering. Converts your 5-channel BBC only set to receive ITA as well.



ITA AERIALS clipping to existing mast 1-2in. dia. 3-element, 22/-; 5-el., 30/-; 9-el., 50/-; Loft mountin , 3-el., 20/-; 5-el., 26/-; Combined single BBC and 5-el. ITA, 75/- with chimney-lashings; Co-axial cable semi-air-spaced, 7d. yd. or 20 yds., 11/-. Aerial prices carr. paid. Postage on cable 1/-.

NEW WAXED TUBULARS, 350 v. or above, 3 of each, 0.001, 0.002, 0.005, 0.01, 0.02, 0.05, 0.1 mF. Total 21 for 4/6, post paid.



GRAMOPHONE AMPLIFIER with 5 in. SPEAKER. On Fabric-covered Baffle 12½ x 5in. Mains and Output Transformers. Metal Rectifier. ECL82 Valve. Tone and Volume Controls. On/Off switch. Plenty of Volume. Fully Guaranteed. Two Knobs supplied. Ready to play. Useful for Stereo.

ONLY 57/-, post 3/-

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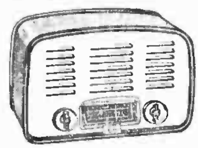

Fully built V.H.F./F.M. set. Wired, aligned and tested. 6 Mullard valves; with mains transformer, 88-98 Mc/s. **ONLY £8.8.0** (4/- carr.). Cheap room dipole 10/-. 300 ohm twin feeder, 6d. yd. Valves 3 months' guarantee.

Delivery by return. C.O.D. 2/- extra. Terms: Cash with order or one-third down and balance plus 7/6 (up to £7.10.0) in four equal monthly payments. Balance over £7.10.0 add 1/- in £1 and pay in not more than 6 monthly payments. See special terms for A.M.-F.M. chassis. All new goods unless stated. Send 6d. for 16-page catalogue.

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Practical Television

& TELEVISION TIMES

Vol. 11 No. 121 EVERY MONTH OCTOBER, 1960

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CONTENTS

The "Olympic"

THIS month we begin the series of constructional articles on our "Olympic" TV receiver. The circuit and construction have been designed especially for the amateur and the set incorporates a number of refinements.

The audio circuits feature a high-gain A.F. amplifier feeding an output stage capable of delivering 3W to the speaker. The distortion is reduced by a large value of negative feedback to about 1 per cent. The audio detector includes an effective noise-limiting circuit to remove ignition and similar interference.

The timebase sections of the receiver have been designed very carefully so as to avoid the need for continual adjustment of the line and frame holds. The frame sync pulses are amplified, with phase reversal, and the frame lock is extremely hard and only lost when the picture is blotted out by interference. Once adjusted, neither line nor frame controls should need alteration during the life of the oscillator valves.

The vision I.F. amplifier has a bandwidth of 3Mc/s but this may be reduced in fringe areas if desired. In the design stages, the use of frame-grid valves was considered but the use of more conventional valves facilitates construction—there is more separation between high-gain stages and instability is more easily avoided. The gain of the vision amplifier is of the order of 100,000 and the gain of the complete vision chain, including the tuner and video stage, is such that three or four microvolts at the aerial input will load the cathode ray tube fully.

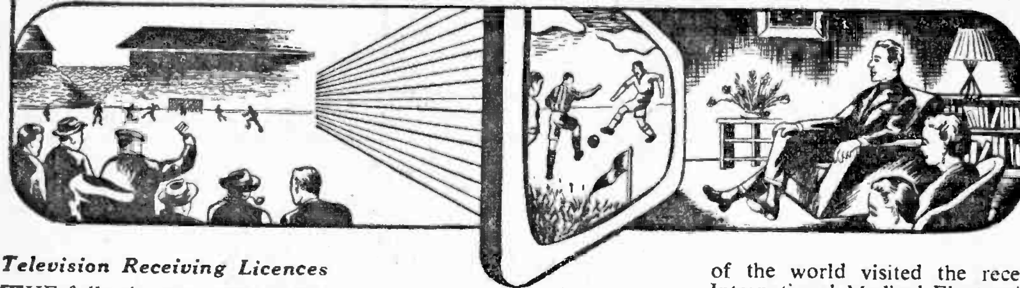
The high gain possible with the receiver is never used: an efficient AGC circuit, operating on the tuner R.F. valve, and first I.F. stage, reduces the gain to the optimum value. As might be supposed, the tuner is one of the most important parts of the receiver and upon its construction the excellent performance of the set depends. Nevertheless, the design has been kept as simple as possible. No control is incorporated for "fine tuning"; the oscillator circuit is extremely stable, and drift as the receiver warms up is negligible. However, those constructors who feel that the construction of the tuner would be beyond them may employ a standard turret tuner.

The power supplies of the set are worthy of note; the latest high-efficiency silicon rectifiers are used in the H.T. circuit and permit operation on mains voltages as low as 190—a great advantage for many constructors.

We are sure that this receiver will prove extremely popular and with the free blueprint included with this issue, even the comparatively inexperienced enthusiast should be able to complete the design with little difficulty. The series of articles on the set begins this month with a description of some of the circuits; next month we shall give a complete list of the parts needed to build the set.

Our next issue, dated November, will be published on October 21st.

TELENEWS



Television Receiving Licences

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

Region	*Total*
London Postal	1,859,368
Home Counties	1,459,169
Midland	1,626,923
North Eastern	1,742,206
North Western	1,424,958
South Western	899,497
Wales and Border Counties ..	646,358
Total England and Wales	9,658,479
Scotland	945,729
Northern Ireland	148,949
Grand Total	10,753,157

Australian TV Station

A NEW Australian television station, which was opened recently at Perth, Australia, has been equipped by Marconi's, of Chelmsford, Essex.

The equipment supplied included two 10kW television transmitters with associated 2kW F.M. sound transmitters, combining equipment and eight-stack high gain aerial, a control desk, programme input equipment (vision and sound), transmitter/studio link and extensive monitoring facilities and spares. The order was placed through Amalgamated Wireless (Australasia) Ltd.

This is the third national transmitting station opened in Australia in recent months. The others were at Brisbane and Adelaide.

British TV Unit for Hungary

AN Outside Broadcast Television Unit manufactured by E.M.I. Electronics Ltd. was shipped from Tilbury to Antwerp recently on the first stage of a journey to Budapest

The unit, mounted on a 7-ton chassis, will be used by the Hungarian Broadcasting Authority for televising outdoor events from all over Hungary. Its new relay switching technique and remote control facilities enable the unit to be used also as a studio control room. This is believed to be the first outside broadcast vehicle with such facilities to be exported to Eastern Europe.

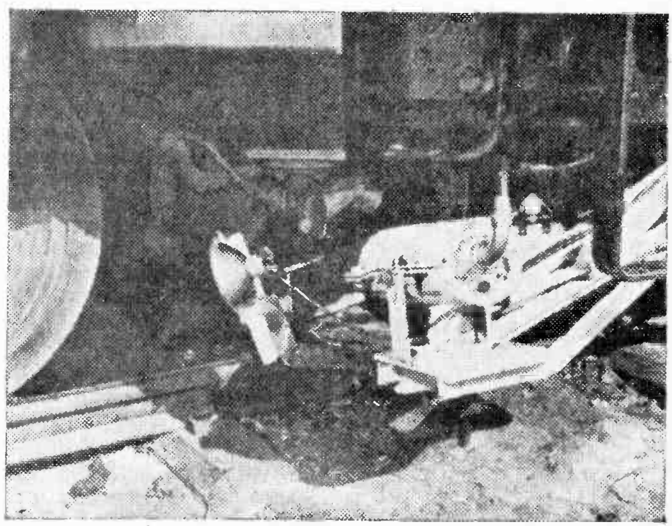
Medical Experts Inspect British TV Camera

MEDICAL engineers and practitioners from many parts of the world visited the recent International Medical Electronics Exhibition at Olympia to see, among other interesting exhibits, E.M.I.'s new colour TV camera.

This all-British camera has already impressed doctors at several hospitals in this country by its colour rendering, low cost and simple controls.

Many surgical operations and clinical procedures have been televised on a 7ft x 4ft screen to large numbers of doctors, and audiences have seen anatomical experiments taking place under a microscope.

Accurate colour rendering is particularly important on such occasions, but space in the theatre or laboratory is always at



Following abnormal wear on sharp curves on some railway tracks, Rhodesian Railways mounted a closed-circuit TV camera on a locomotive so that the action of the wheels could be observed (see "TV for Rhodesian Railways").

a premium. E.M.I.'s compact camera, with an optical system more efficient than relay lens systems, is ideally suited to these applications.

An ingenious lighting system and mirror boom provide all the illumination required, exactly where it is needed, so it is not necessary to clutter up the operating theatre with normal-type studio lamps.

Independent Television Authority

Appointment of Programme Contractor for North-East Scotland

THE Independent Television Authority has accepted, subject to contract, the application of a group called North of Scotland Television to act as a programme company in North-East Scotland.

This group has been formed in Scotland under the chairmanship of Sir Alexander King. He heads the Board of Directors, all of whom are Scots.

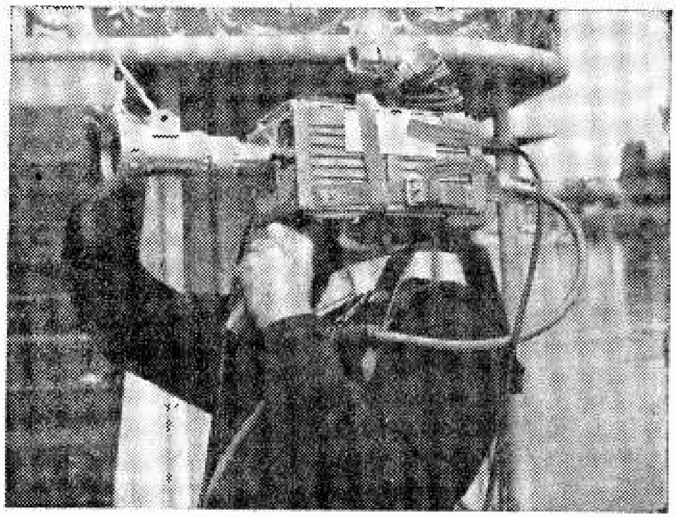
The Authority's North-East Scotland area will be served by two stations, one between Stonehaven and Banchory, which it is hoped will open towards the end of next year, and one on the Black Isle about eight miles north of Inverness, which will be opened during 1962. The first station to be opened will serve some 730,000 people in the counties of Aberdeen, Angus and Kincardine and parts of the counties of Fife, Banff and Perth. The second station will serve a further 140,000 people in Nairnshire, Morayshire, North-West Inverness-shire and the eastern parts of Sutherland and Ross and Cromarty.

TV for Rhodesian Railways

BECAUSE of abnormal wear on sharp curves of some of its railway track Rhodesian Railways mounted a Marconi closed-circuit TV camera on a locomotive so that the action of the wheels could be observed while in motion.

The tests were made because Rhodesian Railway officials wanted to discover whether there was any peculiarity that was causing excessive wear on the rails. Railway engineers fixed the camera on brackets only a few inches from the wheels and track. A monitor screen was installed in a private saloon and thus it was possible to study the wheels actually in motion, and by placing the camera in several different positions all the wheels were viewed in turn.

Rhodesian Railway officials who kept continuous watch on the monitor screen considered the tests very informative.



A member of the camera crew of a replica of one of the famous old Mississippi riverboats, built especially for ITV'S musical series, "Riverboat Shuffle", using a hand-held camera on board the boat.

In France Too?

WRITING in "La Cinématographie Française", M. Y. Ollivier says "Television is to the Frenchman the means of seeing films without leaving his house". Evidently, the French are much the same as the English so far as television is concerned!

Nigerian TV

AFRICA's first full-length live television play, "My Father's Burden" by Wole Soyinka, was broadcast here recently by WNTV, Africa's first television network.

Veteran actor Orlando Martins, making his initial acting appearance in his native Nigeria after returning last year after 45 years abroad, portrayed aristrocratic Chief Nwane whose pride and love of tradition place him in direct conflict with his European-trained, progressive-minded son, portrayed by Christopher Kolade.

The play is the beginning of a series which WNTV plans to present. They will be written by Nigerians and will centre around Nigerian themes. A contest to discover new playwrights has already been launched with a first prize of £250 for the best new play.

TV Films Convention

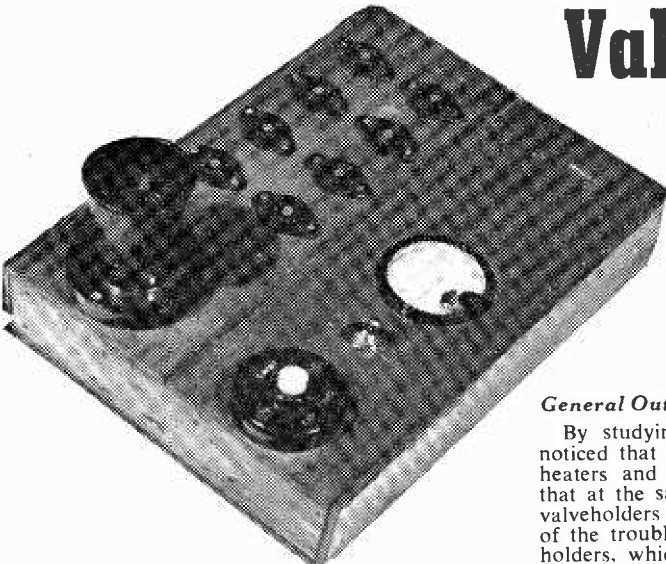
INDEPENDENT producers of television films are requested to contact M. Deslaw, 6 bis, Avenue Durante, Nice, France, so that an international convention of producers of television films may be organised to take place at the end of this year. The location of the convention will be made known later. Already, several European towns have been suggested for the Festival at which it is planned to present the best films of the last five years.

Radar Equipment for Sweden

A CONTRACT from the Swedish Government for the latest army radar equipment has been placed with E.M.I. Electronics Ltd.

This is the largest order for this type of equipment ever placed by the Swedish Government.

The order was given to E.M.I. after exhaustive tests, because of the advanced techniques employed on the E.M.I. equipment.



Valve Testing for Beginners

No. 2—A USEFUL UNIT FOR B9A VALVES By H. Peters

THE main objection to the average valve tester is that it takes so long to set up that it has no economic place in modern workshop practice, and unless used to check the performance of a number of valves of the same type cannot be made to pay its way.

One commercial tester does overcome these objections. You plug in the valve, select the card of its type, pull a lever (just like "clocking in") and the valve is tested. Its price puts it out of reach of the handyman, but its principle is so sound that the instrument to be described tends to follow the same principles.

General Outline

By studying the failure of TV valves it was noticed that the majority of them had 0·3A series heaters and B9A bases. It was further noticed that at the sacrifice of complicated facilities eight valveholders would between them test 90 per cent of the troublesome types. Apart from the valveholders, which in our case were recovered from a "breakdown" chassis, all that is required is a lampholder, a bellpush, an old torch battery and a two-way switch. The tester will work from A.C. or D.C. mains.

Operation

To use the tester a valve is merely plugged into its appropriate holder. If the heater is intact the lamp will light, and as the valve warms up the meter will read its emission. This is given with 1·5V bias applied to the control grid, and by depressing the bellpush this bias is removed to give a rough indication of mutual conductance. In

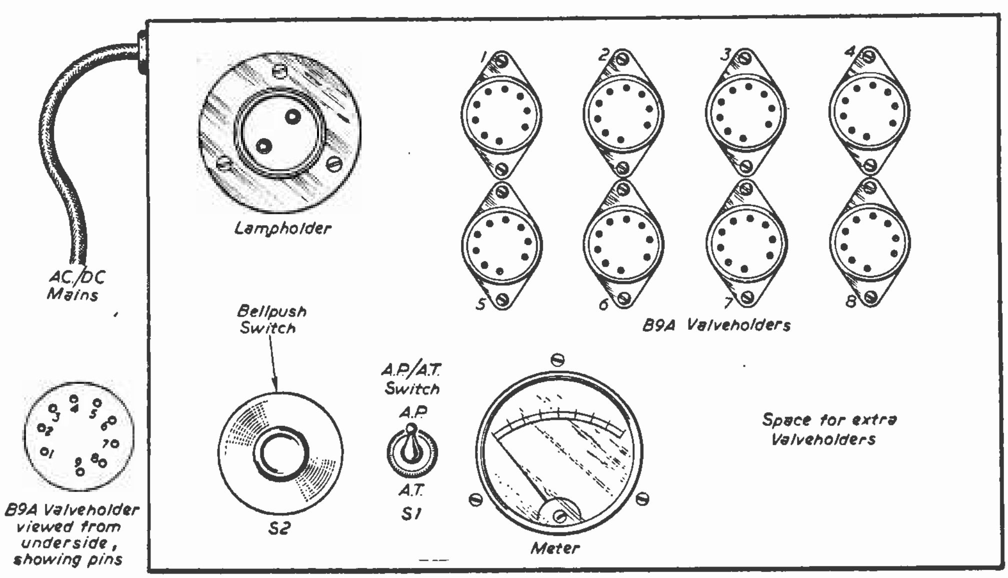


Fig 1.—Plan view of the unit.

the case of double valves, a switch selects each half in turn, and in the case of double triode provides an immediate appraisal of the equality (or inequality) of the two halves. The tester may be hung on a wall, in which case it will test the valves horizontally, i.e. in the plane they are usually to be found in the modern receiver.

Other facilities offered are "soak testing"—for a valve can be left in circuit indefinitely, and checking for microphony by gently tapping the valve whilst under test. The device will also act as a heating rack to keep a valve warmed up whilst out of the set (so handy on intermittent faults) and will light the room and test electric light bulbs.

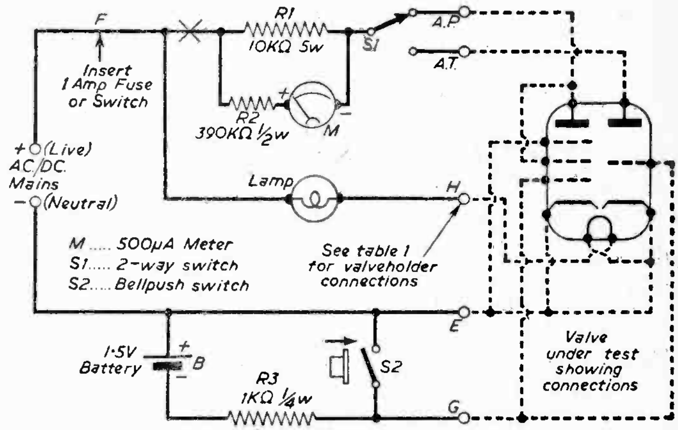


Fig. 2.—The circuit diagram.

Circuit Details

The circuit is shown in Fig. 2 and begins at the "live" mains lead at point (F) where a shielded fuse or on/off switch may be inserted if desired. From here the live lead divides, one lead being taken through a batten lampholder, fitted with a "Home Office" shield, and thence to one heater pin of each valveholder. The other lead from point (F) is taken to the anode load of the valve under test, which comprises a 10k 5W wire-wound resistor R1, across which is connected the 500μA meter in series with 390k ½W resistor R2. The load is switched by two-way switch S1 to either the pentode or triode section of the valve, or, in the case of double triodes, to each half in turn.

