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2·5–25 VOLTS

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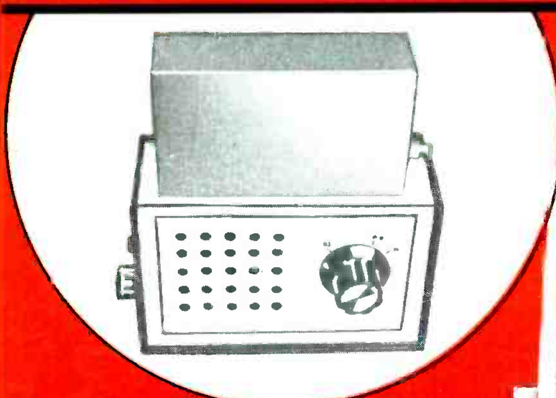

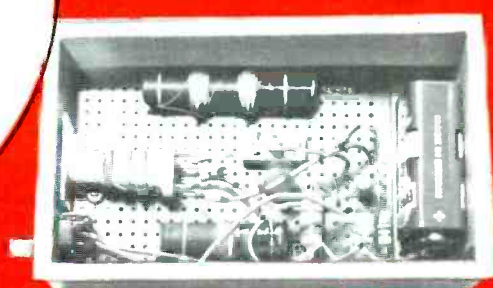

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T2	8	D1374	OC75
T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
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T9	8	2G399A	2N1302
T10	8	2G417	AF117

All 55p each pak

ND 120 NIXIE DRIVER TRANSISTOR
Suitable replacement for BSX 21, C 407, 2N 1893 120volt.

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Q36	7	2N3646 TO-18 plastic 300MHz NPN	0.54
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U 5	60	200mA Sub-Min. Silicon Diodes	0.54
U 6	30	Sil. Planar Trans. NPN like BSY95A. 2N706	0.54
U 7	16	Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0.54
U 8	50	Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0.54
U 9	20	Mixed Voltages, 1 Watt Zener Diodes	0.54
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U49	12	NPN Sil. plastic power trans. 60W like 2N5294/5296	£1.08

Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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ORP12 48p

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PIV	300mA	750mA	1A		1.5A	3A	10A	30A
50	0.05	0.06	IN4001	0.05	0.08	0.15	0.21	0.60
100	0.05	0.07	IN4002	0.06	0.10	0.17	0.23	0.75
200	0.06	0.10	IN4003	0.07	0.12	0.22	0.25	£1.00
400	0.08	0.15	IN4004	0.08	0.15	0.30	0.38	£1.35
600	0.09	0.17	IN4005	0.10	0.18	0.36	0.45	£1.90
800	0.12	0.19	IN4006	0.11	0.20	0.38	0.55	£2.10
1000	0.14	0.30	IN4007	0.12	0.25	0.48	0.65	£2.50
1200	—	0.35		—	0.30	0.58	0.75	£3.00

1975 CATALOGUE NOW READY 10p

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PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0.26	0.28	0.39	0.39	0.52	0.55	0.59	£1.27
100	0.28	0.37	0.52	0.52	0.55	0.64	0.70	£1.54
200	0.39	0.41	0.54	0.54	0.63	0.67	0.83	£1.76
400	0.48	0.52	0.62	0.62	0.74	0.83	£1.03	£1.93
600	0.59	0.63	0.75	0.75	0.85	£1.07	£1.38	—
800	0.70	0.77	0.88	0.88	0.99	£1.32	£1.65	£4.40

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FOR USE WITH TRIACS
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10 amp POTTED BRIDGE RECTIFIER on heat sink. 100PIV. 99p each

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VBOM	2A TO-5 £	6A TO-66 £	10A TO-48 £
100	0.33	0.55	0.83
200	0.55	0.66	0.99
400	0.77	0.83	1.21

INTEGRATED CIRCUIT PAKS
Manufacturers' "Fall Outs" which include Functional and Part Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No. Contents	Price	Pak No. Contents	Price	Pak No. Contents	Price
UIC00=12×7400	0.54	UIC46=5×7446	0.54	UIC90=5×7490	0.54
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UIC02=12×7402	0.54	UIC50=12×7450	0.54	UIC92=5×7492	0.54
UIC03=12×7403	0.54	UIC51=12×7451	0.54	UIC93=5×7493	0.54
UIC04=12×7404	0.54	UIC53=12×7453	0.54	UIC94=5×7494	0.54
UIC05=12×7405	0.54	UIC54=12×7454	0.54	UIC95=5×7495	0.54
UIC06=8×7406	0.54	UIC60=12×7460	0.54	UIC96=5×7496	0.54
UIC07=8×7407	0.54	UIC70=8×7470	0.54	UIC100=5×74100	0.54
UIC10=12×7410	0.54	UIC72=8×7472	0.54	UIC121=5×74121	0.54
UIC20=12×7420	0.54	UIC73=8×7473	0.54	UIC141=5×74141	0.54
UIC30=12×7430	0.54	UIC74=8×7474	0.54	UIC151=5×74151	0.54
UIC40=12×7440	0.54	UIC76=8×7476	0.54	UIC154=5×74154	0.54
UIC41=5×7441	0.54	UIC80=5×7480	0.54	UIC193=5×74193	0.54
UIC42=5×7442	0.54	UIC81=5×7481	0.54	UIC199=5×74199	0.54
UIC43=5×7443	0.54	UIC82=5×7482	0.54		
UIC44=5×7444	0.54	UIC83=5×7483	0.54	UICX1=25 Assorted	
UIC45=5×7445	0.54	UIC86=5×7486	0.54	74's	£1.65

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45p EACH

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200 v RMS	45p ..
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(Similar to 2N2060)

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ULIC700	10 — 709	0.54
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ULIC741	7 — 741	0.54
ULIC747	5 — 747	0.54
ULIC748	7 — 748	0.54

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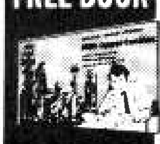

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10 watt wire wound	**12p**
15 watt	**14p**

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VA1005, VA1026 **20p**

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25	4p	5p	6p	8p	8p	15p	18p	20p
50	4p	5p	6p	9p	13p	18p	—	—
100	5p	6p	10p	12p	19p	20p	—	—
250	9p	10p	11p	17p	28p	—	—	—
500	10p	11p	17p	24p	45p	—	—	—
1000	13p	17p	40p	—	—	—	—	—
2000	23p	37p	45p	—	—	—	—	—

As total number of values are too numerous to list, use this price guide to work out cost of your actual value requirements, i.e. 2MFD, 30V would be 5p, or 330MFD, 50V would be 14p, etc. etc.

8/20, 10/20, 12/20 **Solid tantalum** **15p each**
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Bulgin D676 red, takes M.E.S. bulb	**20p**
12 volt red, small pushfit	**20p**
Mains neon, red, pushfit	**18p**

CAPACITOR GUIDE – maximum 500V

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Amp	Volt RMS		
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2	30	LT120	30p
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BYX38-1200	2.5	1,200	50p
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BYX49-300	2.5	300	26p
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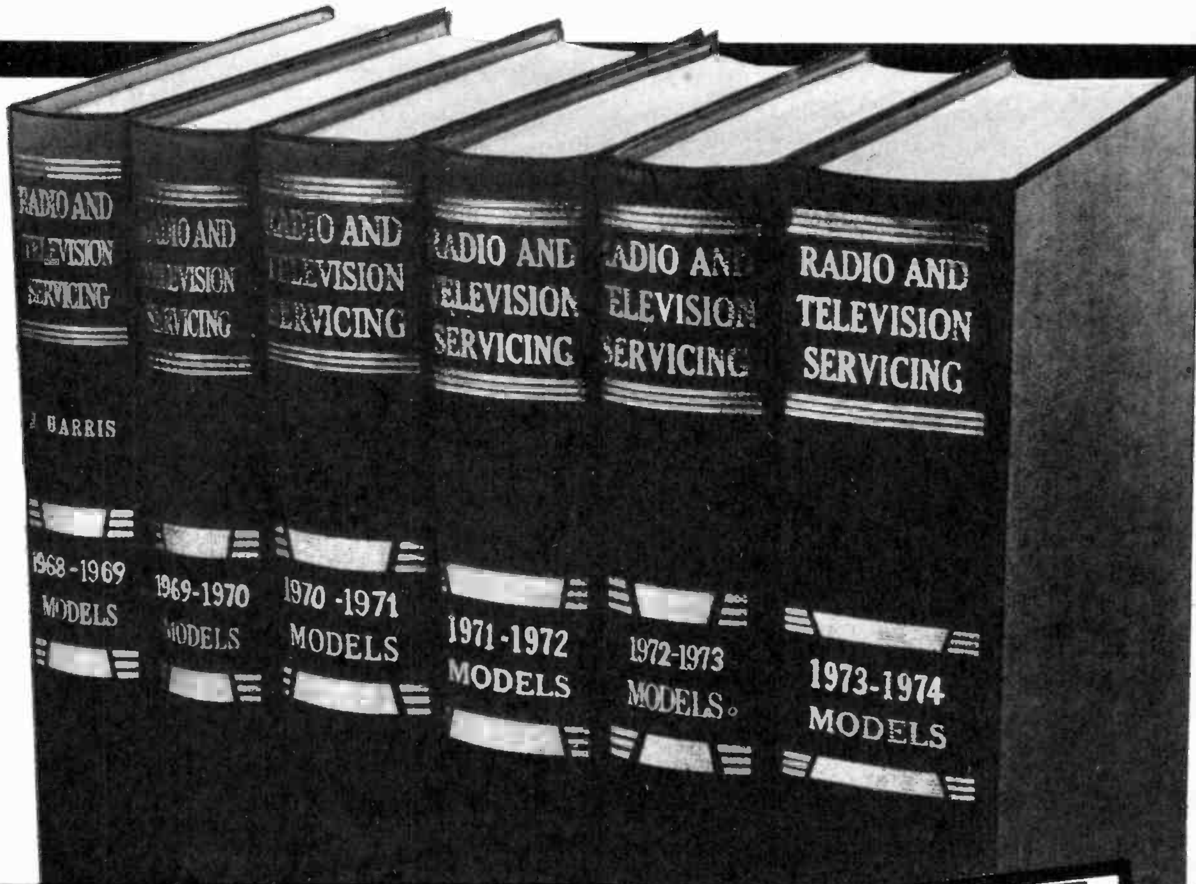

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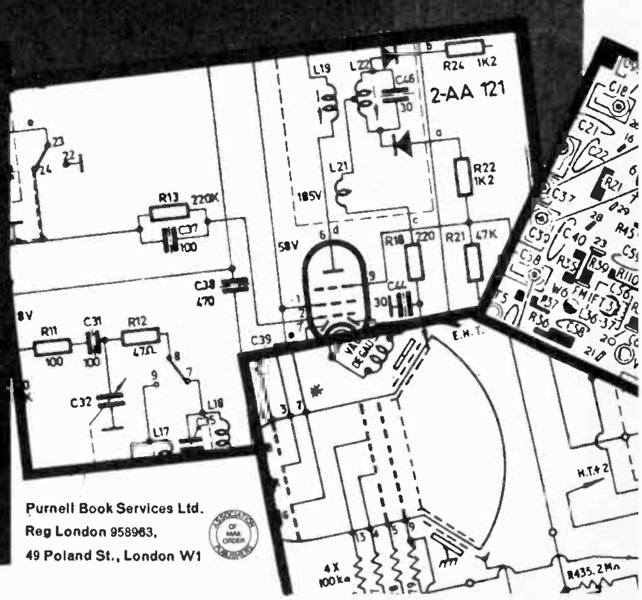

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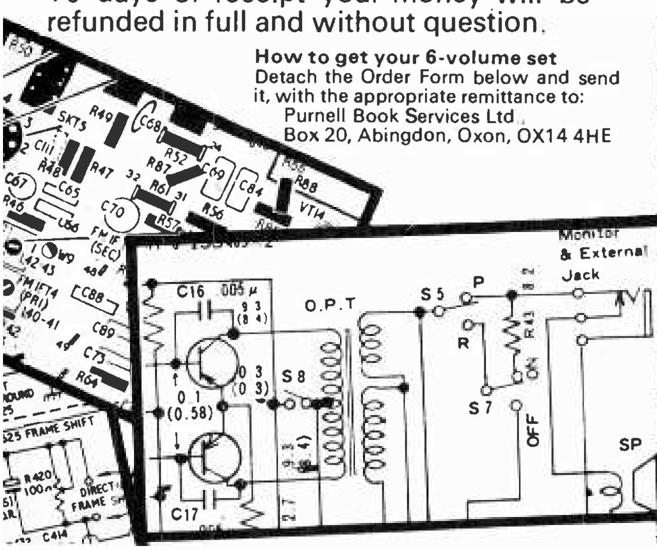

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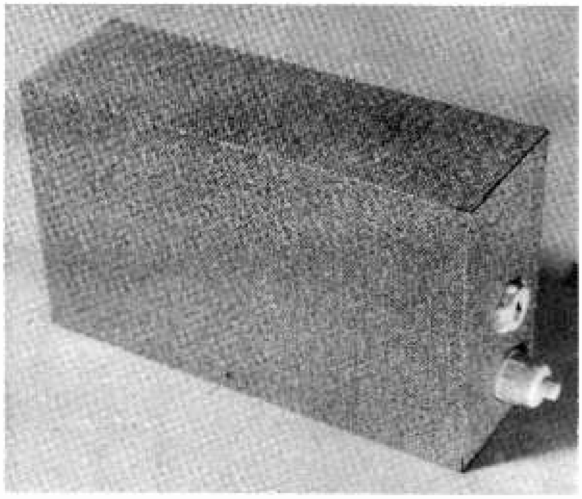
RADIO



By P. R. Arthur

MANY OF THE LESS EXPENSIVE COMMERCIALLY MADE broadcast band receivers, together with the simpler designs for the home constructor, are not equipped to receive long wave transmissions and hence are unable to pick up B.B.C. Radio 2. The inexpensive device which forms the subject of this article can, when placed near any medium wave portable having a ferrite aerial, enable that set to receive Radio 2. This it does by converting the long wave Radio 2 transmission to a medium wave signal.

The unit is self-contained, having its own internal battery and ferrite aerial. No direct connection is made between the converter and the receiver with which it is used.

OPERATING PRINCIPLE

A block diagram showing the various stages of the unit is given in Fig. 1. This is extremely simple and, as can be seen, the circuit consists of a ferrite aerial tuned to the Radio 2 frequency of 200kHz feeding one input of a mixer, and an oscillator having a nominal frequency of 900kHz feeding a second input. The input signals are heterodyned by the mixer to form two additional frequencies at the output. These are 700kHz (900kHz minus 200kHz) and 1,100kHz (900kHz plus 200kHz).

Both these frequencies lie, of course, within the medium wave band, and can be received by a medium wave radio tuned to either. The signal is fed to the receiver by way of a wide band coupling inductor consisting of a ferrite rod with a coil having a small number of turns. When the ferrite rod is placed near the ferrite aerial coil of the receiver the signal is induced from one coil to the other. This method of coupling is very simple but works extremely well.

CIRCUIT FUNCTIONING

The circuit of the converter is shown in Fig. 2. Only one active device is required, this being the dual gate m.o.s.f.e.t. TR1. If the G2 terminal is ignored for the moment, the device can be considered as being very much like a single gate m.o.s.f.e.t., whereupon source bias and decoupling are provided by R1 and C4, and the gate is tied to the negative supply rail via the ferrite coil L1. This coil is tuned to resonate at 200kHz by C1 and C2.

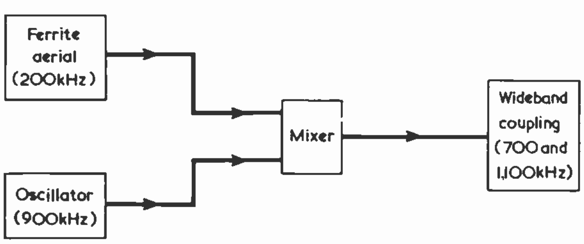


Fig. 1. Block diagram of the Radio 2 converter. The wideband coupling section couples inductively to the medium wave receiver ferrite aerial.

2 CONVERTER

This novel converter unit allows medium wave transistor portables to receive the long wave Radio 2 signal. The converter output couples inductively to the medium wave receiver ferrite aerial and no interconnections are needed.

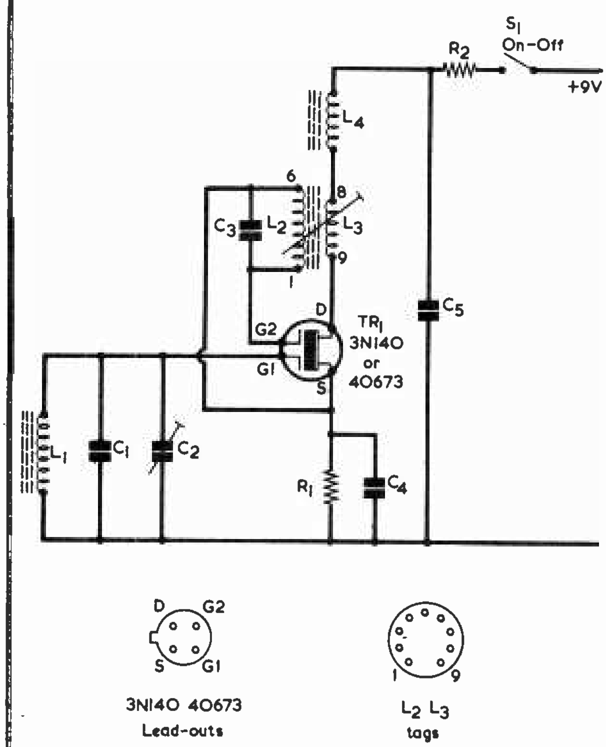


Fig. 2. The circuit of the converter. The dual gate f.e.t., TR1, functions both as oscillator and as mixer.

COMPONENTS

Resistors
(All ¼ watt 5%)

R1	820Ω
R2	680Ω

Capacitors

C1	150pF polystyrene or silvered mica
C2	30–140pF mica trimmer
C3	120pF ceramic plate or silvered mica
C4	0.022µF plastic foil, side wires, Mullard C280 or similar
C5	0.022µF plastic foil

Inductors

L1	see text
L2, L3	Miniature Dual-Purpose Coil, Transistor Usage, Yellow, Range 2T (Denco)
L4	see text

Semiconductor

TR1	3N140 or 40673 (see text)

Switch

S1	s.p.s.t., miniature

Battery
9 volt battery type PP3 (Ever Ready)

Miscellaneous
Ferrite rod, ⅜ in. diameter (see text)
Battery connector
Plain Veroboard, 0.15 in. matrix, 3¾ by 2½ in.
30–34 s.w.g. enamelled or d.c.c. copper wire
Materials for bracket and case

The positive supply is fed to the circuit by way of R2, C5 and the on-off switch, S1. L4 is the wide band coupling coil.

