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JANUARY 1976

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RADIO & ELECTRONICS CONSTRUCTOR

JANUARY 1976
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7402	0.10	0.09	7451	0.12	0.10	74141	0.62	0.60
7403	0.12	0.09	7453	0.12	0.10	74145	0.70	0.65
7404	0.10	0.09	7454	0.12	0.10	74150	1.30	1.25
7405	0.10	0.09	7460	0.12	0.10	74151	0.65	0.60
7406	0.28	0.25	7470	0.26	0.24	74153	0.65	0.60
7407	0.28	0.25	7472	0.22	0.20	74154	1.30	1.25
7408	0.14	0.10	7473	0.26	0.22	74155	0.65	0.60
7409	0.14	0.10	7474	0.27	0.23	74156	0.65	0.60
7410	0.08	0.07	7475	0.44	0.40	74157	0.90	0.80
7411	0.20	0.18	7476	0.28	0.25	74160	0.95	0.85
7412	0.20	0.18	7480	0.40	0.35	74161	0.95	0.85
7413	0.26	0.25	7481	0.95	0.90	74162	0.95	0.85
7416	0.28	0.25	7482	0.72	0.62	74163	0.95	0.85
7417	0.27	0.24	7483	0.80	0.68	74164	1.20	1.10
7420	0.10	0.09	7484	0.85	0.80	74165	1.20	1.10
7422	0.25	0.23	7485	1.20	0.95	74166	1.20	1.10
7423	0.26	0.24	7486	0.30	0.25	74174	1.00	0.90
7425	0.26	0.24	7489	2.70	2.50	74175	0.95	0.85
7426	0.26	0.24	7490	0.38	0.32	74176	1.00	0.95
7427	0.26	0.24	7491	0.60	0.50	74177	1.00	0.95
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7430	0.12	0.10	7493	0.38	0.35	74181	2.00	1.80
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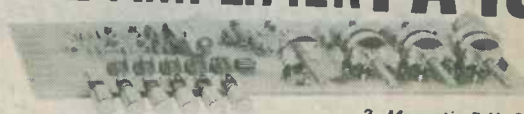
STEREO PRE-AMPLIFIER PA 100



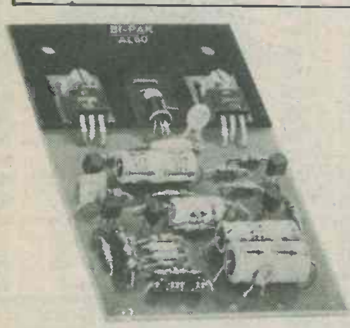
A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency response + £dB 20Hz-20KHz
Sensitivity of inputs:
1. Tape input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms
P.U. Input equalises to R1AA curve within 1dB from 20Hz to 20KHz. Supply – 20 – 35V at 20mA.
Dimensions:
299mm x 89mm x 35mm

£13.50

MK60 AUDIO KIT: Comprising: 2 x SPM80. 1 x BTM80. 1 x PA100. 1 frong panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £27.55** £plus *2p postage.*

TEAK 60 AUDIO KIT: Comprising: Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £9.20** plus 62p postage.



AL 60

25 Watts (RMS)

● Max Heat Sink temp 90C. ● Frequency response 20Hz to 100kHz ● Distortion better than 0.1 at 1kHz ● Supply voltage 15-50v. ● Thermal Feedback ● Latest Design Improvements ● Load – 3, 4, 5 or 16ohms. ● Signal to noise ratio 80db ● Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

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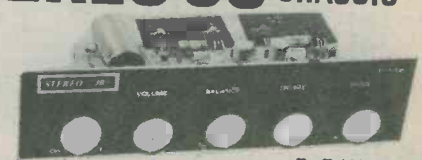
Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.

Input Voltage: 33-40 V.A.C.
Output Voltage: 33V D.C. Nominal
Output Current: 10mA-1.5 amps
Overload Current: 1.7 amps approx.
Dimensions:
105mm x 63mm x 30mm
Transformer BMT80:
£2.60 + 62p postage

£3.00

STEREO 30 COMPLETE AUDIO CHASSIS



7+7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck, etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 minutes)

TRANSFORMER £2.45 plus 62p p&p
TEAK CASE £3.65 plus 62p p&p

£15.75

p. & p. 45p

for stereo, mono audio equipment

MPA 30

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new Bi-Pak M.P.A. 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only. Used in conjunction are 4 low noise, high gain silicon transistors. It is provided with a standard DIN input socket for ease of connection. Supplied with full, easy-to-follow instructions.

£2.65

VAT ADD 25%

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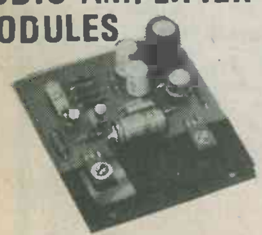
AL10-20-30

AUDIO AMPLIFIER MODULES



The AL10; AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S. The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the home.
Harmonic Distortion Po=3 watts f=1KHz 0.25%
Load Impedance 8-16ohm.
Frequency response ± 3dB Po=2 watts 50Hz–25KHz
Sensitivity for Rated O/P – Vs=25V. RL=8ohm f=1KHz 75mV. RMS.
Size: 75mm x 63mm x 25mm

AL10 3w R.M.S. **£2.30** *AL20 5w R.M.S.* **£2.65** *AL30 10w R.M.S.* **£2.95**

NEW **PA12** **£6.50**

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL10/20/30 Amplifier Modules. Features include on/off volume. Balance, Bass, Treble controls. Complete with tape output.
Frequency Response: 20Hz – 20KHz (–3db)
Bass and Treble range ± 12dB
Input Impedence 1 meg ohm
Input Sensitivity 300mV
Supply requirements 24V.5mA
Size 152mm x 84mm x 33mm

PS12 Power supply for AL10/20/30, PA12, S450 etc Input voltage 15 – 20v A.C. Output voltage 22 – 30v D.C. Output Current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £2:30
£1.20

BI-PAK

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7414	45p
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7483	80p
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74154	67p

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1	140	OSH01-200	20p	0.6	110	EC433	15p
1.4	42	BY164	28p	5	400	Texas	75p

RECTIFIERS

	Amp	Volt	
IN4004	1	400	3p
IN4005	1	600	4p
IN4006	1	800	4p
IN4007	1	1,000	4p
BY103	1	1,500	15p
SR100	1.5	100	7p
SR400	1.5	400	8p
REC53A	1.5	1,250	14p
LT102	2	30	10p
BYX38-600	2.5	600	40p
BYX38-300R	2.5	300	36p
BYX38-900	2.5	900	45p
BYX38-1200	2.5	1,200	50p
BYX49-600	2.5	600	34p
BYX49-300	2.5	300	26p
BYX49-900	2.5	900	40p
BYX49-1200	2.5	1,200	52p
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BCY70/1/2	8p	2G401	10p
BF115	10p	2N711	25p
BY127	7p	2N2926	7p
BZY88 series	5p	2N598/9	6p
HG1005	2p	2N1091	8p
HG5009	2p	2N1302	8p
HG5079	2p	2N1907	2-50
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OA47	2p		
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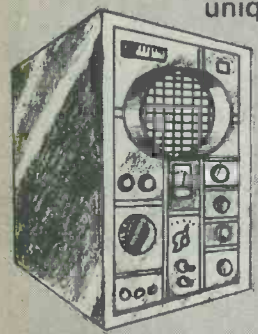

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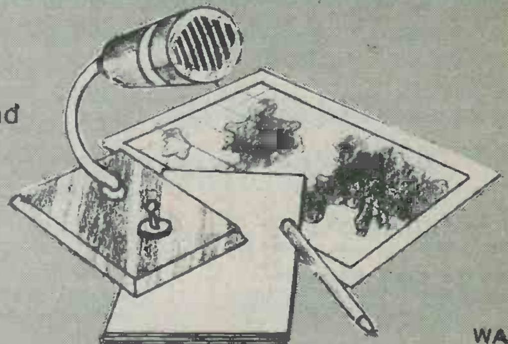

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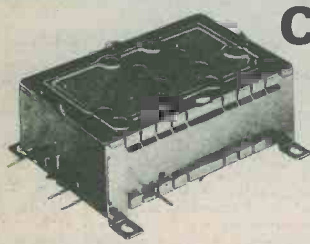

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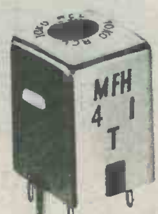

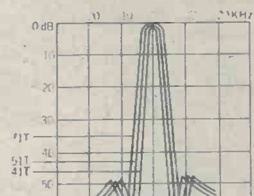

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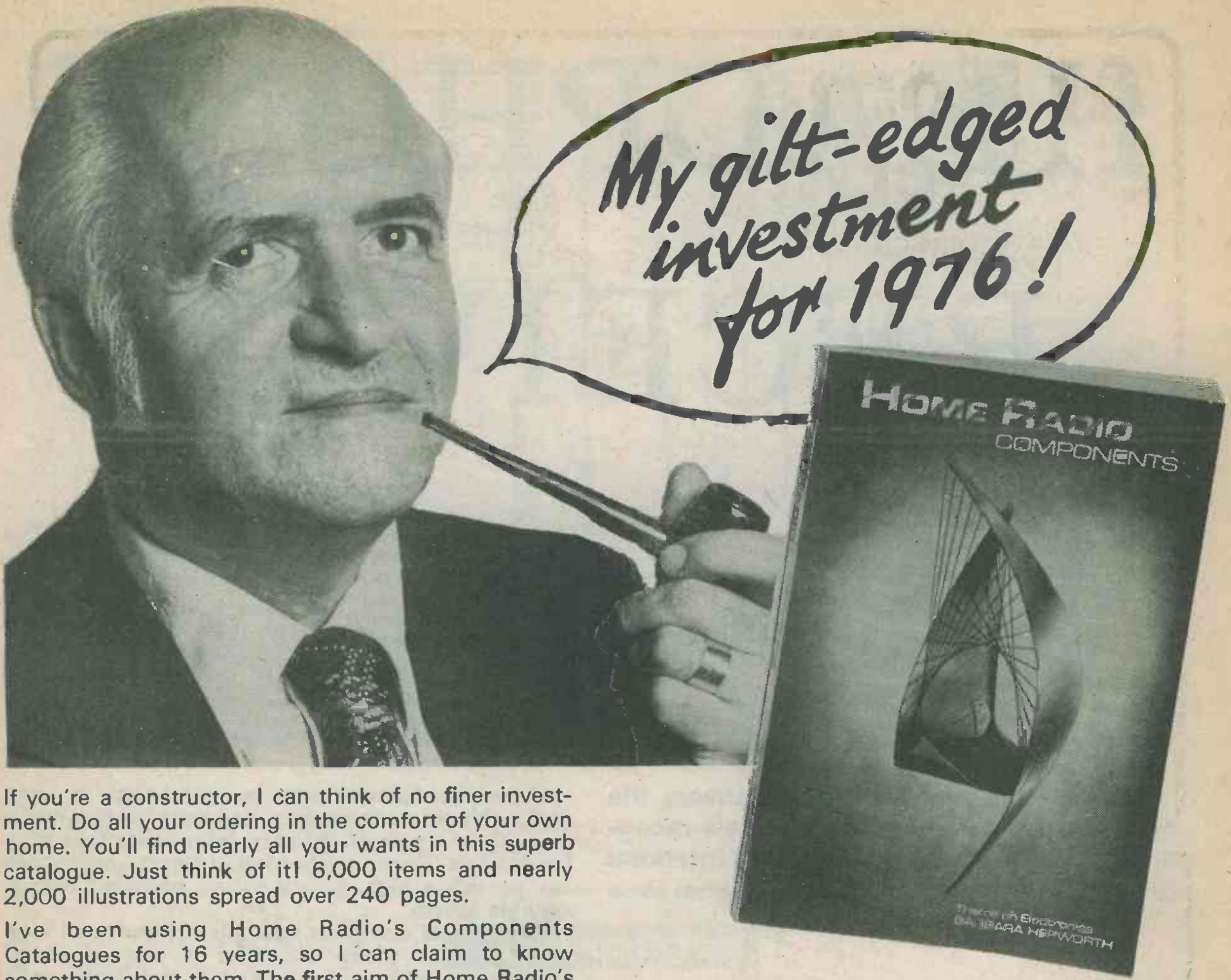

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HEADPHONE RECEIVER

by

R. A. Penfold

This simple receiver, which covers the medium wave band and also gives reception of Radio 2 on long waves, is intended to provide a good quality mono signal for a pair of stereo headphones.

The completed headphone receiver. The controls are simple and easy to operate.

Stereo headphones can be purchased at very reasonable prices these days, and need not cost much more than a pair of ordinary communications type headphones. Even the cheapest of stereo headphones can provide a high quality output when fed from a suitable source.

This article describes a simple medium and long wave receiver which can feed a pair of stereo headphones with a mono signal, and which will provide quality superior to that given by the normal type of receiver using an earphone, ordinary headphones or a miniature speaker.

The receiver is based on the popular Ferranti ZN414 t.r.f. radio integrated circuit and a single transistor output stage. Reception of a number of stations on the medium wave band, including a few foreign transmissions, is provided by the set. B.B.C. Radio 2 on 1,500 metres long waves can also be received. Current consumption from the PP3 9-volt battery is approximately 7mA. An internal ferrite rod aerial is used.

If a 3Ω loudspeaker is connected to the output of the set it can then be employed as a bedside receiver or in any other application where a large level of volume is unnecessary. For the best results the speaker should have a cone diameter of about 5in. or so, as larger speakers are generally more efficient than miniature ones.

CIRCUITRY

Fig. 1 gives the circuit of the receiver. The ZN414 i.c. provides all the r.f. amplification required by the receiver, as well as giving the detector and a.g.c. functions. The ZN414 has a high input impedance which permits the tuned winding of the ferrite aerial to be coupled directly to it. The low impedance coupling winding, L1, on the ready-made ferrite aerial is therefore unused in this circuit.

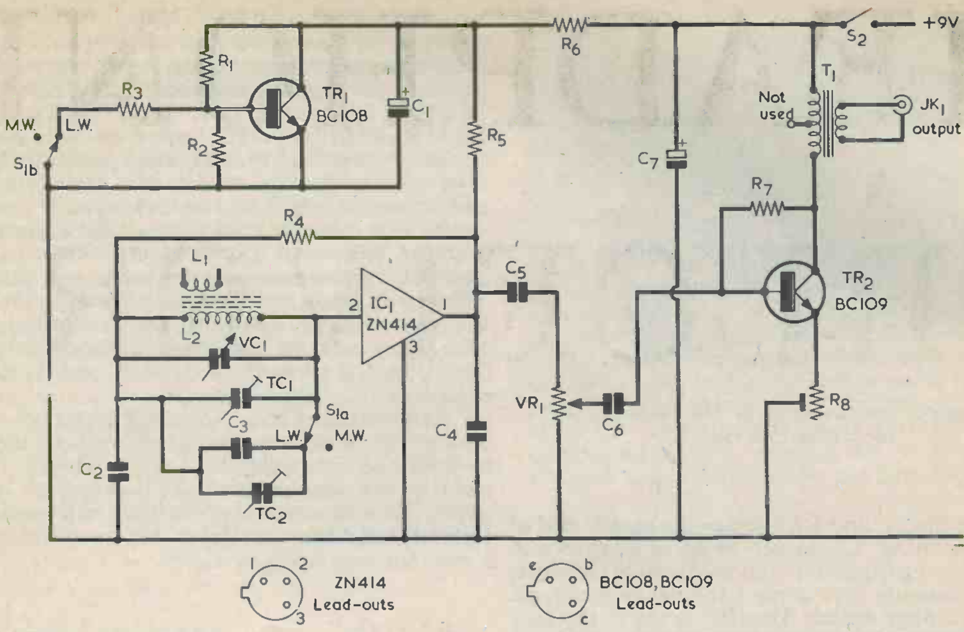


Fig. 1. The circuit of the headphone receiver. This incorporates a ZN414 integrated circuit and provides reception both on medium and on long waves.

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
- R1 3.3kΩ 2%
- R2 3.3kΩ 2%
- R3 5.6kΩ
- R4 100kΩ
- R5 680Ω
- R6 5.6kΩ
- R7 470kΩ
- R8 100Ω pre-set potentiometer, miniature skeleton, horizontal mounting
- VR1 10kΩ potentiometer, log track, with switch S2

Capacitors
- C1 100μF electrolytic, 10V Wkg.
- C2 0.01μF type C280 (Mullard)
- C3 1,000pF polystyrene
- C4 0.1μF type C280 (Mullard)
- C5 0.47μF type C280 (Mullard)
- C6 0.47μF type C280 (Mullard)
- C7 100μF electrolytic, 10V Wkg.
- VC1 208pF variable, part of Jackson type 'OO' 2-gang 208+176pF, with trimmers
- TC1 part of VC1
- TC2 100-500pF mica trimmer

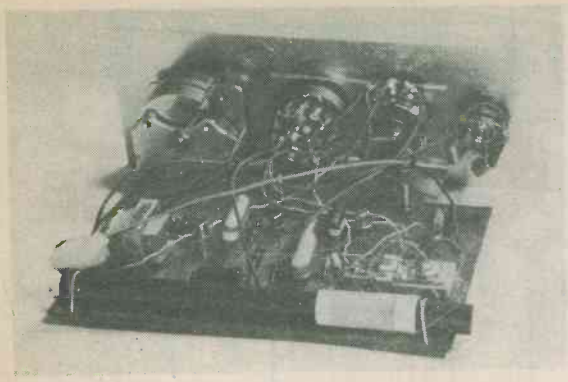
Inductors
- L1, L2 ferrite rod aerial type MW5FR (Denco)
- T1 output transformer type LT700 (Eagle)

Semiconductors
- IC1 ZN414 (Ferranti)
- TR1 BC108
- TR2 BC109

Switches
- S1 (a) (b) d.p.s.t. rotary (see text)
- S2 s.p.s.t., part of VR1

Socket
- JK1 stereo jack, ¼in.

Miscellaneous
- 1 large knob
- 2 small knobs (if S1 is rotary)
- PP3 battery (Ever Ready)
- Battery connector clip
- 8Ω stereo headphones
- S.R.B.P. panel
- 20 s.w.g. aluminium sheet
- Materials for case (see text)



The internal construction of the receiver, as seen from the rear.

R4 biases the i.c. and C2 couples the earthy end of the tuned winding, L2, to the negative supply rail. VC1 is the tuning capacitor, and the parallel trimmer, TC1, is adjusted to give correct frequency coverage. When wavechange switch S1(a)(b) is set to the long wave position, section S1(a) connects C3 and TC2 in parallel with VC1 and TC1. These reduce the resonant frequency of the aerial, and enable TC2 to be adjusted for reception of Radio 2 on the long wave band.

R5 is the load resistor for the detector and a.g.c. circuits of the i.c., and C4 bypasses the r.f. content of the signal at its output. The remaining audio signal is then fed to the volume control, VR1, by way of C5.

In order to obtain the best results from the ZN414 it needs to be fed from a stabilised supply of about 1.3 volts for medium wave reception and about 1.6 volts for long wave reception. The increased supply voltage on the long wave band helps to compensate for the fact that the gain of the ZN414 falls off at these frequencies. Since the ZN414 gain varies considerably with the level of the applied voltage, it is obviously of advantage to use a stabilised supply when the device is used in a battery powered receiver.

Supply regulation is provided by TR1, which is used as a form of shunt stabilizer. The way in which a transistor can be employed in this manner is illustrated in Fig. 2. The transistor must be a high gain silicon type. About 0.6 volt is required across its base-emitter junction before it will begin to conduct. A slight increase in this voltage, up to about 0.65 volt, is enough to bring the transistor into quite heavy conduction.

If R1 and R2 of Fig. 2 have the same value half the collector potential of TR1 will appear at its base. If the collector voltage were to rise from zero the transistor would begin to conduct when it reached 1.2 volts. The collector voltage may then advance slightly further, to about 1.3 volts, before increasing collector current in the transistor prevents any further rise. The circuit then stabilizes with the collector potential at approximately 1.3 volts. As is indicated in Fig. 2, the stabilized voltage at the collector is approximately equal to 0.65 times the sum of R1 and R2 divided by R2.

Returning to Fig. 1, R1 and R2 have equal values, with the result that the supply voltage available on medium waves is about 1.3 volts. When S1(b) moves to the long wave position, R3 is connected in parallel with R2, whereupon the stabilized voltage rises to approximately 1.6 volts. C1 is a decoupling capacitor.

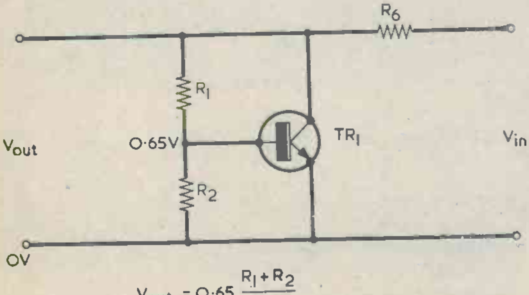


Fig. 2. Illustrating the manner in which a silicon transistor may be employed as a shunt stabilizer.

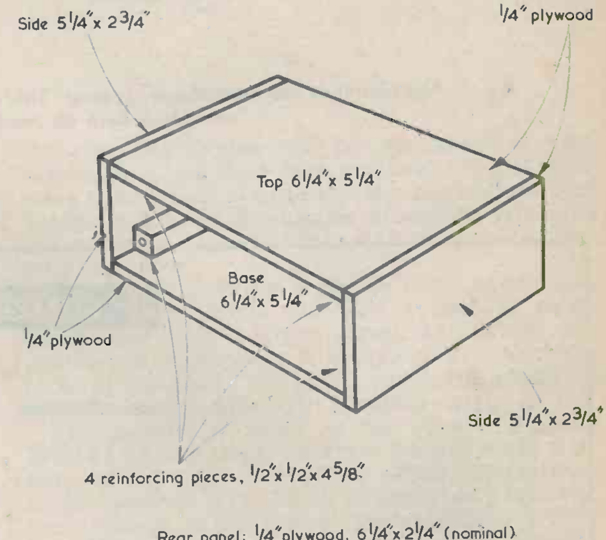


Fig. 3. Details of the wooden case for the receiver.

The output stage consists of a high gain common emitter amplifier employing TR2. This is biased by R7, and transformer T1 matches the collector impedance of the transistor to the low input impedance of the headphones. The latter can be two 8Ω stereo phones connected in parallel to provide an impedance of 4Ω.

With some headphones TR1 may give a little more gain than is necessary, and so R8 has been included to permit extra negative feedback to be introduced. This will reduce audio gain and will also improve the audio quality.

C6 couples the signal at the slider of the volume control to the base of TR2, whilst C7 provides supply decoupling. S2 is the on-off switch, and is ganged with VR1.

CASE CONSTRUCTION

A suitable case can be assembled from ¼in. plywood with ½in. square reinforcing pieces at the corners, as shown in Fig. 3. The rear panel, not shown, is also of ¼in. plywood and its nominal dimensions are 6¼ by 2¼in. In practice, it is cut out to just fit flush at the rear, and its actual dimensions are taken from the two sides and the top and bottom after they have been assembled. This procedure takes up small variations in the thickness of the plywood and any errors in cutting out.

The ½in. square reinforcing pieces are 4⅝in. long, with the result that, taking into account the ¼in. thickness of the rear panel, their forward edges are about ⅛in. behind the front of the case. The aluminium front panel is secured to these forward edges, whereupon it is recessed back, as indicated in the photographs of the completed receiver.

The wooden parts are glued together using any good quality general purpose adhesive. The finished assembly is sandpapered and cleaned, and then covered with a self-adhesive plastic material such as Fablon or Contact. The prototype was finished with a material having a woodgrain pattern, and this gave a very attractive appearance.

PANEL AND BRACKET

The front panel is made of 20 s.w.g. aluminium, and details of this are given in Fig. 4. As with the rear panel, its nominal outside dimensions are 6¼ by 2¼in. but in practice it is cut out to comfortably fit at the front of the case. The actual outside dimensions may, in consequence, differ marginally from the nominal figures. The panel is mounted, later, by four small woodscrews which pass through the holes at the corners into the ends of the ½in. square reinforcing pieces.

VC1 is mounted by three short 4BA screws having countersunk heads. These pass through the 4BA clear holes in the panel into tapped holes in the front plate of the capacitor frame. The positions of the three holes in the panel may be marked out by pressing a piece of paper against the front of the capacitor and then using this as a template. It is important that these holes are drilled very accurately. It is also important that the screws do not pass to any extent beyond the inside surface of the capacitor front plate after they are secured in position, as they could then damage the capacitor vanes. Some washers can be used as spacers between the front plate of the capacitor and the panel to reduce the penetration of the screws and also give clearance for the capacitor front bearing.

It will be noted that the capacitor specified is a 2-gang 208+176pF component with trimmers. Only the 208pF section is used in the receiver, no connection being made to the fixed vanes of the 176pF section. Another point concerning components is that the mounting holes of VR1/S2 and S1 are rather close together. If S1 is a miniature rotary switch of the type shown in the photographs (and with which no connections are made to unused poles), VR1/S2 needs to be a fairly small component to ensure clearance between the two. However, S1 only carries out a d.p.s.t. function and any other switch, rotary or otherwise, which provides this function can be used here.

The component panel is mounted by means of the bracket shown in Fig. 5. This is made from 20 s.w.g. aluminium sheet and is secured behind the front panel by the mounting bushes of VR1/S2 and S1. The component panel is bolted to the two 6BA clear holes, the bolt heads being under the bracket.

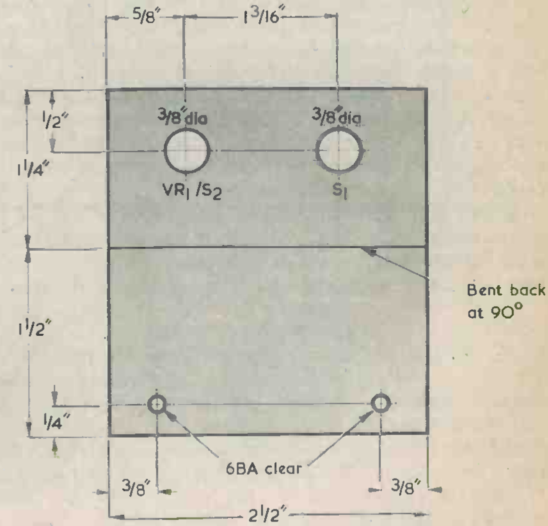


Fig. 5. Dimensions of the bracket to which the component panel is secured.

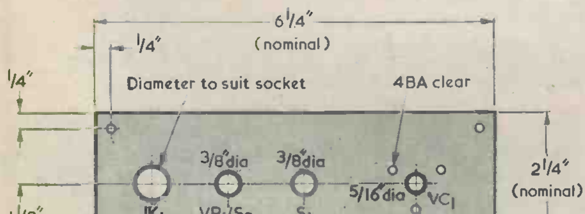


Fig. 4. The aluminium front panel is drilled out as shown here.

COMPONENT PANEL

All the small components together with the ferrite aerial are mounted on a plain s.r.b.p. ('Paxolin') panel which has the dimensions shown in Fig. 6. This diagram also shows component layout, the wiring under the panel and the general wiring of the receiver.

The panel is reproduced actual size, so that when it has been cut out the positions of the mounting holes can be traced. They may then be drilled out using a No. 52 twist drill. When drilling out the two 6BA clear mounting holes it will be helpful to use the bracket of Fig. 5 as a template. The mounting holes need to be marked out carefully, as there is very little clearance between the rear of the component panel and the back panel of the receiver case when the front panel is fitted in place. The mounting hole for TC2 is also

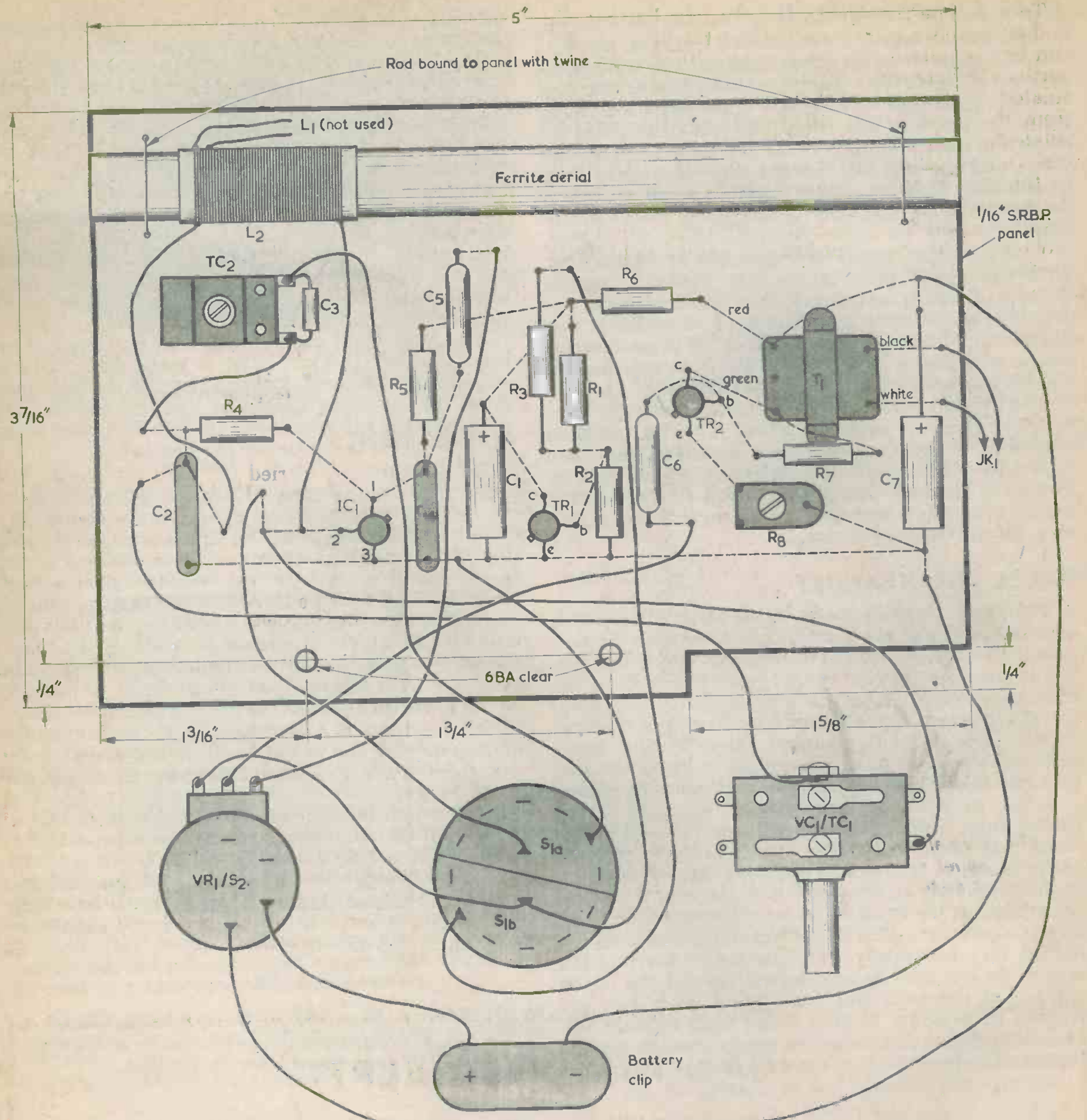


Fig. 6. Wiring up the receiver. The component panel is reproduced full-size, and may be traced. Alternative types of switch may be used in place of that shown for S1(a)(b).