Followers of Ohm's law will readily appreciate that as well as providing a good all-round value of anode load with a maximum current drain of 20mA the above values of R1 and R2 have been carefully chosen so that a dead short inside the valve under test will not overload either of them, and will just produce full scale deflection current through the meter. On A.C. mains the meter needle will not, of course, read full scale deflection but merely go "out of focus" should such a short occur.

TABLE 1

Valve Holder Connections

Valve Base No.	Pins 1	2	3	4	5	6	7	8	9
1	n.c.	G	E	E	H	n.c.	Ap	Ap	E
2	At	G	Ap	E	H	Ap	E	E	G
3	At	G	E	E	H	Ap	E	E	G
4	Ap	G	E	E	E	At	G	E	H
5	Ap	G	E	E	H	At	G	E	n.c.
6	E	G	Ap	E	H	G	E	E	At
7	n.c.	G	E	E	H	n.c.	Ap	n.c.	Ap
8	G	E	G	E	H	Ap	Ap	E	At

Key: n.c. No connection
G Grid
E Return line to mains neutral
H Heater wire from lamp
Ap Pentode Anode (or second triode anode).
At Triode Anode

Method of Testing

All valves are tested as triodes, the screen grids of pentodes being strapped to the pentode anode whilst all suppressor grids, cathodes, and one side of the heater are tied down to the return line—which is the mains "neutral". This latter section prevents the testing of heater-cathode breakdown, but as such a fault produces well-known symptoms in the receiver and is instantly recognisable, the absence of such a facility presents no real hardship.

On A.C. mains the valve will also act as its own rectifier, making an H.T. power unit unnecessary, but any reader to whom this appears unnatural is welcome to insert a metal rectifier at point X. This rectifier can be one which has been discarded from a TV or mains/battery portable because it was "low", and any 300V electrolytic of between 2μF and 50μF connected from the junction of the rectifier and R1 to chassis will provide adequate smoothing. In such a case, however, and on D.C. mains supply of over 200V the readings quoted in Table 2 will be slightly lower than those shown on the meter.

Grid bias is supplied by a U2 battery with a 1k limiting resistor and the bellpush shorts this arrangement out. The difference in anode current gives an indication of mutual conductance but should not be taken as the precise gm of the valve especially on the pentode section of a valve since it is tested as a triode.

Constructional Details

For reasons of safety, a "breadboard" construction on a wood base was used. The measurements of the prototype are 10½in. x 8in., and the underside wiring, which is partly at mains potential, is boxed in with plywood.

Other shapes and sizes may be used, and if it can be made safe, so can a metal chassis. This is best carried out by using a 3-core mains cable and taking the earth lead to the metal case. All the other wiring should then be well insulated from the chassis, taking particular care at the points where it passes through the chassis holes. If a fuseholder is fitted it should be of the shielded type, or enclosed in a small plastic box.

In the illustration the valveholders are on the right of the meter and lamp, but for operating convenience, left-handed users could just as easily construct the unit the other way round.

Valveholder Wiring

The wiring to the valveholders is more complicated to draw than to give in table form (Table 1). Five leads run round the underside of the board and are connected to each valveholder, with the exception of the triode anode lead, which is omitted from valveholders 1 and 7. For easy

TABLE 2

Types to be Tested

Type	Valve Holder Number	Pentode Anode Milliamps With 1½V bias	Pentode Anode Milliamps Without bias*	Triode Anode Milliamps with 1½V bias	Triode Anode Milliamps Without bias*
ECC81	4	5	6	5	6
ECC82	4	6	7½	6	7½
ECC83	4	1½	2½	1½	2½
ECL80	3	8	9	5	6
EF80	1	5	8	—	—
EF85	1	8	10	—	—
PCC84	6	8	9½	8	9½
PCC88	5	8	10	8	10
PCC89	6	8	9½	8	9½
PCF80	2	6	8	8	9
PCF82	2	7	8½	6	8
PCL82	8	11	12	2	4
PCL83	3	10	11	6	8
PL81	1	10½	11½	—	—
PL82	7	10½	11	—	—
PL84	7	11	12	—	—
6F23	1	5	10	—	—
6F19	1	8	10	—	—
6/30L2	5	7	8	7	8
30C1	2	6	8	8	9
30L1	6	8	9½	8	9½
30L15	6	8	9½	8	9½
30P12	7	10½	12	—	—
30P16	7	10½	11	—	—
30PL1	3	10½	12	8	9
30PL13	8	11	12	8	8½

*** With button pressed**

tracing it is advisable to colour-code the wires, especially if extra valveholders are likely to he added at a later date, and our own colour code is given in brackets in the list which follows.

Remembering that the valve pins are numbered 1 to 9 clockwise from the gap, their wiring (Table 1) is completed as follows:

G1 (green wire) from all control grids to the junction of R3 and the bellpush.

E (bare wire or white with metal chassis) from heater pin 4 of each valveholder and also pin 5 of valveholder 4, all cathodes, all G3 pins, all "screening pins" to mains neutral.

H (black wire) from pin 5 of all valveholders except holder 4, where pin 9 is the return heater wire, to the lamp.

Pentode anode (red wire) from all pentode anodes, screen grids and the Triode 1 section of double triodes to one side of switch S1.

Triode anode (hlue wire) from the triode anodes of all valveholders except 1 and 7 (which only test pentodes) to the other side of switch S1.

Valveholders may be numbered with "peel off" sticky labels and, if these are large enough, the type number and brief characteristics of the valve for which the holder will be used principally may be added. The main index (Table 2) can be printed on a stiff card and hung up next to the tester.

TABLE 3

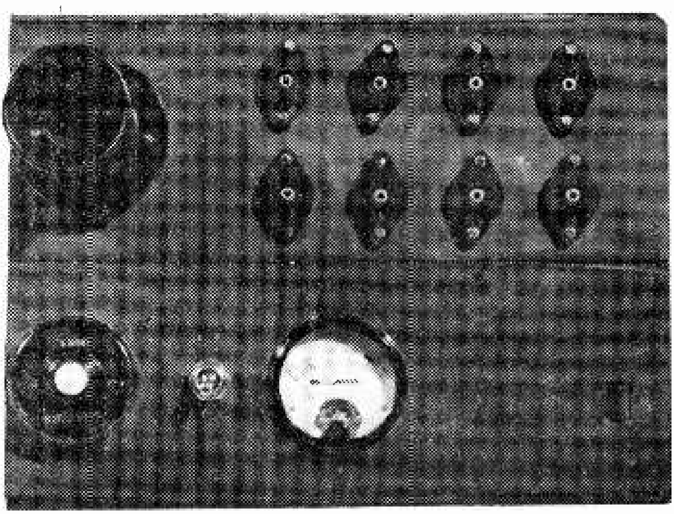
Alternative values of R1 and R2 for other meters

Meter	R1	R2
1 mA	10k 5W	220k ¼W
2 mA	11k 5W	100k ½W
5 mA	13k 5W	40k 1W
10 mA	20k 3W	20k 3W
20 mA	Omit	10k 5W

Alternative Versions

With a 75W lamp the tester will check 300mA heater valves, but it can also be made to check 200 and 100mA valves by removing the lamp and substituting either a 40W lamp or a 25W lamp. Similarly B7G and B8A valveholders can be introduced if desired, although in the writer's case the quantity of these types which pass through the workshop is decreasing daily and does not merit their inclusion. Alternative meters may also he used and any moving coil multimeter may be connected across R1 in place of our meter and R2, if its sensitivity is 500Ω/V or greater. This is best achieved by the provision of a pair of terminals or sockets into which the meter probes will fit, the positive probe being connected to the mains end of R1, and the negative probe to the other end of R1, i.e. at its junction with S1.

(Continued on page 14)



Plan view of the tester.

Choosing your Aerial

USES OF VARIOUS TYPES OF ARRAY

By G. J. King

THERE are numerous factors governing the choice of aerials for television reception, and the choice is by no means simplified by the diversity of types which are currently available. With short-wave and medium-frequency aerials, the primary consideration is that of signal pick-up, and provided the aerial induces sufficient signal of the required station to give adequate signal-to-noise ratio at the receiver, then all is well. With television, although the signal pick-up factor is important, it is not the only factor which needs to be considered. There are additional, equally-as-important factors, as will be seen.

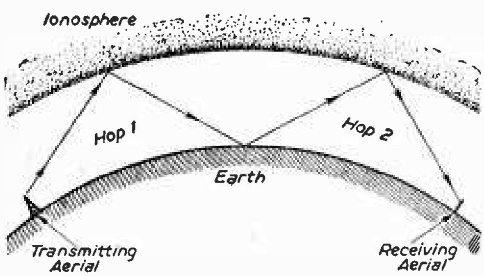


Fig. 1.—Reflection from the ionosphere enables signals to travel long distances. (This does not happen with signals about 30Mc/s.)

Wave Types

With A.M. broadcast signals below about 30Mc/s, the signals are invariably propagated over long distances by reflection back into the reception zone via the ionosphere. Indeed, an increase in range may occur by the signals undergoing a second hop from the earth, back to the ionosphere and then back to the receiving zone, as shown in Fig. 1.

Owing to irregularities of the ionosphere, the receiving aerial may well pick up not only the main reflected signal but also subsidiary signals of the same transmission which arrive a little later than the main signal. This is of little consequence, however, if the delay is not too great. The ear is an accommodating organ, and the resulting sound from the set's loudspeaker is quite acceptable. There are times, nevertheless, when multiple reflections produce a form of distortion, even on A.M. sets, and this distortion may tend to vary as the atmospheric conditions change during a programme from a distant station.

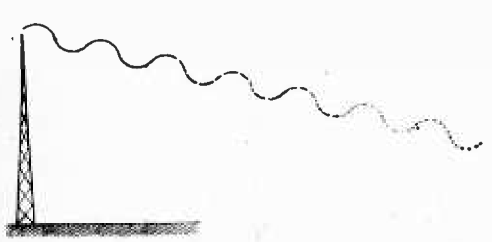


Fig. 2.—Attenuation of signals with distance.

Television signals suffer from attenuation, reflection, diffraction and refraction. The signal is attenuated as it travels away from the transmitter, in the same way as the light from a lamp becomes fainter as distance increases (see Fig. 2). The signal is also further attenuated as it passes through solid objects like large buildings and other structures. Buildings become progressively more opaque to radio signals as the frequency is increased. Thus, a medium frequency signal may suffer only very small attenuation by passing through a building, while with a VHF television signal the attenuation is much more severe, particularly at Band III frequencies. The effects are likely to be even more startling when Bands IV and V are in operation.

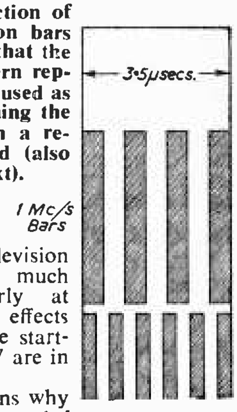


Fig. 3.—This enlarged section of the seven 1Mc/s Definition bars on Test Card "C" shows that the overall width of the pattern represents 3·5μs. This can be used as a time check for determining the extra distance over which a reflected wave has travelled (also see Fig. 4 and the text).

This is one of the reasons why outside aerials are recommended in the fringe of a television service area, and also why outside Band III aerials are necessary in certain areas, even though adequate reception of the BBC signals is possible on a simple or attic aerial. The extra attenuation imposed by roofs and buildings cannot easily be calculated as it depends on the precise construction, but it is interesting to note that dampness of the outside surface has a tendency to increase the attenuation. If just about enough signal is received on an indoor aerial during ideal conditions, then the signal pick-up is likely to deteriorate during wet weather.

Reflection

Reflection of the wave occurs whenever it encounters any solid object the size of which is at least one half the wavelength of the signal. If the object is smaller, there will not be complete reflection and the signal will tend to be diffracted. The higher the frequency, or shorter the wavelength, the more reflections there will be, because there are many more small objects likely to reflect the signal than there are large ones. This means, of course, that Band III signals are more prone to reflection than the lower frequency Band I signals. Reflection troubles will increase when Bands IV and V are used for television. A television set which is receiving two signals, the direct one and the reflected one, will give rise to two pictures. The main picture from the direct signal, and a "ghost" picture from the reflected signal. The ghost will always be displaced from the main picture because the reflected signal arrives at the aerial later than the main signal.

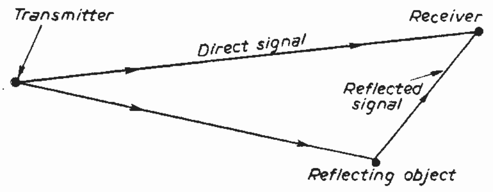


Fig. 4.—The extra distance over which a reflected signal may travel, in relation to the direct signal, can be determined by the displacement of the resulting ghost from the main image.

Based on the fact that radio waves travel at a speed of 186,000ml/sec, simple calculation shows that in 1μs they travel 0·186ml. Now because the scanning spot traverses the picture tube screen horizontally at constant speed, the extent of displacement of the ghost from the main picture can be used to assess the extra time that it takes the reflected signal to reach the aerial.

Test Card "C"

If Test Card "C" is used as a time check, the problem is somewhat simplified, since each alternate black and white bar of the series of seven 1Mc/s definition bars represents exactly 0·5μs (see Fig. 3). Thus, if the ghost is displaced by the same distance as the thickness of, say, four bars, the time addition is 2μs. If this is multiplied by 0·186, the extra distance over which the reflected wave has travelled is obtained. In the example, this works out to 0·372ml (see Fig. 4).

Fig. 5.—Diffraction permits reception over obstacles.

If the reflected signal is in phase, or step, with the main signal, the two signals will add at the aerial and the ghost will resolve as a weak replica of the main picture, but if the signals are of opposite phase, or approaching this condition, then the reflected signal will subtract from the direct signal and the ghost will appear as a negative of the main picture.

Signal reflections are often caused by passing aircraft, and the resulting ghost fluctuates in a very disconcerting manner, changing from a positive to a negative as the phase relationship between the direct signal and the reflected signal changes with the motion of the aircraft. This phenomenon is often known as "aircraft flutter".

Reflected objects which are too close to the aerial to produce a well displaced ghost may cause some impairment of picture definition. The secondary image is, in fact, created, but as it occurs so close to the original it tends to blur the overall display. Reflections from water tanks and the like when an aerial is used in an attic may cause this trouble. If the metal work is too close to the aerial, the aerial impedance may change and cause a mismatch at the feeder termination. To the set, this may look like an extra impedance in series with the aerial circuit, which can also affect the picture quality as it is rather like misalignment of the front-end of the receiver.

Diffraction

Diffraction is the bending of a radio wave when it encounters a hill or large man-made structure, and thus allows the signal to be received behind buildings and hills, even though it may appear that the transmitting aerial is completely shielded from the receiving aerial (see Fig. 5). The amount by which the wave is bent is related to the frequency of the signal, and it becomes less as the frequency is increased. This is one of the reasons why it may be impossible to receive Band III signals at the foot of the hill, although reasonable reception of Band I signals may be possible at the same site (see Fig. 6).

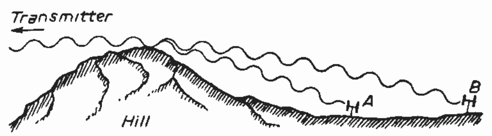


Fig. 6.—Owing to the greater diffraction of Band I signals than Band III signals, a receiver at "A" at the foot of the hill may obtain Band I signals only, while at "B" both Band I and Band III signals would be received.

Some fringe aerials are often seen inclined slightly skywards, this is to allow them to line-up with the wavefront of a signal which has undergone diffraction, and in this way slightly improved signal pick-up is sometimes

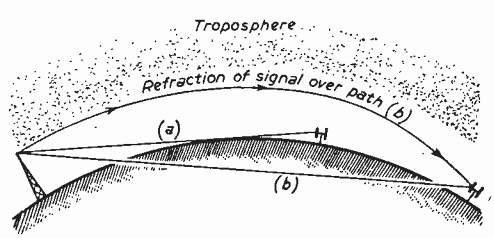


Fig. 7.—Reception beyond the "line of sight".

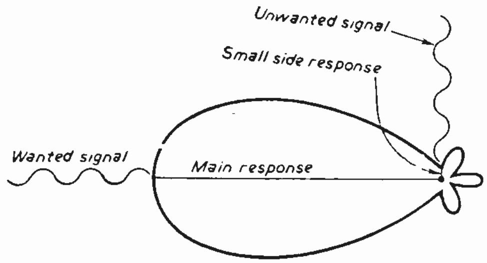


Fig. 8.—An aerial response pattern as shown may well be necessary to obtain maximum discrimination between the wanted and unwanted signals.

possible. In built-up areas it is often found that television aerials point in slightly different directions. This may not be due to poor installation, but may be due to signal diffraction, particularly if each aerial has been orientated individually for the best pick-up. This is why it is desirable to set-up an aerial on the signal, and not rely too much on compass bearings, especially in built-up areas in the fringe area of a transmitter.

Refraction

Refraction is the process which enables a television signal to be propagated over a path of greater distance than that limited by the line-of-sight distance between the transmitting and receiving aerials. In Fig. 7 is shown the maximum line-of-sight distance between the two aerials at (a). Path (b) is in excess of the line-of-sight distance since it falls below the optical horizon. However, it is still possible to obtain reception over path (b) owing to refraction of the signal by the lower atmosphere, often called the troposphere. Refraction occurs where there is a change of density of air with height above ground, and it is this factor which makes fringe reception possible. Unfortunately, the refractive factor rarely remains consistent for any length of time, and this is one of the reasons why fringe area reception is subject to fading and distortion. Over fringe area paths the signal may also undergo diffraction by the ground, and when the tropospheric conditions are disturbed

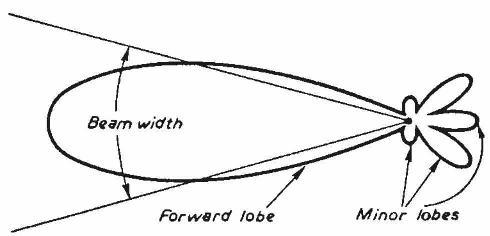


Fig. 9.—As more elements are added to an aerial to provide a narrow forward lobe and extra high gain with small beam, width, subsidiary minor lobes tend to develop, as shown.

interaction between the refracted and diffracted signals may make fringe area viewing even more unsettled. In fringe areas it is usually found that the strength of the aerial signal will increase as the aerial is increased in height. This, of course, is to be expected since then less reliance is placed on the tropospheric factor because the greater height of the aerial gives an increase in the line-of-sight path between the transmitting and receiving aerials.

Sometimes tropospheric and other factors propagate the signals over far more distant paths than normally expected. With the progressively increasing number of stations sharing common channels this can be very disturbing, since there is a tendency for a more distance station breaking through on receivers obtaining their signals from the local station operating on the same channel. Horizontal dark lines is the characteristic symptom, but in severe cases the unwanted picture may be seen drifting to and fro across the wanted picture. Continental interference of this nature is experienced quite often on the south coast, and at one spot known by the writer a French station sometimes takes almost complete control of the receiver, even though the local BBC transmitter is only about 28ml away!

Choice of Aerial

Having in mind all the factors discussed above, it will now be apparent that there is far more governing the choice of aerial than first meets the eye. The aerial should have sufficient gain to help counter the loss of signal due to its travel through space and through large structures. Close to a transmitter a simple indoor or outdoor dipole may be adequate, but with greater distances up to about 60ml from the transmitter, two, three and four element arrays are required.

