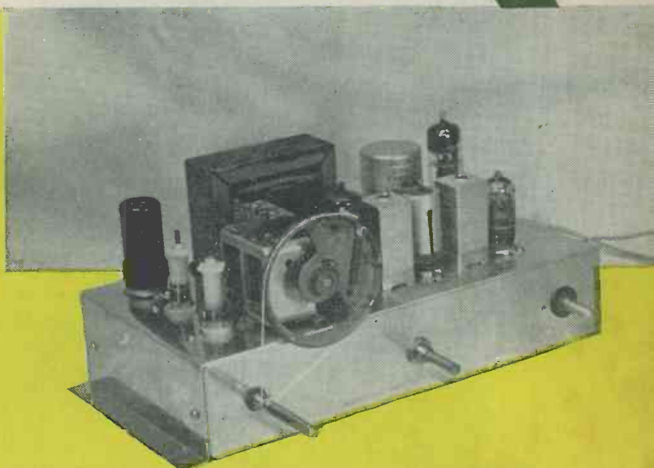
THE Radio Constructor

RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 17 NUMBER 8
A DATA PUBLICATION
PRICE TWO SHILLINGS

March 1964

Short Wave Superhet



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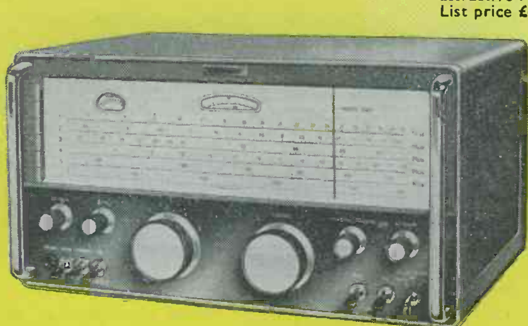

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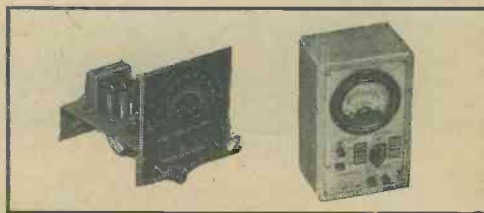
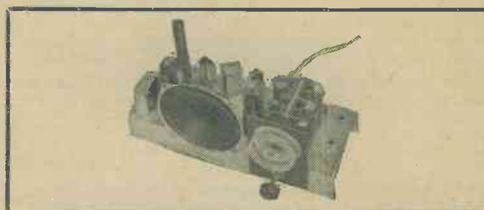
1



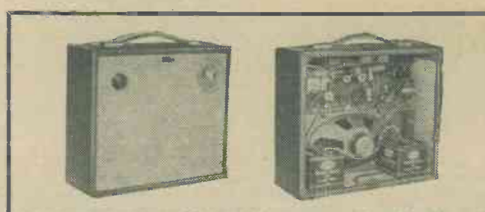
Assembly and use of signal generator and multi-test meter (especially valuable in servicing work).

2



Construction of 5-valve 2-waveband AC/DC superheterodyne receiver, and a number of instructional experiments, using testing instruments.

3



Construction of 6-transistor (with semiconductor diode) 2-waveband portable, and a number of instructional experiments, including a.f. amplifier with microphone pre-amplifier.

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GL-58

MA-12


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MFS

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DX-40U

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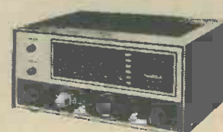

RA-1

RG-1

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and the SKYROVER DE LUXE

GENERAL SPECIFICATION. 7 transistor plus 2 diode superhet, 6 waveband portable receiver. Operating from four 1.5V torch batteries. The SKYROVER and SKYROVER DE LUXE cover the full medium waveband and short waveband 31–94 M, and also 4 separate switched band-spread ranges, 13 M, 16 M, 19 M and 25 M, with band-spread tuning for accurate station selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions.

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WAVEBAND COVERAGE: 180–576 M, 31–94 M, and band-spread on 13, 16, 19 and 25 metre bands.

All components available separately. Four batteries included free. Data for each receiver, **2/6 extra,** *refunded if you purchase the parcel.*

THE SKYROVER

Controls: Waveband Selector, Volume Control with On/off Switch, Tuning Control. In plastic cabinet, size 10" x 6½" x 3½", with metal trim and carrying handle.

Can be built for

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A.C. volts: 0–25–50–250–500 at 1,000Ω/V.
D.C. current: 0–50μA, 0–2.5–50–250mA.
Resistance: 0–2,000Ω, 0–200kΩ, 0–20MΩ.
Basic movement: 40mA f.s.d. moving coil. With universal shunt full scale deflection current is 50mA.
Size/finish: Black plastic case 3½" x 5¾" x 1¾".
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External connections: Two 4mm sockets for test lead plus.
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This offer is exclusive to Lasky's!
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Data and circuit available separately 2/6, refunded if all parts bought. Pair of batteries, 2/5 extra.

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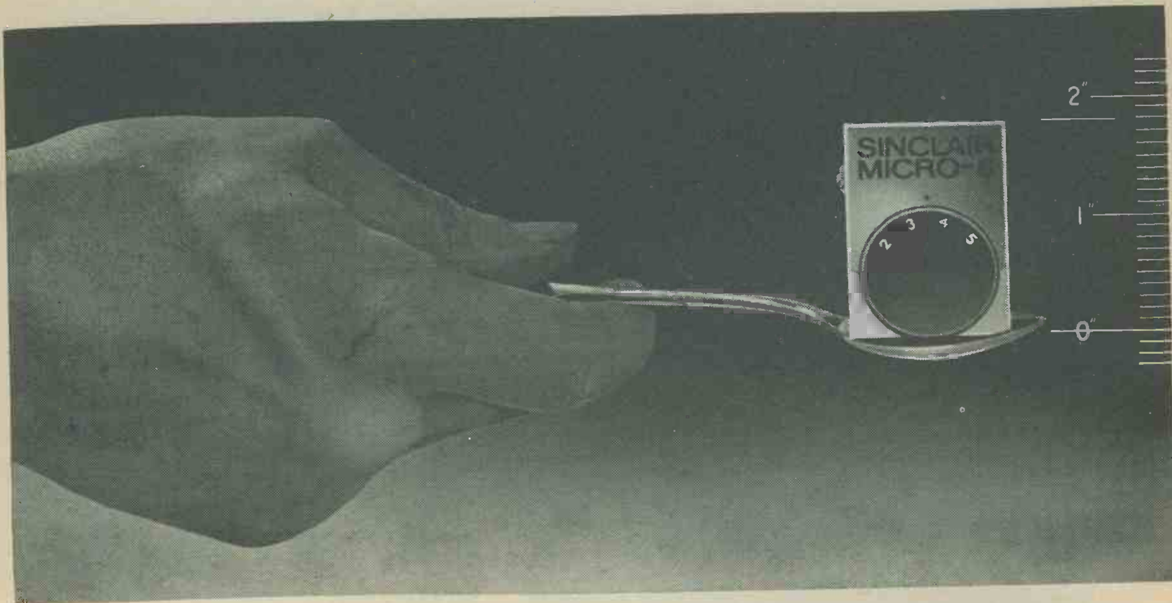
THE SMALLEST



A fantastic development in micro-miniaturisation

The Sinclair Micro-Six is the smallest radio set in the world. Its six-stage circuit gives it the power and sensitivity that make reception possible under the severest listening conditions so that you can have radio at your command no matter where you are, in car or bus, at home or at work. Just look at the remarkable specification of this latest Sinclair micro-electronic design—and then look at its size. It is by the use of micro-components, originally developed for use in space and computer electronics, that a set with these proven standards can be contained within a case considerably smaller than a matchbox.

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A WORLD-BEATING BRITISH DESIGN

SINCLAIR MICRO-6

One of a series of specialised micro-electronic transistor designs by

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SET IN THE WORLD

- Six stage sensitivity
- Unique circuitry gives immense power and quality
- Plays in car, train, bus or plane
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ONLY 1⁴/₅" x 1³/₁₀" x ½"

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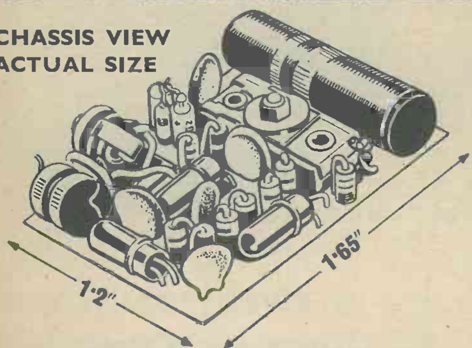
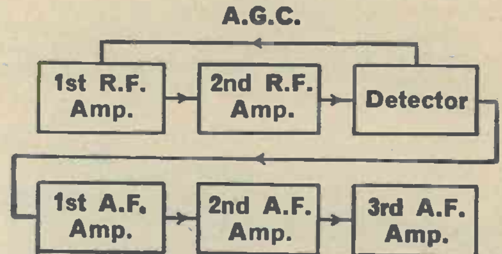


This life-size illustration of the Micro-6 shows the ingenious printed circuit board layout which makes it such a delight to build. By following the well-presented instructions, building could not be simpler.



BLOCK DIAGRAM OF THE SINCLAIR MICRO-6

Advanced design techniques result in six-stage circuitry shown above, and it is this that ensures the wonderful standards of performance of this set.

TECHNICAL DESCRIPTION

The Micro-6 uses Micro-Alloy Transistors (MATs) in a completely new circuit comprising six stages. Two stages of R.F. amplification are followed by an efficient double-diode detector which drives a high gain three stage A.F. amplifier. Powerful A.G.C. is applied to the first R.F. stage to ensure fade-free reception of the most distant station, and tuning covers the entire medium waveband. This is widened out at the high frequency end to provide improved separation of Continental stations. The tiny ferrite rod aerial and earpiece socket were both specially designed for this set. This socket incorporates a switch which operates automatically on inserting the earpiece plug, and switches off when the plug is withdrawn. Listening is by means of the high-impedance lightweight earpiece provided. Quality of reproduction is outstandingly good.

Instructions for building the Micro-6 set a new standard of clarity and simplicity. The diagrams are a masterpiece of technical illustration and the text contains all the information you require.

Total cost of all parts, including earpiece, case, dial and instructions, come to 59/6

Mallory Mercury Cell Type ZM312—1/11 each

MORE SINCLAIR DESIGNS ON NEXT PAGE

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The success of the Sinclair "Slimline" has been demonstrated again and again in the letters we have published from among the many hundreds sent to us by enthusiastic builders of this famous receiver. Of these, none surpasses the one we publish below. It typifies better than anything the ease with which the "Slimline" can be built and also the excellence of the performance it offers. Newcomers to micro-transistor set building cannot do better than start right away with the "Slimline" now.

SINCLAIR 'Slimline' . . .
simplicity itself to build

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3.12.63

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Though you have received many tributes to this fine little set, I should still like to add mine, for I am a complete duffer of over 50 who till now had never attempted anything through sheer ignorance. I am still ignorant of the first principles of radio, but, within two hours of sitting apprehensively at the table to study the instruction, I was listening to my first programme and the quality of reproduction surpasses that of sets many times the price.

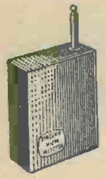
Yours faithfully,

(Signed) HAROLD F. B. CARTER

A facsimile copy of the original of this letter has been shown to the Editor of this and other technical magazines.

It gives you Europe in the palm of your hand

The Sinclair "Slimline" is a micro-miniature receiver with self-contained ferrite rod aerial and accommodation for a standard PP5 battery. Using Sinclair MAT Transistors and special circuitry, it provides great power and quality, tuning over the whole medium waveband, and will play in car, bus or train. With all components, gold-trimmed blue case (size 2 1/16" x 1 1/16" x 3/4") and lightweight earpiece, to build this set costs **49/6**



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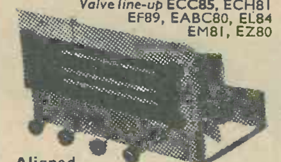

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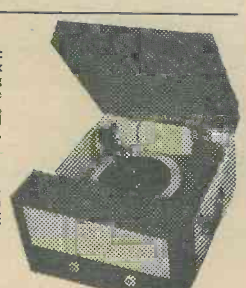
RECORD PLAYER CABINETS



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2/OC81	15/6	OA70	2/9
GET114	6/6	OA81	2/9
OC72	7/6	GEX13	2/9
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Speakers P.M.—3 ohms 2½" E.M.I. 15/6. Goodmans 3½" 16/6. 5" Rola 15/6. 6" Elac 16/6. 7" x 4" Goodmans 15/6. 8" Rola 19/6. 10" R. x A. 25/–. 9" x 6" Goodmans 22/6. E.M.I. Tweeter 22/6.

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Osc. Coil—9/16" diam. M/W.	5/3
Osc. coil M. & L.W.	5/9
Midget Driver Trans. 3.5:1	6/9
Ditto O/Put Push-pull 3 ohms	6/9

Elect. Condensers—Midget Type 15V 1mfd–50mfd, ea. 1/9. 100mfd. 2/–.
Ferrite Aerial—M. & L. W. with car aerial coupling coil, 9/3.
Condensers—150V. wkg. .01 mfd. to .04 mfd., 9d. .05 mfd., .1 mfd., 1/–. .25 mfd., 1/3. .5 mfd., 1/6, etc.
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Battery (extra)	2 3

TG18

Maker: NOMBREX. Resistance Capacity Bridge

Cat. No.	Maker's No.	Description	£ s. d.
TG19	62	RANGES. 1. 1 ohm-10K ohms. 2. 100 ohms-1 Megohm. 3. 10K ohms-100 Megohms. 4. 1pF-.01uF. 5. 100pF-1uF. 1. 0·01uF-100uF. ACCURACY. All the ranges employ close tolerance internal standards, permitting measurement to an accuracy of 2½% or better at mid-scale. POWER FACTOR. This control operates on the highest capacitance range 6, permitting power factor measurements up to 70%. LEAKAGE. Assessment of capacitor leakage is provided by a neon indicator circuit, for all capacitors of voltage rating 250-350 V.D.C. SIZE. 6⅝ in. × 4⅝ in. × 2⅜ in.	8 5 0

TG19

Maker: NOMBREX. Audio Generator

Cat. No.	Maker's No.	Description	
TG20	63	RANGES. 10-1000,000 cycles, in four multiplier ranges. Directly calibrated scale. OUTPUT. Sine wave and square wave. OUTPUT. Voltage: Maximum 1 volt peak, sine and square. Impedance: Maximum 1000 ohms. Stability: Voltage constant over entire range within 1 dB. DISTORTION. Sine wave: Less than 1%. Square wave: Rise time 0·3uSec. ACCURACY. Frequency: Within 5% all ranges (average 3%). Output Voltage: Within 3% of indicated voltage. ATTENUATORS. 1. Continuously variable attenuator, directly calibrated in millivolts. 2. Three-position switched output multiplier, X1, X10 & X100. ...⅝ in. × 4⅝ in. × 2⅜ in.	16 15 0

TG20

Maker: N...
A unit des... transist...
CURRENT ... protect...
VOLTAGE ... Voltag...
REGULA...
ACCURA...
SUPPLY. ... order...
CONSU...
SIZE.

TG21

Please write your name and address in block capitals

NAME ....

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THE **Radio Constructor**

Incorporating THE RADIO AMATEUR

MARCH 1964

Vol. 17, No. 8
Published Monthly
(1st of month)

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9

Telephone
CUNningham 6141
(2 lines)

Telegrams
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Annual Subscription 30s. (U.S.A. and Canada $4.50) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers please pay by cheque or International Money Order.

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Printed Circuit 4-Transistor Amplifier

F. G. Rayer, ASSOC. BRIT. I.R.E.

A.F. amplifiers are always of interest to the home-constructor, and the transistorised design described here is particularly attractive since it employs a ready-made printed circuit board which allows a very neat and compact layout to be achieved. The design is versatile, in that it allows the use of transistors which may already be on hand, and the alternative component values needed with such transistors are fully discussed in the text

THIS AMPLIFIER IS CONSTRUCTED COMPLETE ON A circuit board measuring approximately $2\frac{1}{4}$ x $4\frac{1}{2}$in, and it can be operated from any 9 volt battery. A $7\frac{1}{2}$ volt supply is also satisfactory, with slightly reduced output. Both high impedance and low impedance input points are provided. The high impedance input is suitable for a crystal pick-up and other high impedance sources, while the low impedance may be used with a transistor t.r.f. or superhet tuner.*

* The high impedance input is at 470kΩ, and this may cause a small amount of bass-cut with crystal pick-ups. Such bass-cut need not be a disadvantage, particularly when small speakers and enclosures are employed.—EDITOR.

The amplifier, as constructed on the circuit board, has optional connecting points for TR_1 input, and does not include the volume control. Though the amplifier is of small size, a relatively large output is obtainable. It is intended that the volume control and speaker shall depend on the equipment in which the amplifier is fitted. With a battery driven record player, a 7 x 4in or other fairly large speaker can usually be accommodated, and the volume control can be mounted near the turntable or other controls. Alternatively, for general purposes it may be preferred to place the amplifier in the speaker cabinet with the volume control. A 2–3 ohm speaker is required, and a

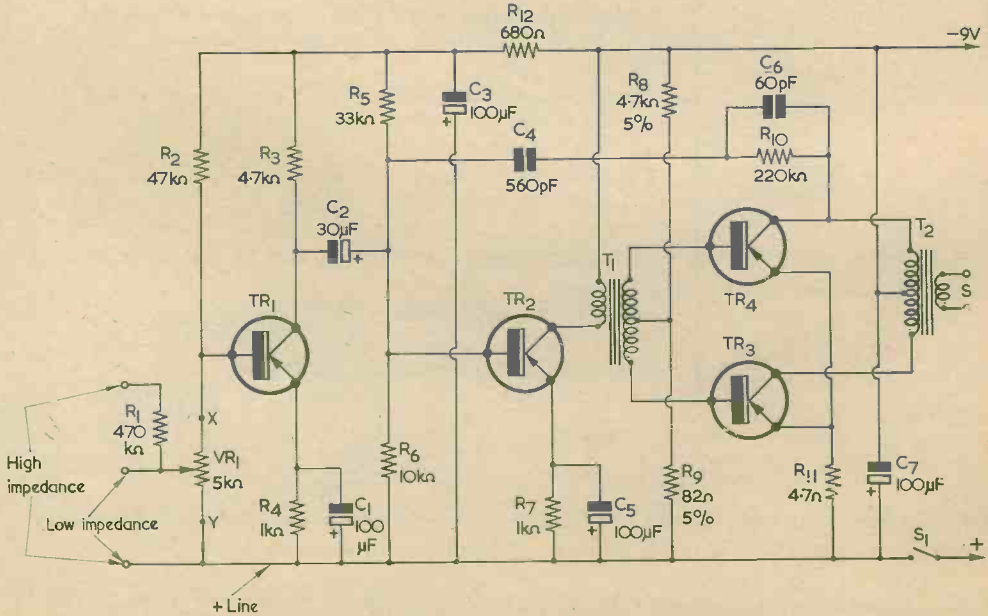

Fig. 1. The circuit of the 4-transistor printed circuit amplifier

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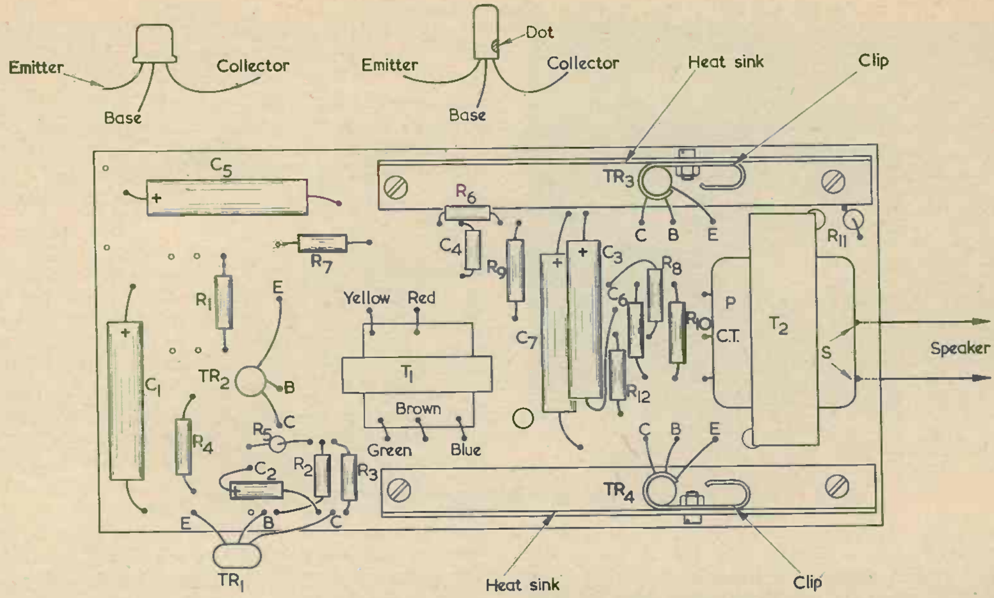


Fig. 2. The components fitted to the circuit board. In some instances it may be preferable to mount R_1 away from the board

miniature unit can be employed if a small overall size in the equipment makes this necessary.

Circuit Board

This is available complete with printed conductors, and it is ready to take all components. Construction is thus much simplified and speeded up, and the chance of making wiring errors is small.

It is only proposed to give brief details of circuit board construction, as no difficulty is likely to be experienced. Components are placed on the insulated side of the board, with wire ends projecting through to the foil side. A small soldering iron with a $\frac{3}{16}$in or $\frac{1}{8}$in bit is most satisfactory, and 20 or 22 s.w.g. radio-grade cored solder is necessary. The solder is always applied to the point where the junction between lead and printed conductor will occur, and *not* to the iron.

Only a little solder is used on each joint, as excess may spread to other conductors. Lengthy application of the iron is not needed and should be avoided, because overheating may damage components.

All components and their positions on the board are shown in Fig. 2, and it is as well to leave the transistors until last. The electrolytic capacitors have positive and negative lead-outs, which are positioned as shown. Resistors can of course be inserted either way round, but care should be taken to see that each value is correct for its circuit position.

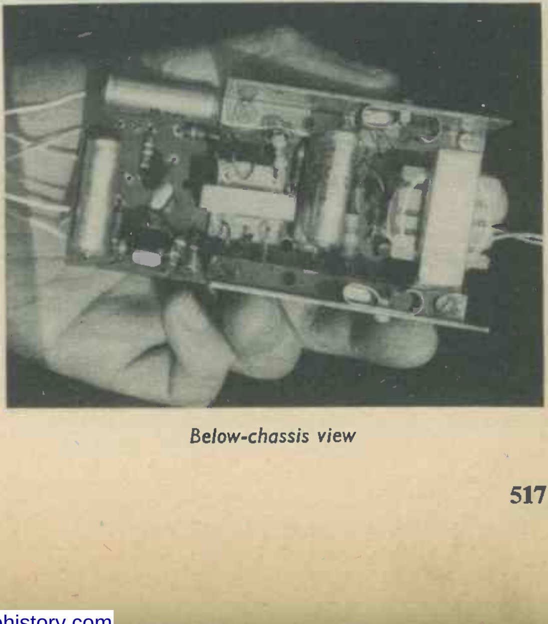
The wire ends of capacitors and resistors are bent over so that they can pass through the appropriate holes. Extremely sharp bends, which may fracture the wires, should be avoided, and leads should not be bent immediately against the component body.

Resistors and capacitors rest on the board, and the protruding wire ends are bent out slightly, to keep the components in place. The board is then turned over, and the joints soldered. A good joint should be made in a few seconds, after which the iron is removed at once. Excess projecting wire is snipped off.

Resistors R_5 and R_{11} stand vertically. One lead is left straight, and the other given two right angle bends.

Transformer T_1 is held by its leads, which are bared and shaped to pass down through the holes indicated. T_2 is secured by projecting lugs, these being soldered to conductors on the foil side of the board.

Fig. 3 shows the underside of the board. Flexible



Below-chassis view

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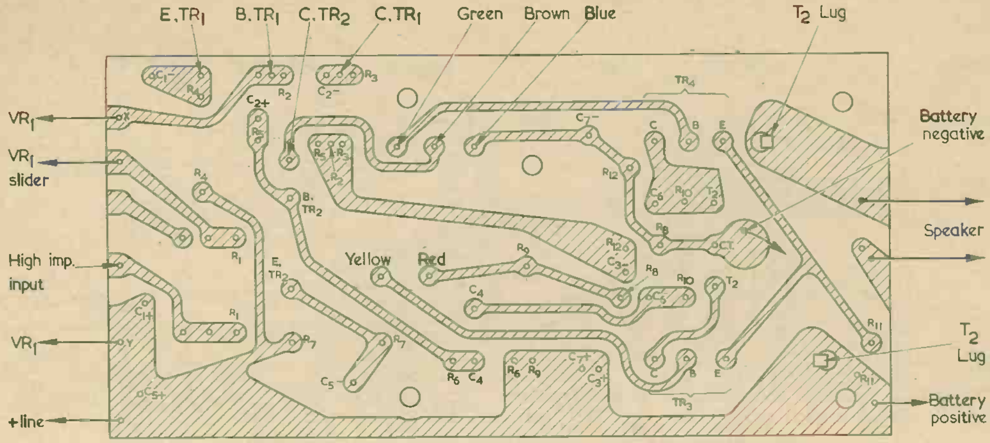

Fig. 3. The connections appearing on the copper side of the board

leads of appropriate length are taken from the connecting points indicated, these comprising twin flex from T_2 secondary to the speaker, and red and black flex for battery positive and battery negative connections. No on-off switch is incorporated in the board wiring. For many purposes, the switch can be provided by the volume control in the usual way, and both miniature and ordinary volume controls are available with a single pole switch for this purpose. However, some turntable mechanisms have a switch incorporated, and the amplifier can then be wired in parallel with the turntable motor. Both motor and amplifier are then switched on by raising the pick-up arm.

Various input circuits are possible, to suit the equipment, and these are explained later.

Transistors

Special care is needed when soldering the transistors, as lengthy heating will cause damage. All transistor leads can be at least ¾in long, and this reduces the chances of excessive heat reaching the body. A heat shunt must be clipped on each lead before soldering. The iron should have reached its proper temperature before attempting soldering, and it should be removed as soon as the joint is made.

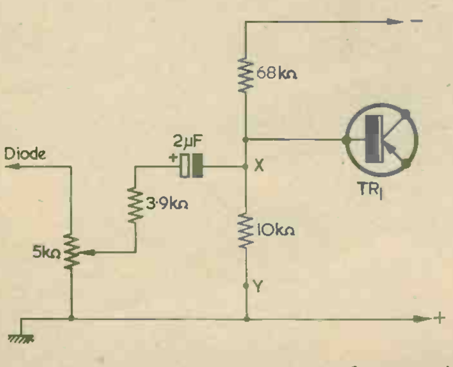

Fig. 4. An alternative input circuit for use with transistor tuner units. The 5kΩ potentiometer may also be the diode load

Transistor wires must not touch each other, or other parts. Sleeving can be placed on leads, if necessary. Fig. 2 shows connections for Mullard and Newmarket transistors. TR_1 and TR_2 are supported by their wires.

TR_3 and TR_4 are fitted in clips bolted to the heat sink plates. This is best done by arranging the transistors in the clips, with collector, base and emitter wires passing through the appropriate holes, and then soldering the leads after the sinks and clips are finally secured. Leads should not be under tension, or bent near the transistor body.

Various alternative transistors can be used with success, but in some cases resistor values have to be changed to suit. The most important point is generally the ratio between the values supplying the base (such as R_5 and R_6 for TR_2, or R_8 and R_9 for TR_4 and TR_5).

With an OC71 or equivalent for TR_1, R_2 and VR_1 may be 47kΩ and 5kΩ respectively, as shown in Fig. 1. For fixed values (volume control in tuner) R_2 may be 68 kΩ with 10kΩ between points X and Y. A good quality transistor is necessary in the TR_1 position, as noise will be amplified by following stages. Many surplus transistors work well with these values, though with some it may be preferable to reduce R_2 to 56kΩ or 47kΩ (when 10kΩ is used instead of VR_1) to obtain a collector current of about 1mA.

TR_2 is an OC81D or equivalent, driving two OC81s or equivalents in the TR_3 and TR_4 positions. In these circumstances, and with a 9 volt battery, up to 500mW may be obtained without heat sinks. The relative values of R_8 and R_9 are important. R_8 should be 4.7kΩ 5%, and R_9 82Ω 5%. With the transistors in clips as described, a somewhat higher output may be obtained. For a 1W output, recommended values are: R_5 47kΩ, R_6 12kΩ, R_7 680Ω,

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R_8 2.2kΩ 5%, R_9 39Ω 5%, and R_{11} 3.3Ω.

If OC72s are to hand, they may be used for TR_3 and TR_4, with an OC71 driver (TR_2). Resistor values for transistors other than those mentioned will be found in published circuits and the maker's data. For many purposes an output of 250mW or so, into a high efficiency speaker of reasonable size, will be adequate.

Inputs

Referring to Figs. 1 and 3, it will be seen that various input connecting points are provided. The unit can be wired up as shown, or the input circuit may be connected to suit the purpose in view.

Points X and Y allow an external volume control to be located near the turntable or elsewhere. In all cases screened wire is required for input connections, the outer braiding forming the "earth" or positive line conductor. With the volume control near the turntable, it is convenient to solder R_1 directly to the control itself, as a junction point for the pick-up leads. If not, R_1 may be located as in Fig. 2. The input impedance is about 470kΩ, and can be reduced to about 250kΩ by changing R_1 accordingly. Sensitivity is sufficient for the usual crystal pick-up, at about 300mV.

The amplifier must not be switched on with VR_1 disconnected, unless a fixed resistor is wired to points X and Y. Fig. 4 shows input connections for use with the usual transistor superhet or t.r.f. tuner incorporating a diode detector.

The low impedance sensitivity is around 5mV or better, and is easily adequate for excellent volume from a transistor tuner.