The gain at the G1 terminal of the f.e.t. is dependent upon the voltage at the G2 terminal. When G2 is biased a couple of volts or so positive of G1, the G1 gain will be high. If, on the other hand, the G2 potential is taken down to, or is even made negative of, the voltage on G1, the G1 gain will be greatly diminished. G2 is held about 1 volt positive by being connected to the source via the oscillator tuned winding, L2. Positive feedback from the drain to G2 to produce oscillation is then given by way of L3. C3 tunes L2 to give oscillation at approximately 900kHz.

Since the voltage at G2 is modulated by the 900kHz oscillation so also is the G1 gain. Thus the 200kHz input signal from L1 is modulated by the 900kHz signal to produce the required additional signals at the output.

It might at first sight be considered that R2 is unnecessary and that the junction of C5 and L4 could connect directly to S1. However, it was found in practice that, without R2, the circuit oscillated rather violently and did not give proper operation.

TR1 can be either a 3N140 or a 40673, both of which are available from Arrow Electronics Ltd., 7 Coptfold Road, Brentwood, Essex, CM14 4BN. The 40673 has integral back-to-back diodes connected to the source to protect the gate insulation from breakdown due to excessive gate voltage. The component employed for L2, L3 is a Denco Miniature Dual-Purpose coil which is normally used as an r.f. interstage coil. It has a base coupling winding which is not employed in the present circuit and which is not shown in Fig. 2.

COMPONENT PANEL

Apart from the battery and S1, all the components are mounted on a piece of plain Veroboard (i.e. without copper strips) of 0.15 in. matrix measuring 3¾ by 2½ in. This is a standard size. A diagram showing component layout on this board is given in Fig. 3.

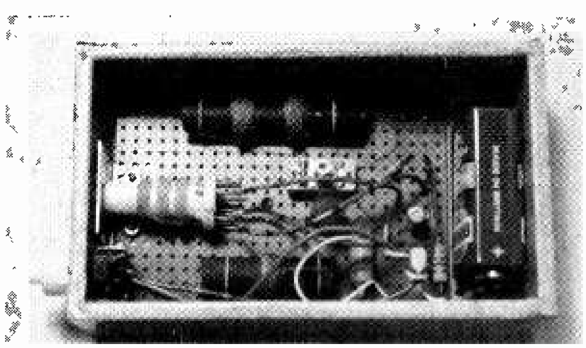
Two lengths of ⅜ in. ferrite rod are required for L1 and L4. That for L1 is 2 in. long and that for L4 is 1½ in. long. Both of these will need to be broken from a longer rod. Ferrite is a very hard and brittle material, and a ferrite rod is most easily broken at a desired point by first cutting a deep V-shaped groove with a triangular file around its entire circumference at the appropriate place. The rod can then easily be broken cleanly in two at this point.

L1 is wound on the 2 in. rod, and consists of two pies, each with 100 turns to give 200 turns overall, of 30 to 34 s.w.g. enamelled or d.c.c. wire. The ends of the winding are taped to the rod to hold them securely in place. L4 has 40 turns of the same type of wire, these being wound in a single pie about ¼ in. wide. It is wound on the 1½ in. rod and, again, the winding ends are taped to the rod.

When L1 and L4 have been completed, they and the other components are mounted in position on the board. If a 3N140 is employed for TR1, do *not* remove the lead-out short-circuiting clip with which this is supplied. It will probably be necessary to enlarge the two holes for the tags of trimmer C2, and it may be necessary, with some trimmers, to cut the tags so that they are a little narrower. L1 and L4 are both tied tightly to the board, each by means of two lengths of twine or similar. They should not be secured with lengths of bare wire as these would constitute short-circuited turns and would prevent correct circuit functioning. The coil L2, L3 is mounted on a small bracket made of 18 s.w.g. aluminium. This is illustrated in Fig. 4, and it is necessary for two of the Veroboard holes to be drilled out 6BA clear to accommodate it. The section of the bracket which secures directly to the Veroboard is below the latter, as indicated in Fig. 3. The two 6BA bracket mounting bolts have their heads below the Veroboard and the nuts on the component side. The aluminium bracket also serves, later, to secure the component board inside the case.

The components are next wired up, as illustrated by the broken lines in Fig. 3. The lead-outs are bent over flat against the underside of the panel and are then taken to the appropriate connection points. Also connected at this stage are the negative battery lead and a lead about 5 in. long which will eventually connect to S1. These last two leads are flexible and insulated.

If TR1 is a 3N140 it is possible for its gate insulation to be broken down by any voltage which may be present on the soldering iron tip when this is applied to the gate circuits. To prevent breakdown, the short-circuiting clip must not be removed until all soldered connections have been completed and the converter is ready for testing. The soldering iron should be earthed, regardless of whether a 3N140 or a 40673 is used.



A view inside the case. The PP3 battery fits at the end of the Veroboard panel.

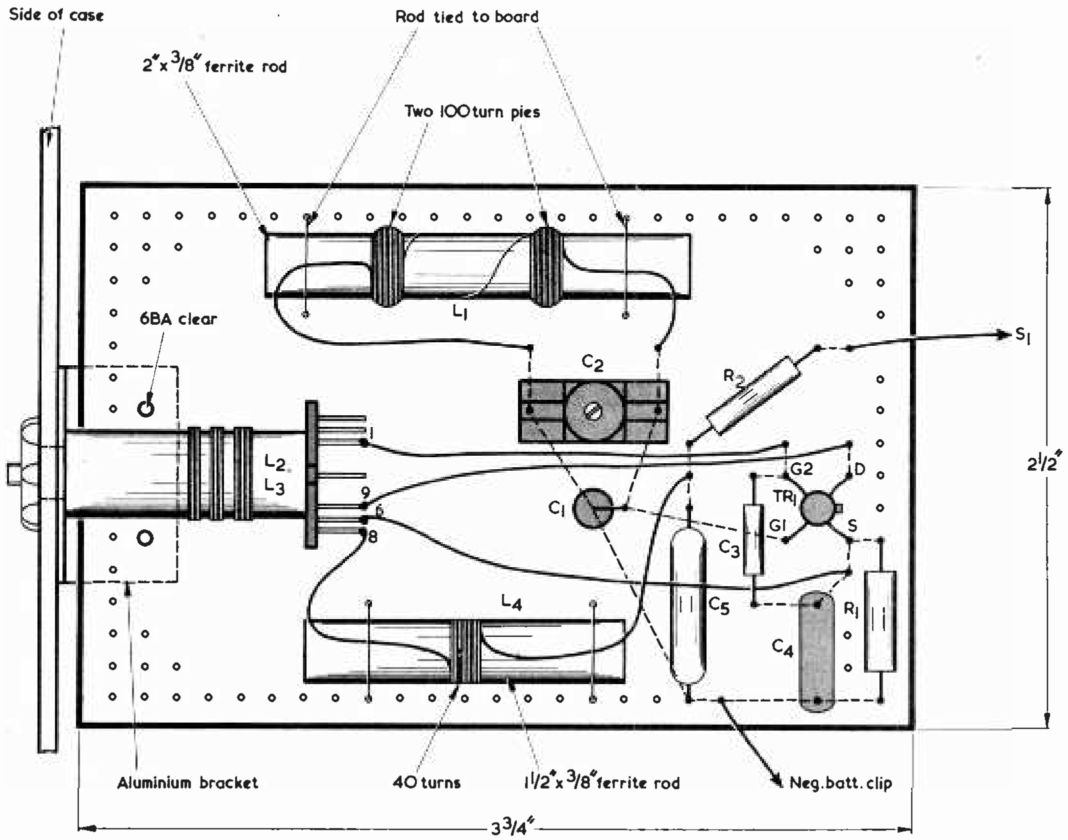


Fig. 3. Nearly all the components are mounted on a plain Veroboard panel. The connections at the coil tags need to be made quickly, as excessive heat here will cause deformation of the plastic insulation.

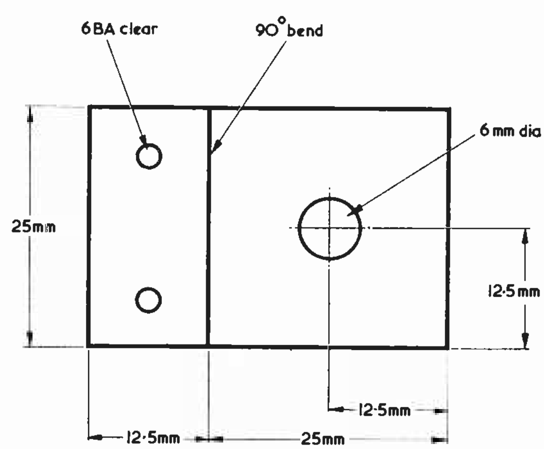


Fig. 4. The aluminium bracket which secures the Veroboard panel inside the case. The positions of the two 6BA clear holes are marked out from the corresponding holes in the Veroboard.

THE CASE

An inexpensive home-made wooden case is used to house the unit, and constructional details for the front, top, base and two sides are shown in Fig. 5. This diagram also indicates how these parts are assembled together. The material is 3mm. plywood, although a slightly different thickness could be used if some of the dimensions are suitably altered. The threaded section of coil L2, L3 will later pass through the central 6mm. (approximately ¼ in.) hole shown in one of the sides. Alongside this is the hole for switch S1, which can be any miniature s.p.s.t. type. In the prototype the author employed a press-button switch which turns on and then off with successive pushes on the button. After cutting out these two holes, the five parts of Fig. 5 may be glued together using a good general purpose adhesive.

When the adhesive has set, the case is covered with a self-adhesive plastic such as Fablon. Switch S1, and then the component board may be fitted. The threaded section of L2, L3 passes first through the 6 mm. hole in the aluminium bracket and then through the 6 mm. hole in the case side, as indicated in Fig. 3 and the

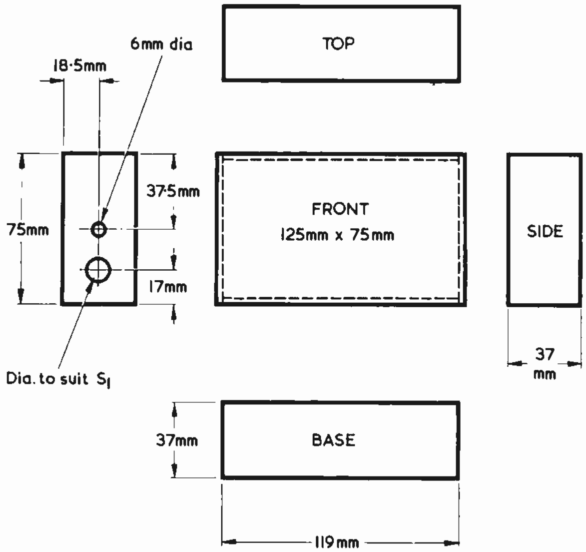


Fig. 5 The dimensions of the parts which make up the case. The material is 3mm. plywood. The top has the same dimensions as the base.

photograph of the interior. The plastic nut for L2, L3 is on the outside of the case, and it should be 'finger tight' only as the plastic screw thread could otherwise be damaged.

The back of the case, which can also be 3 mm. plywood, is next cut out. It should be a tight push fit, and it is prevented from going too far into the case by the presence of the aluminium bracket and the battery. The approximate dimensions of the back will be 119 by 69 mm., but its actual dimensions are best found by measuring from the case itself and taking into account the Fablon which will have been passed over the inside case edges and the fact that the back will itself also be covered with Fablon. It may be fitted with a small knob on the outside to enable it to be removed when necessary.

The wiring may then be completed. The 5 in. lead from the component board is connected to one tag of S1 and the positive battery lead to the other.

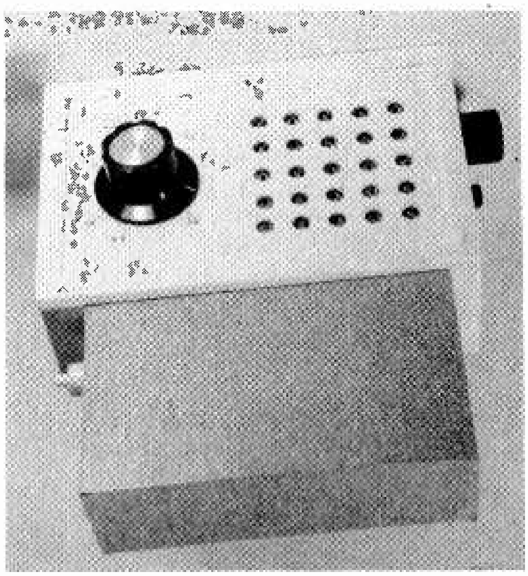
ADJUSTMENT

A current indicating meter should be inserted in series with the positive battery lead before the unit is first switched on, and this should give a reading roughly in the region of 1.2mA if the converter is functioning correctly. If a reading greatly different from this figure is obtained switch off immediately and check for wiring errors.

When a correct current reading is obtained, disconnect the meter and complete the normal positive connection to the battery. Place the unit so that L4 is close (within 2 to 3 in.) to the ferrite aerial coil of a medium wave receiver. The required coupling can frequently be achieved by merely placing the converter on top of the receiver. Tune the receiver to around 700kHz (429 metres) or 1,100kHz (273 metres) and search the dial for the Radio 2 signal. If it cannot be received, slightly adjust C2 and try again. Repeat if necessary until the signal is located.

Should the Radio 2 signal coincide with a medium wave signal, adjust the core of L2, L3 slightly to move the Radio 2 signal away from the medium wave transmission. Alternatively, tune the receiver to the other frequency on which Radio 2 can be picked up. If possible, have the core of L2, L3 adjusted so that none, or only a small part, of the metal thread attached to the core protrudes through the top of the coil. When a clear signal has been obtained C2 is adjusted to peak it.

Although the converter was designed only for reception of Radio 2, the bandwidth of L1 and C2 is quite wide, and it is possible that several other long wave stations may be received as well. These will be tuned in by adjusting the tuning of the medium wave receiver.



The converter has merely to be placed on, or close to, the medium wave receiver with which it is to be used. It is shown here with a small home-constructed receiver.

As a final point, it should be mentioned that the coil employed for L2, L3 is not normally intended for use in an oscillator circuit, and there is a very slight risk that one of the windings on a particular coil may be incorrectly phased. If it is found that oscillation does not take place and that no fault can be located, the connections to pins 8 and 9 of the coil should be temporarily transposed to check whether there is an incorrectly phased winding. ■

RECENT PUBLICATIONS

RECEIVING PAL COLOUR TELEVISION. By A. G. Priestley, B.Sc.(Eng.)
269 pages, 215 x 135 mm. (8½ x 5½ in.) Published by Fountain Press. Price £5.00.

This book is intended mainly for engineers and enthusiasts who are beginning to study colour television, and it explains the principles of PAL reception in terms which apply to the domestic colour television receiver. Also given are details of colour aligning and servicing procedures.

The book commences with a chapter dealing with fundamentals, including some notes on the original NTSC colour system, and introducing brightness, hue and saturation. The second chapter then describes the transmission of a PAL signal, to be followed by a third chapter devoted to colour tubes and beam deflection arrangements. Subsequent chapters cover the decoding of the PAL signal, colour display adjustments, the complete colour receiver, and further aspects of the PAL system which were not dealt with earlier. The final chapter is concerned with servicing. There is an appendix on vectors and phasors, and included also are four pages of colour reproductions showing the chromaticity diagram together with twelve views of the image presented by the colour tube under correct and fault conditions.

This is a hard cover book, and will be of especial value to the student and the service engineer. The reader who is conversant with monochrome television operation may well find that this work provides the vital stepping stone he needs to enter the area of colour television.

MARINE ELECTRONICS HANDBOOK. By Leo G. Sands.
198 pages, 215 x 135 mm. (8½ x 5½ in.) Published by Foulsham-Tab Ltd. Price £1.35.

Another book in the Foulsham-Tab list of American texts with an introductory chapter for English readers, 'Marine Electronics Handbook' deals extensively with the marine communication services that are available in the U.S. for small sea-going craft. The book gives details of v.h.f., a.m. and s.s.b. radiotelephones and, also, of radio direction finding equipment.

Further sections of the book cover aerial systems, additional uses for radiotelephone equipment, power supplies, maintenance and servicing. A final chapter is devoted to rules and courtesy in the operation of radiotelephones.

The book is aimed at the marine enthusiast who has a smattering of electrical and electronic knowledge and it gives a comprehensive listing of services and equipment. Operating references in the book are with respect to F.C.C. regulations whereas, in the U.K., the radio licensing authority is the Home Office.

The following titles are similarly American texts published by Foulsham-Tab Ltd., and they have the same page size.

PICTORIAL GUIDE TO TAPE RECORDER REPAIRS. By Forest H. Belt.
262 pages. Price £1.40.

Illustrated entirely by photographs, this book covers the servicing of tape recorders and ancillary items. The equipments dealt with range from cassette portables to 8-track players installed in cars.

KWIK-FIX TV SERVICE MANUAL. By Forest H. Belt.
390 pages. Price £1.95.

A book, well illustrated with oscillograms and picture tube displays, describing the trouble shooting of 525 line monochrome and colour television receivers. The latter use NTSC circuits.

BASIC ELECTRICITY AND BEGINNING ELECTRONICS. By Martin Clifford.
262 pages. Price £1.40.

This book starts right from scratch with static electricity and takes the reader up to the elements of the triode valve and the transistor. It caters for the real beginner, and offers a helpful introduction to electrical basics.

HOW TO BUILD SOLID-STATE AUDIO CIRCUITS. By Mannie Horowitz.
326 pages. Price £1.75.

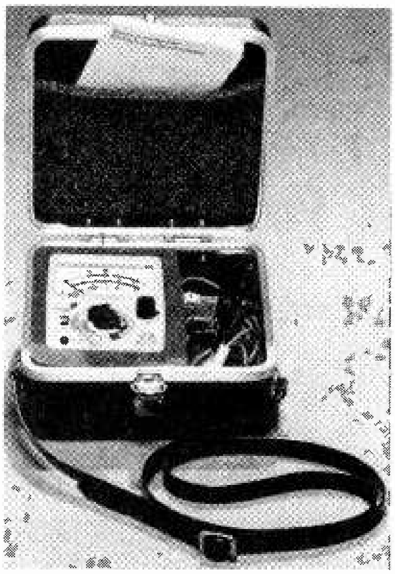
Basic design procedures for a.f. amplifying circuits incorporating bipolar transistors, f.e.t.'s and i.g.f.e.t.'s. A very meaty treatment of the subject with plenty of detail, fairly simple mathematics where necessary, and a considerable number of practical design examples to demonstrate the theory. The book is based on material published by the author in *Radio-Electronics* magazine.