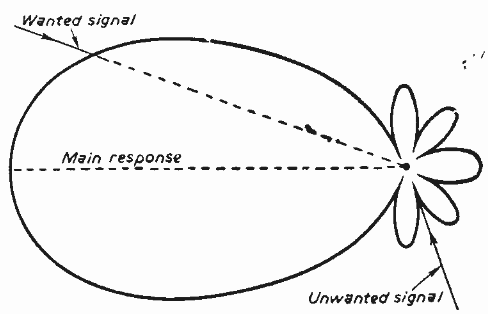


Fig. 10.—If there is one major interfering signal, an aerial with a relatively wide forward lobe may be orientated to give maximum rejection of the interfering signal without unduly affecting the pickup of the wanted signal.

If reflected signals are troublesome, even if close to a transmitter, high-gain directional aerials may well be necessary. A response pattern as shown in Fig. 8 is often desirable under such conditions. The main response can be directed to the wanted signal, and then there is less chance of the aerial picking up the reflected signals, as they fall on the side or rear of the response pattern where the aerial is considerably less sensitive. In this way the best discrimination between the wanted and unwanted signals is available. If such an aerial is required close to the transmitter, then it may be necessary to get rid of some of the signal by the use of an attenuator in the aerial downlead—to avoid overloading the set.

In built-up areas it often happens that there are wide variations of signal level from one end of a street to the other end. The signal can, in fact, vary by as much as 2-to-1 (6dB) over distances as short as 30ft. Thus, it may follow that while one viewer is obtaining good reception on, say, an "H" aerial, equal reception can only be obtained by the next-door neighbour on a three-element array. This often gives rise to many heated discussions over the garden fence!

Lobes

Response patterns of aerials are made up of several lobes. There is the main forward lobe, whose axis represents the direction of maximum sensitivity (or pick-up) of the aerial, and subsidiary minor lobes, which unfortunately tend to crop up when extra elements are added to provide a narrow forward lobe and extra high gain with a small beam width (see Fig. 9). In an area of high interference, with the interfering signals arriving from a variety of directions, an aerial with a relatively narrow forward lobe may well be desirable.

However, if there is one major reflected signal causing a ghost and other interference is not unduly troublesome, an aerial with a relatively wide forward lobe (beam width) may be more suitable, as then the aerial may be orientated away from the direction of the signal slightly, without undue signal reduction, as a means of eliminating the ghost (see Fig. 10). Fig. 11 shows how the response to the wanted signal could be badly reduced when an aerial with a narrow forward lobe is orientated to eliminate the response to an unwanted signal.

Nevertheless, extra-high gain aerials are essential for fringe area operation, but the question of minor subsidiary lobes must be considered if there is a possibility of co-channel interference. It should also be remembered that the lobes charted on manufacturers' polar diagrams are for one frequency only. An entirely different set of lobes may occur at a frequency removed from that to which the aerial is tuned.

Band III signals tend to fall off in strength more quickly with distance than Band I signals. This difference in signal can be equalised, however, by arranging that the forward gain of the Band III aerial is greater than that of the Band I aerial. This is automatically catered for on combined aerials.

Moreover, most receivers are usually more sensitive on Band I than on Band III, which often means that in order to obtain equal pictures on both bands, the Band III signal applied to the set should be slightly stronger than the Band I signal. This, of course, is applicable when the signals are only just about strong enough to work the set properly. When the strength of the signals is above the lowest workable level, then any small unbalance between them is accommodated by the receiver's AGC circuits.

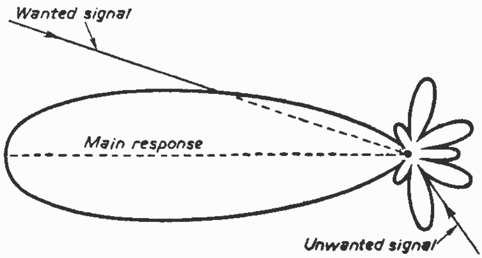


Fig. 11.—This diagram shows how the response to the wanted signal could be severely reduced if an aerial with a narrow forward lobe were orientated to reduce the response to an interfering signal coming in towards the rear. Nevertheless, an aerial with a narrow forward lobe may be required to reduce interference coming in from a variety of directions.

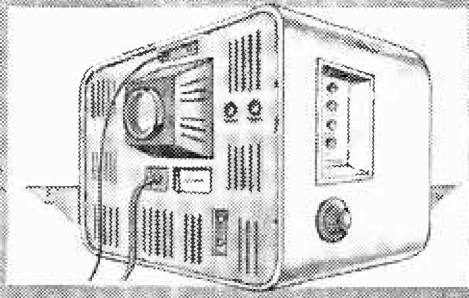
VALVE TESTING FOR BEGINNERS

(Continued from page 10)

The meter in this case should be set to the D.C. range nearest to 200Vfsd and a 100V scale reading will correspond to an anode current of 10mA so that current measurements may be made by dividing by ten. Alternatively the meter can be set to a D.C. current range and inserted in series with the lower end of R1 with its positive connection to R1 and its negative connection to the switch. Table 3 gives alternative values of R1 and R2 for various other types of surplus meter.

It will be noticed from the readings in Table 2 that the greatest amount of current drawn is about 11mA and this means that it would be quite in order to use a multimeter on the 120V or 12mA ranges to obtain a more accurate reading, but some form of protection against overload should be incorporated in the meter circuit. The readings in Table 2 were, incidentally, the result of testing at least three new valves of each type and taking the mean. Due to the fixed anode impedance and bias, which were chosen as good all-round figures and probably do not suit any one valve exactly, the readings obtained cannot be linked with the manufacturer's data. During the testing of new valves a very wide variation was experienced among valves of the same type and between the two halves of double triodes.

Servicing Television Receivers



No. 60—COSSOR 948

By L. Lawry-Johns

THIS 17in. table model uses an AW43-80 electrostatically focused tube and a printed circuit. A Cyldon type C turret tuner is employed and a neon indicator illuminates the channel number selected.

Rear Cover

A "wrap-round" rear cover is easily removed by means of the top and side screws to expose most of the working parts. The bottom of the cover is first pulled clear to allow it to be lifted to clear the top pre-set control knobs. When replacing ensure that the lower corners engage in the slots of the base-board and see that the width control comes through the hole.

The wooden shell (cabinet) is also detachable from the base-board and this is carried out as follows. First loosen the control knob grub screws in the larger knobs, covered by insulating material and pull off all four knobs. Remove the two screws from underneath the cabinet and the two inside the top of the cabinet. Disconnect the

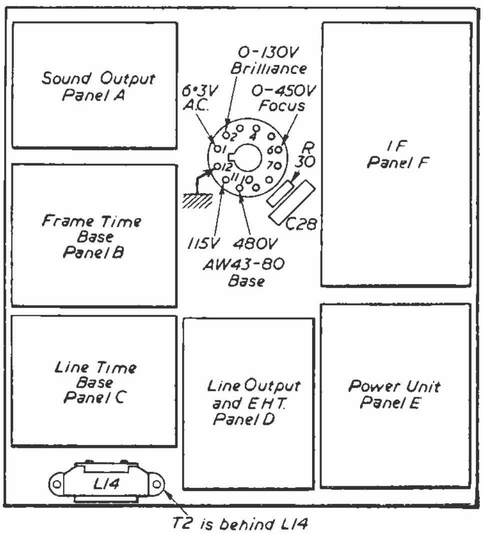


Fig. 2 (Right).—Layout of the printed panels, viewed from the rear.

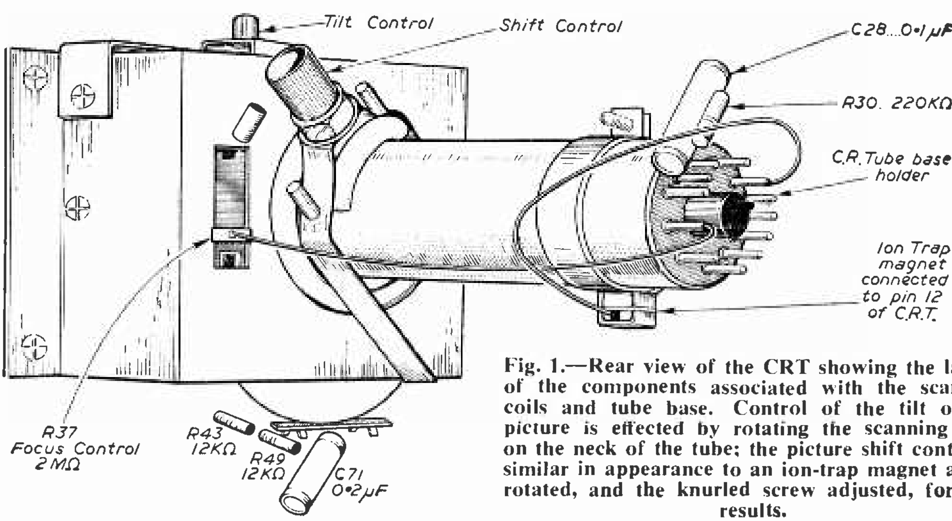


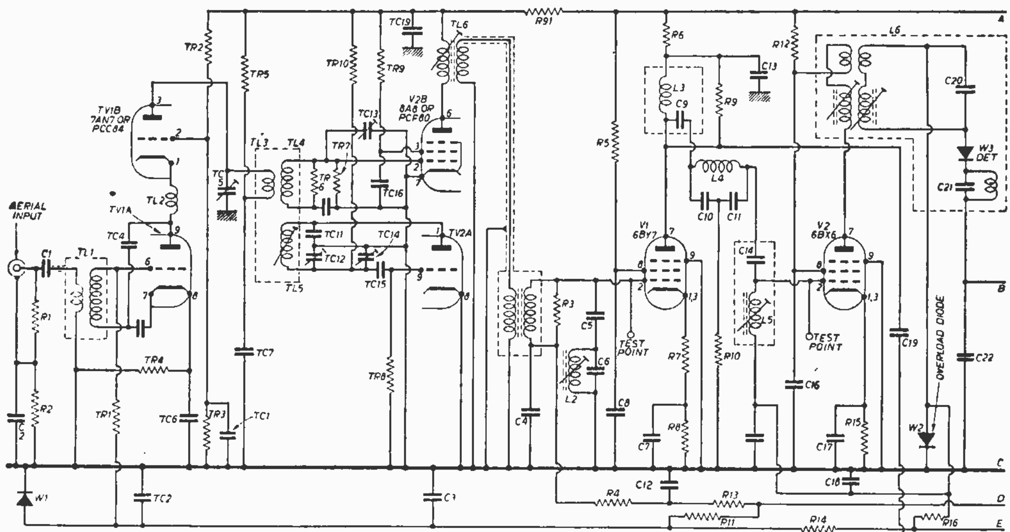
Fig. 1.—Rear view of the CRT showing the layout of the components associated with the scanning coils and tube base. Control of the tilt of the picture is effected by rotating the scanning coils on the neck of the tube; the picture shift control is similar in appearance to an ion-trap magnet and is rotated, and the knurled screw adjusted, for best results.

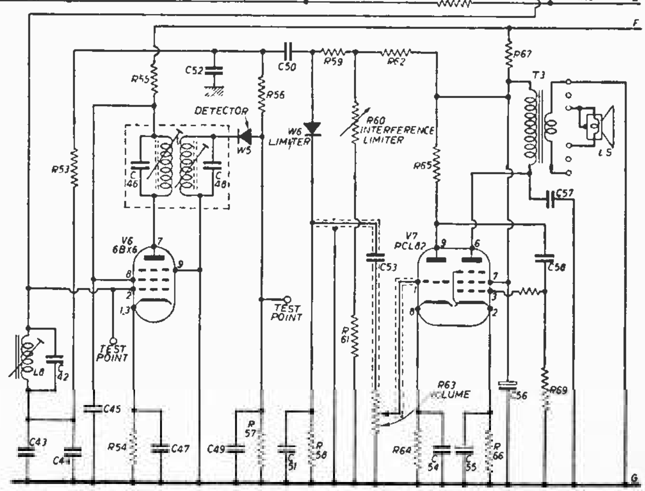
loudspeaker leads from panel A. Slide the shell forward and release the neon lamp wire spring.

Cleaning the Tube

To clean the tube face and window, it is only necessary to remove the domed brass covers of the mirror screws which hold the brass strip marked "Cossor". Remove the screws and strip; lift the heavy glass slightly and move the bottom edge forward and lower gently from the cabinet.

If access to the inside of the turret tuner is required, remove the shell as above, then remove the two 4B.A. screws securing the front bracket to the turret. Swing the turret slightly to the left, remove the two wood screws holding the bracket to the base-board, remove the bracket and swing the turret round to bring its cover to the front. This may sound very involved, but it is really only the work of minutes.





Setting Up Channels

If the fine tuner is not near midway for optimum reception on any required channel, remove the switch knob and fine tuner, having selected the channel, and set the fine tuner spindle midway. Insert the usual trimming tool (knitting needle with screwdriver-shaped end), which must be non-metallic, into the hole provided and tune the oscillator coil core for maximum sound.

Poor Contact Surfaces in Tuner

After having been in service for some time, the turret switch often fails to present the required channel, this being received with the switch turned just over, or just before, the click. Normally this only means that the biscuit studs and contact springs in the tuner require cleaning to restore the surface contact. Merely cleaning the studs with a soft cloth will often produce a temporary cure, but the application of switch cleaner followed by a light application of MS4 grease or even "Vaseline" will give more lasting results.

A noticeable increase in gain, especially on Band III, can often be obtained after the turret has been properly cleaned. The contact springs must *not* be bent or re-bowed in this type of tuner; cleaning is all that is required.

Loss of Gain

Where there is a marked loss of gain, particularly on Band III, where the picture may be grainy, ragged or snowy, with perhaps background hiss on the sound, the tuner valves, particularly the 7AN7 (PCC84) should be checked,

* * *

Fig. 3 (a) and, opposite, (b).—Circuit diagram of the Cossor 948 receiver.

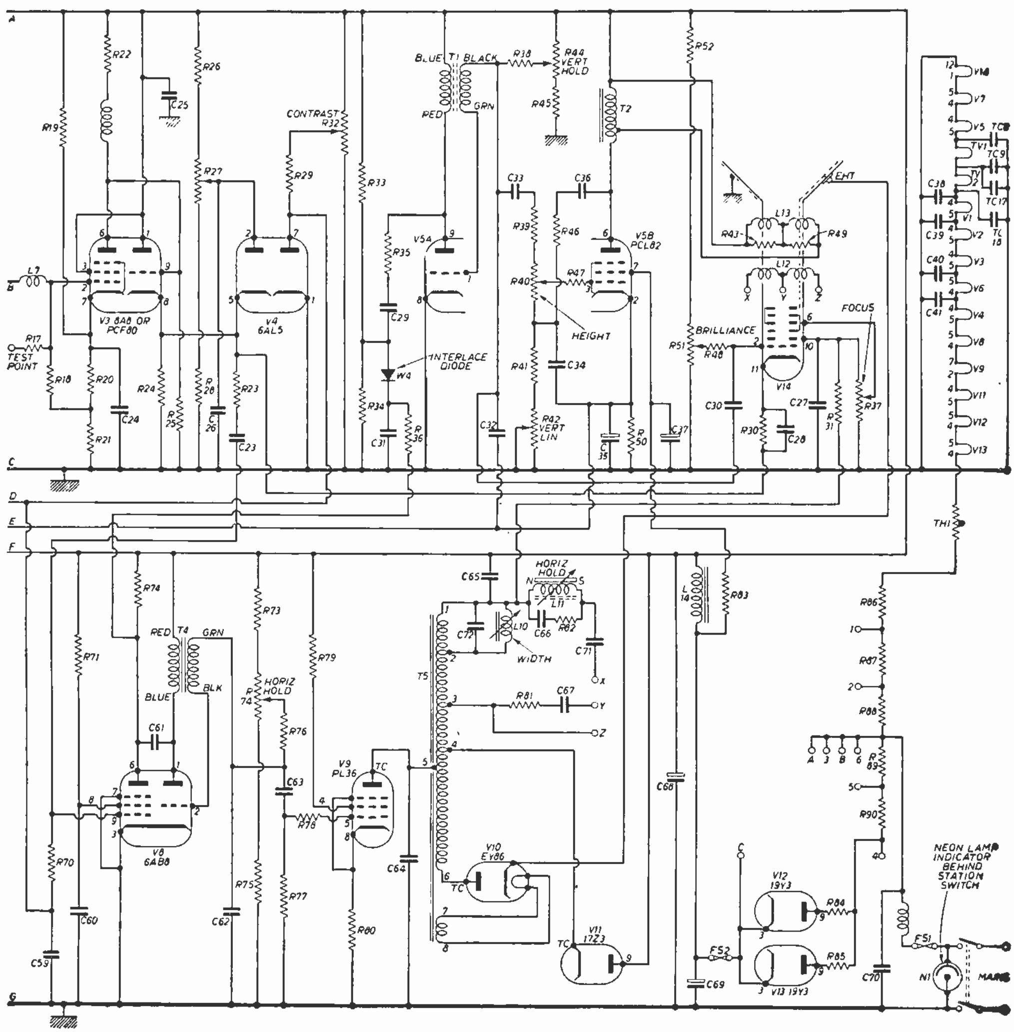
the contacts cleaned as above and the aerial input examined. If these points are in order check V1 (6BY7) and the voltage supplies to this and the turret tuner. If these are in order check the tuner resistors, particularly TR10 (6·8k), which sometimes increases in value, despite the fact that it is a 1W resistor.

Some Common Faults

The symptoms of no sound or vision but with a raster displayed when the brilliance is advanced should direct attention to the 8A8 (PCF80) on the turret tuner, although the 7AN7 may be at fault. When there is no raster at all, and no sign of life from the speaker, it can be assumed that there is no HT. Although this is normally caused by failure of fuse FS2, the writer has encountered several instances of a break in the printed circuit track on the run from pin 3 of V13 to FS2, approximately between the tags of R89 (Panel E). Usually the break is thin enough for solder to be run across to complete the track, but a larger gap should be bridged with a piece of wire or a lead may be taken from pin 3 of V13 to the FS2 holder. The cabinet shell should be removed to gain access to the track.

If FS2 is blown and a replacement also fails immediately or within a short time, inspect the tracks for signs of breakdown from the H.T. runs to chassis or to the A.C. runs. Where a breakdown of insulation does occur and scraping the board fails to clear it, strip out the track and replace with a lead between the required points.

(To be continued)



CURING TV INTERFERENCE

SUPPRESSING ELECTRICAL EQUIPMENT

By A. E. Irwin

MOST forms of TV interference are momentary, but "ghosting" is permanent unless something is done about it.

"Ghosting"

"Ghosts" or images to the right of the main picture can be simply explained. The direct wave which gives the main picture is also reflected from

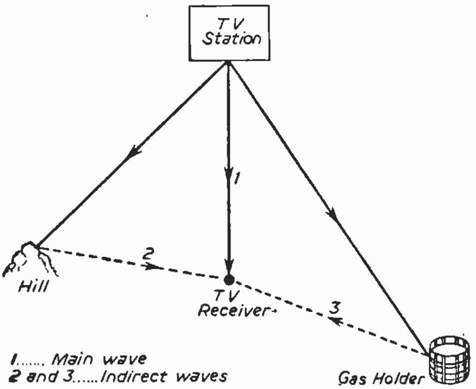


Fig. 1.—Reflected and direct signals.

high ground or nearby objects such as gasholders, masts, etc. Reflections, or indirect waves, have to travel further to reach your receiver, hence the slight displacement of the images from the main picture (see Fig. 1).