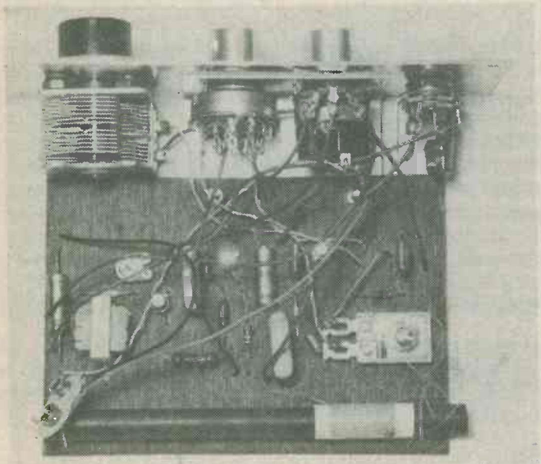
drilled at this stage. It was found with the prototype that T1 could be secured by its lead-out wires only. If it is preferred that this component be held by in position by its mounting lugs, two holes for these may be drilled. Their spacing can be taken from the transformer itself.

The ferrite aerial is tied to the board by two short lengths of twine. Small packing pieces of cardboard or similar may be inserted under the rod at the mounting points to give clearance for the winding. Make quite sure that the rod is held in place securely, and if necessary glue it in position with a gap filling adhesive such as epoxy resin. The winding should be free to move along the rod.

Next, the various small components are mounted in the positions shown, their lead-outs being bent over at right angles on the underside of the panel. The lead-outs are then wired up as illustrated, in broken line, in Fig. 6. If it is intended to secure T1 by its lead-out wires only, its mounting lugs can be bent out through 90° and then ignored. No connection is made to its primary centre-tap.

To complete the wiring, the controls, battery clip and output jack are connected into circuit. The jack can be a standard $\frac{1}{4}$in. 3-way type with the two non-earthy contacts wired together. It should have an insulated construction, so that its contacts are insulated from the front panel. All connecting wires are insulated and should be as short as is reasonably possible. To finish the receiver it is then only necessary to fit the control knobs, connect the battery and instal the assembly in the case. There is a space for the battery behind S1. If desired, control and output jack functions may be identified by legends cut from 'Panel Signs' Set No. 4.

Another view of the completed receiver. Control functions are indicated by 'Panel Signs' legends.



The internal layout of the receiver. The component panel seen here does not have the $\frac{1}{4}$in. cut-out at the front which is shown in Fig. 6, and which gives improved clearance for the tuning capacitor.

ADJUSTMENTS

Adjustments are carried out with the component panel outside the case. First set R8 fully anticlockwise so that it inserts minimum resistance into circuit, and then position the ferrite aerial winding so that its outer end is about $\frac{1}{2}$in. from the end of the ferrite rod. After the receiver has been given a final visual check it may be turned on whereupon, with S1 switched to the medium wave position, reception of a number of stations should be possible. TC1 is then adjusted to give the correct frequency coverage. The exact setting of this trimmer will probably be found to be not too critical, but it should not be screwed down so far that there is a marked lack of coverage at the high frequency end of the band, or unscrewed so far that there is a large section free of signals at this end of the range.

Next switch to the long wave band and set VC1 at about half its maximum capacitance. Adjust TC2 to tune in Radio 2 on 1,500 metres.

If there is generally an excess of volume available on the majority of stations when VR1 is almost fully advanced, the audio gain can be reduced slightly by backing off R8 as required. ■

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.

Hall Effect Devices – H. H. Seymour, 74 Harold Estate, Pages Walk, London SE1 4HW – Names of British Manufacturers and Technical Books on the subject.

CT488 Racall Counter-Timer – M. Frohwein, P.O. Box 178, Manzini, Swaziland, S. Africa – Handbook and circuit diagram, or photostats of them.

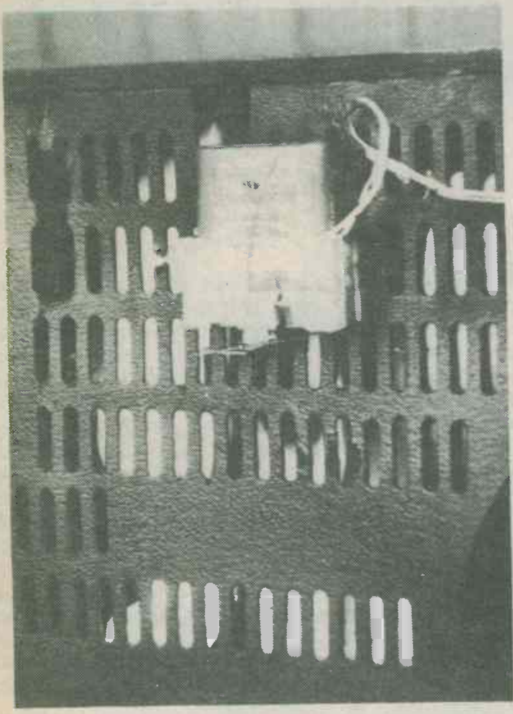
Receiver 68T – P. Whitcombe, 13 Bevan Crescent, Ebbw Vale, Gwent NP3 5UM. – Any information and/or circuit diagram, borrow or purchase.

D.C. Oscilloscope – Testgear (Acton) Ltd. – R. Misquitta, 1 Woodwinds, St. Andrews Road, Bandra, Bombay – 40050, India – Name and address of Maker, or circuitry and operation required.

Marconi CR100/B28 Receiver – D. Leslie, 20 Lighthouse Buildings, Pulpit Hill, Oban, Argyll. – Book and circuit diagram, to borrow or purchase.

NEWS . . . AND .

Safety device warns of TV fires



This simple and economical fire alarm from Clarke Instruments Ltd. gives audible warning of TV set fires and other dangerously high temperatures.

Latest figures issued by H. M. Stationery Office show that 2,000 fires each year originate in switched-off TV receivers. Clarke Instruments Ltd. of Camberley have just announced a simple battery-operated alarm Type 857 that will detect fires of this type in their early stages in TV receivers and other electronic apparatus.

The alarm consists of a battery holder, a temperature-fusible link and a pair of sprung contacts. A self-tapping screw supplied with the alarm can be used to secure it to the back of a TV set in a matter of seconds, if the instructions supplied are followed. Should the temperature at the rear of the cabinet exceed 100°C the link breaks, allowing the spring contacts to come together. These complete a circuit for the integral $4\frac{1}{2}$-volt flat battery (not supplied) either to ring an existing d.c. door bell or else any $4\frac{1}{2}$-volt audible alarm. An extension of the spring arm allows the alarm operation to be tested.

There is no drain from the battery normally, and the battery manufacturers estimate that it will last for at least half its quoted shelf life, in spite of being mounted in a warm position.

Price of the alarm is £1.95 including VAT, post and packing; a matching audible alarm, if required, costs an additional 65p. The Type 857 heat-switch alarm is available direct from Clarke Instruments, 91A High Street, Camberley, Surrey.

Garage door radio control system

Latest news from Radiomobile, one of Britain's leading names in car radios and stereo tape players, is the Portamatic garage door Remote Control System which can be operated from distances of 40-50 feet, when the transmitter is directed at the aerial.

The hand transmitter is a compact $4\frac{1}{2}$ x $2\frac{1}{4}$ ins. and will rest happily in a pocket, handbag, the glove pocket or front parcel shelf of the car. Easy operation is ensured by simply pressing the button, the signals transmitted are then picked up by a small aerial inside the garage, and relayed to the receiver, thus setting the electric motor into action.

The alternative key switch system is simply a little box working on low voltage which ideally can be affixed at car window level to a convenient spot along the driveway. Single or double overhead garage doors can be quietly opened by touching a button from the car *and* the garage light automatically comes on. Alternatively, the doors can be opened by an exterior security key switch or even flicking a switch from inside the house.

. . . COMMENT

"The entertaining electron"

Of all the applications of electrical technology that have developed from Michael Faraday's discoveries over a century ago, perhaps none has had such an impact upon our everyday lives as television.

Television in this country is only 40 years old and yet it is the oldest public television service in the world. In this brief time black-and-white television has become available to 99% of our population and colour to more than 95%.

The 1975/76 IEE Faraday Lecture — "The Entertaining Electron" has been described by its creator, F. Howard Steele, as "a magical mystery tour through the technical wonders of television".

The presentation follows the Faraday tradition in its many practical demonstrations and working models — but it also borrows from television production techniques in exploiting audio-visual aids including film, video-tape and large screen television displays.

The Lecture makes full use of a special complex mobile stage in explaining both the technology and the role of engineering in the production and presentation of television programmes.

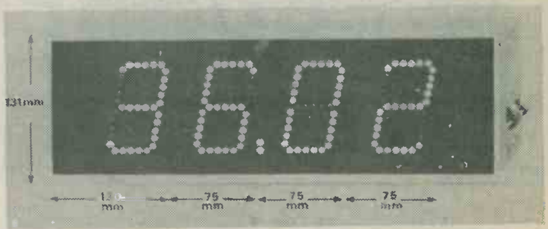
The Lecture will range over the developments of the technology, from the earliest Baird 30-line television, to optical waveguidec, quadrophonic sound and Oracle teletext.

The Lecture is being given in a number of the principal towns and cities of the U.K. Details of venues can be obtained from The Institution of Electrical Engineers, Savoy Place, London WC2 OBL.

Large display system uses extra bright L.E.D's

Spectra-Tek announce their new Series 7500 Modular Display System with 75mm. characters.

The 7-segment LED format is a unique design —



using extra bright LED's in an optical style which gives greater realism and helps achieve a very long viewing range in excess of 40 metres.

As with all their display systems Spectra offer the 7500 made up in any number of digits — packaged complete with panel mounting clips, anodised aluminium bezel, polariser, decoder/driver and edge connector.

TTL or CMOS compatibility is available and Spectra-Tek are happy to consider versions with latch, counter, power, supplies or additional electronics.

Aimed at the professional market the 7500 solves the short life problems associated with filament lamp displays.

Increases in transmitting licence fees

The Wireless Telegraphy (General Licence Charges) (Amendment) Regulations 1975 have been laid before Parliament to apply from 1 December 1975 an 'across-the-board' increase of 60% to all fees for standard radio licences, except broadcast receiving licences. Fees for standard radio licences have remained unchanged since 1968.

Standard-form licences are specified in the Schedule to the Wireless Telegraphy (General Licence Charges) Regulations 1968. They include licences which authorise the transmission and reception of radio by ships, aircraft, mobile radiotelephones, radio-microphones, radio-paging devices, radars, radio beacons, radio amateurs and model control apparatus.

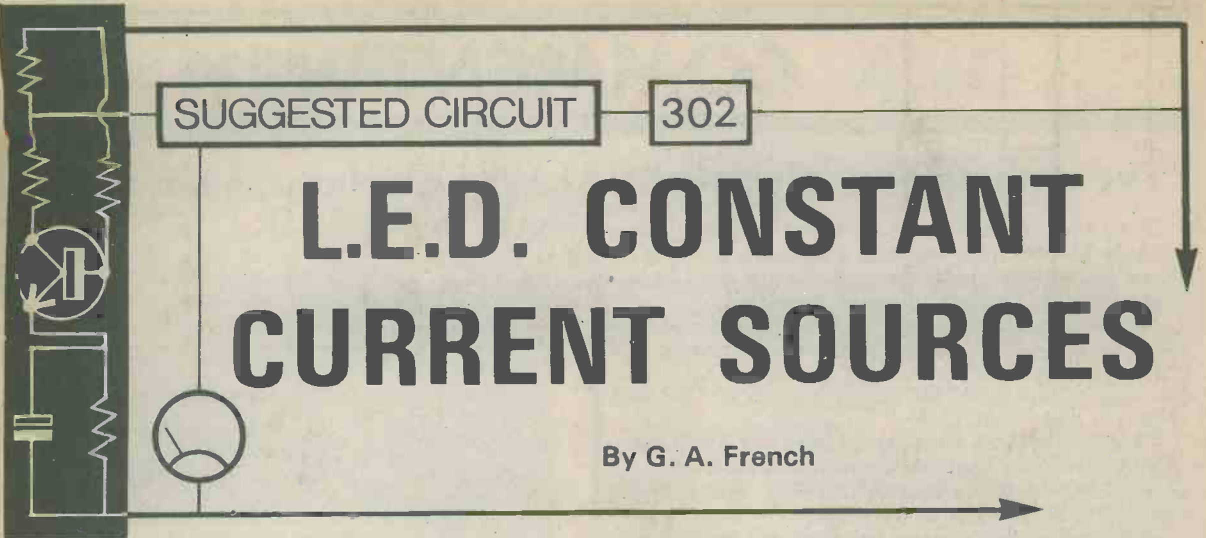
Licences which are not in standard form are specially issued as required and fees for these will also be increased by 60%.

The increases are now necessary because the income from fees is no longer sufficient to cover the cost of licensing and administering the particular uses of radio.

SPECIAL ISSUE

For those readers who could not obtain a copy of our October 1975 issue, containing a free piece of Veroboard, we can now supply a limited number. Cost 30p plus 11p postage.

Our apologies to the author of the article in our October 1975 issue.



L.E.D. CONSTANT CURRENT SOURCES

By G. A. French

It is becoming a fairly common practice to employ a light-emitting diode as a pilot light to indicate that an item of equipment is switched on. The l.e.d. is connected between the two supply rails of the equipment with a series resistor to limit the forward current which flows through it. The advantages conferred by the l.e.d. are that it has an extremely long life and does not burn out, as does a filament bulb, and that it requires a lower current than a bulb to give a visible glow of adequate brightness.

L.E.D. CIRCUIT

The l.e.d. is normally employed in a circuit such as that shown in Fig. 1. If the equipment is mains operated the current flowing in the l.e.d. can be of the order of 10 to 20mA. With battery equipment a lower current of around 3 to 5mA may be passed through the l.e.d., but this will still give an adequate glow in dark surroundings. If the l.e.d. is a Texas Instruments TIL209 the forward voltage dropped across the l.e.d. is typically 1.6 volts, with a maximum figure of 2 volts. Most TIL209's drop a forward voltage at around the 1.6 volt level.

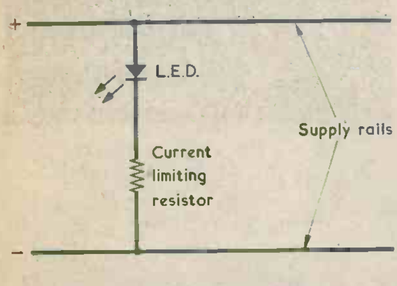


Fig. 1. A normal employing an l.e.d. to indicate that an item of equipment is switched on

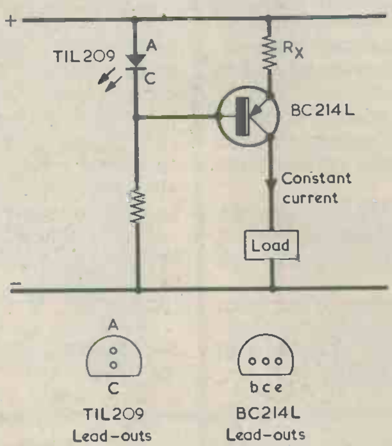


Fig. 2. Incorporating the l.e.d. in a constant current source. The TIL209 and BC214L are suitable for all the applications described in this article.

By the addition of a small silicon transistor and a resistor the l.e.d. can perform the secondary function of providing a reference voltage for a constant current source inside the equipment. Constant currents of 10μA to 10mA can be readily produced simply by varying the value of the added resistor. The requisite circuit is shown in Fig. 2, where the resistor is designated RX.

In this circuit, the base of the transistor is held at a fixed potential relative to the upper supply rail by the forward voltage dropped across the light-emitting diode. An l.e.d. has a very low slope resistance and can be considered as offering the same class of voltage stabilization as does a zener diode. A voltage of about 0.6 volt is dropped across the base-emitter junction of the transistor, whereupon what is effectively a constant voltage appears across RX. Since the voltage across RX is virtually constant, so also is the current which flows through it. The collector current of the transistor is the same as the emitter current less the small base-emitter current needed to maintain that collector current. If we connect a current reading meter in series between the collector and the lower supply rail, as in Fig. 3, we will find that the current indicated by the meter remains virtually unaltered as the variable resistor is adjusted between zero resistance and the maximum value which allows the current to flow. The l.e.d. and transistor circuit may in consequence be looked upon as a constant current source.

If we take the voltage across the l.e.d. as being exactly 1.6 volts, and that across the base-emitter junction of the transistor as being exactly 0.6 volt, then 1 volt appears across RX.

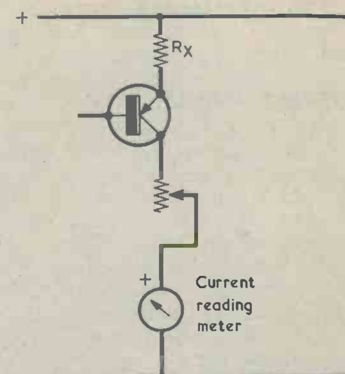


Fig. 3. The performance of the constant current source may be checked with the circuit shown here

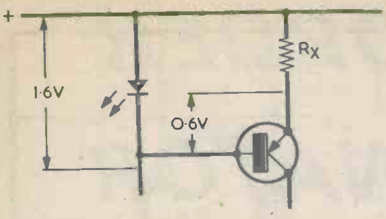


Fig. 4. Typical voltages in the circuit of Fig. 2

See Fig. 4. This fact is helpful in finding the resistance required in RX for different values of constant current. 1 volt across a resistor of 1kΩ causes a current of 1mA to flow in the resistor; thus a value of 1kΩ in RX produces a constant current of 1mA in the collector circuit of the transistor. Similarly a resistance of 100Ω should produce a constant current of 10mA. If RX is increased to 10kΩ the constant current becomes 0.1mA, or 100μA, and with RX at 100kΩ the constant current becomes 10μA.

The author has checked these theoritical figures with a practical circuit incorporating a TIL209 l.e.d. and a BC214L p.n.p. silicon planar transistor. Constant currents of approximately 1mA, 100μA and 10μA were produced with RX at 1kΩ, 10kΩ and 100kΩ respectively. The 10μA figure is probably the lowest constant current that the circuit can reliably supply, since at lower levels leakage currents in the transistor may modify operation. With RX at 100Ω the constant current was approximately 9mA and not 10mA. This is due to the fact that, at a collector current of around 10mA, the voltage across the base-emitter junction of the transistor is greater than occurs at the lower currents, whereupon less voltage is available across RX. Making RX equal to 91Ω brought the constant current up to about 10mA. The current flowing in the l.e.d. during the checks was 8mA, but similar results will be given for any l.e.d. current between 3 and 20mA.

POWER DISSIPATION

The BC214L has a maximum power dissipation rating of 300mW, and a maximum collector voltage rating of 30 volts. When it provides a constant current of 10mA, it would be preferable to keep the voltage across the transistor to less than some 15 volts so that it does not exceed half its maximum dissipation rating. At the lower currents the voltage across the transistor may be any value up to the maximum figure of 30 volts. In the author's tests, the voltage across the transistor was varied between 1 volt and 20 volts for the three lower currents, and between 1 volt and 15 volts at the highest current. No noticeable change in collector current was observed as the voltage varied.

The figures just given are intended as a guide to experimenters who wish to incorporate the circuit of Fig. 2 as a constant current source in any new equipment to be constructed. The fact that approximately 1 volt appears across the emitter resistor, RX, makes calculation of the value required for a particular constant current a very simple matter. Naturally, spread in forward voltage across the l.e.d. and in the base-emitter voltage drop of the transistor will cause some variance in the constant current figures obtained in practice, but the 1 volt assumption offers a useful starting point for design calculations.

APPLICATIONS

The constant current circuit has several applications in electronic equipment.

What is probably the most obvious is the application of the constant current to a zener diode, as in Fig. 5.

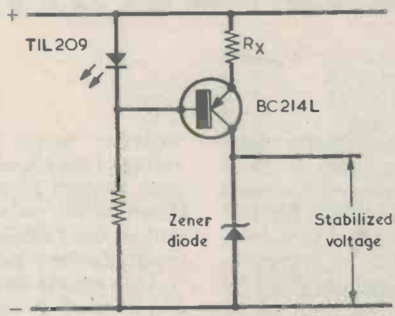
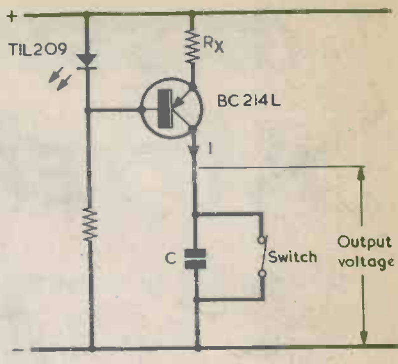


Fig. 5. Using the constant current source to obtain a highly stable voltage across a zener diode

All zener diodes have a significant slope resistance, but if a zener diode is fed with a constant current then the voltage across it becomes constant, too. The circuit of Fig. 5 will give a very stable voltage across the zener diode despite wide voltage fluctutations on the supply rails. Assuming that the l.e.d. circuit is already present, the only extra component needed, as compared with a simple zener diode fed directly by a resistor, is the transistor. Practical constant current values for the zener diode could range from, say, 2mA (with RX at 500Ω) to 5mA (with RX at a little less than 200Ω to take up increasing voltage drop across the emitter-base junction of the transistor).

Another useful circuit is shown in Fig. 6. Here, the constant current is applied to a capacitor which is short-circuited in the diagram by a switch. When the switch is opened the voltage across the capacitor rises in linear fashion, as illustrated in Fig. 7, and does not follow the usual exponential curve given by a capacitor charging via a resistor. The circuit is very useful for timing applications and the production of sawtooth waveforms.



$$V_{(rise)} = \frac{I}{C}$$

Fig. 6. Theoretical circuit illustrating how a capacitor may be charged by a constant current source

Fig. 6 also shows the relationship between voltage rise across the capacitor in terms of the constant current and the capacitance. The equation is true when V(rise) is in volts per second, I is the constant current in amps and C is the capacitance in farads. Thus, a constant current of 1 amp in 1 farad gives a voltage rise of 1 volt per second. The voltage rise will be unaltered if both the numerator and the demoninator on the right hand side of the equation are divided by the same number. If this divisor is one million, then we obtain a rise of 1 volt per second across the capacitor when the current is 1μA and the capacitance is 1μF. Turning to more usable currents we also get a voltage rise of 1 volt per second if the current is 10μA and the capacitance is 10μF. The same rate of voltage rise is given with 100μA and 100μF, 1mA and 1,000μF, and 10mA and 10,000μF.

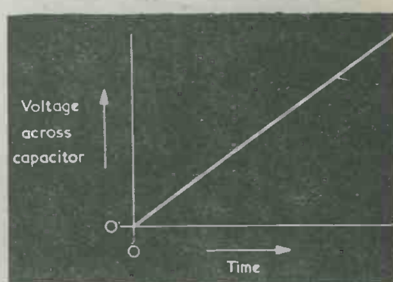


Fig. 7. The voltage across a capacitor charged by a constant current increases in linear manner with time

This relationship between rate of voltage rise, constant current and capacitance makes it possible to design circuits of the type shown in Fig. 6 with a high level of performance predictability. ■

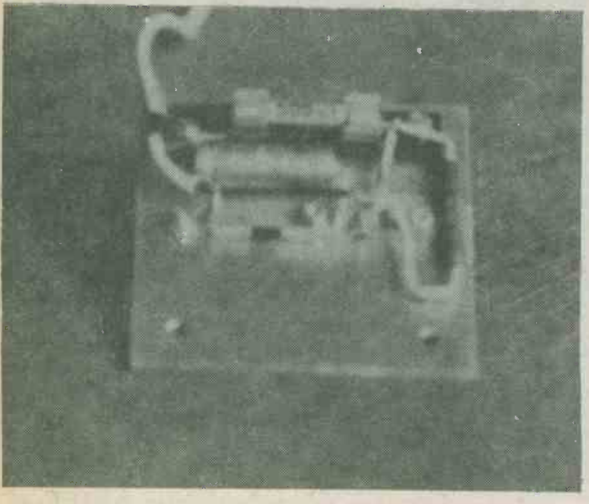
CASSETTE RECORDER BATTERY ELIMINATOR FOR CARS

BY S. V. ESSEX

Intended for use in cars having 12 volt batteries, this unit can be assembled in different versions to cater for positive or negative earth systems and to give outputs of 6, 7.5 or 9 volts.

Many people who own portable cassette tape recorders are discouraged from using them in their cars, especially on long journeys, because of the costs of continually buying new batteries. These do not last long, particularly when the volume control is turned up almost to maximum, as it needs to be to overcome the high noise levels in a car. The voltage required by the recorder will in almost all cases be less than the 12 volt supply that is available from the car's electrical system, and so what is needed is something that will drop the difference. Although it might appear that a series resistor could be used, the voltage applied to the recorder would then alter depending on the car voltage (which, although nominally 12 volts, can vary from around 10 volts to over 14 volts) and the current taken by the recorder (which is dependent to some extent on the volume output). The result would be a very unsatisfactory performance.

This article describes a small inexpensive unit that can be used to lower the car voltage to the 6, 7.5 or 9 volts required by a cassette recorder. If desired, the unit could alternatively supply a radio although, generally speaking, portable radios do not work too well in cars. The unit's output voltage is kept fairly constant over a wide range of input voltages and output currents by the use of a zener diode. It is, of course, necessary for the unit to be installed in the car by a person who understands the simple electrical principles involved.



The few components required are assembled on a small aluminium plate.

CIRCUIT DESCRIPTION

There are two versions of the unit, these being for positive earth vehicles and negative earth vehicles. The two circuits are shown in Figs. 1 and 2 respectively.

Taking the positive earth version first it can be seen that the p.n.p. power transistor TR1, an AD162, is connected as an emitter follower, so that its emitter potential is governed by its base potential. The latter is kept stable by the zener diode ZD1, which is reverse biased. Zener diodes have a sharply defined reverse breakdown voltage with a low slope resistance, with the result that the voltage developed across ZD1 stays more or less constant even for large changes in the current flowing through it. Since the zener diode voltage is stabilized, the emitter voltage of TR1 is also stabilized. Because of the voltage drop in the base-emitter junction of TR1, the possible output voltages are approximately 6, 7.3 or 8.9 volts when 6.2, 7.5 or 9.1 volt zener diodes are employed. Resistor R1 passes the current for the base of TR1 and the current needed to keep ZD1 in zener conduction. TR1 drops the

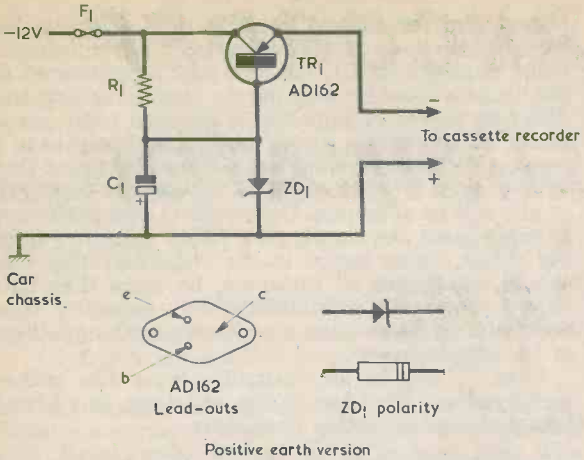


Fig. 1. The circuit of the battery eliminator unit when employed with cars having a positive earth. The value of R1 depends on the output voltage required.

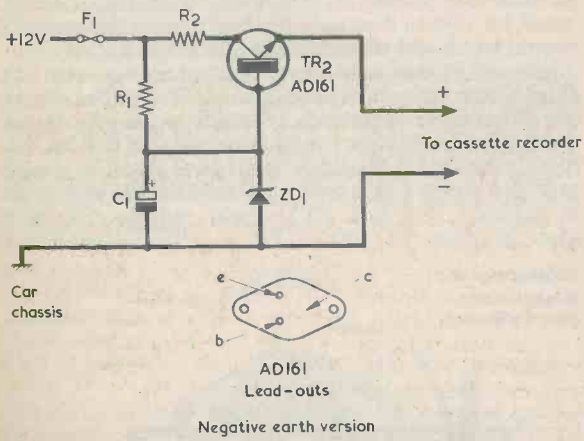


Fig. 2. The negative earth version of the unit. R2 is not required if the unit is intended to give a 9 volt output, and the collector of TR2 then connects directly to fuse F1.

difference between the input and output voltages and dissipates the consequent power as heat.