HOW TO TEST . . . ALMOST EVERYTHING ELECTRONIC. By Jack Darr.
166 pages. Price £1.30.

A large number of tests on domestic electronic equipment are described, each test being dealt with as an individual item. The test equipment employed includes voltmeters, milliammeters, multimeters, electronic voltmeters and oscilloscopes; and the equipment being tested ranges from dry batteries to CB transmitters and colour television receivers.

NEWS . . . AND .

LARGE INSTRUMENT ORDER



Photograph shows the British Gas multi-meter complete with accessories, in its carrying case. The instrument is manufactured by SEI at its Eccles factory.

Salford Electrical Instruments Limited has recently been awarded a large instrument order, by British Gas, worth more than £300,000, over two years.

The contract is for up to 10,000 multi-range test meters designed to a unique performance specification drawn up by British Gas. The meters will meet the special requirements for servicing the electrical circuitry in gas appliances.

The need for a special instrument has resulted from the increasing and more sophisticated use of electricity of both high and low voltages in gas appliances.

R.S.G.B. ANNUAL REPORT AND ANNUAL REVIEW

The Annual Report of the Council of the Radio Society of Great Britain to its members, presented at the Forty-eighth Annual General Meeting of the Society in December, was an encouraging one.

The financial aspect continues to be better and the surplus for the year ended 30th June 1974 exceeded £3,700 and brings the Accumulated Fund to more than £21,000. It is also pleasing to note that H.M. Customs and Excise have agreed that 60% of the subscription from UK members should be zero-rated. An amount of £4,802 is due back, and the Council hope that members will be prepared to leave their individual share of this substantial sum with the Society.

Following upon our remarks last month regarding the extent of voluntary work undertaken by many in our hobby, we noted that there were no less than 13 Committees of Council. The amount of voluntary work given under the auspices of the Society must indeed be enormous, when one also takes into account the work done by the officers of affiliated clubs and societies, and individual members.

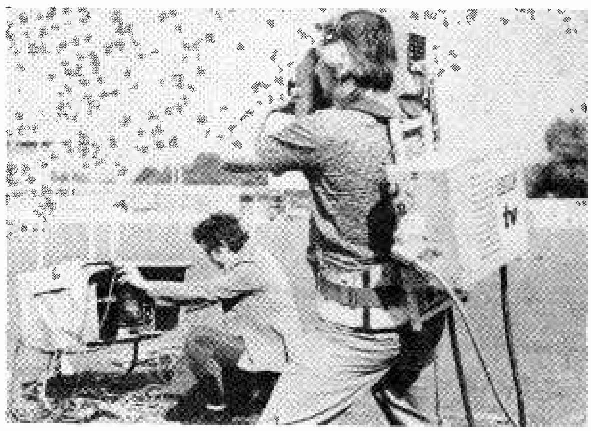
There is much else of interest mentioned in the Annual Review and it reveals the great importance of the R.S.G.B. to amateur radio. This part of our hobby would be infinitely poorer without the R.S.G.B., and we hope that those of our readers who are interested in amateur radio, and not already members, will consider joining – the address is: 35 Doughty Street, London, WC1N 2AE, from whom details can be obtained.

● World Radio Club transmission times as from 4th January, 1975, will be:

1330 – 1345 GMT
2315 – 2330 GMT
2030 – 2045 GMT
0815 – 0830 GMT

BBC MINICAM AT CRYSTAL PALACE SPORTS ARENA

The multi-purpose triaxial cable connecting to the portable outside-broadcast BBC Minicam has to provide a screen, a good earth, d.c. power, digital-on-carrier signals for electronic camera function control, v.f.-on-carrier two-way voice circuits and carry fully colour-coded vision signals back from the camera. The triaxial connector on the left of the back-pack had to be self-latching, sealed, noise-free and robust: an unusual combination of requirements that were met by Lemo (UK) Ltd., of 6 South Street, Worthing, Sussex.



. . . COMMENT

BRIAN RIX AT MIDLAND AMATEUR RADIO EXHIBITION

Mr. Rix visited Leicester on Thursday 31st October 1974, as a guest of Doram Electronics on their stand at the Amateur Radio & Electronics Exhibition held in the Granby Halls.

After a brief address, in which Brian Rix (G2DQU) admitted that he first went on the air using his elder brother's equipment at the tender age of 13, he selected a cordless soldering iron from the Doram catalogue. The photograph shows Frank Chable, General Manager of Doram Electronics, making the presentation.

Having drawn the 50 winners of a competition sponsored by Doram, Mr. Rix talked to electronic enthusiasts about their hobby and demonstrated his own mobile radio station – his car, having been brought into the exhibition and parked adjacent to the Stand.

Doram Electronics was recently established in Leeds to provide a 'by-return-of-post' mail order distribution service for components, kits and accessories specifically for the amateur radio, electronics and hi-fi enthusiast.

Catalogues, priced at 25p and containing full details of more than 4,000 product lines are available from them at PO Box TR8, Wellington Road Industrial Estate, Leeds LS12 2UF.

THE SIR HENRY WHEATSTONE PREMIUM

Mr. J. Elliot, a project manager at the EMI Electronics Limited laboratory at Wells, Somerset, has been awarded the Sir Henry Wheatstone Premium by the Institution of Electronics and Radio Engineers for his paper on a device developed to aid yachtsmen.

His paper describes the device, which consists of a small analogue computer taking account of the apparent wind parameters, together with the yacht's speed. The output indicator is an electrical meter which shows when the optimum course is being steered.

RISING PRICES?

Last month in our report of the Amsterdam Radio Exhibition we quoted the organisers' comments that radio and TV equipment are less sensitive to inflation than other consumer goods.

The large discounts offered by firms in the hi-fi field are some evidence of this, and one can now see something of the same trend in the component field, as keen readers of advertisement pages will have noticed.

However, we do not expect component prices to follow the trend of share prices!

IN BRIEF

● A course of lectures on Modern Colour TV Receivers is to be given at South London College. Topics include: Recent circuit techniques and development of 110° colour television receivers, by Specialists from Bush, Murphy, Ferguson, HMV, Ultra, Marconi, Decca, Philips and Pye. 9 weeks, from 6.30 to 8.30 p.m. each Thursday evening, commencing 23rd January, 1975.

Applications to: Senior Administrative Officer, South London College (formerly Norwood Technical College), Knight's Hill, London SE27, 0TX.

● For the second successive year, Amphenol Limited, the Whitstable based manufacturer of electronic components, has won the British Safety Council's top award. Amphenol has now been awarded a safety performance Citation in each of the three years that the Council's scheme has been running.

With apologies to the author of the Pulse Counting F.M. Tuner article.

TOUCH BUTTON CIRCUITS

By G. A. FRENCH

Suggested Circuit 290

THE FACT THAT THE COLLECTOR OF A bottomed silicon transistor assumes a potential approximately 0.2 volt above its emitter, and that under these conditions the base is about 0.6 volt above the emitter, enables a number of simple and interesting switching circuits to be evolved. A selection of typical switching circuits is given in this article. The principles to be presented are of a general nature and the experienced experimenter will be able to take advantage of one or more of the configurations to meet any specific applications which he may have in mind. From an electrical point of view the circuits can be looked upon as being very 'robust', in so far that reliable operation can be obtained with a wide variation in resistor values. Obviously, semiconductor maximum current and power dissipation figures must not be exceeded.

BASIC CONFIGURATION

A basic switching configuration is shown in Fig. 1. Here, there are two silicon transistors cross-connected in such a manner that one transistor must always be turned on and the other must always be turned off. Let us say that it is TR1 which is turned on. Under these conditions, TR1 collector is about 0.2 volt positive of the negative supply rail, whereupon the base of TR2 is below the 0.6 volt level needed to cause this transistor to conduct. In consequence, TR2 is cut off. The base bias current required to maintain TR1 in the bottomed condition flows through R4 and R3. The collector of TR2 is at the same potential as the junction of these transistors, and with the component values shown in the diagram this potential is of the order of 6 volts. If we should happen to press push-button S2, nothing will happen. The push-button will merely take TR2 base a little further negative and TR2 will stay in the non-conductive condition.

If, however, we press S1, the circuit immediately changes over. This is because S1 takes the base of TR1 down to the negative supply rail, thereby cutting this transistor off. TR1 collector current ceases and bias current can now flow through R1 and R2 to the base of TR2, which turns

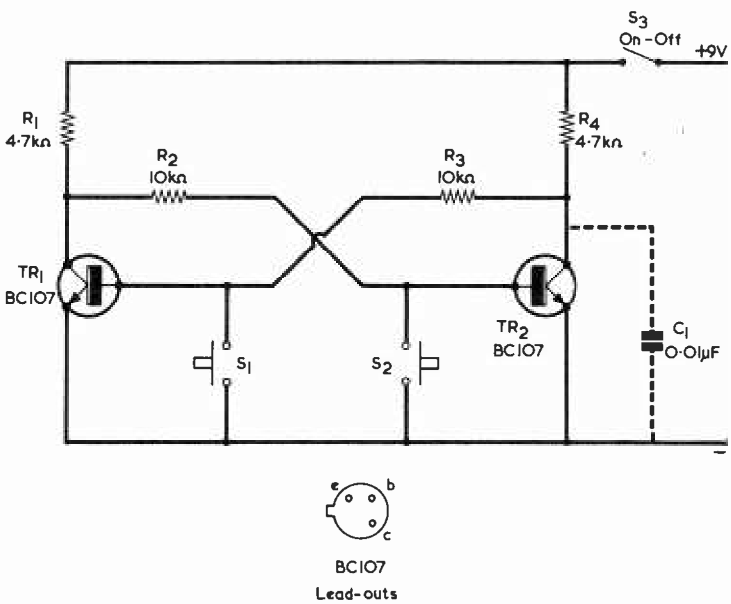


Fig. 1. A basic switching circuit. One transistor is always conductive and the other cut off

hard on. The circuit will remain in this condition when S1 is released because the collector of TR2 will now be at about 0.2 volt positive of the negative rail, and will prevent the flow of bias current to the base of TR1. The circuit will continue with TR2 on and TR1 off until we press S2, whereupon it will at once revert to the original condition.

When the 9 volt supply is applied either of the two transistors will turn on. Checks with a practical circuit showed a nearly completely random pattern here, although the transistor with the higher gain tends to be the one which turns on more frequently at supply switch-on. If a capacitor of suitable value is connected between one transistor collector and the negative supply rail that transistor will always be the one which turns on when the supply is applied. In Fig. 1 the capacitor is connected, as shown in broken line, to the collector of TR2, and it causes a slight delay in the rise of base current in TR1 at supply switch-on, thereby favouring the turning on of TR2. A value of 0.01μF was found to be satisfactory and this did not have any noticeable effect on circuit control by the push-buttons. It is probable that a lower value than 0.01μF could be used in conjunction with the resistor values shown, although this point would have to be checked by experiment with the particular transistors employed.

The collector voltages of TR1 and TR2 may be employed to control external circuits, and the arrangement has the advantage that control is exerted even though the short-circuiting of either base to the negative supply rail is of a momentary nature only.

LIGHT-EMITTING DIODE

In Fig. 2 the collector resistor for TR1 is replaced by a light-emitting diode type TIL209 and a 330Ω current limiting series resistor. Despite its asymmetry this circuit functions just as reliably as that of Fig. 1. A current of about 20mA flows through the l.e.d. when TR1 is on, causing it to glow brightly. The bias current for TR2 flows through the l.e.d. when TR1 is off. This current is a little less than 1mA, and it results in a just perceptible glow in the light-emitting diode. Due to the much higher current requirement of TR1 collector load, TR1 is always off after supply switch-on. If a 0.01μF capacitor is connected between TR1 collector and the negative supply rail, TR1 is always on after switch-on. The value of 0.01μF proves to be satisfactory in practice despite the higher collector current loading for TR1.

Fig. 2 provides the same facilities as Fig. 1, with the added feature that the circuit state is indicated by the light-emitting diode.

In Fig. 3(a) a second l.e.d. is added, this becoming fully illuminated when TR2 is turned on. Circuit operation is

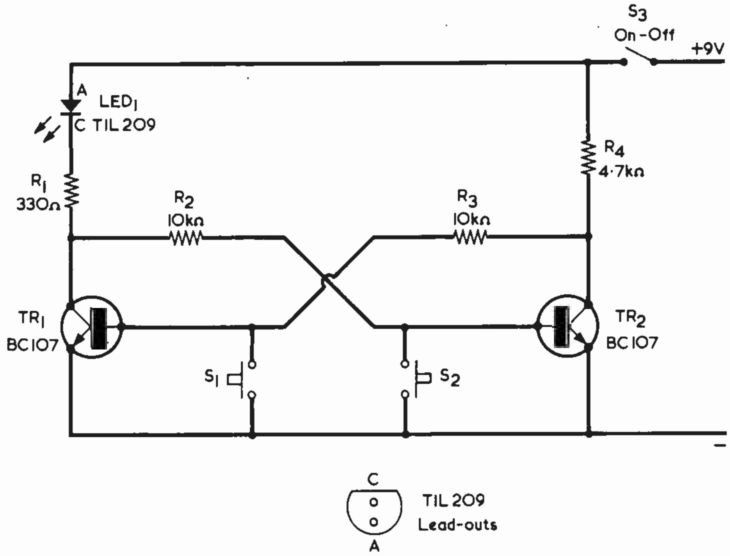


Fig. 2. In this circuit the collector load for TR1 consists of a light-emitting diode and series resistor

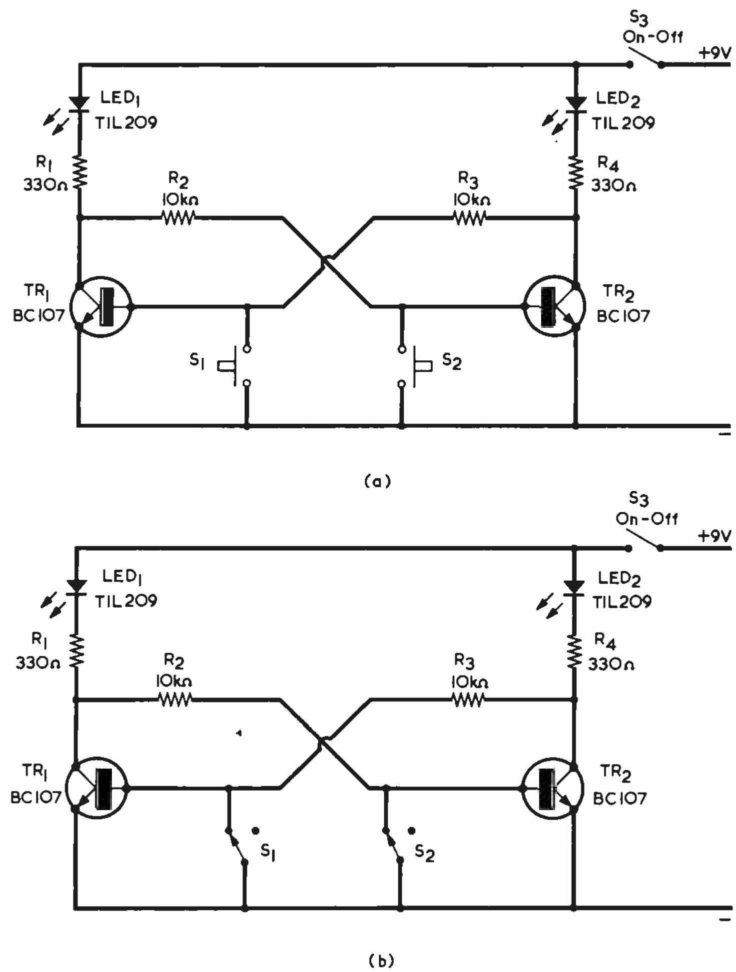


Fig. 3(a). Here, an l.e.d. appears in both collector circuits
(b). Replacing the push-buttons by switches that are normally closed results in a precedence detector circuit

the same as before, and a 0.01µF capacitor can be employed with either of the two transistors to ensure that that is the one which turns on at supply switch-on. If S1 and S2 are omitted the circuit can be used as a gambling toy, in so far that either l.e.d. may light when the 9 volt supply is applied. However, it will be impossible to obtain a true 50:50 random distribution between the two l.e.d.'s and there will be a bias towards one or the other depending on the relative gains of the two transistors.

In Fig. 3(b) the press-buttons are replaced by two switches which are normally closed. In consequence, both transistors are turned off. If, say, S1 is now opened TR1 will at once become conductive and it will be impossible for TR2 to turn on even if S2 is opened only fractionally later. The fact that S1 has opened first will be indicated by full illumination in LED1. Had S2 opened before S1, then this fact would be registered by full illumination in LED2.

The circuit may be used as a precedence detector to indicate which of two pairs of contacts has opened first. S1 and S2 may, for instance, be physical switches operated by two contestants in a quiz game.

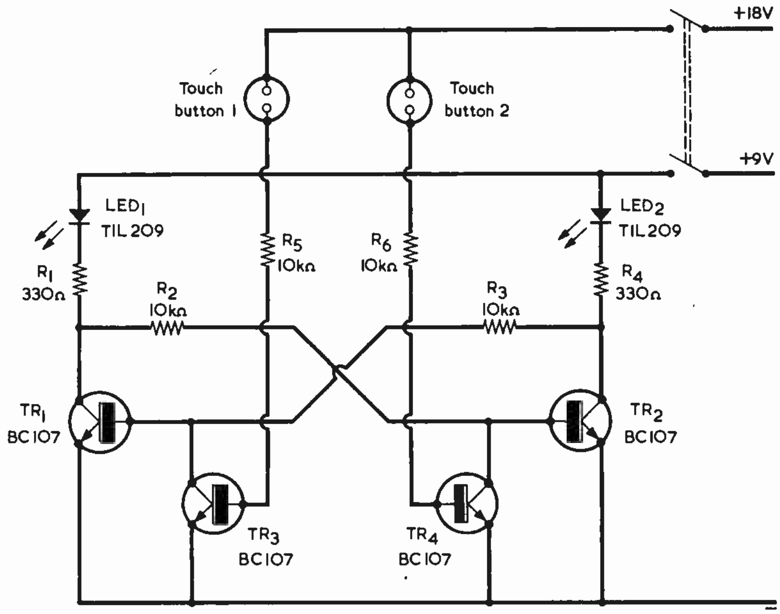


Fig. 4. Altering the basic circuit to give control by touch button

TOUCH BUTTONS

Touch buttons appear to be all the rage these days, and the basic circuit adapted for operation by two touch buttons is shown in Fig. 4. Two transistors, TR3 and TR4, have been added and the bases of these couple to the touch buttons via current limiting resistors R5 and R6. A supply of 18 volts is provided for the touch button circuit.