Current Drain

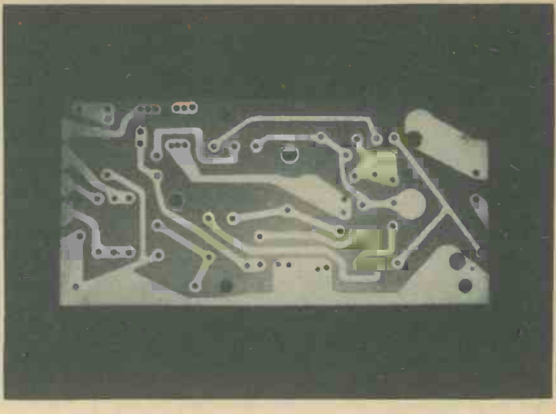
Current drain depends on actual transistors and resistor values, especially R_8 and R_9. With no signal, or with low volume, a meter in one battery lead should show about 8mA to 12mA or so. As volume is increased, current peaks will rise to some 20mA to 25mA with good volume, and approximately 34mA to 40mA or more with considerable volume.

If the same battery is used to power the turntable unit, the meter should be included in one battery lead to the amplifier only, or it will indicate both motor and amplifier current.

Negative Feedback

If an alternative transformer is used instead of T_1, and oscillation arises, the amplifier should be switched off at once, and the secondary leads of T_1 reversed, or C_6 and R_{10} transferred to the collector of TR_3.

The feedback circuit is frequency sensitive, and is generally satisfactory. An alternative, giving increased feedback at lower frequencies, consists of removing C_4 and C_6, and of changing R_{10} from 220kΩ to 560kΩ, it being wired from TR_4 collector to TR_2 base. An 0.25μF capacitor and 120Ω resistor are then wired in series, and connected across the primary of T_2 to suppress high frequencies. The amplifier may also be operated without feedback, whereupon it gives slightly increased gain.



Printed circuit—compare with Fig. 3 opposite

Components List

See text for alternative transistors and resistor values

Resistors

(All fixed resistors 10% ¼W unless otherwise stated)

R_1 470kΩ
R_2 47kΩ
R_3 4.7kΩ
R_4 1kΩ
R_5 33kΩ
R_6 10kΩ
R_7 1kΩ
R_8 4.7kΩ 5%
R_9 82Ω 5%
R_{10} 220kΩ
R_{11} 4.7Ω
R_{12} 680Ω
VR_1 5kΩ volume control, log track, with switch S_1 (see text)

Capacitors

C_1 100μF 6V wkg.
C_2 30μF 6V wkg.
C_3 100μF 12V wkg.
C_4 560pF
C_5 100μF 6V wkg.
C_6 60pF
C_7 100μF 12V wkg.

Transistors

TR_1 OC71 or NKT252
TR_2 OC81D or NKT252
TR_3, TR_4 matched pair OC81 or NKT251

Switch

S_1 s.p.s.t. ganged with VR_1 (see text)

Miscellaneous

4-transistor amplifier circuit board (Osmor)
T1 Driver transformer type QXD1 (Osmor)
T2 Non-miniature output transformer QXO2 (Osmor)
Two heat sinks approximately 1¼ x 3in with clips (Osmor)

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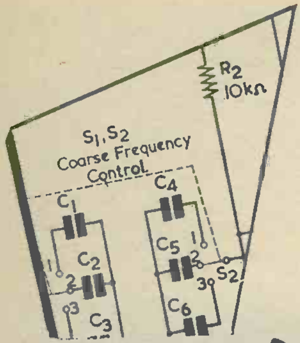
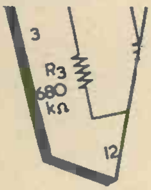


suggested circuits



The circuits presented in this series have been designed by G. A. French, specially for the enthusiast who needs only the circuit and essential data

No. 160 An Expanded Scale Voltmeter with Compressed Centre Section

In last month's contribution to this series the author described an expanded scale voltmeter which was capable of monitoring mains voltage, and of thereby giving warning of excessive voltage drops due to power cuts and similar circumstances. The voltmeter circuit employed a zener diode to provide a reference voltage, and a milliammeter and series resistor to measure the potential difference between this voltage and a fraction of the a.c. mains voltage after full-wave rectification. With correct component values, the circuit was then capable of indicating a small range of voltages over the entire scale of the meter. Thus, an input voltage of 210 could cause zero deflection of the meter, whilst 250 volts could result in full-scale deflection. By presenting mains voltages in this manner, small variations become much more evident to the observer than occurs with a conventional linear instrument, and the entire scale of the meter is devoted to the range of voltages which are of importance.

After this article had been written and despatched, the writer considered further, and more complex, applications for expanded scale voltmeters. A typical instance might, for instance, occur when it is required that a piece of equipment be provided with a supply voltage which should lie within certain limits. Alternatively, it may be necessary to ensure that the output voltage of an item of equipment does not go either above or below a certain range. In both these cases all that needs to be shown by a monitoring meter is the amount by which the voltage passes outside the specified limits. For the meter to offer maximum information, the space taken up on its scale by the "safe" range of voltages should be a negligible proportion of the whole.

To take an example, let us assume that a device is designed to offer an output voltage which lies between, say, 90 and 110 volts. If a fault condition arises, it is possible for the output to fall below the 90 volt figure to 70 volts, or to rise above the 110 volt figure to 130 volts. How can this particular information be most satisfactorily displayed by a monitoring meter? In the writer's view, the best method would consist of having very nearly one-half of the meter scale calibrated from 70 to 90 volts, a negligibly small proportion of the scale calibrated from 90 to 110 volts, and the remaining part of the scale calibrated from 110 to 130 volts. The resulting meter scale would look like that shown in Fig. 1 and, as may be seen, this offers maximum information with respect to the voltages which exist under fault conditions.

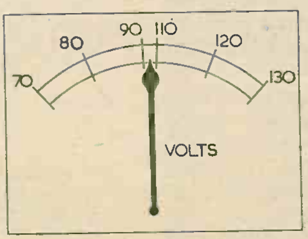


Fig. 1. A typical example of an expanded meter scale with a compressed central section

Not only does the meter scale of Fig. 1 have an expanded scale, but it also has a compressed section at the centre as well. The writer investigated the possibilities of producing meter readings of this type, and he found that these could be obtained very easily by simply taking advantage of an attribute of the zener diode which is usually ignored. In order to present a practicable circuit for publication, tests were then carried out with a prototype which was capable of monitoring mains voltages.

The Basic Principle

The basic manner in which a zener diode may be employed to provide an expanded meter scale with a compressed central section is illustrated by the circuit of Fig. 2. In this diagram a zener diode is connected in series with a centre-zero milliammeter and a resistor, the latter two components constituting a voltmeter. Also provided is a fixed reference voltage, which could be given by a neon tube or similar device. The

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voltage to be monitored is applied to terminals A and B with the polarity indicated.

When the reverse voltage across a zener diode exceeds a certain figure the diode passes a reverse, or zener, current. This effect is analogous to reverse voltage breakdown with a normal semiconductor diode. The zener diode is, however, especially designed to pass a continuous zener current, and it offers the advantage that the reverse voltage which appears across it remains substantially constant for all zener currents within its safe operating range. In consequence, the zener diode can be employed as a voltage stabiliser or as a voltage reference device. Apart from this property, the zener diode is just the same as any other semiconductor diode. If a forward voltage (i.e. in the conducting direction) is applied to it, forward current flows. Advantage is taken of this fact in Fig. 2.

Let us assume that the positive potential at terminal A of Fig. 2 is higher than that offered by the reference voltage. Conventional current (from positive to negative) then flows from terminal A to the positive terminal of the reference voltage. This current is in the forward direction for the zener diode which, acting in the same way as any other semiconductor diode, then conducts. Under this condition the zener diode can be considered as presenting what is very nearly a short-circuit, whereupon the meter gives an indication of the voltage difference existing between the voltage applied to terminals A and B, and the reference voltage.

Since terminal A is more positive than the positive terminal of the reference voltage, the needle of the centre-zero meter is deflected to the right.

If we next decrease the voltage applied to terminals A and B we are, at the same time, decreasing the voltage difference between terminal A and the positive terminal of the reference voltage, whereupon the meter deflection decreases also. This process continues until the voltage at terminals A and B becomes equal to the reference voltage. Under this condition the meter needle remains at the centre of its scale, to indicate zero, and the zener diode ceases to pass current. If we continue to decrease the voltage at terminals A and B the meter will still indicate zero, because the zener diode is now biased in the reverse direction and it passes no current.

If the voltage across terminals A and B is decreased still further, the voltage difference between terminal A and the positive terminal of the reference voltage eventually becomes equal to the zener voltage for the diode. The diode now commences to pass zener current. In this case, however, conventional current flows from the positive terminal of the reference voltage to terminal A, passing through the zener diode in the reverse direction. The meter will now give an indication which is proportional to the potential difference between the voltages, minus the zener voltage which is dropped across the diode. Since this current flows in the opposite direction to that which flowed previously, the needle is deflected to the left. The meter needle will suffer increased deflection to the left as the voltage across terminals A and B decreases further.

As may be seen, we now have the necessary conditions for a meter to offer an expanded scale with a compressed central section. The expanded scale results from the use of a reference voltage, whilst the compressed centre is the result of employing a zener diode and a centre-zero meter. When the difference between the voltage to be monitored and the reference voltage lies between zero and zener voltage, the needle stays in the central position. We have, therefore, a circuit which is capable of producing a meter scale similar to that shown in Fig. 1.

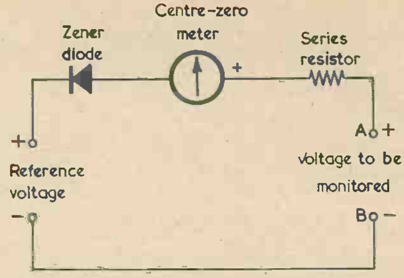

Fig. 2. A zener diode meter circuit which provides both an expanded scale and a compressed central section

Practical Considerations

The actual meter calibration obtained with the circuit of Fig. 2 depends upon the sensitivity of the meter, the value of the series resistor and the zener voltage of the diode. If the set-up is to be used to monitor direct voltages, these components can be chosen accordingly. It may also be necessary to step down the voltage to be monitored by means of a fixed potentiometer in order to bring the compressed central section of the meter scale within the limitations offered by a practical zener diode. The experimenter who understands the principle of operation of the circuit of Fig. 2 will be quite capable of working out the required external circuitry needed under such conditions.

To carry out a practical check on the zener diode circuit, the writer made up the prototype shown in Fig. 3. The function of this prototype was to monitor a.c. mains voltages above and below an arbitrary central range. In Fig. 3 the a.c. mains voltage is applied to the rectifier circuit given by D_1, the limiter resistor R_1, and reservoir capacitor C_1, whereupon a rectified voltage proportional to the mains voltage appears across C_1. A reference voltage is provided by the VR105/30 regulator tube, this stabilising at approximately 105 volts. A fraction

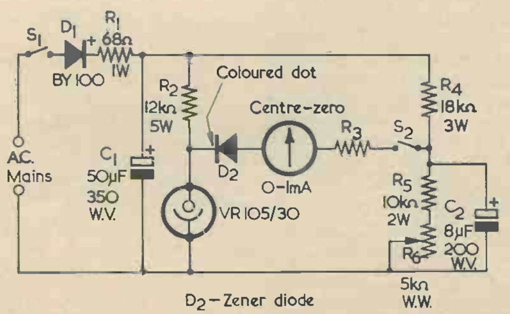

Fig. 3. Employing the basic circuit of Fig. 2 to monitor a.c. mains voltages

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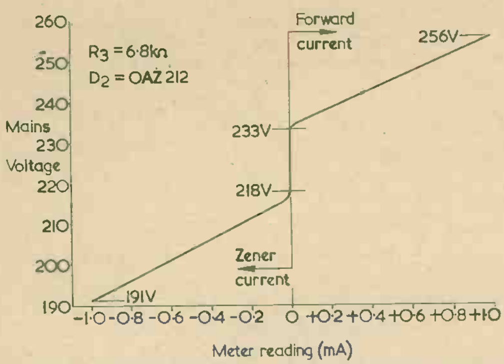

Fig. 4. The results given by the circuit of Fig. 3 when an OAZ212 is used, and R_3 has a value of 6.8kΩ

of the rectified voltage appears at the junction of R_4 and R_5 and is applied to a series combination of a resistor (R_3), a meter and a zener diode in the same manner as occurred at terminal A in Fig. 2. In the prototype, the variable resistor, R_6, was set up so that, at an a.c. voltage approximately midway between 210 and 250, the voltage at the junction of R_4 and R_5 was equal to the reference voltage appearing across the VR105/30.*

The voltage appearing at the junction of R_4 and R_5 is proportional to the a.c. mains voltage. Since the VR105/30 stabilises at about 105 volts, the voltage at the junction of R_4 and R_5 is approximately $\frac{105}{230}$ of the applied a.c. voltage. The curves given in Figs. 4, 5 and 6 were taken against mains voltages, and the corresponding direct voltages at the junction of R_4 and R_5 will be approximately $\frac{105}{230}$ (nearly ½) of the a.c. voltages indicated.

The first curve taken is shown in Fig. 4. An OAZ212, which has a zener voltage of 9.1 ±15% at 1mA, was employed in the D_2 position, and R_3 was given a value of 6.8kΩ. As is shown by the curve, the compressed central section appeared between 233 and 218 volts. The difference between the onset of forward and zener current is, therefore, 15 volts. Scaling down by a factor of ½ (to obtain the corresponding voltages at the junction of R_4 and R_5) this corresponds to some 7.5 volts, which is what would be expected from an OAZ212.

It was next decided to increase the sensitivity of voltage indication, and to narrow the compressed central section of the meter scale. Accordingly, R_3 was reduced to 3.9kΩ and an OAZ210 (6.2 ±15% zener volts at 1mA) fitted in the D_2 position. This resulted in the curve shown in Fig. 5. The compressed section now appears between 234 and 224 volts, the difference between these voltages scaling down to some 5 volts, as would be expected from an OAZ210. The a.c. voltages corresponding to +1mA and −1mA now become 253 and 198 respectively, instead of 256 and 191, as in Fig. 4.

To obtain a further increase in sensitivity, R_3 was next reduced to 2.2kΩ, giving the curve shown in Fig. 6. In this curve the central compressed section is approximately the same as for Fig. 5, and the a.c. voltages corresponding to +1mA and −1mA become 248 and 203 respectively.

The practical result indicated by the curve of Fig. 6 is that the left-hand half of the meter scale indicates a.c. voltages from 203 to 224, whilst the right-hand half indicates a.c. voltages from 223 to 248. Both 224 and 233 volts appear at the same point at the centre of the scale, this representing the compressed section of the range.

It will be noted that, in Figs. 4, 5 and 6, the parts of the curves which correspond to forward current and zener current are shown as being linear, with a small amount of curvature near the zero current section only. So far as could be judged, within experimental error, this high degree of linearity was achieved with the prototype circuit, although the published forward and zener characteristics for the zener diodes employed would lead one to expect more pronounced curvature, particularly near the zero current points. Between the points at which forward current and zener current commence, the curve is quite definitely a straight vertical line, since the meter simply indicates zero over the corresponding range of voltages!

The zener current sections of the curves have a greater slope than the forward current sections. This is doubtless due to the fact that zener slope resistance is greater than forward slope resistance.

Practical Points

The circuit of Fig. 3 represents one application of the principle illustrated by Fig. 2, and it can be employed in practice to monitor mains voltages above and below any arbitrary preferred range. This being so, there are several points which need to be discussed.

The reference tube employed for the circuit need not necessarily be a VR105/30, and any other voltage regulator having a maximum current of the order of 30mA could be employed in its place. A running current of some 10 to 20mA would be

*As the curves of Figs. 4, 5 and 6 show, the actual a.c. voltage was about 233 volts. However, the purpose of the experiment was to prove the results which could be given by the zener diode circuit of Fig. 2, and it was only necessary to have an arbitrary setting in R_6 to achieve this end.

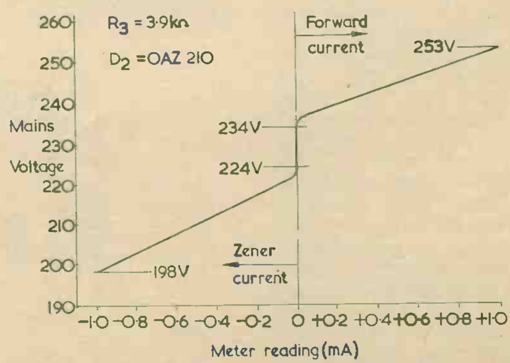

Fig. 5. The compressed section is narrowed with an OAZ210, and sensitivity is increased by reducing R_3 to 3.9kΩ

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adequate. The potentiometer offered by R_4, R_5 and R_6 should draw some 10mA or so, and should offer a voltage to R_3 which is equal to the reference voltage when the a.c. voltage is at the uppermost end of the range to be compressed. It is helpful to insert a pre-set potentiometer in the R_6 position for final setting up.

The width of the compressed range depends upon the characteristics of the zener diode chosen for the D_2 position. Sensitivity is controlled by the value of R_3.

If the zener diode is reversed the circuit will still function. However, the potential at the junction of R_4 and R_5 should then be equal to the reference voltage when the a.c. voltage is at the lower end of the range to be compressed instead of at the higher end.

The circuit of Fig. 3 employs a reservoir capacitor, whereas it is normal in measuring instruments to use full-wave rectifying circuits without a reservoir component. However, the zener diode cannot function correctly in the presence of the heavy ripple following an unsmoothed full-wave rectifier, and some form of smoothing is essential. If the circuit of Fig. 3 is adopted, accuracy should be maintained quite well with time if the reservoir capacitor has a value considerably higher than that needed to cause the peak voltage to appear after the rectifier. There is, then, a reserve in hand before loss of reservoir capacitance causes the device to read low. The time constant of C_1 and the associated components of Fig. 3 is of the order of 0.5 seconds, which seems to be reasonable in this respect.

Capacitor C_2 was included to ensure that the voltage applied to the zener diode circuit was well smoothed. It is possible that the circuit would function as well, or nearly as well, without C_2, but this point was not checked in practice.

Two switches are employed, one controlling the a.c. mains input and the other the zener diode and meter circuit. It is preferable to switch S_2 on after S_1, and to switch S_2 off before S_1. This prevents charging and discharging currents from the electrolytic capacitors passing through the meter. Whilst these currents are not excessively high they may cause the meter needle to travel beyond full-scale deflection for short periods of time.

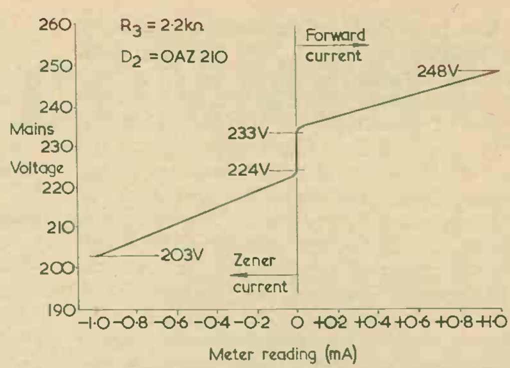

Fig. 6. Sensitivity is further increased by employing a 2.2kΩ resistor in the R_3 position

Fault Finding in Home Constructed Equipment

JOHN D. BENSON

Our contributor, who is a professional radio and television engineer of many years' standing, recounts a case-history which will be of interest both to the beginner and the advanced constructor

Attracted by the apparent simplicity of constructing a stereo amplifier using printed circuits, a friend, whose only qualification for tackling the job was a limited amount of experience with soldering, purchased a complete kit of parts for building the unit, complete with power pack and control panel.

The building instructions were religiously followed and eventually "the moment of truth" arrived, when the completed amplifier was to be tested. The results were chaotic, and the writer was hastily called in to sort out the troubles.

First Checks

First reactions were to check the control panel connections and circuitry, and several errors were found which could have accounted for the behaviour of the amplifier. These were corrected and a text was run. Results were poor with the output at "mouse-power"—certainly not up to the 10 watts as advertised! The output was also marred by a background of continuous crackling. It was now obvious that the fault lay in the printed circuit panels. Voltage tests proved anode, screen-grid and cathode voltages to be correct, and

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eliminated the possibility of incorrect values of components in these circuits, a very common fault in amateur-built equipment.

A simple shock test applied to the grid circuits showed a lack of sensitivity, so it was decided to switch off and check them. Ohmmeter tests to the chassis line with these circuits gave readings which varied in value from almost zero to a few hundred ohms! It was no wonder there was no amplification. Colour coding on components indicated correct values, so it was decided to examine the soldered joints on the reverse side of the circuit board, paying particular attention to the grid pin connections. In the case where an almost-zero reading had been obtained, the cause was self-evident—a small spike of solder had extended to an adjacent earth point. The other grid connections where low readings were obtained showed no apparent faults to the naked eye, but examination with a jeweller's eye-piece revealed that the spaces between the grid connections and adjacent cathode pins or earthing points were filled by minute specks of solder. Further examination of the remaining soldering points showed a number of "dry" joints. These were due to neglecting to clean the component connecting wires *before* soldering. The writer has often found that these wires become covered with a hard oxide when in storage and failure to remove this before use invariably results in a dry joint. As flux-cored solder had been used throughout, the faulty joints had been effectively covered up. In the case of the grid short-circuits the answer was not so easily arrived at. Diplomatic questioning revealed that the soldering iron which had been used was heated on a gas ring, with the result that the bit was too hot. When applied to the joint the flux in the solder "exploded" and sprayed out tiny particles of molten solder, which then embedded themselves in the surface of the circuit board and became hidden from the eye by a layer of molten flux. It required a considerable amount of patience and a stout darning needle to remove them, after which the board was re-varnished.*

* Joints on printed circuit boards should always, of course, be made with a reliable *electric* iron.—EDITOR.

Checking with the ohmmeter showed that the correct values were now obtained. With valves reinserted, and control-panel, player, power unit and speakers connected, the power was switched on. All was well as regards volume, etc., but there was still a nasty crackle in the background, which varied as the units were moved.

Screened Lead

The screened lead between units was at once suspected, experience having taught the writer that braiding, when soldered, can be a real source of trouble. Careful examination traced the offending joint, and the cause was, once again, an over-heated soldering iron. This had ruptured the conductor insulation, allowing the solder to penetrate. Once more all units were again connected and the favourite record put on. Joy of joys! This time, melodic strains came forth, pure and clear of crackling. Clear, that is to say, until the writer's friend walked across the room to tell his wife the good news. With each step there came the familiar crackle!

Yet again, screened leads and connecting wires were checked over and tested for mechanical defects or poor joints, but without success. The printed circuit boards were then subjected to shock tests (i.e. tapping with a screwdriver handle) and the right hand channel amplifier was found to be the culprit. By lightly tapping the individual components on the panel, the offending item was found to be a tubular coupling capacitor. The reason why this otherwise reliable component had developed trouble was because the connecting wires had been bent too sharply near the body to accommodate them in the appropriate holes in the panel. Replacement of the injured capacitor restored the output to its specified high quality.

Summing Up

In summing up, then, we may learn that when soldering it is important to use an iron heated to the correct temperature; to clean all component wires before soldering, thus eliminating much of the risks of "dry" joints; and not to make sharp bends in component wires near the body of the component, as this is liable to fracture the internal connection.

LOSSES OF MAIL

Unfortunately, one of our regular advertisers, Henry's Radio Ltd., of 303 Edgware Road, London, W.2, have recently suffered regular losses of their mail, and they have asked us to insert the following announcement.

"We have received a large number of queries and complaints from readers and customers concerning the non-delivery of goods ordered by post from ourselves between 10th November and 31st December last.

As soon as we discovered this regular loss of mail we contacted the Post Office Special Investigation Department, who have since discovered and dealt with the cause of the losses. The Post Office advised us that customers who have sent postal orders, etc., or letters to 303 Edgware Road, should claim for same and re-order as necessary.

The Post Office have apologised for the inconvenience caused to us (Henry's Radio Ltd.) also to the general public. We at Henry's would also send our regrets to all those concerned during this unfortunate episode and would emphasise that the fault was in no way our own."

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NEWS AND COMMENT . .

Instant Electronic Newspaper

At the end of last year we were pleased to receive our usual "Christmas Card" from the famous editor of the American *Radio-Electronics* magazine, Mr. Hugo Gernsback.

The "card" takes the form of a small 32 page booklet giving Mr. Gernsback's 1964 forecast of scientific facts of the future. This form of greeting has been distributed for the past 30 years and always makes interesting reading for those interested in radio.

The main feature this time was the forecast of Instant Electronic Newspapers. The method of producing such newspapers being called RAFAR (Radio Automated Facsimile And Reproduction). Type would be set up by compositors, as now, photographed and put on film or special paper for facsimile radio transmission. The complete newspaper would then be transmitted by its own radio-facsimile station. At the reader's end his "rafar" transistorised receiver will be switched on continuously. Attached to the receiver will be an optical projector. The radio signals are translated on to a facsimile-set recorder on a special paper roll giving "pages" of about one-third the usual size.

When the owner of the receiver comes down for breakfast, by pressing a few buttons, he sees correctly enlarged and projected by a lens-reflecting system, Page 1 of his favourite newspaper.

The Radio Constructor pages even now are committed to film and, as the Managing Editor is a pioneer of amateur radio teleprinting in this country, is it too fanciful to imagine some copies of *The Radio Constructor* being produced in this fashion in a few years time?

Letters to Advertisers

When reading advertisements containing imaginary conversations extolling the virtues of various products, one often feels that here is a conversation which could never have taken place because of the unreal phraseology used.

Sometimes the same feeling occurs when reading letters in advertisements, which do not purport to be imaginary, and it is easy to visualise someone thinking up glowing tributes from A.C. of Brighton or D.G. of Leeds, etc., etc., although never from "Disgusted" of Tunbridge Wells. However we can vouch for the authenticity of the letters quoted in this issue by Radionics Ltd., concerning their Slimline receiver, and by ourselves in the advertisement for our latest publication *Understanding Television.*

Voice-controlled switch

A voice-controlled switch which can stop any electrical device on spoken command has been developed in the United States and is expected to find wide use as an emergency shut-off for industrial machines.

The switch is plugged into an ordinary electrical outlet and any apparatus for which voice-control is desired is then plugged into the switch. To halt the machine's operation, one need only call "Stop, stop!" or "Off, off!" and the switch will turn off the electricity.

It is able to "hear" and respond to these commands even when background noise, such as in a machine shop, is louder than the spoken command! The switch is inside a flat aluminium box about 9in long and 6½in wide. It is equipped with a microphone which picks up the commands.

The switch was developed by the Voice Systems Corporation of Campbell, California. The same firm also developed a voice-responsive machine with a vocabulary of the numerals zero through nine, plus six other commands. That machine, popularly known as "the shoebox" because of its size, was demonstrated at the Seattle World's Fair in 1962. There, the machine was attached to an adding machine which totalled numerals spoken into the microphone.

Other possible uses for more advanced models could be operation of cash registers by a grocery cashier who calls out the prices while his hands are free to check and pack the merchandise.

The switch and "shoebox" operate by means of "property filters" which screen the microphone's input and activate other components when a sound is "recognised".

On "Sound"

Some of our readers may not be aware that every fortnight on Network 3 there is a programme called "Sound", a magazine for radio and recording enthusiasts.

Talks by leading personalities in the radio, tape recording and hi-fi fields are given and discussions held on matters of interest to the amateur. It is of interest that one of the team advising on these broadcasts is F. C. Judd, author of our Data Book *Radio Control for Models* and contributor to these pages from time to time.

The programmes are usually broadcast on Sunday afternoons at 2.30 p.m., details, of course, being given in *The Radio Times*.

On Sunday 2nd February a repeat was given of the programme first broadcast in December, which started with "The Story of The Radio Society of Great Britain" in which John Clarricoats, who was general secretary for 36 years, and Geoffrey Stone, the President, were interviewed. Many interesting facts were given: for example, did you know that the call signs of the licensed amateurs in the early days before the First World War were self-assigned and always included the prefix X to represent experimental?

Did you know that the first president of the Society, A. C. Swinton, as early as 1908 forecast the use of the cathode ray tube for high definition TV?

Two TV Set Families

We are gradually becoming used to the idea of two-car families but, Mr. Perring-Thoms, chairman of Radio Rentals, has conjectured whether, with the advent of BBC 2, we may be entering on the era of two TV sets for one family.

It does seem a possibility because it must be extremely rare for any family not to have the occasional argument as to which programme shall be watched at a given time. We have already found in our experience that, in a good reception area, it is very useful to have a transportable TV with indoor aerial so that minority programmes may be watched in a room away from the rest of the family.

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2mA Indicating Lamp for Transistor Radios

R. M. MARSTON

MEMBERS OF THE WRITER'S FAMILY HAVE THE unfortunate habit of not always turning the transistor radio right off after use, but of only turning the volume control to the low end of its track. The writer must confess in all honesty that he is not immune from the same habit himself and, apparently, nor are most of his friends. This tends to be rather expensive on batteries. After looking at a large and pathetic pile of dud cells in the junk box one night—the result of only a couple of months of absent-mindedness—the author decided to find a cure to the problem.

The obvious solution is to fit some sort of warning lamp to the set, but this is not without snags. The lowest current rating of generally available low voltage bulbs seems to be about 40mA, which would run down a transistor battery in a few hours. Neon indicators will work with only a few microamps, but need between 100 and 250 volts applied before they will strike. Clearly, a certain amount of thought had to be given to the problem.

Transistor Oscillator

The final solution decided on was to use a transformer-driven low frequency transistor oscillator, with a step-up secondary winding giving an output of about 120 volts and up to 50μA, which could then be used to feed a neon indicator. The circuit is strapped across the radio supply lines via a decoupling circuit, and draws a total of only one or two milliamps from a 9 volt battery. The circuit is shown in the accompanying diagram.

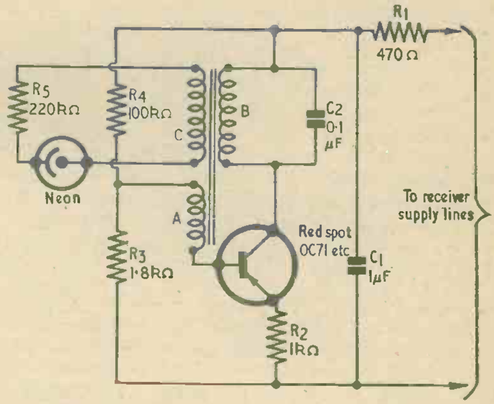
A Red Spot transistor was used in the test circuit, but almost any other low frequency transistor with an adequate voltage rating could be employed. The transformer was specially wound.

With reference to the diagram, the circuit is connected to the receiver supply lines, R_1, C_1, forming a decoupling network to prevent feedback to the radio a.f. stages. Resistors R_2, R_3, and R_4 provide the stabilising and biasing networks. On the transformer, winding B is the collector winding, A is the feedback or base winding, and C is the step-up output voltage winding which feeds the neon indicator and its limiting resistor, R_5. The capacitor C_2 is connected across the collector winding and determines the operating frequency of the circuit. The latter is not in any way critical, but should be kept reasonably low so as not to cause radiated interference in the set.