The negative earth version of the circuit shown in Fig. 2 is basically similar apart from the inclusion of R2, although of course the zener diode and capacitor polarities have been changed and the transistor is now *an n.p.n.* type AD161. R2 needs to be included if the *output* current exceeds 300mA to share some of the power that has to be dissipated when the AD161 is employed since, although it is the same physical size, its power rating is less than that of the AD162. R2 is only required when the unit is built for a 6 or 7.5 volt output, however, since the transistor does not dissipate much power when it gives a 9 volt output.

Fuse F1 is included to provide overload and short-circuit protection, which is very necessary in a car because of the hazards that can occur if the car's wiring overheats or catches fire because of a short-circuit.

COMPONENTS

Resistors
R1 330Ω ½ watt 10% (6 volt output)
220Ω ½ watt 10% (7.5 volt output)
180Ω ½ watt 10% (9 volt output)
R2 5.6Ω 2 watt 10% (Fig. 2, 6 volt output)
2.7Ω 2 watt 10% (Fig. 2, 7.5 volt output)

Capacitor
C1 250μF electrolytic, 16 V. Wkg. (see text)

Semiconductors
TR1 AD162 (Fig. 1)
TR2 AD161 (Fig 2.)
ZD1 BZY88/C6V2 (6 volt output)
BZY88/C7V5 (7.5 volt output)
BZY88/C9V1 (9 volt output)

Fuse
F1 500mA cartridge (6 volt output)
500mA cartridge (7.5 volt ouput)
250mA cartridge (9 volt output)

Miscellaneous
Fuseholder
Mica washer and insulating bushes for TR1/TR2
Aluminium sheet
Nuts, bolts, etc.

Normally, a fuse is cheaper but is not otherwise as convenient as is an automatic transistor overload circuit. On the other hand, there is no way in which the fuse can be inadvertantly invalidated. Fig. 3 shows a conventional overload protection circuit for the negative earth version of the unit and demonstrates how a short-circuit between the negative output lead and the car chassis could make the protection circuit useless.

Whilst on the subject of accidental short-circuits a warning must be given not to use the positive earth circuit "upside-down" in a negative earth car, as

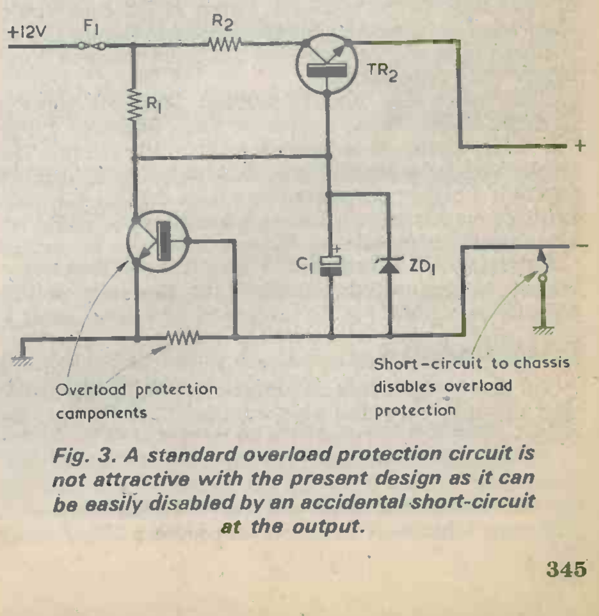


Fig. 3. A standard overload protection circuit is not attractive with the present design as it can be easily disabled by an accidental short-circuit at the output.

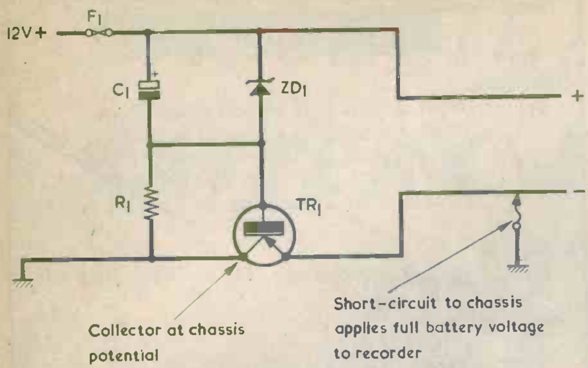


Fig. 4. The positive earth circuit should not be adapted for use in a negative earth car (and vice versa) as an output short-circuit could cause damage to the cassette recorder.

shown in Fig. 4. Although this results in the collector of the transistor being at chassis potential and thus enables the transistor to be bolted direct to the chassis without the usual mica washer, disaster could occur if for any reason the negative output lead (or part of the recorder connected to it) contacted the car chassis. This is because the full voltage from the car battery would then be applied to the recorder. The resultant current might not be sufficient to blow the fuse and the recorder could be seriously damaged. Thus the circuit must be used "right way up", even though the transistor has to be mounted on a mica washer with insulating bushes. The same comments apply to the use of the negative earth circuit, similarly "upside-down", in a car with a positive earth.

Any external metalwork on the recorder may be common with one of its supply rails. If the supply rail is the same polarity as the car earth (as is given, for example, if the recorder metal work was common with its positive supply rail and the car had a positive earth) then no harm would result if the metal work and the car chassis came into contact. If, However, the polarities were different, care would need to be taken to ensure that the metal work and the car chassis did not contact each other, as the fuse would then blow. In general, this requirement should not be difficult to meet, the situation has to be borne in mind where it is applicable.

The maximum output current that the unit is capable of delivering is 500mA when built for a 6 or 7.5 volt output. It is 250mA when built for a 9 volt output, since zener diode dissipation limitations prohibit a higher output current to be drawn. The fuse must of course have a rating lower than, or equal to, the output current.

Capacitor C1 is included to lessen the effects of interference generated elsewhere in the car on the cassette recorder.

COMPONENTS

All the components required are readily available and the only ones that need comment are C1 and the fuse.

As was just mentioned, the function of C1 is to suppress interference from the car electrical system, and the value required here will vary considerably with different vehicles. The author employed a 250μF component and this should be more than adequate for most installations. If it is desired to find the minimum value required for C1, the unit may be connected to the cassette recorder with the car engine running and different values of capacitance checked until one is found which reduces supply-bourne interference to a reasonable level. In many cases it may be found that values much lower than 250μF (or even no capacitor at all) will be adequate. Constructors who prefer not to experiment can simply fit a 250μF capacitor from the outset, being secure in the knowledge that this should, in almost all instances, be more than sufficient to remove interference. Any capacitor connected in the C1 position must have a working voltage of 16 volts or more.

Fuse F1 can be any cartridge type. The author employed a 1.25in. fuse in the prototype, this fitting into a chassis-mounting fuseholder.

CONSTRUCTION

The unit can be assembled on a piece of aluminium sheet which can be bolted underneath or near the dashboard of the car. It should not be mounted under the bonnet of the car as high temperatures are present in this area. Since the transistor (and R2, if fitted) must be able to dissipate the heat that is developed it would be unwise to mount the unit in the battery compartment of the cassette recorder or in a plastic box. The aluminium sheet should be secured to the chassis (or some other large area of metal in the car) to dissipate the heat. It is, for instance, no use bolting it to the dashboard if the latter is made of wood or plastic.

Fig. 5 shows the layout adopted with the prototype.

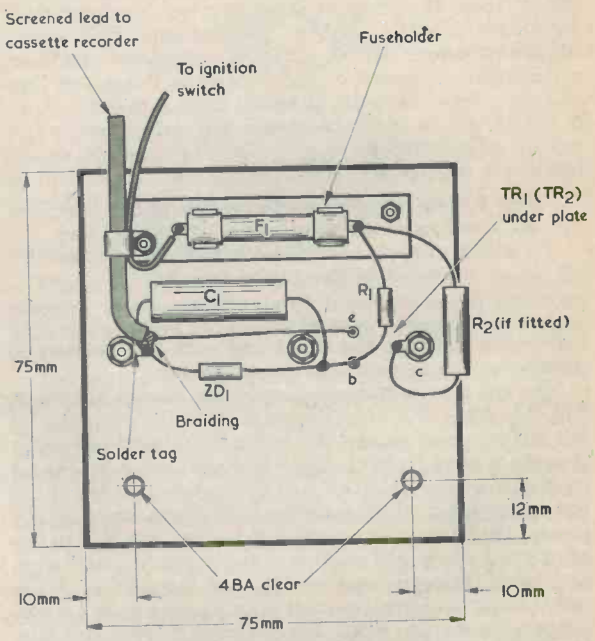


Fig. 5. The components may be assembled on an aluminium plate, as here. The polarities of C1 and ZD1 depend on whether the unit is for positive or negative earth operation.

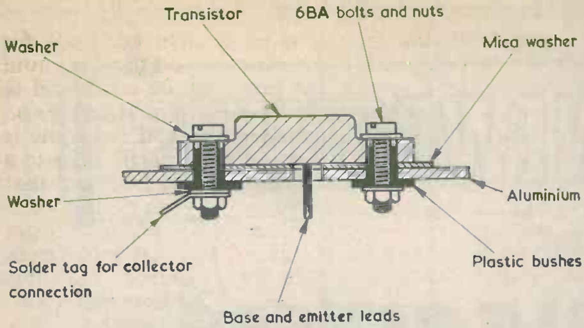


Fig. 6. Illustrating the manner in which TR1 or TR2 is mounted on the aluminium plate.

All the components are mounted on an aluminium sheet measuring 75mm. (or 3in.) square, this having two fixing holes drilled in it at one end. The transistor is bolted to the aluminium, but is insulated from it by a mica washer and two plastic bushes, as illustrated in Fig. 6. Fig. 7 gives drilling details for the holes used to mount the transistor and allow the passage of its base and emitter lead-outs. A smear of silicone grease on either side of the mica washer improves the conduction of heat from the transistor to the aluminium.

The fuseholder is mounted by two 6BA bolts; one of these is used also to secure a cable clip which, in turn, holds the input and output leads. There is no separate earth connection when the aluminium is bolted to the car chassis. The output lead can conveniently be a length of ordinary screened microphone cable, with the outer braid soldered to the same solder tag that takes the earthy leads of C1 and ZD1. Bearing in mind the vibration to which the unit could be subjected, it is a wise precaution to cover all bare wires with sleeving. This will insulate them if a lead shifts in position or a soldered connection comes adrift.

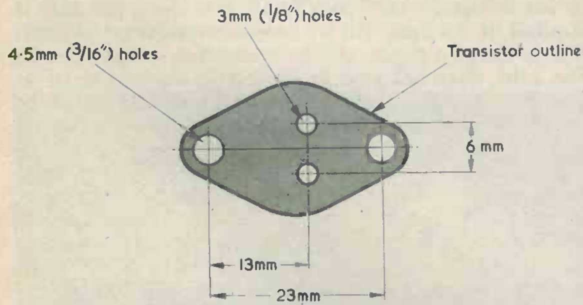
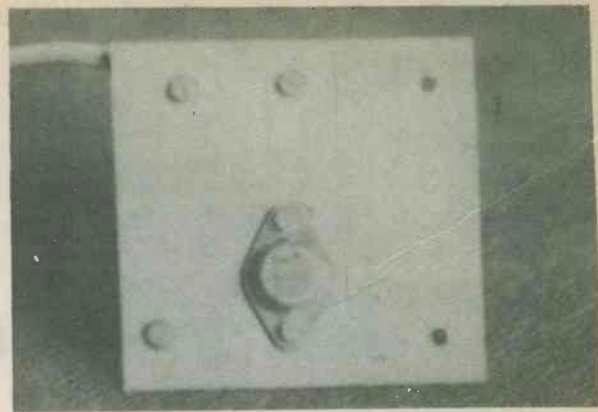


Fig. 7. The dimensions of the mounting holes for the power transistor. The inch equivalents shown are approximate.



The aluminium plate is bolted to the car chassis and serves as a heat sink for the transistor.

CONNECTING UP

The unit should be wired up so that it is disconnected from the battery when the ignition is switched off. If the car is fitted with a radio which turns off when the ignition switch is off, the unit can be wired up in the car radio circuit. Alternatively, it can be connected to the terminal of the ignition switch that is live when the ignition is switched on. If the ignition switch is inaccessible, the handbook of the car should be consulted to determine which of the car's fusebox terminals it is safe to connect the unit to, or which terminal a car radio controlled by the ignition switch would be connected to. The connection will probably have to be made with a ¼in. push-on connector.

Unless the cassette recorder is to be permanently fitted in the car, a method of coupling it to the output of the unit will also have to be devised. This could consist of a non-reversible 2-way socket into which a power lead from the recorder may be plugged, or a similar type of installation. Care should be taken to ensure that there is no chance of a short-circuit between the live output and the car chassis when the recorder is removed from the car.

In conclusion, it may be stated that the use of the supply unit completely eliminates the cost of running a cassette recorder. And, nowadays, any way of getting something for nothing is very definitely well worth the trouble! ■

'NOTES FOR NEWCOMERS'

THE VARIABLE ZENER

BY T. MILES

A single transistor and a pre-set potentiometer provide a useful means of obtaining voltage stabilization at any desired low voltage above 0.6 volt.

Most newcomers to electronics will be aware of the fact that a zener diode offers a convenient way of providing voltage stabilization. A zener diode appears in Fig. 1(a) and consists of a silicon diode connected so that it passes current in the reverse direction, i.e. in the direction opposite to that given if it were acting as a rectifier. A stabilized voltage appears across the zener diode, this increasing only slightly for relatively large increases in current through the diode.

'VARIABLE ZENER'

Whereas a zener diode stabilizes at one nominal voltage only, the stabilizing circuit of Fig. 1(b) is capable of stabilizing at any voltage from about 0.6 volt to 10 volts or more. What is more, the range of voltage at which stabilization occurs is continuously variable by adjustment of the pre-set potentiometer.

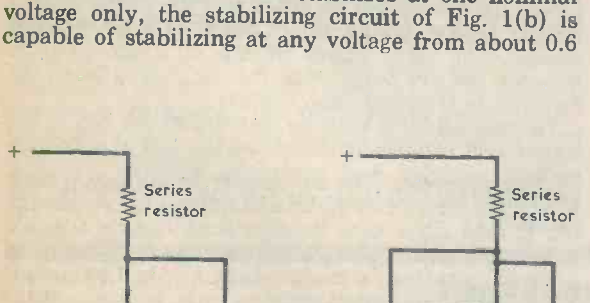


Fig. 1(a). Obtaining a stabilized voltage from a zener diode
(b). Stabilizing circuit incorporating a 'variable zener'

To understand how the circuit of Fig 1(b) works, let us assume that the slider of the pre-set potentiometer is set mid-way along the track, so that half the voltage on the transistor collector, relative to the lower rail, is applied to the base. All we need to remember in addition is that an n.p.n. silicon transistor, as appears in Fig. 1(b), does not pass any collector current until its base is about 0.6 volt positive of its emitter.

Let us now increase the voltage applied to the circuit via the series resistor, starting from zero. As the voltage increases up to just below 1.2 volts the transistor will not pass any current because the voltage on its base is below 0.6 volt. When the applied voltage reaches 1.2 volts the transistor will commence to pass current because the base voltage is now 0.6 volt. Should the applied voltage rise above 1.2 volts the transistor will draw an increasing current, causing the collector voltage to increase only slightly above the 1.2 volt level. The extra voltage is dropped across the series resistor.

The reason why the transistor collector remains at about 1.2 volts is that an increasing voltage at the collector causes an increasing current to flow into the base, whereupon the transistor simply passes a greater collector current. If the transistor has a high current gain the increase in collector voltage due to increasing input voltage is very small.

If we require voltage stabilization at a level higher than 1.2 volts this would be achieved by moving the slider of the pre-set potentiometer towards the lower end of its track. A smaller proportion of the voltage on the transistor collector would then be applied to the base, with the consequence that the collector voltage could rise to a higher level before the base-emitter voltage reached 0.6 volt and the transistor commenc-

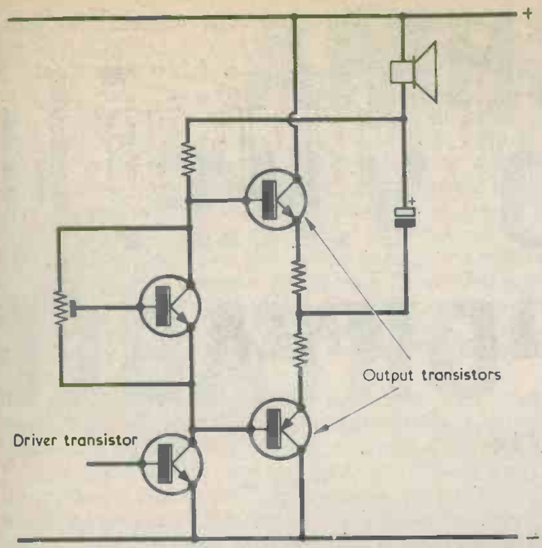


Fig. 2. A common application for the stabilizing circuit of Fig. 1(b) is to maintain a fixed voltage between the bases of two output transistors in an a.f. amplifier

ed to pass current. About the highest useful practicable voltage for stabilization is of the order of 10 volts or so.

If the slider of the pre-set potentiometer is moved up the track from the mid-way setting the transistor stabilizes at collector voltages lower than 1.2 volts. When the slider is fully at the top end of the track the transistor stabilizes at around 0.6 volt, which is of course the base voltage at which the transistor commences to draw current.

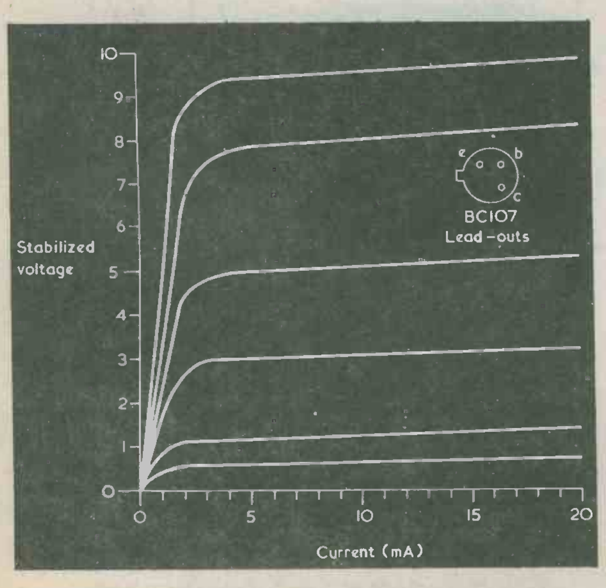


Fig. 3. A series of curves taken with the circuit of Fig. 1(b), employing a BC107 transistor and a 5Ω pre-set potentiometer

APPLICATIONS

The stabilizing circuit of Fig. 1(b) has a number of applications, the most common being that of maintaining a fixed potential between the two Class B output transistor bases of an a.f. amplifier, as illustrated in Fig. 2. The potentiometer is adjusted so that the two output transistors pass a small current under quiescent conditions.

In Fig. 1(b) the transistor is an n.p.n. device. A p.n.p. silicon transistor can also be used if the polarities are reversed.

Fig 3. shows a series of curves prepared by the author to give an indication of stabilizing performance at different voltages and currents. These were drawn using a BC107 as the transistor and with a 5kΩ pre-

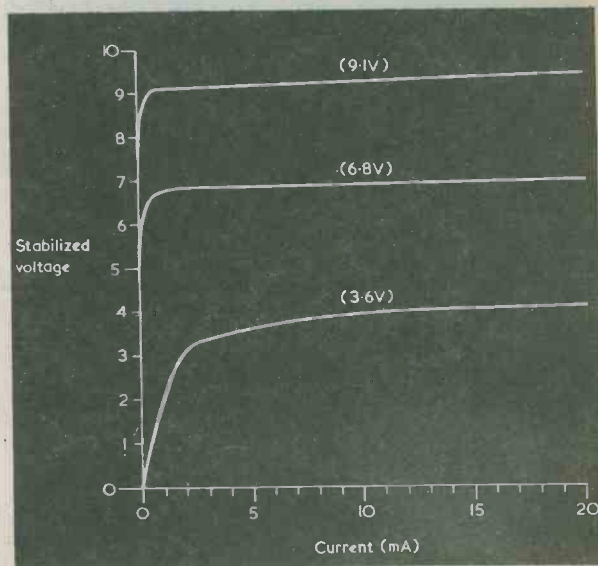
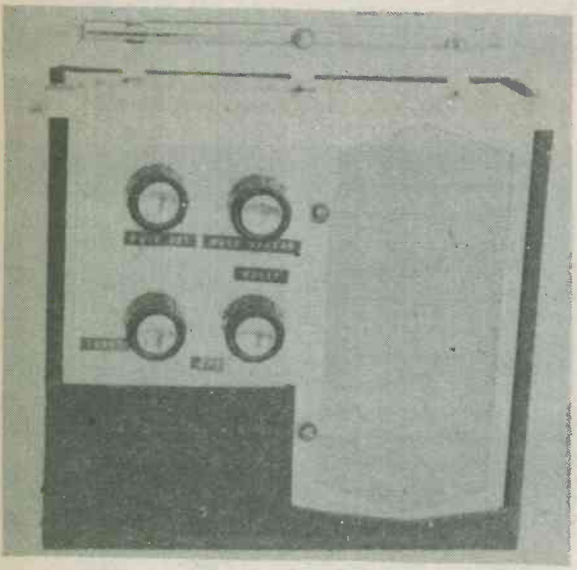


Fig. 4. Typical voltage-current curves for three 400mW zener diodes

set potentiometer. The lowest curve is that given when the potentiometer slider is right at the upper end of its track, and shows that the stabilized voltage remains between 0.6 and 0.7 volt, increasing only slightly as current increases. The remaining curves are for settings in the potentiometer where the slider progressively approaches the emitter end of the track.

Fig. 4 shows typical voltage-current curves for three 400mW zener diodes having nominal zener voltages of 3.6, 6.8 and 9.1 volts. It will be gathered from these that the circuit of Fig. 1(b) offers a better performance than the zener diode at stabilized voltages below some 5 volts or so, but that the zener diode is marginally better above this voltage. Above 5 volts, also, the zener diode starts to stabilize at currents of only 1 to 2mA, whereas the 'variable Zener' has to be taken up to some 5mA before it commences to stabilize. ■

THE 'DRACHMA' S.W. AND V.H.F. PORTABLE



Part 2

By
Sir Douglas Hall, K.C.M.G.

In the preceding article the circuit operation of this reflex design was described, as also were the first steps in construction. This concluding article completes the constructional information.

In last month's issue we described the circuit of this receiver and commenced details of construction by describing the various pieces of plywood and s.r.b.p., etc., which are required for its assembly. We now continue with the construction of the receiver.

COILS

The items of Figs. 2(a) to (d) (published last month) may now be put on one side. The next parts to be made up are the coils and these are shown in Figs. 3(a) and (b).

The v.h.f. coil, L1, is illustrated in Fig. 3(a). The former is a 2¼in. length of the body of a 'Bic' ball-point pen, and the coil is wound with 24 s.w.g. enamelled wire. Two $\frac{1}{16}$in. holes are required and, ignoring the parts of the coil ends which pass through the holes, there are 4 complete turns. Readers who have made the author's 'Quasister' v.h.f. tuner (described in the April 1974 issue of this journal) may be surprised that only 4 turns are required for the coil, as the 'Quasister' v.h.f. coil, which was also wound on a former cut from a 'Bic' pen, had 8 turns. The reason for the difference is that the earlier coil had very short leads to the tuning capacitor, whereas in the present design a fair proportion of the inductance is provided by the wiring to switch S1. This point indicates, incidentally, that it is important to follow the layout of the prototype or it will be necessary to redesign L1.

L2 is shown in Fig. 3(b). First take a piece of Fablon 4in. by 1¾in., and remove a ½in. section of backing

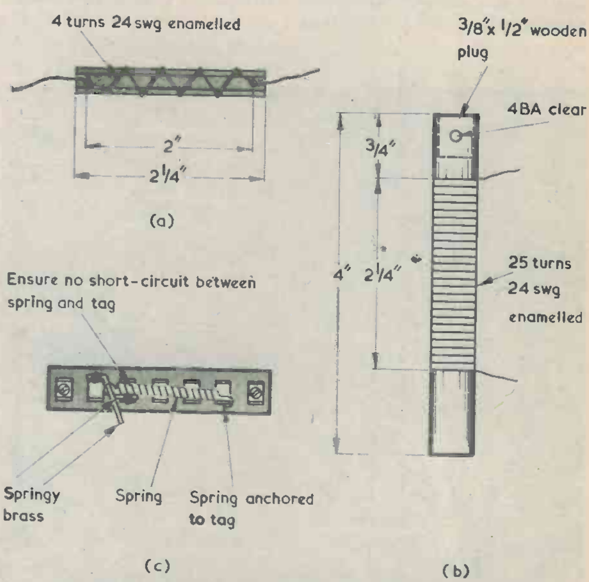


Fig. 3(a). Details of coil L1. (b). Coil L2 is wound in the manner shown here. (c). Switch S1 is home-made and part of it is shown here. The contact between the two brass strips is broken when the lower end of the longer strip is moved to the left.

paper from one 4in. side. Wrap the Fablon around the ferrite rod and stick it to itself with the exposed strip, making a tube which is fairly tight on, but removable from the rod. Cut a second piece of Fablon 4in. by 4in., remove a $\frac{1}{2}$in. strip of backing paper from one edge and wrap this round the other tube, which is already on the rod. Again use the exposed strip for fixing. Remove both tubes from the rod, discard the inner tube and replace the outer tube on the rod. Wind on 25 turns of 24 s.w.g. enamelled wire spaced out as shown in Fig. 3(a), and secure the ends of the winding with Sellotape or narrow strips of Fablon. Cut a $\frac{1}{2}$in. length of $\frac{3}{8}$in. diameter wood dowelling and insert it into the end of the coil having first wrapped on a turn or two of Sellotape to make it a tight fit. Drill a hole as shown to take a 4BA bolt.

The ferrite rod used in the prototype was Orange grade, and is available from Amatronix Ltd., 396 Selsdon Road, South Croydon, Surrey, CR2 0DE.

Next, take up the 18-way tagboard. This is an R.S. Components 'Standard' group panel, and it has outside dimensions of approximately 172 by 54mm. Cut out a 7 tag strip from the board, as illustrated in Fig. 3(c). Two of the contacts for S1 appear on this strip. Using a springy brass clip taken from an old 4.5 volt flash lamp battery, cut out and solder the switch sections shown in the diagram. The longer section is bent so that it presses against the short section which is soldered to the third tag from the left. In the first instance the long strip should extend about $\frac{1}{4}$in. below the tagstrip, but it may need to be cut back a little later when the drive drum is fitted to VC3. Although this may not prove essential, good contact is assisted by hooking a short metal spring through a hole in the longer strip and anchoring its other end to the sixth tag from the left. Make sure that the spring does not short-circuit against the third tag from the left. The tagstrip is secured later by passing small woodscrews through the holes in the two end tags.

Turn next to Fig. 4, which shows the components mounted on the plywood piece of Fig. 2(b). Cut four tagstrips from the 18-way tagboard, these having 1, 3, 4 and 6 tags respectively. Cover the plywood with small pieces of Fablon at the places where the 3, 4 and 6-way tagstrips will be mounted. This insulates the tags from the plywood. Fit the tagstrips with small woodscrews in the positions indicated. Ensure that the 6-way tagstrip will not foul VC1 when this component

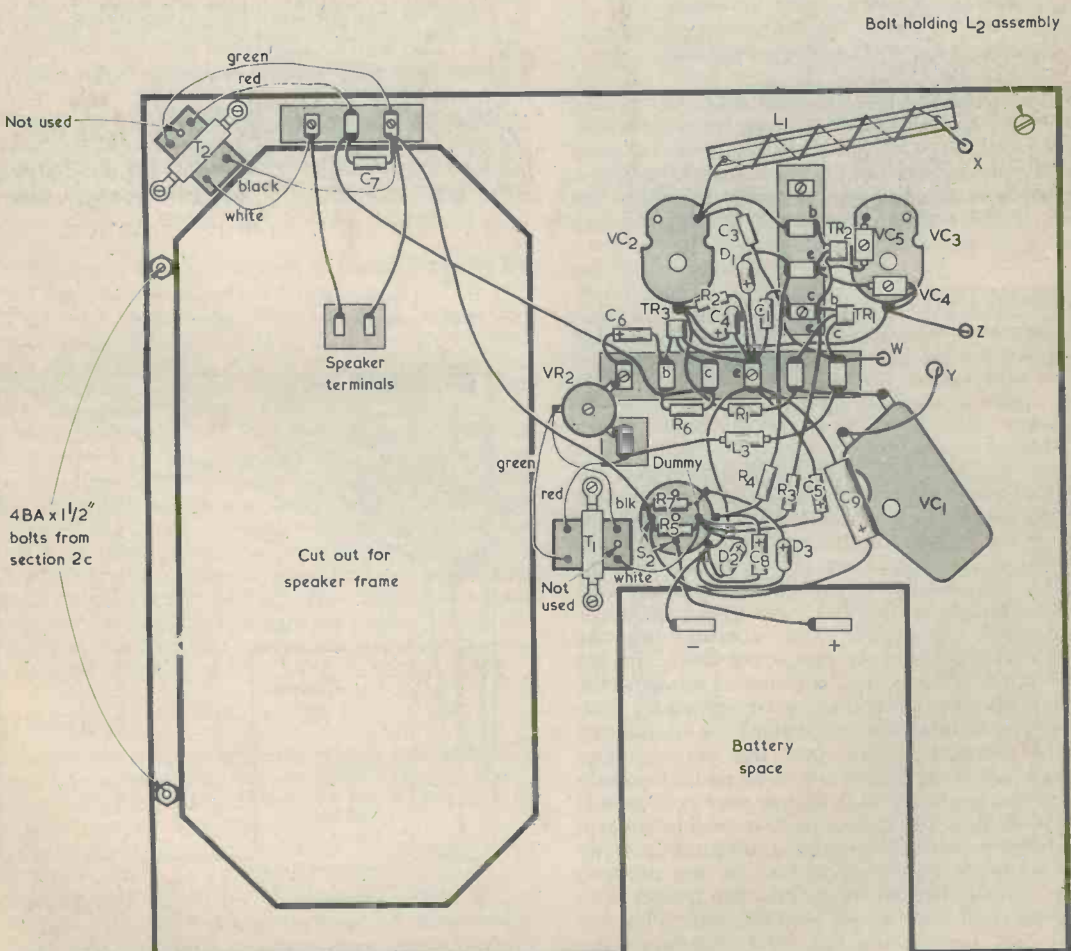
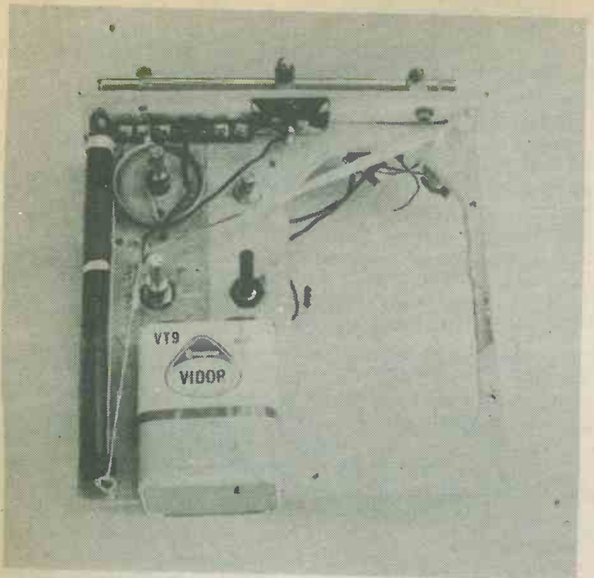


Fig. 4. Component and wiring layout on the panel of Fig. 2(b). Note that one tag of the unused pole of S2 is used as a dummy tag for the anchoring of components.