If a finger is applied to one of the touch buttons, it bridges the two contacts of the button and allows a small current to flow to the base of the corresponding transistor. Thus, if TR1 is on and Touch Button 1 is touched by the finger, a current flows into the base of TR3 via R5. This current causes TR3 to conduct sufficiently to reduce the bias current for TR1. TR1 turns off and TR2 turns on. TR1 can be turned on again by applying a finger to Touch Button 2.

The prototype version of Fig. 4 functioned quite reliably, but the author puts this circuit rather in the experimental category because it relies extensively on the resistance presented to the touch button by the finger and this factor cannot be controlled. It is interesting to note that a hard calloused skin can, when dry, offer a very high resistance to the touch buttons and may need to be pressed down somewhat firmly to actuate the circuit rather than merely touched against the surface. The electrical sensitivity of the touch button circuit is high; with the prototype, operation was obtained by connecting a 2MΩ resistor across either button.

The touch buttons themselves have to be home-made, and each consists of two small adjacent metal areas which can be bridged by the finger and which are mounted on an insulating base. The metal employed should be one which presents a shiny surface that will not oxidise. For his experiments the author employed two adjacent strips on a small piece of Veroboard which had the flux removed by a little light sandpapering. These could, however, oxidise too readily in time to function as the basis of a permanent touch button.

In all the circuits given in this article, the resistors may be ¼ watt 5 or 10%. ■

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

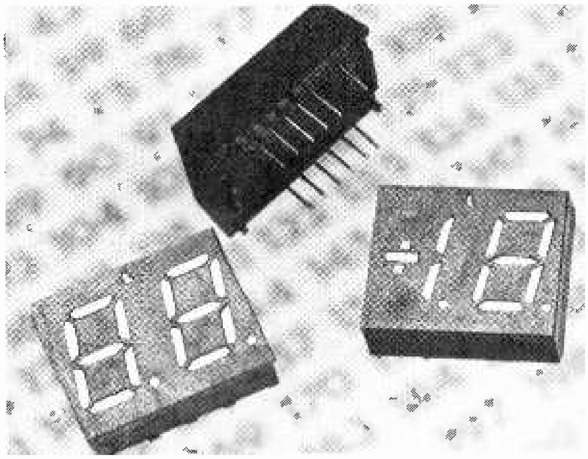
We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is the cover price stated on the issue, plus 6p postage.

Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.

We regret that we are unable to supply photo copies of articles where an issue is not available.
Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

Trade News . . .

DUAL-DIGIT DISPLAYS



With their red-lit characters of 0.5in. height, the DL-721 and -727 dual-digit displays are the first of their kind currently available from any optoelectronic manufacturer.

Litronix announce two new dual-digit red-lit numeric displays, believed to be the only displays of their type currently available. Designated DL-721 and DL-727, they have been created for a broad range of commercial and domestic applications, from digital clocks and t.v. tuner indicators to digital instrumentation and point-of-sale systems. DL-721 contains a polarity indicator, and can register from 00 to 19; DL-727 incorporates two 7-segment digits, and can register from 00 to 99.

In both cases, the digits measure 0.5in. in height and have a right-hand decimal point. They are end-stackable on 0.5in. digit centres.

Typical electrical characteristics of these common-anode units include a forward voltage of 2V at 0.5 to 50mA, dynamic resistance of 6-ohm at 10mA, and luminous intensity of 3mcd at 20mA.

Both the –721 and the –727 are priced at £2.44 in quantities of 1,000.

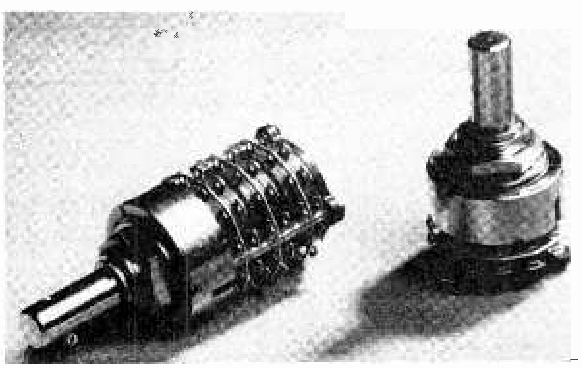
MINIATURE ROTARY SWITCHES

The FEME 5922 series of miniature rotary switch from *FR Electronics* are available up to 6 poles 12 way. The professional version of the switch has gold contacts, either hermetically sealed or with adjustable stop, whilst the economic version has silver contacts, unsealed, with or without adjustable stop.

The switch is moulded in diallylphtalate and is rated at 0.3A at 220 V.AC, or 1A at 30 V.DC.

High quality standards of manufacture are maintained and good deliveries available.

Further details are obtainable from FR Electronics, Switching Components Group, Wimborne, Dorset.

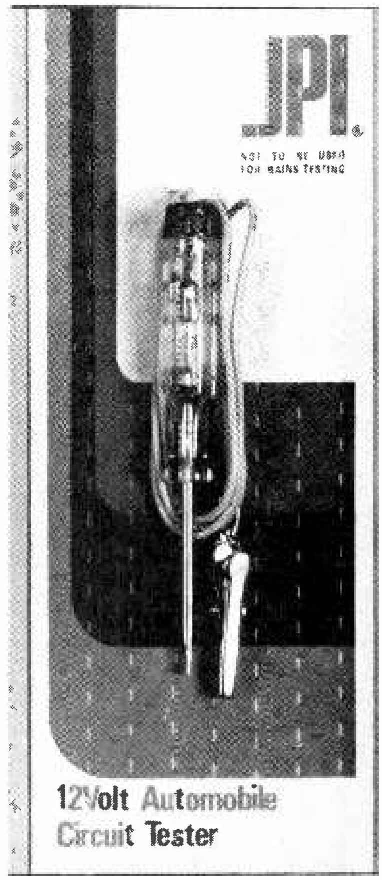


CIRCUIT TESTER FROM JPI

A low-priced, combined 6/12 volt circuit tester and electrical screwdriver has been introduced by J. P. Isaacs Ltd., of Mark House, Harrow, Middlesex.

The tester, made in West Germany, consists of a 4½in. screwdriver with a hollow, insulated handle containing a festoon bulb, and a 30 in. lead terminating in a crocodile clip. By clipping the lead to any convenient earth point the tester can be used to check virtually any automobile circuit or component except the starter solenoid. It is also suitable for low-voltage radio circuit testing, but not for mains voltages.

At a recommended retail price of 63p plus VAT, the tester which is skin-packed with full instructions will shortly be available through garages and motor accessory shops. Trade inquiries should be addressed to local motor factors.



SHORT WAVE NEWS
FOR DX LISTENERS
By Frank A. Baldwin

Times = GMT

Frequencies = kHz

I am sometimes asked the questions "Is it possible to hear Dx stations on the higher frequency bands?" and "Do you log any Dx on the HF bands?" or "Can you give me any information of HF bands Dx stations?". Yes it is, yes I do and yes I can.

HF BANDS DX

The hunting grounds of the avid Dxer are the 60 and 90 metre bands but it is perfectly possible to go Dx chasing on the HF bands especially at this time of the year. Try the following:–

● MALAYSIA

Kota Kinabula on **15275** at 1517, series of chimes repeated till 1530 when YL announcer with "Inilah Suara Malaysia, Kuala Lumpur", announcements and Arabic-type music.

● SRI LANKA

Colombo on **11800** at 1540, the All Asia Service in Hindi, Indian-type music, some QRM from Moscow.

● INDONESIA

RRI Jajapura on **7190** at 1348, OM in Indonesian, Arabic-type music, chants.

● CLANDESTINE

How about some of these stations? R. Pathet Lao on **6211.5** at 1405, YL with harangue in Laotian; Voice of the United Front of Cambodia on **9988.5** at 1413, OM and YL alternate in Cambodian, local music, off suddenly 1431; Voice of the Thai People on **9422.5** at 1543, OM & YL in Thai, music, off 1610 after slogans.

CURRENT SCHEDULES

● SOUTH AFRICA

Radio RSA, "The Voice of South Africa", Johannesburg, operates an External Service in English to West Africa and Europe from 2100 to 2150 on **7270, 9525, 11900** and on **15155**. Radio RSA also presents programmes in English as follows – to East and Central Africa and the Middle East from 0300 to 0430 on **3995, 5980, 7270** and on **9525**; to West Africa from 0615 to 0705 on **11900, 15220** and on **17780**; to South and North East Africa (Sundays only) from 1000 to 1050 on **11970** and on **15220**; to Central and East Africa from 1100 to 1200 on **11900, 15220** and on **21535**; to Central and East Africa from 1300 to 1550 on **11900** (to 1456), **15220** and on **21535**; to East Africa and the Middle East from 1600 to 1650 on **7270, 11900** and on **15155** and to North America from 2230 to 2320 on **9525, 9695, 11900** and on **15155**.

● NEW ZEALAND

Radio New Zealand, Wellington, has an External Service mostly in English to the Pacific islands from 0600 to 0845 on **6080** and on **9540**; from 1700 to 1945 on **6080** and on **9755** and from 2000 to 0545 on **15110**. Programmes not in English are from 0645 to 0710 in Samoan (Saturdays); 0730 to 0800 in Samoan; 0820 to 0845 in Raratongan (Wednesdays).

● TAIWAN

The Voice of Free China, Taipeh, presents an External Service in English to Africa and Europe from 1900 to 2000 on **9685, 11825, 11860, 15125, 15370, 17720** and on **17890**; to North America, Far East and Pacific from 0200 to 0350 on **5980, 7130, 9685, 11825, 11860, 15125, 15370, 17720** and on **17890**.

● BRAZIL

Radio Nacional, Brasilia, radiates a programme in English directed to the Americas and Europe from 2100 to 2200 on **11780**.

● VENEZUELA

Radio Nacional de Venezuela, Caracas, has an External Service in English to Europe, North and South America, from 2200 to 2300 and from 0001 to 0100 on **11750** and on **15390**.

● CHINA – 1

Radio Peking has introduced broadcasts in Quechua beamed to Peru, Ecuador and Bolivia from 2230 to 2300 on **11685** and on **15520**.

● PORTUGAL

Radio Portugal, Lisbon, now radiates in English to Europe from 2230 to 2300 on **6025** and on **9740**.

● BANGLADESH

Radio Bangladesh, Dacca, in the External Service, radiates in English as follows – from 0445 to 1515 to the Middle East, India and Pakistan on **17745** and on **21685**; from 1120 to 1150 to Nepal on **7250** and on **9550**; from 1230 to 1300 to Europe on **15525**; from 1815 to 1900 (and from 1900 to 1915 with newscast at slow-speed) to Europe on **7250** and on **9488**.

Radio Bangladesh operates a Home Service mostly in Bengali but a few newscasts in English are included, these being from 0145 to 0155 on **4890** and on **5985**; from 0605 to 0610 on **9550, 9605** and on **17690**; from 1205 to 1210 on **4890, 5985, 7250** and on **17690**.

● **MOROCCO**

Moroccan Radio, Rabat, has an External Service in Arabic to Africa ("Voice of Moroccan Sahara") from 2100 to 2200 on **6170**, **6190** and on **9615**; in Spanish to Europe and Africa from 2205 to 2235 ("Voice of the Sahara") on **7225**.

● **CLANDESTINE**

Radio Independent Spain ("Radio Espana Independiente") radiates mostly in Spanish throughout the day but the evening schedule can be heard from 1800 to 2310 on **7690**, **10110**, **12140** and on **14485**; also from 2005 to 2025 on **15185**. This one is pro-communist, anti-Franco and the transmissions probably emanate from Bucharest.

Radio Euzkadi ("Voice of the Basque Resistance") in both Spanish and Basque from 1930 to 2100 and from 2130 to 2200 on a frequency between **13200** – **13300** and between **12000** – **12100** (frequencies vary daily). Previously radiated from a station located near Bordeaux, France (till August 1954), they are now thought to be transmitted from the northern part of the South American continent.

"Radio Iran Courier" (Radyo-ye Peyk-e Iran) broadcasts in Kurdish, Azerbaijani and Persian from 1430 to 1620 on **9560**, **11415** and on **11695**; from 1620 to 1810 on **11415** and on **11695**. Programme content is pro-Soviet, Anti-Shah, Iranian Government, Western interests in Iran, CENTO etc.

● **NORTH KOREA**

Radio Pyongyang operates a Home Service which may interest Dxers. The broadcasts are from 2000 to 0830 on **6290** and on **6600**; from 2330 to 0420 and from 0530 to 0848 on **11350**.

● **CHINA—2**

Radio Peking has a First and Second National Programme which may also interest Dxers when logged on the following channels. First National Programme, from 2000 to 2340 and from 1053 to 1735 on **3220**; from 2000 to 0100 and from 0948 to 1735 on **4460**; from 2000 to 0100 and from 1100 to 1735 on **3450** and on **4800**; from 2000 to 0100 and from 1033 to 1735 on **4905**; from 2000 to 0140 and from 0923 to 1735 on **5320**; from 2000 to 0100 and from 1100 to 1735 on **6225**, **6750**, **7095** and on **7516**. Second National Programme, from 2100 to 2330 and from 1133 to 1645 on **3290**; from 2100 to 2400 and from 1023 to 1645 on **4250**; from 2100 to 2400 and from 1118 to 1600 on **4850**; from 2100 to 0245 and from 0823 to 1645 on **5075**; from 2100 to 2400 and from 1023 to 1600 on **5163**; from 2100 to 2400 and from 0918 to 1645 on **6345**.

Other transmissions from Radio Peking of interest to Dxers would be the minority-language broadcasts in the Home Service. In Kazakh from 0130 to 0225 and from 1400 to 1455 relayed by Urumchi on **4400** and on **5800**; in Tibetan from 2330 to 0025 and from 1100 to 1155 relayed by Lhasa on **4035**, **9490** and on **9652**; in Uighur from 0030 to 0125 and from 1300 to 1355 relayed by Urumchi on **4110** and on **7050**; in Mongolian from 2200 to 2250 relayed by Huhehot on **4068** and on **4895**; in Mongolian from 0430 to 0520 relayed by Huhehot and Hailar on **6620**, **7202** and on **8320** and by Urumchi on **4220** and on **5440**; in Mongolian from 1200 to 1250 relayed by Hailar, Huhehot and Urumchi on **5915**, **6620** and on **7202**.

AROUND THE DIAL

● **POLAND**

Warsaw on **7125** at 1835 with a talk in English about the fruit growing industry in Poland, in parallel on **7285**.

● **FINLAND**

Helsinki on **11755** with a feature on the Finnish Post Office in English, also in parallel on **15185**.

● **AFGHANISTAN**

Kabul on **15195** at 1130 with commencement of English programme to Europe, station identification repeated several times.

● **IRAQ**

Baghdad on **9745** at 1930, news and comment in English until 2010 when YL with identification followed by National Anthem.

QSX

For the Dxer we offer the following –

● **INDONESIA**

RRI Banda Aceh on **4955** at 1548, OM in Indonesia followed by Moslem chants.

RRI Padang on **3960** at 1608, OM in Indonesian with readings from the Quran.

RRI Yogyakarta on **5045.5** at 1546, gamelan music with OM announcer.

RRI Bukittinggi on **4884** at 1550, local music, YL with songs, OM announcer.

RRI Medan on **4764** at 1555, local music, OM announcer, sign-off without the traditional "Love Ambon" at 1600.

RRI Jakarta on **4804.5** at 2203, OM with opening announcements, newscast in Indonesian till 2212 then local 'pops' on records, YL announcer, through to 2245.

● **NEPAL**

Radio Nepal on 3425 at 1501, newscast in English by YL after identification, at 1506 local music and song records with English announcements.

● **PAKISTAN**

R. Pakistan on **3400** at 1600 with identification and newscast in English.

R. Pakistan on **3870** at 1615, OM in Asian dialect, local music and songs.

● **INDIA**

AIR Delhi on **4800** at 1747, local music and song programme; on **3205** at 1516, OM with talk in vernacular and on **3295** at 1523, OM in Hindi.

AIR Kerseong on **3355** at 1525, OM with talk in vernacular.

AIR Gahauti on **3375** at 1526, local music, YL with songs.

● **MALAYSIA**

Kuching, Sarawak on **4950** at 1532, OM with song in English, Euro-style dance music records.

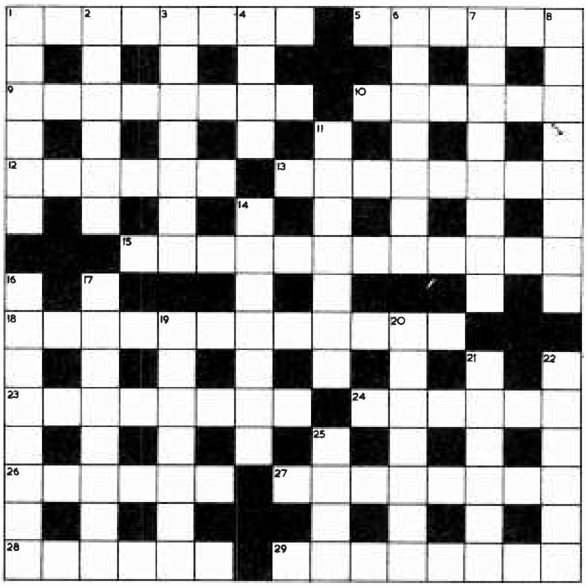
Sibu, Sarawak on **5005** at 2212, OM with song in dialect, local music with YL announcer.

● **KASHMIR**

Srinigar on **3277** at 1521, OM with talk in vernacular, difficult channel with surrounding commercial QRM.

CONSTRUCTOR'S CROSSWORD

By J. R. Davies



Clues Across
1. How Mrs. Samuel F. B. let herself in? (5, 3)
5. Coil units – and where to buy them! (6)
9. Drawing office transparencies. (8)
10. Sharpness and penetration. (6)
12. A.C. peaks play their parts. (6)
13. What capacitors used to do? (8)
15. Static, although confusedly free in centre. (12)
18. These were classed as ethereal distributors before relativity. (12)
23. Pole given tea despite procedural no. (8)
24. Give the diode another anode to make it this. (6)
26. B.B.C., relatively speaking. (6)
27. Crest of the wave. (8)
28. R and D produce this. (6)
29. When assessing resistance it's them or me! (8)

Clues Down
1. Common, as with inductance. (6)
2. Traces, how the regenerative detector responds? (6)
3. Early TV camera tube. (7)
4. Field distorting effect in air-spaced capacitors. (4)
6. Device which converts decimal to BCD. (7)
7. Descriptive of the magnetic flux that's left. (8)
8. Ceramic magnets are this in manufacture. (8)
11. Abbreviated devices with high input resistance. (7)
14. Have faith in the decibel I eventually evaluate. (7)
16. Wire gauge flying in the wind? (8)
17. Cots turned upside down. (8)
19. Making an adjustment and its result. (7)
20. Metal with atomic number 45. (7)
21. C.G.S. unit for e.m.f. (6)
22. Popular final cabinet finish. (6)
25. 25.40 mm. (4)

(Solution on page 360)

TWO MORE USES FOR THE 555

by J. Lewis, B.Sc.