None of the component values used are critical, and may in some cases be varied by as much as a few hundred per cent without adversely affecting performance. The values shown are given purely as a rough guide.

The Transformer

The transformer was wound on a 0.7in stack of "E" and "I" transformer stampings of about 2 x 1.5in, and with a tongue width of 0.4in, these being taken from a burnt-out transformer in the junk box. The base winding (A) was put on first



and is made up of 30 turns of 38 s.w.g. enamelled copper wire. This is followed by 250 turns of the same wire, for winding B. Finally, the output winding (C) is laid on, being 5,000 turns of 42 s.w.g. enamelled copper wire. This final winding is a bit tedious to put on by hand, and great care should be taken when winding it, as the wire is rather fragile. A breakage half way through the job can be, to put it mildly, a little annoying. Once again, the actual dimensions of the core, the number of turns and the gauge of wire used are in no way critical, and the figures given here are only to be taken as a rough guide. The only figures of any real importance are the ratios between the collector, base and output windings. If the reader so desires, there is no reason why he should not miniaturise the transformer as long as he bears these ratios in mind.

Finally, the neon indicator (an ordinary Radiospares component in the writer's case) may be screened with a small piece of sheet tin, wired to the positive supply line, to eliminate any radiated interference that otherwise might be caused.

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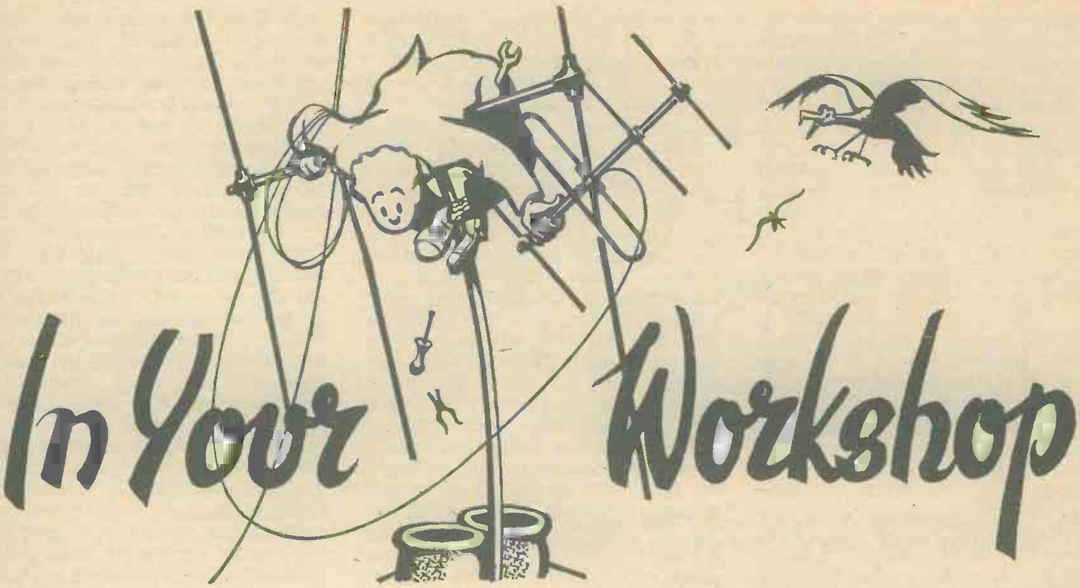
In Your Workshop



This month Smithy the Serviceman, aided as always by his able assistant Dick, sorts out the tale of woe which results from Dick's attempts at servicing in the home

"PEOPLE," REMARKED DICK SADLY, "can be very demanding."

Smithy sipped his tea and nodded gravely.

"Especially," continued Dick, "when they are relatives."

Thoughtfully, Smithy put his lunch-time cup of tea on the bench and turned round to look at his assistant.

"You have," he observed, "made a very profound statement. So far as my own relatives are concerned, it has always been a source of complete mystery to me that people outside the family regard them as just ordinary people."

"I didn't know," remarked Dick innocently, "that you even *had* any family."

"Of course I have," snorted the Serviceman indignantly. "It's just I keep quiet about them, that's all."

Recommendations

"My trouble," continued Dick morosely, the sudden vision of a vast hidden army of Smithy's kinsmen fading beneath the magnitude of his own afflictions, "is *aunts*."

"Ah yes," said Smithy sympathetically. "I must agree that you have more than your fair share there."

"Most of them are O.K.," admitted Dick grudgingly. "The main snag at the time being is my Aunt Evalina."

"What's she been up to?"

"Two years ago," said Dick aggrievedly, "and I want you to note the fact that it *was* two years ago, she asked me what make of TV I recommended."

"Don't tell me," chuckled Smithy, "that you were actually mug enough to recommend a make."

"As a matter of fact I recommended both a make *and* a model," said Dick. "And that is the one she bought."

"You don't need to say any more," said Smithy with confidence, "because I'll tell you exactly what has happened since. The set you recommended has worked perfectly well over the last two years, but it has now suddenly packed up. Whereupon she expects you to fix it for her on the cheap."

Dick's jaw dropped open.

"How on earth did you know that?"

"Also," continued Smithy assuredly, "she's told you that she expects you to do this because she wouldn't have bought it in the first place if you hadn't recommended it!"

Dick gazed at the Serviceman in utter wonder.

"You must be psychic," he gasped eventually. "That's exactly what *did* happen. But how did you know?"

"It's the oldest trick in the book," replied Smithy. "Nowadays, whenever anyone asks *me* what make of TV I recommend I always advise them to get one on rental!"

"That," said Dick glumly, "is a bit of useful advice I'll remember for the future. But it's the present that worries me."

Regretfully, Smithy put aside all thoughts of a lunch-time free from gossip about servicing.

"What," he asked resignedly, "was wrong with your aunt's set?"

"Just a little thing," replied Dick. "it had weak and distorted sound. As a matter of fact, I went up to her place last night and got the job half finished."

"Weak and distorted sound shouldn't have been too much trouble," commented Smithy. "Faults like that are our bread-and-butter jobs."

"True enough," agreed Dick, "and that was my own reaction when she first told me about it. Anyway, I

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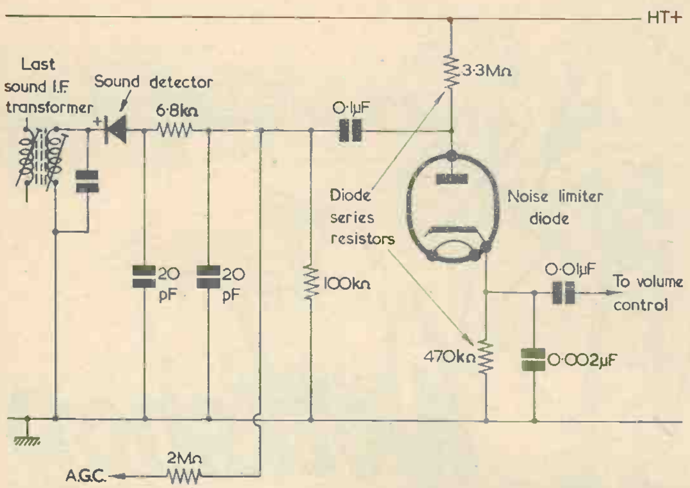

Fig. 1. A typical television sound detector and noise limiter circuit. The component values shown are representative of commercial practice

picked up a spare valve or two, a testmeter and a few odds and ends of wire and stuff, and went to have a look at it. The first thing I did was to try the set out and see what form the fault actually took. The sound was weak and distorted all right."

"Did you try both channels?"

"I didn't think of doing that," replied Dick. "should I have done?"

"Trying both channels can be helpful occasionally," said Smithy. "Especially as it only takes a second or so to do before you start probing into the works."

"What could it show up?"

"Not a great deal," admitted Smithy, "but you might be lucky enough to obtain a clue if you find that distortion is much worse on one channel than on the other. Disregarding anything as new-fangled as Bands IV and V for the moment, the signals most people get on Bands I and III vary quite a bit in strength, the Band I signal usually being the stronger. If you're losing gain in the sound i.f. amplifier you might then find that the weaker channel only gives enough audio signal after the detector for the sound to become audible when the volume control is turned fully up. Whereupon you may have quite a heavy background of hiss and field buzz which would otherwise be masked."

"Hiss and field buzz," objected Dick, "are not the same as distortion."

"True enough," agreed Smithy. "But they sometimes get described as such by the customers. I thought I'd mention the point, anyway."

"In my aunt's set," said Dick positively, "I was getting *real* distortion. Like you get when you've got too much bias on an a.f. output valve."

"Fair enough," commented Smithy. "I'll take your word for it!"

Interference Limiter

"After checking the symptoms," continued Dick, "I next got the back off the set and had a shufti around inside. Everything looked O.K. and so I swopped the triode-pentode a.f. amplifier and the valve containing the noise limiter diode."

"Very sensible," approved Smithy. "Even when it's doubtful that a valve is at fault, it's still always worthwhile changing it. If you're lucky you may then clear the snag without having to lug the chassis out of the cabinet."

"It didn't work for me this time," said Dick regretfully. "The distortion was just as bad with the new valves. So I had to get the works out."

An expression of anguish spread over Dick's face at the memory.

"Smithy," he said bitterly. "you should just *see* my Aunt Evalina's house. There isn't a single table with a surface of more than one and a half square feet or with legs thicker than quarter of an inch. And you know what it's like getting *some* chassis out! They've got tough knobs and the chassis fits so tightly that you have to remove it at just the right angle. Whereupon, even then, you've still got short little bits of flex coupling it to the speaker and what-not inside the cabinet. This set was one of those; a point which I should have thought about, incidentally, when I recommended it. You can't imagine what it was like trying to pull out that chassis with the set standing on a ricketty little polished table and my aunt blowing gaskets all over the place whenever she saw any dust inside."

"Working in peoples' houses," said Smithy sympathetically, "does tend to be a little difficult."

"The worst bit," said Dick, "was when I was getting the chassis past the most ticklish position. It was at that precise instant that I trod on the cat."

Dick heaved a doleful sigh at the recollection.

"Were it not," he remarked, "for the nerve of iron which I have acquired through my normal servicing work, that episode would have reduced me to a final gibbering wreck. As it was, I managed to keep a hold on the chassis whilst the cat shot off in the direction of the coal house with my aunt in hot pursuit."

"Very trying indeed," commiserated the Serviceman. "But it could have been worse. At least you didn't have a budding Marconi of five with his nose one inch from the chassis whilst the fond mother gazes on. *That* is murder!"

Dick looked at the Serviceman with a newly awakened interest.

"Don't tell me," he queried, "that you've been through this sort of thing as well."

"Many, many times," replied Smithy wearily. "It's one of the occupational hazards of being a service engineer. However, let's get back to that set of your aunt's."

"Well," said Dick, collecting his thoughts. "After I'd got the works out I had a short period of blessed respite while my aunt ministered to the injuries of her poor old pussy. And so I checked the series diode resistors in the sound interference limiter circuit." (Fig. 1.)

"Very good," approved Smithy. "Those are nearly always the most likely suspects when you have weak and distorted sound. They only pass about 50 to 100μA or so, yet they have a most annoying habit of going open-circuit or high in value. When they go open-circuit the diode tends to act as a peak rectifier, and you get very weak and distorted sound as a result. Incidentally, I hope you understand how the circuit works."

"Of course I do," replied Dick indignantly. "You told me about it a year or so ago. The sound detector is connected up in such a

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manner that the detected signal is negative-going. When you get a pulse of interference, the anode of the noise limiter diode goes negative. The cathode also tends to go negative, but it does this much more slowly because of the capacitor connecting it to chassis. By the time the pulse comes to an end the cathode has gone only slightly negative, and so most of the pulse is lost."

"That's right," confirmed Smithy. "At the same time, the time constant of the capacitor and resistor in the cathode circuit is sufficiently short to enable the cathode to follow normal variations in speech and music. When the circuit is working properly, the diode is held conductive all the time by reason of the resistors between the h.t. positive line and chassis, and so it simply passes the audio signal applied to its anode."

"As you say," commented Dick. "Anyway, I checked the two resistors and I found that these were both O.K. So I carried on to the a.f. voltage amplifier triode, whereupon I found that it was one of those stages that have no grid bias at all. Just a 10MΩ resistor from the grid down to deck." (Fig. 2.)

Contact Potential

"There's nothing wrong with that," commented Smithy. "Lots of voltage amplifiers are employed without external bias potentials. They're designed to work without them."

"I don't trust them," said Dick dogmatically. "I don't trust them at all. Here was I looking for distortion and what did I find? A stage which, so far as I can see, deliberately introduces distortion!"

"How do you mean?"

"It *must* introduce distortion," said Dick heatedly. "Dash it all, it's nothing more nor less than a leaky-grid detector."

"You do get some funny ideas at times," commented Smithy. "There may be no external bias voltage, but the valve is still properly biased for low-level input signals."

"I can't see that," expostulated Dick. "How can the valve handle *any* input signal if the grid is at the same potential as the cathode?"

"But it isn't," protested Smithy. "The grid is negative of the cathode."

"Hey?"

"The grid," repeated Smithy firmly, "is negative of the cathode. In point of fact, it's negative by a potential which may be as high as 1 volt, and which is usually described as the 'contact potential'. Contact potential tends to vary from valve to valve, but it can quite frequently reach the 1 volt figure I've just mentioned."

"But where does this contact potential come from?"

"From the processes which go on inside the valve," replied Smithy. "The complete business is, actually, rather complicated, and it isn't entirely true to refer to the voltage between grid and cathode simply as contact potential. Incidentally, the definition of contact potential is that it is the e.m.f. which is given when two dissimilar conductors are placed in contact. In a valve, the surfaces of the cathode and grid will employ dissimilar materials and it can be said that they are in contact by way of the electron stream. There are other factors involved, however, and these include negative grid currents which flow due to ionisation of the traces of gas left in the envelope, or negative currents which are caused by the actual process of electron emission through the valve itself. The result of all these factors is that, if you couple the grid of a valve to its cathode via a very high resistance, you get a negative potential on the grid. This voltage may be a combination of contact potential and the potential dropped across the resistor by the negative grid current. A circuit in which the grid of an a.f. voltage amplifier valve is returned to its cathode via a high value resistor is variously referred to as employing 'contact potential bias', 'grid leak bias' or 'grid current bias'."

"In other words," said Dick, "if you use this type of bias, you don't run into positive grid current at all."

"You don't," confirmed Smithy. "Provided, that is, that the input signal is smaller than the difference between the negative potential appearing on the grid and the potential at which positive grid current starts to flow. If your input signal should happen to exceed this level you could have the same effect as with a leaky-grid detector, whereupon the valve will bias itself back a bit. But, for low level signals, the valve functions just as though it was getting its bias from a cathode bias resistor."

"Blimey," said Dick, impressed. "That's something I didn't know before. Are these negative grid currents and things very small?"

"They're pretty small," said Smithy, "although they're still quite capable of being measured. When the grid is joined to cathode via a high value resistor you can sometimes get a small indication of negative voltage on the grid relative to cathode by checking with a high resistance voltmeter. Incidentally, if ever you have an idle quarter of an hour to use up, you can often amuse yourself by measuring the contact potential on a valve which isn't connected to anything at all!"

"That sounds interesting," said Dick. "How do you do that?"

"You start off", said Smithy, "by choosing a valve in a piece of equipment which has a fairly heavy cathode. An a.f. output valve is a pretty good choice. You next switch on the equipment and let it run for about five minutes, so that the cathode of the valve gets good and hot. Then you quickly pull out the valve and immediately apply the test clips of a high resistance voltmeter to the grid and cathode. (Fig. 3.) If you're nippy enough you'll get readings of the order of half a volt or so before the cathode cools off."

"You get these readings," said Dick incredulously, "without the valve being connected to *anything*?"

"That's right," said Smithy cheerfully. "Although it's possible that,

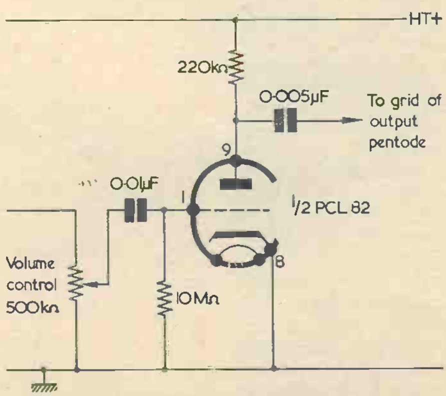

Fig. 2. The a.f. voltage amplifier stage encountered by Dick

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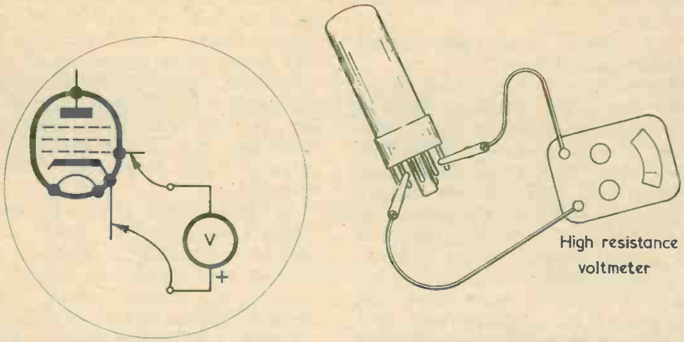

Fig. 3. "Contact potential" readings may be obtained from valves whose cathodes are at emitting temperature. The voltmeter is connected as shown in the inset circuit

without an h.t. supply, you're losing some of the causes of negative grid current. Nevertheless, you will still get the voltage reading if you're quick enough in connecting up the meter before the cathode cools off. I've done it with 6V6's and I speeded things up by connecting up the leads of the meter to the grid and cathode tags of a spare octal valveholder. By whipping out the 6V6 and popping it immediately into this valveholder I got quite high voltage readings. You'll probably get readings which last longer if you try the experiment with a booster diode, or a valve of that nature. In this case, the contact potential would appear between the anode and cathode instead of between the grid and cathode."

"I'm dashed," exclaimed Dick "I must have a stab at that one of these days."

"I should," agreed Smithy. "It's quite instructive. Anyway, how about returning to the saga of your Aunt Evalina's TV set?"

"Oh, yes," said Dick. "I'd forgotten all about that! Well, as I was telling you, I'd checked the noise limiter resistors, and I then bumped into the triode voltage amplifier stage with its high resistance grid leak. Now that you've explained this to me I can understand how it functions, but all that I did at that time was to regard it with suspicion and merely measure the resistance between the grid and cathode. This came to the 10MΩ marked on the resistor, and so I passed on to the next stages."

"Very commendable," approved Smithy. "If the resistor had been too high in value, the grid operating point might have wandered off a little, whereupon you could have got quite a noticeable bit of distortion. And if, due to the resistor itself or leakage in the components around the grid and cathode pins, there had been too low a resistance, you'd have had zero grid bias with a similar possibility of distortion. Incidentally, it's rather doubtful if either of these snags would cause a very great loss in volume. Don't forget that your faults were distortion *and* weak sound."

Coupling Capacitors

"That's a point," admitted Dick. "Anyway, at that moment my aunt returned after having carried out first aid on the cat."

"Any damage?"

"None at all," replied Dick, a note of indignation entering his voice. "Fortunately, I'd just stepped on the tip of his tail. Indeed, so far as I could tell, he'd forgotten all about it. But old Aunt Evalina was covered all over with coal dust and, she had that awful thin-lipped look which maiden aunts have when they intend visiting the solicitor in the morning."

"At any rate, I'm glad to hear the cat was O.K."

"The cat was fine," snorted Dick. "He was rubbing himself against my trouser legs all the time and purring fit to bust. Besides, I *like* cats. We've got a big fat tabby at home and I'm very fond of him."

Smithy frowned as a sudden thought struck him.

"The only cat I can ever remember you having," he remarked after a moment, "was a scraggy old mog who was always out on the tiles."

"It's the same cat," replied Dick. "We had him doctored, and he's never looked back since."

"I see," said Smithy. "Perhaps we'd better get back to your set again. What was the next thing you did?"

"I checked the anode load of the triode a.f. amplifier. *And* its anode voltage. These were both all right, and so I proceeded to the pentode output section." (Fig. 4.)

"There couldn't have been much to go wrong there," commented Smithy. "Did you check the coupling capacitor for leakiness?"

"That was the first thing I did," said Dick. "And I used an old dodge you showed me ages ago."

"What's that?"

"I shorted the grid-leak," replied Dick, "and listened for a crackle in the speaker. (Fig. 5.) If there's no crackle you assume that the potential on the grid remains the same whether the short-circuit is on or not. With the result that there can't be any leakiness in the coupling capacitor."

"That's the idea," said Smithy.

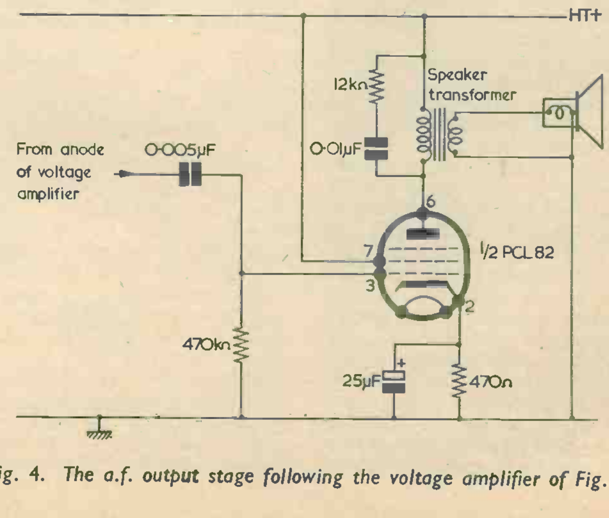

Fig. 4. The a.f. output stage following the voltage amplifier of Fig. 2

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"You can save quite a lot of time with that little dodge."

"Funnily enough," said Dick thoughtfully, "there's a point that's just struck me about that short-circuiting test. Why didn't I get the same negative grid current and contact potential effect at the pentode grid as occurred at the triode grid?"

"There are several reasons for that," said Smithy. "First of all, the pentode grid leak has a much lower value than the triode grid leak and so any negative grid current which flows will cause a much lower voltage to appear across it. The second reason is that you're using an external bias supply which makes the grid go negative relative to cathode. As the grid goes negative, its negative grid current decreases. Because of these two factors, the effect of negative grid current becomes negligible and it can, for all practical purposes, be ignored."

"Where does the external bias supply come from?"

"It comes," said Smithy patiently, "from the bias resistor in the cathode circuit."

"Oh yes, of course," exclaimed Dick. "At any rate, it seems that checking for coupling capacitor leakage by short-circuiting the grid leak doesn't apply if the valve uses grid current bias like the triode did."

"It wouldn't be a good test there," agreed Smithy. "Because the short-circuit would be bound to cause a change in grid voltage."

"How about measuring the voltage between grid and chassis?" asked Dick. "If a coupling capacitor were leaky the grid should go highly positive."

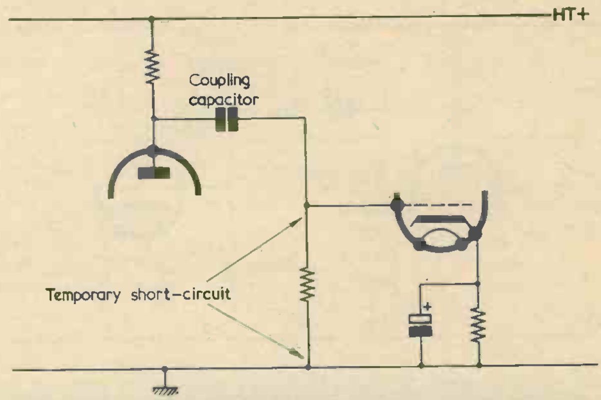

Fig. 5. A simple test for coupling capacitors in a.f. amplifiers. If short-circuiting the following grid leak does not cause a crackle in the speaker, it may be assumed that both ends of the leak are at the same potential and that the coupling capacitor is not, therefore, leaky. This test cannot be applied when grid current bias is employed, as in Fig. 2

"No it shouldn't," contradicted Smithy. "And that's because the grid and cathode would act as a diode, causing the grid to take up a relatively small positive potential only. This voltage would, however, show up much more obviously if you pulled the valve out, but that's a course I don't entirely recommend in a TV set."

"Why not?"

"Because," said Smithy, "the heaters in a TV set are connected in a series chain, and the triode-pentode a.f. valve is often at the chassis end of the string. (Fig. 6.) If you pull out this valve whilst the set is switched on and operating, the heaters of all the other valves, together with that of the c.r.t., go up to full mains potential. There is, then, a certain risk of heater-cathode breakdown somewhere along the line which I would prefer to avoid."

"But," protested Dick, "the same thing would happen if the triode-pentode heater burnt out in the normal course of events."

"I couldn't agree more," said Smithy. "But I still don't see any point in *buying* trouble. I'm possibly being over-fussy in this respect, but I prefer to be on the safe side. Incidentally, it isn't always generally realised how high the insulation resistance of a.f. coupling capacitors should be if you want to avoid trouble. If you have, say, 100 volts on the previous anode and a grid leak of 500kΩ, (Fig. 7), a leak of 50MΩ in the coupling capacitor will cause the following grid to go nearly 1 volt positive of chassis."

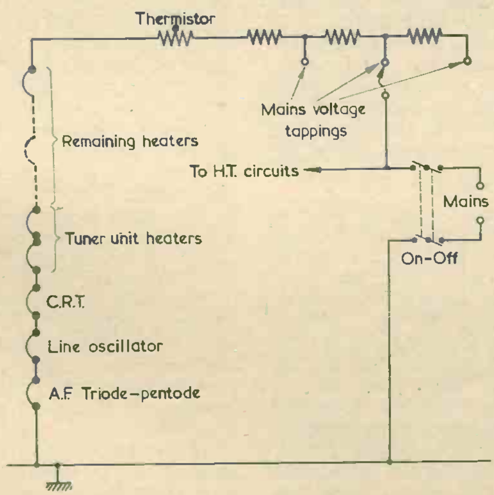

Fig. 6. An example of a television receiver heater chain, showing the order in which the heaters at the chassis end may typically appear

Output Transformer

Smithy paused for a moment.

"We've digressed a little," he remarked. "Anyway it seems that you checked almost everything that needed checking in the a.f. stages of your aunt's set. Pretty well all that was left was the output pentode and its anode circuit."

"That's right," agreed Dick. "The next thing I did was to measure all the voltages around this valve. It had a 470Ω cathode bias resistor, and there was 14 volts dropped across it, so *that* part of the circuit seemed O.K."

"A reasonable assumption," com-

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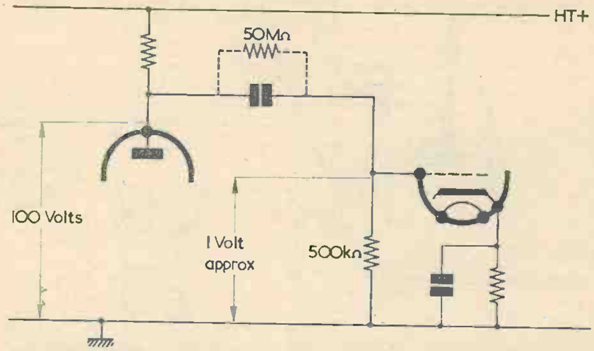

Fig. 7. Anode-to-grid a.f. coupling capacitors must have a very high insulation resistance. In this example, a 50MΩ leak in the coupling capacitor causes the following grid to go positive of chassis by nearly 1 volt

mented Smithy. "What was the valve?"

"A PCL82."

"Yes, quite reasonable," confirmed the Serviceman. "A drop of 14 volts across 470Ω corresponds, rough check, to about 30mA. Which is just what you'd expect for the cathode current of the pentode section of a PCL82."

"That," said Dick, impressed, "was a very quick calculation. I always have to go through the R equals E over I patter when I work out these little Ohm's Law problems!"

"Over the years," replied Smithy, "I've evolved a little mental short-cut for Ohm's Law problems in radio and TV circuits. I always start off by saying that 1 volt across 1kΩ corresponds to a current of 1mA. In the present case we have 14 volts across 470Ω. Now, 14 volts across 1kΩ would equal 14mA, but in this instance it's across 470Ω. So, since 470Ω is slightly less than half of 1kΩ the current is slightly more than doubled. It works out, approximately, at about 30mA."

"Well, I'm dashed," said Dick. "I must remember that little dodge in the future."

"I find it helpful myself," commented Smithy. "Although, of course, other people may prefer to use different ideas for doing their mental arithmetic. Did you check anode and screen-grid voltages?"

"I did," said Dick. "The anode voltage was 181 and the screen-grid voltage was 183."

A gleam came into Smithy's eye. "That's interesting," he commented. "What did you make of those voltages?"

"They seemed O.K. to me," said Dick carelessly, "and so I had a look at the secondary circuit of the transformer. I thought that if there was a high resistance joint here, this would result in both weak sound and distortion."

"That's possible, I suppose," commented Smithy somewhat critically. "But I think that it would be a doubtful possibility in practice."

"I looked for it, anyway," said Dick. "There were no cold joints, but I did find a wire hanging off one of the voice coil tags on the speaker. It took me ages to find out where it was supposed to connect to."

"I would guess that it should have connected to the metal frame of the speaker."

"As a matter of fact," said Dick, a touch of annoyance in his voice, "that's exactly where it *should* have connected. After a long search I found a solder tag under one of the speaker mounting nuts. The wire had broken away from that."

"Did you solder it back on again?"

"I did," said Dick aggrievedly. "And it didn't make a blind bit of difference! Tell me, Smithy, why *do* manufacturers waste time by fitting gash bits of wire between one of the voice coil tags and the speaker frame?"

"They don't," replied Smithy severely, "waste time at all, because that connection serves a very useful function. In some sets, you have one side of the speaker transformer secondary connected to chassis, whereupon the speaker frame is then also at chassis potential via the bit of two-way flex which joins the two together. (Fig. 8 (*a*).) In other cases you may have the transformer secondary isolated from the chassis, but you will still have the connection between one side of the voice coil and the speaker frame. (Fig. 8 (*b*).) Or you may have the same arrangement with, say, a 1MΩ resistor between the voice coil circuit and chassis. (Fig. 8 (*c*).) And, in some receivers, you'll find that there's no connection between the speaker frame and the voice coil at all."

"So far as I can see," maintained Dick, "it just seems to be an additional complication that's not needed."