The component panel as seen from the front. This shows the tuning drum assembly actuating switch S1 with the ferrite rod almost completely out of the short wave coil.

is fitted. Mount VC1, VC2, VC3 and VR1. Also mount T1 and T2 by means of adhesive or by woodscrews passed through tags soldered to the feet of their clamps. Wire up all the small components as in Fig. 4, keeping leads as short as is reasonably possible. The two leads to the speaker and those passing through holes W, X, Y and Z are not connected yet.

RANGE SWITCH

Turn the panel over and refer next to Fig. 5. Take up the Jackson 4028 tuning drive drum, remove the grub screw and replace it with a 1in. cheesehead brass or nickel plated brass 4BA bolt. This projects outside the periphery of the drum and constitutes part of switch S1. It is, of course, automatically connected to the moving vanes of VC3 and VC2. Fit the drum over the spindle of VC3 and tighten up the 1in. bolt. Next stick a strip of Fablon to the plywood at the point which will be taken up by the tagstrip of Fig. 3(c), then screw the latter to the plywood as shown in Fig. 5 such that the head of the 1in. bolt can actuate the long brass strip contact as the drum rotates anti-clockwise. Note the two woodscrews which are partly screwed into the plywood on either side of the long brass strip. The one on the left is a switch stop and it prevents strain on the long brass strip by the drum being turned too far anti-clockwise. The woodscrew on the right is a roundhead type. It is screwed further into the plywood and causes the head of the 1in. screw to be sprung slightly away from the plywood as it passes over it. There is therefore a noticeable indent action which ensures that the long brass strip is moved adequately away from the short strip and maintained in that position when the drum is turned to operate the switch. The setting of the right hand screw is fairly critical but not excessively so. Loosen the 1in. bolt and rotate the spindle of VC3 so that this will be at minimum capacitance when the switch is operated. Tighten up the 1in. bolt again.

Pass a ⅞in. countersunk 4BA bolt through the hole at the top left in Fig. 5, and secure it with a single nut above the panel. Pass the dowelling end of the L2 assembly over the bolt and secure it with another nut on top. Insert the ferrite rod in the coil. Screw in the two screw-hooks as shown. These are of the type that are used with springy curtain wire. Tie a piece of nylon drive cord round the end of the 1in. bolt in the drive drum, wrap it round the drum then pass it through a tight-fitting grommet on the lower end of the ferrite rod. Adjust the cord in the grommet so that the latter is just against the lower screw-hook when switch S1 is actuated. Take the other end of the cord through the lower screw-hook and tie it to a length of 4-cord elastic as sold in women's underwear departments. The elastic passes through the upper screw-hook and is then anchored to a screw at the top right hand corner of the panel. As VC3 spindle is rotated the rod moves in and out of the coil, and the elastic and cord should be tied such that there is just a slight tension on the rod when it is most out of the coil. The natural stiffness of VC3 spindle should hold the rod steady against the pull of the elastic at other settings but if necessary a little extra friction between its knob and the front panel of the receiver can be incorporated later. Complete all the wiring shown in Fig. 5, including the wires which pass through holes W, X, Y and Z. The lead to the aerial is connected later. Fit Jackson type 4827 spindle extenders to the spindles of VC1 and VC3.

Take up the section of Fig. 2(c) and secure the speaker to it by means of two 1¼in. countersunk 4BA bolts at the two outside holes. Fit two further nuts to the screws and pass the plywood panel of Fig. 2(b)

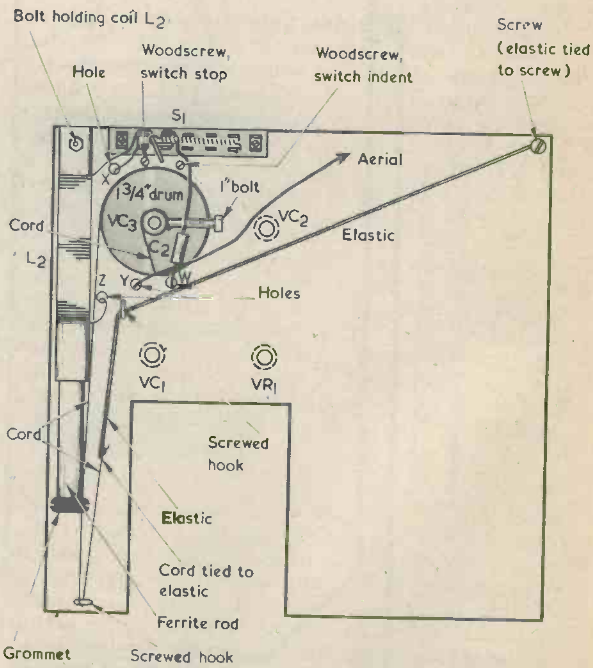


Fig. 5. The reverse side of the component panel, illustrating the mechanism of switch S1 and the manner in which the ferrite rod is moved in and out of coil L2.

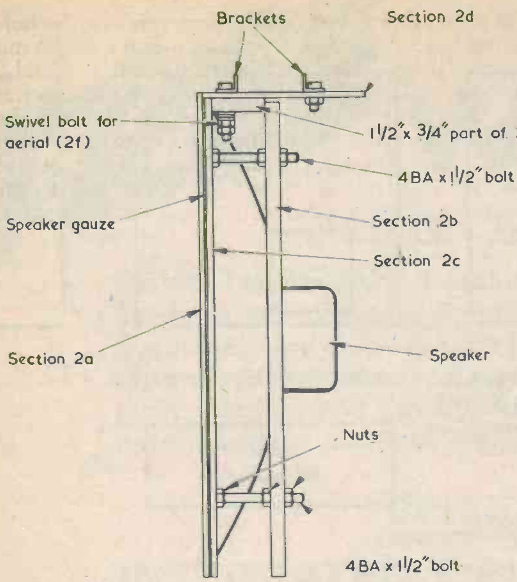


Fig. 6. Side view illustrating how the various sections of the receiver assemble together.

over these with two more nuts after it, as shown in Fig. 6. The spindle of VC2 should fit snugly into the ball drive on the section of Fig. 2(c). There should then be about $\frac{3}{4}$in. between sections Fig. 2(b) and Fig. 2(c). The next item to fit is section 2(d), which is also shown in Fig. 6.

The section of Fig. 2(d) is held in place by the $1\frac{1}{2}$ by $\frac{3}{4}$in. wooden part which was shown in Fig. 2(f) but which has not been made yet. This may now be cut out, and the position of the 4BA clear hole in it found by using the section of Fig. 2(d) as a template. All the clips of Fig. 2(e) and the $1\frac{1}{2}$ by $\frac{3}{4}$in. wooden part are then fitted to the piece of Fig. 2(d). The lead from hole Y is soldered to the aerial tag. The $1\frac{1}{2}$ by $\frac{3}{4}$in. piece is next screwed between Figs. 2(c) and 2(b) as indicated in Fig. 6, and the 4BA nuts on the $1\frac{1}{2}$in. speaker bolts are finally tightened up, as also is the grub screw in the ball drive. Fig. 2(e) showed two small 'holes for screws' and these may now be drilled. They allow small woodscrews to pass through into the upper end of the plywood section of Fig. 2(b). The screws pass through the Fablon which covers the part of Fig. 2(d).

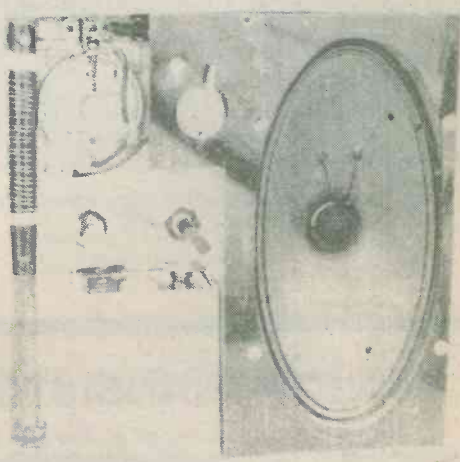
Finally solder the two connections to the speaker tags, as shown in Fig. 4.

TESTING

Receiver assembly is now sufficiently advanced for testing to be carried out. Adjust VR2 so that its slider is nearly fully clockwise, as seen in Fig. 4. Set VC1 to maximum capacitance, and adjust VC4 and VC5 so that they are about half a turn from maximum capacitance. Set VC3 to minimum capacitance so that S1 is operated to select the v.h.f. range. Switch on but do not turn VR1 further than is needed to operate S2. There should be quite a loud hiss. Advance VR1 (thereby reducing the current pasing through D1) and the hiss will reduce slightly. Continue to advance VR1 until a point is reached where the hiss increases again a little. This hiss indicates oscillation and denotes a state of sensitivity suitable for reception of f.m. signals. Rotate VC2, adjusting VR1 as may be necessary to maintain the oscillation hiss, and the three B.B.C. stations should be heard, as well as the local v.h.f. station if there is one. The vanes of VC2 will probably be about half enmeshed. Adjust VC4 until a position is found where the v.h.f. stations are at optimum strength with VR1 advanced by about one-quarter to one-half of its travel. Try different angles and directions for the aerial. In very strong signal areas, signal strength can be reduced by adjusting VC1, although on v.h.f. this control only starts to lower signal strength when it is very close to minimum capacitance. If necessary reduce the length of the aerial by closing some or, in extreme cases, all the sections. Adjust the slider of VR2 for maximum volume consistent with good quality.

When the v.h.f. stations have been received satisfactorily, VC3 is advanced, just beyond the switch indent position, to select short waves. The 13 metre band broadcast band should then be found when reception conditions are suitable, this being normally during the morning and early afternoon. For a.m., the most sensitive condition is given when VR1 is just short of the oscillation hiss point. Make sure that oscillation takes place satisfactorily at the high frequency end of the range (ferrite rod nearly fully out of the core) and readjust VC4 a little if necessary, checking back that all is still well at v.h.f. Now enmesh the vanes of VC3 fully, adjusting VC5 so that oscillation takes place at about the half-way setting of VR1. Stations on the 49 metre band should be available for testing here, preferably in the afternoon or evening. On the short wave bands a vertical position of the aerial will normally be best. When setting up is complete, VR1 may be treated as a volume-reaction control.

VC1 can be used with advantage as a selectivity control on the short wave bands. If interference is experienced, reduce the capacitance of VC1 and advance VR1 a little to keep the receiver nearly os-



Here, the loudspeaker panel is secured in front of the component panel.

cillating. The setting of VC1 will have some effect on the critical setting for VR1, but only a small effect on tuning. Sometimes a slight tendency to hand-capacitance difficulties may be overcome by a judicious setting of VC1.

If there should be any tendency for a growl or squeal to be heard just on the oscillation point, change over the connections to the red and green leads of T1. If this does not help, adjust VR2 to offer greater resistance between its slider and C6.

RECEIVER CASE

After testing has been completed, the front panel of Fig. 2(a) may be fitted in place. It is secured by two ½in. 4BA bolts at the 4BA clear holes, these passing also through the corresponding panel and speaker holes in the part of Fig. 2(c). The bolt heads are visible from the front and, to give a good appearance, they should preferably be nickel plated roundhead or similar. The speaker fabric is held between the two panels.

A suggestion for a suitable case appears in Fig. 7. The back is screwed to the sides and base as indicated, and the front is then screwed in position.

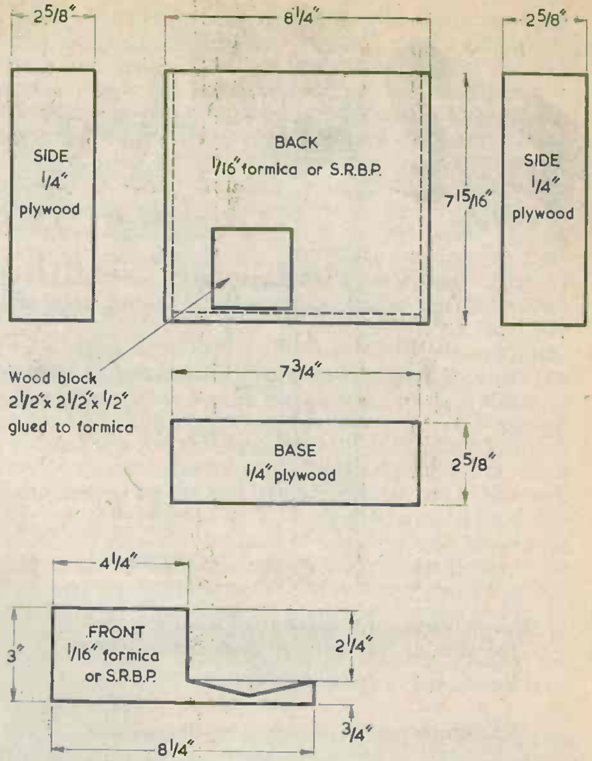
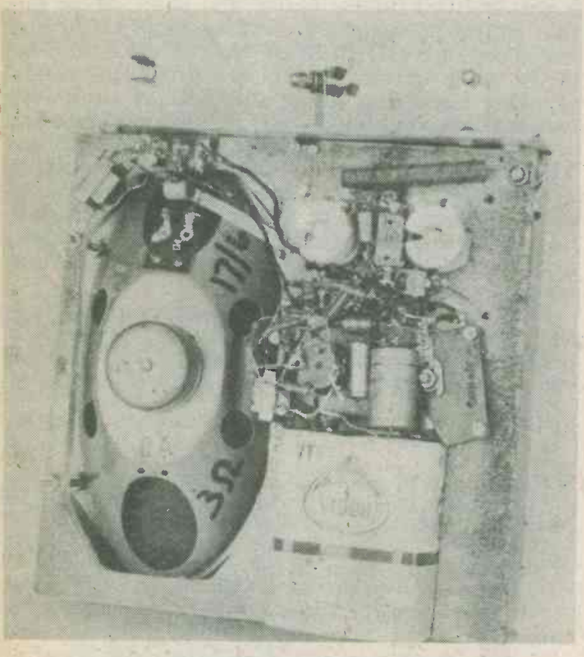


Fig. 7. Details of a suitable case for the receiver.



A rear view of the assembled component and loudspeaker panels.

The whole is covered in Fablon. The case width, depth and height dimensions given in Fig. 7 assume that the receiver 'chassis' has been made with extreme accuracy, and they should be looked on as a guide only. In practice, these case dimensions should be taken from the actual receiver itself.

The wooden block glued to the back is approximately behind the battery, and keeps it in position. The chassis is inserted from the top, and two simple clips may be devised to hold it in place. Finally to be fitted are legends indicating control functions. A short piece of wire can be affixed to the flange of the slow-motion drive, this projecting, parallel to the front panel, under the knob for VC2. The wire then acts as a pointer indicating the setting of this capacitor. ■

'NEW TRANSISTORISED OSCILLOSCOPE'

In this design, described in the last September, October and November issues, the 4μF 600V. Wkg. capacitor specified for C3 has now been discontinued. A suitable alternative is the polycarbonate 10% 440VAC 2μF capacitor advertised by Marco Trading elsewhere in this issue. Satisfactory e.h.t. smoothing is still given despite the lower capacitance.

FREE

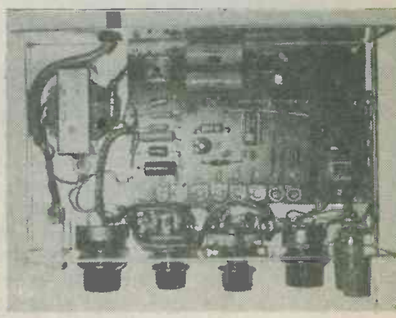
NEXT MONTH WALL CHART

DESIGN DATA TABLES — 1

SAVE TIRESOME CALCULATIONS — The Design Data Tables list both capacitive and inductive reactances at radio and audio frequencies. Also given are the resistance and capacitor values required in symmetric multivibrators running at audio frequencies, sinusoidal a.c. peak, average and r.m.s. values, decibel ratios up to 100dB, maximum potentiometer currents and information on copper wire gauges.

SPECIAL FEATURES

INTEGRATED L.F. FUNCTION GENERATOR — Part 1 (2 parts)

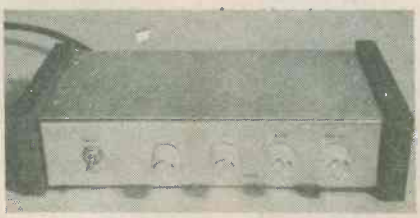


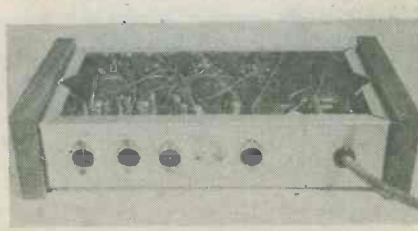
Offering triangular, square and sine wave outputs from 0.1Hz to 100kHz, this function generator is built around the Intersil 8038 integrated circuit. The use of this i.c. enables a relatively simple assembly procedure to be adopted.

Construction and setting up will be described in following month.

4 CHANNEL STEREO MIXER

A comprehensive design which allows four separate stereo signals to be combined at any required mixing level.





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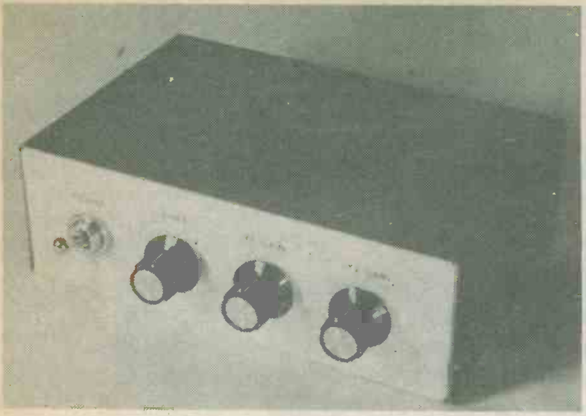


OSCILL
TRACE

By A. R

Employing a novel technique, this c... to the oscilloscope on e...

Virtually everyone who possesses a single beam oscilloscope will eventually find it desirable to convert their instrument to double trace operation by adding a trace doubler at the input. This additional facility is extremely useful, as it enables the phase relationship of two signals to be displayed by the oscilloscope, and it also allows simultaneous voltage measurements of two signals to be made. In fact there are many occasions when it is necessary to display two waveforms simultaneously, and a trace doubler makes an extremely useful oscilloscope accessory.

A comprehensive trace doubler having integral pre-amplifiers and an upper bandwidth limit of several megahertz is of necessity an extremely complicated design. However, most amateur constructors will only require a trace doubler for work at audio frequencies, and a suitable unit for such work can be easily constructed at low cost. It is a simple instrument of this type which forms the subject of the present article.

BASIC OPERATION

The basic principle of operation of the device is illustrated by the block diagram shown in Fig. 1. A negative-going pulse, obtained from the oscilloscope timebase during flyback, is passed to the first stage.

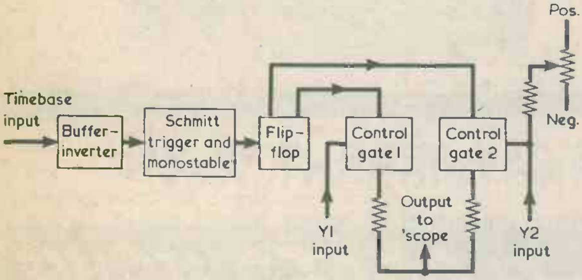


Fig. 1. Block diagram for the trace doubler, illustrating the individual stages.

COMPO

Resistors
(All fixed values ¼ watt 5%)
- R1 220kΩ
- R2 27kΩ
- R3 10MΩ
- R4 4.7kΩ
- R5 3.9kΩ
- R6 220Ω
- R7 2.2kΩ
- R8 56kΩ
- R9 33kΩ
- R10 33kΩ
- R11 2.7kΩ
- R12 2.2kΩ
- R13 56kΩ
- R14 2.7kΩ
- R15 5.6kΩ
- R16 5.6kΩ
- R17 1.5kΩ
- VR1 5kΩ potentiometer, carbon linear
- VR2 5kΩ potentiometer, carbon linear
- VR3 47kΩ or 50kΩ potentiometer, carbon linear

Capacitors
- C1 0.1µF plastic foil, type C280 (Mullard)
- C2 100µF electrolytic, 10V Wkg.
- C3 32µF electrolytic, 10V Wkg.
- C4 0.0047 F or 0.005 F paper or plastic foil
- C5 680pF polystyrene or silvered mica

OSCOPE

OUBLER

by

P. Roberts

trace doubler presents alternate inputs
ach succeeding trace sweep.

ONENTS

C6 0.01μF ceramic plate or plastic foil
C7 0.01μF ceramic plate or plastic foil
C8 680pF polystyrene or silvered mica
C9 100μF electrolytic, 10V Wkg.

Semiconductors
IC1 74121
TR1 2N3819
TR2 BC109
TR3 BC109
TR4 BC109
TR5 BC109
D1 BZY88C5V1
D2 OA91
D3 OA91

Sockets
SK1-SK4 3.5mm. jack sockets

Switch
S1 s.p.s.t., toggle

Miscellaneous
Case, Samos type S3 or similar (see text)
PP6 battery (Ever Ready)
Battery connector
3 knobs
Plain perforated s.r.b.p. board, 0.1in. matrix

This is a buffer-inverter which presents a high input impedance (10MΩ) to the timebase signal, and inverts it so that the negative-going pulse becomes a positive pulse.

A Schmitt trigger and monostable multivibrator are triggered by the pulse to produce a further brief positive-going pulse. Thus, this pulse appears during the oscilloscope flyback period, and any sawtooth signal has been effectively removed. The output pulses from the monostable are of a constant width which is independent of the timebase frequency, and they can be used to reliably operate a conventional flip-flop, or divide-by-two, circuit.

The flip-flop has the usual two outputs, and the circuit is only stable when one or other of these outputs is high and the other is low. Each successive pulse from the monostable causes the flip-flop to change state, the low output going high and the high output going low.

Each of the two flip-flop outputs operates a control gate. The Y1 input is taken to one gate and the Y2 input to the other gate. The two gate outputs are combined in a passive mixer, and the output from this is connected to the Y input of the oscilloscope.

The control gates only enable the signals at their inputs to pass when they are receiving a flip-flop control voltage which is low. The result is that only one signal at a time can reach the oscilloscope, as only one output of the flip-flop is low at any one time.

What actually happens is that one input is fed to the oscilloscope for one complete sweep of the trace, then during flyback the flip-flop changes state and the other input is fed to the oscilloscope for the next complete sweep. The changeover of inputs continues in rapid succession and, provided the timebase frequency is not less than some 50Hz, persistence of vision will give the impression that there are two separate and continuous traces on the screen.

In order to enable the two traces to be placed one above the other on the screen, a d.c. shift potential can be fed to the Y2 signal. The resulting potential difference between the two signals spaces them slightly apart on the oscilloscope screen.

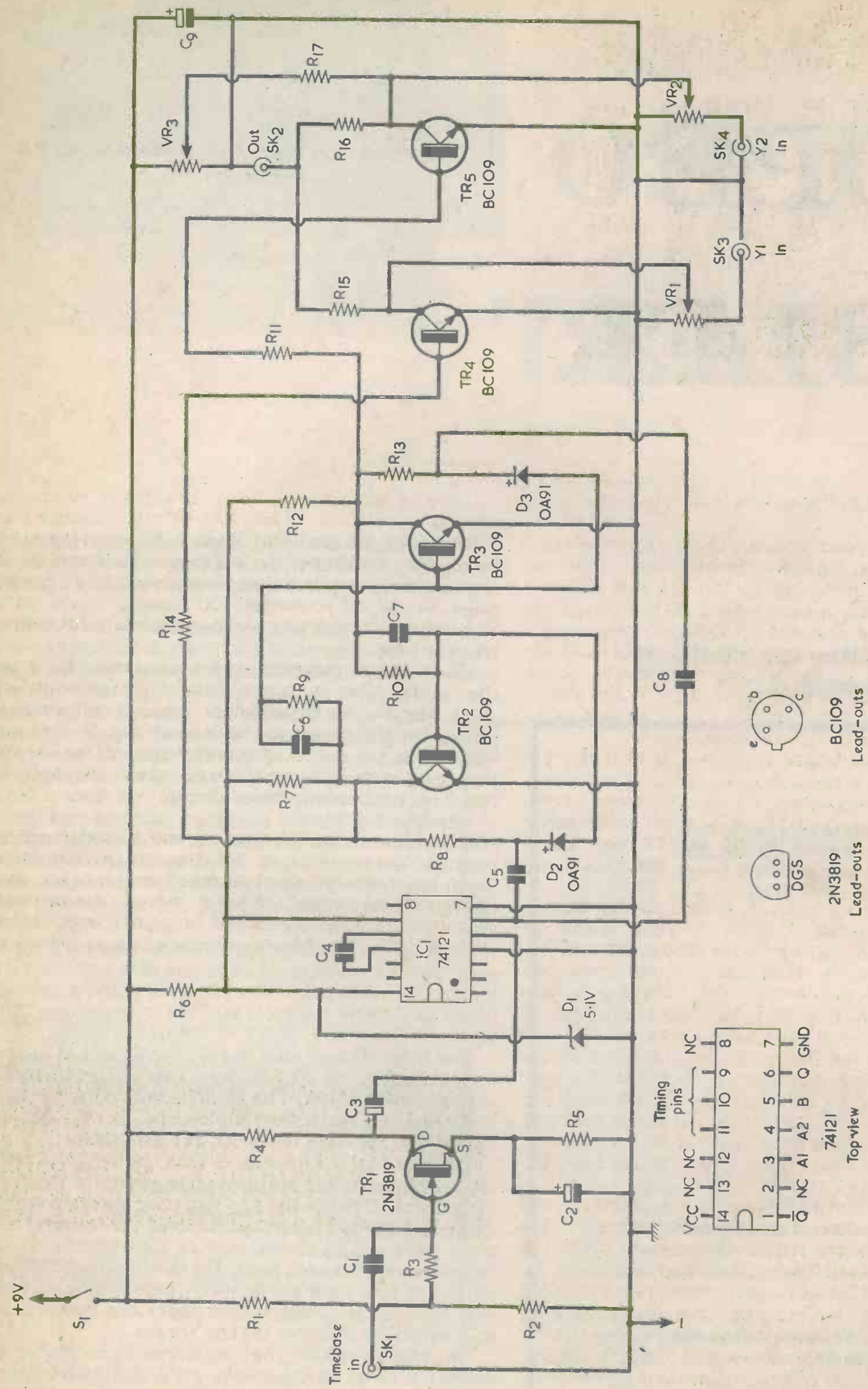
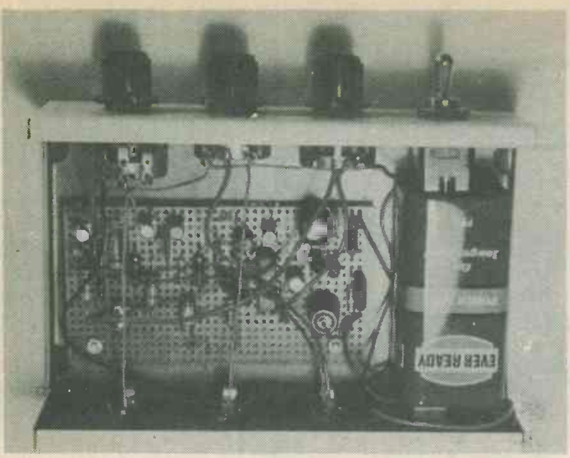


Fig. 2. Complete circuit for the oscilloscope trace doubler. Power is provided by a 9 volt battery.



The component board fits comfortably into the internal layout.

THE CIRCUIT

A complete circuit diagram of the trace doubler is shown in Fig. 2.

A jugfet, TR1, connected in the common source mode provides the buffer-inverter stage. This has offset gate biasing provided by R1, R2 and R3.

The output of TR1 is coupled via C3 to a 74121 i.c. which contains the Schmitt trigger and monostable circuits. There are three inputs to the 74121, and the one which is used in the present application is the positive edge Schmitt trigger input at pin 5. For this to operate, one of the other inputs (pin 4 in this case) must be connected to the negative supply.

Timing components are contained within the i.c. but these provide a pulse length which is too short, and the external capacitor, C4, is connected across pins 10 and 11 to lengthen the pulse. The zener stabilizing circuit formed by R6 and D1 provides a regulated 5.1 volt supply for the 74121, and this is also used to power the flip-flop.

TR2, TR3 and their associated components form a conventional flip-flop circuit having speed-up capacitors C6 and C7 and steering diodes D2 and D3. These diodes ensure that the pulses from the monostable are directed to the base of the appropriate transistor in the flip-flop, and thus cause the circuit to change state with each successive pulse.