New applications for the versatile 555 timer continue to be found. This article shows how it may be employed as a voltage comparator actuated by light or temperature level changes.

ONE OF THE MORE INTERESTING INTEGRATED CIRCUITS to come on to the market recently is the 555 timer. Originally made by Signetics, this is now second sourced by many other manufacturers.

The 555 has formed the basis of a number of projects both in this magazine and others, and usually in the mode for which it was designed, i.e. as a timer. In this application it can function as either a monostable or a free running astable.

BLOCK DIAGRAM

For readers who may not be completely familiar with 555 operation it may be as well to look at a simplified block diagram of the device, as in Fig. 1. It will be seen that there are two voltage comparators, a flip-flop and an output stage. The comparator which is connected to pin 6 only triggers when the voltage on it reaches two-thirds V_{CC}. The voltage needed to trip the comparator on pin 2 is one-third V_{CC} and has to be the negative edge of a low going pulse.

When the pin 2 comparator is triggered the flip-flop changes state and drives the output on pin 3 high; at the same time it takes off the short-circuit to earth which has been applied via pin 7. This means that an external timing capacitor connected to pins 6 and 7 and to earth can charge up to V_{CC} via a resistor. As soon as the voltage across the capacitor reaches two-thirds V_{CC} the flip-flop is changed back to its previous state, the output is driven low and the short-circuit on pin 7 reapplied. The cycle will repeat itself when next pin 2 falls to one-third V_{CC}.

The interesting thing about this device is that one can use the comparators themselves just as comparators and forget the timing applications. It has been found that if the comparator connected to pin 6 is held at V_{CC} and the applied potential to pin 2 is varied about one-third V_{CC}, the flip-flop will change state driving the output high or low. We can thus use the i.c. as a very sensitive voltage switch which has distinct advantages over other methods in that it can be used to drive a load directly and is not very particular regarding supply voltages. Any transducer which produces a voltage change, either directly or as a result of Ohm's Law, may be used as the sensing element.

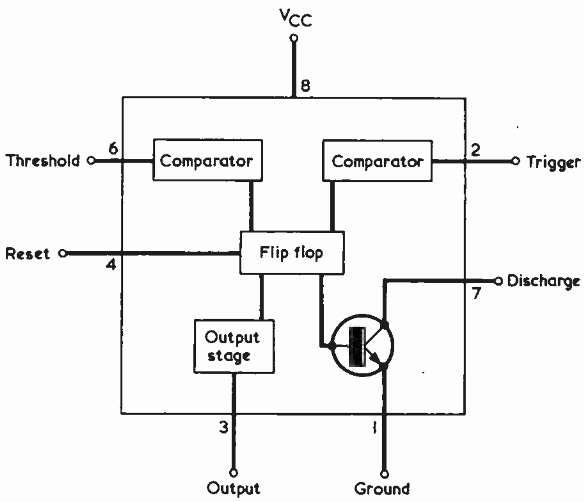


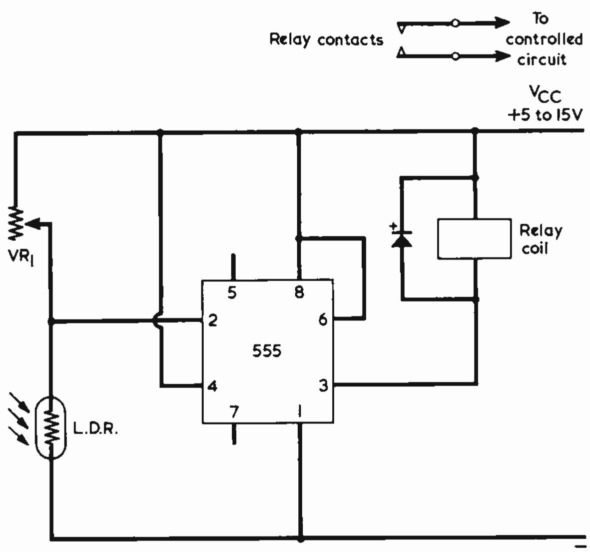
Fig. 1. Block diagram showing, in simplified form, the internal sections of the 555 integrated circuit.

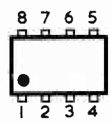
PROTOTYPE CIRCUITS

Two prototype circuits were made up, one being light sensitive and the other heat sensitive. The circuits are shown in Figs. 2 and 3 respectively. In both of these a relay coil connects between pin 3 and Vcc, a protective diode being connected across the coil to prevent the formation of a high back e.m.f. when the output goes high and the relay de-energises. The circuit polarities are such that when pin 2 of the 555 is below one-third Vcc the output at pin 3 is high and the relay does not energise, and when pin 2 is above one-third Vcc the output at pin 3 is low and the relay energises.

The theory of operation is simple. In Fig. 2 the transducer can be a light dependent resistor such as the ORP12. If this is illuminated it exhibits a low resistance, holding down the voltage at pin 2 and keeping the relay de-energised. Should the illumination of the l.d.r. drop in intensity its resistance increases, the voltage on pin 2 of the 555 rises and the relay energises. A typical application is as a burglar alarm, in which the relay energises when a light beam illuminating the l.d.r. is interrupted by an intruder. Another application is the switching on of a lamp at sunset. In this case the l.d.r. is normally illuminated by sunlight during the day and the relay is then de-energised. The resistance of the l.d.r. increases as the sunlight intensity decreases, allowing the lamp to be turned on at a pre-determined low level of illumination.

In the heat sensitive circuit of Fig. 3 the thermistor exhibits decreased resistance as its temperature rises. Any small glass bead type thermistor, such as the R.S. Components type TH-B11 or TH-B15, can be used. The TH-B11 has a resistance of 1MΩ at 20°C, 30kΩ at 100°C and a final minimum hot resistance of 170Ω; whilst the TH-B15 has a resistance of 100kΩ at 20°C, 79.5kΩ at 25°C and a minimum hot resistance of 320Ω.





555 (8-pin D.I.L.) Top view

Fig. 2. The 555 employed as a voltage comparator. Here, it causes the relay to energise when the light falling on the l.d.r. drops below a pre-determined level, as set by VR1.

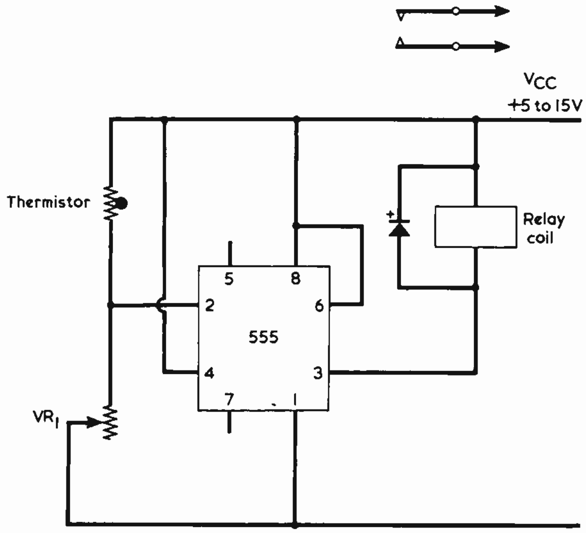


Fig. 3. In this circuit the 555 is triggered by a thermistor, causing the relay to become energised when thermistor temperature passes a pre-determined level.

When, in Fig. 3, thermistor resistance decreases due to increasing temperature, pin 2 of the 555 is taken positive until, at a pre-determined level, the relay energises. A typical application for the circuit is as a thermostat.

The value required for VR1 in Figs. 2 and 3 depends upon the transducer and the light or temperature level at which it is required that the relay energises. A possible starting value for the potentiometer could be 1MΩ. When the final adjusted value has been experimentally determined, a series combination of a fixed resistor and a potentiometer of smaller value could be fitted in place of VR1, giving a finer degree of control and easier adjustment. For maximum sensitivity, the potentiometer is adjusted to the level just below that at which the relay energises.

LATCH UP

Fig. 4 shows how the output can be made to latch up. This makes use of the 'reset' facility on pin 4 which, if taken to below 1 volt, drives the output to its low state. Pin 7 is the 'discharge' pin for an external timing capacitor when the 555 is used as a timer, and it gives a short-circuit to earth when the flip-flop operates. It is coupled here to pin 4 via the 220Ω resistor, and it causes the i.c. output to latch at the low state when the relay is energised. To reset the i.c. the circuit between pins 7 and 4 needs to be broken.

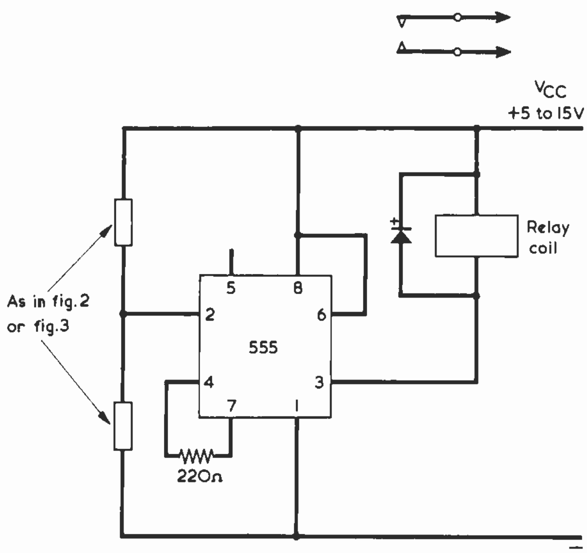


Fig. 4. The circuits of Figs. 2 and 3 can be made to latch up by the addition of a low value resistor between pins 7 and 4.

The circuits described can be assembled on a small piece of 0.1 in. Veroboard, to which the 555 in its 8 pin d.i.l. package can be readily fitted. Supply voltages should not exceed the maximum rating for the i.c. of 16 volts. In some instances the supply could consist of a 9 volt battery, as the current drain on standby with the relay de-energised is only of the order of 7mA at this supply voltage. The relay should be capable of energising at a coil voltage a little lower than the supply voltage and the coil current should not exceed the maximum output current rating for the 555 of 200mA. Preferably, the coil current should be 100mA or less. As an example the relay available from Home Radio under Cat. No. WS159, which has two changeover contact sets, could be used with a 9 volt supply. This relay has an energising voltage of 6 volts and a coil resistance of 185Ω, whereupon the coil current cannot exceed some 49mA. Other relays offering a similar performance can be used. The diode across the relay coil can be any general purpose silicon diode, such as the 1N914. Take care to connect the diode into circuit with correct polarity; if it is connected wrong way round the i.c. will be damaged.

The reader will see from this short article just how versatile the 555 can be. No doubt before very long even more applications will be discovered. ■

2.5 - 2

PO

SUP

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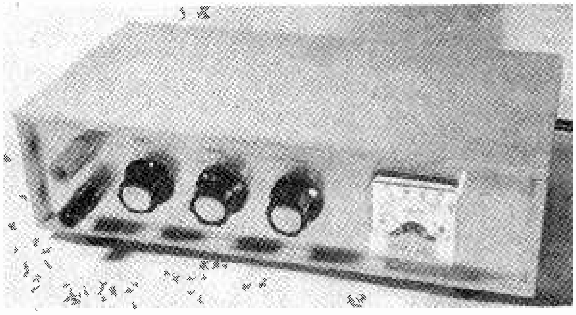
By R. A.



A VARIABLE OUTPUT LOW VOLTAGE POWER SUPPLY unit is one of the most useful pieces of test equipment for the electronics enthusiast, and should be one of the first items he obtains. The power supply unit described in this article provides a well smoothed and regulated output at any voltage between approximately 2.5 and 25. The maximum continuous current rating is 500mA on the higher voltage outputs (10 volts and above) and a little less than this on the lower outputs.

The unit is protected against short term overloading by a built-in current limiting circuit. The regulation efficiency is more than adequate for most amateur applications, and the maximum difference between zero and full load conditions is less than 200mV at any voltage setting. A switch selects either positive or negative earth.

A reasonably compact design has been achieved, and the unit is housed in an attractive home-made case measuring about 10 by 5 by 3 in. excluding the feet and control knobs. A built-in voltmeter indicates the output voltage.

BASIC REGULATOR CIRCUITS

All the common types of regulated power supply unit require a stable voltage reference source. The stability of this reference voltage is of prime importance, since the stability of the final power supply output voltage can be no better than the stability if the reference source.

The circuit of the familiar basic zener shunt stabilizer is shown in Fig. 1(a), and this type of circuit can give

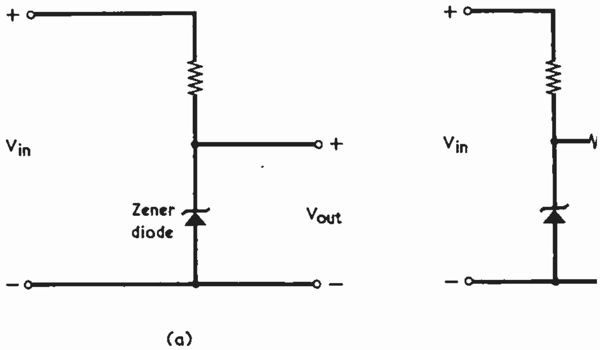


Fig. 1(a). A basic zener diode voltage stabilizing
offer a high level of stabiliza
(c). Even greater protection against varying input
curr

5 Volt

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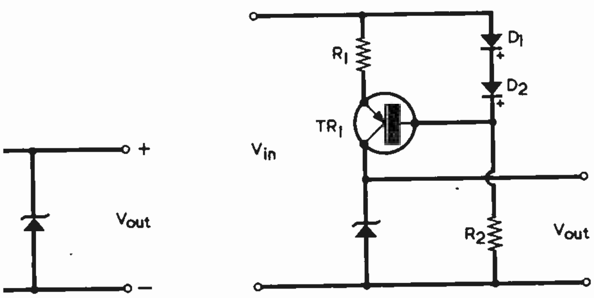
Offering a continuously variable output voltage ranging from 2.5 to 25 volts, this power supply unit features automatic output limiting for currents in excess of 600mA and a constant current voltage stabilizing reference circuit.



(c)

uit. (b). Two zener diodes connected as shown here despite input voltage variations
ıge is given by this circuit, in which TR1 is a constant source

very good results. Unfortunately, though, small inexpensive zener diodes are far from perfect. In a circuit such as is used here, where the input voltage to the zener stabilizer can vary from several volts above the zener voltage to almost double this level, the voltage across the zener diode can alter by a comparatively large amount.

Two zener regulator circuits can be connected in series as shown in Fig. 1(b). This configuration can work extremely well provided the final output voltage is considerably less than the minimum input voltage. The circuit is unsuitable for use in the present design, however, where the stabilized output voltage can be close to the unstabilized input voltage.

A more unusual arrangement, but one which is more suitable for use in this particular power supply unit circuit, is shown in Fig. 1(c). TR1 has its base voltage stabilized at about 1.2 volts negative of the positive supply rail by silicon diodes D1 and D2, these being forward biased and thereby exhibiting a forward voltage drop of about 0.6 volt each. At the same time, TR1 emitter will be held at approximately 0.6 volt positive of TR1 base.

In consequence, a stabilized potential of about 0.6 volt appears across R1, and since the voltage across this resistor remains fixed, the level of current flowing through it will be constant also. TR1 collector current is very nearly equal to its emitter current, and so the transistor operates as a constant current source feeding a zener diode. This arrangement gives a highly stable voltage output, and the circuit will still function efficiently even if the minimum input voltage is as little as 1 volt greater than the zener voltage.

PRACTICAL CIRCUIT

The circuit diagram of the complete power supply unit is shown in Fig. 2.

T1 is a mains transformer whose 30 volt secondary offers taps at 12, 15, 20 and 24 volts, all at 0.5 amp. No connection is made to the taps and the total 30 volt secondary is applied to the bridge rectifier given by D1 to D4. This feeds into the reservoir capacitance made up by C1 and C2 in parallel.

The zener reference voltage is given by D5, and this diode is fed from the constant current source comprising TR2, R2, R3, D6 and D7. The positive stabilized voltage from the zener diode is coupled to the emitter follower TR3, causing a voltage to be built up across VR1 and R1 which is equal to the zener voltage less 0.6 volt dropped in the base-emitter junction of TR3. VR1 is the voltage control for the power supply unit, and its slider can be adjusted to select any voltage from about 4 to 26.4, this voltage being at a fairly high impedance with respect to the negative rail.

TR4 and TR5 are a Darlington pair emitter follower having R5 and R6 respectively in their emitter circuits. The output voltage at TR5 emitter is equal to the voltage at VR1 slider minus about 1.4 volts dropped across the base-emitter junctions of TR4 and TR5. This output voltage can in consequence be varied by adjusting VR1, whereupon the output voltage ranges from approximately 2.5 to 25 volts. The exact voltage range will vary slightly in individual power supplies due to tolerances in the zener diode, VR1 and R4.

TR4 and TR5 provide a high degree of current amplification and so the unit achieves a very low output impedance. Output currents of up to 500mA may be provided with a minimal voltage drop in TR4 and TR5.

CURRENT LIMITING

Unless suitable precautions are taken, the high current which TR5 can pass could cause this transistor to be destroyed if the power supply output were accidentally short-circuited. An ordinary fuse is too slow-acting to give adequate protection against short-circuits and it is usual in circuits of this nature to incorporate some form of electronic current limiting. In the present design the current limiting is provided by R1 and TR1.

R1 is connected in the negative supply rail and the voltage across it is proportional to the output current. This voltage is applied to the emitter and base of silicon transistor TR1, which will be unaffected when the voltage is lower than about 0.5. If the voltage exceeds 0.5 volt TR1 will commence to pass collector current, thereby diverting current from the zener diode.