"There's a very good reason for connecting one side of the voice coil to the speaker frame," said Smithy. "You must remember that, in the speaker, there is a very tiny gap between the voice coil and the magnet pole-pieces. If the voice coil and pole-pieces are not bonded together it is possible for a small static voltage to appear between them, with the result that you may get tiny sparks or discharges occurring, these being particularly evident with loud sounds where the voice coil suffers relatively large excursions. It's even possible that, under these conditions, the voice coil wire actually touches the pole-pieces. At any event, the result is that the discharges can be picked up in the early stages of the receiver whereupon they result in sharp cracks on sound and, possibly, flashes on the screen. This effect is most likely to occur, incidentally, if you use an indoor aerial mounted close to the receiver."

"I've never heard of a fault like that before."

"It's fairly rare," admitted Smithy, "this being mainly because most manufacturers bond the speaker frame and voice coil together in order to prevent it. You may, nevertheless, bump into it now and again with sets which don't have the speaker frame bonded. It's most likely to show up on Band III because the length of the wiring to the speaker is liable to be closer to Band III than to Band I wavelengths. Also, since the Band III signal is often weaker than the Band I signal, the set is functioning under more sensitive conditions on this Band. The cure is, of course, to connect the speaker frame to the voice coil in the same manner as occurs in other sets. However, you have to be a little careful here."

"How come?"

"If," said Smithy, "the speaker frame is capable of being touched or if it is in contact with, say, a metal speaker grille, you may be introducing a shock hazard to the customer if you bond the frame to the voice coil. So, check very carefully before you add such a connection. In some receivers there *is* a slight risk of such contact to the speaker frame, whereupon the manufacturers make doubly sure by isolating the speaker transformer

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secondary from the chassis. That explains the second circuit I mentioned. (Fig. 8 (*b*).) Or they may isolate the secondary and prevent static voltages building up in the circuit by using a 1MΩ resistor, as in the third circuit I talked about. (Fig. 8 (*c*).) You have to keep an eye open for these things."

"Why," asked Dick despondently, "do even the simplest things in television get complicated as soon as you start digging into them? I would have thought that there was nothing simpler than earthing a speaker frame. I find, now, that I've got to take shock hazard into account as well!"

"It is," said Smithy philosophically "just the nature of the beast we have to handle. At any rate, how long did it take you to find that the speaker transformer had shorted turns in the primary?"

For the second time that day, Dick's jaw dropped open.

"You *are* psychic, Smithy," he gasped. "How could you possibly have known that?"

"I didn't actually," chuckled Smithy. "I just made a guess at it. You told me that the output anode voltage was 181 and that the screen-grid voltage was 183. Most sets run the sound output pentode screen-grid direct from the same h.t. positive line which feeds the speaker transformer primary, and I risked the assumption that this was so in your aunt's set."

"As it happened," confirmed Dick, "the screen-grid and transformer primary *did* run from the same h.t. line."

"Good," said Smithy briskly. "We learnt earlier that the cathode current of the output pentode was 30mA and, with a valve like the pentode section of a PCL82, this would mean that there would be about 25mA flowing in the anode circuit. However, the difference between anode and screen-grid voltages meant that the speaker transformer primary was only dropping 2 volts."

"Wait a minute," interrupted Dick. "Let's work this out using that mental short-cut of yours! If we start off by saying that 1 volt at 1mA infers a resistance of 1kΩ, then 2 volts at 1mA infers a resistance of 2kΩ."

"Right," said Smithy.

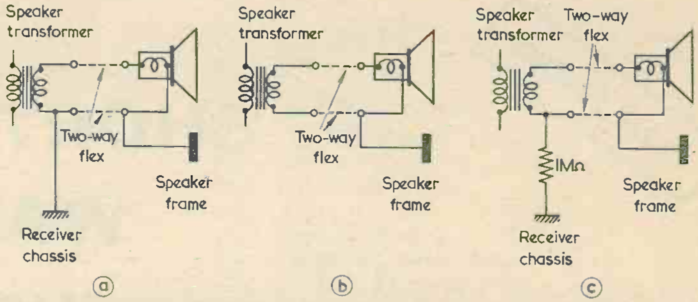

Fig. 8. It is common practice to connect the metal frame of a speaker to one side of the voice coil. In these three diagrams, it is assumed that two-way flex couples the television chassis proper to the speaker. In (a) the speaker frame is at receiver chassis potential whereas in (b) there is no chassis connection. In (c) the formation of static voltages in the secondary circuit is prevented by the 1MΩ resistor

"But in this instance," continued Dick, "we have 2 volts at 25mA, so that the final resistance is 2kΩ divided by 25."

Dick stopped.

"Perhaps," he added, "I should have done it on paper after all!"

"Nonsense," snorted Smithy. "2kΩ divided by 25 is the same as 2kΩ divided by 100 and multiplied by 4. The answer is 80Ω."

"Of course it is," said Dick excitedly. "And, blimey, that's the figure I found when I measured the resistance of the primary!"

"Fair enough," commented Smithy. "Most of the sound output trannies in TV sets are pretty tiny affairs, and they usually have primary resistances of the order of 200 to 500Ω. A primary resistance of 80Ω would indicate a most suspicious state of affairs."

Success at Last

"That's what I thought," said Dick. "And I was able to prove it very easily."

"How was that?"

"My aunt," explained Dick, "has a mains radio as well as a TV, and so I put the radio on another of her ricketty tables near the television chassis. After which I unhooked one of the connections from the primary of the TV speaker transformer, and then coupled the h.t. positive line and the pentode anode to the primary of the speaker transformer in the radio set. Whereupon, lo and behold, the latter gave forth sound of the utmost volume and fidelity!"

"I have no doubt it did," said Smithy. "Was your aunt pleased about it?"

"She was at first," replied Dick cautiously. "But it was at that moment that the cat decided to investigate the odd bit of flex I'd used to join the TV chassis and the radio speaker together. With the result that he pulled the connection out again."

"Not to worry," said Smithy soothingly. "You'd proved your point. All you've got to do now is to go back tonight and pop a new sound output tranny into that TV set."

"That bit," replied Dick morosely, "is easy."

"Then what are you beefing about?"

"You haven't heard the worst," wailed Dick. "When that dratted cat broke the connection he also toppled the radio off the table as well, with the result that it fell to the deck with the most almighty crash you ever heard. So I've got to start all over again, and fix the radio!"

"You *were* unlucky," commiserated Smithy. "What's the snag with it?"

"After the thump," snarled Dick, "it developed weak and distorted sound!"

UNDERSTANDING RADIO

PART 31

Due to circumstances beyond our control, we regret that this part of the series has been held over until next month.

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Cover Feature

SHORT WAVE SUPERHET

V. E. HOLLEY

THIS LITTLE RECEIVER WILL PROVIDE A LOT of entertainment for those who like exploring the shorter wavelengths. Results on these wavelengths are always of interest; many Continental transmissions can be received consistently at good programme level and there is always the chance of picking up some really distant signals.

Circuit

The receiver covers the range 9.5 to 60 metres (31.5 Mc/s to 5 Mc/s) with two sets of plug-in coils. Referring to Fig. 1, it will be seen that the r.f. stage does not have the usual tuned grid circuit, the signal from the aerial being applied, instead, through the capacitor C_1 direct to the grid of the

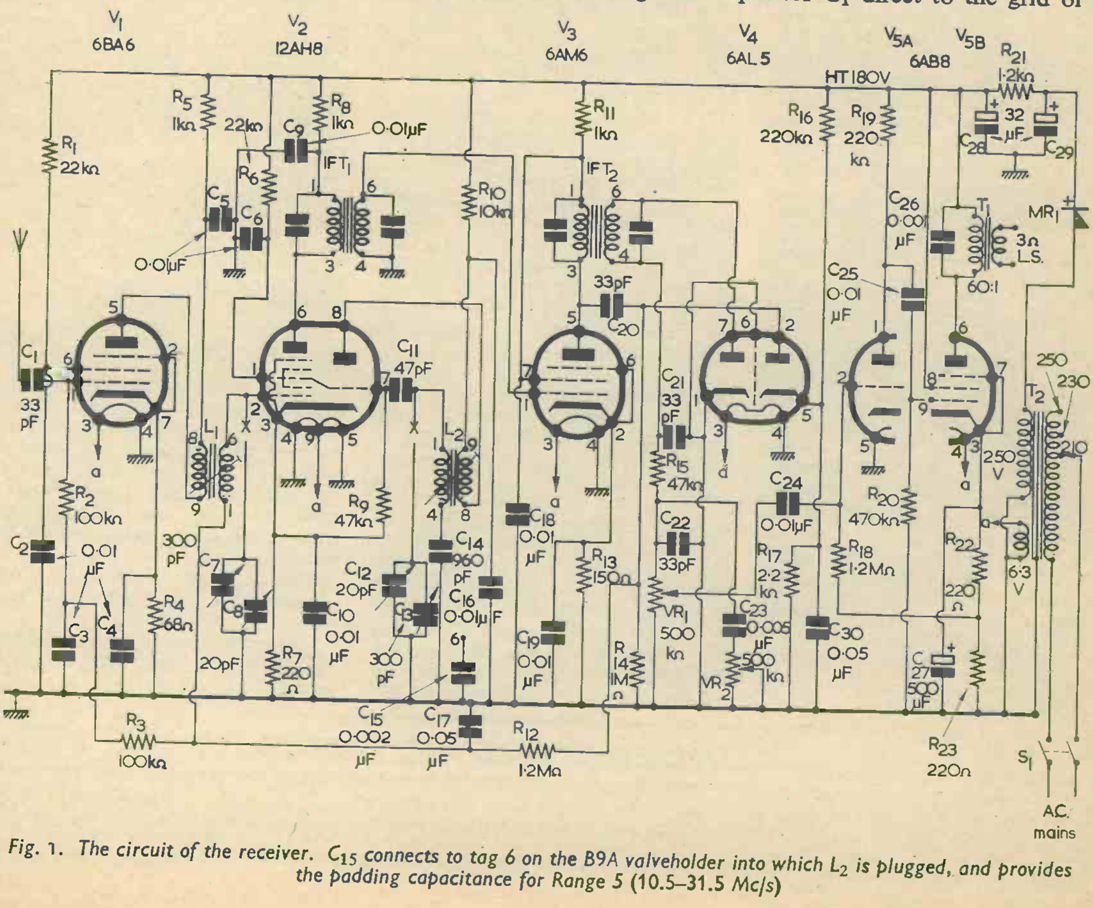

Fig. 1. The circuit of the receiver. C_{15} connects to tag 6 on the B9A valveholder into which L_2 is plugged, and provides the padding capacitance for Range 5 (10.5–31.5 Mc/s)

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Components List

Resistors
(All fixed resistors ½ watt 10% unless otherwise stated)

R_1 22kΩ
R_2 100kΩ
R_3 100kΩ
R_4 68Ω
R_5 1kΩ
R_6 22kΩ
R_7 220Ω
R_8 1kΩ
R_9 47kΩ
R_{10} 10kΩ
R_{11} 1kΩ
R_{12} 1.2MΩ
R_{13} 150Ω
R_{14} 1.2MΩ
R_{15} 47kΩ
R_{16} 220kΩ
R_{17} 2.2kΩ
R_{18} 1.2MΩ
R_{19} 220kΩ
R_{20} 470kΩ
R_{21} 1.2kΩ, 5 watts (see text)
R_{22} 220Ω
R_{23} 220Ω
VR_1 500kΩ log track (with S_1)
VR_2 500kΩ log track

Valves

V_1 6BA6
V_2 12AH8
V_3 6AM6
V_4 6AL5, (or two diodes GEX34)
V_5 6AB8

Coils

L_1 Miniature dual purpose ranges 4 and 5 Yellow (Denco)
L_2 Miniature dual purpose, White, ranges 4 and 5. (Denco)
$IFT_{1, 2}$ Transformers type IFT.11—1.6 Mc/s (Denco)

Capacitors
(All fixed capacitors 350V wkg. unless otherwise stated)

C_1 33pF
C_2 0.01μF
C_3 0.01μF 200V wkg.
C_4 0.01μF 200V wkg.
C_5 0.01μF
C_6 0.01μF
C_7, C_{13} } 300pF, 2 gang
C_8 20pF trimmer
C_9 0.01μF
C_{10} 0.01μF 200V wkg.
C_{11} 47pF
C_{12} 20pF trimmer
C_{14} 960pF 5% silver mica
C_{15} 0.002μF 5% silver mica
C_{16} 0.01μF
C_{17} 0.05μF 200V wkg.
C_{18} 0.01μF
C_{19} 0.01μF 200V wkg.
C_{20} 33pF (see text)
C_{21} 33pF
C_{22} 33pF
C_{23} 0.005μF 200V wkg.
C_{24} 0.01μF 200V wkg.
C_{25} 0.01μF
C_{26} 0.001μF
C_{27} 500μF electrolytic, 15V wkg.
C_{28}, C_{29} } 32+32μF, electrolytic (with mounting clip)
C_{30} 0.05μF 200V wkg.

Rectifier

MR_1 250V 50mA contact cooled

Transformers

T_1 Output transformer, 60:1 for 3Ω speaker
T_2 Mains transformer. Secondaries: 250V half wave, 50mA, 6.3V, 2A

Sockets

2 B7G valveholders with screens (V_1, V_3)
1 B7G valveholder without screen (V_4)
4 B9A valveholders without screens (V_2, V_5, L_1 L_2)
1 pilot lamp holder
1 aerial socket

Miscellaneous

1 tuning drive (see text)
1 pilot lamp
1 2-way tagstrip
1 3-way tagstrip
Knobs, grommets, wire, etc.

first valve, a variable-mu pentode type 6BA6. This arrangement saves the cost of two coils and enables a two-gang capacitor to be used for tuning in place of the more expensive three-gang component; it also simplifies alignment and reduces the risk of instability. The gain of the stage is, of course, reduced, but all its other advantages—improved a.g.c. action, better signal to noise ratio, removal of aerial loading from the mixer grid, etc., are retained. A.G.C. is applied to the stage in the series mode through resistor R_2, while R_5 and C_5 serve to decouple the anode circuit.

Mixer

The output from V_1 is applied by way of the r.f. transformer L_1, to the signal grid of the mixer stage, where a 12AH8 is used in a conventional circuit. The triode section, in conjunction with

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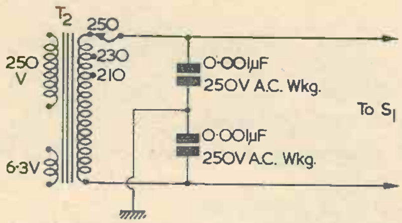

Fig. 2. Modulation hum may be cleared by adding two capacitors as shown here. The receiver chassis should preferably be earthed

coil L_2, generates the local oscillator frequency which is then combined inside the valve with the signal frequency at grid 1 to produce the intermediate frequency of 1.6 Mc/s at the anode. A.G.C. is applied to the signal grid via the secondary of L_1.

I.F. Amplifier

The choice of 1.6 Mc/s for the intermediate frequency means that the image or second channel reception point is spaced 3.2 Mc/s from the frequency to which the signal circuit is tuned. As a result, image reception is very much reduced and almost every transmission will be received at one point on the tuning scale only. The transformer IFT_1 selects the required frequency from the anode of V_2 and applies it to the grid of V_3, which, in order to obtain a high degree of gain, is a high slope pentode type 6AM6. As this is not a variable-mu valve a.g.c. cannot be applied to it, but the control voltage is of most value on the grids of the r.f. and mixer stages, and very little is lost by omitting it from the grid of V_3. The resistor, R_{13}, provides the necessary fixed cathode bias.

Detection And A.G.C.

A double-diode valve, 6AL5, provides detection and a.g.c. A.G.C. is especially important in a short wave receiver and, to obtain the most effective control, the a.g.c. diode is fed from the anode of V_3 through the capacitor C_{20}. The voltage obtainable here is appreciably higher than that at the secondary of IFT_2. Note that the insulation of C_{20} is particularly important. If it should fail, the full h.t. voltage will be applied to the diode with distressing results. A good quality mica or ceramic component should be used. Resistor R_{14} is the a.g.c. diode load and the d.c. voltage developed across it is fed through R_{12} to the a.g.c. line. In order to retain maximum sensitivity for weak signals, the application of a.g.c. voltage to the controlled valves is delayed by applying to the cathode of the a.g.c. diode a positive bias of 1.8 volts obtained from the potential divider R_{16}, R_{17}. The controlled valves thus operate at maximum gain until the signal at the a.g.c. diode exceeds 1.8 volts.

The other half of V_4 deals with signal detection. Resistors R_{15} and VR_1 form the load proper, while capacitors C_{21} and C_{22} remove the now unwanted intermediate frequency. Connected to this network, C_{23} forms, with VR_2, a simple top-cut

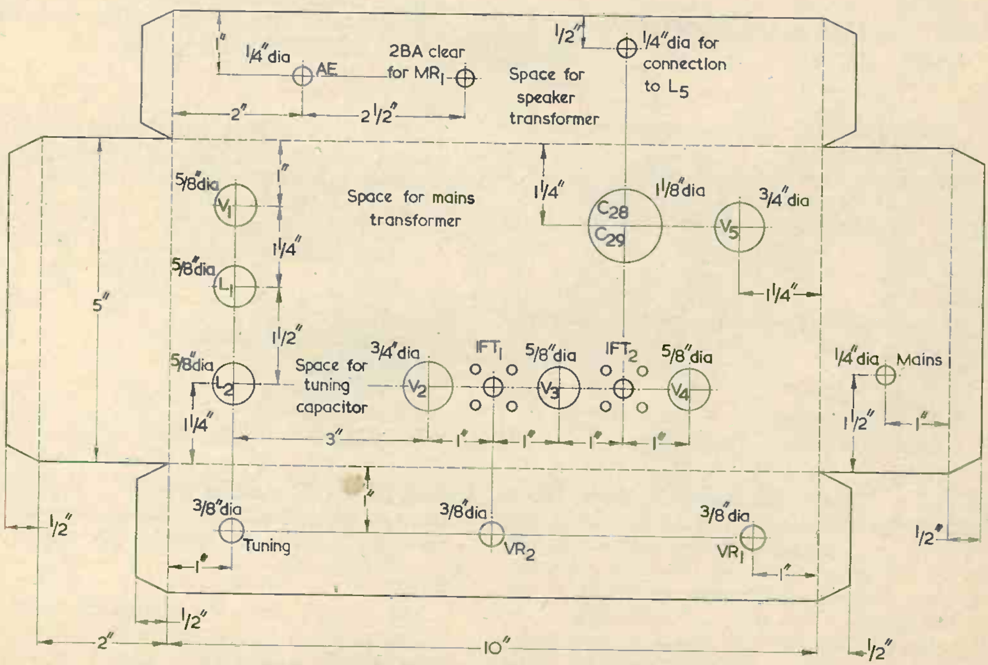

Fig. 3. Top view of chassis before bending, showing the principal holes which have to be made

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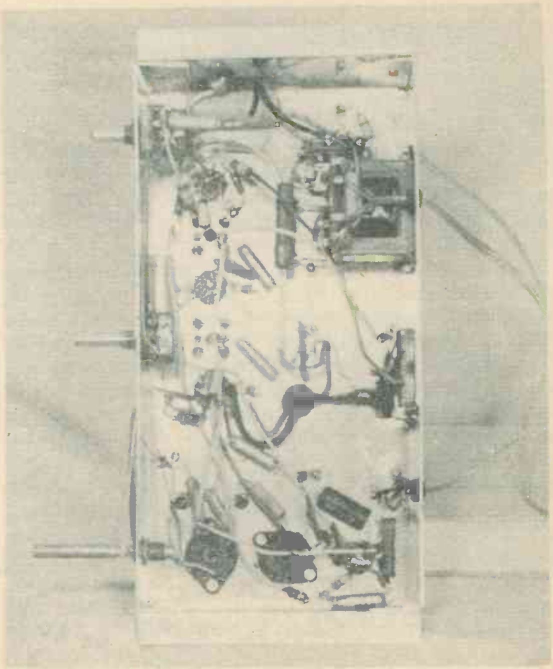
tone control which will be found useful for reducing whistles and other high audio frequency interference which is sometimes common on short waves. A pair of germanium diodes of the GEX34 type can be substituted directly for V_4 if desired, with no alteration in performance. The red ends of the diodes correspond to the cathodes of the 6AL5.

A.F. And Output Stages

Audio frequency amplification and power output are obtained simply and economically from a triode-pentode valve type 6AB8. As the bias requirements for the two sections of this valve are different and there is only a single cathode, it is necessary to return the grid resistor of the triode to a tapping on the cathode bias resistor. This works quite well provided the cathode is adequately bypassed to chassis. A large capacitor is needed and C_{27} has been given a value of 500μF. As an output valve, the pentode section will deliver about 1½ watts into a load of 11kΩ and, if the usual 3Ω speaker is to be used, the output transformer in the anode circuit must have a ratio of about 60:1. Suitable transformers are readily available. The capacitor C_{26} across the primary serves to correct the response at the higher audio frequencies.



Below-chassis view

Power Supply

The h.t. requirement of the receiver is about 45mA at 180 volts. This is supplied by the double-wound mains transformer, T_2, the half-wave h.t. secondary of which feeds a contact-cooled metal rectifier, MR_1. Smoothing is provided by the resistor R_{21} in conjunction with the electrolytic capacitors C_{28} and C_{29}. The gain of the a.f. section

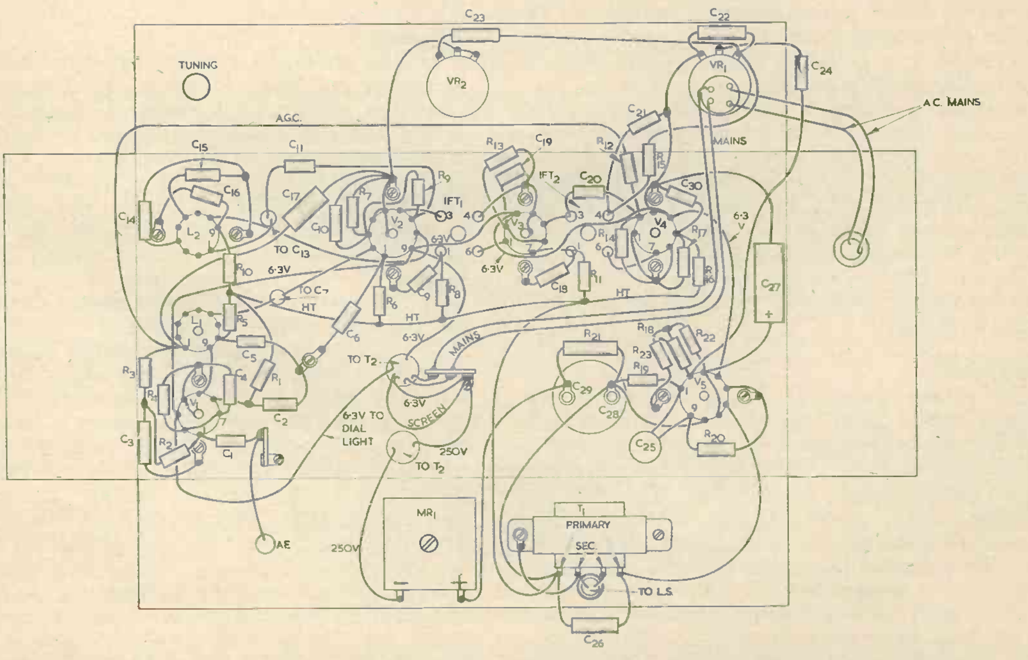


Fig. 4. Below-chassis layout and wiring. The tags on the switch of the particular volume control employed should be checked, as they may vary in position from those shown here

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of the receiver is not high and no further smoothing is needed. It should be noted that the value of R_{21} which is required to produce the correct h.t. line voltage depends to some extent on the output of the transformer and rectifier combination employed, and may need to be varied accordingly.

The valve heaters require a total of 1.5 amps and, allowing for the addition of a dial light, the transformer should be capable of supplying 2 amps at 6.3V.

To avoid the possibility of modulation hum, it is advisable that the transformer primary be screened. If there is no screen and modulation hum is experienced, it may be cured by fitting two small capacitors in series across the primary winding and earthing the centre point to chassis as in Fig. 2. Good quality capacitors rated at 250 volts a.c. working should be used.

Construction

The receiver is constructed on a chassis of 18 s.w.g. aluminium sheet, 10 x 5 x 2in, details of which are given in Fig. 3. The positions of the fixing holes for the tuning capacitor and the transformers will vary according to the components used and are not, therefore, shown in this drawing. There is plenty of room in the chassis for all the components, and construction can proceed in any desired order except that the connections to C_{28} and C_{29} must be made before fitting the output transformer as they are rather inaccessible afterwards. The overall gain is high and the constructor who does not wish to experiment is advised to adhere to the layout of Fig. 3 and keep all the wiring as short and direct as can conveniently be managed. This applies particularly to the i.f. stage where the high slope of V_3 is a potential cause of instability. V_1 and V_3 should be screened.

A complete wiring diagram is given in Fig. 4. Note that the positions of the components, as shown, are only approximate and that much of the wiring, which has been opened out for clarity, appears longer than is permissible in construction. Tinned copper wire of 22 s.w.g., covered with sleeving, is suitable for all the wiring.

The two 20pF trimmers C_8 and C_{12} serve for both ranges and should be mounted on top of the tuning capacitor.

Components

The tuning capacitor should be 300pF each section, but a 500pF component will serve quite well if fixed capacitors of 1,000pF are inserted at the two points X in Fig. 1. Close tolerance mica components should be used for this. The remaining capacitors can be of any type, though disc ceramics are very convenient in some places, notably for C_{25}. All capacitors except those in grid and cathode circuits, must be rated for 350 volt working because, when the set is first switched on, they must withstand the full peak value of the h.t. supply until the valves warm up and begin to draw current. The wattage ratings for resistors are given in the Components List.

Four coils are needed, two for the 5–15 Mc/s range and two for 10.5 to 31.5 Mc/s. The cost can, of course, be reduced by fitting one pair only and if this is done, the 5–15 Mc/s range should be selected as it is generally the more rewarding. The padder capacitor, C_{15} (Fig. 1) will not then be required. The specified coils must be used or the plug-in arrangements will not hold good.

The tuning control should ideally be a good quality vernier drive but quite a good performance can be obtained from the much less expensive arrangement shown in the illustration. This consists of a 3½in drum driven by an ordinary cord drive, a pointer fixed to the driven spindle being made to traverse any arbitrary semicircular scale.

Testing

When construction is complete and the wiring has been checked carefully against the diagrams, a test should be made, with a meter on a high ohms range applied between C_{29} and chassis, to see that there are no short-circuits in the h.t. wiring. When a meter lead carrying positive voltage is applied to C_{29}, a large initial deflection should be observed and the apparent resistance should then gradually increase to infinity or thereabouts as C_{28} and C_{29} become charged from the meter battery. All being well, a speaker can be connected, power applied and further tests made to see that voltage appears at the screens-grids, anodes and cathodes of the valves (except V_4). Check also that the h.t. line voltage is 180 ± 10V. Any greater difference should be corrected by altering the value of R_{21}.

Alignment

Unless pre-tuned transformers have been used, it will be necessary to use a signal generator to align the i.f. amplifier. Inject a 1.6 Mc/s signal at the signal grid of V_2 and adjust the transformer cores for resonance in the usual manner. Resonance is best detected by a high resistance voltmeter (20,000Ω p.v.) connected across VR_1, but if this is not available, a modulated signal can be used, the volume control being turned up and resonance judged by ear. In either case, it is essential to keep the injected signal to the minimum necessary to produce a reliable indication.

The signal and oscillator circuits present little difficulty. Start with the 5–15 Mc/s range and, with the gang at minimum capacitance, inject a 15 Mc/s signal at the aerial. Tune it in with the trimmers C_8 and C_{12}. Then, with the gang at maximum, inject at 5 Mc/s and adjust the cores of L_1 and L_2 for the best results. The range is now correct and it remains to track the oscillator. Set the generator to 7 Mc/s and tune the receiver to the harmonic at 14 Mc/s. Manipulate the tuning capacitor and the trimmer C_{12} to find the combination of settings for maximum response. Note the tuning scale reading carefully. Now tune in the 7 Mc/s signal and by manipulation of the gang and the core of L_2, again find the optimum combination. Return to the 14 Mc/s

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scale position and make final adjustment to C_{12}. The coils for the 10.5 to 31.5 Mc/s range can now be inserted and their cores adjusted for optimum response at 14 Mc/s. Do not make any alteration to the trimmers C_8 and C_{12}.

Alignment without a Generator

This is a practical proposition (provided the i.f. amplifier is pre-tuned) though it requires a little patience. Withdraw the core of L_2 about ¼in, connect a good aerial and search for transmissions towards each end of the 5–15 Mc/s band. The oscillator circuit will take charge and if the operation is carried out after dark, when reception conditions are good, it will usually be possible to find two transmissions which are not too badly affected by fading. Identify them so that they can be found again and use them in lieu of the generator signals. It will not be possible to check the range of the coils but this is not a matter of any great moment. When the r.f. and oscillator adjustments have been carried out, tune in a transmission on the 49 metre band and check the alignment of the pre-tuned i.f. transformers. Only very small adjustments to the cores should be necessary to compensate for differences of stray capacitances. Do not make any large alterations or the original alignment will be lost. The second set of coils can now be fitted and their cores adjusted as previously described, using a transmission in the 25 metre band.

Operation

The stronger signals can be received on about 18 in of wire but, as with all receivers, the best results are obtained with an efficient aerial. The prototype gave a good account of itself on a 30ft outdoor aerial, the a.g.c. system proving well able to cope with the large and rapid variations of signal strength which occur on short waves. An earth connection will eliminate mains-borne interference.

TOWNSEND FERRIES TEST TELEVISION

AID TO PRECISION BERTHING

A Marconi Marine closed-circuit television installation was recently tried out on board the cross-channel car ferry vessel *Free Enterprise*, with the co-operation of her owners, Townsend Bros. Ferries Ltd., in order to investigate what assistance this equipment can provide in the docking and general harbour manoeuvring of vessels of this type.

These ships berth stern-on and to do so have to go astern, at sufficient speed to maintain adequate steerage way, between two rows of dolphins, coming to a stop with the stern some six feet off the shore car ramp. This naturally demands fine handling, particularly in a cross-wind or poor visibility or darkness. For precise information regarding the ship's position and movement relative to the dolphins and shore ramp the master normally relies upon the observations of an officer stationed on the after mooring bridge, who passes it on over the talk-back system.