If you live near, or on, a hill "ghosting" will almost certainly occur. The interference becomes worse as the main wave decreases in strength and so becomes very bad in fringe areas. To minimise "ghosting" and interference generally the aerial system must be as efficient as possible.

Fig. 2.—Ignition suppressor.

Aerial Adjustment

If you have an ordinary dipole or even a three element array, you may have to install a six-element broadside array (two six-element arrays mounted alongside each other) before you can cure this trouble.

This gives a forward gain of 10½dB over an ordinary dipole

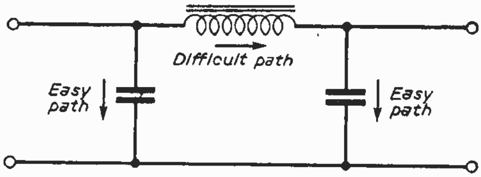


Fig. 3.—Behaviour of filter circuit at low frequencies.

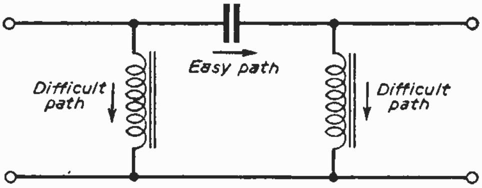


Fig. 4.—Behaviour of filter circuit at high frequencies.

and perhaps what is more important, a minimum pick-up from the back and sides. With the extra gain and improved directivity the minimum point of reception of the indirect waves can be found easily as you rotate it. The ease with which this can be done depends largely on whether the aerial is inside or outside the house. In the latter case it is advisable to let a qualified serviceman move the aerial.

In weak signal areas, the siting of the array is most important. Moving it a few feet may remove the "ghosts" entirely. In such areas, "ghosting" can be aggravated by using a feeder of the wrong impedance. Do not use a cable with a pair of leads, which may be anything from 100-300Ω, particularly if it is a long one, and join it to the 75Ω coaxial socket of your receiver. Use a proper coaxial cable with one lead and a screen and which is of the correct impedance of 75Ω. Any surplus cable should be cut away. In other words, make the input lead as short as possible.

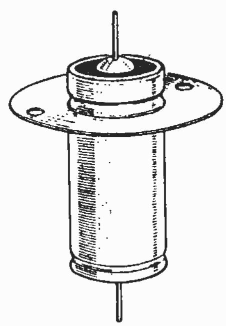


Fig. 5.—Lead-through condenser.

Ignition Interference

Until all motorists are compelled to fit ignition suppressors, we shall continue to have a pattern of white dots moving up and down our screen every time an unsuppressed vehicle passes near.

Ignition interference is easily suppressed, at the source, by fitting a resistor of 15k in the car H.T. lead near the distributor. The screw-in type costs about 2s. 6d. and can be fitted quickly in the following manner.

Unscrew the distributor lead and screw the suppressor in its place. Then screw the distributor lead into the threaded hole provided for it on the suppressor

Manufacturers claim it gives reduced plug burning, less pinking and easier starting in cold weather, as well as the required suppression (see Fig. 2).

Interference Limiter

Careful adjustment of the interference limiter on your receiver may lessen some types of interference. This may be achieved by turning the control right round until the highlights become dark. A slight movement in the opposite direction, to restore the picture to normal, gives the correct setting.

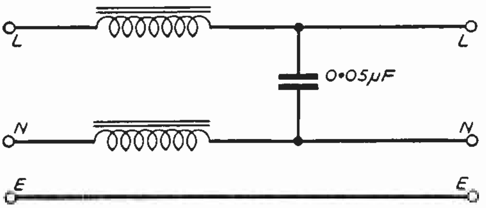


Fig. 6.—A flex-lead filter.

Several narrow bands right across the screen is one source of interference easily recognised. A lamp in the room is the most likely cause. Take it out of the holder and reverse the connections by turning it round before replacing in the lampholder. Failing this, try a new lamp.

No single suppression filter will cover the entire range of the radio, medium and long, wave-bands, TV Band I and TV Band III (i.e., 200kc/s to 200Mc/s). Actually radio suppressors are of little use at TV frequencies and vice versa.

Effects of rise in frequency

For effective suppression, condensers should be of low impedance and inductors of high impedance (Fig. 3). Normally, as the frequency increases to above 2Mc/s, the impedance of the ordinary condenser, owing to its self-inductance, starts to rise. Similarly, the impedance of an ordinary inductor, owing to its self-capacitance by-passing the H.F. current, starts to fall.

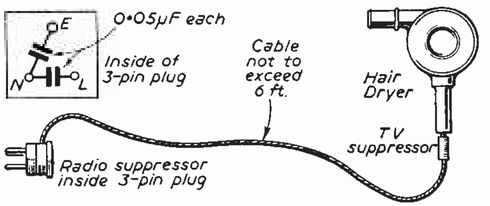


Fig. 7.—Suppression for radio and TV.

As the frequency is further increased, the situation rapidly becomes worse. Finally the components shown in the filter circuit of Fig. 3 have to all intents and purposes, changed places. Condensers are behaving like inductors and inductors like condensers (see Fig. 4). Their suppression value at Band III frequencies is negligible.

Coils wound on dust cores will suppress over the radio bands, TV Band I and partially TV Band III, but special coils are made for Band III.

The self-inductance of capacitors is reduced by making the internal leads as short as possible. In one type the foil ends are joined to a close-fitting metal case which is used as one terminal. Any gap increases the inductance.

Another type of condenser suitable for carrying large currents is the lead-through capacitor. A metal rod carrying the current passes through the main body of this capacitor. A rolled type of condenser is wound round it, one set of foil ends being connected to the rod and the other set to the surrounding metal case. A flange forming part of the metal case has two fixing holes for firmly bolting it to the framework of a machine, etc. Being of extremely low inductance, its impedance is comparatively low at the higher frequencies (see Fig. 5).

A flex lead filter is obtainable to cover the radio bands and TV Band I (for 2A) but this must be fitted within 6in. of the appliance (see Fig. 6).

Filters

One way to give overall suppression, for power drills, etc., is to use two filters, one for the radio bands and one for TV Band I (such as shown in Fig. 6). The medium and long wave-bands suppression filter is incorporated in the mains plug (see Fig. 7). The cable must not exceed 6ft. in length.

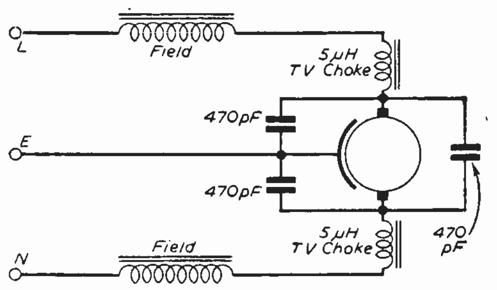


Fig. 8.—Motor suppressed for TV (Band III).

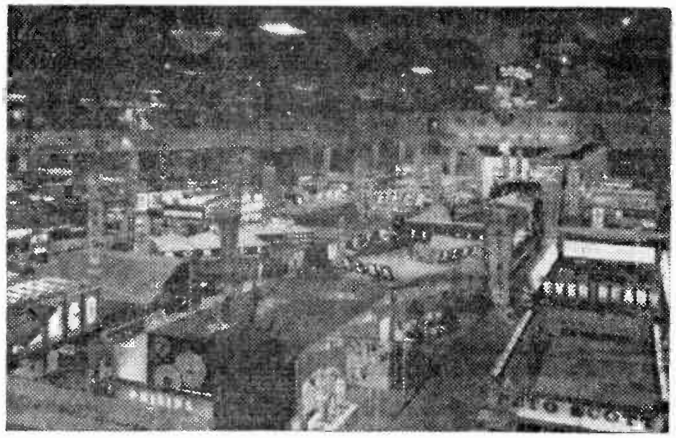
Any filter for Band III must be fitted inside the apparatus as an external filter would radiate interference. Inductors must be joined in series with the brush leads and as close as possible to the brush terminals.

Owing to the high frequencies involved, TV suppression components are much smaller in size than radio components.

A universal motor fully suppressed for Band III is shown in Fig. 8. If there is room inside the apparatus, radio suppression components can be added. If not, the mains plug with suppression condensers fitted inside (see Fig. 7), can be used.

RADIO SHOW 1960

A review of some of the products shown at Earls Court this year



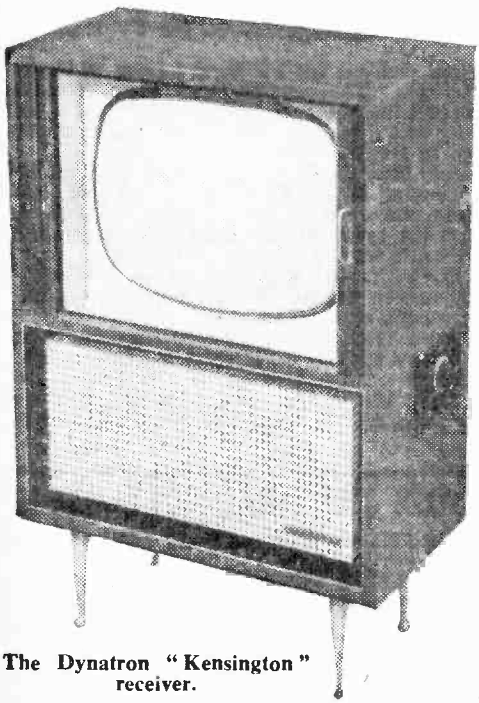
A view of the stands at last year's Show.

AERIALITE LTD. STAND NO. 13

The new Aeraxial trunk cable for television relay was displayed this year together with a new non-radiating type of television cable. The range of Aerialite coaxial cables was also exhibited. Various displays of television aerials featured a wide range of separate aerials available for BBC and ITV reception and a range of single and twin band pre-assembled aerials were shown. Among the new aerials was a twin band indoor aerial suitable for all channels.

BELLING & LEE LTD. STAND NO. 63

One of the features on the " Belling-Lee " stand was a range of " set-top " aerials. The " Vedette " is a new set-top aerial supplied complete with cable and coaxial plug and retails at 23s. The " Metropolitan " which was shown at last year's show was again exhibited together with the " Golden V ". Other aerials on show included a range of telescopic aerials which plug directly into the back of the set with a simple means of fixing, and a complete range of outdoor and attic aerials including the new 9D extended nine-element array.



The Dynatron " Kensington " receiver.

DYNATRON RADIO LTD. STAND 52

Seven television receivers were displayed on this stand including a new 17in. console model, the " Kensington ". This receiver has a combined 17in. television and VHF radio receiver retailing at 97 guineas. The " Dorchester " is a new 21in. table model with a 110deg tube. The slim-style cabinet has bow doors and is finished in medium walnut veneer. This receiver retails at 92 guineas. A transportable television, the Envoy, with 110deg tube was exhibited on this stand. Housed in a cabinet in pigskin Vynide this receiver has side-by-side station positions on the turret tuner and two elliptical speakers. The retail price is 68 guineas. The Autoview 21in. console model has an aluminised 110deg tube and motorised press-button control of TV and BBC VHF radio broadcasts. An armchair remote control unit has provision for station changeover and volume control. This is available in three models, " Queen Ann " TV 50, 170 guineas, " Chippendale " TV 50CH, 185 guineas and " Contemporary " TV 51 which retails at 149 guineas.

E.K. COLE LTD. STAND 58

The Ekco stand showed several Ekcovision models ranging in price from 59 guineas to 99 guineas. A 17in. portable receiver, Model TP373, incorporates VHF radio and is housed in an attractive plastic cabinet. The operating controls are positioned on top of the cabinet and a carrying handle drops flush with the top when not in use. Another portable receiver exhibited was Model TP347. This retails at 59 guineas and is a super-slim receiver with an overall depth of only 12in. The operating controls are positioned on top of the receiver and a carrying handle is provided. The lightweight case is moulded in a plastic. Model TC313 is a 21in. console receiver which is housed in a bow fronted walnut-veneered cabinet. The price is 99 guineas..

E.M.I. SALES AND SERVICE LTD. STAND 24

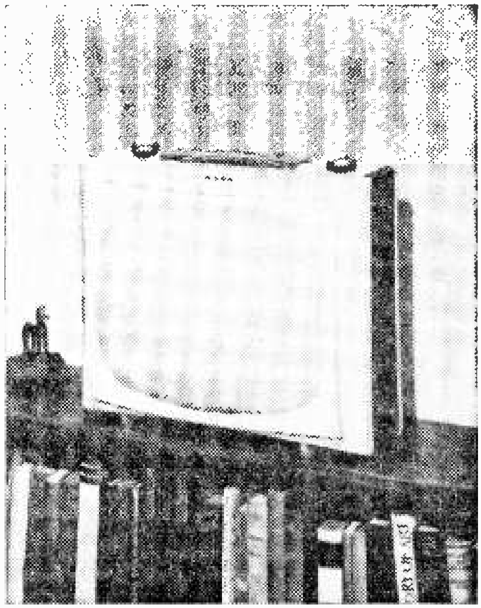
At this year's show E.M.I. Sales and Service Ltd. had a stand separate from that of its parent company E.M.I. Ltd. The two-inch wide video-tape as used by the BBC and ITV companies was shown together with a range of Enitape magnetic recording tape. A complete range of Marconi valves was also exhibited on this stand.

INDEPENDENT TELEVISION AUTHORITY STAND 74

This year at the Radio Show, ITA featured its national network in a special pavilion on the ground floor. This pavilion formed part of a display provided jointly by Associated Television, Southern Television, Independent Television News and the Authority. Inside the pavilion was a large map of the United Kingdom in relief form; visitors were able to stand around it on raised platforms and listen to the story of the Independent Television network. Transmitting stations, studio centres and network links were indicated by coloured models and the lighting sequence was controlled automatically by specially constructed relays. In the "Garden" Studio many Independent Television stars made personal appearances on the circular celebrity dais. Live closed-circuit programmes were transmitted from the stage.

LABGEAR LTD. STAND NO. 25

A comprehensive range of television and VHF/FM aerials was shown on this stand including the "Satellite" telescopic "V" aerial. The aerial accessories included diplexers and triplexers, outlet boxes and pre-amplifiers. One of the new distribution amplifiers is Model E.5054 which is a two stage dual-band amplifier with an A.C. mains consumption of approximately 20W.



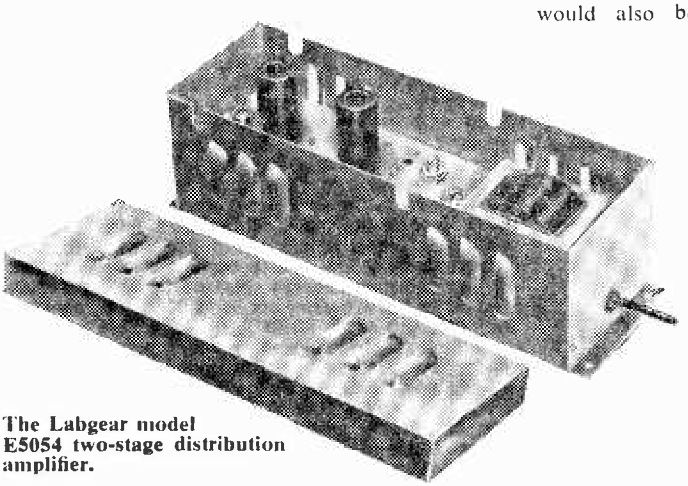
The Ekcovision 17in. portable receiver, model TP 347.

SOBELL LTD. STAND NO. 64

Four new models were exhibited on this stand each including VHF radio and automatic contrast control operated by photo-electric cell. The sound quality was improved by the use of two elliptical loudspeakers, one on either side of the tube, facing forward, to direct the sound towards the listener. All four models were provided with a simple connection for use with a remote control unit which, attached to 15ft of cable, enables the viewer to adjust volume and brightness, and switch on or off from his easy chair. This attachment would also be a boon for the elderly and infirm, bed-ridden patients or anyone incapacitated. (The price of this unit is 2½ guineas.)

STANDARD TELEPHONES AND CABLES LTD. STAND 14

To demonstrate the surge handling capacity of the new STC silicon rectifier for television receivers, a series pair of diodes was subjected to a surge of 35A every 5sec through the duration of the Radio Show. These diodes have a rated maximum current of 500mA and are particularly suitable for modern compact television receivers. In the semiconductor field, in addition to the television rectifier Type FST 1/4 mentioned above, there were many other silicon and selenium rectifiers.



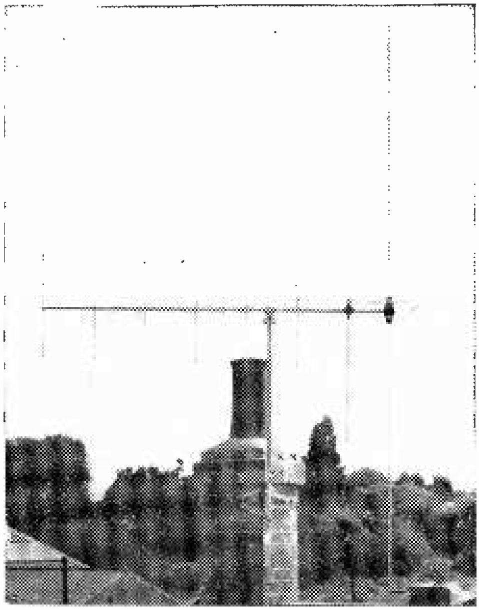
The Labgear model E5054 two-stage distribution amplifier.

TELEGRAPH CONDENSER COMPANY LTD. STAND 42

The emphasis of the T.C.C. stand this year was on the firm's recent progress in the fields of condensers, printed circuits and ceramics. Wider ranges of sub-miniature electrolytics were shown together with Tantalum anode electrolytics for use in equipment meeting with extremes of temperature conditions and in apparatus which is subject to remote control or must operate satisfactorily for long periods without the need for servicing. A comprehensive range of condensers, chokes and filter networks was exhibited, catering for the new requirements in suppression for radio and TV frequencies. Among printed circuits shown were several for combining two aerials into a common downlead (diplexers).

WOLSEY ELECTRONICS LTD. STAND 43

On this stand Wolsey displayed aerials for all bands, covering both single arrays and combined models. A new range of combined aerials was shown for the first time known as Collector Combines. These are tuned to both Bands I and Band III and have phasing bars to enable correct matching to be maintained on both Bands. Many new additions were made to the range of aerial accessories. A display of relay and multi-outlet vision network systems was in operation during the show. This consisted of four channels of vision and four channels of sound.



One of Wolsey's "Collector Combines".

TWO-BAND PRE-AMP

(Described in the June and July 1960 issues)

AN ALTERNATIVE INPUT CIRCUIT

On making further experiments with the "Two-band Pre-amp", the author finds that the circuit modifications given in the diagram below (Fig. 1), may give improved results in some areas. When switching from Band I to Band III, the Band III coil is now connected in parallel with the Band I coil, but the aerial coupling coil, L1, remains in circuit, thus providing coupling for both Bands I and III. This arrangement permits optimum matching to be obtained more easily on Band III. No modifications are needed to the remainder of the circuit.

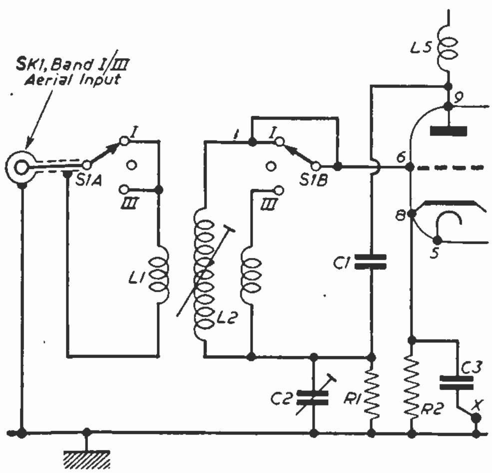


Fig. 1.—The alternative input circuit.