The Y1 input is applied to the collector of TR4 via the Y1 gain control potentiometer, VR1. The Y2 input is similarly applied to the collector of TR5 via VR2. When the collector of TR2 is high, TR4 is biased hard on by the current which flows through R14 to its base. During this period TR3 collector will be low and TR5 will receive no bias current.

The Y1 signal is blocked by the low impedance path to chassis via the collector and emitter of TR4, but the Y2 signal can pass via R16 to the output. When the flip-flop changes state, TR5 will turn on and block the Y2 signal, whilst TR4 will turn off and permit the Y1 signal to pass to the oscilloscope. Thus the Y1 and Y2 signals are alternately coupled to the oscilloscope.

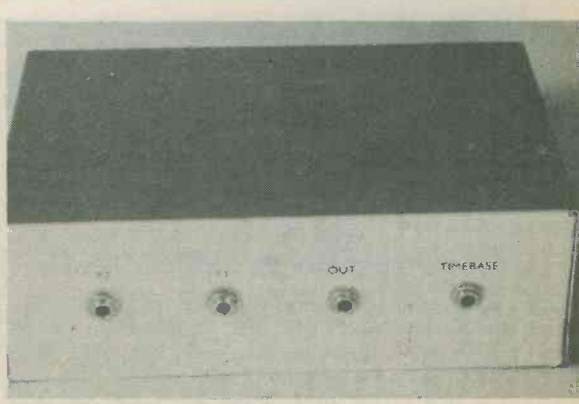
A d.c. potential is applied via R17 to the Y2 input. VR3 controls the level of this voltage and so also controls the separation of the two traces. R15 and R16 form a conventional passive mixer, and prevent interaction between the two gates.

CONSTRUCTION

The prototype is housed in a ready made p.v.c. covered steel case which has external dimensions of 150mm. by 100mm. by 50mm. This is the Samos case type S3, available from Doram Electronics. Any similar case can be used, provided it is of the same size or slightly larger. A smaller case is not recommended as there would be insufficient space for all the parts.

Most of the components are assembled on a small perforated plain s.r.b.p. ('Paxolin') panel with 0.1in. hole matrix. The component layout and underside wiring of the panel are shown in Fig. 3. The panel should be cut out to the correct size (37 by 20 holes) using a small hacksaw, and then the two 6BA clearance mounting holes drilled out with a No. 31 twist drill.

One by one, the components are mounted and connected up according to the diagram. Where component leads are too short to reach one another, extension wires of around 22 s.w.g. tinned copper may be soldered on. Sleeving should be passed over any wire if it is felt that there is a risk of short-circuit to a



A view of the sockets on the rear panel.

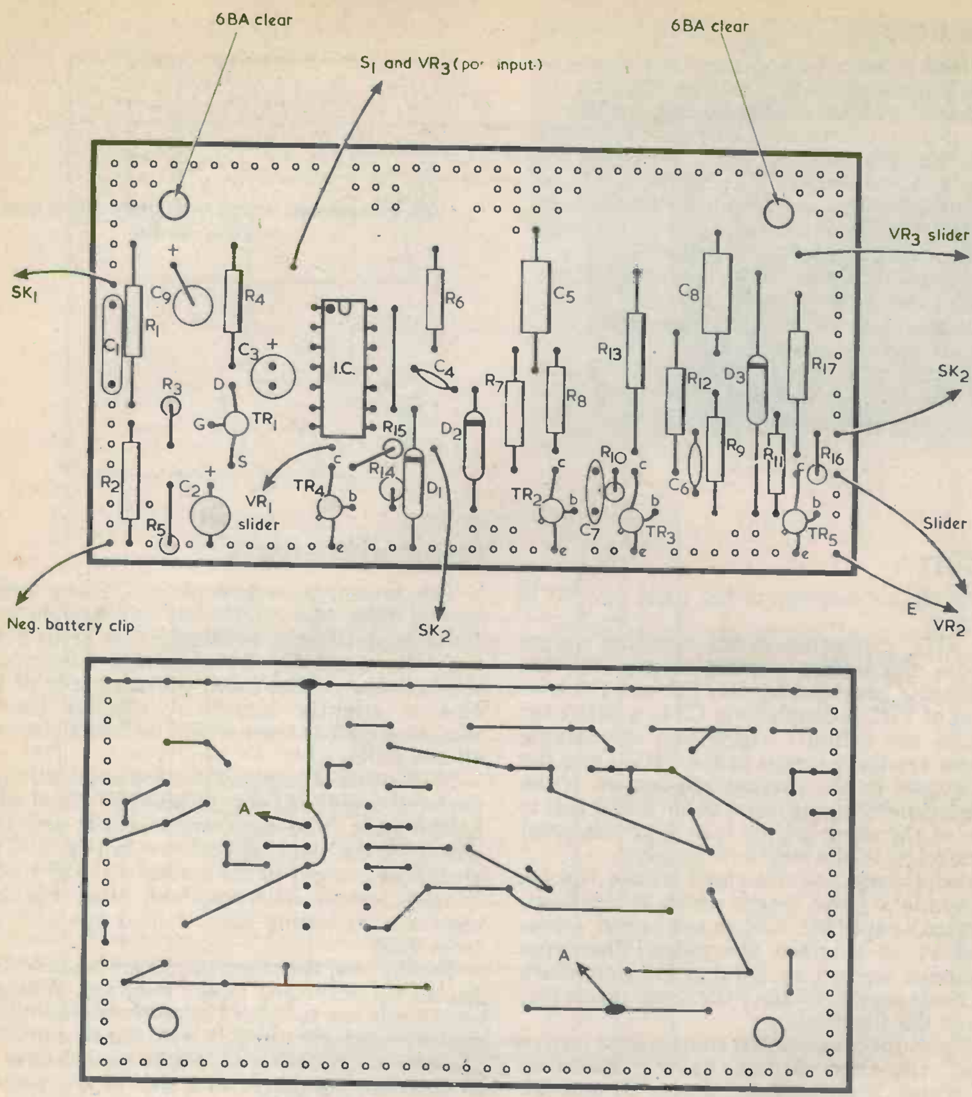


Fig. 3. The smaller components are assembled on a plain perforated s.r.b.p. board. The upper view shows the component layout, whilst the lower view illustrates the wiring underneath the board.

neighbouring wire. An insulated link wire on the underside of the panel connects together the two points 'A'.

Details of the layout of the unit can be seen from the photographs. The completed component panel is mounted by two ½in. 6BA bolts. Extra nuts are placed over these bolts between the case and the panel, and these serve to space the panel underside clear of the bottom of the case.

The four controls are positioned symmetrically along the horizontal centre line of the front panel. From left to right, these are S1, VR3, VR1 and VR2. The four sockets are similarly laid out on the rear panel. Looking at the rear panel, SK4 is at the left-hand end (i.e. at the same end as VR2), with SK3 next to it, then SK2 followed by SK1 at the right hand end.

The lead from the panel marked 'E' in Fig. 3 connects to the earthy tag of VR2. Insulated leads connect this tag to the earthy tags of the other potentiometers, and to the earthy tags of the sockets. The mounting bushes of the latter automatically provide the chassis connection to the case. The wiring between VR1 and SK3, between VR2 and SK4, and between S1 and the battery is next completed. Signal-carrying leads are not screened but they should be kept reasonably short. The flying leads from the panel shown in Fig. 3 are also wired to the appropriate points, as indicated.

There is just enough space for a PP6 9 volt battery on the left-hand side of the case. This has a good operational life, since the current consumption of the trace doubler is about 20mA only.

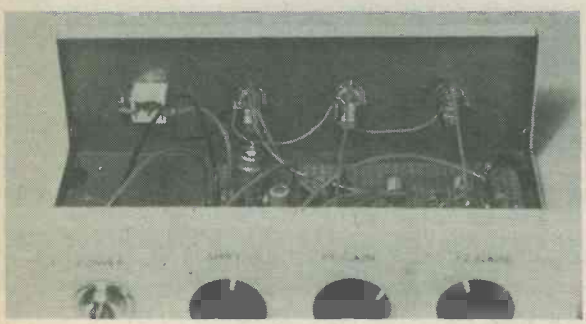
USING THE UNIT

A screened lead is required to connect the output of the unit to the Y input of the oscilloscope, whilst a second screened lead couples the oscilloscope timebase to socket SK1 of the trace doubler. These leads should be as short as it practicable.

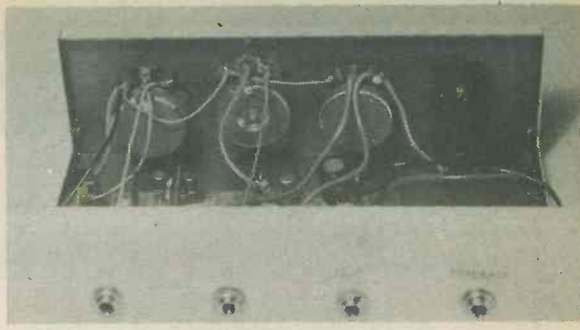
The author's transistorised oscilloscope has a timebase output of 4 volts peak-to-peak and this is connected directly to the timebase input of the trace doubler. Oscilloscopes employing valves often have a larger output than this. If the timebase output is more than about 20 volts peak-to-peak it would be advisable to attenuate this to a lower and safer level, say to about 10 volts peak-to-peak.

The input impedances of the unit are low. This is essential since the series resistances in the inputs are also low to minimise phase shifts and to ensure that the overall frequency response is affected as little as possible. The extent to which signal phase and frequency response are modified by the presence of the trace doubler is entirely dependent upon the input capacitance of the oscilloscope, but neither are likely to be affected by any significant amount in ordinary audio frequency work.

There is, of course, a limit to the maximum timebase frequency at which the trace doubler can give satisfactory operation. This point should not be a disadvantage in general audio work as the upper limit to timebase frequency is at about 20kHz.



Connections to the jack sockets. An insulated socket was employed for SK1 in the prototype, but a standard open type would normally be fitted.



The wiring to the three potentiometers on the front panel.

It is unlikely that the low input impedance of the unit will be a great drawback when testing low impedance transistor circuits. On the few occasions when a higher input impedance has been required the author has used a pre-amplifier ahead of one input.

Due to the simple method of gating employed it is important that input signals having high potentials or very low impedances should not be applied to either input with the relevant gain control fully advanced. This is because TR4 and TR5 place virtual short-circuits across the inputs during the periods when they are turned on, and these transistors, the gain controls, the apparatus from which the input is taken, or even all three, could be damaged as a result of the high current that would flow. Also, the input signals should not cause the 20 volt maxiumum V_{CEO} rating for the BC109's used for TR5 and TR5 to be exceeded.

Therefore, when feeding the trace doubler from a high voltage or low impedance source, either couple to the input via an attenuator or turn back the appropriate gain control.

The system used here of synchronising the gating to the timebase signal is more complicated than the popular method of controlling the gates by an astable multivibrator, but the traces lose no definition with the present system which is often not the case with the multivibrator method. This system is especially advantageous when used with one of the simpler oscilloscopes having a comparatively limited upper bandwidth, and with which the multivibrator method of trace doubling often produces a badly distorted trace. ■

CATALOGUE

Now available under the title "Henry's Radio and Transonics Catalogue" is the 11th Edition of the well-known Henry's Radio Catalogue. This offers an increased range of products compared with previous catalogues and has adopted a new method of presentation in which like items are grouped together.

There are eight of these groups, followed by a ninth which consists of a price/code supplement. The supplement will be published quarterly, to keep abreast of the unstable price situation. The catalogue also has an index to enable specific items to be located.

To give an idea of the method of listing catalogue items, Group D includes transistors, thyristors, rectifiers, crystals, integrated circuits, triacs, valves and diodes. Another Group, G, covers test equipment ranging from complete oscilloscopes to individual panel-mounting meters, and taking in a wide selection of testmeters. Other groups offer intercoms, amplifiers, hi-fi equipment, calculators and many more items.

The catalogue is available from Henry's Radio Ltd., 303 Edgware Road, London, W2 1BW, for 50p plus postage as advised in Henry's Radio advertisements. Each catalogue includes a Discount Voucher with a value of 50p.

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

In the past two issues we have been dealing with the subject of Dx transmissions from the East and Far East, now continuing with some of the most difficult of all stations to receive — the Indonesians.

RRI Ujung Padang operates with 50kW on **4720** from 1225 to 1520, the best time to listen for this one being from around 1400 but do not be surprised if you find it on **4719**, it was there the last time we logged it!

RRI Jakarta on a nominal **4805** with a power of 20kW is probably the easiest Indonesian to receive and certainly the most consistent with regard to reception here in the UK, they have been reported in the SWL press virtually throughout last year. Listen from 2150, when they open with a series of chimes (interval signal) followed by identification and a newscast.

RRI Jambi is another regular here in the UK, despite the low power of 7.5kW. Listen on **4927** from around 1530, the station closing at 1600 with an appealing melody "Love Ambon" rendered on a Hawaiian guitar. The schedule is from 2200 to 0100 and from 1000 to 1600.

On **4955** we have Banda Aceh with a power of 10kW, opening transmission at 2200 and closing at 1600 — the two best times to log this one. The full schedule is from 2200 to 0100, 0500 to 0800 and from 1000 to 1600.

Then of course there are those terribly difficult signals from far away New Guinea — but more about these next month.

CURRENT SCHEDULES

● ISRAEL

The Israel Broadcasting Authority operates an External Service in English to Europe from 0500 to 0515 on **5900, 7395, 9009, 9815, 11643, 12025, 15240 15405** and **17685**; from 1200 to 1230 on **11643, 12025, 15100, 15240, 15405, 15485, 17685** and **17815**. The evening schedule is from 2000 to 2055 on **7395, 9009, 9495, 9815, 11643, 12025** and on **15240.**

For those of our readers who speak the Hebrew language, a relay of the Domestic Service 2nd Programme is beamed to Europe as follows:— from 0400 to 0600 on **7413, 9400** and **12080**; from 0600 to 1845 on **12080** and **15513**; from 1900 to 2000 on **9400** and on **12045.**

● CHILE

"Radio Nacional La Voz de Chile", Santiago, presents an External Service in English to Europe and the Americas from 1215 to 1230, 1330 to 1350, 1450 to 1510, 0010 to 0030, 0130 to 0150, 0250 to 0310 and from 0410 to 0430 on **6190, 11810** and on **15150.**

● CHINA

Transmissions from Foochow on **4975** will interest the Dxer. Programmes for local comsumption are radiated from 2050 to 0540; from 0740 to 1600; those directed to Taiwan being from 1600 to 1810.

Another Chinese regional station is Silinhot on **4952** which radiates the Home Service 1 from 2200 to 0100 and from 0950 to 1500.

● DAHOMEY

Cotonou may be heard on **4870** where it operates in French, English and vernaculars from 0515 to 0830 Mondays to Fridays and from 1615 to 2300 daily (except Saturdays from 1600, Sundays from 1630).

● INDIA

Hyderabad on **4800** is on the air from 1130 to 1830 and a newscast in English can often be logged at 1530.

● 60 METRE BAND USSR STATIONS

There are a number of USSR stations now currently operating on the 60 metre band (**4750** to **5060kHz**) which unfortunately for Dxers, at least in some cases, mask the underlying Dx transmissions. The number of Soviet transmitters has grown apace in recent years, most of them providing a local service. For those readers who wish to log these stations the result of a recent survey by the writer is published here.

Petrozavodsk on **4780** at 0355, light music with YL and OM (young lady and old man — see under following heading) announcers. Petrozavodsk is on the shore of Lake Onega (northeast of Leningrad) and is scheduled from 0200 to 2100 relaying Moscow 1 except for the period from 1500 to 1530 when local programme is presented. Petrozavodsk can also be heard in parallel on **5065.**

Baku on **4785** at 0305, light musical programme. This is the Baku Relay with the Baku 1 programme in Azerbaijani and Armenian scheduled from 0157 to 2100 and the Moscow 1 programme from 2100 to 2200. Also in parallel on **9840.** Baku is on the western shore of the Caspian Sea.

Yerevan on **4810** at 1943, local pops with vocals, dance music. This transmission is in the Yerevan 2 programme scheduled from 1300 to 2000, the Yerevan 1 programme being radiated from 0200 to 1300. Yerevan is just over the border with Turkey.

Khanty-Mansiysk on **4820** at 1745, YL and orchestra with operatic selections. The schedule of this transmitter is from 0100 to 2000 relaying the Moscow 2 programme. Khanty-Mansiysk is on the West Siberian Plain on the banks of the river Irtysh.

Ashkabad on **4825** at 1947, classical music, OM announcer. The schedule is from 0100 to 0000 relaying Moscow 1, 2, and a local programme in Turkmen (times unknown). Ashkabad lies at the foot of the Kopet Mountains just over the border with Iran and to the south of Kara Kum (Black Sand Desert) in Turkmenistan SSR.

Tyumen on **4895** at 1750, OM with a talk in Russian. This transmitter relays Moscow 1 from 0100 to 2005 except for local programmes from 0235 to 0300 Monday to Friday (Saturday from 0230); 0315 to 0400; 0420 to 0430; 1445 to 1530. On Saturdays from 0420 to 0430 and from 0515 to 1600. On Sundays from 0215 to 0300.

Kiev on **4920** at 1829, dance music, OM announcer in Slovak. This transmitter is one of several USSR 60 metre band stations that (a) only operate for part of the year on the frequencies stated and (b) radiate the Moscow Foreign Service either wholly or in addition to purely local programmes. Kiev operates on this channel from September to April (this year commencing operations on September 7th) radiating the Moscow Foreign Service in German and Slovak from 1400 to 2200, which also includes a relay of the Moscow 1 programme. Dxers then can cease to look for Brisbane on this channel around 2000 during the above period. Kiev is on the banks of the Dnieper river in the Ukraine SSR.

Kiev on **4940** at 1915, chimes interval signal, identification "Govorit Kiev". This is Kiev 2 in Ukrainian, scheduled from 0300 through to 2200.

Yerevan on **4990** at 1919, dance music with OM announcer. On this channel, Yerevan radiates the Moscow Foreign Service from 1730 to 2200, Moscow 1 from 1300 to 1630 and the local programme from 0200 to 1300. This transmitter was formerly on **7275**.

Archangelsk on **5015** at 2127, classical music, piano solo. This station relays Moscow 2 from 0200 to 2200. Archangelsk is a White Sea port at the mouth of the river Dvina.

Alma Ata on **5035** at 1922, OM with a talk in Standard Chinese. Relays Moscow 2 from 2100 to 1230, the Tashkent/Alma Ata Foreign Service in Kazakh and Uigher from 1230 to 1630 and the Moscow Foreign Service in Chinese from 1630 to 2100. Alma Ata is in the Kazakhstan SSR is near the Sinkiang-Uigher (north of Tibet and also a province of China) border.

Tbilisi on **5040** at 0348, light classical music, YL announcer. This is the Tbilisi programme 1 which is scheduled from 0200 to 2105 in Georgian, Russian, Armenian and Azerbaijani. Tbilisi lies to the south of the Caucasus Mountains, in the Georgia SSR.

Logging the USSR stations on the 60 metre band can be quite interesting but it should be mentioned that some of the channels are occupied by more than one USSR transmitter. For instance, on **4860** there is Moscow, Sverdlovsk and Chita. To sort them out here are the details. — Moscow with the Foreign Service to USA and Canada in English, Spanish and Ukrainian alternate from 2200 to 0500, Moscow 2 from 0500 to 0600 and 2000 to 2200, Moscow 3 from 0600 to 2000. Sverdlovsk with Moscow 2 from 2000 to 0100 and from 0200 to 0600, Moscow 3 from 0600 to 2000. Chita with Moscow 2 from 0800 to 1430.

As a Dxer, one could always try for Vladivostok on **5015** (relays Moscow 2 1600 to 1900, local programmes from 1900 to 1500 with the exception of Foreign Service programmes to the N. Pacific on Sundays, Wednesdays, Fridays and Saturdays from 0700 to 0800 and from 1900 to 2000). Or why not try for remote Ulan Bator in Mongolia? The schedule is from 2155 to 1500 with the Home Service 1, the time period stated also including a relay of the Moscow Foreign Service in Mongolian from 0600 to 0650, 0930 to 1000 and from 1315 to 1400 and the Chinese and Russian programmes from 1030 to 1100 (except Wednesdays, Saturdays and Sundays).

● OM and YL

These two contractions merely stand for Old Man and Young Lady. In the early days of amateur radio when the morse code was the main method of communication many such contractions were used — their usage eliminated a lot of dots and dashes. Today many of these contractions are still used even where the mode used is AM or SSB and most certainly where CW (continuous wave or Morse) is "fisted".

The convention that a lady is forever young and a man continually old is, I must confess, one of the more gallant aspects of amateur radio!

AROUND THE DIAL

● SINGAPORE

Radio Singapore on **5052** at 1532, OM with a newscast in English, station identification at 1535.

● MOZAMBIQUE

Com Phumo (formerly Mozambique) on **4923** at 1759, ON in Portuguese, single chime and identification at 1800. The country is now termed the Popular Republic of Mozambique (unless it changes by the time this appears in print)

● HONDURAS

Radion Progresso, El Progresso, on **4920** at 0447 with Latin American music, identication in Spanish at 0449 and world news at 0450. The schedule of this one is from 1100 to 2200 (1.5kW) and from 2200 to 0530 (10KW).

● COSTA RICA

Radio Capital San Jose, on **4832** at 0437 with a programme of (surprisingly) light music, identification at 0440.

● BRAZIL

Radion Clube do Para, Belem, on **4855** at 0320, seemingly endless talk in Portuguese, commercials with echo effect at 0325.

● INDONESIA

RR1 Banda Aceh on **4955** at 2220, YL with Arabic-type song, local music, OM announcer. This channel is often subject to commercial interference making the reception of Banda Aceh a somewhat difficult matter at times. Schedule is from 2200 to 0100, 0500 to 0800 and from 1000 to 1600, the power being 10kW.

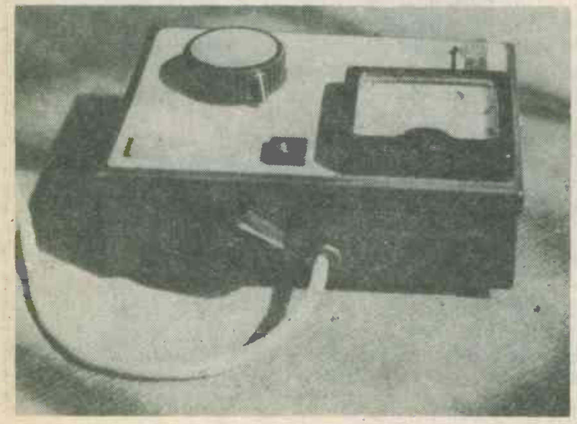
● SRI LANKA

Colombo on **4902** at 2048, YL with song, bells, gongs then chants. This is the Home Service 1 In Sinhala, heard on a full moon day. Schedule is from 0015 to 0230, from 1125 to 1730 daily. On full moon days from 1030 to 0800.

COMPACT STABILIZED POWER SUPPLY

By S. V. Essex

Offering a continuously variable output voltage from 1 to 20 volts at currents up to 200mA, this stabilized power supply has complete overload and short-circuit protection. It is designed to be assembled in an extremely small metal case.



The stabilized power supply gives a high level of performance in an extremely compact housing

A low voltage power supply which eliminates the need for batteries when experimenting with transistor circuits is one of the most useful items of equipment in any workshop. To be as useful as possible it should have a wide range of output voltages, but it need not have a high current rating since the current drawn by most transistor circuits is usually only small. The unit described in this article was designed to provide a stabilized continuously variable output voltage from about 1 to 20 volts, at a maximum output current of 200mA. An overload and short-circuit protection circuit has been incorporated to render the supply virtually destruction-proof. With care, the supply can be built in an aluminium box measuring only 5¼ x 4 x 1½in., resulting in a very compact unit which takes up little space on the (usually overcrowded) experimenter's workbench.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. The mains input is applied, via fuse F1 and switch S1, to the primary of the mains transformer, T1. This has a neon indicator connected across it to show when the power supply is switched on. The transformer has two secondary windings, each providing 12 volts. These are connected in series to give 24 volts, which is

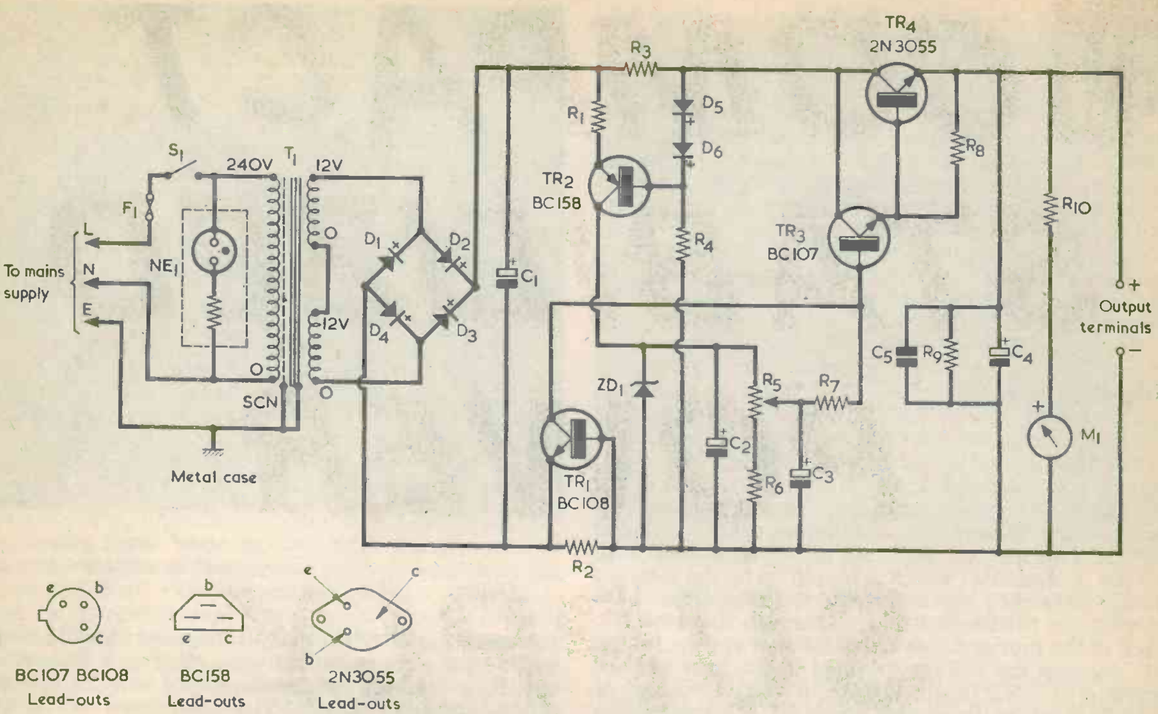


Fig. 1. The circuit of the stabilized power supply. This has several unusual features to improve overload performance and output voltage stability

COMPONENTS

Resistors
(All fixed values ¼ watt 10% unless otherwise stated)
R1 100Ω 5%
R2 2.7Ω ½ watt 5%
R3 1.5Ω ½ watt 5%
R4 15kΩ
R5 10kΩ potentiometer, linear
R6 1kΩ 5%
R7 220Ω
R8 2.2kΩ
R9 4.7kΩ
R10 see text

Capacitors
C1 2 X 800μF electrolytic, 40 V. Wkg., type C431 (Mullard)
C2 50μF electrolytic, 25 V. Wkg., type C426 (Mullard)
C3 50μF electrolytic, 25 V. Wkg., type C426 (Mullard)
C4 250μF electrolytic, 25 V. Wkg., type C426 (Mullard)
C5 0.47μF polyester

Transformer
T1 Miniature Mains Transformer, secondaries 0-12V 3VA, 0-12V 3VA (R.S. Components)

Semiconductors
TR1 BC108
TR2 BC158
TR3 BC107
TR4 2N3055
D1-D4 silicon bridge rectifier type REC70 (R.S. Components)
D5 1N4001
D6 1N4001
ZD1 BZY88C22V

Meter
M1 moving-coil meter (see text)

Switch
S1 Illuminated S.P.S.T. Rocker Switch (R.S. Components)

Neon
NE1 part of S1 assembly

Fuse
F1 100mA cartridge fuse, 20mm.

Miscellaneous
Aluminium box type AB10, 5¼ x 4 x 1½in. (see text)
Chassis mounting fuse holder
Knob
Insulating washer and bushes (for TR4)
Veroboard, 0.15in. matrix
4 rubber feet
Metal for capacitor clip
3-core mains lead
Mains lead clamp

applied to the bridge rectifier consisting of the four diodes D1 to D4. The d.c. output from these is smoothed by the reservoir capacitor C1, and is then passed on to the regulating and stabilizing circuit.

TR4 and TR3 are connected as a Darlington pair emitter follower, giving a very high current gain and a voltage gain of almost unity, i.e. the voltage at the emitter of TR4 follows the voltage at the base of TR3. Thus the output voltage can be varied by varying the voltage at TR3 base, which is connected to the slider of R5 via the low value resistor R7. R5 taps off a proportion of the reference voltage developed across the zener diode ZD1, and acts as the output voltage control.

Now, the voltage developed across the zener diode, as can be seen from the zener slope resistance characteristic shown in Fig. 2, is fairly stable but it still varies to a small extent according to the zener current flowing through the diode. In consequence, to ensure that the voltage across the zener diode is constant it is necessary that the current flowing through the diode be kept constant also. This is achieved by the constant current source comprising R1, TR2, D5 and D6. (R3 may be neglected for the moment). TR2 is a p.n.p. transistor which is biased on by the forward voltage developed across the silicon diodes D5 and D6 by virtue of the current flowing through them via R4. Each of the diodes drops about 0.6 volt and so, taking into account the voltage dropped in the base-emitter junction of TR2 (again about 0.6 volt) a voltage of about 0.6 volt is developed across R1. This voltage is constant and thus, since R1 has an invariable resistance, the emitter current of TR2 is similarly constant. As a result, the current flowing through TR2 and also ZD1 is constant, and the zener diode is biased to a single point on its characteristic curve. A truly stabilized variable voltage can therefore be applied to the base of TR3.