In discussions between Townsend Bros. Ferries Ltd. and officials of the Marconi International Marine Co. Ltd., it was felt that a closed-circuit television installation might supplement this verbal information by providing the master on the bridge with an actual picture, in close-up, of what his officer, stationed aft, was seeing. Arrangements were accordingly made to carry out an evaluation project with a television installation aboard the 2,600-ton *Free Enterprise*, 316 feet in length.

A test was made during a Channel crossing and return, a team of engineers from the Marconi Marine Company sailing in the vessel. Two fixed-aspect cameras were mounted on the port and starboard guard rails at the after end of the boat deck, covering the stern and quarters of the vessel; and display monitors were placed in the port forward corner of the wheelhouse. With this positioning of cameras and monitors the equipment was used during docking and undocking at both Dover and Calais, the trial proving most successful—so much so that during the return crossing the opportunity was taken to reposition the cameras, mounting one on the centreline of the after goalpost structure, looking aft, and moving the other forward to observe the forecastle head and the mooring party there, the master's view in this direction being somewhat restricted by the forward guard rail of the boat deck and the fan house. It was considered that this latter arrangement, giving the master simultaneous viewing of rope handling fore and aft, as well as of the positioning of his ship in relation to the dolphins and shore ramp, could be of great value.

On the result of tests, it is known that the light-grasp of this particular camera is better than that of the human eye in conditions of restricted visibility, especially at dusk or even in darkness with adjacent illumination, and the Marconi Marine Company intends to carry out further operational trials to prove the television system under such conditions.

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Design for a *LONG* Wave Light Programme Car Radio

Flt. Lt. J. H. Thompson,
ASSOC. BRIT. I.R.E., M.I.P.R.E.

If a car radio receiver is generally employed to receive one station only, why introduce the complexity of a superhet circuit? In this article, our contributor describes a car radio which is intended for reception of the Light Programme on 1,500 metres. Since single-station working is all that is required, the radio then becomes a simple t.r.f. receiver which can be constructed at a component cost of £4 or even less

HAVING USED A CAR RADIO FOR MANY YEARS the author has found that, after the first thrill of the new toy, the set has been left more or less permanently tuned to the long waveband Light Programme on 200 kc/s.

This programme gives, in the author's opinion, all that is required for the motorist; music, short news broadcasts, and a mass of light entertainment that requires little or no concentration. The strength of the long wave Light Programme trans-

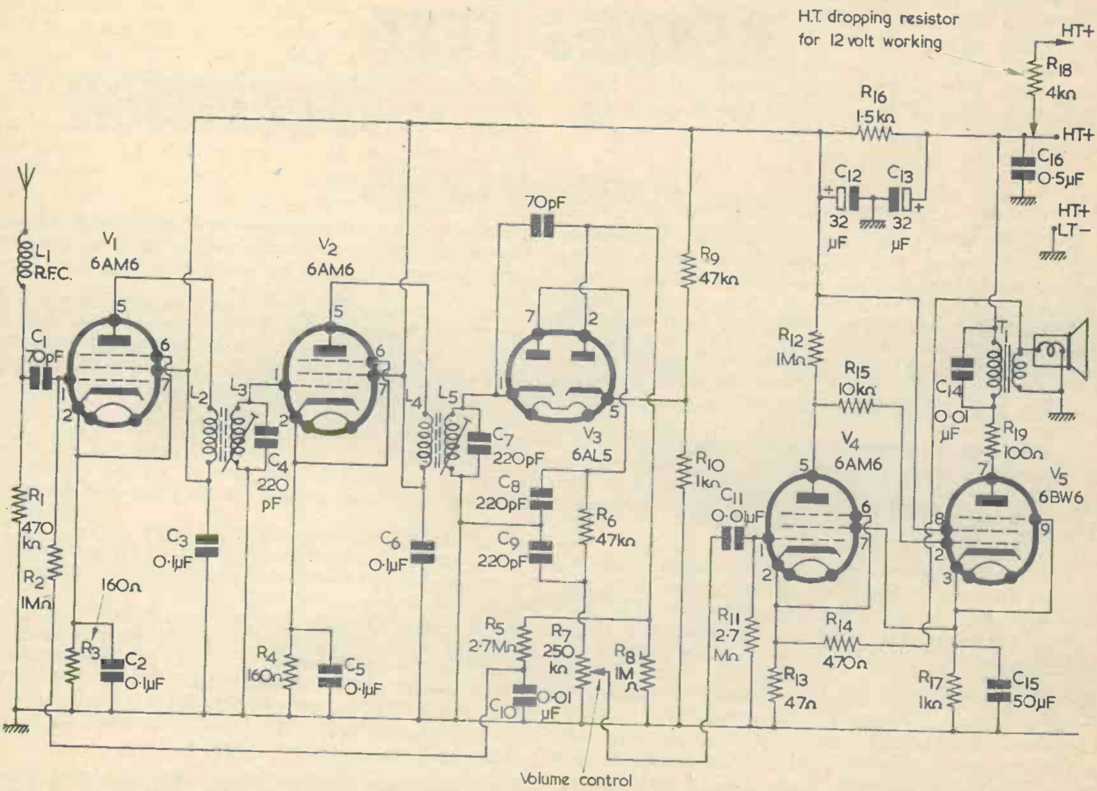

Fig. 1. The circuit of the receiver. The valve heater connections are shown in Fig. 3. R_{18} is only required with 12-volt car systems. In the event of a.f. oscillation, reverse the connections to the secondary of T_1

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mitter is such that good reception is assured throughout the British Isles, and on a recent posting to Fontainebleau, some thirty miles south of Paris, the station still came in loud and clear with only a slight amount of "sideband splash" from the Continental Radio I signal.

T.R.F. Receiver

The normal car radio, designed to cover the long and medium wavebands is, of course, a superhet. This is to obtain high and equal gain throughout the fairly large frequency coverage. If, however, the receiver is to be spot tuned to one frequency (in this case 200 kc/s) the same problems do not exist, and so it was decided to use a straight receiver, making the r.f. gain as high as possible and following this by a high gain audio frequency amplifier.

As may be seen from Fig. 1, the first r.f. stage is untuned. An untuned input circuit may seem peculiar, but this method of coupling the car radio aerial to the receiver was found, by experiment, to give superior results to any form of tuned coupling. There are two stages of r.f. amplification using 6AM6's. These valves give a very high stage gain and, when the aerial circuit was tuned, it was found difficult to prevent the set from becoming unstable on a weak signal. The receiver was quite stable on a moderate-to-strong signal as the a.g.c. voltage automatically reduced the gain of the first valve and removed the instability. After experimenting with various forms of tuned input circuit the present untuned version was adopted, and it has been found to give good gain and to be rock stable.

The radio frequency choke in the aerial circuit cuts down any r.f. ignition interference noises generated by the car engine. The 470kΩ resistor R_1 serves two purposes. It is the untuned grid-cathode load of the first r.f. valve and it also leaks away any static voltages picked up by the car aerial. The second r.f. stage is quite straightforward. It is not connected to the a.g.c. line and its main

Components List

Resistors

(All fixed values ¼ watt 20% unless otherwise stated)

R_1 470kΩ
R_2 1MΩ
R_3 160Ω
R_4 160Ω
R_5 2.7MΩ
R_6 47kΩ
R_7 250kΩ potentiometer, log track
R_8 1MΩ
R_9 47kΩ
R_{10} 1kΩ
R_{11} 2.7MΩ
R_{12} 1MΩ
R_{13} 47Ω
R_{14} 470Ω
R_{15} 10kΩ
R_{16} 1.5kΩ 1 watt
R_{17} 1kΩ 1 watt
R_{18} 4kΩ 10 watts†
R_{19} 100Ω
R_{20} 14Ω 3 watts†

Valves

V_1 6AM6
V_2 6AM6
V_3 6AL5
V_4 6AM6
V_5 6BW6

Switch

S_1 On/Off toggle

Miscellaneous

Valveholders, chassis, wire, nuts, bolts, etc.

Capacitors

C_1 70pF mica or ceramic
C_2 0.1μF paper
C_3 0.1μF paper
C_4 220pF mica
C_5 0.1μF paper
C_6 0.1μF paper
C_7 220pF mica
C_8 220pF mica or ceramic
C_9 220pF mica or ceramic
C_{10} 0.01μF paper
C_{11} 0.01μF paper
$C_{12, 13}$ 32+32μF electrolytic, 300V wkg. (6V version) or 500V wkg. (12V version)
C_{14} 0.01μF paper
C_{15} 50μF electrolytic, 50V wkg.
C_{16} 0.5μF paper
C_{17} 0.5μF paper
C_{18} 100μF electrolytic, 6V wkg.*
C_{19} 100μF electrolytic, 12V wkg.†

* Only required for 6V wkg.
† Only required for 12V wkg.

Inductors

L_1 R.F. choke type RFC8 (Denco Ltd)
$L_{2, 3}$–$L_{4, 5}$ R.F. coupling coils "Maxi-Q" Range 1, Yellow (Denco Ltd)

Rotary Transformer

Surplus item (manufactured by Hoover Ltd)
12V input—450V output
6V input—250V output (Available from Relda Radio Ltd, 32A Coptic Street, London, W.C.1.)

Output Transformer

T_1 Ratio 50:1

Speaker

3Ω impedance

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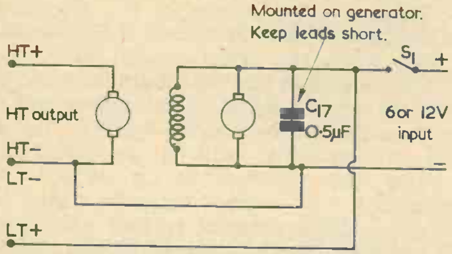

Fig. 2. The connections to the rotary transformer for either 6 or 12 volt input. The noise suppressor capacitor, C_{17}, is mounted direct to the rotary transformer with leads as short as possible. A negative earth is assumed, but if the car has a positive earth, the h.t. negative output will correspond to the positive input connection. Before wiring up, check that the rotary transformer has no internal connections between its input terminals and case (which may necessitate its insulation from the car body). After wiring, ensure that the h.t. output polarity is correct before connecting to the receiver

purpose in life is to give as high a gain as possible.

This stage is followed by a double diode (6AL5). One diode demodulates the signal in the normal way and the other produces the necessary a.g.c. voltage to control the first r.f. stage. The 47kΩ and 1kΩ resistors (R_9, R_{10}) in the cathode circuit of the a.g.c. diode give the system a delay of somewhere in the region of 5 volts.

Audio Frequency Section

The audio frequency section is of interest. The first stage (6AM6) has a high anode load of 1MΩ and is directly coupled, through the 10kΩ resistor, R_{15}, to the output valve (6BW6). The gain is very high, so high that a large amount of negative feedback can be used, making the a.f. output from this set very pleasant to listen to.

The bias resistor in the output stage, R_{17}, fulfils three functions: (1) It produces the necessary bias for the output valve; (2) it produces a high voltage, in excess of that required for bias, to overcome the h.t. positive voltage from the anode of the previous valve; (3) it supplies the screen grid voltage for the first a.f. valve, the actual potential being about 30 volts.

If a valve other than a 6BW6 is used in the output stage, the value of the cathode resistor can be found in the following way: (*a*) commence with a 1kΩ resistor in circuit; (*b*) connect a milliameter between the output transformer primary and the h.t. positive line; (*c*) ascertain what anode current the valve should consume for an h.t. potential of 250 volts; (*d*) if the meter registers too low a current, decrease the bias resistance and (*e*) if the meter registers too high a current, increase the value of the bias resistance.

The circuit is, however, largely self-balancing, and 1kΩ is approximately correct for most valves.

Rotary Transformer

The rotary transformer used gives an output of 250 volts for an input of 6 volts. If the input is increased to 12 volts the output will rise to about 450 volts. The rotary transformer circuit is shown in Fig. 2.

If the set is required to operate on a 12 volt car system then an h.t. dropping resistor will have to be inserted, in the receiver, between the h.t. positive input and the 1,500Ω smoothing resistor, as shown in Fig. 1.

The receiver consumes approximately 50mA, so Ohms Law gives the value of the additional series resistor as follows:

Voltage to be dropped (450–250)=200 volts

$$R=\frac{E}{I}=\frac{200}{50}\times 1{,}000=4k\Omega$$

$$\text{Wattage}=EI=\frac{200\times 50}{1.000}=10 \text{ watts}$$

Two 6 volt versions of this car radio have been constructed and installed in Renault *Dauphines*, both have given excellent results and there has been no trouble whatsoever with car ignition interference.

The heater circuits for 6 and 12 volt supplies are given in Fig. 3.

Setting Up

Setting up the equipment is very simple. Connect a voltmeter across the bias resistor of the first

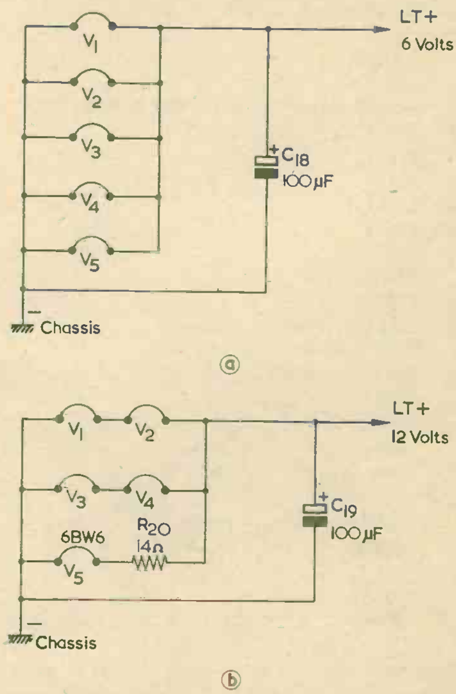

Fig. 3. The heater circuit for 6 volt working is shown in (a), and that for 12 volt working in (b). The associated capacitor (and resistor) should be mounted in the receiver chassis. As in Fig. 2, a negative earth is assumed. A positive earth will necessitate reversal of the parallel electrolytic capacitor

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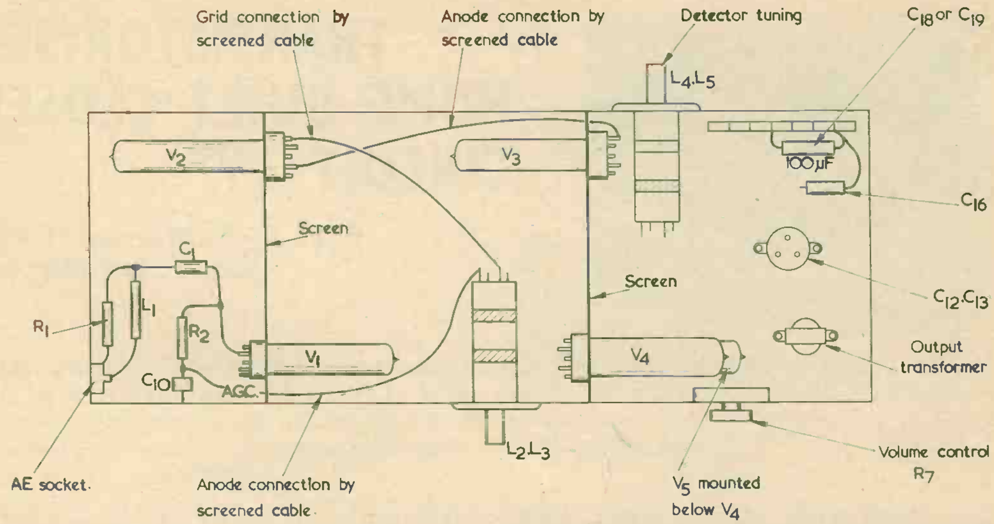

Fig. 4. The basic layout employed by the author. The final size is dependent upon the space available in the car, but it is strongly advised that the general layout shown here be employed. A metal screen should be fitted to the top of the receiver on completion. It would be preferable to fit V_1, V_2 and V_3 with screening cans

r.f. valve (maximum potential 2 volts) and adjust the two tuned circuit iron dust cores for the lowest reading, corresponding to maximum dip in the meter. On a normal car radio aerial, maximum dip on the Light Programme should be somewhere in the region of 0.5 volt.

Total Cost

The total cost of the installation, excluding the aerial, is in the region of £3 to £4. This assumes the use of the rotary transformer recommended (10s. 6d. at the time of writing) and Government surplus valves. At this price the author considers the receiver to be good value for money. No additional noise suppression devices, other than those shown, were found necessary. It is recommended that the rotary transformer be mounted out of hearing, as it produces quite a large amount of physical noise.

Editor's Note

When the receiver is used for 12 volt working, the full h.t. voltage available from the rotary transformer will appear on the h.t. positive line until the valves warm up. In consequence, capacitors connected across the h.t. supply (C_3, C_6 and C_{16}) should, preferably, have a working voltage of 500 for this condition. This increased working voltage is already specified in the Components List for C_{12} and C_{13}.

New Alpha Monitor Detects Radium Leakage

A new portable instrument which can detect alpha radiation even in the presence of high gamma fields, so making it ideally suited for detecting leakage from radium needles by direct examination, has been developed by EMI Electronics Ltd.

This new instrument, Alpha Monitor Type PAM1, is also suitable for monitoring Americium 241 and Radium 226 for alpha radiation.

In the past, instruments could not detect low levels of alpha radiation in strong gamma fields and when monitoring radium needles it was necessary to make wipe tests to determine whether they were leaking. With this new instrument the needles can now be directly monitored. So high is the sensitivity of Alpha Monitor PAM1 that small leaks, difficult to detect by a wipe test, can be detected even in a 50 millicurie needle.

The monitor is of all-transistor construction, is battery operated and incorporates a standard EMI 100 sq. cm. Alpha Probe Type AP3. The ratemeter is housed in a durable reinforced plastics case which fits neatly over the probe.

If required, the probe can be detached from the ratemeter and used separately. The phosphor is zinc sulphide on perspex and the photomultiplier is EMI Type 9600H. Weight of the complete instrument is $3\frac{1}{2}$ lb.

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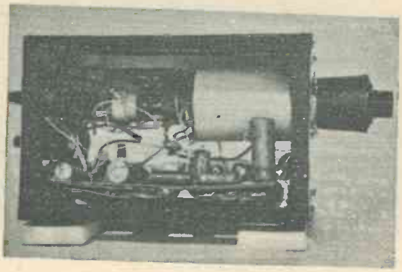

TRANSISTORISED HOME BUILT CLOSED CIRCUIT TV

Part 3—R. Murray-Shelley and T. Ian Mitchell

The third in a series of four articles describing the construction and operation of an amateur-built closed circuit television camera. The camera, which is fully transistorised, provides an r.f. output at any channel in Band I and it may, in consequence, be used in conjunction with a conventional domestic television receiver

Power Supplies

The power supplies required for the camera are, relative to the earth line:

(*a*) 12 volts, negative at approximately 100mA.
(*b*) 100 volts, negative at approximately 2.5mA.
(*c*) 300 volts, positive—very small current.
(*d*) 6.3 volts, 0.6 Amps, a.c. 50 c/s.

There are a number of ways in which these supplies can be obtained and the method which is adopted will depend rather on what the individual constructor has already available. The 300 volt and 6.3 volt supplies can be obtained from almost any receiver type power pack. The writers had such a pack and this was pressed into use. The 100 volt negative supply was obtained initially from a small dry battery—such a small current is required that battery life is very long. (A 90 volt receiver battery is quite suitable). The 12 volt supply, with which is associated a rather larger current, can be taken from a miniature accumulator. (The writers used one of 12 volt 0.75 amp. hour rating obtained from ex-government sources) Fig. 11 shows the connections of a pack made up as above. The power supplies were, in the writers' case, external to the camera proper and connected to it via a multi-way cable with connectors made up from B9A valve bases and suitable plugs at each end.

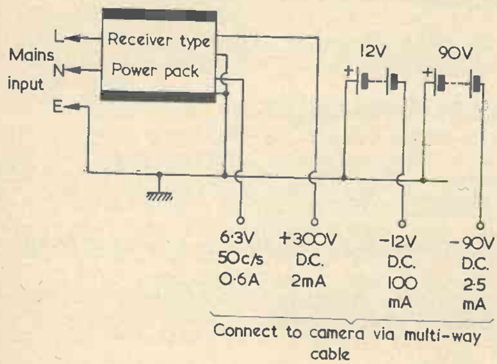

Fig. 11. A suitable power supply, showing interconnections. Switches may be included where appropriate

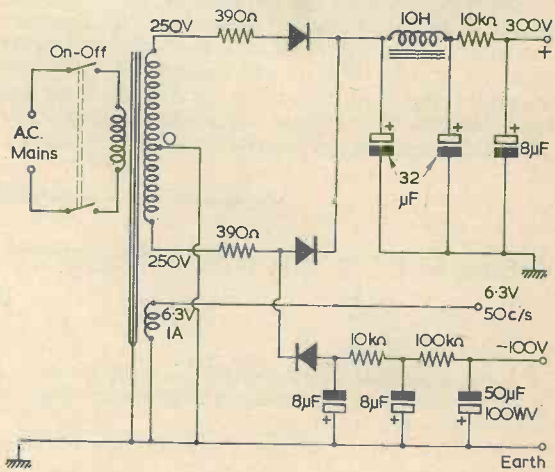

Fig. 12. Illustrating how the +300, −100 and 6.3 volt supplies may be obtained from the mains. The transformer h.t. secondary has to supply a low current only. Capacitors with working voltages of 450 are recommended unless otherwise stated. Resistors may have a rating of 1 watt. All diodes are Lucas type DD008, or similar types with 800 volt p.i.v. ratings

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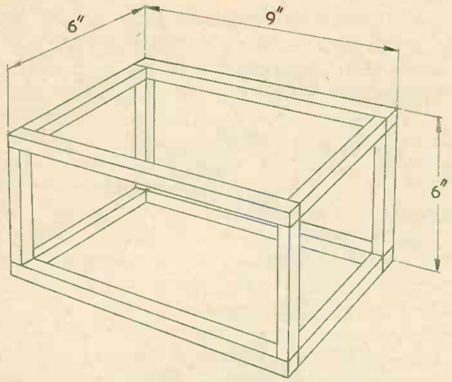

Fig. 13. The camera case frame. The material is ½ x ½in wood batten. The use of ferrite materials must be avoided

Side view. The line oscillator coil and associated components are mounted on the vertical sheet of insulating board

The 100 volt supply can also be derived from the mains quite easily, as shown in Fig. 12.

Whatever method of supply is adopted, it is essential that the currents supplied to the camera are thoroughly smoothed, otherwise mains interference may show on the picture. This is readily detectable since it covers the picture with a mesh pattern. No voltage stabilisation of the supplies was found to be necessary.

Construction

The whole of the electronic assembly is housed in the camera head, which occupies a space of 9 x 6 x 6in. The case for the unit is made by screwing aluminium sheet on to a wooden frame constructed as shown in Fig. 13. The operating controls and the pre-set controls, together with the coaxial output socket and the power input socket, are all carried on the rear panel of the camera case. The drilling dimensions for this panel are given in Fig. 14, whilst Fig. 18 shows the control layout.

The front panel carries the focus and scan coil assembly and the lens mount. We will have more to say on the subject of lenses and lens mounts later. The focus coil assembly is held in place by three screws, the Vidicon tube itself being fully supported within the assembly. Fig. 15 gives the drilling data for the front panel.

A method of constructing the electronic circuits using conventional chassis and tagboards was considered but rejected, primarily on the grounds of the space which such a method would take up, and also because it was felt that the transistorised circuitry lent itself to a more compact form of assembly—no valveholders and large transformers, etc., being required.

Accordingly, the construction involves the use of an insulating board. The components are mounted through holes punched in the board and interconnections are made on the reverse side of the board. A very neat and compact layout is possible by this method, and it is one which

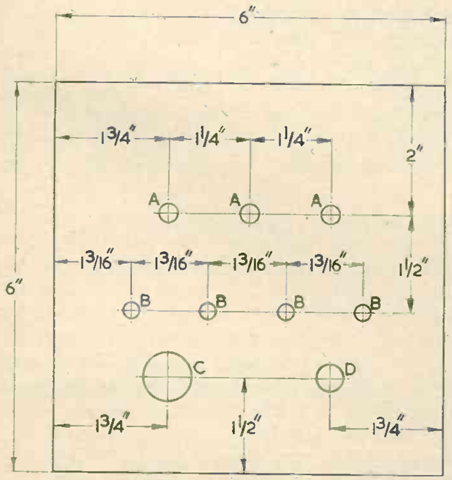

Fig. 14. Drilling details for the camera rear panel. The material is 18 s.w.g. aluminium sheet. Hole diameters are as follows: "A" ¼in; "B" to suit pre-set potentiometers; "C" to take B9A socket; "D" to take coaxial socket

The underside of the camera

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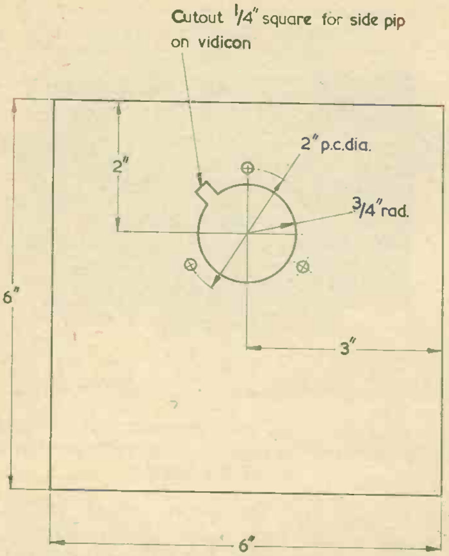

Fig. 15. The front panel of the camera case

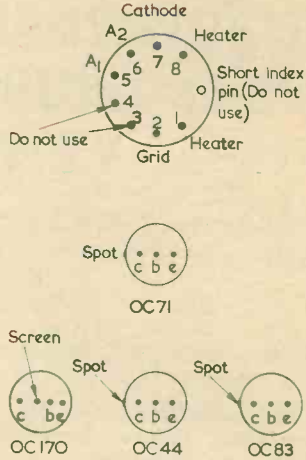

Fig. 17. Base connections for the Vidicon and transistors. (A_1 and A_2 may also be referred to as G_2 and G_3 respectively)

has excellent mechanical and electrical stability. In the writers' case the type of board used was that made under the name of "Prespahn board"—a form of insulating sheet which has the appearance of treated cardboard. Should this not be available, thin Paxolin or plastic sheet could be used equally well.

The video amplifier, r.f. oscillator, vertical timebase and blanking mixer can all be accommodated on a single piece of the board as shown in Fig. 16. Fig. 16 also shows a suitable layout for the video amplifier. The rest of the construction is carried out in much the same manner.

The line oscillator can be constructed on a second piece of board. This unit incorporates some rather large components in the shape of the line oscillator coil and the inductor in the collector circuit of the output stage. These components are most easily mounted by soldering their tags to the tags on a small length of miniature group-board. This group-board can then be attached to the rest of the assembly with small screws. The completed line oscillator assembly can be fixed to a convenient part of the wooden case frame with wood screws. The main electronic assembly can be held in place with glue in the position shown in the accompanying photographs.

Wiring techniques

Little need be said about the actual wiring of the equipment, except perhaps for a few cautionary remarks regarding the semiconductors. These components are sensitive to heat and could easily be damaged if subjected to serious overheating. Accordingly all transistor leads should be kept fairly long and a thermal shunt—a pair of long nosed pliers—should be used during soldering. It is suggested that the transistors be inserted after the general wiring has been completed and, further, that they are mounted on the opposite side of the

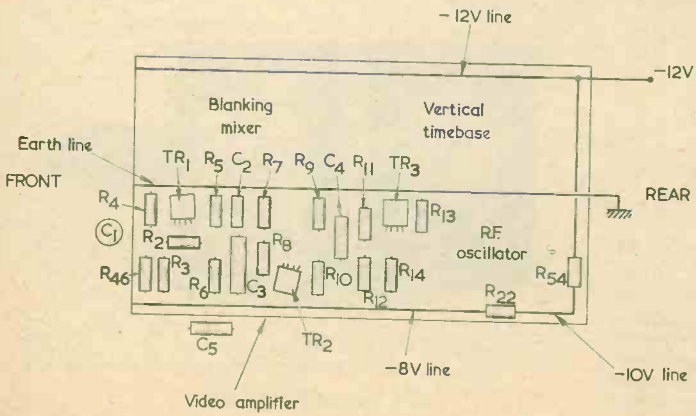

Fig. 16. General circuit layout. A suitable layout for the video amplifier components is also shown

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board to the rest of the components. Note that the "screen" connections on the OC170 transistors are earthed. Also, make sure that the metal cases of these transistors do not come into contact with other parts of the circuit.

The earth busbar and the 8, 10 and 12 volt busbars shown in Fig. 16 are made from lengths of 14 s.w.g. tinned copper wire.

The line and vertical deflection coil connections are colour coded, the codes being given in the circuit diagram (Fig. 6, published last month). It is important that these codes are observed, otherwise a reversed or inverted picture will result.

For correct operation, it is essential that the r.f. wiring around transistor TR_5 and L_1, L_2 and L_3 be kept *as short as possible.* This point is of considerable importance, and failure to ensure that it is carried out may result in poor functioning of the camera.

Each of the sections of sheet metal forming the case should be in electrical contact with the others, and the case as a whole should be earthed.

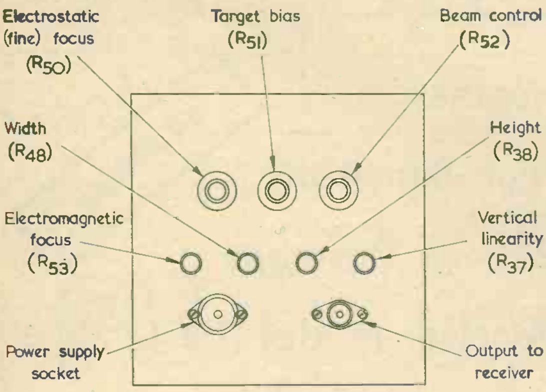


Fig. 18. The control panel layout

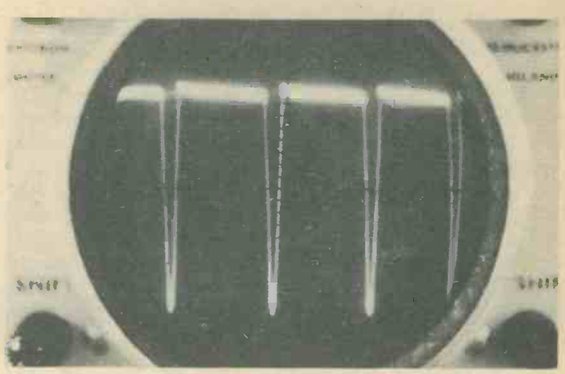
The focus and scanning coil assembly has an integral screen around the end of the Vidicon tube. This must be earthed using the braid provided. Failure to do this would almost certainly cause severe patterning on the picture due to mains interference.