5,000,000A ARC

A CAPACITOR bank of 390,000μF—2,000 capacitors of almost 200μF 6,000VW each—is being built for a Boeing Aircraft wind tunnel in Seattle, USA. The capacitors contain 200 acres of aluminium foil and will fill a room 35ft x 35ft x 25ft. In this huge bank will be stored 7,000,000 joules of electricity. It can be discharged in a few milli-seconds, creating the highest-current arc ever known, 5,000,000A.

Because there is no device capable of switching and carrying such a current, a piece of steel piano wire will be vaporized near the arc electrodes, releasing metal ions. These ions will close the circuit between the electrodes, allowing the capacitors to discharge. The speed of discharge must be very high. Since all inductances in the current path slow up the speed of discharge, special engineering is being employed to keep the inductive reactance very low and to carry the huge current.

The enormous energy released by the arc heats the air in the arc chamber to 18,000deg F, creating air pressure near 30,000lb/sq. in. This pressure ruptures a plastic diaphragm which permits a high-energy shock wave to rush through the test section of the wind tunnel. This shock wave is followed by a hypersonic flow of air past the model to be tested. Before each shot, the wind tunnel is pumped out to a high vacuum to increase further the pressure differential that creates the air flow.

Video Troubles Explained

VIDEO AMPLIFIER CIRCUITRY AND SERVICING

By J. F. Kimber

ONE of the least understood sections of a television receiver is the video amplifier stage. This is the section of the vision channel of which the counterpart is the output stage of the sound channel. Unlike the sound output stage, however, which is called upon to supply *power* to the loudspeaker, the requirement of the video amplifier is to supply a voltage the magnitude of which varies in direct sympathy with the waveform of the vision signal without causing either undue delay or distortion.

Changes

If the vision signal suddenly falls from, say, peak white to grey then the video amplifier has, theoretically, to respond to the resulting change in voltage almost instantaneously. If the vision signal falls to grey for 1μs. and then reverts to peak white again, a good quality visual reproduction can only be achieved if the video amplifier is able to keep up with this swift change in signal.

The measure of the speed at which the video amplifier can respond is known as the "rise-time" of the circuit. An amplifier with a short rise-time can respond very quickly and thus follow the sharp rises and falls of the vision signal. If the amplifier is "sluggish" in operation, then it would have a long rise-time and the finer detail of a picture would be completely lost as the fast pulses which make up fine detail would occur completely unnoticed by the amplifier. Only the less detailed component parts of a picture would then be reproduced on the picture tube screen, as these comprise wider, slower-going pulses, to which the video circuits would be able to respond. If the rise-time is very long, of course, even the less detailed parts of the picture would be lost.

Effect on Sync

Faults often occur in the video circuits which decrease the rise-time. Such faults cause not only poor definition, but also unstable synchronising, pulling on whites, and line pulling etc. The reason for this is that the video circuits have to deal with the sync pulses as well as the picture signal. Sync pulses need to be square-shaped for accurate synchronising, but they can only be kept square when the video circuits have a fast rise-time. If something happens to decrease the rise-time, the sides of the pulses tend to curve off into a noticeable slope and this as would be expected, can seriously affect the locking of both line and frame and cause irregular triggering of the timebase generators.

In Fig. 1 is shown one line of a television signal between two line sync pulses. The full line of the waveform represents the theoretical ideal, while the dotted line sections show how the sharp leading edges and corners of the various pulses are destroyed when the rise-time of the video circuits is impaired. It is obviously impossible to obtain, or reproduce, a perfectly square wave, since there must be a time delay from zero to the pulse building up to maximum, or from maximum to the pulse collapsing to zero. Thus, a television waveform will never appear as the theoretical ideal. The problem is inherent at the transmitter as well as at the receiver, and in order to help resolve this, at both ends of the chain, small time intervals at black level are arranged to occur for 1·5μs just before the line sync pulses and for approximately 6μs directly after the pulses. These intervals are known as the front and back porches, as indicated in Fig. 1.

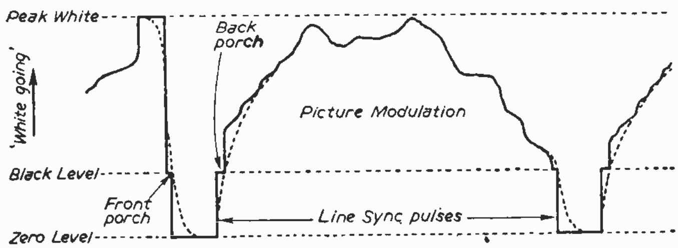


Fig. 1.—One line of a television signal between two line sync pulses. The dotted line shows the distortion of the theoretically ideal wave-shape which results from too great a rise-time in the amplifier.

They allow the video amplifier response time to catch up with the signal, if necessary. In Fig. 1 the picture modulation preceding the first line sync pulse is peak white, which means that the video circuits are expected to respond to a sudden change from peak white, via black level to zero. However, as this overall change is buffered by the front porch the signal can be delayed by almost 1·5μs and yet still produce the leading edge of the line sync pulse before the start of the next line scan. It is the leading edge of the pulses, of course, which initiates the line scan in the receiver. If the video rise-time is such that the picture modulation is unable to change from peak white to black in less than 1·5μs then line pulling will be in evidence.

Line Pulling

Clearly, the signal of a line scan ending with white picture content will take a longer time to fall to black level, towards the line sync pulse, than the signal of a line scan ending with grey or black picture content. When the video rise-time exceeds the front porch interval of 1·5μs, the extra time it takes for the signal to fall from white to black will delay the leading edge of the sync pulse and thus delay the start of the next line. As the delay will be less when the line scan ends with grey or black, the overall effect is that where the right-hand edge of the picture is lighter than the other parts of the right-hand edge, slices of the picture ending in white, or near white, will be displaced horizontally to the left of the screen. The displacement occurs in a random manner on a moving picture as governed by its instantaneous make-up, but on a still picture, such as Test Card "C," the symptom is obvious. On the Test Card, the lines following the white border blocks will be clearly displaced to the left in relation to the lines following the black boarder blocks. The black and white border around the Test Card is, in fact, designed to check this fault.

Video Bandwidth

Square waves and pulses which go to make up a television waveform are composed not only of the fundamental frequency of the signal, but also of many harmonics which extend well above the basic frequency. Indeed, a square wave can be resolved purely into sine waves of many related frequencies. It would follow, therefore, that the bandwidth of the video circuits must be wide enough to pass these component frequencies without undue attenuation. A television signal, looked at in this way, extends from D.C. to a little in excess of 3Mc/s. Thus, provided the circuits have like bandwidth, the rise-time will be sufficient to pass a component of the vision signal which corresponds to the highest frequency the television system as a whole is able to handle.

Broadly speaking, the rise-time of the video amplifier is a function of its bandwidth. This is also true of hi-fi amplifiers, and this is one of the reasons why such amplifiers have a frequency response which extends well beyond the highest audio frequency. Certain sounds are made up of rapidly occurring square waves or transients, and in order that these may be preserved with sharp leading edges throughout the system, a fast rise-time in the amplifier is essential.

Video Stage

In Fig. 2 is shown a typical vision detector and video amplifier circuit. T1 is the final vision I.F. transformer which feeds signals to the vision detector diode, V1. The demodulated signals are coupled to the control grid of the video amplifier, V2, via choke L1. The amplified signals are developed across the video load resistor, R4, and fed to the cathode of the picture tube through the filter network L2, C4, R5 and R6.

The picture tube cathode requires a negative-going picture signal, which of course is provided by the positive-going signal applied to the control grid from the vision detector. For example, as the control grid of V2 is made more positive, as would occur with a "white-going" picture signal, so more current flows in the load resistor R4. This causes a fall in voltage at V2 anode, which is reflected as a negative-going signal at the tube cathode. In other words, a phase reversal occurs in the video amplifier. The signal at V2 anode is also fed to the sync separator valve, which extracts only the sync pulses from the signal. The sync pulses are then passed to the line and frame timebase generators via suitable filters.

Loading

The high-frequency response of the video amplifier is secured (a) by the use of a high slope valve and (b) by the use of relatively low value resistors for the detector load and video anode load, these are resistors R1 and R4, respectively, in Fig. 2. Low value resistors tend to limit the gain of the stage, but this is counteracted in some measure by the high slope of the valve itself. In effect, the use of low value resistors outweighs the input and output capacitances of the video amplifier valve, and thus avoids undue attenuation of the high-frequency components of the vision signal whilst decreasing the rise-time of the circuits.

For reasons of gain, the load resistors cannot be reduced to very low values, so it necessary to adopt a compromise by using "medium" value resistors coupled with some other method of maintaining a good high-frequency response. One method of enhancing the response is by the inclusion of peaking coils in the grid and anode circuits of the video amplifier valve. Such coils are shown in Fig 2 (L1 and L2). These usually consist of a single layer of closely wound turns of wire on an air-cored former of small dimensions. An insulated resistor often forms the former, and the resistor then acts a damping across the winding as, for example, R5 across L2. The coils are designed

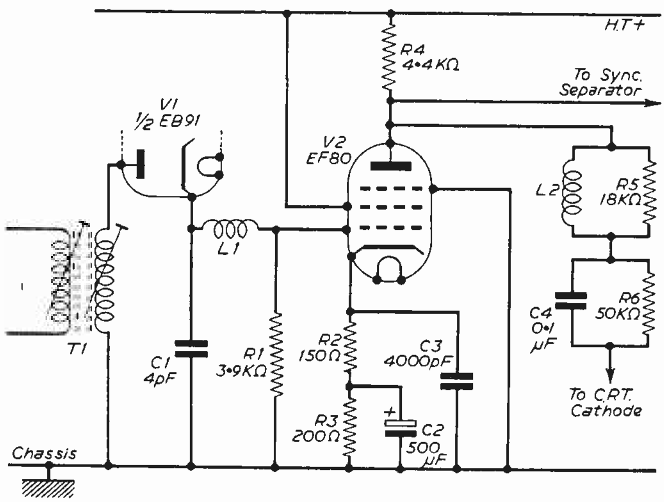


Fig. 2.—Typical vision detector and video amplifier stages. Note the direct coupling from the detector to the amplifier.

to resonate towards 2Mc/s to 3Mc/s in conjunction with their self-capacitances. This provides a boost in gain of the amplifier at the high frequency end of the video spectrum, since at resonance the impedance of the circuits increases, which is almost equivalent to an increase in value of the load resistors themselves. In this way the high-frequency output of the video stage is increased relative to the low-frequency output.

Peaking coils also tend to "ring" at their resonant frequency. To a small degree this is not undesirable as it tends to sharpen-up any rounding off of the sides and corners of the sync and video pulses which may have been introduced owing to a short-coming in the rise-time of the video circuits as a whole. Excessive ringing, however, causes black-after-white and white-after-black and "overshoot" effects on the picture. The ringing is thus controlled where necessary by a damping resistor connected in parallel with the coil. In the vision detector circuit a coil may be connected to act as a filter to the vision intermediate-frequency, and to prevent this signal from entering the video amplifier stage.

Cathode Compensation

Further compensation of the video output signal is sometimes provided in the video amplifier valve cathode circuit. A preset capacitor may be connected across the cathode resistor, or two cathode resistors may be used, one bypassed by a large value capacitor (C2 in Fig. 2) and the other bypassed by a small value capacitor of more critical value (C3 in Fig. 2). A large value capacitor avoids negative voltage feedback from occurring from the lowest to the highest video frequency, while a small capacitor results in progressively increasing feedback from the high to the low-frequency end of the video spectrum. Thus, in the latter case, the gain of the stage is greater at the high-frequency end with respect to the low-frequency end and in this way high-frequency compensation is accomplished. When pre-emphasis is provided by a peaking coil and a pre-set capacitor is used in the cathode circuit, the degree of "ring" or overshoot can be controlled by careful adjustment to the pre-set capacitor. This is often called a "quality control" and enables the video amplifier to be adjusted to give the very best results under the prevailing signal and reception conditions.

In some receivers will be seen a metal rectifier in place of the cathode resistor in the video amplifier valve cathode circuit (Ferguson 991T, for example). This provides normal grid bias for the valve, but in addition looks to the circuit like a constant resistance throughout the range of video frequencies. This could be realised otherwise only by the use of an ordinary resistor shunted by an infinitely large value capacitor. Instead of a metal rectifier, other sets use a Metrosil which gives more or less the same results.

Direct Coupling

The picture signal extends from D.C. to approximately 3Mc/s. This means that direct coupling between the detector, via the video amplifier, to the picture cathode (or grid) is a general requirement. The detector is coupled direct to the video amplifier valve. However, in some cases the D.C. is partially suppressed between the video amplifier and picture tube, as in Fig. 2 by capacitor C4 in parallel with R6. One of the reasons for this is to alleviate the rapid fluttering effect caused by passing aircraft as the flutter is a function of rapid variation of the D.C. content of the video signal. Partial suppression of the D.C. component does little to detract from the overall presentation of the picture, and is invariably counteracted by other artifices.

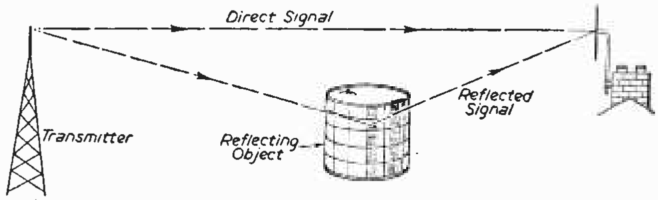


Fig. 3.—Reflections of the transmitted signal may cause "ghosts" on the picture. This effect may be confused with "ringing" intentionally introduced in the video amplifier.

Video Drive

As most video amplifiers require a positive-going picture signal, the stage must always be operating on the part of the valve's curve which allows an increasing current in the anode circuit without limiting towards the high output end. A valve with low emission, for example, may well allow an increase in video output signal up to a certain point (below full drive), but above that point cause severe limiting of the signal, with no increase in output for increase in picture white level. When this happens the picture appears very flat, rather like having the vision interference limiter turned full on. It should be noted, however, that a similar symptom is caused by a low emission picture tube, but before condemning the tube, it pays to check the video amplifier valve.

A similar fault can occur owing to a change in value of a component in the cathode circuit of the valve. In most cases, however this trouble also promotes defective synchronising and impaired definition for the reasons given earlier in this article.

Other Faults in the Video Stage

An increase in value of the load resistor R4 will give excessive video gain at the expense of picture quality. Instability may also result with the possibility of poor synchronising. The same would apply to an increase in value of the detector load resistor R1. It is always well worth bearing in mind that defective synchronising may not have its origin in the sync separator and associated stages, but that the video amplifier circuits, especially the cathode circuit, may be responsible.

The effect of poor high-frequency response on a picture can easily be demonstrated by connecting an $0{\cdot}1\mu F$ capacitor between the cathode of the picture tube and the chassis of the receiver. It is a good idea to have this symptom in mind, as it may save a lot of time later on.

The Practical Television OLYMPIC

By D. R. Bowman

IN introducing the "Olympic" television receiver it may be said that here is a nearly beginner-proof design which will appeal to the experienced and novice constructor alike. The aim has been to offer a receiver of modern design, high performance and straightforward construction.

Some of the features are conventional and simple, while some are more advanced in nature and less conventional. Neither construction nor adjustment is highly critical though in these respects of course, opinions may vary. It may be claimed, however, that, although the absolute beginner ought to try something simpler first, the amateur who is familiar with normal wireless set circuitry can tackle it with confidence. It is, perhaps, too much to expect that every possible difficulty has been thought of in advance! Nevertheless, it is hoped that most have been foreseen, and indeed the design has given very little trouble during its development.

It was considered that a good modern design should include the following features:—

(a) High sensitivity,
(b) Low noise,
(c) Suitability for both service and fringe areas, with little or no modification,
(d) Good linearity,
(e) Good resolution,
(f) Adaptability for use with cathode ray tubes other than those specified,
(g) Excellent "interlace",
(h) Effective automatic gain control,
(i) High quality sound output with simple circuitry,
(j) High stability against temperature changes.

In addition it had to be borne in mind that components specified must be available to the constructor, and at a reasonably low price. The success with which all these matters have been attended is left to the constructor to judge, but it is confidently expected that he will feel every satisfaction with the results achieved.

General Survey of the Circuits

Power Supplies

For several reasons it was considered desirable to arrange for A.C./D.C. operation. Although live-chassis apparatus is not ideal, nearly everyone is quite used to it nowadays, and provided proper precautions are taken there need be no risk of fire or injury. By taking advantage of the new silicon power-rectifiers it has been found possible to design for line voltages as low as 190 either A.C. or D.C. without modification to the circuitry, and also for the higher line voltages of up to 250. This will be very convenient in a good many localities.

The R.F. Tuner

The tuner is without doubt the most highly specialised unit in any television receiver for operation on both Band I and Band III. The tuner for this receiver is for home construction, and has been kept simple because very few constructors will have the necessary facilities for

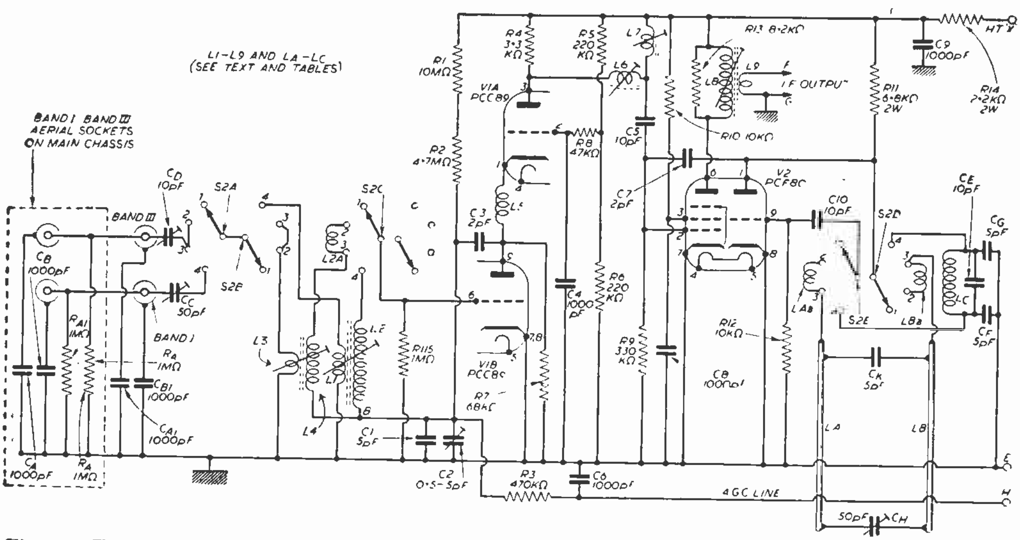
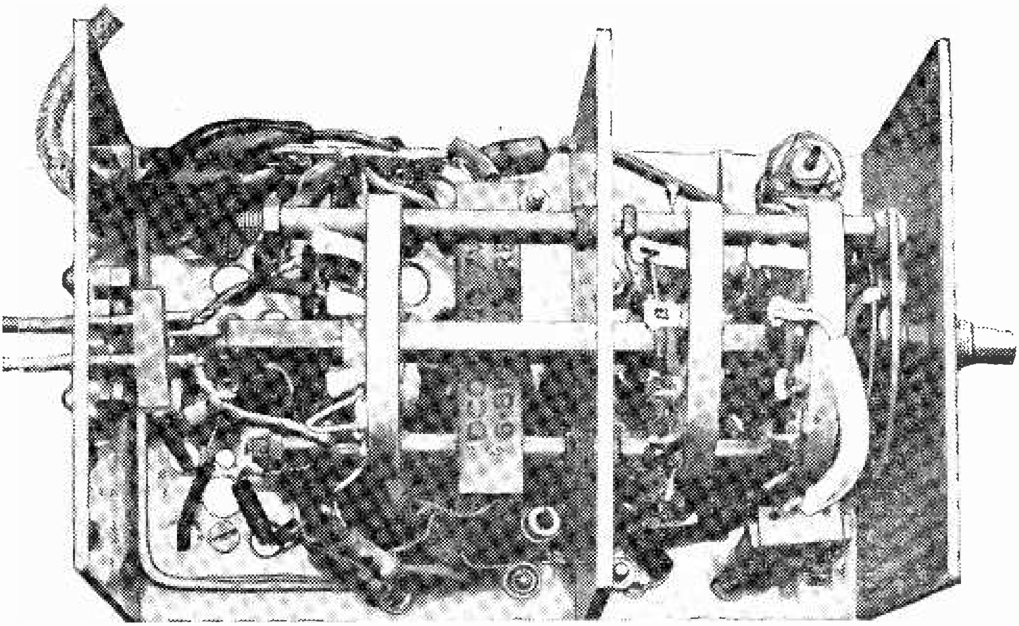


Fig. 1.—The circuit diagram of the tuner unit. (The cathode of the input triode—V1b—may be decoupled by C67, as on the blueprint, if necessary. Condensers C10 and C5 are N750K.)