A further effect has next to be considered. The voltage 'lost' in the base-emitter junctions of TR3 and TR4 increases slightly with increasing output current, whereupon the output voltage will still vary with output current even if the voltage at TR3 base is perfectly stable. R3 is included in the constant current circuit to compensate for this. When the output current increases the voltage developed across R3 becomes larger and increases the bias applied to TR2. A greater current flows through TR2 and also through

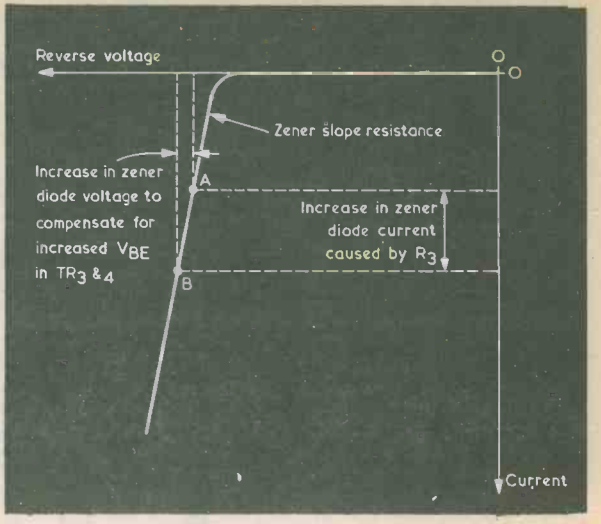
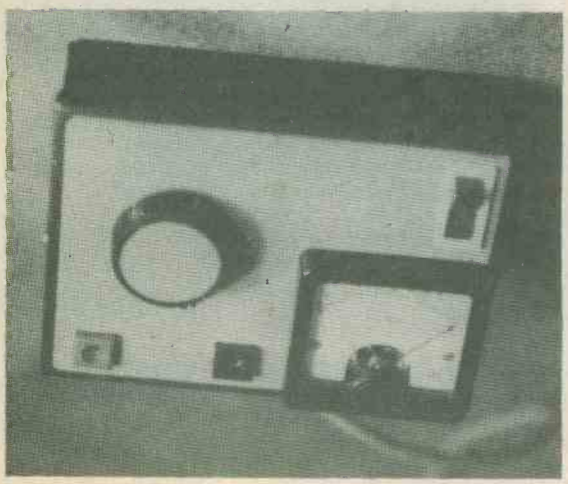


Fig. 2. Curve illustrating zener diode slope resistance and the compensation afforded by the presence of R3

the zener diode. The effect of this is to move the bias point on the characteristic curve in Fig. 2 from A to, say, B, so that the voltage developed across the zener diode increases slightly. The component values are chosen so that this increase just compensates for the increase in base-emitter voltage of the two output transistors when R5 is set for maximum output voltage. Due to the fact that R5 only taps off a proportion of the zener diode voltage, the compensation is unfortunately less efficient at lower output voltages.

OVERLOAD PROTECTION

Overload and short-circuit protection is provided by TR1 and R2. As the output current and in consequence the current flowing through R2 increases, a



Another view of the completed power supply

TEST VOLTAGES

Voltages given under no-load conditions with R5 set to tap off 12 volts. Voltages should be within 10% of the figures given. All transistor voltages are with respect to the negative output terminal.

Circuit Point	Voltage
Across C1	33-37V
TR2 base	32-36V
TR2 emitter	32.5-36.5V
TR2 collector	22V
TR3 base	12V
TR3 emitter	11.4V
TR3 collector	33-37V
TR4 base	11.4V
TR4 emitter	10.8V
TR4 collector	33-37V

level is reached where the voltage developed across R2 is sufficient to forward bias the base-emitter junction of TR1, thus causing this transistor to pass collector current. The current reduces the voltage at the base of TR3, to which the collector of TR1 is connected. The result is that output voltage then reduces as the output current increases. This action limits the current to a safe value and protects the power supply from overloads and accidental short-circuits.

Normally, with this type of circuit, the collector of TR1 would be connected to the junction of ZD1 and TR2, and such a method of connection was checked with the prototype. Although it worked well enough when protecting the circuit against a normal overload, it did not act fast enough to prevent damage to the circuit when a direct short-circuit was applied across the output terminals. For this reason TR1 collector was connected direct to TR3 base, which in turn was connected to the slider of R5 and C3 by the low value resistor R7. TR1 does not then have to discharge C2 and C3 when it is necessary for the output voltage to drop rapidly. This circuit does have a few disadvantages, however. The short-circuit current (i.e. the maximum current that can flow if the output were short-circuited) varies slightly with the setting of R5, and the current level at which the overload protection takes effect is less distinct than it might otherwise be. These are not great disadvantages, and the present method of connection does mean that the circuit is more reliable in operation. Fig. 3 shows performance curves for nominal output voltages of 20, 10 and 2 volts.

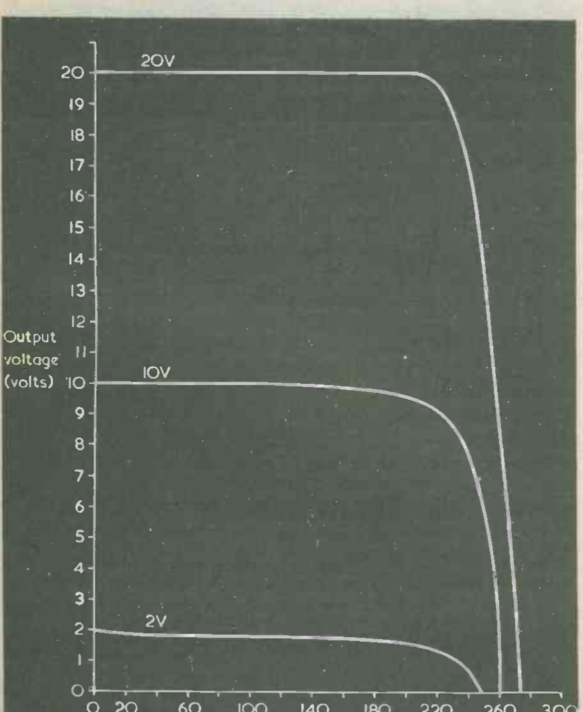
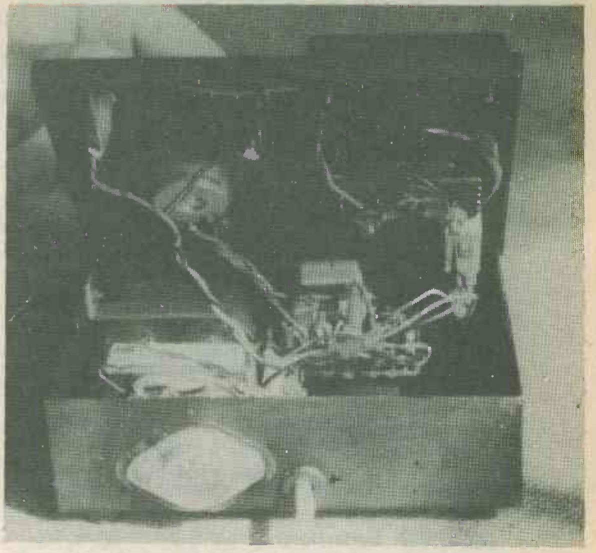


Fig. 3. Performance curves for output voltages of 2, 10 and 20 volts



Flexible wiring couples the components mounted inside the box to those on the top panel

It is advantageous to have an output voltage meter included in the unit both to eliminate the necessity of calibrating the voltage control and to indicate when the circuit is being overloaded, since the output voltage will then drop noticeably.

A neon indicator across the mains transformer primary is also desirable. Without such an indicator it would be possible for the unit to be left switched on with its output short-circuited, since the output voltmeter would read zero volts under these conditions and give the impression that the unit was switched off. This would place unnecessary strain on the power supply circuit.

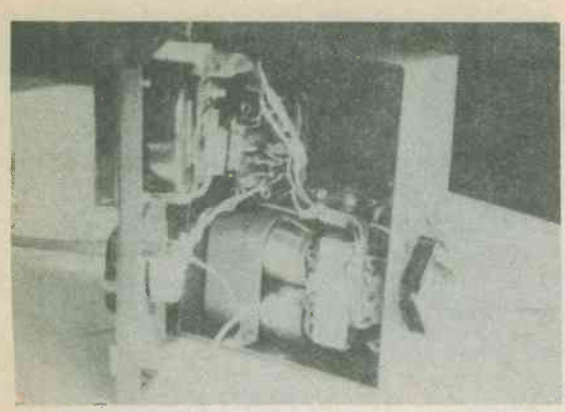
C4, C5 and R9 are all included to keep the circuit stable and reduce the output impedance at high frequencies.

COMPONENTS

Some comments need to be made on a few of the parts employed in the power supply. To begin with, the author assembled his power supply in an aluminium box type AB10, this having the measurements mentioned at the beginning of this article. The box is listed by a number of supplers, including Home Radio and Electrovalue. It must be emphasised, however, that the assembly inside this box is very compact and that the less experienced constructor would be well advised to use a larger metal case, of which a wide variety is available from the mail-order houses. Layout is not at all critical and the only requirement of the case, other than that of housing the components, is that one of its sides is used as a heat sink for TR4.

The meter employed in the prototype for M1 was a surplus 1mA type which measured 2½in. square. A possible alternative is a meter from the Henelec 38 Series, which are retailed by Henry's Radio, Ltd. The front of a 38 Series meter is 1.7in. square, so there should be adequate room for it if an AB10 box is used. One of the meters in the series is scaled 0-20 volts.

The on-off switch and neon indicator are combined in a single component, this being the R.S. Com-



Looking inside the box at the internal components

ponents 'Illuminated S.P.S.T. Rocker Switch'. This requires a rectangular hole in the front panel of the unit. The mains fuse used in the prototype was a 20mm. type to save space. It was fitted in a chassis-mounting fuseholder.

The rectifiers D1 to D4 consisted of the R.S. Components bridge rectifier type REC70. This was chosen because of its small size. If more space is available, four separate rectifier diodes, such as the 1N4001, could be used instead.

The 22 volt zener diode specified for ZD1 results in a maximum output of just over 20 volts, causing the voltmeter needle to pass over the top end of the scale when R5 is put to its maximum setting. If this is considered undesirable, a 20 volt zener diode type BZY88C20V may be employed instead, whereupon the maximum output voltage will be around 19 volts.

The reservoir capacitor C1 (actually two capacitors in parallel in the prototype) is specified as having a capacitance of 1,600μF. This may be considered rather large, but a reservoir capacitance of this value does reduce the ripple on the voltage suppled to the stabilizing circuit to a very low value.

The voltage control, R5, can be an ordinary carbon track potentiometer. The knob fitted to it should be a large type to enable fine adjustments to be made easily.

The series regulating transistor, TR4, is a 2N3055. This is a very high power transistor and is consequently run well within its ratings in this design; this ensures cool running and reliability. An insulating kit should be purchased with it so that it can be mounted on the side of the case, which acts as a heat sink, whilst still being electrically isolated from it.

The output terminals can either be screw terminals or simply 4mm. sockets, and it should be noted that neither terminal is connected directly to the metal case. The output is in consequence floating. The case connects to the mains earth.

CONSTRUCTION

Fig. 4 gives drilling details for the top of the AB10 box, which forms the front panel of the unit. The internal layout is illustrated in Fig. 5. Not shown in this diagram are four holes near the corners, to take mounting bolts for rubber feet. The clamp which secures the two capacitators specified for C1 is shown in Fig. 6, and it is secured to the case side and bottom by 6BA

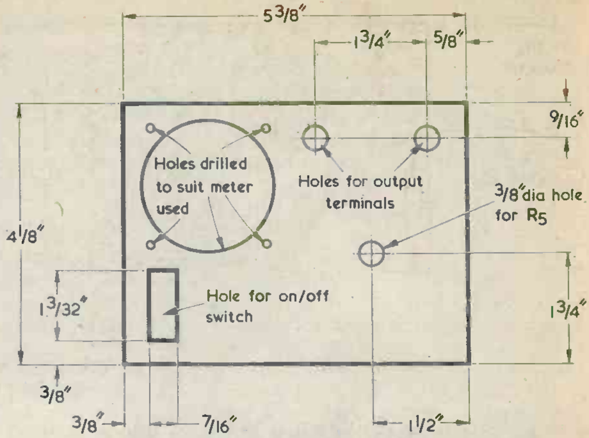


Fig. 4. Drilling details for the top of the box, which forms the front panel of the power supply

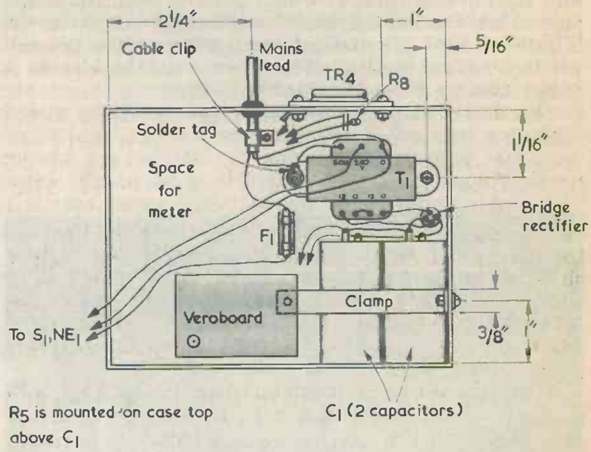


Fig. 5. The positioning of components inside the aluminium box

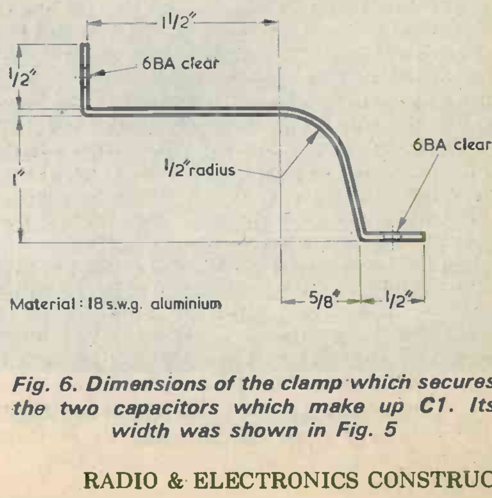


Fig. 6. Dimensions of the clamp which secures the two capacitors which make up C1. Its width was shown in Fig. 5

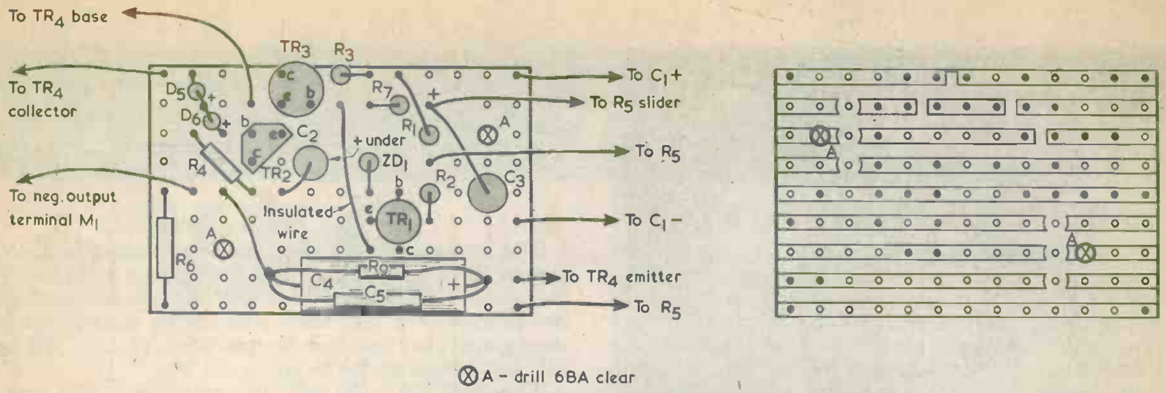


Fig. 7. Component and copper sides of the Veroboard assembly

screws and nuts. Take care that the metal cans of these two capacitors do not make electrical contact with the case. The inside end of the clamp also passes under one end of the Veroboard. Essential dimensions are given in Fig. 5 and components themselves may be used for marking out holes not dimensioned. In the case of TR4, its mica insulating washer may be used as a template for marking out the holes required in the side. This transistor is mounted mid-way between the bottom of the case and the lower edge of the case top when the latter is fitted. The hole for the mains lead is about ⅜in. up from the case bottom.

The earth wire of the mains lead connects to the metal case at a solder tag under one of the transformer securing nuts. So also does the 'SCN' tag of the transformer. The transformer is very nearly 1½in. high and care must be taken to ensure that no contact can be made between its connecting spills and the case top when the latter is fitted. These spills stop slightly short of the transformer top and there is little risk of short-circuit to the case top so long as the solder used for connection does not extend above any of the spills. The spills can, in any case, be bent down a little if this is considered safer.

There should be no burrs on the holes for TR4, and a smear of silicone grease may be applied to either side of its mica insulating washer before it is fitted. This will improve thermal conductivity between the transistor and the case. Note that R8 is wired directly between its emitter and base pins.

The remaining components are assembled on a piece of 0.15in. matrix Veroboard having 9 strips by 13 holes. The component and copper sides of this board are illustrated in Fig. 7. The BC158 has three pins intended to self-lock into a printed circuit board. These pins will push-fit loosely into holes on a 0.15in. matrix board in the manner shown in Fig. 8. This necessitates making a break in a copper strip between holes, but the break can be made quite easily with a sharp knife. There are several other breaks between holes in the strips, as well as the normal breaks made at the holes themselves. When fitted in place, the Veroboard is spaced off from the case bottom by additional nuts on the 6BA mounting bolts.

Unless the meter used for M1 is intended to read 0-20 volts directly, it will be necessary to find a value for R10. If the meter has a full-scale deflection of 1mA, then R10 will require a value of 20kΩ less the resistance of the meter. The easiest approach here consists of making R10 an 18kΩ 5% resistor in series with a miniature 5kΩ pre-set skeleton potentiometer. The power supply output is set to exactly 20 volts, as read by another meter, and then the pre-set potentiometer is adjusted for a full-scale reading in M1. A slightly lower voltage may be employed if a 20 volt zener diode has been used. The 18kΩ resistor and 5kΩ potentiometer can be mounted on a small perforated circuit board secured to the meter terminals.

The case may be painted any colour desired. The prototype was painted matt black to help dissipate the small amount of heat generated in it. If desired, an insulated black plastic transistor cover may be clipped over TR4. This is available from Electrovalue and is not included in the Components List.

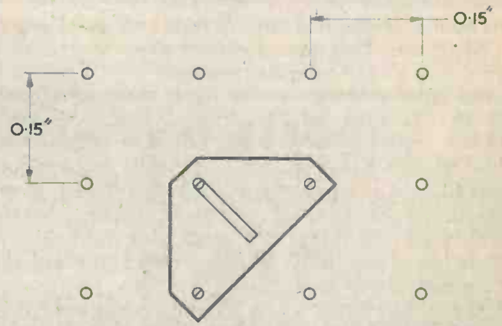


Fig. 8. The pins of the BC158 fit into a 0.15in. hole matrix in the manner shown here

FAULT-FINDING

Care should be taken before switching on for the first time to ensure that there are no loose wires or blobs of solder in the unit which could cause short-circuits. If the output voltage is low or non-existent, check the voltage across C1, which should be of the order of 33 to 37 volts. If it is not, check for wiring faults around the transformer and the bridge rectifier. Should the voltage across C1 be correct, next check the voltage at the base of TR3; if the voltage here is high either TR3 or TR4 is faulty or has been wrongly wired up. If the voltage at TR3 base is low, however, check the voltage across the zener diode. If this is low, and is less than 1 volt, the diode has been connected up the wrong way round.

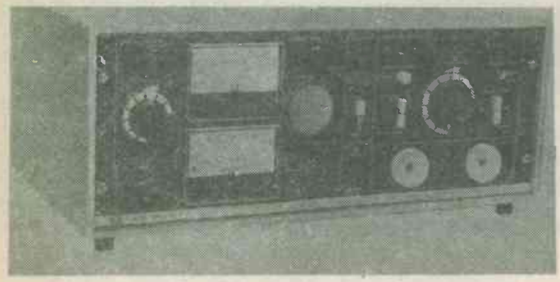
In conclusion the author would like to state that the prototype has now given many hours of faithful service, and has been found so useful that he wonders how he ever got along without it before. ■

Trade News . . .

Avo insulation tester

The accompanying photograph illustrates the Avo Model RM215-L/2 high voltage insulation tester, intended for testing insulating materials in electrical and electronic components or equipments.

The instrument can operate in either the d.c. or the a.c. mode. In the case of a.c. testing an important feature is that the leakage current measured is the inphase component rather than the total current, which is likely to contain a large wattless capacitive component. Total current may still, however, be read out if required.



The Avo Model RM215-L/2 high voltage insulation tester. This can operate in either the d.c. or the a.c. mode

The testing voltage is continuously variable from zero to 12kV on d.c., and zero to 6kV on a.c. Although the source impedance is low, the current delivered on test is limited to less than 10mA. The instrument is mains operated and can be powered by 110, 220 or 240 volt mains at 50 to 60Hz.

The RM215-L/2 can be employed for non-destructive testing by the detection of the ionisation which takes place prior to insulation breakdown. Ionisation is indicated aurally by a built-in loudspeaker.

A further feature is that insulation breakdown, in the form of a momentary flashover, is signalled by a warning lamp which illuminates for 3 seconds even though the actual breakdown may have only lasted for 1mS. The peak current required to trigger this signal is adjustable between 100μA and 1mA. The warning signal is repeated at a socket into which a counter may be plugged.

Insulation leakage current, down to 2μA, is read directly from an Avo Dinline panel meter. Breakdown of insulation is indicated by the voltmeter reading falling to zero and the illumination of the breakdown warning lamp.

Full details of the Insulation Tester can be obtained from Avo Limited, Archcliffe Road, Dover, Kent, CT17 9EN.

IBA exports technical know-how

An agreement between the Independent Broadcasting Authority and the French firm Laboratoire General des Telecommunications (LGT) will provide LGT with full design information on a range of specialised UHF measuring equipments developed by IBA engineers.

This is the first such arrangement made by the IBA with a major overseas manufacturing company.

The agreement, signed by Mr. Howard Steele of IBA and Mr. Henri Chemin of LGT, and negotiated through the IBA's marketing consultants, Sinor Conrath International Limited, covers all design information and technical know-how for precision synchronous demodulators and tuneable and fixed-channel UHF receivers. These together form a versatile range of specialised units for transmitter and transposer measurements, monitoring, testing and maintenance. LGT propose to manufacture and market equipment to these IBA designs.

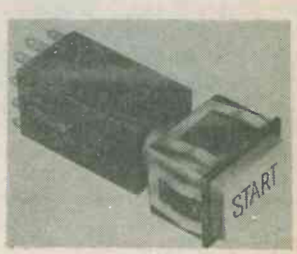
This series of precision units was developed at IBA's engineering and administrative centre at Crawley Court, near Winchester, and enables such characteristics as differential gain, line-time linearity and 'k-ratings' to be measured to high orders of accuracy.

Bulgin illuminated switch

The latest addition to the Bulgin DS.1000 switch range, manufactured by A. F. Bulgin & Co. Ltd., Bye-Pass Road, Barking, Essex, IG11 OAZ, is the successional action push-button model DSR.1066. This has an up-to-the-minute appearance and offers all modern features, including rectangular configuration, simple push mounting, illuminated or unlit button with message option, push-on push-off finger tip action, panel grouping facilities and rear projecting tags for easy wiring.

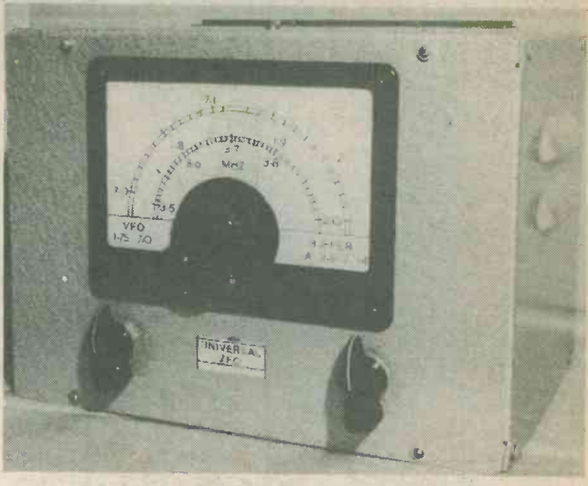
Incorporated in the design is a twin single-pole changeover microswitch unit rated at 5 amps at 250 volts. The l.e.s. low voltage illumination circuit is isolated from the switches, and five lens colours are available.

The component parts can be factory assembled with other items from the existing DS.1000 range, which now exceeds 40 models, to provide a wide choice of switching and panel presentation.



The new successional action illuminated switch, model DSR.1066, manufactured by A. F. Bulgin & Co. Ltd.

UNIVERSAL V.F.O.



by
F. G. Rayer

Consisting of a stable oscillator followed by a buffer-multiplier stage, this v.f.o. design offers outputs over a wide range of the amateur bands.

This variable frequency oscillator allows operation without crystals with many transmitters having optional crystal control or v.f.o. input. It was primarily intended for use with the 30 watt transmitter described by the author in the July and August, 1975, issues of this journal, and when coupled to this transmitter gives operation over all bands from 160 to 10 metres.

The circuit is shown in Fig. 1, and it will be seen that there are two stages. V1 is the oscillator and V2 a buffer amplifier or multiplier. In the 30 watt transmitter just mentioned, the 6146 power amplifier requires about 2mA grid current, and the v.f.o. easily provides more drive than this on all bands.

V.F.O. COVERAGE

The 2-way switch S1(a)(b) selects either L1, or L2, tuned by VC1. C1 is in parallel with VC1 when L1 is in use, and coverage is approximately 1.75MHz to 2.0MHz. This caters for 160 metres (1.8 to 2.0MHz) and after doubling the 1.75MHz to 1.9MHz sector gives coverage for 80 metres (3.5 to 3.8MHz).

With L2 and C2 in use, oscillator range is approximately 7.0MHz to 7.25MHz. This gives complete coverage of the 40 metre band, and of the 20 metre and 15 metre bands by doubling and trebling. For 10 metres, quadrupling allows coverage of the 28MHz to 29MHz sector.

Oscillator frequency depends on the values of C1, C2, VC1, C3 and C4, as well as the inductance of L1 and L2. By using close tolerance capacitors for C1 to C4 there is a little range to spare at the extreme minimum and maximum capacitance settings of VC1, and no trimmers are needed. It is only necessary to adjust the core of L1 for 1.75MHz with VC1 at nearly maximum capacitance, and the core of L2 for 7.0MHz with VC1 at a similar setting. Suitable coverage for each band is then achieved.

Should a more comprehensive adjustment of coverage be wanted, C1 and C2 can be reduced in value by about 20 to 30pF, and a 50pF or 60pF trimmer wired in parallel with each. Adjustment of the trimmers and coil cores then allows band coverage to be modified. Such an adjustment has no bearing on the eventual *accuracy* of calibration, and it was felt that trimmers were unnecessary.

C3 and C4 almost completely swamp out any slight changes in capacitance in V1, and this is a reliable and stable oscillator.

BUFFER

V2 is driven from V1 cathode circuit, and has a 4-way switch, S2, in its anode circuit. This selects choke RFC2, L3, L4 or L5. As a result, there is individual selection of possible output frequencies.

With RFC 2 in use, V2 is untuned and the output will be at 1.75MHz to 2.0MHz, or 7.0MHz to 7.25MHz, according to the band selected by S1(a)(b). With V1 on 1.75MHz, the v.f.o. can drive a 160 metre transmitter, or an 80 metre transmitter if the latter has a doubler stage. With V1 on 7MHz, the v.f.o. can provide this frequency for transmitting on 40 metres, or on 20 metres with doubling in the transmitter at its driver stage.

L4 is broadly tuned to 7MHz and boosts output when operating on 14MHz or 21MHz, the transmitter driver stage providing double or triple multiplication. For 28MHz, efficient operation with the author's 30 watt transmitter is obtained with 7MHz input from the v.f.o., the transmitter driver stage being tuned to the fourth harmonic. However, with some equipment better drive may be obtained if the p.a. driver is doubling, and L5 may then be switched into circuit. L5 is broadly resonant at 14MHz, so that this frequency is available at the output with V2 acting as a doubler.

L3 is broadly resonant in the 80 metre band, and may be switched in if the transmitter requires additional harmonic suppression so that a 1.75MHz drive is unsatisfactory. L3 can also be used if more drive is required, or when 40 metres is covered with a transmitter driver operating as doubler.