With a potential of about 0.6 volt across R1, TR1 will be biased almost to saturation, whereupon the

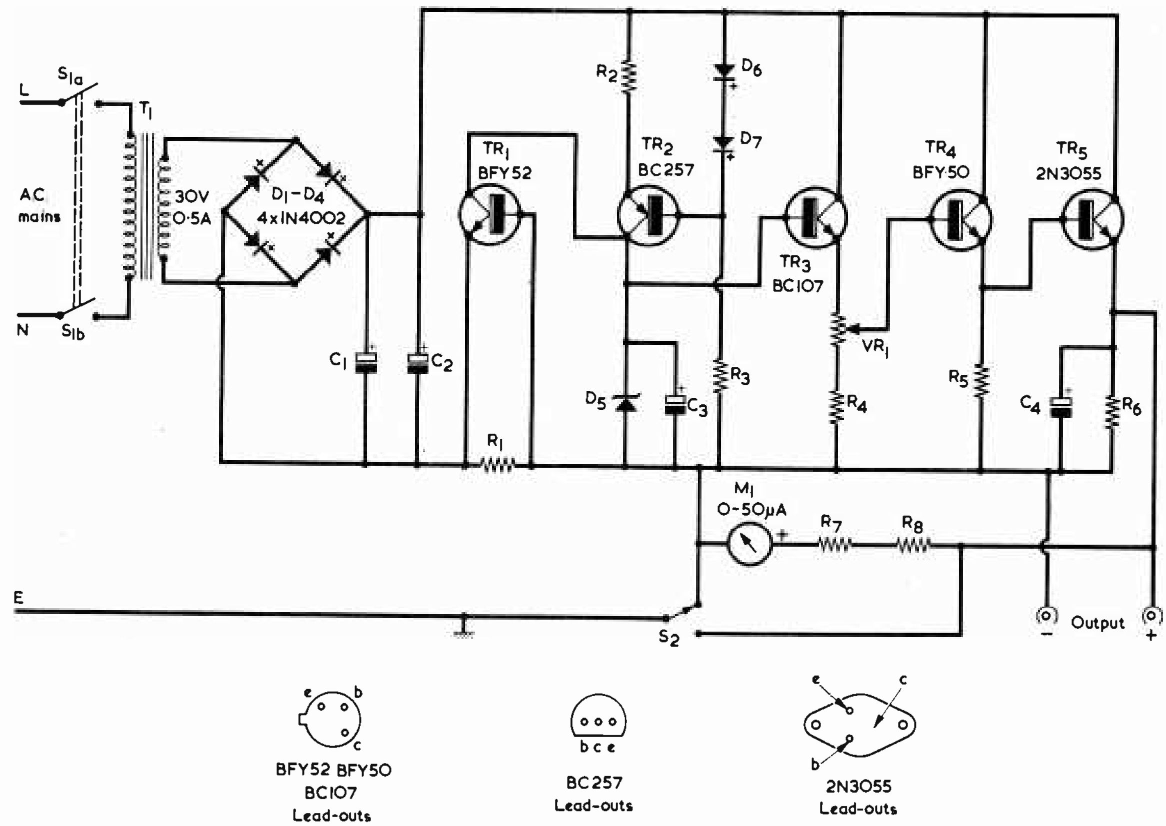


Fig. 2. The complete circuit of the power supply unit. Current limiting is given by R1 and TR1

voltage across the zener diode and, in consequence, the power supply output will be virtually zero. It is obvious from Ohm's Law that a voltage of 0.6 across R1, which has a value of 1Ω, corresponds to a current of 0.6 amp, or 600mA. As a result, 600mA is the maximum output current that can flow, even when the output is short-circuited.

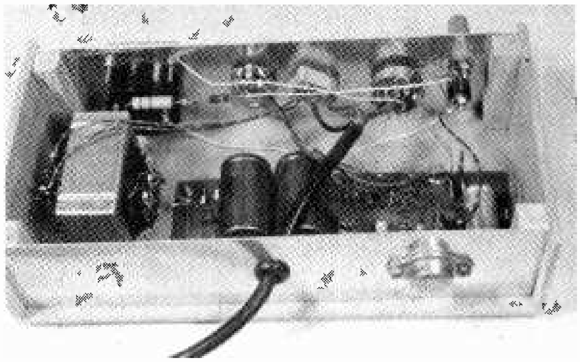
Although the current limiting configuration is extremely simple and requires only two additional components, it nevertheless works extremely well, giving a very well defined current threshold. Note, however, that it is only intended to provide short term protection. The output should not be short-circuited indefinitely as, in time, this will cause TR5 to be destroyed by overheating.

Meter M1, in company with series resistors R7 and R8, forms a voltmeter having a full-scale deflection of 25 volts. This monitors the power supply output voltage. C3 provides a low a.c. impedance across the zener diode and reduces any hum ripple here and at TR3 emitter, thereby producing a level of electronic smoothing across VR1. C4 provides further smoothing If the unit is used with equipment such as a Class B a.f. power amplifier, C4 provides any current peaks which exceed the 600mA threshold of the current limiting circuit.

S2 is the positive/negative output earth switch. This component must be a break-before-make type as a make-before-break switch will short-circuit the output whenever it is operated.

COMPONENTS

The mains on-off switch, S1 (a) (b), is a rotary toggle type. If difficulty is experienced in obtaining a 2-way break-before-make rotary switch for S2, a 3-way switch may be employed with no connection made to the centre fixed contact. This has the slight disadvantage that the



The components inside the supply unit

switch has to pass through two indent 'clicks' instead of one when it is adjusted from one position to the other. In the prototype, meter M1 is a 0–50μA movement and the type employed is from the Henelec 38 Series retailed by Henry's Radio. A small economy would be effected by using a 0–500μA or 0–1mA meter from the same Series. With a 0–500μA meter R7 requires a value of 47kΩ, and with a 0–1mA meter it requires a value of 22kΩ. The value of R8 is found by experiment after the unit has been completed. Variable resistor VR1 is a standard carbon potentiometer. If R1 cannot be obtained in ½ watt 5% carbon, a small wire-wound resistor, such as that available from Henry's Radio in 1 watt, can be employed instead.

The two diodes, D6 and D7, in the constant current section can be any small general purpose silicon diodes, suitable types being BAY31 or OA200, etc. Mains transformer T1 is a Douglas component type MT112, and it can be obtained from Adam Scientific Products, Ltd., Byre House, Simmonds Road, Wincheap, Canterbury, Kent, CT1 3RW. The BC257 required for TR2 is listed by Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB.

COMPONENTS

Resistors
(All fixed values ½ watt 5% unless otherwise stated)

R1	1Ω
R2	220Ω
R3	15kΩ
R4	820Ω
R5	3.3kΩ
R6	1.8kΩ 1 watt
R7	470kΩ 2%, high stability
R8	see text
VR1	5kΩ potentiometer, linear carbon

Capacitors

C1	500μF electrolytic, 50 V. Wkg.
C2	500μF electrolytic, 50 V. Wkg.
C3	10μF electrolytic, 35 V. Wkg.
C4	1,000μF electrolytic, 25 V. Wkg.

Transformer
T1 Mains transformer, secondary 30V at 500mA, Douglas MT112 (see text)

Meter
M1 0–50μA meter, Henelec 38 Series (see text)

Switches
S1 (a) (b) d.p.s.t. rotary toggle
S2 s.p.d.t. rotary, break-before-make

Semiconductors

TR1	BFY52
TR2	BC257
TR3	BC107
TR4	BFY50
TR5	2N3055
D1	1N4002
D2	1N4002
D3	1N4002
D4	1N4002
D5	27V zener diode type BZY88C27
D6	silicon diode (see text)
D7	silicon diode (see text)

Miscellaneous
3 control knobs
1 insulated terminal, red
1 insulated terminal, black
4 rubber feet
3-core mains lead
1 grommet
Printed circuit materials
Aluminium sheet, plywood, etc. for case (see text)

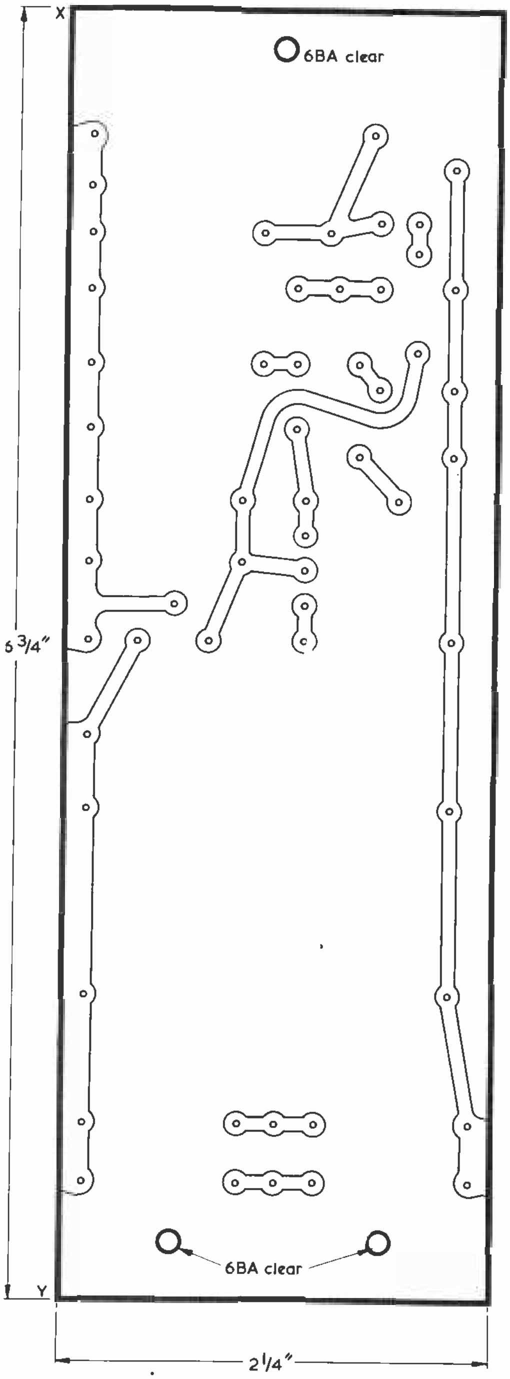
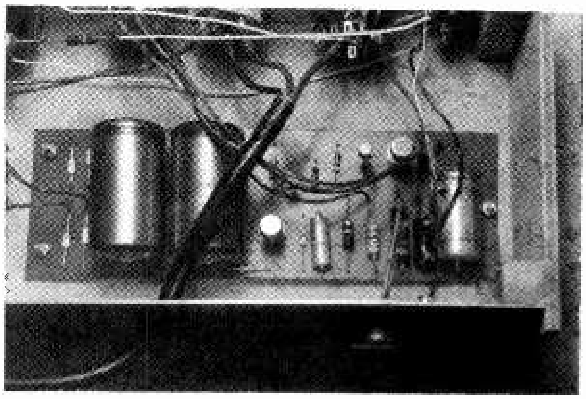


Fig. 3. Most of the power supply unit components are fitted to a printed circuit board, the copper side of which is shown here. This is reproduced full-size for tracing



A close-up view of the printed circuit board assembly

PRINTED CIRCUIT BOARD

Most of the components are mounted on a printed circuit board measuring $6\frac{3}{4}$ by $2\frac{1}{4}$ in. The copper side of the board is reproduced full-size in Fig. 3, whilst Fig. 4 shows the layout on the component side of the board. The letters 'X' and 'Y' apply to the same corners in Figs. 3 and 4, and assist in mentally orienting the two views. The printed circuit board is prepared in the usual way, and the three mounting holes are drilled for 6BA clearance.

When the board has been etched, drilled and thoroughly cleaned, the various components are mounted in the positions shown. The printed circuit board assembly is completed by soldering in the flexible insulated leads which will later connect to the output sockets, TR5, T1 secondary and VR1. The approximate lengths of these leads can be judged by referring to the photographs of the prototype and to Fig. 6. They should be made slightly on the long side, and can be cut to the final required lengths when the free ends are connected.

THE CASE

Construction of the case commences by cutting out two 18 s.w.g. aluminium sheets $9\frac{1}{2}$ by $2\frac{1}{4}$ in. These form the front and rear panels. The front panel then requires the holes shown in Fig. 5. No diameters are given for the holes for S1, S2, and the two output terminals, as these depend on the particular components used here. The large cut-out for the meter may be made by means of a fret saw. The four small meter holes are drilled for 6BA clearance, and their positions can be marked out, after the large hole has been made, with the aid of the meter itself.

The rear panel is next drilled to take the mains input cable grommet and TR5. The hole for the grommet is at the centre of the panel. The exact positioning for TR5 is not critical and it may be mounted at the point indicated in the photograph of the rear. It should be

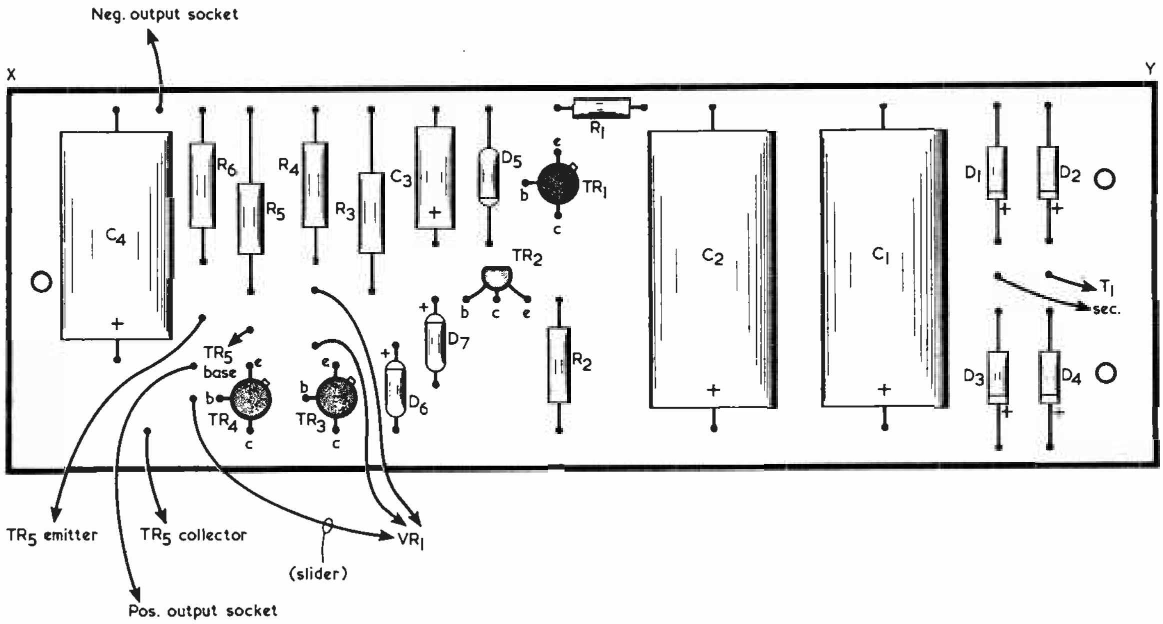


Fig. 4. Layout and wiring on the component side of the board

central between the top and bottom of the panel. Most retailers will supply TR5 with a mica washer and insulating bushes, whereupon the mica washer can be used as a template to mark the hole positions for this transistor. Alternatively, the positions can be taken from the transistor itself. The transistor is mounted directly to the panel and is not insulated from it. A tight thermal contact between the transistor and the panel is essential, and the panel surface must be flat and free from burrs at any of the holes.

The construction of the remainder of the case is illustrated in Fig. 6. The $9\frac{7}{8}$ in. dimension shown for the top and bottom panels assumes that $\frac{3}{16}$ in. thick plywood is employed. If a different thickness is used then the $9\frac{7}{8}$ in. dimension is changed to a figure equal to $9\frac{1}{2}$ in. plus twice the thickness of the wood. The parts of the case are next glued together by means of a high grade adhesive, such as Araldite. This adhesive is employed for securing the aluminium panels in position as well as the wooden parts. The lid is made so that it is a tight push fit into the rest of the case.

When the adhesive has firmly set, four small holes are drilled near the corners of the case bottom to allow rubber feet to be mounted. Then, the printed board assembly and the other components are mounted in their respective places. The approximate positioning of the board assembly and transformer T1 can be judged from Fig. 6. The printed circuit board requires three short 6BA mounting bolts with small spacing washers between the bottom of the case and the board underside. T1 is mounted by means of two short 4BA bolts. All the bolt heads are below the case bottom.

A solder tag is fitted under the upper mounting nut of the meter which is nearer VR1. As already mentioned, TR5 is bolted direct to the rear panel, and a solder tag under one of its mounting nuts provides the connection to its collector. Silicone grease should be applied to the transistor and panel surfaces to ensure a good thermal contact.

WIRING

The free ends of the leads from the printed circuit board are now trimmed to length and connected to the appropriate components. The mains lead is passed through the grommet in the rear panel and its live and neutral wires connected to two of the tags of S1 (a) (b), as in Fig. 2. The remaining two tags of S1 (a) (b) are then connected to the primary of T1. The mains earth

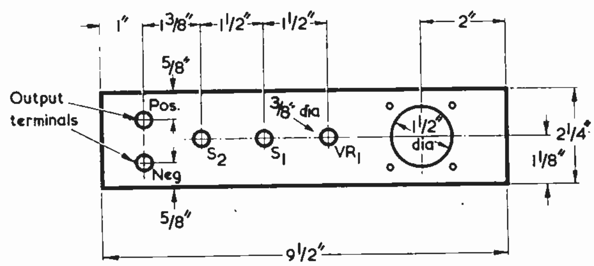


Fig. 5. Drilling details for the front panel. The material is 18 s.w.g. aluminium sheet

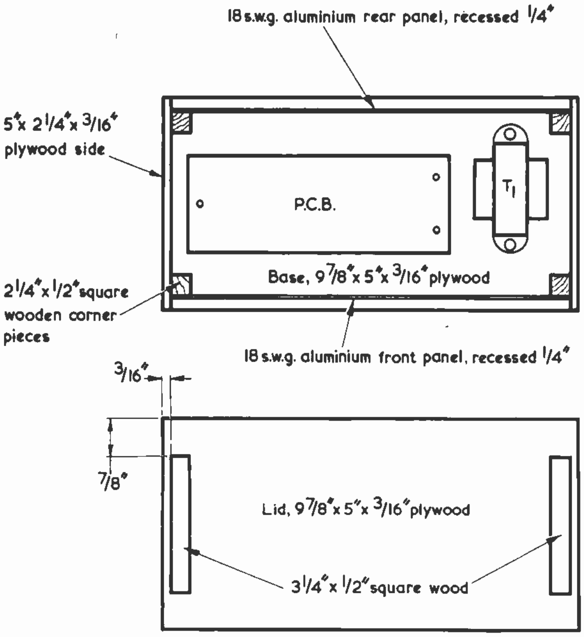
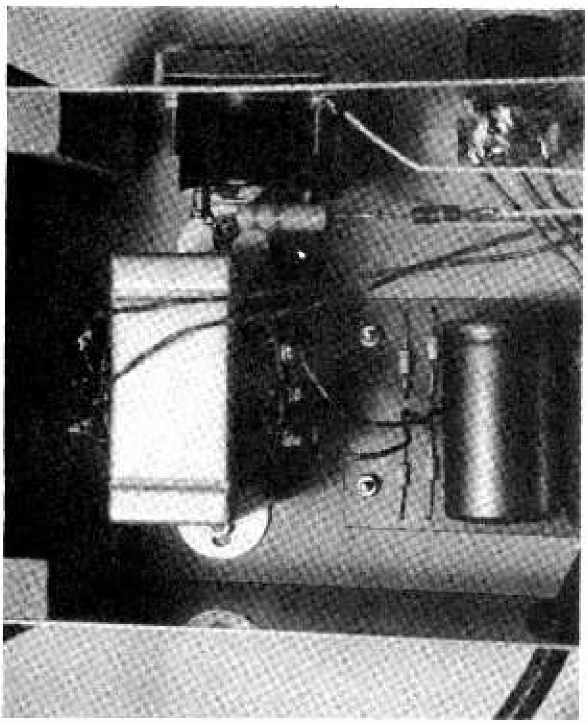


Fig. 6. How the case and lid are made up. As is explained in the text, the case width dimension needs to be altered if a different thickness of plywood is employed



The connections around the mains transformer. Also to be seen are the two series resistors for the panel meter

wire connects to the arm of S2. Also connected to this switch arm is an insulated wire which travels to the solder tag secured under the mounting nut of the meter. Thus, the front panel is connected to the mains earth. In Fig. 2 the front panel is represented by the chassis symbol.