Underchassis wiring of the tuner.

either constructing or setting-up a 13-channel unit. The station coverage is for two or three channels —one in Band I and one or two in Band III. With the switch and wafers specified, there is a spare position which may be used either for an additional channel or, at a later date, for Band IV or Band V operation. It is felt, however, that constructors who have the apparatus needed will also have the skill to set up the much more complicated circuits needed, and here only two—or three-channel use will be described. Any one who wants to use a 13-channel tuner can incorporate it in the receiver provided it complies with the following:—

(a) Series operated heaters taking 0·3A at 16·2V,
(b) I.F. output 34-38Mc/s,
(c) I.F. output at 80Ω (or near),
(d) AGC line connected to the grid of the cascode R F. amplifier.

A separate sensitivity control will be no disadvantage, although with the AGC system used in this receiver it will probably be superfluous.

The Vision I.F. Amplifier

It would have been possible to reduce the number of valves in both vision and sound I.F. amplifiers by using the new frame grid valves. However, this was decided against for this reason: to obtain the requisite selectivity with the correct bandwidth would have meant using multiple tuned circuits between the stages and these would have been difficult to reproduce in the home with the necessary degree of precision. As an alternative, over-coupling and unequal damping of the tuned circuits might have been arranged, but without specialised equipment the setting-up would have been difficult, probably beyond the degree of precision possible to the average constructor. Band-pass inter-stage tuning has therefore been adopted with stagger of tuning, in the vision stages, with straightforward damping to obtain the necessary bandwith. The moderate gain of the well-tried EF80 valves reduces the chance of feedback efforts. This difficulty is also counteracted by the improved mechanical separation between tuned circuits that an extra valve entails.

The gain of the vision amplifier is of the order of 100,000. With the R.F. tuner, an over-all gain gain from R.F. grid to the video amplifier grid of 10^6 is easily obtained, and with a video gain of about 25, three or four microvolts at the aerial input will load the cathode ray tube fully. This is, of course, far more than is ever necessary, because circuit noise will give a greater output voltage than this. However, the high gain possible is never used because an efficient automatic gain control, operating on the R.F. valve and the first I.F. valve, reduces the amplification to the level where cross-modulation between sound and vision signals is negligible. The effect of noise is also reduced to the point where, at 50 miles from the London transmitter, a copper tube five feet long standing in one corner of a ground-floor room gives a picture of full entertainment value.

The complete list of parts for the "Olympic" receiver will be given in next month's issue. Heater circuit details will be given in a separate diagram and will therefore not be given in the various circuit diagrams of the individual sections.

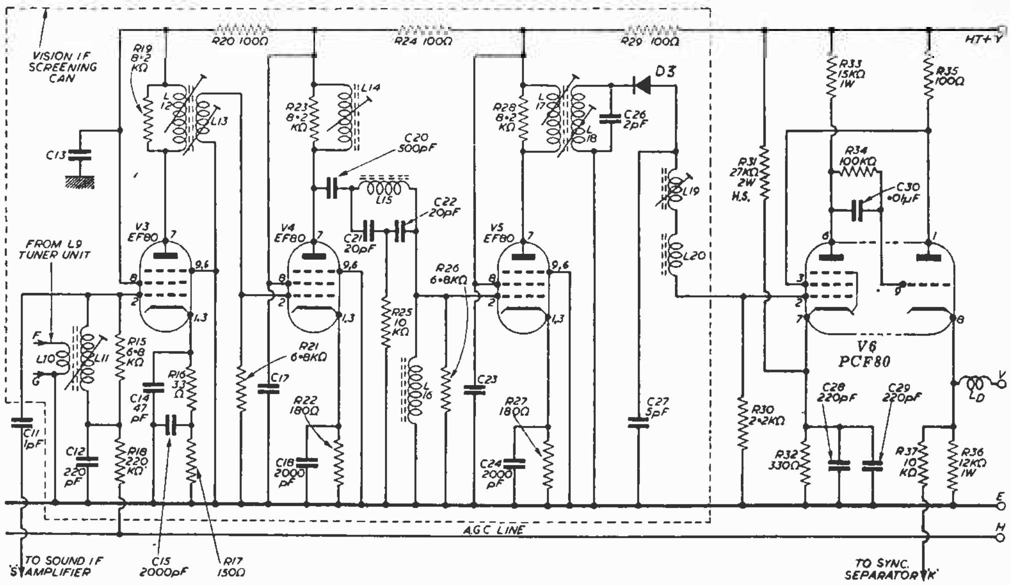


Fig. 2.—Vision I.F. circuits. (Notes: Condensers C21 and C22 are ±5 per cent; C21, C22 and C26 are all silver-mica. R31 is a High Stability component. Condensers C13, C17 and C23 consist of two 2000pF components in parallel. Components C26 and D3 are included in the can of L17/18 and therefore do not appear on the blueprint.)

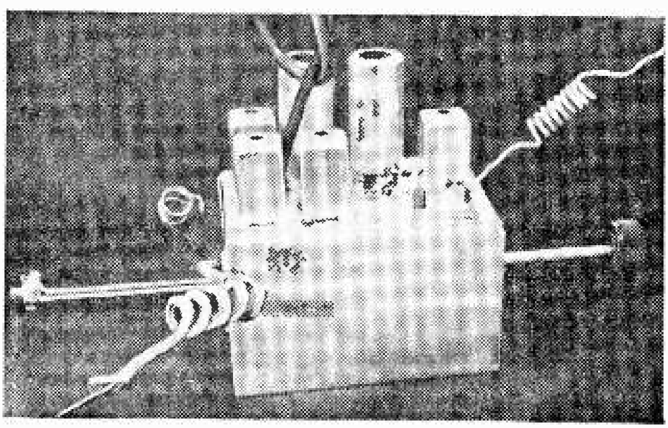
The Sound I.F. Amplifier

This is also of quite conventional design, although both mutual inductance and top-capacitance coupling are used together to obtain the correct bandwidth with high amplification. The requirements of the sound amplifier are, if anything, more exacting than those of the vision amplifier. The reduced bandwidth, essential for eliminating traces of the sync signals, is inseparable from sharply peaked tuned circuits, with high stage gain. Stability presents problems not met to the same extent in the vision amplifier. To obtain good interference noise suppression (ignition, vacuum cleaners, and so on) a precisely defined bandwidth is necessary, and this bandwidth must not be too small. The choice of coupling made for this I.F. amplifier ensures that bandwidth conditions can be reproduced exactly enough by the home constructor.

The Sync Separator

Patchett's sync separator is used in this circuit, with small modifications. This circuit is probably the most successful yet devised and deserves wider use. Even under severe noise conditions, interlace is very good, and when noise is no longer visible on the picture, interlace is perfect.

The use of this separator entails the employment of a special and rather expensive valve the 6F33. This valve is not normally used in series-heater circuits because its rated consumption is 0·35A, and it is underrun at 0·3A. However, it appears to function perfectly in these circumstances.



Side view of the completed tuner unit.

The Video Stage

To enable a cathode-follower to be used without a separate valve, the PCF80 frequency changer valve is specified as the video amplifier. The low compactness of the valve, together with the small circuit capacitances possible when a "combined" valve is used, enable high gain to be achieved over the full bandwidth of 3Mc/s without the use of correction inductors.

The video stage is thus completely free from "ringing" effects—"overshoot"—and if ringing is seen on the tube face it is due to phase distortion in the R.F. or I.F. stages. Thus, adjustment is much simplified—and indeed complete adjustment has been undertaken, as an "exercise", without the use of a signal generator at all. This is not recommended; the correct I.F. can only be achieved with a proper calibrated signal generator.

The Sound-on-Vision Eliminator

The sound trap consists of a bridged-T filter, consisting of a phase-corrected tuned inductive-capacitance coupling between the anode and grid circuits of two adjacent vision I.F. stages. The coupling is so chosen as to provide the correct "top-inductance" coupling while attenuating the sound I.F. frequency by at least 40dB with the required bandwidth. The use of a single trap is very advantageous in that minimum interference with the vision pass-band is obtained.

The graph showing the response curve of the vision I.F. amplifier (next month) shows also the very sharp and deep dip at the sound intermediate frequency. The second peak (outside the video pass-band) is over 25dB down on the vision signal, and, therefore, has very little effect in practice. It should be noted that this secondary peak is inseparable from the use of sound traps of any economical design, and is not a fault.

Vision I.F. Detection

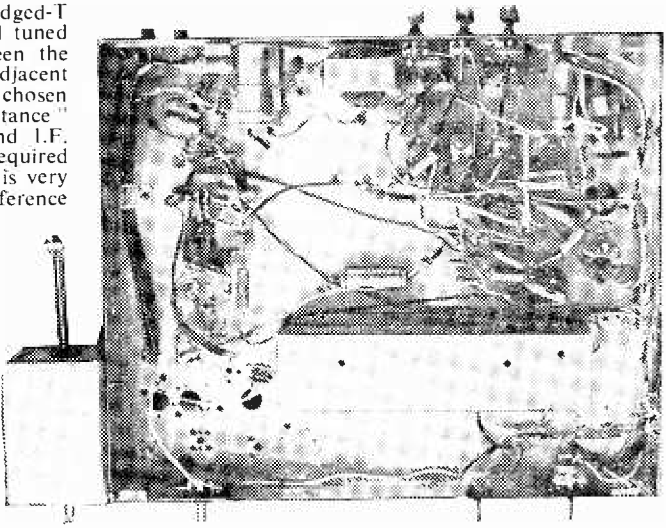
Employment of a germanium diode, within the last vision I.F. can, for video detection removes at once both the chance of hum being introduced and the likelihood of I.F. harmonics being fed back through heater leads and so causing instability or phase distortion. A simple but effective —and non critical—filter ensures that the I.F. signal and its harmonics do not reach the video stage.

The Audio Detector

A simple noise limiter can readily be incorporated with the audio detector by the use of a double diode. Germanium crystals are not used in this stage because of the fact that one side of one diode is connected to H.T.+, and under warm-up conditions a high voltage may well appear at this electrode; a crystal might not last very long here, although crystals have been used successfully in similar (though not identical) circuits. The noise limiter is very efficient at removing the type of noise caused by ignition and electric razors, and this efficiency is also related to the adequate bandwidth of the sound I.F. amplifier.

The Timebase Generator

Slight differences occur between the generators for the 90deg and 70deg versions. The 90deg version is the standard, however, and will be described here. In either case, however, both frame and line oscillators are of the cathode-coupled multivibrator type. The line generator is synchronised direct from the sync separator through a differentiating circuit of very short time constant. The range of control is adequate even when severe line-tearing occurs owing to excessive noise. The frame synchronisation is effected through an amplifier of gain about 3, with phase reversal. This entails the use of an extra valve, but by using a triode-pentode as the frame output



Underchassis wiring of the "Olympic".

valve, this triode is contained in the output valve itself and does not appear as a physical component. The frame lock is exceedingly hard, and is only lost when the picture is blotted out by interference. The main use of a variable control in this position is to enable fine adjustment to be made to secure good interlace in the presence of excessive noise. Where a good signal is present it may be forgotten altogether.

Once adjusted, neither line nor frame controls should ever need touching again within the life of the oscillator valve.

Linearity in the line circuit is achieved by correct choice of boost H.T. capacitor, and this is very effective. A very slight "stretch" may be seen at the left of the tube, but this is not noticeable on picture; it will be due in most cases to manufacturing tolerances in the value of the boost H.T. capacitor, and is so small as to be not worth correcting.

Linearity in the frame circuits is always hard to achieve, when an output transformer is used, without the use of negative feedback. In this receiver negative feedback has been avoided because of the chance of feeding line-pulses back as well. This effect, due to capacitance between line and frame scan coils, has a very serious effect on interlace; and because the interlace is so good it was decided that negative feedback could hardly be chanced. Instead, a rather complex linearising

(Continued on page 51)

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.*

ASPECT RATIO

SIR,—It seems a long time ago that the BBC changed the aspect ratio to that used in most sets today, and I would have thought it would not be impossible to make yet a further change in this. With the increasing use of 110 deg tubes, the shape of the tube front could surely be modified, although, of course, this should be carried out in such a manner that existing receivers could make use of the picture. This was done in the last change, and one simply ignored the slight dark area at top and bottom of screen. I have experimented on my receiver, and by opening out the line scan (I have plenty of power available) I can obtain an image on my 16in. tube which is slightly larger than my friend's 21in. picture, and although I lose certain details at the sides of the picture, I find that the increased sizes of heads in close-ups, for instance, makes it much more enjoyable, and I am, in fact, thinking of making this a permanent modification, with a switch to make the change-over from wide screen to normal. —B. MORLEY (Camberley).

RADIO SHOW

SIR,—No doubt many readers visited the Radio Show and I wonder how many of them, like myself, found it to be of no interest whatsoever for anyone seeking technical information about any of the TV or radio sets on show.

Why is it that British electrical manufacturers seem to find it necessary to present their products behind a front of gaily illuminated signs? Do they think all the public is fooled by this type of advertising?

If only they would say simply why their product is better than another in terms that both electrical experts and ordinary members of the public could understand, I am sure their sales would increase appreciably.—J. MATTHEWS (Brentford).

TUBE EQUIVALENTS

SIR,—We would like to bring to your attention the incorrect information given in "Your Problems Solved" column, September issue, to R. Bacon (HMV 1845) and W. Anson (Marconi UT69DA).

The AW 36/21 is not a replacement for the Emiscope 5/2. The AW 36/21 is electrostatic focused and would certainly not focus if placed in an HMV 1845.

In the case of the 4/15G, again if replaced by MW 43/64 or 69, very poor focusing will result owing to the Emiscope gun having triode characteristics although it is a tetrode.

We can supply both 4/15G and 5/2 fully reprocessed and fitted with the correct type of Emiscope electron gun. — TECHNICAL DIRECTOR, (Lawson Tubes, Malvern, Worcestershire).

SOUND REPRODUCTION

SIR,—The letter from Mr. Chester in the July issue made very interesting reading, and in my case I think I have an even better solution. Years ago I built a very good amplifier, and this cost a lot of money, as a result of which, I tried to save on future apparatus. The results have proved extremely worth while in various ways. For instance, I built a radio tuner only—not a complete radio. This is fed into the amplifier and my present installation consists of the amplifier with associated speakers in a single cabinet. As auxiliary units I have a radio, VHF tuner, record-player and television set (up to the first audio stage), all of which are switched by one single multiple switch into the amplifier. The result is that everything, including the television, sounds really good, and I have been very surprised that you have not described what might be termed the "front end" of a television so that others could adopt a similar idea. I agree, the manufacturers are so keen to try to put everything into a small cabinet, that the much desired quality of reproduction is ignored completely. — F. RANDELL (N.W.).

VALVE TROUBLE

SIR,—In reference to the letters which have appeared during recent issues on troubles in the line output valve, I seem to remember reading in some periodical some time ago, that valves can become magnetised, especially with modern high-flux loudspeakers. A cure which was suggested was to attach a small magnet or magnetised piece of iron to the glass bulb of the valve. Perhaps the idea would be worthwhile to those readers who are experiencing the trouble, and I think I read that the position of the magnet had to be found by trial, as well as the exact polarity. — F. H. BETTERSON (Reigate).

TV Dx

SIR,—I find that French TV, which I often manage to obtain on my set, is received with most clarity between 4 and 5 p.m. each day.

One or two of my friends disagree with this time interval of best reception, and place it rather later in the evening from about 6 to 7.30.

Although in a minority, I think they are wrong and would be glad to know if any other reader has come to the same conclusions as myself or my friends.—A. A. HILL (Hove).

USING THE WOBBULATOR

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

(Continued from page 609 of the September issue)

By R. Brown

IN the previous article, the y-axis of the display on the oscilloscope was achieved by using an attenuator between the wobbulator and the 'scope. The frequency axis of the display must now be calibrated. This can be carried out in a number of ways. One method is to couple a signal generator into the input of the I.F. amplifier. When the wobbulator frequency coincides with the signal generator frequency a beat will be produced, which will be clearly visible on the display. This is shown in Fig. 6a. If a crystal oscillator, or one of the crystal calibrators used to check the frequency of transmitters and signal generators, is available this can be coupled into the input of the I.F. amplifier instead of the signal generator. If the crystal oscillator has a frequency of, say, 1 Mc/s, or better still 0·25Mc/s, the wobbulator will beat with the individual crystal harmonics, to produce a series of very accurate markers. Fig. 6b shows this. An absorption type wavemeter can be used to produce yet another type of marker. A type of marker which is termed a passive marker. The wavemeter is coupled into the input of the I.F. amplifier, as was done with the signal generator. When the wobbulator frequency equals that of the wavemeter, some of the output from the wobbulator will be absorbed. The input to the I.F. amplifier will be reduced, and a small dip will show up in the displayed response curve (Fig. 6c).

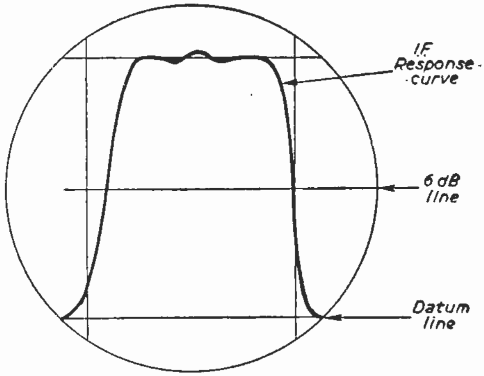


Fig. 5.—Assessing relative amplitudes within the display.

Frequency markers produced by any of these three methods pass through the equipment under test. The result of this is that their displayed amplitude will depend upon the gain of the equipment under test. If they are adjusted to be of reasonable amplitude on the top of the response curve, it may be very difficult to see them on the skirts of the response. And, if they are adjusted to be easily visible on the skirts of the response curve, they will be so large on the top of the response curve that they will seriously distort the display.