Most of the components associated with the Vidicon controls, viz. C_{14}, C_{15}, C_{16}, etc., can be mounted either on the main circuit board or directly connected to the controls themselves. The connections to the Vidicon base can then be made with flying leads. The connections to this base are shown in Fig. 17.

In order to avoid beat patterns being generated between the mesh of the deccelerating anode A3 and the scanning lines, the tube should be mounted so that the scanning lines are at 45° to these mesh bars. This means that the tube should be rotated in its mounting so that the plane of a diameter through the index pin is horizontal.

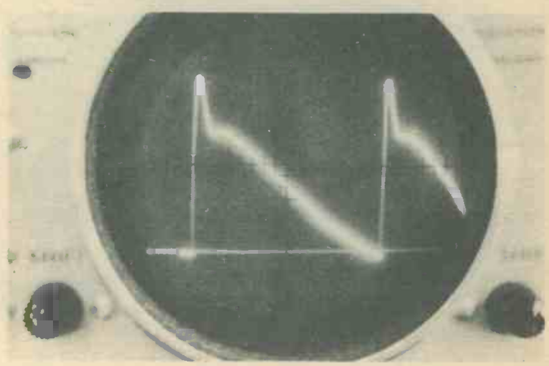
Lenses

It is necessary that the scene which is to be



The line scan waveform, as provided across the deflector coils

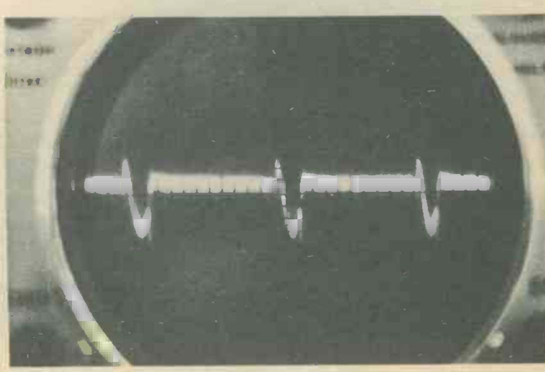
televised be focused on to the photoconductive film. This means that some form of optical system must be incorporated. The writers, in their initial experiments made use of an ordinary film camera, the back of which had been removed. This proved to be very useful since it allowed easy access to



The vertical scan waveform

the Vidicon. Something a little more permanent than this, however, is required in the final equipment.

It was mentioned earlier that the scanned area of the Vidicon target is such that it permits the use of standard 16mm cine lenses. If such a lens is available to the constructor then this can be used.



The vertical sync pulses

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The type of lens mount and the method of securing it to the camera will be almost entirely governed by the choice of lens, and a certain amount of ingenuity is required on the part of the individual constructor. The lens should have some provision for focusing and should preferably, be fitted with an iris diaphragm. The larger the lens aperture (the smaller the stop number) then, in general, the more useful will the lens prove to be. Focusing is carried out by moving the whole lens assembly nearer or further away from the Vidicon target. If it becomes necessary to make some sort of lens mount or lens holder, adequate provision should be made for this focusing.

The writers, faced with the prospect of being able to obtain a 16mm lens only at some not inconsiderable expense, decided to explore the possibilities offered by the government surplus market.

It was discovered that a lens system removed from the ex-R.A.F. gun camera, type G.45, was quite suitable for the project. This gun camera is obtainable on the surplus market both from electrical dealers and from photographic dealers.* The lens itself is not ideal since the field of view is rather narrow, also it is not fitted with an iris diaphragm. This latter facility is not essential since, unlike a camera fitted with photographic film, the sensitivity of the television camera can be adjusted to some extent electronically. It is useful to be able to stop down the lens in certain situations, however; when a large depth of field is required, for example, and also to avoid "overloading" the tube in bright light. The lens mount in which the gun camera lens was originally housed can, with some modification including reversal of the lens, be used on the television camera. This lens has an aperture of about f/3.

EDITOR'S NOTE
We are informed that a lens, suitable for use with the Vidicon 10667M, is obtainable from the D.T.V. Group, 126 Hamilton Road, West Norwood, London, S.E. 27. This is the Beulah Lens type Z1.

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* G.45 gun cameras are available from Direct Photographic Supplies, Ltd., 224 Edgware Road, London, W.2.

(*To be continued*)

Heathkit High-Sensitivity General Coverage Receiver **Model RG-1**

Kit Review

SPECIFICATION

Frequency Coverage:
- BAND A ... ... 600 kc/s–1,500 kc/s (medium wave band)
- BAND B ... ... 1.7 Mc/s–4 Mc/s
- BAND C ... ... 3.9 Mc/s–8 Mc/s
- BAND D ... ... 7.9 Mc/s–14 Mc/s
- BAND E ... ... 13.9 Mc/s–22 Mc/s
- BAND F ... ... 21.9 Mc/s–32 Mc/s

Intermediate Frequency:
1,621 kc/s (½ lattice filter)

Sensitivity:
3 microvolts for 10dB S/N ratio or better.
8 microvolts M.W. band

Image Rejection:
40dB or better

Input Impedance:
600 ohm (nominal)

Audio Output Impedance:
3 ohm (speaker) 600 ohm line (phones)

Audio Output:
2 watts

Panel Controls:
AF GAIN incorporating AC on-off
RF GAIN
MAIN tuning
BAND switch
BFO ON-off
AVC on-OFF
BFO Variable Pitch Control
CALibrate press-on switch
NL MIN–max.

Valve and Diode Complement:
EF183 RF amplifier, ECH81 Mixer-oscillator, EF183 1st IF amplifier, ECF82 2nd IF amplifier–BFO, OA81 Detector, OA81 AVC, EB91 Noise limiter, ECL86 1st audio-audio output, EZ81 Rectifier, OA2 Stabiliser.

Power Requirements
110–240V AC, 50–60 c/s, 50 watts

Cabinet Size:
13¾" wide x 11½" deep x 6½" high

General:
Tuning meter zero adjust. Provision for muting. Phone jack on front panel

Net Weight:
18lb

Shipping Weight:
23lb

Optional Extras:
1 Mc/s Crystal Calibrator Model CL–1M. Matching loudspeaker cabinet Model SG–4. Speaker–Part No. 401–501

This receiver is a versatile high performance semi-communications receiver including many refinements normally only found on higher priced receivers of this type. It is suitable for communication purposes, as a high-performance amateur radio receiver or for reliable reception in areas far distant from a transmitter. Housed in a strong steel cabinet having a low silhouette styling and a silver-green colour scheme, the attractive appearance of this well designed equipment may be seen from the illustration shown herewith.

From the specification it will be noted that the frequency coverage of the receiver is from 600 kc/s to 1.5 Mc/s and from 1.7 Mc/s to 32 Mc/s continuous. The frequency break from 1.5 to 1.7 Mc/s permits the use of a 1,621 kc/s i.f., which produces

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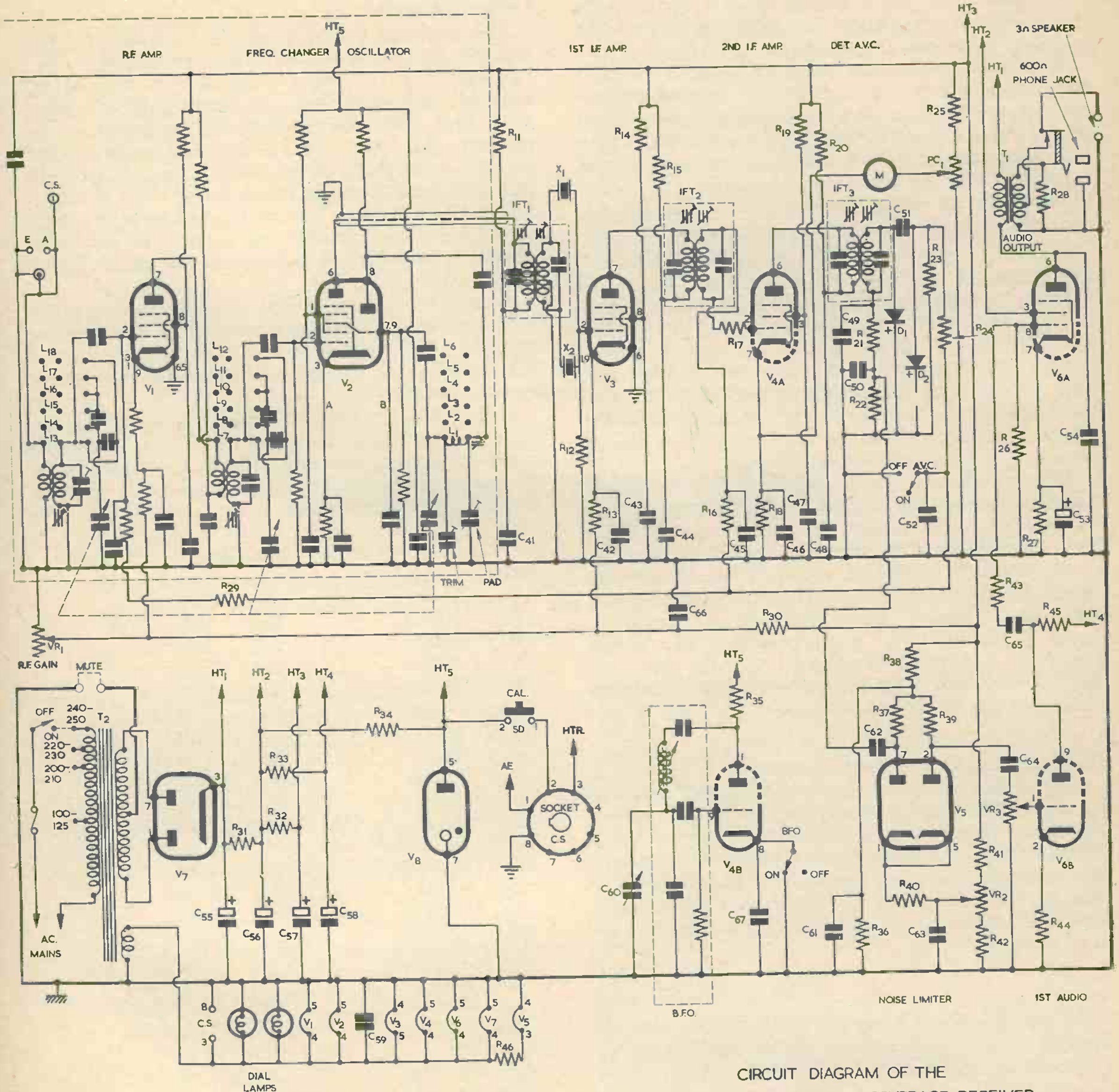

CIRCUIT DIAGRAM OF THE
HEATHKIT GENERAL COVERAGE RECEIVER
MODEL RG-1

a far superior image rejection than do intermediate frequencies in the 450 kc/s region.

Each band is separately calibrated on a large easy-to-read slide-rule scale, the dial itself being illuminated and providing approximately 9in of bandspread for each band. A two-speed drive is incorporated, thus allowing a small section of the band to be tuned at a very slow rate.

The design features an S-meter, a tuned r.f. amplifier stage, a half-lattice filter, an adjustable noise limiter and provision for connecting a Q multiplier and frequency calibrator.

Circuit Description—R.F. Amplifier and Mixer/Oscillator

From the circuit of the receiver it will be seen that the incoming signal from the aerial is applied through the inductance L_{13} (when the bandswitch is in position "A"), through the bandswitch, and on to the grid of the r.f. amplifier V_1 (EF183). The amplified r.f. signal output from this stage is then applied, via the inductance L_7 (again assuming position "A" of the bandswitch), to the grid of the heptode section of the frequency changer $V_{2(a), (b)}$ (ECH81).

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V_2 heterodynes the incoming signal frequency with the oscillator frequency in order to obtain the required difference frequency of 1,621 kc/s.

The position of the third bandswitch section determines which inductors and associated capacitors are used in conjunction with the triode section of the valve ($V_{2(b)}$) in the oscillator circuit. These inductors and capacitors, including the main tuning capacitor, set the oscillator frequency 1,621 kc/s higher than the signal frequency to which the r.f. circuits are tuned.

I.F. Amplifier

From the anode of $V_{2(a)}$ the signal is coupled, through IFT_1 and the half-lattice crystal filter in the secondary circuit, to the grid of the first i.f. amplifier V_3 (EF183). The half-lattice crystal filter has been included in the design to provide a narrow bandpass for the suppression of unwanted adjacent signals, and it provides the receiver with an exceptionally good selectivity characteristic.

The amplified i.f. signal from the anode of V_3 is coupled through the second i.f. transformer (IFT_2) to the grid of the second i.f. valve $V_{4(a)}$ (ECF82), this stage further amplifying the i.f. signal. By turning the b.f.o. switch on, the beat frequency signal from oscillator $V_{4(b)}$ may be heterodyned with the i.f. signal. The introduction of the b.f.o. signal (1,621 kc/s $\pm$1 kc/s) produces an audible signal for continuous wave (c.w.) or single sideband (s.s.b.) reception. The output from $V_{4(a)}$ is coupled through IFT_3 to the diode D_1.

Detector, A.G.C. and Noise Limiter

Diode D_1 detects the i.f. signal and, after filtering to chassis the unwanted r.f. component, the audio signal passes to the noise limiter stage V_5 (EB91). When in use, the noise limiter effectively removes peak pulses caused by ignition or other impulsive interference, VR_2 being the threshold control. The diode D_2 rectifies the i.f. signal and provides an a.v.c. voltage.

Audio Stages

The audio signal from the noise limiter stage is applied to the grid of the triode section of V_6 (ECL86) via the volume control VR_3. $V_{6(b)}$ is the first audio amplifier and the output from this is taken to the grid of the pentode section $V_{6(a)}$, this further amplifying the audio signals and applying these to the speaker or headphones via the output transformer T_1. Insertion of the headphones jack plug automatically mutes the speaker.

Power Supply

V_7 (EZ81) is utilised here as a full-wave rectifier, giving an h.t. supply which is fully isolated from the a.c. mains by the mains transformer T_2. H.T. filtering is provided by resistors R_{31}, R_{32} and R_{33}, and capacitors C_{55}, C_{56}, C_{57} and C_{58}. Voltage regulation for the oscillators $V_{2(b)}$ and $V_{4(b)}$ is given by V_8 (OA2).

Optional Extras

The optional extras available for use with this receiver may be briefly described as follows.

A suitable frequency calibrator is the Model CL–1M, this providing calibration marker signals at 1 Mc/s intervals throughout the range of the receiver. An octal socket is mounted in the receiver for the connection of this unit if so desired. Its power requirements are small, being 150V at 1.2mA and 6.3V at 0.3A. The calibration unit is ideally suited for use either with this receiver or any other which is capable of supplying its small power requirements.

A speaker cabinet, Model SG-4, finished in green with a silver anodised grille, effectively matches the receiver. This cabinet is ideal for mounting a 3Ω 7 x 4in elliptical speaker and the latter component can also be supplied.

A Q multiplier, Model QPM-16, is also available, its operating frequency being 1,600 kc/s. This unit is self-powered, a connection to the a.c. mains being all that is required, other than the necessary connection to the receiver itself.

Components List

Resistors

R_{11}	1kΩ	R_{31}	1kΩ
R_{12}	3.9kΩ	R_{32}	2kΩ
R_{13}	560Ω	R_{33}	27kΩ
R_{14}	47kΩ	R_{34}	5kΩ
R_{15}	1kΩ	R_{35}	560kΩ
R_{16}	100kΩ	R_{36}	220kΩ
R_{17}	10Ω	R_{37}	100kΩ
R_{18}	1kΩ	R_{38}	220kΩ
R_{19}	33kΩ	R_{39}	220kΩ
R_{20}	1kΩ	R_{40}	100kΩ
R_{21}	47kΩ	R_{41}	47kΩ
R_{22}	22kΩ	R_{42}	47kΩ
R_{23}	2.2MΩ	R_{43}	47kΩ
R_{24}	1MΩ	R_{44}	2.2kΩ
R_{25}	330kΩ	R_{45}	220kΩ
R_{26}	560kΩ	R_{46}	10Ω
R_{37}	270Ω	PC_1	2kΩ linear
R_{28}	1.5kΩ	VR_1	5kΩ linear
R_{29}	220kΩ	VR_2	10kΩ linear
R_{30}	47kΩ	VR_3	500kΩ log

Capacitors

C_{41}	0.005μF
C_{42}	0.1μF
C_{43}	0.005μF
C_{44}	0.005μF
C_{45}	0.005μF
C_{46}	0.1μF
C_{47}	0.005μF
C_{48}	0.005μF
C_{49}	200pF
C_{50}	200pF
C_{51}	15pF
C_{52}	0.01μF
C_{53}	25μF electrolytic
C_{54}	0.005μF
C_{55}	60μF electrolytic
C_{56}	75μF electrolytic
C_{57}	20μF electrolytic

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C_{58} 20μF electrolytic
C_{59} 0.01μF
C_{60} 20.5pF
C_{61} 0.25μF
C_{62} 0.005μF
C_{63} 0.005μF
C_{64} 0.005μF
C_{65} 0.005μF
C_{66} 0.1μF
C_{67} 0.005μF

Crystals

X_1 1.6197 Mc/s
X_2 1.6214 Mc/s

Valves

V_1 EF183 Mullard
V_2 ECH81 Mullard
V_3 EF183 Mullard
V_4 ECF82 Mullard
V_5 EB91 Mullard
V_6 ECL86 Mullard
V_7 EZ81 Mullard
V_8 OA2 Mullard

Semiconductors

D_1, D_2 OA81 Mullard

(*Note:* Resistors R_1 to R_{10} and capacitors C_1 to C_{40} are all contained in the tuner unit shown within the dotted lines on the circuit diagram.)

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Miniature Oscilloscope CT84.—L. P. Walls, 30 Duppas Hill Terrace, Croydon, Surrey, requires handbook or other information regarding usage.

* * *

Signal Generator IRMC CT11.—J. W. Vickers, Atherstone Road, Measham, near Burton on Trent; service sheet or manual required, loan or purchase.

* * *

BC659 Rx/Tx, TR2002 Tx/Rx and Rx type 127.—B. Dodds, 42 Alma Place, North Shields, Northumberland, data and circuits required.

* * *

Marconi CR150 Receiver.—V. Sammut, 158 Old Theatre Street, Valetta, Malta; circuit or service manual required, loan or purchase.

* * *

R107 Receiver.—T. E. Port, 11 Bournewood, Hamstreet, Ashford, Kent, wishes to purchase manual.

* * *

"Saja" M40 Standard Tape Recorder.—G. Coombe, 45 Saxon Road, Exeter, Devon, wishes to purchase or borrow circuit or manual.

* * *

Triplett 1632 Signal Generator.—A. Nash, 3 Shawley Crescent, Epsom Downs, Surrey, requires loan or purchase of manual or circuit.

* * *

R220 Receiver.—J. N. Price, c/o 5 Priorsfield Road North, Coundon, Coventry, circuit or manual required, loan or purchase. Has for disposal copies of *Practical Wireless* October 1961 to December 1963 inclusive. No payment required except refund of postage.

* * *

R107 Receiver.—N. Sudron, 1 Aiskew Grove, Fairfield, Stockton-on-Tees, Co. Durham, requires service manual or circuit, loan or purchase. Modification details would also be welcome.

* * *

R.F. Unit 10P/2390 and I.F. Unit 10U/16621.—J. Anderson, 27 Tytherington Court, Tytherington Park Road, Macclesfield, Cheshire, has obtained these units and requires to know the circuitry, valve functions, voltages and connections as well as frequencies of these units, also whether they were intended to work together.

* * *

R1155A and Pye Receiver type PM121.—V. Tennant, High Park, Stanhoe, King's Lynn, Norfolk, requires service manuals or circuits, loan or purchase.

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An Interchangeable Oscilloscope

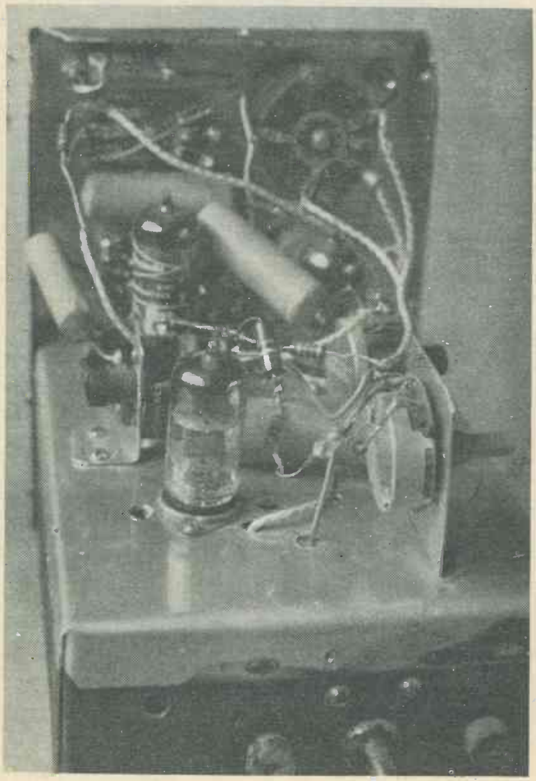
PART 2

by J. Hillman

Construction of the Power Supply Unit

MARK AND CUT OUT THE FRONT PANEL AS shown in Fig. 11, and bend up the ½in edges at right angles.[1] Mark and cut out the chassis as in Fig. 12 bending the edges in the following order: A, B, C, D, E, F, G, H, I. Next bolt up the back of the chassis to the sides with 6BA nuts and bolts. Now place the chassis and front panel together as in Fig. 13, drill 6BA clear holes through both sides and secure to the chassis with

[1] The dimensions given here for the power unit metalwork may need to be varied if the mains transformers and smoothing choke have large dimensions. This point should be checked before commencing construction.—EDITOR.



Above-chassis view of the timebase and X amplifier

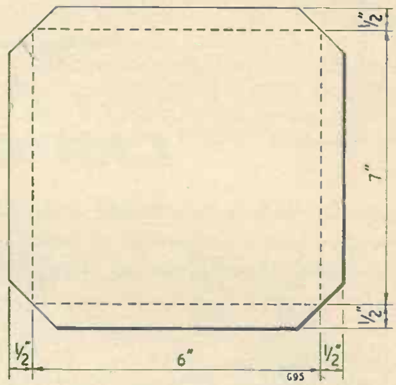


Fig. 11. The front panel of the power unit

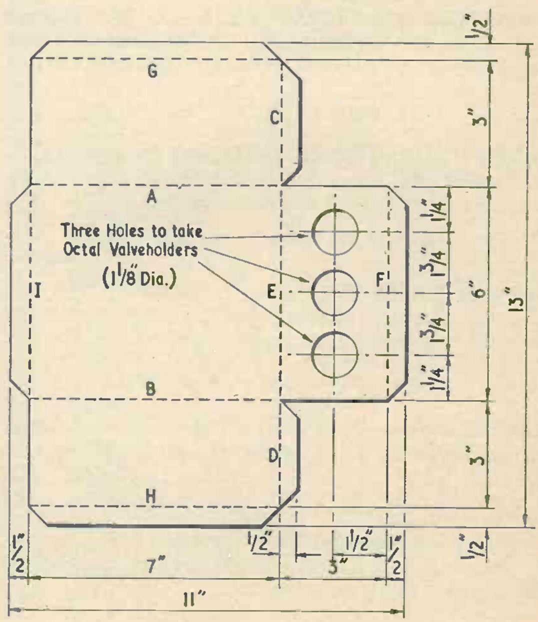


Fig. 12. The power unit chassis

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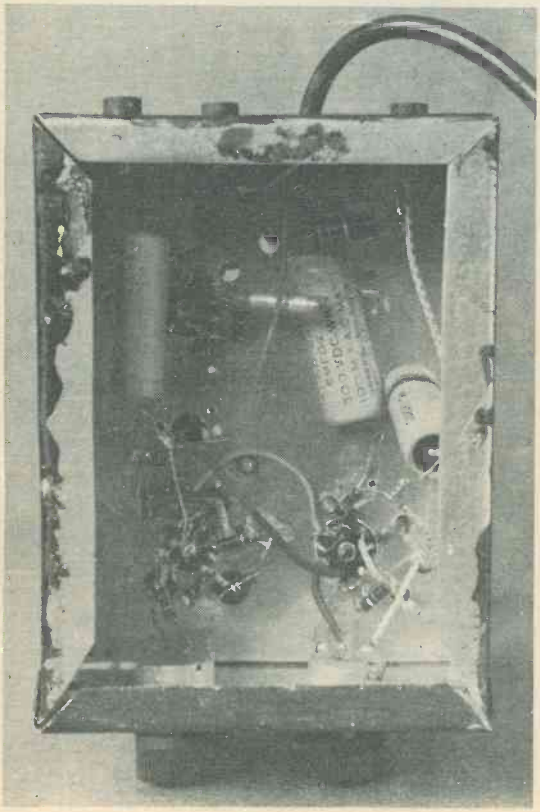
6BA bolts. The hole for the valveholder on the chassis comes next. Cut out this hole 1⅛in diameter as shown in Fig. 14. The front panel is then drilled as in Fig. 15, and the parts indicated in this diagram fitted to it. The mains transformers are fitted next, no dimensions being given as these depend on the size of the transformers used. The only point to watch here is the positioning of the transformer cores. Place them at right angles to one another so that their magnetic fields tend to cancel out. The below-chassis layout is shown in Fig. 16. Mounted on the side of the chassis is C_4, whilst two tagstrips are mounted on spacers to raise them and avoid e.h.t. arcing to chassis. Note that the tagstrips have widely spaced tags, the distance between tags being about ½in. The three octal valveholders are now fitted to the back of the chassis and the rest of the components fitted and wired as in Fig. 17. Octal socket 2 should be a moulded type.[2] The chassis is earthed to h.t. negative and e.h.t. positive. The top cover is next made as in Fig. 18 and is bent in the following order: A, B, C, D, E. Finally, the baseplate (Fig. 19) is made.

The warning light is fitted across the heater

[2] Improved e.h.t. insulation would be provided if pins 3 and 5 of socket 2 were left blank, other pins (say 6 and 8) being used for the tube heater supply. See Figs. 17 and 10.—EDITOR.



The below-chassis layout of the timebase and X amplifier

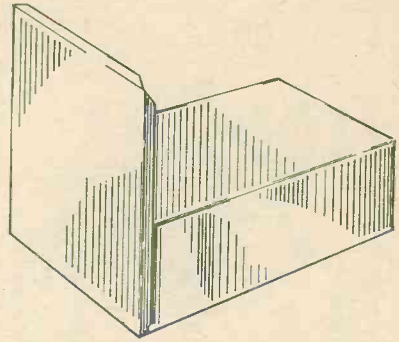


Fig. 13. Fitting the front panel to the chassis

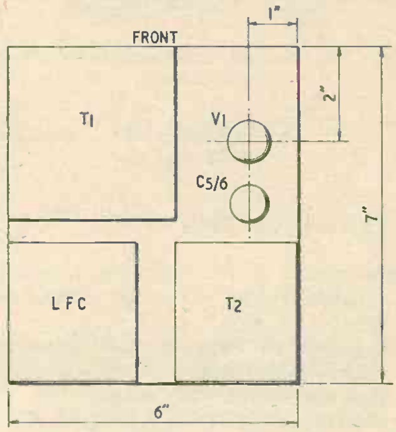


Fig. 14. Above-chassis layout

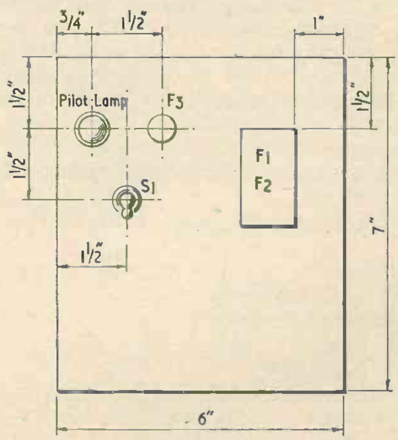


Fig. 15. Front panel layout

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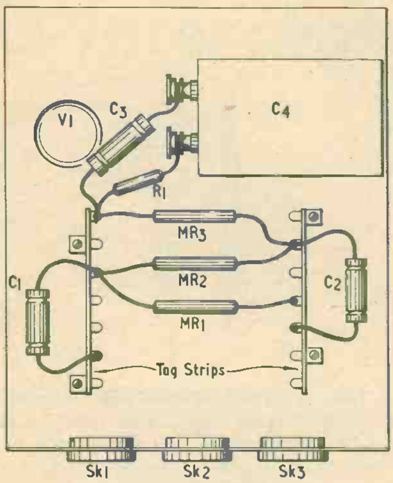

Fig. 16. The principal components under the power unit chassis

Components List
(Fig. 17)

Resistor
R_1 220kΩ ½ watt 20%

Capacitors
- C_1 0.1μF 1kV wkg.
- C_2 0.1μF 1kV wkg.*
- C_3 0.1μF 1.5kV wkg.
- C_4 0.25μF 1.5kV wkg.
- C_5 8μF electrolytic 450V wkg.
- C_6 16μF electrolytic 450V wkg.

Valve
V_1 5Z4G

Metal Rectifiers
$MR_{1,\ 2,\ 3}$ K3/25 (Standard Telephones and Cables Ltd.)

LFC
10H, 100mA smoothing

Transformers
- T_1 Secondaries: 350–0–350V, 80mA; 6V 2A, 5V 2A
- T_2 Secondary: 6V 2A (c.r.t. heaters)*

Miscellaneous
- 1 Twin panel fuseholder
- 1 Single panel fuseholder
- 2 Fuses (1A)
- 1 Fuse (100mA)
- S_1 on/off toggle d.p.s.t.
- 4 Valveholders I.O. (1 moulded—see text)
- 2 Tagstrips 7-way (widespaced)
- 1 Warning bulb and assembly

* If the c.r.t. unit employs a VCR139A. C_2 and MR_3 are not required. Also, T_2 should give a secondary voltage of 4V 1A.