A further insulated wire connects the negative terminal of the meter to the negative output terminal of the power supply. R7 and R8 in series are connected to the positive meter terminal, and their remote end is connected to the positive output terminal by another insulated lead, in the manner shown in the photograph of the interior of the unit. For the time being, R8 can be a 12kΩ resistor if a 0–50μA meter is employed, a 1.8kΩ resistor if the meter is 0–500μA, or a 1kΩ resistor if the meter is 0–1mA. These values will allow the meter to give approximate indications of output voltage. Constructors who prefer to have resistors secured between fixed points may fit a small 2-way tagstrip to the cabinet bottom near the meter and solder one lead of R7 and both leads of R8 to this.

TESTING

After all the wiring has been thoroughly checked the unit can be connected to the mains and switched on. Connect a multimeter set to read 25 volts across the output, and check that VR1 controls output voltage over a range of about 2.5 to 25 volts.

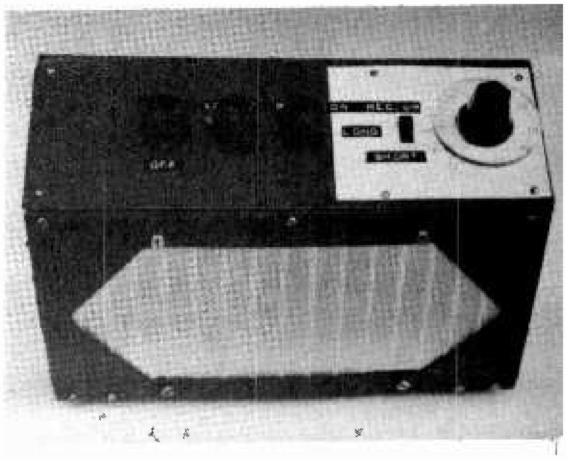
Many panel meters have a fairly wide tolerance and, in order to obtain an accurate front panel voltmeter for the power supply, different values for R8 should be tried experimentally until one is found which causes the reading of the panel meter to agree with that of the multimeter connected to the output terminals. Obviously, the multimeter should be a good quality type if a high degree of accuracy is to be given. With the prototype, a value of 12kΩ was found to be correct with the 0–50μA meter, but it is quite possible in some cases that R8 may require a value quite far removed from the temporary value given to it.

To check the current limiting circuit, a high wattage resistor of about 22Ω is connected across the output terminals with the output voltage set to 22 volts. If the unit is working correctly this should cause the output voltage to drop to around 13 volts. The dissipation in the 22Ω resistor used for this test is about 8 watts. However, a resistor with a lower wattage rating can be used if it is connected to the output terminals for a very short period only.

When using the power supply unit it must be remembered that the front panel is always at earth potential and is coupled to whichever output terminal is selected by S2. The rear panel of the unit is, however, at the same potential as the collector of TR5. Great care must be taken to ensure that the rear panel does not come into contact with any earthed objects as damage to components can then be caused. For output voltages below 10 volts, the maximum output current should be derated linearly from 500mA at 10 volts to 330mA at 2.5 volts.

To finish off the unit, constructors who feel confident to carry out the task may carefully mark up the scale of the meter in terms of volts from zero to 25. The case may then be given a coat or two of varnish. The appearance of the front panel is improved if legends indicating control functions are added. These may be taken from 'Panel Signs' Set No. 4. ■

Three Waveband Transistor Portable



Part 2.

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

The article published in last month's issue described circuit operation and the construction of this receiver. This concluding article gives details on setting up and the assembly of a suitable case.

DETAILS OF CIRCUIT OPERATION AND A DESCRIPTION OF the major part of the construction of this receiver were given in the article which appeared last month. We now carry on to the process of setting up.

SETTING UP

It is next necessary to fit and connect up the two batteries on the battery platform. The PP3 battery is held in place by the 1 in. spring clip, whilst the No. 800 battery is fitted, negative terminal strip downwards, between the screws at holes C and E of the platform. The positive terminal strip presses against the bolt at hole C, and the battery is secured in position by means of the s.r.b.p. strip of Fig. 3(c). Set S1 to short waves, VC1 with its vanes fully open, VR1 fully anti-clockwise, VR2 slider fully to the left as seen in Fig. 2, VR3 fully clockwise and VR4 with its slider fully to the track end connecting to the anode (negative) lead-out of D5. Temporarily disconnect the lead between S2 and the positive terminal of the 3 volt battery and insert a current reading meter set to give a clear indication of 8mA. Switch on and turn VR5 clockwise. Adjust VR4 to give a reading of 8mA. Take the meter out of circuit, and replace the connection to S2. For maximum useful life of the battery it is helpful to repeat this adjustment after the receiver has been in use for about 20 hours and the battery voltage has settled down.

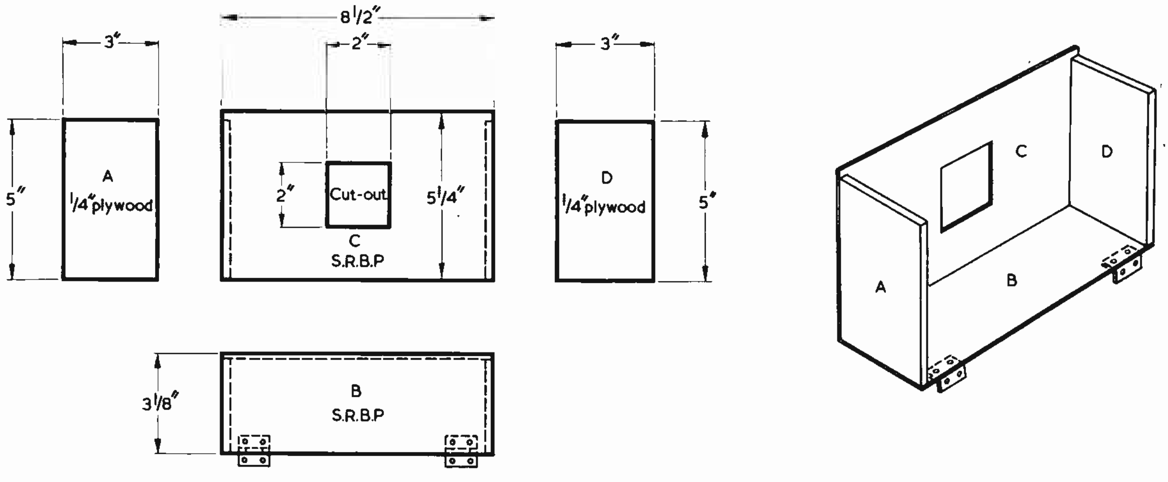
Next set the meter to give a reading of 0.7 volt with at least 20kΩ meter resistance in circuit. That is to say, a 20kΩ per volt meter may be set to read 1 volt or more full-scale, a 10kΩ per volt meter to read 2 volts or more full-scale or a 1kΩ per volt meter to read 20 volts or more full-scale. The 0.7 volt reading should, in the last case, just be capable of being resolved. Clip the meter across VR3, with positive to the tag which connects to TR2 collector, and adjust VR2 until the reading of 0.7 volt is given. Disconnect the meter.

Turn VR1 carefully in a clockwise direction until a slight hiss is heard. Short wave stations should be heard around the dial, the bands which provide most signals depending on the time of day or night. Keep the receiver in its most sensitive state by adjusting VR1 to the point at which the hiss occurs, and orientate the receiver for best results when a station is found. Position L1 on the 7 in. ferrite rod so that the 19 metre band is received with the vanes of VC1 almost fully open. This will involve one or two turns of L1 lying beyond the end of the rod. Do not reduce the number of turns in L1 in an attempt to have the coil fully on the rod, as this will result in a refusal of the circuit to oscillate at the high frequency end of the short wave band.

Next set S1 to medium waves. Check that the receiver functions satisfactorily and that medium wave signals are picked up. It is permissible to add a few turns to, or remove a few turns from, L2 if either end of the medium wave band is not properly covered.

Similarly check for reception on the long wave band. If no wiring mistakes have been made and the receiver has been set up as described on the short wave band, results should be satisfactory on the other two bands.

When all the setting up processes are completed, the speaker panel and the plywood panel of Fig. 4(b) can be screwed together. Place insulating tape over the speaker frame at any points where this may touch or short-circuit against components and wiring on the group board.



(a) (b)

Fig. 5(a). A hinge-on case for the receiver may be assembled with the parts shown here. The precise positioning of the two hinges is not important. The four holes required for mounting rubber feet to part B are not shown

(b). The parts of (a) assembled togethe

RECEIVER CASE

A case can be made up as shown in Fig. 5. The dimensions given here are for guidance and may be amended slightly if the receiver 'chassis' has not been made exactly to the dimensions given in the constructional details. Note that there is a 2 in. square aperture in part C. The case is fixed to the 'chassis' by means of the two small hinges shown in Figs. 5 and 4(b). These are on the inside of the speaker panel but are on the outside of section B of the case. Section B is the bottom of the case, and is fitted with four small rubber feet to ensure that the hinges do not scratch any surface the receiver is placed on.

The case is covered with Fablon or Contact before it is fitted to the receiver 'chassis'. A piece of thin speaker fabric is affixed to the inside of the 2 in square cut-out after the Fablon or Contact has been applied.

A neat appearance can be given by covering the top of the receiver, which is the plywood panel of Fig. 4(b), with an extra panel of s.r.b.p. covered with Fablon or Contact. This may have glued to it a card tuning scale, inscribed with wavelengths or frequencies, for VC1. Two tuning scale pointers can be made with wire and screwed to the flange of the tuning drive. A particularly neat effect is given by alternatively fitting a circular piece of Perspex to the tuning drive flange. This can be inscribed with two radial lines on either side of the tuning drive spindle.

The current drawn for from the PP3 battery is a little less than 1mA. The current from the No. 800 battery can rise to 50mA or more at a.f. output peaks, but it will be around 10mA for low level outputs. At the time of writing, these two batteries cost less than a single PP9 type, which many similar receivers would employ. Also, the use of two batteries makes for very stable operation on the short wave band. ■

THREE TRANSISTOR REGENERATIVE RECEIVER

In Fig. 3 of this article, which appeared in the November issue, the lower lead-out of C1 is shown connected to the lower lead-out of R2. There should be no connection between these two points.

CONSTRUCTOR'S CROSSWORD – SOLUTION

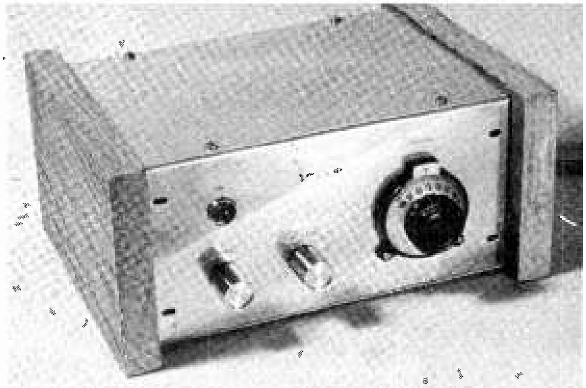
Across

1, Morse Key. 5, Henrys. 9, Tracings. 10, Acumen. 12, Actors. 13, Condense. 15, Interference. 18, Transmitters. 23, Negative. 24, Double. 26, Auntie. 27, Antinode. 28, Design. 29, Ohmmeter.

Down

1, Mutual. 2, Reacts. 3, Emitron. 4, Edge. 6, Encoder. 7, Remanent. 8, Sintered. 11, MOSFET's. 14, Believe. 16, Standard. 17, Tangents. 19, Setting. 20, Rhodium. 21, Abvolt. 22, Veneer. 25, Inch.

PULSE COUNTING F.M. TUNER



Part 2.

By R. A. Penfold

Details of circuit operation and cabinet assembly were given in last month's issue. This concluding article completes the information on construction and also describes the building of a mains power supply unit.

THE R.F. AMPLIFIER SECTION IS ASSEMBLED ON A 6-WAY tagstrip, as shown in Fig. 7. The tagstrip employed by the writer had a length of approximately 3 in., and the s.r.b.p. strip on which the tags are mounted is horizontal. If a similar type of tagstrip cannot be obtained, it may be cut out from an R.S. Components 18-way 'Standard' groupboard. An 8-tag section should be cut out, and the two end tags then drilled out to provide mounting holes. The 6-way tagstrip thus obtained will be a little shorter than that used by the author but will still, nevertheless, be satisfactory. The R.S. Components groupboard can also provide the tagstrip required, later, by the mixer section.

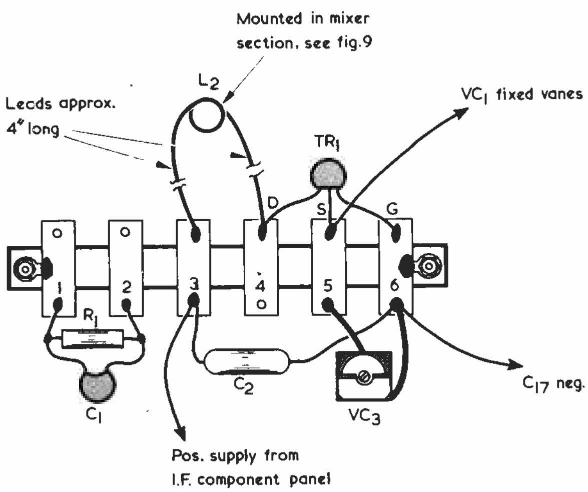


Fig. 7. Components on the r.f. amplifier tagstrip. Stout wires connect VC3 to the tagstrip so as to hold it securely in position. The lead to C17 negative tag is not needed if a battery supply is to be used. For clarity, L1 is omitted; the manner in which this coil is connected is described in the text.

In the r.f. amplifier layout shown in Fig. 7 all leads are kept as short as possible, especially those connecting to chassis. All tags and component wires should be tinned before soldering, and VC3 should be mounted in a position which enables it to be adjusted from above the tagstrip. The two end tags are connected to chassis by way of solder tags held under the mounting nuts, as shown in the diagram.

For clarity, coil L1 is omitted from Fig. 7. This coil is made from a short length of 16 s.w.g. enamelled copper wire and is self-supporting. It is wound on any $\frac{5}{16}$ in. diameter former, such as a $\frac{5}{16}$ in. diameter twist drill, and has precisely 5 turns. These are well spaced out, and the finished coil is stretched out to a length of $\frac{3}{4}$ to 1 in. before the former is removed. The coil has lead-outs about $\frac{1}{4}$ to $\frac{1}{2}$ in. long, and it connects to tags 2 and 5 of the tagstrip in Fig. 7 by these lead-outs. Before it is mounted, a tap needs to be made into the coil $1\frac{1}{2}$ turns from the end which will connect to tag 2. The enamel is scraped off at the tapping point and the bare wire underneath is tinned. The coil may then be soldered to the two tags, ensuring that the lead-outs are no longer than the dimension just mentioned. The coil is positioned above the tagstrip.

The coaxial aerial input socket is coupled to the r.f. amplifier strip by a short length of coaxial cable. At the amplifier strip the centre conductor of the cable is soldered to the tap in L1 and its outer braiding is earthed to the solder tag connecting to tag 1. The other end of the braiding is also earthed, being connected to the solder tag held under one of the nuts securing the coaxial socket.

Coil L2 has $1\frac{1}{2}$ turns, spaced approximately by wire thickness, of 16 s.w.g. enamelled wire with an inside diameter of $\frac{5}{16}$ in., and it is also self-supporting. Although this coil is connected to the r.f. amplifier tagstrip it is positioned at the mixer tagstrip, being in line with coil L3 and thereby providing signal coupling to the latter. The two lead-outs of L2 are about 4 in.

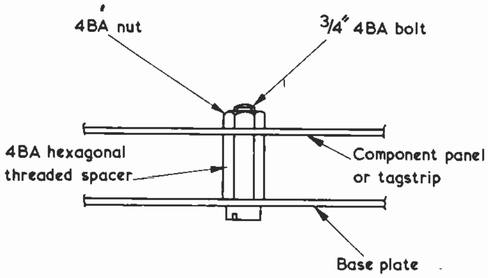


Fig. 8. Threaded hexagonal spacers are used to space off the tagstrips and component boards.

long and pass behind the 2-gang tuning capacitor before connecting to tags 3 and 4 of the amplifier tagstrip. It may be found more convenient to solder L2 into circuit after the mixer section has been assembled and mounted in position.

The r.f. amplifier tagstrip is mounted to the tuner base plate in the position shown in Fig. 5 (published last month). It must be spaced a little clear of the base plate to ensure that none of the tags short-circuit to chassis. The method employed is illustrated in Fig. 8, and this same method of spacing is used for the mixer tagstrip and the component boards.

MIXER-OSCILLATOR

The mixer-oscillator section is shown in Fig. 9. This is wired on a 7-way tagstrip of the same type as is used for the r.f. amplifier. The length of the tagstrip in the prototype is approximately $3\frac{3}{8}$ in. and, if necessary, a suitable alternative can be cut out from the R.S. Components 18-way groupboard in the same manner as was described for the r.f. amplifier tagstrip. The end tags are earthed to chassis, as illustrated, and again all leads must be kept as short as possible.