In instances where circuits are not well segregated or separated it is of advantage to double at each stage, since stray feedback does not then cause instability. With the transmitter mentioned, however, V1, V2, the transmitter driver and the transmitter power

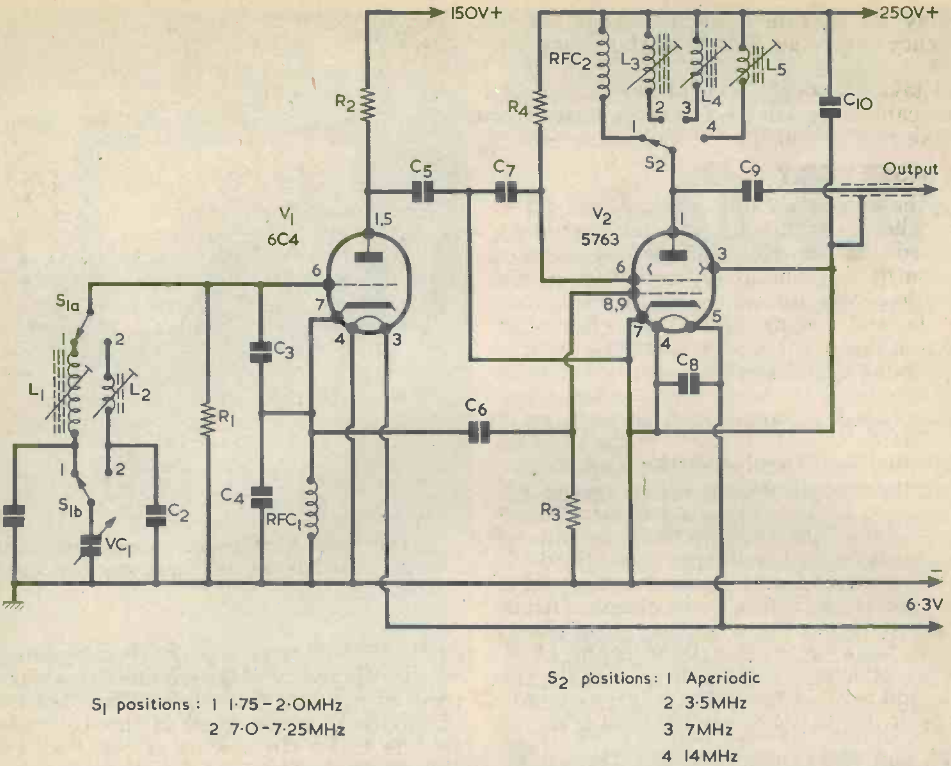


Fig. 1. The circuit of the universal v.f.o. With the appropriate transmitter this is capable of covering all bands from 160 to 10 metres

COMPONENTS

Resistors
(All 10%)
R1 68kΩ ½ watt
R2 3.9kΩ 1 watt
R3 100kΩ ½ watt
R4 33kΩ 1 watt

Capacitors
C1 150pF 1%, silvered mica
C2 470pF 1%, silvered mica
C3 680pF 1%, silvered mica
C4 680pF 1%, silvered mica
C5 0.01μF disc ceramic.
C6 100pF silvered mica
C7 0.05μF disc ceramic or plastic foil
C8 0.01μF disc ceramic
C9 47pF silvered mica
C10 0.1μF plastic foil
VC1 100pF variable, type C804 (Jackson)

Inductors
L1 Miniature Dual-Purpose Coil, valve usage, Yellow Range 3 (Denco)
L2 Home-wound
L3 Miniature Dual-Purpose Coil, valve usage, Red Range 2, modified (Denco)
L4 Miniature Dual-Purpose Coil, valve usage, White Range 3 (Denco)
L5 Home-wound
RFC1 2.6mH r.f. choke, type RFC.5 (Denco)
RFC2 2.6mH r.f. choke, type RFC.5 (Denco)

Valves
V1 6C4
V2 5763

Switches
S1(a)(b) 2-pole 2-way rotary
S2 1-pole 4-way rotary

Metalwork
2 Universal Chassis sides, 2 x 6in.
3 Universal Chassis sides, 2 x 5in.
1 Universal Chassis plate, 5 x 6in.
1 Hardware Kit.
1 Case, 8 x 6 x 6in., type "W" (H. L. Smith & Co. Ltd.)

Miscellaneous
Tuning drive (see text)
2 pointer knobs
1 B7G valveholder with screening can
1 B9A valveholder with screening can
2 coil formers, polystyrene cored, 0.375in. diameter (Denco)
32 s.w.g. enamelled wire
3 insulated stand-off tags
2 grommets
Coaxial cable, low-loss.

amplifier may all operate straight through on the same frequency (such as 7MHz) without any difficulties.

Output is taken through 12in. of low-loss coaxial cable. A long cable here will tend to cause losses, and will also make retuning of L3, L4 and L5 necessary.

CHASSIS ASSEMBLY

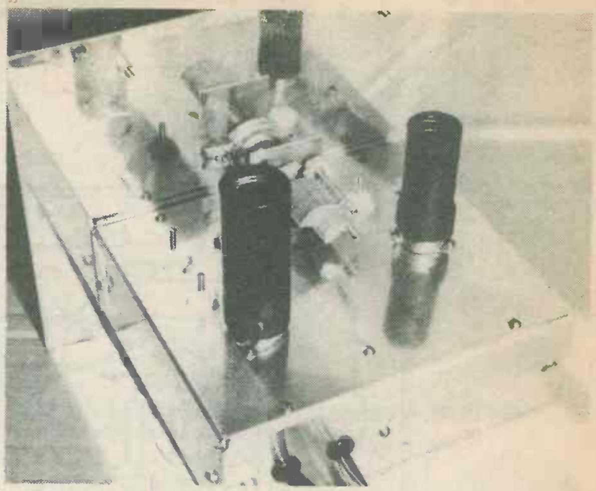
The top of the chassis is shown in Fig. 2, and dimensions can be taken from this so that holes can be drilled or punched for the coils and valveholders. A bracket is also made from scrap metal to hold VC1 with its spindle centre ⅞in. above the chassis.

Components and wiring under the chassis are shown in Fig. 3. A central screen separates the v.f.o. and buffer circuits. The chassis is assembled from the "Universal Chassis" parts quoted in the Components List, the extra 5 by 2in. flanged member forming the screen. The "hardware kit" consists of the nuts and bolts, etc., needed for assembly of the chassis.

To prepare the chassis, fit the flanges of the 5 by 2in. members *inside* the 6 by 2in. members. Check that they are square and then fit the 5 by 6in. flat plate with suitable bolts. The flanges of the third 5 by 2in. member are then filed or cut so that they fit inside the front and back flanges of the chassis. (All the flanges are not shown in Fig. 3 for reasons of clarity, but they may be seen in the photographs of the chassis). Holes for heater and h.t. leads, for the connection to C6 and to allow the fixing of three stand-off tags should be drilled in the screen before it is secured in position.

The front panel is 6 by 8in. and is secured to the chassis by means of the switch bush mounting nuts. For the case listed, the bottom edge of the panel must project below the chassis by ½in. The ball drive fits as in Fig. 2, and the scale is secured with four 6BA bolts.

The drive assembly used by the author is a modified Jackson type 4103, which is supplied complete with 5 by 4in. dial surround and blank scales, together with a dual ratio 36:1/6:1 ball drive. A single 6:1 ball drive is perfectly adequate here and so VC1 is coupled to a Jackson ball drive type 4511/F instead of the dual ratio drive. The Jackson type 4104 transparent pointer used in the 4103 assembly can also be fitted (by means of two 8BA bolts) to the 4511/F drive. The 5 by 4in. dial surround and blank scales of the 4103 assembly are not available separately, and so the constructor may either obtain a 4103 assembly and modify it by using the 4511/F ball drive, or he may obtain the 4511/F ball drive and a 4104 transparent pointer then make up a home-made dial surround and scale with the aid of thin Perspex and card. All the parts just mentioned are available from Home Radio.



The only components appearing above the chassis are VC1 and the two valves

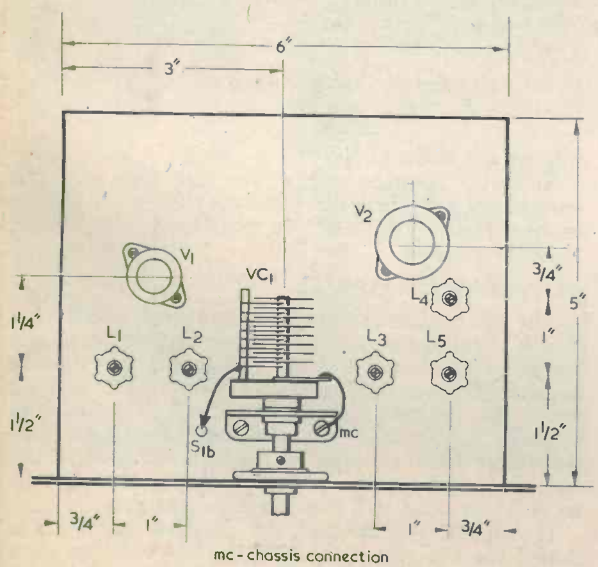


Fig. 2. Positioning of components above the chassis and drilling details

WIRING POINTS

In Figs. 2 and 3, all points marked "MC" consist of solder tags bolted to chassis at the positions indicated.

Connect VC1 moving vanes to a chassis tag as shown in Fig. 2, and take a lead from the fixed vanes down to S1(b), as in Fig. 3. All other connections will be seen in Fig. 3.

Wiring should be rigid, and reasonably short and direct. The three insultated tags on the screen support R2, R4 and RFC2. Although not shown, a further insulated tag could be employed at the junction of C9 and the centre lead of the output coaxial cable, if so desired. The central spigot of V2 valveholder must be earthed in the manner shown.

A 4-way power supply lead is required. This can be black for chassis, blue for heater, orange for 150 volt and red for 250 volt circuits, although any other alternative colours can of course be employed. The wires are twisted together and run through a grommet in the chassis rear.

About 12in. of low-loss coaxial cable is prepared, and the braiding connected to the chassis, as in Fig. 3. The free end is terminated with a plug to suit the transmitter v.f.o. input.

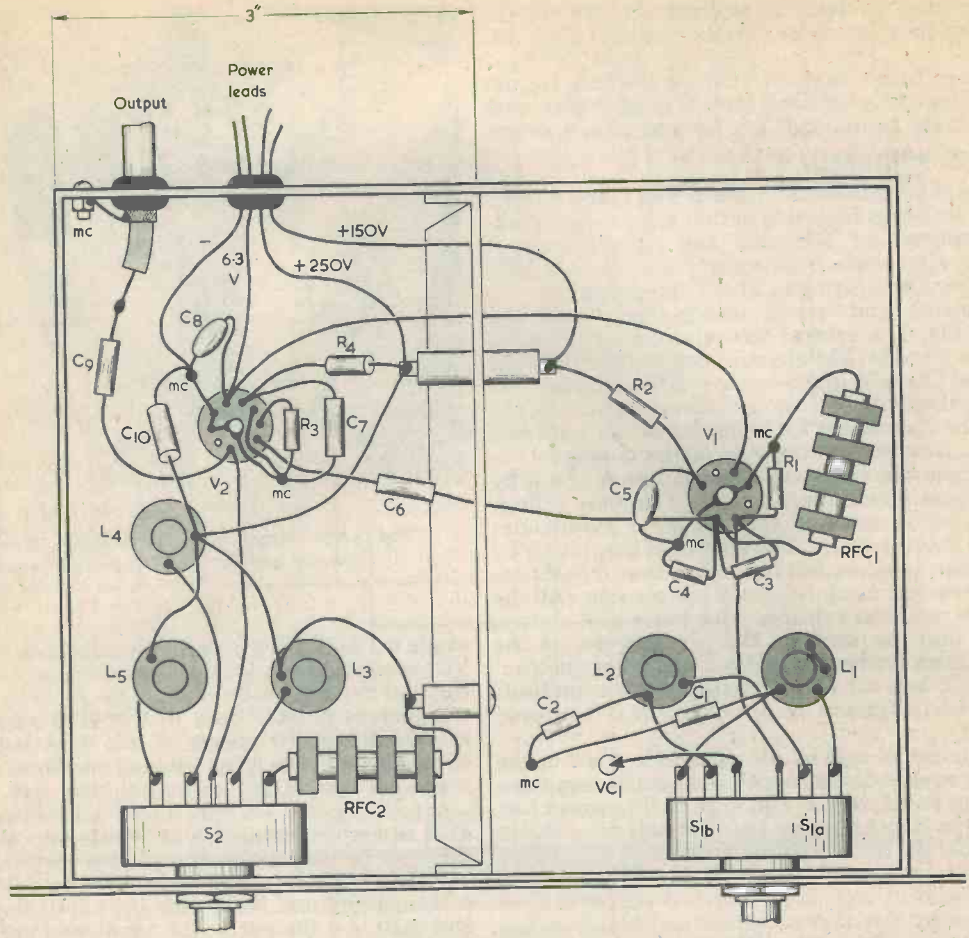


Fig. 3. Layout and wiring below the chassis. Connections to the two rotary switches should conform with the circuit of Fig. 1

INDUCTORS

Quite a high inductance is required for L1, and this is a Denco Yellow Range 3(valve usage) coil. Tags 6 and 8 are joined, and the remaining winding tags, 1 and 9, are connected to S1(a)(b) as in Fig. 3.

L2 is wound with 32 s.w.g. enamelled wire, and has 12 turns side by side on a ⅜in. diameter cored Denco former. This is a polystyrene coil former of the same type as is used for the readywound coils. The winding is near the tagged end of the former, and its turns are held in place with Bostik 1 or similar adhesive.

L3 is a Denco Red Range 2 (valve usage) coil. The small winding is removed. The outer end of the large winding is unsoldered, 28 turns are taken off and the coil end is then re-soldered.

L4 is a Denco White Range 3 (valve usage) coil, connections being to tags 1 and 3.

L5 has 17 turns of 32 s.w.g. enamelled wire, wound side by side, and also uses a Denco ⅜in. diameter cored former. The anode end of the winding passes directly to S2 and does not connect to any of the tags on the coil former. The turns are secured in the same way as are those of L2.

Soldered connections to the coil tags must be carried out quickly as the plastic of the former readily melts with heat. If possible, a small heat shunt should be employed.

POWER SUPPLIES

The two heaters require 0.9 amp overall at 6.3 volts. The h.t. voltage is not too critical. A 250 volt 60mA supply is ideal, and the 150 volt supply can then be obtained from an OA2 voltage regulator, this and the two valves drawing about 55mA in all. No particular evidence of frequency modulation or other difficulties was found when running V1 from an unregulated but well smoothed supply, whilst V2 can receive as little as 200 volts and still provide excellent drive.

If an OA2 is to be used, the simplest method is to derive the 150 volt point from the 250 volt line via a 10kΩ 3watt resistor, as in Fig. 4. The 250 volt circuit could be switched by a spare contact in the transmitter function switch, wired so that h.t. reaches the v.f.o. when the transmitter driver stage is on.

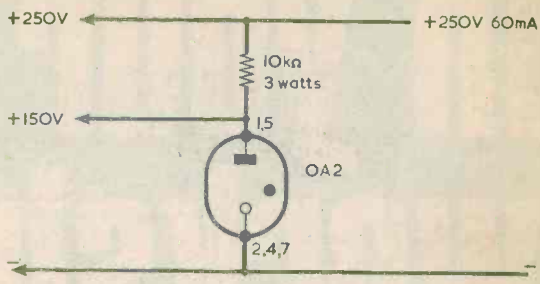
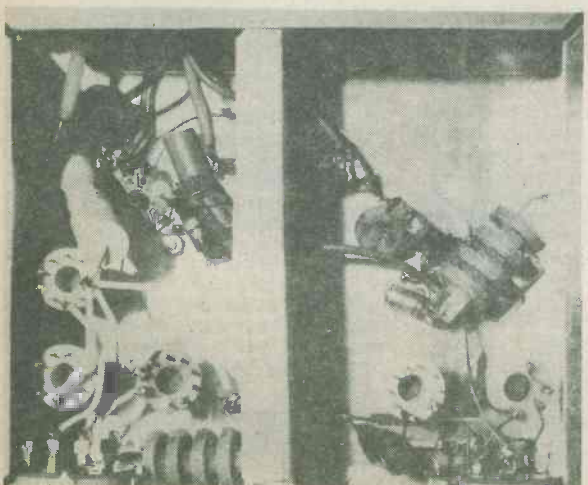


Fig. 4. An h.t. supply offering 250 volts at 60mA may be used to power the v.f.o. The OA2 provides a regulated 150 volt supply for V1

V.F.O. CALIBRATION

Screening cans must be placed over the valves before calibration or use of the v.f.o. VC1 is coupled to the tuning drive such that it is at minimum capacitance when the pointer is fully clockwise. For calibration, VC1 is set almost fully to maximum capacitance, S1(a)(b) is set to select L1, and the core of this coil is adjusted until the carrier is at 1.75MHz, or its second harmonic at 3.5MHz, on the station receiver. The coil core is locked with a 6BA nut.

Fundamental frequency calibration of this range is at 1.8, 1.9 and 2.0MHz, and second harmonic calibration is at 3.5, 3.6, 3.7 and 3.8 MHz. The calibration points can be found accurately if the V.F.O. is tuned to zero beat with a 100kHz crystal marker. To do this, a lead from the receiver aerial socket is brought near the outputs of the v.f.o. and the marker. The receiver, tuned to the requisite frequency, is used to listen for the heterodyne between the v.f.o. and marker but does not itself have any bearing on the accuracy of calibration by this means.



A view of the layout under the chassis

A similar setting up procedure is carried out for L2, with calibration from 7.0 to 7.25MHz. The 50kHz points can be found readily by tuning the receiver to the second harmonic. As an example, 14.1MHz on the receiver will be 7.05MHz from the v.f.o.

The higher frequency scale of the v.f.o. was not marked with frequencies for the 14, 21 and 28MHz bands, as these are direct multiples of the 7MHz range.

BUFFER TUNING

The comments which will next be given apply primarily to the author's 30 watt transmitter, although they will be of guidance if the v.f.o. is used with any other transmitter of similar type.

Set S2 to select L3, tune the v.f.o. to about 3.6MHz, then adjust the core of L3 for maximum grid drive in the transmitter.

Next select L4, tune the v.f.o. to about 7.1MHz, and rotate L4 core for maximum drive with the transmitter operating on the 14, 21 or 28MHz bands. Finally, select L5 with the v.f.o. still at 7.1MHz, and adjust its core for best grid current with the transmitter on the 28MHz band.

With the 30 watt transmitter, the low frequency range can be used for 160 or 80 metres, with S2 selecting RFC2. The v.f.o. high frequency range is used for all other bands, with S2 selecting RFC2 for 40 metres and selecting L4 for the 14, 21 and 28MHz bands. With these last three bands the first stage of the transmitter acts as multiplier. If it is intended to work 28MHz only with this transmitter, S1(a)(b), L1, C1, RFC2, L3, L5 and S2 may all be omitted.

OPERATION

Operation with the v.f.o. is basically the same as with crystal control, except that the frequency can be set as required. To begin transmitting on a clear channel found with the receiver, switch on the v.f.o. and driver stages (this is the "Spot" position on the 30 watt transmitter function switch) and tune the v.f.o. to the receiver frequency. This may be done by having the receiver b.f.o. on, as there is normally enough r.f. present from the v.f.o. for its output to be heard on the receiver. The procedure is similar when answering a station heard calling, the v.f.o. being tuned to zero beat with the signal received.

Subsequently, the transmitter is switched to "Transmit" and the p.a. tuning and loading controls are adjusted as required. Transmission on the v.f.o. frequency then proceeds. ■

In your workshop

This month Smithy the Serviceman greets the New year by introducing a Resolution designed to improve the social tone of the Workshop. His failure here is, at least, counterbalanced by success in diagnosing the cause of instability in a medium and long wave transistor radio.

"Happy New Year, Smithy!"

"And a Happy New year to you, my boy."

Dick hung his raincoat on the peg behind the Workshop door then wandered over to Smithy, rubbing his hands together as he did so to rid them of the cold of the early January morning. Inside the Workshop, all was warm and snug.

"Well," asked Dick, "did you have your usual New Year's Eve thrash last night?"

"I celebrated the arrival of the New Year," replied Smithy primly, "in the sober and seemly manner which is proper to one of my years."

"Stap me," commented Dick, surprised. "You must be getting past it. Ever since I've known you, you've entered New Year stoned out of your mind."

RESOLUTION

"That was not the case so far as 1976 is concerned," returned Smithy sternly. "What is more, I've made a firm New Year Resolution about things of this nature. In the future I intend to observe a proper decorum in all my activities."

"Flaming heck," pronounced Dick. "This I've got to see."

"What is more," continued Smithy, "I'm also going to ensure that this Workshop is run in a manner befitting an establishment where high quality servicing is carried out. From now on I don't want to hear any more vulgar language from you."

"Vulgar language?" repeated Dick, astonished. "Since when have I been using vulgar language?"

"What you said just now," retorted Smithy, "was, in my opinion, most vulgar."

"Blow me," snorted Dick, "All I said was 'flaming heck'."

An expression of distaste crossed the Serviceman's features.

"Please," he said disdainfully, "refrain from using terms of that nature."

"Don't tell me," said Dick in disgust, "that just because I said 'flaming heck' you're now getting your knickers all in a twist."

Smithy stiffened.

"That's *enough*," he snarled furiously, "I will *not* have that sort of talk in here."

"A fine New Year this is going to be," grumbled Dick. "Well, if I'm not allowed to talk ordinary English I'd better get on with a bit of work."

Mutinously, he walked over to the "For Repair" rack. This gave evidence of the lull in work after the Christmas rush and held only one item, a small medium and long wave transistor radio. Dick's expression brightened, and he turned round to the Serviceman.

"Permission to speak?"

"Now look," responded Smithy, "there's no need to be sarcastic just because I'm trying to raise the tone of things in here."

"Well," said Dick, "there's only one flip . . ."

The expression on Smithy's face caused him to stop.

"There's only one set," he grated, "that needs fixing."

"Is there?" responded Smithy. "Let's have a look at it."

Dick brought the little receiver over to Smithy's bench and switched it on. Whoever had last used the receiver had left it tuned to the local medium wave Radio 4 station, and it at once reproduced this signal at good strength and with acceptable quality.

"It seems all right so far," commented Dick. "Let's see what it's like on other stations."

He adjusted the tuning control of the receiver. As soon as this was taken off the centre of the Radio 4 signal a whistle became audible from the speaker, this increasing in frequency and loudness as the control was turned. Surprised, Dick tuned back into the Radio 4 signal. As he did so the whistle decreased in frequency and then disappeared when the signal was fully tuned in.

"This," remarked Dick, "is like tuning in a t.r.f. receiver with the reaction turned up too high."

"Try some other stations," suggested Smithy.

Obediently, Dick turned the tuning knob. Several other stations could be picked up along the medium wave band, each accompanied by a heterodyne whistle. In each case the whistle dropped to a very low frequency as the signal was fully tuned in, but with none of the signals was it possible to eradicate the whistle completely. Even with the signal tuned in correctly the heterodyne continued to be evident as a low grumbling background noise. Dick switched to the long wave band. There was a loud hiss all over the band, this increasing in volume as he tuned towards the low frequency end. This hiss diminished as he tuned in Radio 2 on 1,500 metres, but his signal was also accompanied by the same heterodyne note that had appeared behind the medium wave stations.

"Humph," grunted Smithy. "There's not much guesswork needed to say what's wrong here. We've got a pretty straightforward example of i.f. instability."

"Hell's teeth," gasped Dick, "don't say . . ."

"Now, I'm not going to warn you again," interrupted Smithy. "Kindly moderate your language."

Dick swallowed.

"Goodness gracious," he resumed through clenched teeth, "how can you make a diagnosis like that just by listening to the set?"

"It's obvious," replied Smithy. "What's happening is that the i.f. amplifier in this set has gone unstable and that it's oscillating at the intermediate frequency."

I. F. AMPLIFIERS

"I still don't get it."

"All right," said Smithy, "let's get down to basic principles. Now, a basic superhet has an aerial input which couples to a mixer or frequency-changer. In the old days of valve receivers a separate oscillator was also coupled to this mixer, the output of which passed into the i.f. amplifier. In transistor a.m. receivers the oscillator and mixer functions are carried out by a single transistor, but operation is

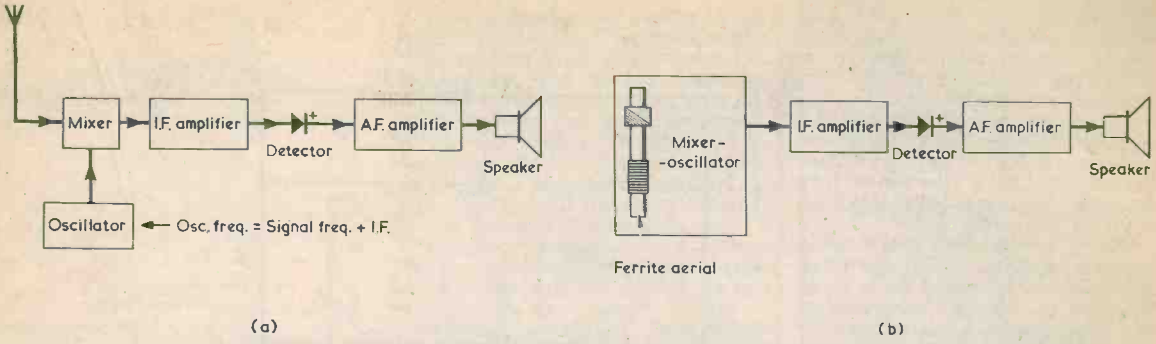


Fig. 1 (a). Block diagram for an a.m. superhet receiver with a separate local oscillator, and without an r.f. stage. (b). Portable transistor a.m. superhets have the mixer and oscillator combined in a single stage and employ a ferrite aerial.

otherwise just the same. One of the outputs from the mixer is a modulated signal whose frequency is equal to the difference between the oscillator and the signal frequencies, and this is the intermediate frequency. It is fed into the intermediate frequency amplifier, which provides a high level of amplification and selectivity before passing the signal on to the detector. In fact, nearly all the pre-detector sensitivity and adjacent channel selectivity in the receiver is provided by the i.f. amplifier stages." (Figs. 1(a) and (b).)

"I know all that," said Dick impatiently. "And all about the intermediate frequency being equal to the difference between the oscillator frequency and the aerial signal frequency."

"Very well, then," resumed Smithy. "Now, another way of looking at the frequency relationship is to say that the oscillator frequency determines what signal frequency is to be applied to the highly selective pre-tuned intermediate frequency amplifier. You can notice this state of affairs if you adjust the oscillator trimmer of a superhet. Adjusting the oscillator trimmer gives the same effect as if you were tuning the whole receiver."

"That's right," chimed in Dick. "Adjusting the aerial tuned circuit trimmer merely varies the strength of whatever station has been selected by the oscillator frequency, whilst adjusting the oscillator trimmer actually selects the station itself. All that the aerial tuned circuit does is bring in the required signal at maximum strength."

"That's not the only thing the aerial tuned circuit does," stated Smithy. "Apart from peaking up the required signal it also keeps out any unwanted second channel signals. Let's say that the intermediate frequency of an a.m. superhet is 470kHz, and we want to receive a signal at 1,000kHz. To do this, we tune the receiver oscillator to 1,470kHz, whereupon the difference frequency of 470kHz slips neatly into the i.f. amplifier. But the receiver is also open to interference from any signal which happens to be 470kHz *higher* than the oscillator frequency, because this will also give a difference frequency in the mixer of 470kHz. With the figures I've chosen this second signal would have a frequency of 1,940kHz, and it is an example of the second channel signal I was referring to just now. It may also be called an 'image' signal. So, the purpose of the aerial tuned circuit is, first, to encourage the required signal to come in and, second, to discourage the entry of any unwanted signal which is on the second channel frequency."

"Fair enough," said Dick. "All this gives us the background on superhet receiver operation, but how can you be so certain that the particular superhet we have here is suffering from i.f. instability?"

"Because," replied Smithy, "there was a beat note whistle on every station you tuned in. On medium waves the i.f. amplifier must be oscillating fairly gently at the intermediate frequency whereupon, as you yourself mentioned, the audible result is a beat note with received carriers similar to what you get with a t.r.f. set whose reaction control has been advanced too far. I say that the i.f. oscillation is of a gentle nature because the beat note disappeared when you tuned to the centre of the local Radio 4 signal. This signal is the strongest in our locality and will produce the highest a.g.c. voltage. In fact the a.g.c. voltage it produced reduced the i.f. amplifier gain to a level where the oscillation ceased, and so the oscillation *must* have been of a pretty gentle nature. In these medium and long wave transistor radios the a.g.c. voltage is almost invariably fed back only to one of the i.f. amplifier transistors, and this further clinches the supposition that the instability is in the i.f. amplifier."

"Why did the instability get worse," asked Dick, "when I switched to long waves?"

"That's probably due to the fact that the long wave oscillator frequency range is closer to the intermediate frequency than is the medium wave oscillator frequency range," replied Smithy. "This factor could boost oscillation level since it would allow the mixer-oscillator transistor to at least partly enter the loop of stages which are giving oscillation. Also, the long wave aerial tuned circuit may not be as selective against the intermediate frequency as is the medium wave tuned circuit."

SERVICE MANUAL

Smithy glanced at his watch and frowned.

"Dear me," he said irritably. "I've been nattering away here for nearly quarter of an hour and we haven't even got the back off that set yet. If we carry on like this throughout 1976 we'll never get any work done at all."

"Take it easy Smithy," replied Dick carelessly. "We've got all day to fix this set so there's no need to get all uptight about it."

Smithy glanced at his assistant.

"Please do not," he stated sternly, "use that horrible term 'uptight' in here. That's another word we shall refrain from using in future."

"Oh, pooh," snorted Dick. "Well, at any rate I'll get started on this set and do the usual initial checks."

"Okey-doke," returned Smithy. "I'll go and get its service sheet."

Dick removed the back of the receiver and made a quick examination of its interior for obvious visible faults. All the components on the printed board were visible from the set rear, and these appeared to be in order. The battery consisted of four 1.5 volt cells in series. Dick checked the voltage across them with the set switched on and was rewarded with a testmeter reading of almost exactly 6 volts.

"Here we are," said Smithy, returning from the filing cabinet. "This is the circuit of the receiver, and here are the mixer-oscillator and i.f. amplifier stages."

Smithy placed the service sheet on the bench and pointed at the appropriate section of the receiver circuit. (Fig. 2).

"That seems pretty straightforward," remarked Dick, glancing at the circuit. "No it isn't, though!"

"What's wrong with it?"

"It's got Japanese transistors in it," complained Dick. "Look, the mixer-oscillator is a 2SA102 and the i.f. transistors are 2SA101's. How can we fix a set when we don't know anything about the transistors in it?"

"That's no problem now," stated Smithy cheerfully. "With the latest addition to my bookshelf we've got as much gen on Japanese transistors as we'll ever need for servicing work."

He leaned forward and took a copy of *Tower's International Transistor Selector* from the shelf above his bench. He opened it and turned the pages.

"Now, let's see," he stated, running his finger down a column in the book. "Both the 2SA101 and the 2SA102 are listed here. They're high frequency germanium types made by Matsushita, and the European equivalent for both of them is the AF124."

"Is it?" said Dick in an impressed tone as Smithy returned the book to the shelf. "Well, the AF124 is a nice familiar type number. I feel more at home with this circuit already!"

He turned back to examine the circuit diagram in more detail.