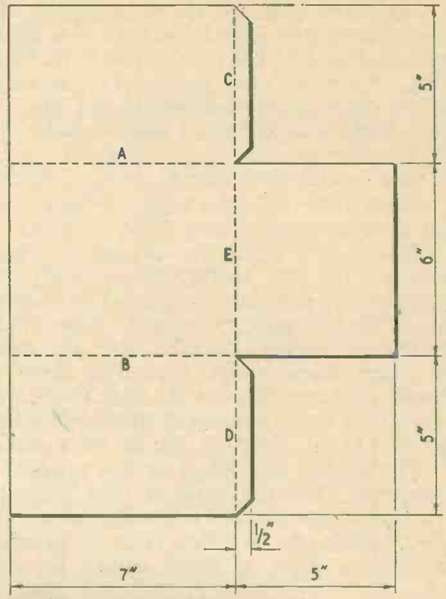

Fig. 18. The top cover

supplies and gives an indication when the unit is switched on. The primaries of the transformers are protected by the two fuses F_1 and F_2, the h.t. secondary being protected by F_3. All these fuses are mounted on the front panel to make them more easily accessible for replacement. If the VCR139A is used then transformer T_2 will be a 4V 1A type though any current rating above this value will be quite suitable. Also, the e.h.t. will need to be reduced by removing C_2 and MR_3, this giving a voltage of 600.

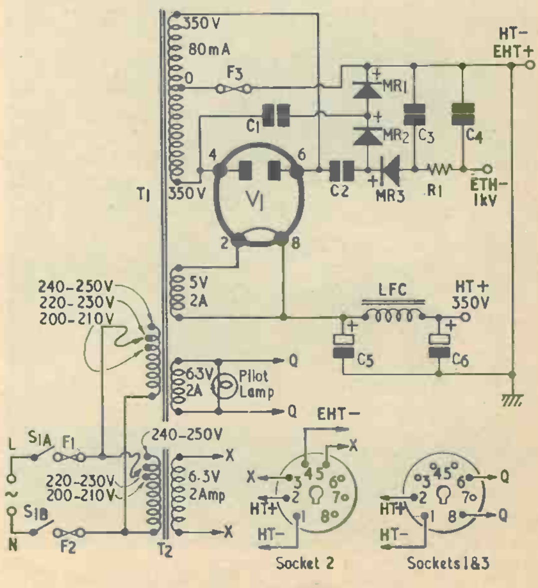

Fig. 17. The circuit of the power unit

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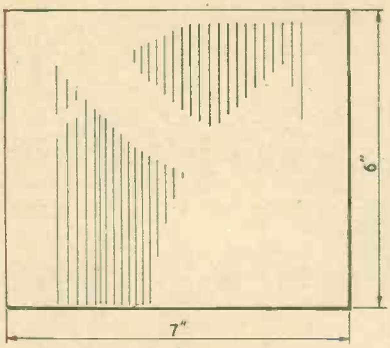

Fig. 19. The power unit baseplate

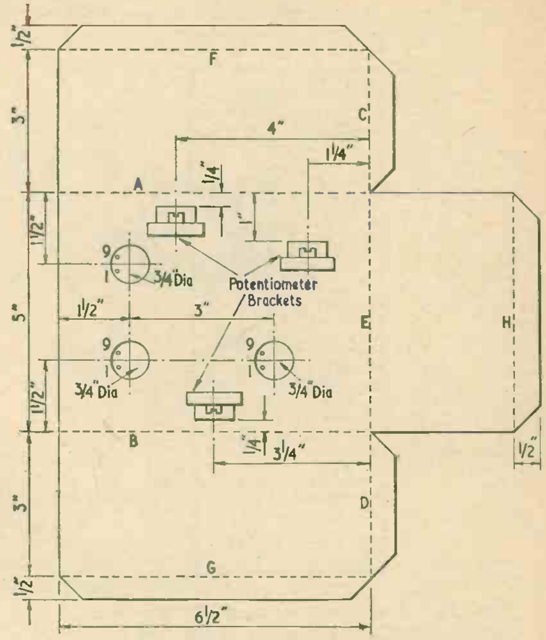

Fig. 20. Front panel of the timebase unit

Testing

The power supply and c.r.t. units can now be connected up after having first tested the power unit to see that the correct voltages are present at the right terminals. The plug from the c.r.t. unit is fitted into the centre socket at the back of the power supply unit and the power switched on. After a short time the spot should appear on the screen of the c.r.t. It will probably be blurred, whereupon the focus control must be adjusted until a sharp spot is seen, adjusting the brilliance control as necessary. Next, operate the two shift controls X and Y, these should move the spot to any position on the screen. There is no cause for worry if there are some parts to which the spot cannot be moved, for this will right itself when the other units are connected. The reason is that the amount of shift depends on both the e.h.t. and h.t. voltages and the latter will not be at its final level at this stage. The shift controls have a positive voltage at one end of their tracks due to the h.t. supply and a negative voltage at the other end due to the e.h.t. supply, and thus applying either a positive or a negative voltage to the deflection plates the spot is deflected either way.

Next, operate the beam switch S_1 (Fig. 8 published in last month's issue) whereupon the spot should disappear with the switch in the off position. If by any chance the spot cannot be centred on the screen, check the values of R_2 and R_3 (Fig. 8). Make sure also the other resistors in the e.h.t. chain, R_5, R_6, VR_3 and VR_4, all have the correct values. The focus control should be able to bring the spot into focus as it is moved one way and then cause it to go out of focus again as it is moved still further in the same direction. Another possible cause of lack of spot on the screen is the failure to wire up pins 8, 9 and 11 of the c.r.t. to chassis, this being sometimes overlooked. If the spot dances about, this is due to hum, and the heater leads should be moved away from other wiring. It may also be necessary to move the power supply away from the c.r.t. unit.

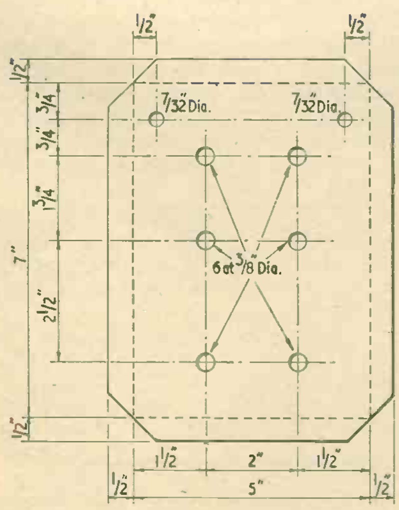

Fig. 21. The timebase chassis

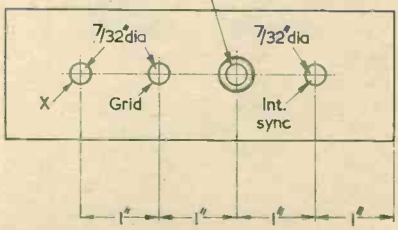

Fig. 22. The rear of the timebase unit

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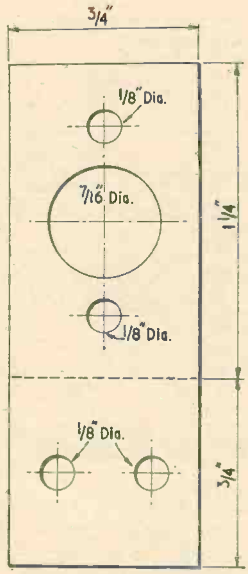

Fig. 23. Potentiometer mounting bracket. It is assumed that potentiometers of the type having two mounting screws are used

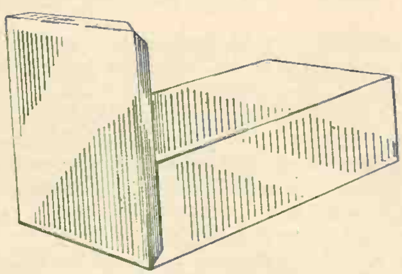

Fig. 24. Fitting the timebase panel and chassis together

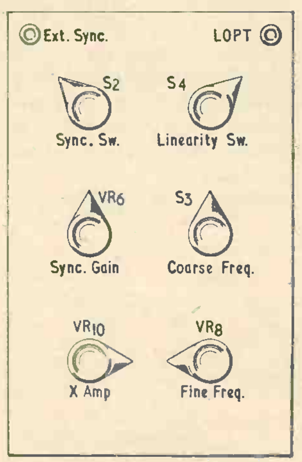

Fig. 25. Front panel layout

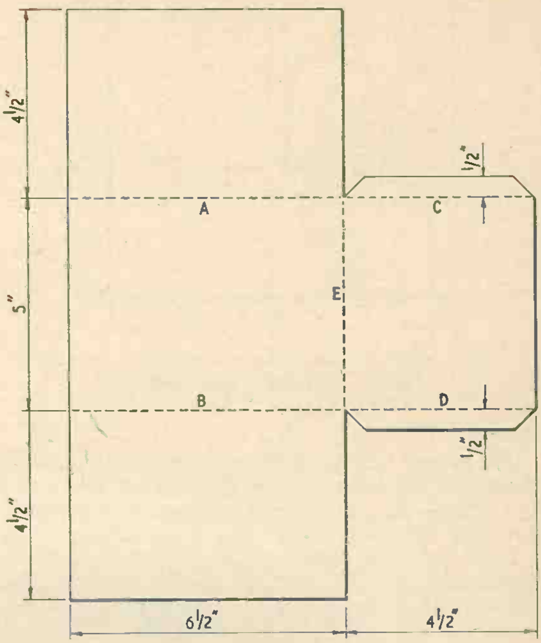

Fig. 26. The timebase unit cover

Construction of the Timebase and X Amplifier

First mark out the front panel as shown in Fig. 20, and drill the required holes as shown. Bend up the $\frac{1}{2}$in edges at right angles. Mark out the chassis as in Fig. 21 and bend the edges in the following order: A, B, C, D, E, F, G, H, securing edges C and D to the back of the chassis with 6BA nuts and bolts. The three valveholder holes are drilled or punched next to $\frac{3}{4}$in diameter. The holes to be drilled in the back of the chassis as in Fig. 22 can now be made. A rubber grommet is fitted to these holes, together with three wander plug sockets. The three valveholders are fitted next and these are placed so that pins 1 and 9 have the orientation shown in Fig. 21 looking down on the top of the chassis. Next make up three brackets as shown in Fig. 23, bending the $\frac{3}{4}$in section at right angles, and drilling the holes as shown. These three brackets are fitted

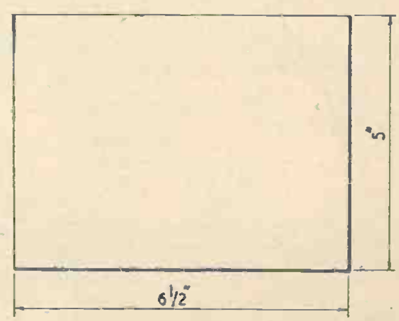

Fig. 27. The timebase unit baseplate

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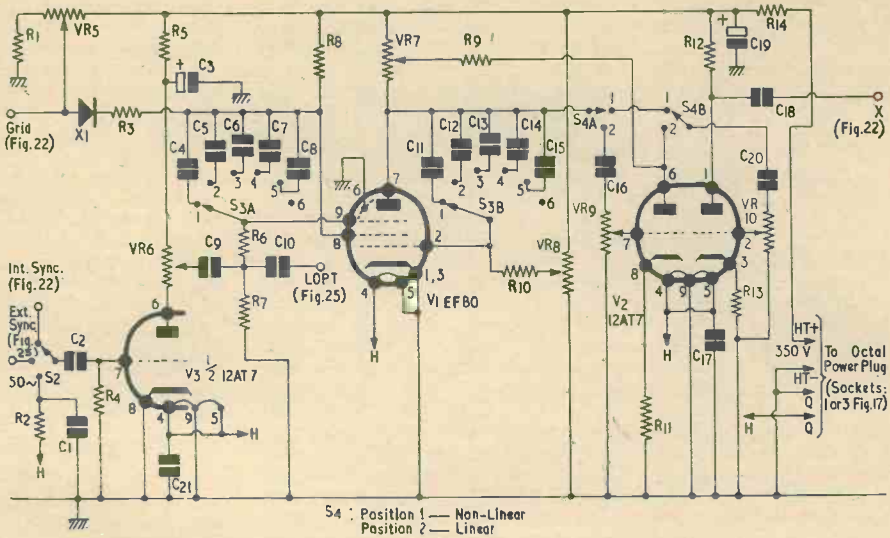

Fig. 28. Circuit diagram of the timebase and X amplifier

Components List
(Fig. 28)

Resistors
(All ½ watt 10% unless otherwise stated)

R_1 470kΩ
R_2 47kΩ
R_3 470kΩ
R_4 1MΩ
R_5 47kΩ
R_6 100kΩ
R_7 10kΩ
R_8 22kΩ 1 watt
R_9 150kΩ
R_{10} 390kΩ 5%
R_{11} 220kΩ
R_{12} 47kΩ
R_{13} 1kΩ
R_{14} 22kΩ 1 watt

Potentiometers

VR_5 1MΩ pre-set (Blanking)
VR_6 100kΩ (Sync)
VR_7 50kΩ pre-set (Linearity)
VR_8 2MΩ (Fine Freq.)
VR_9 500kΩ pre-set (Linearity)
VR_{10} 100kΩ (X Amp Gain)

Capacitors (all 350V wkg.)

C_1 0.1μF
C_2 0.01μF
C_3 8μF electrolytic
C_4 0.01μF
C_5 0.001μF
C_6 100pF
C_7 15pF
C_8 5pF
C_9 0.01μF
C_{10} 500pF
C_{11} 0.02μF
C_{12} 0.001μF
C_{13} 100pF
C_{14} 15pF
C_{15} 5pF
C_{16} 0.25μF
C_{17} 0.005μF
C_{18} 0.25μF
C_{19} 8μF electrolytic
C_{20} 0.25μF
C_{21} 0.005μF

Valves

V_1 EF80
V_2 12AT7
V_3 12AT7

Diode

X_1 OA91

Switches

S_2 1-pole, 3-way (Sync Selector)
$S_{3a,\,b}$ 2-pole, 6-way (Coarse Freq.)
$S_{4a,\,b}$ 2-pole, 2-way (Linearity)

Miscellaneous

3 Valveholders (B9G)
5 Wander plug sockets
1 Tagstrip (5-way)
2 Tagstrips (2-way)
1 Plug (I.O.)
1 yard 4-core cable
6 Pointer knobs

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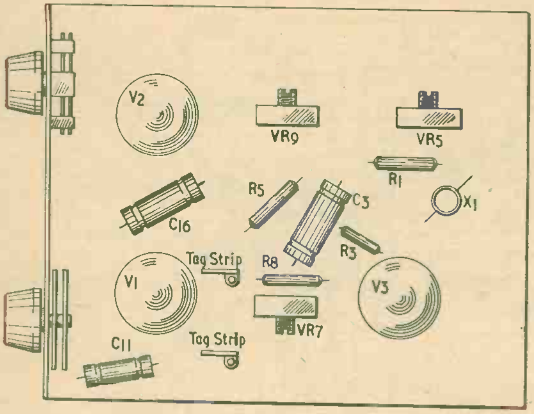

Fig. 29. Above-chassis layout

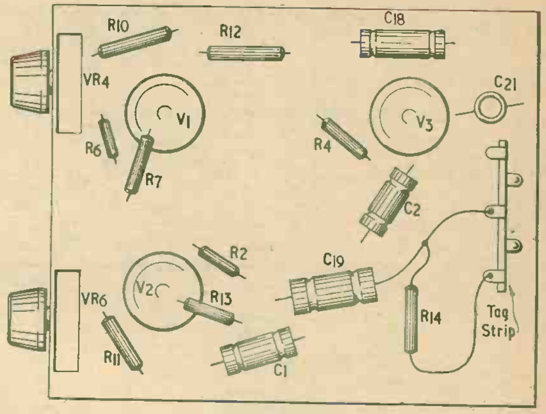

Fig. 30. Layout below chassis of the timebase unit

as in Fig. 21. Next place the front panel and chassis together, and drill and bolt up with 6BA nuts and bolts as in Fig. 24.

The front panel components are now fitted next as in Fig. 25, the front panel having previously been painted with black crackle paint and allowed to dry. Next, the top cover is marked out as in Fig. 26, its edges being bent in the following order: A, B, C, D, E. Edges C and D are secured to the sides with 6BA nuts and bolts. The baseplate, as in Fig. 27, is then cut out and secured to the chassis base with self-tapping screws. The top cover is also secured with self-tapping screws, after which it is removed, as also is the baseplate.

Wiring up now commences. The layout of components is as shown in Figs. 29 and 30, whilst the circuit diagram is shown in Fig. 28. Two 2-way tagstrips shown in Fig. 29 are used as anchor points for the oscillator capacitors C_4 to C_8, and for the integrator capacitors, C_{11} to C_{15}. When wiring up, the main aim should be to keep all wiring as short as possible and not to try for a good appearance by using right-angle bends, etc. The wires to pins 2, 7, 8 and 9 of V_1 should, in particular, be as short as possible. All capacitors are suspended in the wiring and no valve screens are fitted. The supply lead is fed in through the grommet at the back of the chassis and is anchored to a 5-way tagstrip of which one outer tag is h.t. positive and the other outer tag one side of the heater supply. The remaining heater supply lead connects to the chassis tag. The supply lead is made up of one yard of 4-core cable terminated in an I.O. plug, using the pin connections for socket 1 or 3 shown in Fig. 17.

It will be noted that only one section of the 12AT7 (V_3) is employed in the circuit. The remaining electrodes may be connected to chassis. (Alternatively, the grid and cathode of the unused section may be connected to chassis, the anode being coupled to h.t. positive via a 2.2MΩ resistor. This method of connection avoids cathode poisoning in the unused section.)

(*To be continued*)

RADIO TOPICS . . .

BEFORE THE WAR, IT WAS THE custom for radio journals appearing around March and April to publish articles enthusiastically exhorting readers to carry out spring-cleaning operations on their equipment. In those days most amateur constructors had fewer components and items of gear than is general at the time being, with the result that much care was devoted to looking after bits and pieces. Also, components were relatively dearer than they are today, and this fact increased the desirability of keeping equipment in good order.

The pre-war spring-cleaning articles started off by urging the reader to lower his aerial, check all connections and clean the insulators. I should add that, in those days, most households sported long inverted-L receiving aerials with Woolworth's china insulators at each end, instead of the TV aerials which nowadays dominate the skyline. After cleaning the insulators, the next job consisted of checking the earth connection. The family receiver followed, and it was usually suggested that this be thoroughly cleaned out and all connections inspected, after which there should be a touch-up on all trimmers which were immediately available. Many sets in those days still operated from 2 volt accumulators, and these were to be given special attention during spring-cleaning, this including a careful search for corrosion and the final smearing of exposed metal terminal surfaces with petroleum jelly.

After having proceeded so far, it was assumed that the amateur could relax in the knowledge that he would be safe for at least another twelve months from all the misfortunes which could be reasonably anticipated, including dead shorts on the

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aerial insulators and accumulators eaten away by sulphuric acid. After dealing with aerials, earths, receivers and accumulators, the writers of pre-war spring-cleaning articles finally concluded with a few paragraphs on the general cleaning up and tidying of "dens" and workrooms.

Memories of those earlier articles entered my mind when, several days ago, I decided to clean up my own workroom. As always happens on these occasions, all that was evident at the end was a rearrangement of spare parts and components, with absolutely nothing thrown away whatsoever. I suppose the time will eventually come when I *do* have to discard something—if only to get into the place—but there is still plenty of space left yet.

Electronic Scrap

My own continually increasing collection goes some way towards emphasising the fact that, particularly since the war, component factories have been maintaining a very high production level of capacitors, resistors, transformers and all the other bits and pieces which go to make up domestic receivers. At the same time, receiver factories have been just as busily occupied in assembling these parts into complete sets. This process has been under way without interruption for at least seventeen years now, and vast piles of raw materials—copper, steel, aluminium, cotton, rayon, mica, nylon, tin, polystyrene, Bakelite, wood, paper, glass, nickel, silver and even gold—have been consequently used up. These raw materials, and many more, have been flowing into the component and receiver manufacturing complex in great quantities, emerging at the other end as a flood of new and shiny television receivers, record reproducers and sound radios. Finally, this deluge of equipment has entered the houses of the people in this country.

But where has it gone from there?

So far as I can tell, most of it ends up either on the municipal rubbish dump or, when the items are too big for the dustbin, on unofficial dumps. I note, for instance, that no less than thirty discarded television sets were recently found on Black Down in Sussex, and I have little doubt that many others have been similarly "ditched" at other remote places in the country.

At a guess I would say that much of the domestic "electronic scrap" which is being discarded at present is 1946 to 1952 production. This, in worn-out form, has been thrown out either by householders whose homes are saturated with radio and TV gear or by similarly saturated retailers who have accepted the equipment as trade-ins for new sales. By 1970, the 1952 to 1958 production will start appearing on the dumps, and so the process will go on. Eventually, we will have vast depositories of domestic electronic scrap in which (and here's a thought) many of the individual components and parts will be capable of functioning just as well as they did on the day when they were manufactured. In the meantime, at the other end of the system the raw materials will still be pouring into the components factories, and production managers will still be developing ulcers converting these into further parts for the receiver factories.

It seems to be almost a pity that there is no life cycle with electronic equipment as there is with organic life, wherein the dead and decaying provide the bricks from which new life is formed. With electronic gear the system works in one direction only: from the raw material to the rubbish tip.

In a way this is rather a gloomy thought, but I can lighten it a little by saying that at least some of the 1946 to 1952 production has found a safe haven in my workroom. Which probably accounts for the name the female members of the household assign to it!

π x 625=1964

January 1st has an unfortunate habit of following New Year's Eve and it is not, in my opinion, always the best day with which to start a year.

Last January 1st was, however, completely made for me as soon as I glanced through my daily paper. As I turned the pages three identical advertisements swam into my field of vision, these all carrying the cryptic message:

$$\pi \times 625 = 1964$$

By the time these notes appear in print the message will probably have been explained in later advertisements, but I am quite proud of the fact that I gathered its import straightaway. After a little scribbled calculation in the margin to confirm that π multiplied by 625 is, indeed, equal to 1964*, I was quite ready to accept that Pye, in combination with 625, gave the exact conditions required for 1964.

This must be one of the cleverest advertisements which has been produced for quite a while, and the juxtapositioning of Pye, 625 (for 625 lines) and 1964 (the year in which 625 line programmes commence) is surprisingly effective. I don't know the identity of the unsung hero at Pye of Cambridge who discovered this happy relationship of numbers, but I definitely feel that he should have been mentioned in the New Year Honours List!

* 3.142 multiplied by 625 gives 1963.8, and $\frac{22}{7}$ multiplied by 625 gives $1964\frac{2}{7}$.

TV Booster

Gordon J. King is well known for his authoritative articles and books on television, radio and many other aspects of electronics. In consequence, it is interesting to note that Gordon J. King (Enterprises) Ltd. have now introduced a particularly useful TV booster which offers simultaneous amplification of both Band I and Band III channels. An f.m. version gives amplification on Band II. The booster is intended for insertion between the aerial and the set, and can raise weak and noisy pictures well above the entertainment value level. A signal which, without the booster, could not even offer reliable line and vertical hold can be amplified to provide perfectly acceptable pictures which lock solid. Not only, therefore, does the booster improve results in fringe areas, but it also enables outside aerial to be replaced by less costly indoor aerials in close-to-fringe areas.

The unit, known as the "Telebooster", is fully transistorised and, since it runs from its own internal 9 volt battery, requires no connections to the mains. A low current consumption of 1.5mA ensures long battery life. There are two coaxial sockets on the case of the booster, one of which accepts the aerial feeder whilst the other provides an output for the receiver. All impedances are at 70 to 80Ω. There are three versions of the Telebooster, one offering amplification on Channels 1, 2 and 3 and all of Band III, a second offering amplification of Channels 3, 4 and 5 and all of Band III, and a third, for f.m. receivers, offering amplification on all of Band II. Voltage gains for Band I are, typically, 18dB, for Band II 16dB, and for Band III 14dB. The unit measures $3\frac{1}{2}$ x $3\frac{1}{2}$ x 2in, and weighs approximately $\frac{1}{2}$lb with the battery fitted.

The basic circuit configuration in the Telebooster employs the earthed-base mode, a special top-end collector coupling circuit providing impedance matching and the dual band characteristic. An important attribute of the circuit is its ultra-low noise operation. The unit is designed and marketed by Gordon J. King (Enterprises) Ltd., 6 New Road, Brixham, Devon.

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TRANSISTORISED TELEVISION CIRCUITS

PART 5 By Gordon J. King, Assoc.Brit.I.R.E., M.T.S., M.I.P.R.E.

In this, the fifth article in a six-part series, our contributor concludes his discussion on line timebase and synchronising circuits. The article then carries on to consider the vertical timebase

Line and Sync Circuits

LAST MONTH WE DISCUSSED THE LINE TIMEBASE and a.f.c. circuits as featured in the Pye TT1 transistorised television set. A similar arrangement is adopted in the "Portarama" by Perdio, as will be seen from the block diagram in Fig. 12.

The line sync pulses are compared for phase with a reference pulse signal picked up from the line output stage in a phase discriminator network. The polarity and level of the voltage at the output of the discriminator is dependent on the phase relationship between the two signals. Circuit details are given in Fig. 13, while the phase discriminator section is highlighted in Fig. 14 (*a*), which shows that the network consists of two diodes (D_{104} and D_{105}) connected back-to-back.

Phase Discriminator

The operation of the circuit is as follows. The point marked "A" in Fig. 14 (*a*) is "earthed" to a.c. signals through C_{200}, while to point "C" (the other end) is connected an integrating circuit made up of R_{204} and C_{201}. This circuit integrates the negative-going reference pulses from the line output transformer and produces a sawtooth waveform at point "C".

Now, positive-going line sync pulses applied at point "B" result in the conduction of both diodes. If synchronisation is correct, the instantaneous amplitudes of the sync pulses and the sawtooth waveform will be equal, though of opposite polarity. Their sum will thus produce zero d.c. voltage at point "C" for the duration of the pulse, as shown in Fig. 14 (*b*).

However, if the timebase is asynchronous, the instantaneous amplitudes of the sync pulses and the sawtooth waveform will differ, and their sum will then produce a plus or minus d.c. voltage at point

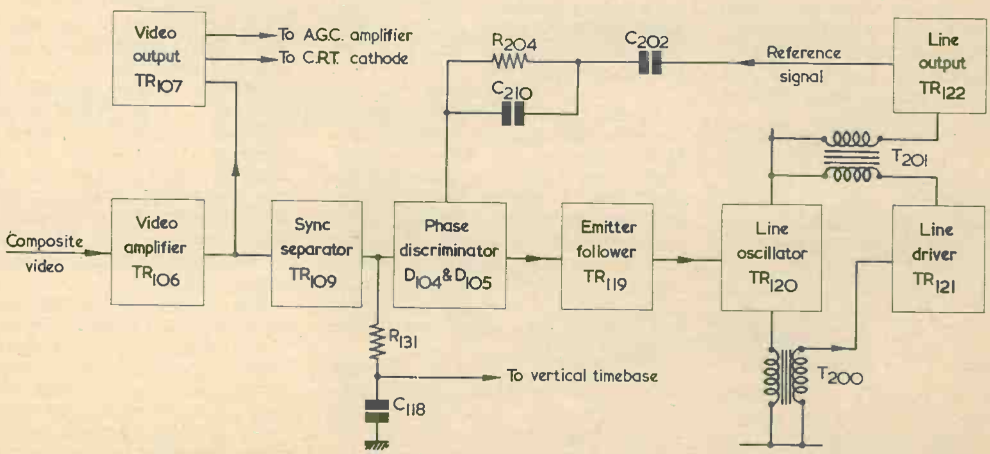

Fig. 12. Block diagram of the phase discriminator and line timebase in the Perdio "Portarama" transistorised television receiver

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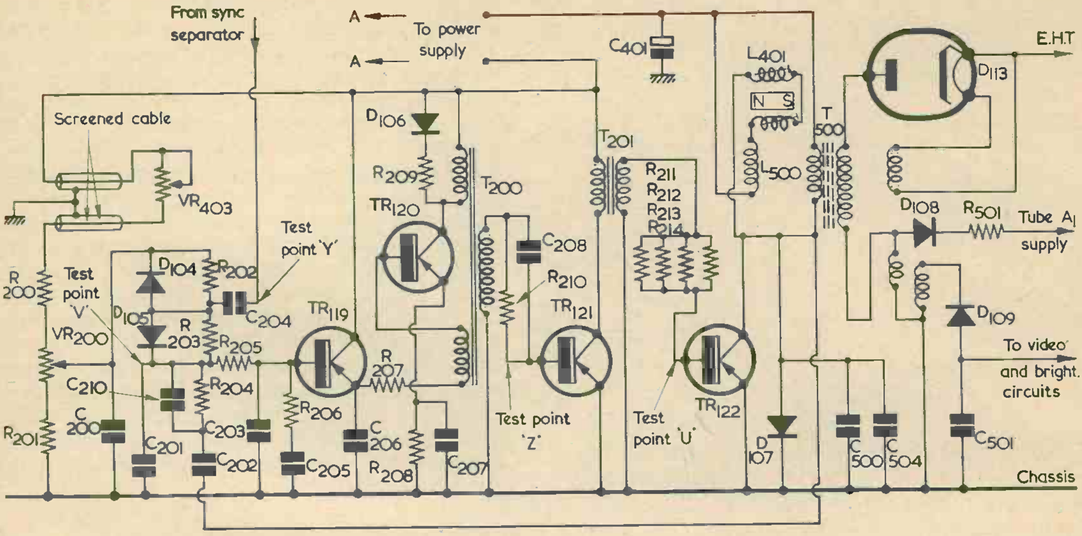

Fig. 13. Circuit details of the Perdio line timebase section

"C". This voltage will be proportional to the phase difference between the two applied signals.

The discriminator output is applied to a d.c. amplifier (TR_{119}), via a low-pass filter and damping network, comprising C_{205}, C_{203}, R_{206} and R_{205}. This latter network determines the "pull-in" and "lock-in" characteristics of the timebase and endows it with a "flywheel" attribute.

D.C. Amplifier

The d.c. amplifier (TR_{119}) provides the correct impedance match to the blocking oscillator (TR_{120}), the output from the emitter of the former being coupled to the base of the latter via a primary winding on the blocking oscillator transformer T_{200}. The changing current in the emitter circuit of the d.c. amplifier provides a control of line frequency, in rather the same way as the manual line hold control on a conventional blocking oscillator gives a control of frequency by altering the time-constant of the circuit, in effect. The frequency of the line oscillator is established initially by VR_{200} and VR_{403}, a d.c. voltage purposely being reflected into the discriminator circuit to secure the starting balance.