This problem can be solved by using a slightly different method of mixing the frequency calibrating source with the wobbulator output. In Fig. 8, a small portion of the wobbulator output is

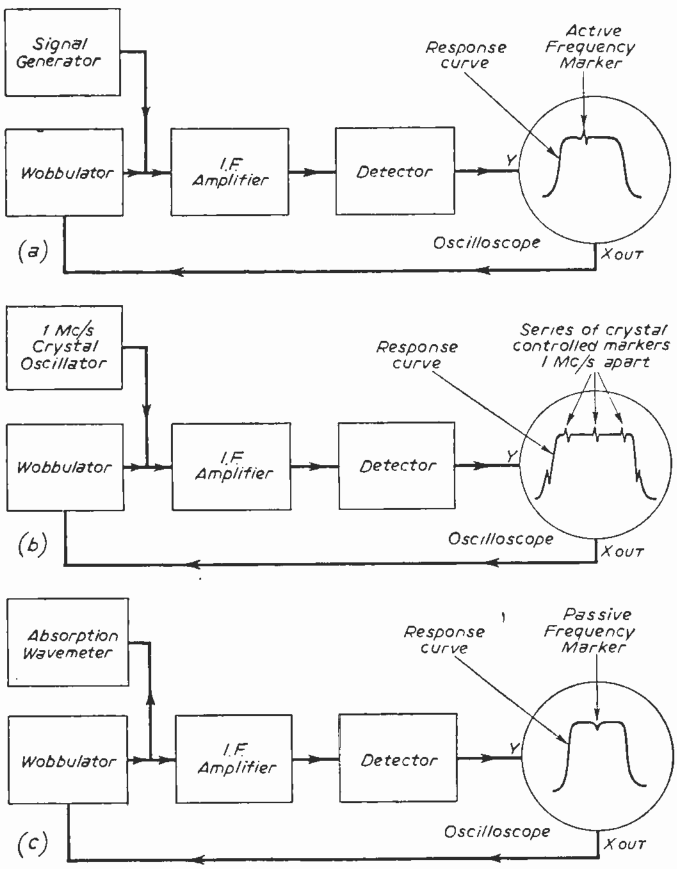


Fig. 6.—Three types of frequency marker.

tapped off and mixed separately with the output from the frequency calibrator. The frequency markers produced are then taken direct to the oscilloscope and mixed with the demodulated output from the I.F. amplifier. The amplitude of the markers is thus independent of the gain of the I.F. amplifier, they are of constant amplitude, appearing on the display even at frequencies right outside the passband of the I.F. amplifier.

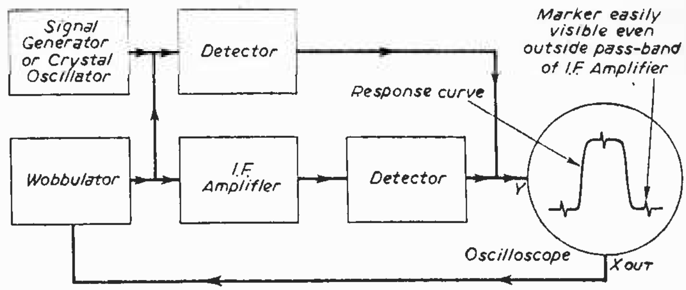


Fig. 8.—Producing markers that by-pass the equipment under test.

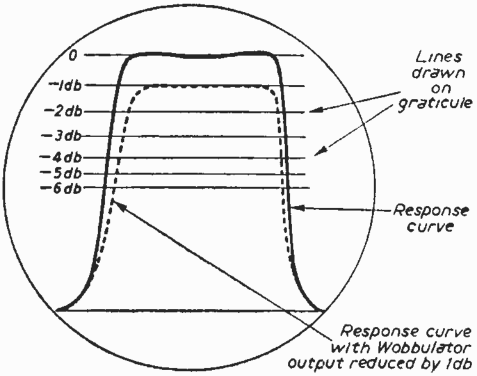


Fig. 7.—Calibrating the C.R.T. graticule using an attenuator.

ease with which an accurately calibrated display can be achieved. As with all electronic measurements, however, certain precautions are necessary. The greatest source of possible error is having too fast a sweep speed. If the sweep speed is too fast the voltages in the tuned circuits will not have sufficient time to reach their maximum amplitude, and the displayed response curves will appear to have a lower amplitude than the true response curve. It will also appear to be shifted slightly in the direction of the upper frequency end of the display. If it is suspected that this sort of thing is happening, it can be checked by reducing the sweep rate. If the shape of the response curve changes then the sweep rate was too fast, and it should be reduced until no further change occurs.

Intensity Modulation

The distortion of the display, which has already been mentioned, is something which occurs with all of the systems of producing markers that have so far been described. A frequency marker amplitude control is essential; but even if the amplitude of the marker, or markers, is reduced so that it is barely visible the distortion can be a nuisance. This distortion can, however, be avoided provided that one is prepared to go to more trouble and expense when constructing the frequency calibration circuits.

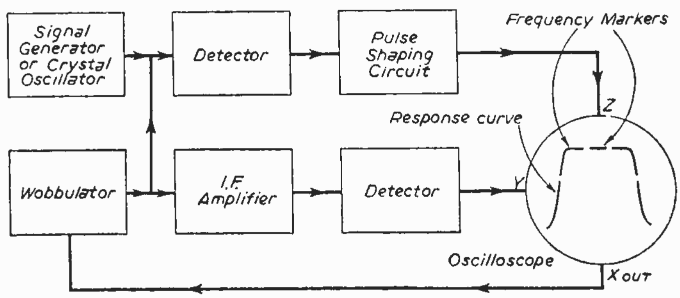


Fig. 9.—Using frequency markers to intensity-modulate the display oscilloscope.

A suitable arrangement is shown in Fig. 9. This is similar to the set up shown in Fig. 8. The beats between the wobbulator and signal generator, or crystal oscillator, are detected, as before; but instead of being taken direct to the "Y" input of the oscilloscope they are taken to a pulse shaping circuit. This pulse shaping circuit converts them to very narrow pulses. These pulses are then used to intensity modulate the oscilloscope. So that the beam is blanked off whenever a pulse occurs. The blank spots produced can be made very sharp indeed, and they give a distinct mark which does not distort the display.

A Word of Warning

Enough has been said to show the very real usefulness of the wobbulator, and the comparative

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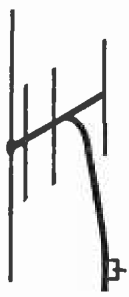

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Adding an I.F. Stage

A METHOD OF INCREASING GAIN IN FRINGE AREAS

By H. E. Underwood

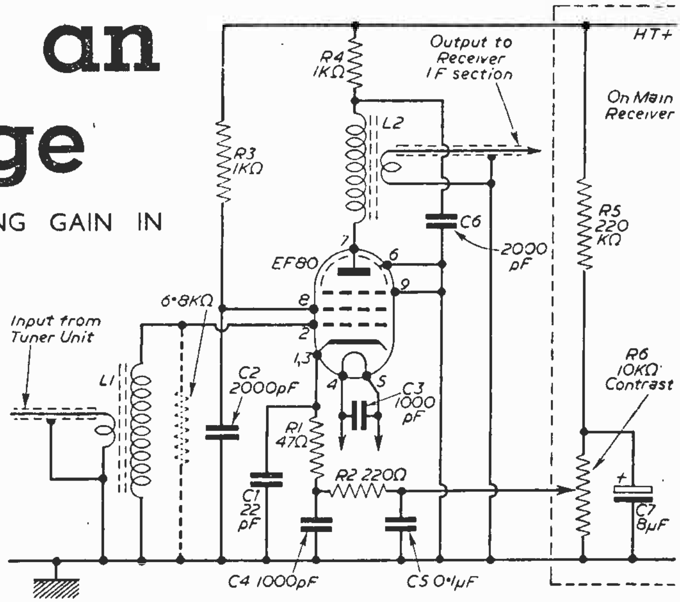


Fig. 1.—The circuit diagram.

THIS unit was designed as a result of a friend asking me to have a look at his recently acquired fairly modern set, as he was not at all pleased with its performance. One glance showed that insufficient amplification was being given to the signal. The picture on BBC, with the set working full on, was pale and uninteresting, with almost complete lack of contrast. Tricky timebase operation and inability to hold the picture during signal fluctuations were other symptoms. As the set was operating at approximately 45ml from the BBC transmitter, and the set was not of the "fringe" pattern, this was not surprising. Results on ITV were very much better. No modifications were possible to the aerial system, so attention was concentrated on the set.

Circuit

An examination of the receiver showed that it comprised the normal tuner unit with two valves, followed by two EF80 I.F. stages for vision. Sound was taken off the first I.F. stage and employed one more stage before detection. Contrast was applied by varying the AGC derived from the sync separator to the first tuner unit valve grid. The only other method of varying the gain of the receiver was by a "sensitivity" control varying the bias on this same PCC84 valve—not an ideal arrangement for the conditions obtaining.

The first experiment carried out was to disconnect the AGC line from the grid of the first valve and load it to earth. Whilst this improved the picture slightly, it was not felt that it justified the elimination of even simple AGC.

Pre-amplification was then considered, but this would necessitate careful design and construction, some complicated switching and possibly mutilation of the cabinet. The only thing left, then, was to try adding an additional I.F. stage common to both vision and sound.

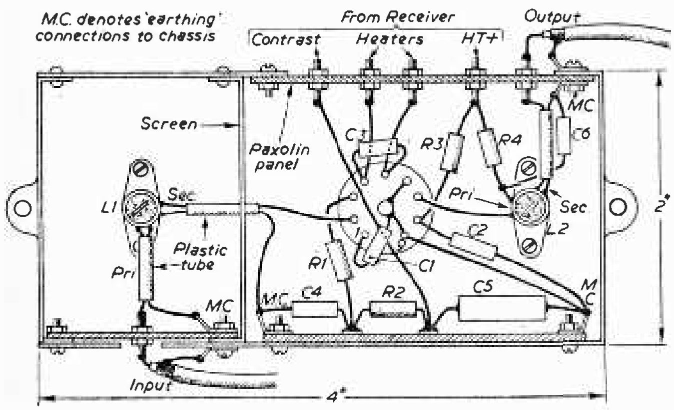


Fig. 2.—The wiring diagram.

New Contrast Control

As with most tuner units, connection between this and the I.F. section was made with a short length of screened cable, and this formed an excellent place to insert the new I.F. stage. This was therefore designed and incorporated a new contrast control with hopes of better operation than the existing one, which was mounted at the back of the set—in itself a nuisance. By drilling only one hole in the front of the cabinet it was proposed to mount this new control in a more convenient position.

Using an EF80 valve as a basis, a small subchassis was constructed to bolt on to the top of the receiver chassis in a position between the tuner unit and the

I.F. unit. The size and shape of the chassis may have to be modified for other receivers, but there is considerable flexibility in the design.

Construction is quite straightforward, and the unit is completely stable provided normal TV wiring techniques are employed, with short connections and well soldered joints. Note the screen between L1 and the remainder of the circuit.

Wiring

The tag-boards can be either plain paxolin with small bolts inserted for solder connections, or ordinary tag strips cut down as necessary. Standard ¼in. Aladdin coil formers were used as these necessitate less drilling. The end connections of the coils are run through short pieces of plastic tubing to obviate "loops" and if the windings are secured with cellulose tape, they are as efficient as the canned types, with easier means of altering turns if necessary.

The heater chain of the main receiver was broken at a convenient point and connections made to the new valve. The extra valve made little difference to the voltage distribution. If the tube voltage, however, shows a distinct drop, then it is advisable to tap down on the mains adjustment panel. Purists may decide to derive the heater voltage from a separate small transformer. The few additional milliamps of H.T. should be easily obtainable from the main supply. Make sure that the wire carrying the H.T. supply to the new unit is well clear of all timebase components so as to avoid pick-up of frustrating "vision-on-sound" effects.

Tuning proved to be quite simple. Coil L1 tunes rather sharply, and it may be desirable in some cases to dampen the secondary winding with a 6·8k resistor. The 22 turns on the coils proved just right for the standard 35-38Mc/s I.F. frequency.

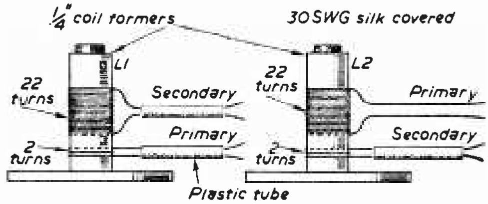


Fig. 3.—The I.F. coil details.

STEREOSCOPIC TELEVISION

THERE is a growing need for a third dimension in industrial television pictures, and it is to meet this that Pye has added to its standard range of equipment a beam splitting attachment and a 14in. mirror stereoscope. Since we are able to see scenes three-dimensionally, because we have two eyes (each seeing objects from slightly different aspects) it follows that any three-dimensional television system must also have two "eyes"—or putting it more correctly, there must be two physically displaced points of view. To fulfil this binocular requirement, it has been the usual practice in the past to duplicate almost all the equipment found in the normal television chain, which means complexity of operation and servicing, plus an increase in space and cost.

The latest additions to the Pye industrial TV range provide the answer to true stereoscopic television without the difficulties previously involved. In order to appreciate how the two new units are able to synthesise sense of depth in the mind of the observer, it is now necessary to digress slightly into the theory of stereoscopic vision.

Theory

It is normal practice to use both eyes when observing one's surroundings—but since the two eyes see the scene from slightly different viewpoints the observer is really seeing two different pictures at the same time. The optical axes of the two eyes also converge to some extent to meet in the objects on which attention is concentrated at any instant. Mental processes then fuse the two different pictures into one which has the appearance of solid relief. This effect of relief and depth is the "stereoscopic effect." This effect is lost in the normal television chain since the camera sees things from one angle only. To re-create the full sense of depth it is necessary to obtain two views at the same time with a camera having a means of obtaining those views from slightly displaced viewpoints, so that it copies the actions of those two eyes. If it is then arranged that each of these views is only capable of being seen with one eye, then (if certain other conditions are also met) the resultant picture will be stereoscopic.

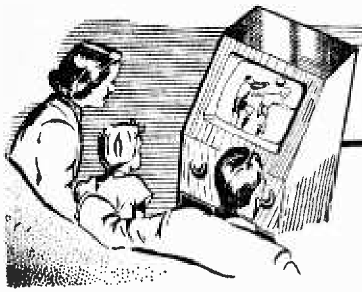
Two Picture Chains

There are many ways in which the above effect may be obtained, and the obvious way would appear to be the use of two separate cameras which have their optical axes separated by approximately the distance between the human eyes; namely, 2½in. However, if this system is adopted, virtually all the equipment required in a normal television chain will be duplicated.

In the system now offered by Pye, the stereoscopic effect is obtained by a mirror beam splitting system at the camera position and a system of mirrors at the monitor position which have the effect of providing each eye with the relevant picture information as though the eyes were at the camera position.

Exhibition

At their exhibition at the Royal Festival Hall, in August, Pye demonstrated the use of three-dimensional television for the accurate handling of dangerous materials such as radio-active substances. An operator was seen using mechanical "hands" to manipulate flasks and test-tubes and he, and the public, were able to watch the operations on television screens.



UNDERNEATH THE DIPOLE

TELEVISION PICK-UPS AND REFLECTIONS

By Iconos

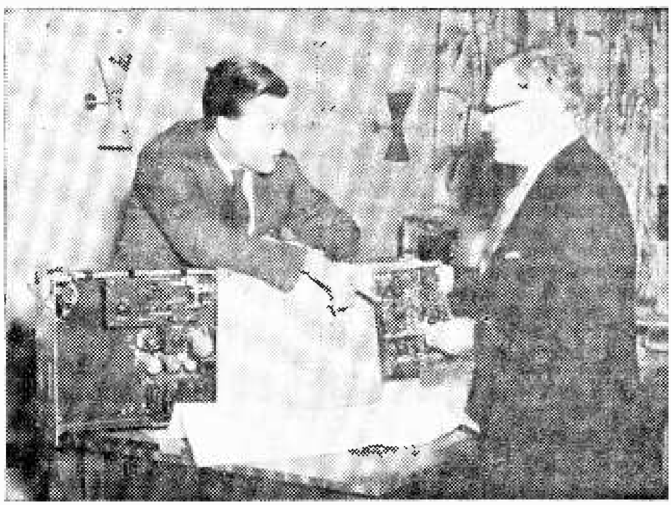
AFTER the uproar about the use of video tape, 16mm and 35mm films still fill up a lot of time on both BBC and ITV channels, and fill it up very adequately indeed. The BBC telecine seems to be of a better average technical quality, partly due to their use of occasional films of outstanding photographic qualities. Such a film was "The Artist Speaks", a documentary made by the BBC's own film unit, produced by John Read and photographed by David Prosser. It was about an eccentric old French artist, Anthony Goss, who painted what were, to my eyes, most unattractive surrealistic pictures. The subject matter would not appeal to me very very much in the ordinary way but the interesting directorial and pictorial treatment restrained me from switching over to the ITA.

Flying Spot Telecine

Afterwards, I thought it worth while to find out from the BBC exactly why the photographic qualities were so good. Of course, it is necessary to start with a good negative. This was obtained by using mainly a medium sensitive 35mm negative. After dubbing the music and commentary on the edited picture, a normally graded print was made which was transmitted on the early type twin-lens Cintel flying-spot scanner, a telecine machine designed many years ago which is capable only of running 35mm film. This, I find, is still regarded as the de-luxe telecine machine by BBC engineers, who have only recently purchased additional equipment of this type. Commercial television programme contractors have mainly bought vidicon types of telecine—a simple and efficient arrangement in which the respective projection beams from a slide projector, a 35mm film projector or a 16mm film projector, can be directed on to a vidicon camera. The quality is good, but if the original film negative is of exceptional quality, a flying-spot telecine, particularly the old twin-lens type, will give a much wider range of tones and a more accurate reproduction of the original print. It is interesting to note that Westward Television's TV Centre at Plymouth will instal one of these twin-lens Cintel flying-spot scanners in its group of four telecine machines.

Line Standards for Export

Nevertheless, there are trends in some of the major companies to turn over to flying-spot telecine, which is much more versatile for coping with filmed inserts in "live" TV plays being made on more than one standard on video tape for foreign sales. At the new ATV studios at Elstree and at ABC's Teddington studio, for instance, equipment is being arranged to cope with 625 lines at 50 fields per second (European Standard): 525 lines at 60 fields per second (U.S.A. and Japanese Standard): or with the British 405 lines standard. At the moment, best results are obtained by repeating the complete action of a play for a second or third "take", with cameras, equipment and video tape machine readjustment to the additional line and frequency standards required for export use. In due course, 625 lines will be introduced in England, alongside 405 lines from the same transmitter masts. But this is not likely to take place until a new solution is



Mr. Baynham Honri, Technical General Manager of Westward Television, and Mr. John Mulliner, Studio Planning Engineer of ABC TV, examining the latest types of a printed board which is used in the Mk. IV television camera channel, which equipment is to be supplied to Westward Television.

found to the standards conversion problem — which may take years. Putting a television picture on a screen and re-photographing it on to another standard on video tape can be good but is not 100 per cent reliable, as there are too many variables. When an all-electronic solution is found there will be rapid progress in England to 625 lines, with its immensely improved qualities and almost invisible line structures.