"The waveband switching," he went on, "seems to be quite simple. One section of the wavechange switch selects the medium and long wave ferrite aerial tuned windings whilst a second section connects the base of the mixer-oscillator transistor to one or other of the coupling windings. The third section of the switch simply connects an extra 120pF capacitor and a trimmer across the oscillator tuned circuit when long waves is selected. Hey, wait a minute!"

"What's the trouble?"

"The third section of the wavechange switch also connects the 120pF capacitor and the trimmer across the long wave aerial tuned winding when medium waves is selected. What's the reason for that, Smithy?"

"It's to ensure that the long wave tuned winding is resonant at a frequency which is well removed from the medium wave band when medium waves is switched in," explained Smithy. "There is a perennial difficulty whenever you have a medium and a long wave winding on the same ferrite aerial rod, and this is due to the fact that a long wave winding on its own can become resonant, with its own self-capacitance, at a frequency in the medium wave band. The long wave winding then has an absorption effect on the medium wave tuned circuit and this upsets medium wave tuning. One solution is to have a section of the wavechange switch short-circuit the long wave winding when medium waves is selected. The receiver we have here employs another approach, and it connects extra capacitance across the long wave winding to ensure that it's tuned well clear of the medium wave

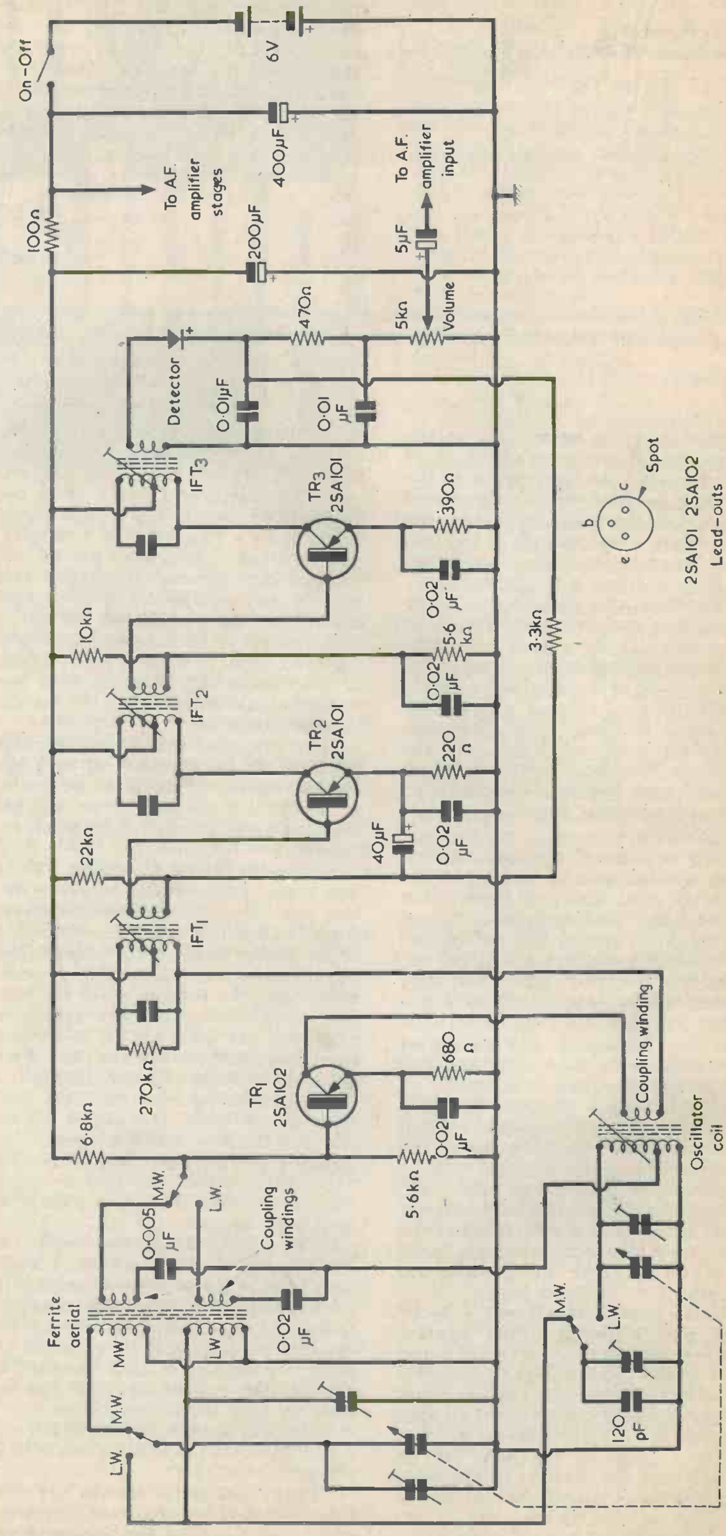


Fig. 2. The mixer-oscillator and i.f. stages of the a.m. receiver serviced by Dick and Smithy.

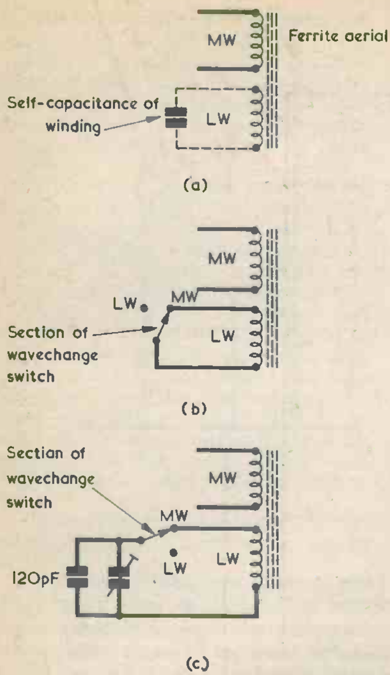


Fig. 3 (a). Unless suitable precautions are taken, a long wave tuned winding on a ferrite rod can become resonant, with its own self-capacitance, at a frequency in the medium wave band. (b). The effect can be overcome by short-circuiting the long wave winding on medium waves. (c). In the circuit on Fig. 2, additional capacitance is connected across the long wave winding when medium waves are selected.

range when the wavechange switch is on medium waves." (Figs. 3(a), (b) and (c).)

"That's a knobby idea," commented Dick approvingly. "The oscillator section of the first stage seems to be quite straightforward. The collector of the mixer-oscillator transistor connects to a coupling winding on the oscillator coil and then goes to the first i.f. transformer primary. A tap in the tuned winding on the oscillator coil couples back to the base of the transistor via the coupling windings on the ferrite aerial, and the overall winding is tuned in the usual way by one section of the receiver 2-gang variable capacitor. With, as I said just now, extra capacitance added on long waves. Now, I wonder what that 270kΩ resistor across the primary of the first i.f. transformer is for."

"It's probably just intended to damp it down a little," replied Smithy. "This set has three single-tuned i.f. transformers, and the i.f. response could be a little peaky if they were all set to exactly the same frequency without that resistor. The resistor will also partly inhibit any tendency on the part of the i.f. transformer primary to 'pull' the oscillator frequency towards its own resonant frequency."

"Perhaps," suggested Dick, "that 270kΩ resistor has gone open-circuit and it's that which is causing the i.f. instability we have here."

"That's possible," conceded Smithy, "but I wouldn't say that it's the most likely suspect."

"Isn't it?" replied Dick. "Oh well, press on! The rest of the i.f. amplifier seems to be quite standard, with two further transistors and then the detector diode and volume control. And I suppose that a.g.c. goes back from the detector to the base of the first i.f. transistor via the 3.3kΩ resistor and the secondary of the first i.f. transformer."

"That's right," confirmed Smithy. "The detector diode is wired up so that its cathode, which connects to the 470Ω resistor above the volume control, goes positive as signal strength increases. This means that the base of the first i.f. transistor goes positive too, whereupon its base bias decreases and it gives less gain."

"The secondary of the first i.f. transformer," remarked Dick, still studying the receiver circuit diagram, "is bypassed to the transistor emitter by a 40μF electrolytic. That's a pretty hefty value for an r.f. bypass, isn't it?"

"It's not only an r.f. bypass capacitor," said Smithy, "it's also an a.f. bypass capacitor. The a.g.c. voltage at the cathode of the detector diode has the detected a.f. signal on it. The 3.3kΩ resistor and the 40μF electrolytic then prevent this a.f. getting back to the base of the first i.f. transistor. Or, rather, to the base and emitter of the first i.f. transistor in this particular receiver, because the 40μF electrolytic is returned to the emitter instead of to chassis."

BYPASS CAPACITOR

"That's rather an unusual method of connection, isn't it?"

"Not really," replied Smithy. "In fact, returning the base bypass capacitor to the emitter instead of to chassis is quite a usual state of affairs in the i.f. stages of a.m. receivers. Even if only an r.f. bypass capacitor is required, this may also be returned to the emitter instead of the chassis." (Fig. 4(a).)

"What's the idea behind that?"

"Connecting the bypass capacitor in this manner," said Smithy in reply, "ensures that signal currents in the base and emitter circuit of the transistor flow only inside the loop given by the i.f. transformer secondary, the

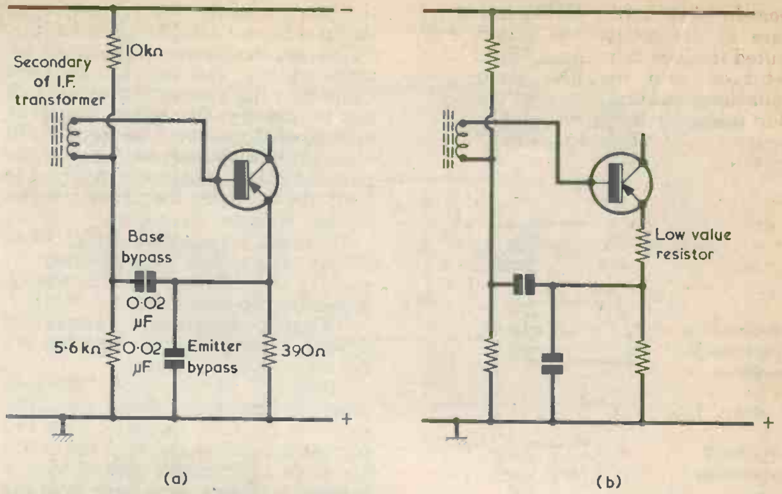


Fig. 4 (a). In a.m. superhets, base bypass capacitors in i.f. amplifier stages are frequently returned to the emitter rather than to chassis. Component values shown here are representative. (b). Occasionally, a low value resistor is inserted in series with the emitter of an i.f. amplifier transistor to reduce gain. A typical value is 10Ω.

bypass capacitor and the base-emitter junction of the transistor. The result is a small but useful measure of isolation from other circuits coupling to the chassis rail, with a consequent slight improvement in stability. Whilst talking about i.f. emitter circuits in these receivers I might mention in passing that you may occasionally encounter a low value resistor between the bypass capacitor and the emitter itself. Such a resistor is purposely included to reduce transistor gain by a small amount, which it does by introducing negative feedback." (Fig. 4(b).)

"Well, there aren't any unbypassed emitter resistors in this set," remarked Dick, "but we still have a nasty attack of i.f. instability. You seem to have a pretty good idea of what's causing the trouble, Smithy. Which component is it?"

"I'm not by any means a hundred per cent certain," stated Smithy cautiously, "but there is one component common to both i.f. transistors *and* the mixer-oscillator transistor, and this is by far the most likely culprit. Can you spot it?"

Dick's face assumed a deep scowl as he gazed closely at the circuit.

"Why, it's staring me in the face," he exclaimed. "It's that 200μF electrolytic across the suppy rails, and it's the bypass capacitor for all the i.f. transformer primaries. Why has it got such a high value if it's acting as a bypass at intermediate frequencies?"

"Because," replied Smithy, "it's another capacitor which is also acting as an a.f. decoupling capacitor. In company with the 100Ω series resistor in the negative supply rail it's preventing a.f. from the audio stages getting back to the i.f. amplifier. Now, an electrolytic capacitor isn't always a good component for r.f. bypass purposes because it can develop a fairly high r.f. impedance whilst still having a low impedance at audio frequencies. In this set that 200μF electrolytic has a really man-sized bypassing job to do because it has no less than three successive collector loads returned directly to it. It only needs to develop a small r.f. impedance to allow signals from the third transistor collector to be fed back, via the first i.f. transformer, to the base of the second transistor."

"Would those signals," asked Dick doubtfully, "be in the right phase to set up oscillation?"

"They could easily be," said Smithy. "In any case you've got three tuned circuits in the feedback loop all tuned to the same frequency, and these will assist any tendency towards oscillation that there may be. Now, the acid test consists of checking the capacitor, and the simplest method of doing that is to slap another capacitor across it."

"Righty-ho," said Dick cheerfully. "I'll dig out another 200μF electrolytic."

"Get a new one," stated Smithy. "Don't get a junky old one that's been knocking around in your spares box for ages."

Dick walked over to the spares cupboard whilst Smithy peered inside the case of the receiver, and then consulted the service manual. When Dick returned with the new electrolytic capacitor, Smithy indicated the position taken up by the existing component on the printed circuit board of the receiver.

"I'll switch on the set," stated Smithy, "and tune in one of the weaker medium wave signals which give the whistle. Then you temporarily connect this capacitor across the existing one. Right way round, mind."

Smithy turned on the receiver and tuned it to a medium wave signal to produce the heterodyne whistle, then watched as Dick applied the lead-outs of the new capacitor across the component soldered to the board. (Fig. 5). As soon as the new capacitor bridged the existing one the whistle disappeared and the signal was reproduced correctly.

"There you are," said Smithy cheerfully. "That was quite easy, wasn't it?"

"I'll say it was," agreed Dick warmly as he switched off the receiver. "All we've got to do now is whip out the old capacitor and put in the new one."

He looked critically at the interior of the receiver.

"It looks as though it's going to be a ticklish job getting this printed board out," he went on. "It hasn't half got an awkward mounting."

"There's no need to get it out," replied Smithy. "The leads to the existing capacitor are reasonably long. Just snip these close to the capacitor body and then solder the new capacitor to the old leads."

"As you like," said Dick equably.

After noting carefully the positive end of the faulty capacitor he cut its leads close to its body. He then carefully bent them up vertically and soldered the new capacitor to them. (Fig. 6). He next switched on the receiver. It now reproduced the received signal correctly, and there were no more whistles, either on medium or on long waves. Also, the hiss on the long wave band had completely disappeared.

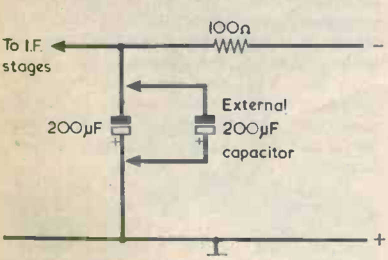


Fig. 5. Checking the 200µF supply rail bypass capacitor by temporarily connecting an external capacitor of the same value across it.

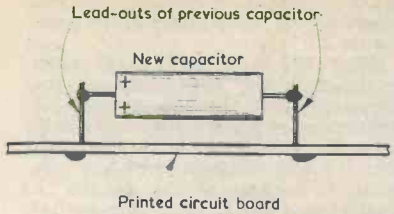


Fig. 6. Dick soldered the replacement electrolytic capacitor to the lead-outs of the faulty component.

RETURN TO NORMAL

"That," remarked Smithy, "is an excellent start to the New Year."

"It is, isn't it?"

"And what I like, too," continued the Serviceman, "is that we've managed to do a really professional job without relapsing at any time into vulgar or profane language. If we keep this up, 1976 is going to be a really refined and well-bred year for us."

"These are early days yet, Smithy," warned Dick darkly, "so don't get your guts in an uproar."

"I shan't," replied Smithy contentedly. "If we carry on like this we'll transform the place. *What* did you say?"

"I said, don't get your guts in an uproar."

Smithy looked dubiously at his assistant's youthful face.

"That must," he remarked slowly, "be about the most revolting expression I've ever heard. What on earth does it mean?"

"It's a common enough saying these days," responded Dick carelessly. "It just means, don't get too excited in advance."

"Does it, indeed?" remarked Smithy musingly. "Do you know any other colourful terms like that?"

"Stacks of them."

"Well, I'm always interested in current English usage," stated Smithy. "Let's close up this place and go down to Joe's Caff, and you can tell me all about them down there."

It took the pair hardly any time at all to switch off the lights and their bench sockets.

"Just a minute," said Dick, as he pulled on his raincoat. "What about this New Year Resolution of yours about not using vulgar language?"

"Oh that," said Smithy. "To tell the truth I was beginning to feel that it was going to be too much trouble trying to keep it up, anyway. Let's get back to normal."

"So?"

"So," said Smithy happily as he walked out of the Workshop on this very first day of 1976, "ballet tights to the Resolution." ■

RADIO TOPICS

By Recorder

I hardly need to tell you that resistance in ohms is equal to voltage divided by current in amps.

This is, of course, the redoubtable Ohm's Law. If we apply 2 volts across a 1Ω resistor then the current which flows in the resistor is 2 amps. Should we increase the voltage to 10 volts the current in the 1Ω resistor goes up to 10 amps. If we apply the 10 volts to a 2Ω resistor instead of a 1Ω resistor then only half the previous current, i.e. 5 amps, flows in the resistor.

WORKING WITH KILOHMS

All very sensible, logical and easy to follow. But I find that quite a few newcomers to our hobby tend to get out of their depth when they start working with resistance in kilohms. Those three noughts at the end of the resistance figure tend to get a little out of hand if they are not subdued firmly. Fortunately, with transistor equipment there is an easy solution to the problem since most voltages are low in value and most currents are of the order of milliamps.

All you have to remember is that, in just the same way that 1 volt across 1Ω gives a current of 1 amp, so does 1 volt across 1kΩ give a current of 1mA. Immediately, you lose the three noughts in the resistance figure and you start dealing directly with the current units which are actually involved.

Les us say that we have a transistor amplifier stage in which the transistor emitter connects to chassis via a 1kΩ bias resistor. We apply a voltmeter across the resistor and it gives a reading of 2 volts. What does this tell us? It informs us that the current flowing in the 1kΩ resistor (and hence the emitter current of the transistor) is 2mA. A voltage of 3 volts across the 1kΩ resistor would have indicated a current of 3mA, a voltage of 4 volts across the 1kΩ resistor a current of 4mA, and so on. With a 2kΩ resistor, a voltage of 3 volts would have indicated a current of 1.5mA and a voltage of 4 volts a current of 2mA.

I know that I've picked easy figures for these examples, and that in the hard world of reality the resistances would be awkward values such as 2.7kΩ or 4.3kΩ, and that the voltages would not be neat whole numbers of volts but would be more like 1.3 volts or 3.4 volts. However, once you get a little practice in thinking in terms of kilohms and milliamps, these more unwieldy numbers can still enable you to mentally work out an approximate idea of current flow. You only have to get the pencil and paper out when you need to calculate precise current values.

The kilohm and milliamp relationship also sheds light on the ohms per volt figures quoted for voltmeters. If a voltmeter is specified as having a resistance of 1k per volt then it draws a current of 1mA at full-scale deflection of its needle. A resistance of 10kΩ per volt means that the current at f.s.d. is one-tenth of a milliamp, or 100μA. Voltmeter advertisements usually quote sensitivities in terms of ohms instead of kilohms, presumably because the string of noughts looks more impressive. So, a sensitivity of 10kΩ per volt becomes expressed as 10,000Ω per volt. The meter still passes 100μA at f.s.d., though.

It is a profitable exercise to think in terms of current flow in resistors whenever you are doing a little servicing or building a constructional project. You *have* to do this if you intend carrying out serious design work and every little bit of experience helps.

And, with transistor electronics, it is always a good thing to remember the basic fact that the volt, the kilohm and the milliamp form a harmonius threesome in which everything fits precisely and Ohm's Law is obeyed to the letter.

DIGITAL CAPACITANCE METER

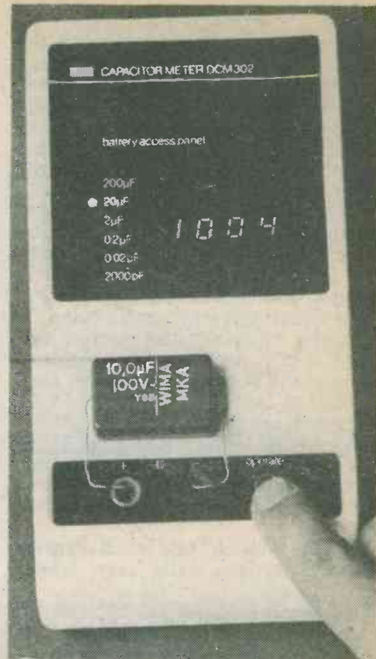
The accompanying photograph shows the Digital Capacitor Meter type DCM 302, which is now being manufactured by Aim Cambridge, Ltd.

The meter is compact and has many applications in production, test, servicing and inspection. A great advantage is its simplicity of operation: there are no nulling or other adjustments and all that is required is that the test capacitor be connected and a touch-pad touched. There is no need to switch the unit off, as this is done automatically after 10 seconds. Accuracy is typically within 0.5% of reading.

The unit ranges automatically over 6 decades of capacitance up to 199.9μF, and in addition to the 3½ digit display (the first figure is 0 or 1) a separate l.e.d. lights up to indicate the decade in which the reading is being given. The read-out characters are 7.5mm. high and can be distinguished up to 12ft. away.

The unit is powered by two PP3 batteries, these giving an operating life of at least 6,000 measurements. A separate mains power unit is available if required.

Further details can be obtained from Aim Cambridge Ltd., Nuffield Road Industrial Estate, St. Ives, Huntingdon, Cambs.



The Digital Capacitor Meter type, DCM 302. Manufactured by Aim Cambridge, this gives digital read-out of capacitance up to 199.9μF.

CHURCH TV CENTRE

The Marconi Mk. VIII colour television camera, manufactured by Marconi Communication Systems Limited, is well-known for its exceptionally advanced design, and is used by the I.T.V., the B.B.C., and by broadcasting authorities in more than 20 overseas countries.

Two more Mk. VIII cameras and a range of ancillary equipment are being supplied to the Churches' Television Centre. The cameras and ancillaries will be used to extend the facilities of the Churches' studio at Bushey, Herts, which Marconi re-equipped for colour in 1972.

The Television Centre was first established in 1959 and has been in its present permanent headquarters at Bushey since 1965. Under the Lord Rank Foundation for Christian Communication, it provides material for religious programmes and a wide spectrum of training for clergy and ministers, student groups, sixth-formers, church laymen and specialist groups of many descriptions. Since its studio is run by only a relatively small technical staff, the choice of the Marconi Mk. VIII camera, with its comprehensive automatic colour balance, centreing, line-up and check features, was a natural one when the question of expansion arose.

The Mk. VIII camera is also the subject of a contract recently concluded by Marconi Communications Systems and London Weekend Television. This calls for the supply of a camera and ancillary broadcast equipment for a control centre in London which will ultimately be the source of a colour television programme service for British Forces stationed in West Germany. The London Control Centre, as it will be known, is planned to be operational by March 1976.

The provision of a colour television service to the BAOR, made up of programmes drawn from the schedules of the BBC and ITV networks, will eventually be accomplished by relaying a television signal from the London Control Centre to Swingate in Kent and thence across the Channel to Roetgen in West Germany. From Roetgen the signal will be distributed via a network of microwave links to some 50 low power transmitters which are sited at various points throughout Germany so as to provide programme coverage to all UK military personnel stationed there.

Because of the complexity of the overall system, in which Marconi Comunications is to play the major role, the project has been divided into phases. An initial interim service in the north of Germany is based on tape programmes played from a mobile trailer unit. As more transmitters are added to the network, and links between them are established, the mobile unit will move to an appropriate new site and so progressively extend the system southwards towards Roetgen. Work on the cross-channel link from the UK to Roetgen will run concurrently with these developments.

London Weekend Television, who manufactured the mobile trailer unit, have responsibility for the planning of the London Control Centre, and will staff and manage it on behalf of the British Forces Broadcasting Service. The Marconi Mk. VIII, which will be the only camera at the Centre, will be used to provide "live" links between the scheduled BBC and ITV programmes and to originate news and affairs programmes of interest to the military in Germany.

APPROACHING LIGHT

My second photograph provides a useful reminder that if we go high enough up in the electromagnetic spectrum we find ourselves in the range of visible light.

The device illustrated is made by EMI-Varian Limited, 248 Blyth Road, Hayes, Middlesex, and consists of a sub-millimetre detector tunable over four octaves from 70GHz to over 1,100GHz. A GHz is 1,000MHz. and 1,100GHz is just entering the realm of infra-red rays. The detector is electronic in operation and consists of a Schottky barrier diode mounted in an oversize waveguide coupled to a horn fitted with a phase correcting low loss lens.

The detector is intended for quasi-optical systems and is tested with a hydrogen cyanide laser running at 890GHz. At this frequency the beamwidth to the 3dB down points is approximately 2 degrees.

Thus, an input signal from what we normally consider to be a light emitting device is picked up and detected by a purely electronic instrument.

This new sub-millimetre quasi-optical detector has been developed by EMI-Varian Limited, and is tunable over four octaves from 70GHz to over 1,100GHz.

TRANSISTOR NUMBERS

Transistor type numbers, especially those in the 2N series, do not have quite the same evocative character that the old valve type numbers had, but they can still create an impression. For instance, I bumped recently into a home-constructor circuit which had several transistors type 2N2222. This is a small n.p.n. silicon transistor and no one could deny that its type number is in a category of its own.

Musing along these lines I leafed through the pages of my *Towers' International Transistor Selector* to see if there were any other notable transistor type numbers. I found the 2N1111 (p.n.p. germanium), the 2N3333 (an f.e.t.), the 2N4444 (a thyristor) and the 2N5555 (another f.e.t.) The letter-number combinations were less rewarding, and I often feel that it was a mistake to choose the prefix BF for silicon r.f. devices. Type numbers like BDY10 can be rather disturbing, and I get the impressfion of a little beady-eyed transistor glaring out at the world from the corner of some remote printed circuit board.

Then it occurred to me that the manufacturers of transistors may well have the same approach to distinctive type numbers as car-owners have towards distinctive number-plates. I visualised the scene in some semiconductor R and D laboratory of the future, as a flustered manager pokes his head round the door.

'Hey Joe, how's the latest transistor coming along?'.

'Mighty fine, boss. It should be ready for registration in a fortnight.'

'In a *fortnight?* Can't you make it a week?'

'What's the rush, boss?'

'I particularly promised J.G. that we'd get 2N9999 in our range, and the registrations are already up to 2N9990. Don't forget that Motorola beat us to 2N7777, and Texas whipped 2N8888 right out from under our noses. We've just *got* to get that 2N9999.'

'O.K. boss. I'll cut a few corners, and I'll get this one done a bit earlier.'

'You'll do that, Joe?'

'Sure will boss. No sweat.'

And, as a relieved manager scuttles off to other urgent business, we can reflect on the unsung human stories which lie behind so many of our twentieth century technological advances. ■

New Products

TRIO HEADPHONES INTRODUCED TO UK

Trio's United Kingdom distributors, B. H. Morris & Company, are to introduce two headphones to the range of hi-fidelity equipment they market here. The models are the KH 32 and KH 52.

The KH 32 employs high quality full-range transducers in vented enclosures to give undistorted sound. The earpieces are extremely comfortable and the headband is of the twin-bar type to distribute weight evenly for long periods of listening. The KH 32 is fully adjustable: click-stops on the stirrups prevent the earpieces slipping — an annoying fault with many headphones.

Similar in design to the KH 32, the KH 52 gives an even wider, cleaner rendering of all types of music. Spun Mylar transducers ensure exceptionally low distortion. A twin-bar headband is padded for extra comfort, as are the earpieces.

Specification

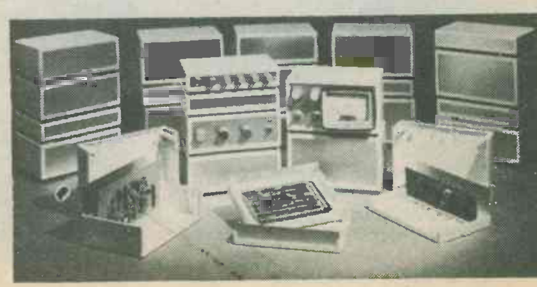
Transducers:	Dynamic type, employing 25 micron Mylar film elements	Connecting lead:	KH 32 — 2m vinyl cable KH 52 — 3m mesh cable Both leads terminate in stereo jack plugs
Sensitivity:	106 dB @ 1 mW input	Weight (without lead):	KH 32 — 290 grams KH 52 — 300 grams
Maximum input:	100 mW		
Frequency response:	20Hz-20,000Hz	Maximum selling prices (inclusive of VAT):	KH 32 — £16.80 KH 52 — £22.80
Matching impedance:	4-16 ohms		

PLASTIC VEROBOXES WITH METAL FRONT AND REAR PANELS

Vero Electronics Limited recently announced the introduction of a new range of Plastic Veroboxes which have been designed to house the smaller type of instrument or control unit.

The boxes are constructed of two mouldings in light grey high impact A.B.S. to give a very high quality outward appearance. These contain built-in guide slots for vertical mounting of P.C. boards or metal plates. The base panel is also fitted with threaded inserts for the attachment of an horizontal P.C. board or chassis. The boxes include, anodized aluminium front and rear panels for the mounting of switches, knobs, meters or plugs and sockets. These panels are held in position by the mouldings so that no panel fixing screws are required. The two mouldings themselves are screwed together by four screws which enter through the base moulding and are hidden from view by the plastic feet used with the boxes.

The illustration shows the various sizes of Verobox which are available together with examples of the fixing of P.C. boards. A new full colour brochure is now available describing these latest additions to the Vero range of small enclosures.



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WANTED TO PURCHASE: All early books on radio, preferably before 1925. Box No. 282.

"HEDDON VALLEY ELECTRONICS" free catalogue and order forms 1976 now available. Many popular semiconductors, resistors, condensers, etc., all at competitive prices. Prompt attention on all orders regardless of sizes, all components guaranteed. A must for the home constructor, for the price of an s.a.e. Heddon Valley Electronics, Bumpsley Mill, Parracombe, Barnstaple, North Devon.

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(Continued on page 389)

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