The line oscillator is conventional, and in Fig. 13 it will be seen that a "damping" network (D_{106} and R_{209}) is employed across the collector winding of the blocking oscillator transformer to suppress high peak voltages that could damage the transistor.

To provide a good line amplifier switching action, the oscillator is coupled and matched into the base of the output transistor TR_{122}, via a driver transistor TR_{121}. The transformer T_{201} provides "power" coupling between the two stages.

A single transistor is used in the output stage in this model, but the line coils (L_{500}) remain in series with the collector, the primary of the line output transformer (T_{500}) being in shunt with the coils, as in the Pye set. (See Part 4.) The line output transformer provides a pulse voltage for e.h.t., as well as a further voltage for the first anode supply to

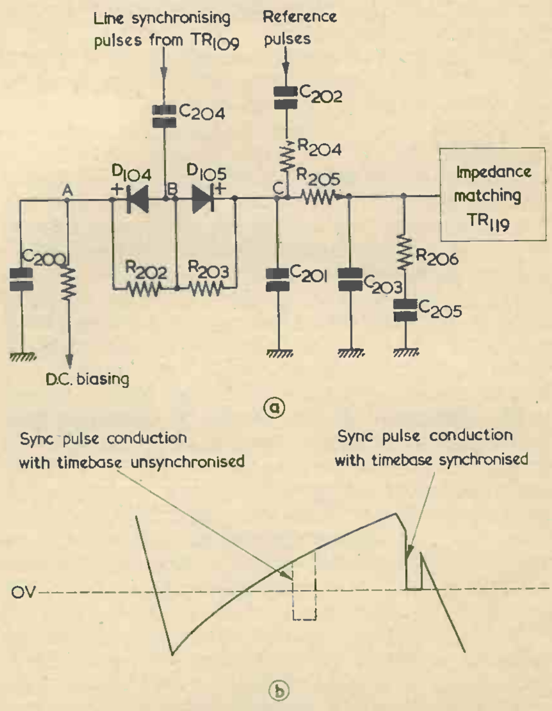

Fig. 14. (a) Highlighted phase discriminator section of the Perdio receiver, with the waveforms at (b) illustrating the method of operation

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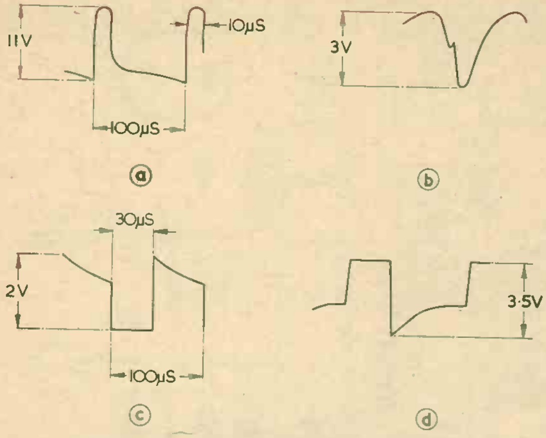

Fig. 15. Details of the waveforms at Test Points "Y", "V", "Z" and "U" in Fig. 13 are given at (a), (b), (c) and (d) respectively

the picture tube via D_{108}, and −90 volts for the video amplifier and brightness control circuit via D_{109}.

D_{107} is the shunt-connected efficiency diode, and variable line linearity is provided by the "saturated reactor" type of circuit, comprising L_{401} and an associated magnet to set the saturation level of the core and, hence, the current waveform in the line scanning coils L_{500}. The e.h.t. rectifier is, of course, the thermionic valve D_{113}.

Waveforms and their characteristics at points "Y", "V", "Z" and "U" in Fig. 13 are given in Fig. 15 at (*a*), (*b*), (*c*) and (*d*) respectively.

Sync Separator

So far we have considered the line sync pulses as being already correctly formed for application to the Pye a.f.c. circuit or to the Perdio phase detector. We must now see how the pulses are obtained in the first place.

In Fig. 16 (which shows part of the Pye TT1 set) TR_{22} is the sync separator transistor. This circuit requires a fast-switching transistor, and the Mullard OC44 is a good choice. Other requirements are low saturation resistance and a high beta.

The function of the circuit is identical with valve-type sync separators, in that the picture content and noise-carrying tips of the sync pulses are removed by "clipping". A good receiver a.g.c. performance helps in maintaining a fast switching time, for then the parameters can be adjusted to avoid severe overloading at the base, a condition which can result in excessive hole storage and thus impaired switching speed.

In Fig. 16 the composite video signal from the collector circuit of the video amplifier (see Fig. 9, Part 3) is fed to the separator base through C_{69}. During the sync period the negative-going sync signal drives the transistor hard into conduction so that a sharp, positive-going sync pulse is produced across the collector resistor, R_{68}. It will be seen that this has a relatively large value for a transistor, but the higher the value here, the better the limiting.

Simultaneously, the flow of base current charges the base capacitor C_{69}, and as the signal returns to the sync base level on the positive-going trailing edge of the pulse, the sync separator base is left in a "biased-off" condition and no video signal can reach the timebase circuits connected to the collector load. To avoid the separator action from being affected by current reflections during the line retrace period, TR_{22} collector is powered from the filtered 10 volt supply (see Fig. 10, Part 4).

The sync signal at the collector is fed direct to the "horizontal sync phase-splitter" (see Fig. 11, Part 4), and also to the "vertical sync inverter", TR_{23} (Fig. 16). This stage is primarily intended to invert the field sync pulses to a positive-going polarity to "trigger" the field (i.e., vertical) oscillator. The stage also assists in isolating the field timebase from the line timebase and thus ensures optimum interlace performance.

Vertical Oscillator

A blocking oscillator is used in the vertical timebase circuit, and this is TR_{25} in Fig. 16. Regeneration is obtained by transformer coupling (T_{11}) between the emitter and base circuits. The repetition frequency is governed by the time-constant (R_{73} plus R_{74} and C_{72}) in the base circuit, with R_{73} being variable to give a control of field speed (i.e., vertical hold control). The time-constant here serves, in fact, to control the "switched-off" period of the transistor.

The timebase "charge" circuit is connected to the collector of TR_{25} (C_{74} and C_{75}) and, to provide adequate drive waveform over a reasonably linear portion of the charging curve, the charging resistors (C_{75} and R_{76}) are connected to one of the −60 volt supplies derived in the line timebase (see Fig. 10, Part 4). One of these resistors is the "height control".

Vertical Driver Stage

A further aid to linearity is provided by the "vertical driver" stage, TR_{26}. This avoids the necessity of having the charging capacitors supply the relatively large current needed to drive the vertical output stage. Coupling to the base of the driver from the oscillator is via C_{76}. The *emitter* of the driver (this being an emitter-follower to provide the correct matching conditions) then couples to the base of the vertical output transistor through C_{77}.

Vertical Output

The vertical output transistor, TR_{27}, is biased for the correct operating conditions by the base potential divider given by R_{81} and R_{82}. The upper resistor is variable, and this permits the bias to be adjusted accurately subsequent to transistor replacement or timebase servicing. This control is adjusted just beyond the point at which scan compression at the bottom of the picture disappears; the picture is then linearised in the normal way.

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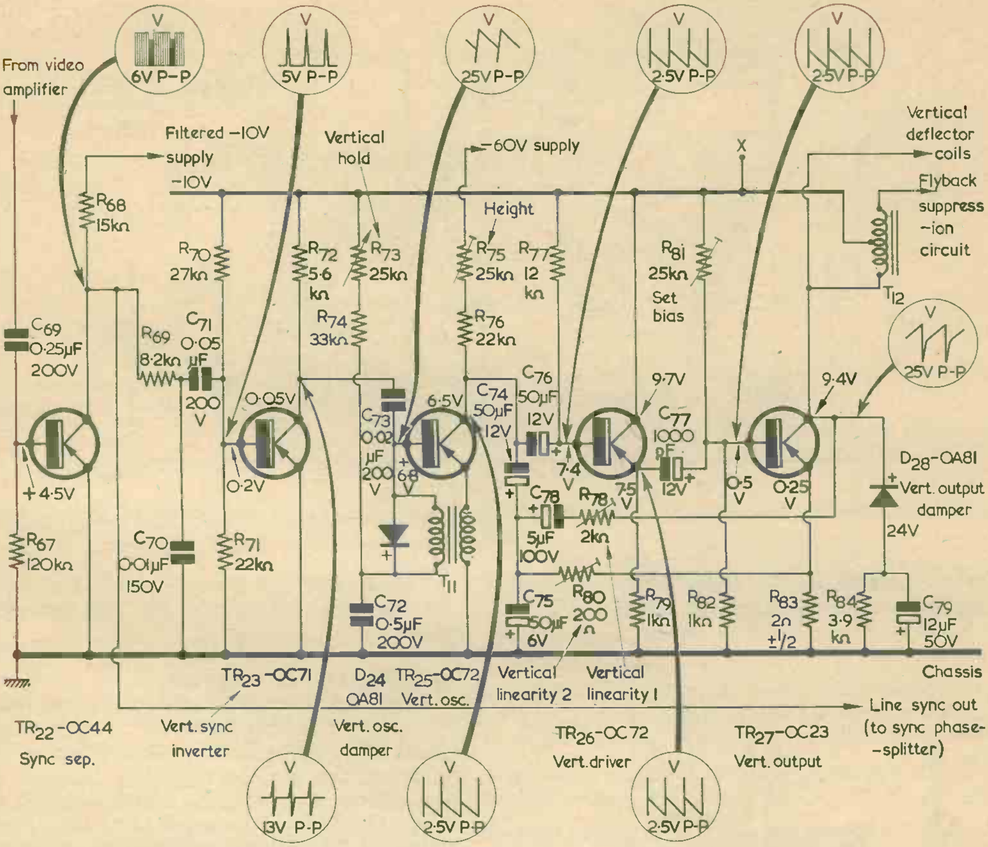

Fig. 16. Sync separator and vertical timebase circuits from the Pye TT1 circuit

If this adjustment is incorrect, the vertical output stage will be running inefficiently and it may be impossible to secure reasonable vertical linearity by means of the two controls R_{78} and R_{80}. These appear in two overall feedback circuits between both the collector and emitter of TR_{27} and the base of TR_{26}. The "Linearity 1" control mostly affects the overall linearity of the picture, while the "Linearity 2" control adjusts the topmost linearity of the picture.

It will be seen that the collector circuit of the amplifier is connected direct to the vertical scanning coils (the other end of the coils is connected to the negative line). This normally has the disadvantage of causing "decentering" of the picture due to the d.c. in the coils. In the Pye receiver, however, this is combated by having a part of T_{12} shunt the coils. The section in shunt with the coils is of large inductance and low resistance compared with the coils themselves. Thus the d.c. component is bypassed while the full scanning signal is applied to the coils. The other winding on T_{12} provides the field blanking signal for flyback line elimination, as discussed in Part 4.

Both the oscillator base circuit and the output transistor collector circuit are provided with "clamp" diodes to prevent damage to the respective transistors from the high voltage peaks induced during the retrace period.

The waveforms at the various circuits in Fig. 16 clearly reveal the manner in which the circuits function, and these should prove of considerable assistance during a servicing operation in the vertical timebase circuits.

Perdio Circuit

In Fig. 17 is shown the vertical timebase circuits in the Perdio "Portarama". Here, transistor TR_{111} is connected as a blocking oscillator, to the collector of which are applied sync pulses from the sync separator. These are fed via VR_{103}, the sync level control, adjustment being made for optimum vertical lock and interlace. The pulses "trigger" the oscillator, and the resultant field pulses are fed, via TR_{112}, to the base of the emitter-follower vertical drive transistor, TR_{113}.

The pulses are shaped by the feedback network comprising C_{129}, C_{130}, R_{143} and the linearity control VR_{101}. The output from TR_{113} is d.c. coupled to the base of the vertical output transistor, TR_{114}. This stage is connected in the common-emitter condition, and the scanning coils are choke-

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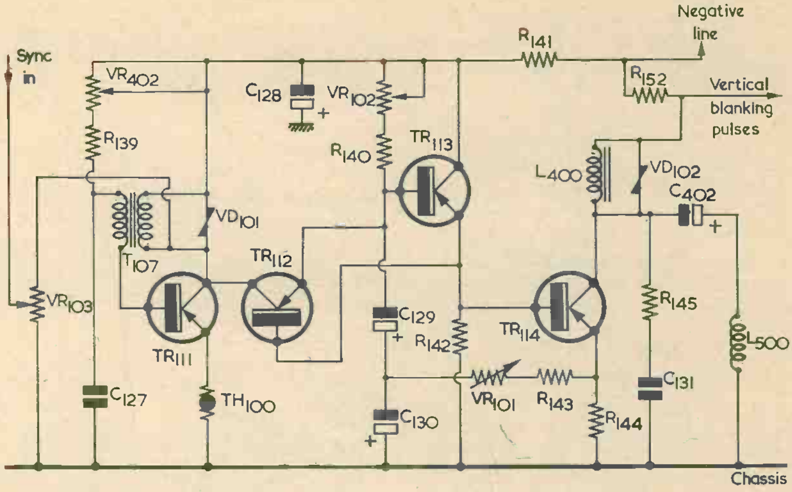

Fig. 17. Vertical timebase circuits of the Perdio transistorised television set. C_{402} is used to block d.c. from the scanning coils L_{500}

capacitance coupled to the collector by L_{400} and C_{402}, the latter also blocking d.c. from the coils.

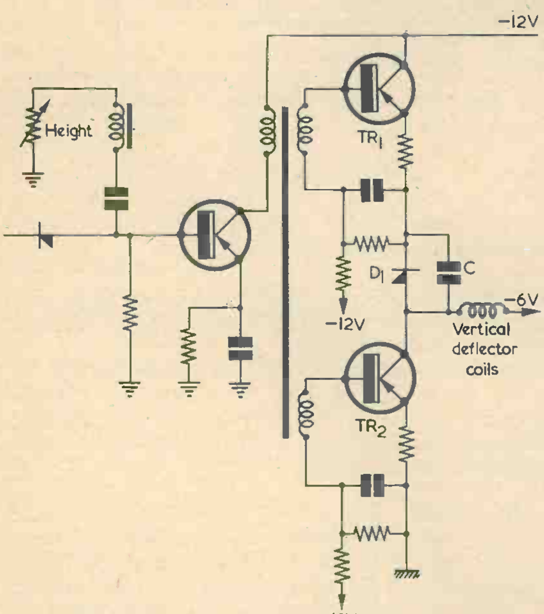

Fig. 18. Base circuit of a Class B vertical timebase

Voltage dependent resistors, VD_{101} and VD_{102} are employed to suppress the high voltage retrace peaks.

Push-Pull Vertical Amplifier

While single-ended vertical output stages are favoured in most commercial equipment, the basic circuit of a push-pull output stage is shown in Fig. 18.

This circuit has the advantage of good efficiency and cancellation of d.c. in the vertical scanning coils. Diode D_1 is included to avoid a "clamping" action by TR_1 which would otherwise happen when TR_1 is "switched on" and TR_2 "switched off". "Clamping" of this nature would tend to slow down the current reversal in the scanning coils on the retrace, and thus extend the latter, resulting in foldover at the top of the picture (i.e., slow flyback).

During the forward scan D_1 conducts and its resistance is added to the resistance of TR_1 emitter circuit. During the flyback, when TR_1 is "switched off", the LC and R elements of the circuit tend to produce a damped oscillation, as is normal in this type of circuit.

The chief disadvantages of this type of circuit are (i) maintaining good stability under all conditions, (ii) keeping a low level of crossover distortion and (iii) securing good thermal stability.

In the next article we will look at some of the power supply circuits of transistorised television receivers, and also consider some aspects of servicing.

(*To be concluded*)

CORRECTIONS

On page 423 of the January issue ("Single Transistor Impedance Transformer") the calculation for input impedance did not take into account the loading effect of the bias network. In consequence, an OC44 with a typical α' of 100 and an assumed gain of 0.9 (which may be lower than that given in practice) offers an input impedance in the circuit of approximately 400kΩ.

Due to a drawing error, the screen grid components for V_1 and V_2 in Figs. 1 and 2 of "Converting the IM-81/UP Standing Wave Indicator" in the January issue are shown as connecting to the control grids. These components are shown connected correctly in Fig. 4, and the error does not affect the actual modification.

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American Astronomer Visits EEV

During the latter part of 1963 an American astronomer, Dr. William C. Livingston, of the Kitt Peak National Observatory, Arizona, made a reciprocal visit to English Electric Valve Company in Chelmsford.

Earlier in the year Dr. R. L. Beurle, then Chief of Camera Tube Research at EEV, made a special journey to Kitt Peak with an EEV Image Intensifier for Dr. Livingston to use in his astronomical studies; it has since proved highly successful.

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Full information on the P829D and others in the series is available on request from EEV.

Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. Queries should be submitted in writing.

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Contributions on constructional matters are invited, especially when they describe the building of particular items of equipment. Articles should be written on one side of the sheet only and should preferably be typewritten, diagrams being on separate sheets. Whether handwritten or typewritten, lines should be double-spaced. Diagrams need not be large or perfectly drawn, as our draughtsmen will re-draw in most cases, but all relevant information should be included. Photographs should be clear and accompanied by negatives. Details of topical ideas and techniques are also welcomed and, if the contributor so wishes, will be re-written by our staff into article form. All contributions must be accompanied by a stamped addressed envelope for reply or return, and should bear the sender's name and address. Payment is made for all material published.

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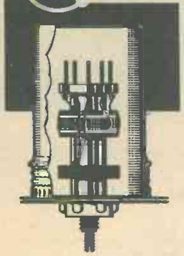

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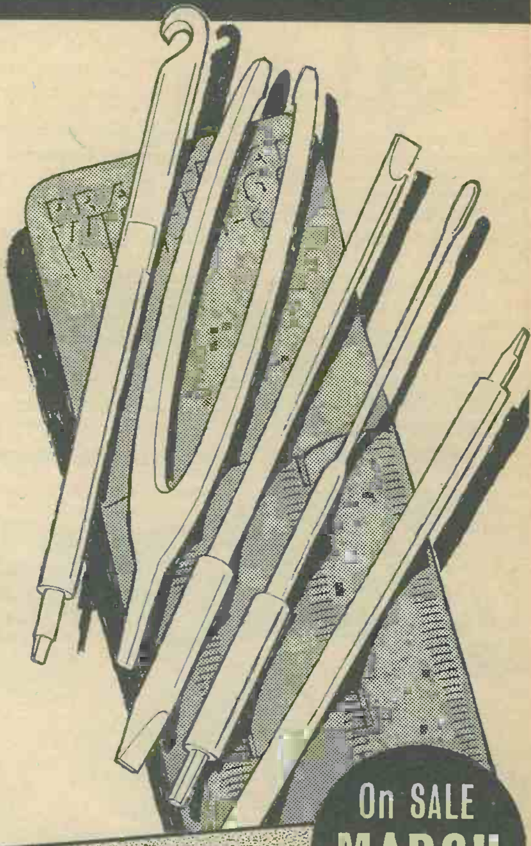

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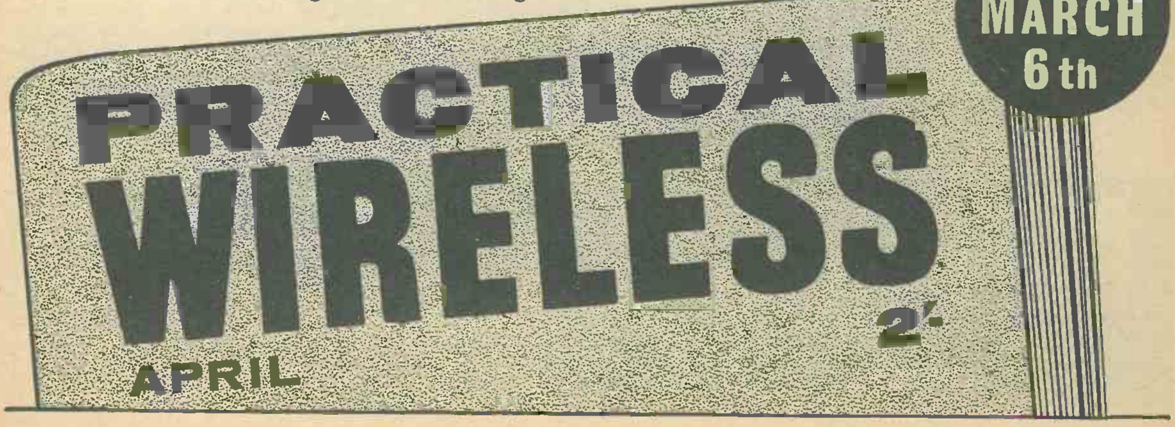

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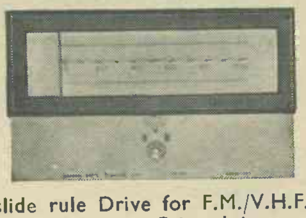

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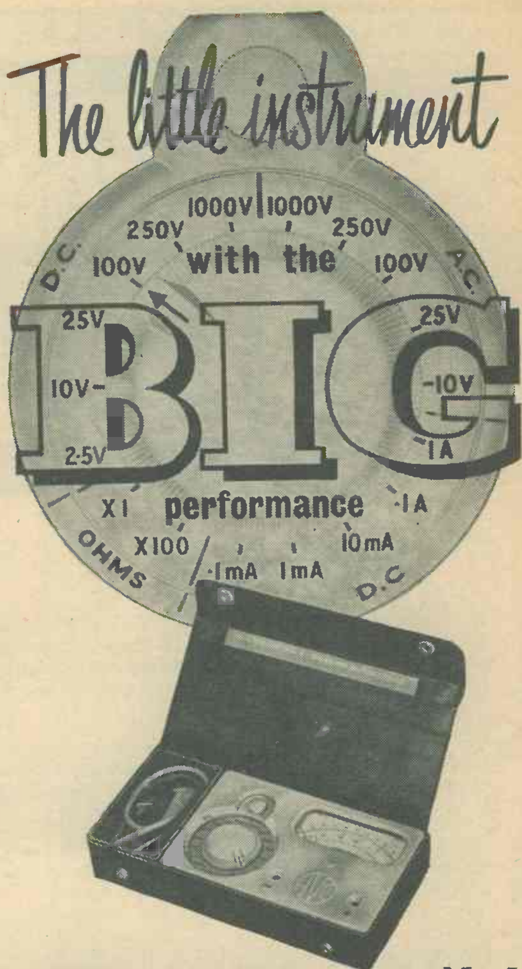

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We require for prompt cash settlement all types of valves, loose or boxed, but must be new. Send list of types available for offer by return.

6BE6	4/9	20P1	12/6	ECC81	3/6	KTW62	5/6	UCF80	8/9	OA210	9/6
6BH6	5/3	20P3	12/–	ECC82	4/6	KTW63	5/6	UCH21	8/3	OA211	13/6
6BJ6	5/6	20P4	13/6	ECC83	4/6	KT66	12/3	UCH42	7/–	OC16W	35/–
6BQ7A	7/6	20P5	12/3	ECC84	5/9	KT88	28/–	UCH81	6/6	OC19	25/–
6BR7	8/6	25A6G	7/6	ECC85	6/3	MHL4	7/6	UCL82	7/9	OC22	23/–
6BR8	8/–	25L6GT	6/–	ECC88	10/–	MKT4	17/6	UCL83	8/6	OC23	57/–
6BW6	6/9	25Z4G	6/6	ECC189	11/6	MU14	4/6	UF41	6/9	OC25	12/–
6BW7	5/–	25Z5	7/3	ECC804	16/4	N78	26/–	UF42	4/9	OC26	25/6
6C5	4/–	27SU	23/3	ECF80	6/–	N339	15/–	UF80	6/3	OC29	25/6
6C9	10/9	28D7	6/9	ECF82	6/3	PABC80	6/9	UF85	6/9	OC35	18/–
6CD6G	18/–	30C15	9/–	ECF86	11/6	PC86	10/3	UF86	9/–	OC36	21/6
6CH6	5/–	30C18	10/6	ECH21	9/9	PC88	14/7	UF89	6/–	OC41	8/–
6D3	9/6	30F5	5/9	ECH35	6/3	PC95	11/8	UL41	6/6	OC42	5/–
6D6	3/–	30FL1	9/3	ECH42	7/6	PC97	7/9	UL44	23/3	OC43	12/6
6E5	9/6	30FL12	11/–	ECH81	5/9	PCC84	5/6	UL46	8/6	OC44	8/3
6F1	9/6	30L15	9/3	ECH83	6/6	PCC85	6/9	UL84	6/–	OC44PM	11/–
6F6G	3/9	30P4	12/3	ECH84	9/6	PCC88	10/6	UM4	15/2	OC45	8/–
6F13	4/9	30P12	7/6	ECL80	6/–	PCC89	7/9	UM34	16/10	OC45PM	10/–
6F23	9/–	30P19	12/3	ECL82	7/–	PCC189	10/6	UM80	8/3	OC65	22/6
6F24	9/6	30PL1	8/6	ECL83	9/6	PCF80	5/6	URIC	6/6	OC66	25/–
6F33	3/6	30PL13	9/6	ECL86	8/9	PCF82	6/3	UU6	9/–	OC70	6/6
6J5G	3/–	30PL14	12/6	EF22	6/6	PCF84	8/6	UU8	11/6	OC71	3/6
6J6	3/–	35A5	20/9	EF36	3/3	PCF86	7/9	UYIN	10/3	OC72	8/–
6J7G	4/6	35L6GT	6/9	EF37A	6/6	PCL82	6/6	UY21	8/–	OC73	16/–
6K7G	1/3	35W4	4/9	EF39	3/9	PCL83	7/9	UY41	4/6	OC74	8/–
6K8G	3/3	35Z3	16/4	EF40	8/9	PCL84	7/–	UY85	5/–	OC75	8/–
6K25	24/–	35Z4GT	4/6	EF41	6/9	PCL85	7/6	VP4	14/6	OC76	8/6
6L1	10/–	35Z5GT	5/9	EF42	4/9	PCL86	8/9	VP4B	20/5	OC77	12/–
6L6G	6/6	50C5	6/6	EF73	5/–	PCL88	12/6	VP13C	7/–	OC78	8/–
6L7GT	4/6	50L6GT	6/3	EF80	3/9	PEN46	4/3	VP23	2/6	OC81	4/–
6L18	10/–	52KU	14/6	EF83	9/9	PEN383	10/3	VP133	9/9	OC81D	4/–
6LD20	5/6	72	6/6	EF85	4/9	PL33	9/–	VR105	5/6	OC82	10/–
6N7GT	5/–	77	5/–	EF86	6/–	PL36	8/–	VR150	5/–	OC83	6/–
6P28	11/6	78	4/9	EF89	4/–	PL38	16/–	W76	3/6	OC84	8/–
6Q7G	4/6	80	5/3	EF91	3/–	PL81	6/9	W81M	5/9	OC139	12/–
6R7G	5/9	85A2	8/6	EF92	2/6	PL82	5/3	X41	15/–	OC140	19/–
6SL7	5/–	90AG	67/6	EF97	11/8	PL83	5/3	X61	6/3	OC170	8/6
6SN7	4/–	90AV	67/6	EF98	10/–	PL84	5/6	X65	5/6	OC171	9/–
6U4GT	8/6	90CG	42/–	EF183	7/9	PM84	9/3	X66	7/3	OC200	10/6
6U5G	5/–	90CV	42/–	EF184	7/9	PX4	9/–	X76M	9/–	OC201	29/–
6U7G	7/–	90C1	16/–	EK32	5/9	PX25	8/6	X78	20/6	OC203	14/–
6V6G	3/9	150B2	16/6	EL32	3/6	PY31	6/6	X79	20/6	OCP71	17/6
6V6GT	5/6	185BT	34/11	EL33	6/9	PY32	8/6	XH(1.5)	6/6	TS2	12/6
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continued from page 571

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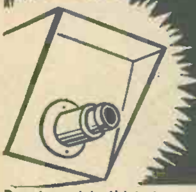

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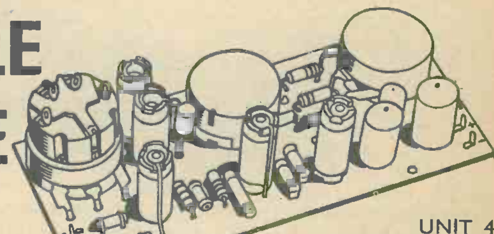

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SMALL ADVERTISEMENTS

continued from page 573

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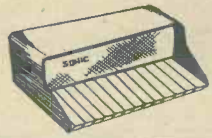

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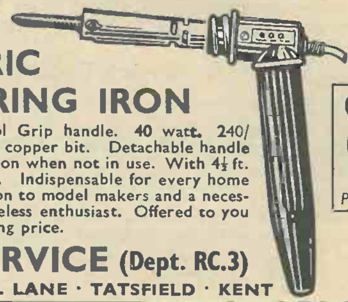

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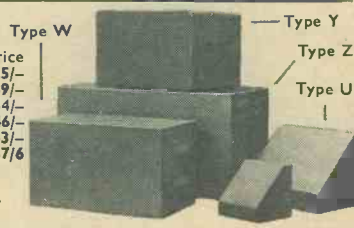

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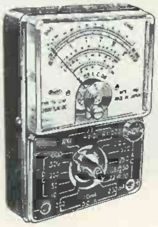

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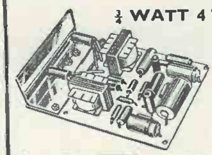

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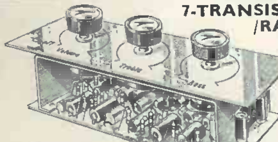

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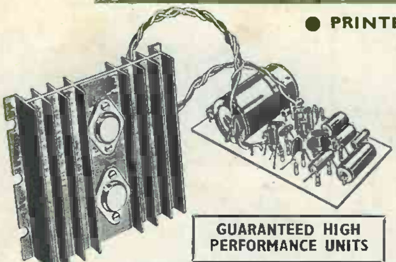

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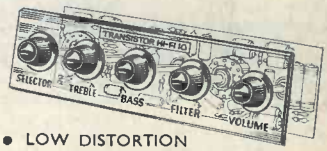

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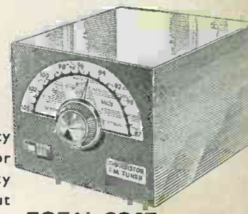

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