"Dream Girl"

If you are looking out for a good television play, look for the name of the producer or director almost before you take in the title and the cast. I must confess that if I had not noticed that Eric Fawcett's name was down as the director, I wouldn't have bothered to look at "Dream Girl", the BBC play which turned out to be very much better than its hackneyed-sounding title. Here was a light story with several amusing dream sequences as the main gimmick, beautifully played by a large cast, headed by Judith Stott and William Sylvester. Judith has crazy day-dreams which lend themselves to delightful pictorial treatment, enhanced by Roy Oxley's settings, Elmer Rice's dialogue, and camera work that, on the whole, was above average. The exceptions were extreme close-ups of Judith Stott's face, which were most unflattering, the wide-angle lens that was used distorting her features and adding on the years. These shots, which introduced the dream sequences, were of quite different quality from the rest of the photography, and most unattractively so. William Sylvester added to his reputation as a first-class television actor who recognises the value of underplaying a scene when the camera is so close that the viewer can see the whites of his eyes! This should be an axiom for all television actors and producers. Eric Fawcett is an old hand at TV play production and was probably the very man who first recognised that television must acquire conventions of its own, quite different from those of the stage or screen.

TV News

The BBC made a major change several years ago when they substituted the live news service for the wholly filmed TV newsreel. It seems strange to think of it now, but the newsreader's face was actually seen for the first time, and only some of the items were illustrated with films, still photographs, slides or diagrams. Impersonal though the first BBC newsreaders were, with inscrutable expressions and unchangeable voices, they dominated the scene. Indepedent Television News projected the personality of the newsreader in a much more informal manner than the BBC, and even allowed him to disclose a sense of humour to his viewing audience. The use of film, and particularly 16mm film in ITN was steadily increased, though much of it was photographed mute and provided with sound commentary rather than with real synchronous sound. This method of news presentation lent itself to high speed operation—and filmed items are rushed on to the telecine machine within a few minutes of being processed and checked at the studio. But this method is lacking in its impact as compared with synchronous sound. A few weeks ago ATV at Birmingham secured impressive mute shots of a man on the roof of a high building threatening to jump off. The cameraman photographed would-be rescuers persuading the would-be suicide to return to safety. Just think of the sensational impact of the same scene with synchronous sound instead of with a commentary spoken by the newsreader. In this day and age, magnetic sound strips on the edge of the 16mm film together with a tiny transistorised amplifier in the film camera could have captured the real sound with ease. But the more general use of synchronous sound has been held back mainly by the extra size and weight of equipment, additional complications and delays in editing. Many events of every day could be more effectively presented with synchronous sound, and this, I think, will be the trend in the all - important regional news supplements to the excellent Independent Television News.

Prompters

How do the newsreaders remember so accurately all the news items, with only occasional glances at their scripts? Well, they do have scripts, to which they refer occasionally, in between glances at the camera lens or at a prompting machine near the camera—about a third of the time being devoted to each kind of "look". Several kinds of prompting machines are in use, one of the simplest being devised and built by the Independent Television News engineers. This comprises a very small 625 line Epsylon vidicon camera directed at a typed roll of paper about four inches wide, which is passed in front of it by rotating a handle. The resultant picture of the text of the script is reproduced on a 17in. monitor screen, placed by the side of the main TV camera. The words are typed on the paper with an ordinary electric typewriter, and the girl operator merely turns the prompter handle at the appropriate speed.

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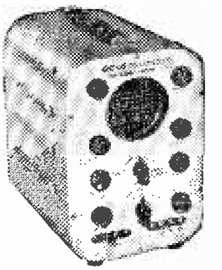

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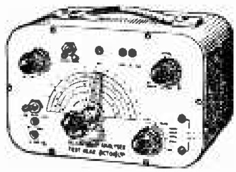

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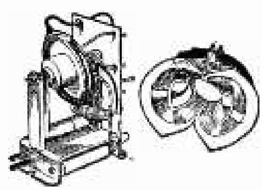

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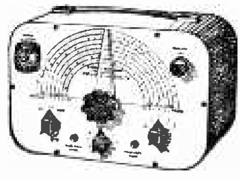

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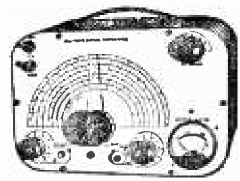

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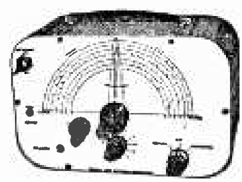

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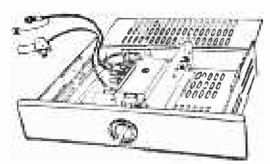

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COLUMBIA MODEL C503

I wish to convert this set from BBC channel 2 to channel 5 but do not know the layout of the oscillator and R.F. coils. This information is not given in the "Radio and TV Servicing" volumes which I possess, and I cannot find the equivalent Sobell model.—R. Whillence (Durham City).

The Columbia C503 is directly equivalent to the Sobell T121. You will see that the aerial R.F. mixer grid and oscillator coils have alternative tappings. It is only necessary to remove the link to F2 and connect to F1 in each case and then retune the oscillator coil for maximum sound and the other coil cores for optimum vision and sound. V1 is on the front left side (R.F. amp); V2 is next to it.

ENGLISH ELECTRIC C.42

I cannot trace the cause of dark streaks appearing to the right-hand side of all bright objects on the screen. They extend right across, often obliterating other bright objects. I am using a regunned MW 53-20 tube with this chassis. On this set, and also on an Ekco T161, I am troubled by visible flyback lines whenever the brilliance is turned up to normal. The Ekco also has a regunned tube.—A. Henshaw (Halstead).

See that pin 7 of the C.R.T. base is connected to pin 10 or pin 11. Check the I.F. alignment and the video detector and amplifier resistors 6·8k, 390Ω and 10k. Correction of the streaking fault may also cure the flyback lines, especially if one of the above resistors is at fault. Ekco T161: Change C.R.T. cathode resistor 220k (red red yellow) to 470k (yellow violet yellow).

DECCA BM3/C

On this set it is almost an impossibility to prevent the picture rolling and it requires very careful adjustment of frame form control. The picture cannot be adjusted by the frame height control and all images are very tall.—J. Jones (Solihull).

Check the 0·1μF capacitor associated with the sync feed to the frame output oscillator triode grid, also the 150pF. It will then be necessary to check the other capacitors associated with the ECL80.

BUSH TV12A

Sound and vision on this set are fine except for the width of the picture, which is about 2in. and cannot be made to fill the screen. The height and focusing are also in order.—D. N. Hall (High Barnet).

Check the 2μF capacitor under the front of the main deck (inclined panel) which feeds the scanning coils socket, then suspect a deflective line output transformer inside the round can on the right side. The coil in the square section on top of this can need not be suspected.

BAIRD 1815

The picture is sometimes very good but faint lines keep flickering over the screen. Sometimes I can cut them out with the converter. The line lock control is as far advanced as possible clockwise. The frame lock does not work, neither does the focus. The other controls are in order and the sound is perfect. A converter is fitted to this set so two aerials are necessary. These are well apart in the loft.—F. Colquhoun (Bootle 20).

We presume the patterning is experienced on ITV. If so, this is the result of BBC breakthrough, and the coaxial stub from the converter to the aerial socket of the receiver must be kept as short as possible. Remove the BBC aerial plug when receiving ITV and separate the cables.

EKCO T205

The picture and sound suddenly went off, leaving a ¼in. bright line across the middle of the screen. All valves have been checked and found to be in order except 6F15, which is very low. The set has a built-in turret tuner and the two valves have been checked and found to be in order.—A. Carson (Liverpool).

We would say that a H.T. failure is more likely to cause your fault than the 6F15. Check the various H.T. feeds in the set and look for charred H.T. feed resistors denoting a breakdown in one of the sections of the circuit. The fault may be inside the tuner unit, especially if rotating the turret causes flashes in the tube.

VIDOR C1306

The above console model was bought in 1951. After the set has been switched on the picture is "jittery" (up and down). It settles down after a few minutes but soon starts again.—G. Breddy (Retford).

You should replace the 6K25 (Mazda) grey metalised valve in the centre of the chassis.

MURPHY V200A

I wish to obtain a suitable converter for this set and would like your advice as to the best one to use. As soon as the supply voltage drops a little, the picture slips, which I think may be due to a weak sync pulse.—J Radford (Devon).

The best tuner to fit to the V200A is Murphy's own C1. This involves internal wiring but will ensure a strong ITA signal without patterning. Your sync fault is more likely to be low H.T. (faulty RM4) than anything else, but the sync separator is the 10C2 on the top left hand chassis as you look in at the back.

PAM 750

The picture, raster, and sound on this set have failed. All valve heaters were glowing except E.H.T. rectifier EY86. There is a spluttering sound from the scanning coil assembly. Voltage at H.T. smoothing choke is approximately 200. I removed the scanning coil assembly, and the "Megger" test between one section of frame coils and one set of line coils was zero, and both these coils were 500k to earth. Corresponding tests between remaining sections of coils is infinity.—J. Pink (Ferris Bay).

Your symptoms seem those of a straightforward scan coil failure. Check first of all that the breakdown is not in the screened lead feeding the line scan to the coils.

ENGLISH ELECTRIC 16C19D

The tube on the above set is faulty. Can I replace it with an English Electric tube T901B? The existing tube is a Mullard MW41-1. The main thing I am worried about is the deflection angle.—P. Rice (Derby).

The T901.B was the type originally fitted and the MW41-1 is equivalent. Therefore you should experience no trouble at all.

MARCONIPHONE VG59DA

This set has no picture but the sound is good —very loud and clear when the contrast control is turned fully clockwise. If it is turned anticlockwise. the sound fades. The screen is blank except for a narrow, stationary, horizontal bright line. This line has no definite edges. When the contrast control is turned anti-clockwise this excites the line and causes a slight crackle on fading sound. When the brilliance control is turned up to full extent the line expands to about 4in. wide. I renewed the frame blocking oscillator transformer but with no results. The EY51 would not light up so I renewed this, but the new one will not light either. I have replaced the PL81. The soldered connections of the EY51 do not arc but will spark when tested with a screwdriver.—J. Woolfall (Lancaster).

The second ECL80 (LN152) to the right of the metal rectifier is most probably at fault. Check the height control and the metal rectifier itself, 14A86. If the LN152 is not at fault check H.T. to pins 1 and 6.

STELLA ST8517

The picture has begun to slip sideways and the figures twist into queer shapes until it jumps back into position. This is repeated again and again.— W. Macintosh (Dumbarton).

We suggest you replace the PL81 valve, which is to the left of the right side line output section. It has a top cap connection and has the PY81 next to it.

PILOT 1800

There is no sound or vision on this set, and the C.R.T., which is a MW43-64, shows only a narrow band of illumination horizontally. All the valve heaters and the C.R.T. heater glow and a blue spark can be drawn from the EHT connection when it is removed from the final anode on the C.R.T.—J. Waite (Chingford, E.4).

The Pilot model is not 1800, and from your remarks we must conclude that it is a TV87 fitted with a Mullard tube in place of the original Brimar and adapted with a turret tuner. Under the tube on the left side you will find a valve. 12BH7. Check this valve and the voltages applied to pins 1 and 6. Pin 1 should read about 50V; pin 6 370V; pin 8 about 18V.

PHILIPS 1100U

The top of the picture bends from right to left, and at times it seems as if a strong breeze is blowing from left to right. I have checked valves ECL80 and U8PL81 and found them to be in order.—F. Griffiths (Greenford).

Check the 10pF sync feed capacitor to the PL81 control grid and the components associated with the right side ECL80—pins 6, 8 and 9. If the hold control is at one end of its traverse, change the PL81.

PYE VT4

The trouble is lack of width in spite of the fact that I have replaced both PY82's, PL81 and PY81 valves. I have also replaced the 3·3k resistor in the line output section with little or no difference. —V. Robertson (Scotland).

Check the value of the 47Ω anode stopper on the PL81, and examine the raster for taper from top to bottom. If taper is pronounced, suspect a faulty winding on the deflector coils. If there is little taper, check the components in the drive circuit between the ECL80 and PL81. especially the 220pF condenser across the line drive control.

G.E.C. BT302

Can you tell me the most common reasons for "ghosting" on this receiver, which is fairly new? —W Furse (Fife).

Ghosting is caused by a reflected signal appearing on the screen a few microseconds after the original signal is picked up by the aerial. The action to be taken is to reorientate or find another position for the aerial. Trial and error is the only method.

COSSOR 908

On switching on I found there is a deep humming sound. The humming disappears when I turn the fine tuner but increase in volume causes flashing across the screen. When the volume control is touched it causes a loud grating noise.—A. Russell (Abertillery).

Your volume control seems to be excessively noisy. Try any of the usual solvents, or, if not available, a solution of Vaseline in turps substitute. Having introduced the fluid rotate the control once or twice, then leave for half an hour before

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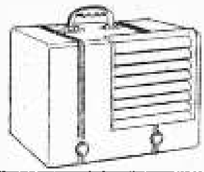

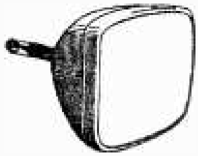

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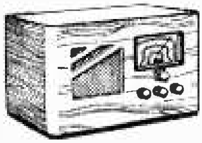

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testing. Suspect also a heater/cathode short in the PCF80 in the turret tuner.

KOLSTER BRANDES OV30 NEW QUEEN

When the picture first appears there is a vertical black line 2in. wide on the right hand side of the screen. This sometimes clears after a few minutes or after a slight adjustment of the horizontal hold. During the course of the evening, the set has to be adjusted as vertical lines in buildings appear to twist about 1in. from the top and sometimes with an erratic line racing across the top of the picture.—E. Spark (Co. Durham).

We would advise you to replace the PCF80 video amplifier-line oscillator valve (V6). This is situated on the centre of the chassis between the 6AL5 and the PC182. Also have the PY83 and 50CD6 valves inside the screened section on the left checked if the gap on the right side is troublesome.

BUSH TV24C

The set was not used for about two weeks and on switching on the sound came but there was no raster and no picture. A clicking sound could be heard, and upon investigation it was found to coincide wth a flashing around the electron gun inside the tube. The flash can be seen arcing across between the grid and what I take to be the first anode. EHT is present and appears to be high enough judging by the length of spark from the EY51. The earthing contact between the outside of the tube and the chassis does not look too good as there is a sparking at that point as well.—R. Sant (West Hartlepool).

We would advise you to change the EY51 before condemning the tube. If the flashing continues the tube will have to be replaced.

WELDING TUBE HEATERS

There is no sound or vision on the above set. The valves and the tube do not light up, but I have been told that the tube heater is in order. With the set switched on, I can hear a faint vibration, which seems to be from the valves.—L. Deegan (London, W.13).

To check the tube heater, short pin 1 to pin 12 on base. If the valves then light up—the tingling stops—the tube is at fault. This does not necessarily mean that the tube must be replaced. The heater can be welded by a high voltage-high current pulse. This is readily available from the top cap of the PL36 line output valve. The EHT will not do. It is important to realise that only a momentary pulse is required. It may be applied as follows. Remove the tube base socket, short tags 1 and 12 to preserve the heater continuity of the valve chain. Connect pin 1 of the tube to chassis. When the receiver has had time to reach operating standard, touch a lead from the PL36 top cap to pin 12 of the C.R.T. Repeat if necessary until the spark has a flame-like quality, proving the heater is intact.

THE "OLYMPIC"

(Continued from page 31)

circuit is used. Not only is a correction network included between generator and output valve, but the curvature of the valve characteristic is also involved. There are thus three frame linearity controls. They are not difficult to adjust however. The result is effective in that non-linearity is only detectable within about ½in. of the top of the tube.

The line-output stage utilises the valves PL81 and PY81. The EHT rectifier for the 90deg version is an EY86, while an EY51 serves for the 70deg version.

A width control is not incorporated. The width can be adjusted, by other means than the usual variable inductor, during construction, and it is not necessary thereafter to alter the circut. A height control is, however, provided, so that the correct aspect ratio can be achieved.

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(To be continued)

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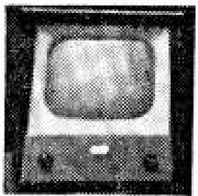

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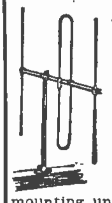

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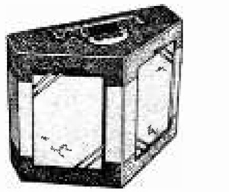

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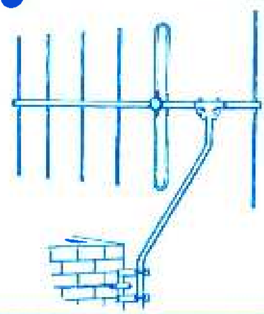

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5 watt 1/3, 10 watt 1/6, 15 watt 2/- **WIRE-WOUND RESISTORS** 25 ohms—10,000 ohms

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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/-	Metal 7" reels 2/- each
	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, 384, 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.** ½in. sq. x 2½in. and ¾in. sq. x 1¾in., 2/- ea., with cores. **SOLON**—Soldering Iron, 220/40 v. 25 w., 24/-. **REMPLOY Instrument Iron**, 230 v. 25 w., 17/6. **MAINS DROPPERS.** 3in. x 1½in. 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 1¼in., 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
1S5	7/6	6L6G	10/6	EB91	6/-	HVR2A	6/6
1T4	6/-	6N7M	6/6	EBC33	8/6	MU14	9/-
2X2	3/6	6Q7G	8/6	EBC41	8/6	P61	3/6
3S4	7/6	6SA7	6/-	EBF80	10/-	PCC84	9/6
3V4	7/6	6SJ7M	6/-	ECC84	9/6	PCF80	9/6
5U4	7/6	6SN7	6/6	ECF80	9/6	PCL82	11/6
5Y3	7/6	6V6G	6/6	ECH42	10/6	PEN25	6/6
5Z4	9/6	6X4	7/6	ECL82	10/6	PL82	10/6
6AM6	5/-	6X5	6/6	EF39	5/6	PY80	7/6
6B8	5/-	12AT7	8/-	EF41	9/6	PY81	9/6
6BE6	7/6	12AU7	8/-	EF50	5/6	PY82	7/6
6BH6	9/6	12AX7	8/-	EF80	8/-	SP61	3/6
6BW6	9/6	12BE6	8/6	EF91	5/-	UBC41	9/6
6D6	6/-	12K7	6/6	EF92	5/6	ECH42	9/6
6F6G	7/6	12Q7	6/6	EL32	5/6	UF41	9/6
6H6	3/6	35L6	9/6	EL84	8/6	UL41	9/6
6J5	5/6	35Z4	7/6	EM81	9/6	UY41	8/6
6J6	5/6	80	9/6	EZ40	7/6	U22	8/6
6J7G	6/6	807	5/6	EZ80	7/6	VR105	9/6
6K6GT	6/6	954	1/6	E1148	1/6	VR150	9/6
6K7G	5/6	EA50	1/6				

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).
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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 1½in. 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. 4/6 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. 2⅛in. x 1in. x 1in. High Q and good bandwidth. By Pye Radio. Data sheet supplied.
WEARITE M800. Miniature 465 Kc/s. 12/6 pair.
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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.	3/6	2,500/3v.	4/-
16/450v.	3/-	8 + 8/500v.	5/-	5,000/6v.	5/-
16/500v.	4/-	8 + 16/450v.	3/9	32 + 32/450v.	6/-
32/450v.	3/9	8 + 16/500v.	5/6	32 + 32 + 32/350v.	7/-
25/25v.	1/9	16 + 16/450v.	4/3	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/-; 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, FMT1, 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/-. **8/CANS** B7G, B9A, 1/- ea.

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