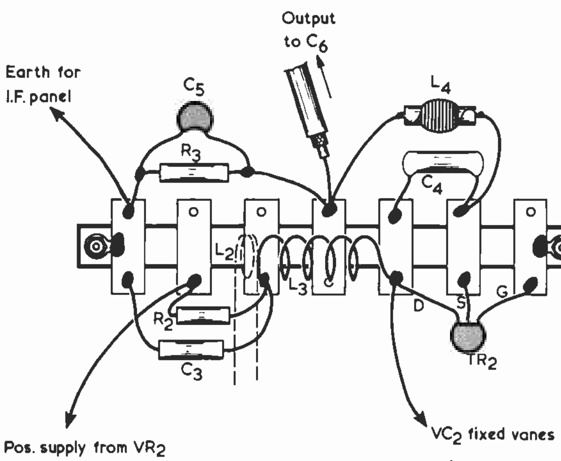
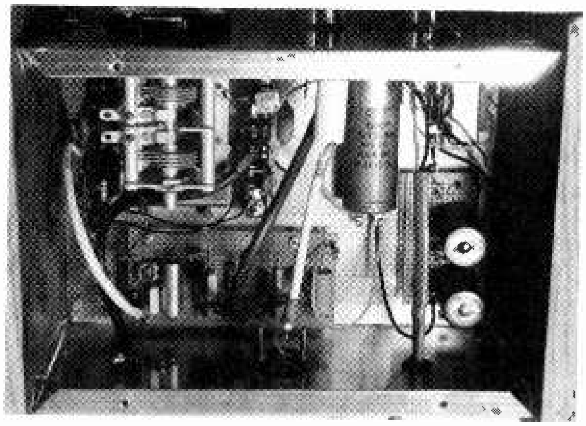


Fig. 9. The mixer-oscillator section. Coil L2, at the earthy end of L3, is shown in broken line

Coil L3 is almost identical to L1, having the same number of turns, the same wire, the same inside diameter and the same lead-out length. It is, however, only $\frac{1}{2}$ in. long and it does not have a tap. Coil L2 is shown in broken line alongside the earthy end of L3.

L4 is a home-wound r.f. choke. It consists of 45 turns of 24 s.w.g. enamelled wire pile-wound on the body of a $\frac{1}{4}$ watt 47kΩ resistor. The ends of the winding are anchored by being soldered to the lead-outs of the resistor fairly close to the body. The resistor lead-outs are then, in turn, soldered into circuit at the tags indicated.

The completed mixer-oscillator section is mounted alongside the 2-gang tuning capacitor in the position illustrated in Fig. 5. For convenience, VR2 and C14 are separate from the tagstrip, being mounted on the i.f. amplifier component board.



The layout of the circuit modules inside the case

I.F. AMPLIFIER

The i.f. amplifier, discriminator and a.f. amplifier stage are assembled on a plain 0.1 in. Veroboard having 37 by 17 holes. The component layout is illustrated in Fig. 10, the wiring under the board being shown in broken line. The board is cut from a larger piece with the aid of a Junior hacksaw, after which the two 4BA clear mounting holes are drilled out. This type of board is fairly brittle, and care must be exercised when it is being cut and drilled.

The various components can then be mounted in the positions shown in the diagram, their leads being bent over after they have passed through the appropriate holes in the board. Most of the wiring can be carried out using the component lead-outs themselves, although two lengths of bare tinned copper wire will be needed for the positive and negative rail leads which traverse most of the length of the board. Two wires need to be insulated with sleeving, these being the lead from C6 to TR3 base and that from C11 to TR6 base. The output of the mixer-oscillator section, at the junction of R3 and L4, connects to the i.f. component board by way of a short length of coaxial cable. The braiding of this cable is earthed to chassis at the component board end only, in the manner indicated in Fig. 10. The holes which

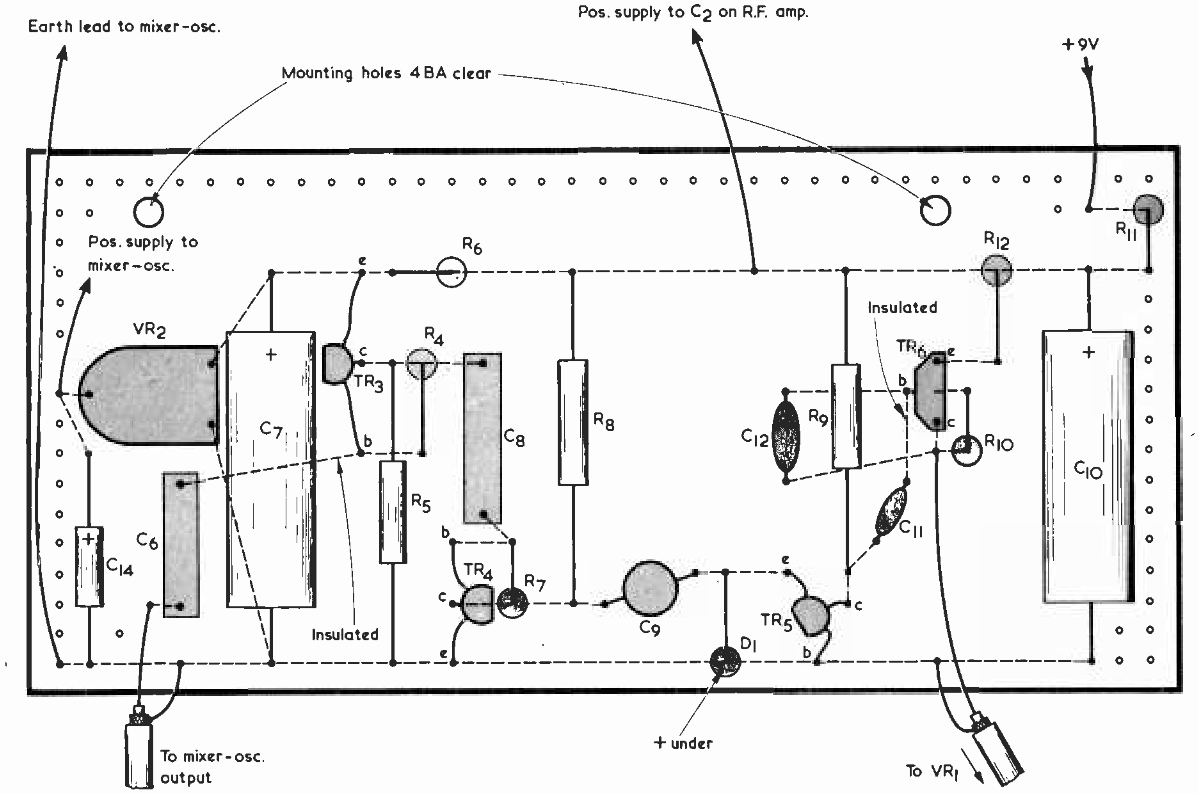


Fig. 10. Components and wiring on the i.f. amplifier board. The discriminator and a.f. amplifier are also assembled on this board

take the tags of VR2 and TR6 are slightly enlarged by careful drilling. All the wiring under the board should be kept close to its underside so that there is no risk of short-circuits to the tuner base plate when the board is mounted in position.

The a.f. output from the board couples to VR1 via a screened lead. Capacitor C13 is mounted at the volume control central tag in the manner shown in Fig. 11. The connection from this capacitor to the output phono socket is made via a screened lead also.

When completed, the component board is mounted to the tuner base plate in the position indicated in Fig. 5.

MAINS SUPPLY UNIT

The tuner can be powered by a 9 volt battery, such as a PP6 or PP7, and since the current consumption of the tuner is only about 10mA the battery will have a long life. There is ample space for it inside the case. Should a battery be employed, its negative terminal is connected to any convenient chassis point. Its positive terminal is routed via one pole of switch S1 to the positive input point, at R11, of the component board of Fig. 10.

If a mains-powered version is preferred the simple

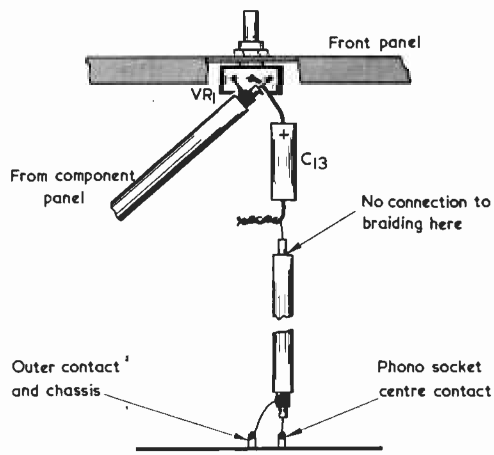
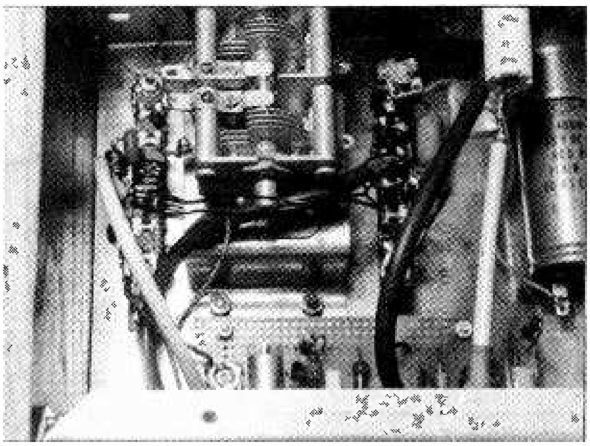


Fig. 11. Wiring to volume control VR1. If the phono socket employed does not have its outer contact common with chassis the chassis connection here should be made by way of a solder tag secured under one of its mounting nuts



Close-up of the r.f. amplifier and mixer-oscillator sections

stabilized supply shown in Fig. 12 can be used. In this simple circuit, D2 and D3 provide full-wave rectification into the reservoir capacitor C15, this being followed by the smoothing and voltage stabilizing circuit incorporating R13, C16, C17 and zener diode D4. Originally, C17 was not included, but it was added when it was found that the hum content without it was too high. The value of C17 is not very critical, but it should be at least 2,500µF. T1 is any small mains transformer offering 9-0-9 volts at some 80 to 100mA, and which is capable of fitting into the space available. This particular transformer does not have mounting feet, but two solder tags may be soldered to it to enable it to be bolted down.

Most of the power supply components are assembled on a second piece of 0.1 in. Veroboard, this also being the plain type and having 24 by 13 holes. This board is shown, from the component side, in Fig. 13, the wiring under the board being indicated in broken line. As with the i.f. component board, the power supply board has

COMPONENTS

The following components are required for the optional mains power supply.

Resistor
R13 100Ω $\frac{1}{4}$ watt 10%

Capacitors
C15 1,000µF electrolytic, 15 V. Wkg.
C16 1,000µF electrolytic, 12 V. Wkg.
C17 4,000µF electrolytic, 12 V. Wkg.

Transformer
T1 Mains transformer, secondary 9-0-9V, 80-100mA

Diodes
D2 1N4002
D3 1N4002
D4 BZYC88C9V1

Neon
NE1 Neon bulb assembly, 250V

Miscellaneous
Plain Veroboard, 0.1 in. matrix
2 4BA $\frac{1}{2}$ in. threaded spacers.
Clamp (for C17)
$\frac{3}{8}$ in. grommet
3-core mains lead

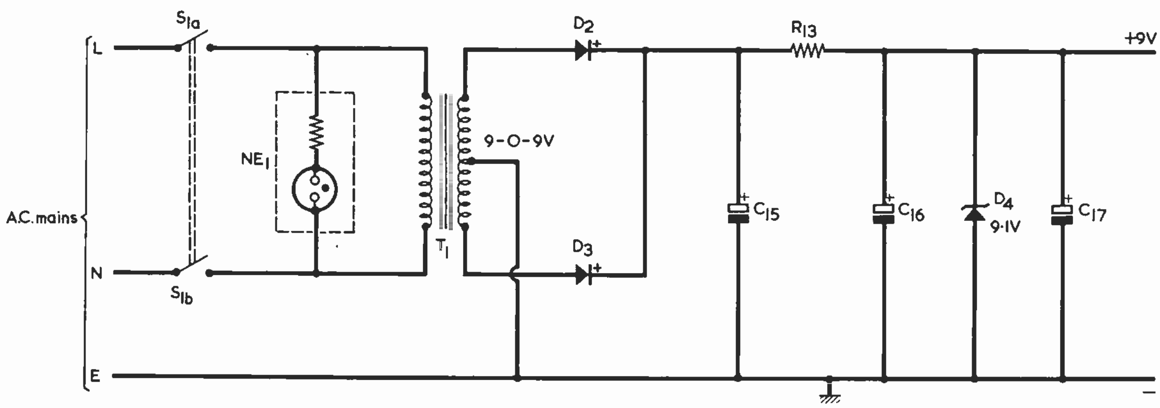


Fig. 12. Circuit of the mains power supply unit

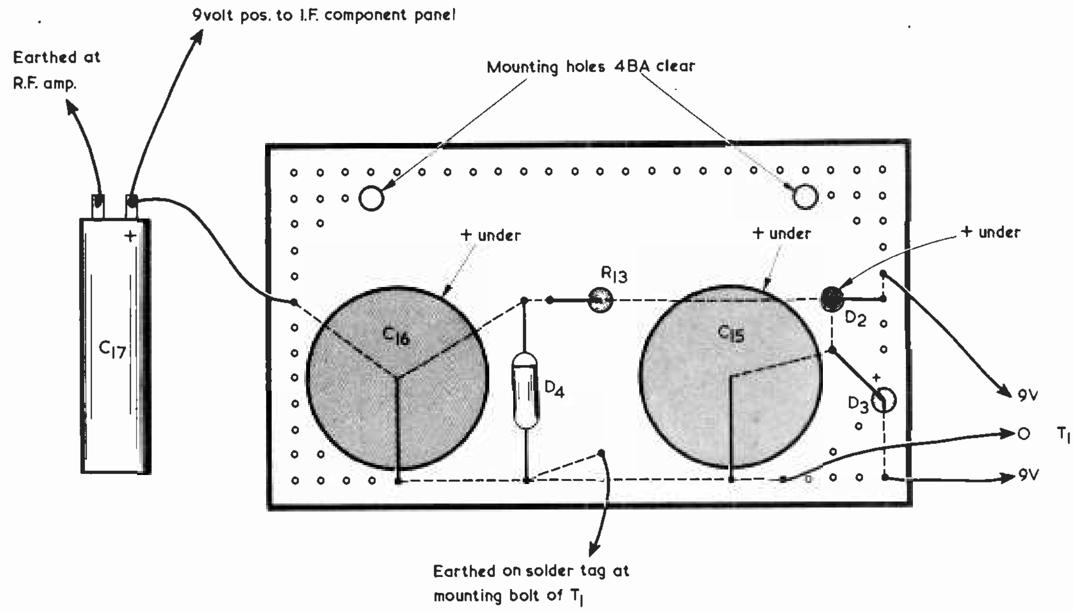


Fig. 13. Most of the power supply components are mounted on a second piece of plain Veroboard

to be cut out and drilled with care. Wiring up on the board is carried out in the same manner. As may be seen from the photographs and from Fig. 5, T1 and C17 are mounted on the base plate separate from the board, C17 being secured in a horizontal position by means of a home-made aluminium clip.

A solder tag is fitted under one of the nuts securing the mains transformer, and the earth lead of the mains cable is soldered to this. The live and neutral mains leads connect to the two poles of S1, these in turn connecting to the primary of T1, as in Fig. 12. If any doubt exists as to tag positioning on S1, its two poles may be identified with the aid of a continuity tester or ohmmeter. The neon lamp assembly, which as already mentioned is of the type having its own integral series resistor, connects to the primary of T1 either at the transformer tags or at S1 tags, according to which is the more convenient. The neon assembly should, preferably, have flying leads.

AERIAL

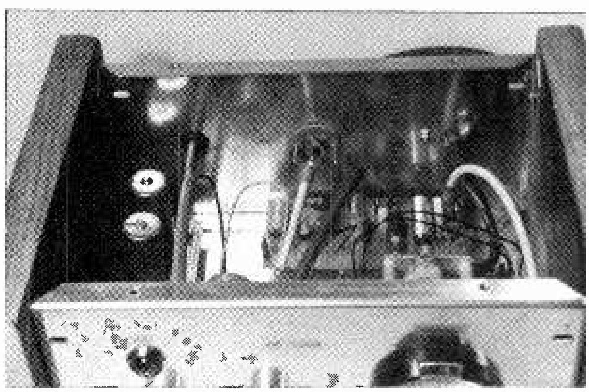
The input circuit is designed to accept a quarter wave whip aerial. This merely consists of a short metal rod about ¼ in. in diameter, coupling to the receiver via a length of coaxial cable. The inner and outer conductors of the cable connect to the coaxial plug at the receiver in normal manner, but only the centre conductor of the cable connects to the whip aerial, there being no connection to the outer conductor at this end.

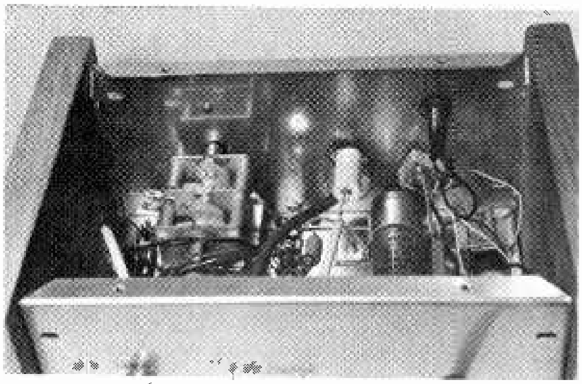
The length of the rod is calculated from the formula:

$$\text{Length} = \frac{2808}{\text{Frequency}},$$

where length is in inches and frequency is in MHz. For the band covered here, the length works out at about 30 in. There is no need to have a different length for each station, as an aerial cut for the centre of the band gives satisfactory results. A dipole can also be used, and will give better results. The additional element will also be

Angled view looking at the rear





Inside the front panel, as seen from the rear

30 in. in length, and will connect to the outer conductor of the coaxial cable.

In nearly all instances the three main B.B.C. signals are transmitted with horizontal polarisation, whereupon the receiving aerial must also be horizontal. It will have directional properties and should be orientated for maximum signal strength.

With an indoor aerial, results will vary considerably with the positioning of the aerial. Generally speaking, the aerial should be mounted well away from walls, which have an adverse effect on the signal, and should be as high as possible.

ADJUSTMENTS

For initial testing, VR2 is set to pass almost the maximum supply voltage to the oscillator circuit. This setting is nearly fully clockwise. VC3 is set to half its full capacitance, or to about a quarter of full capacitance if a 10pF trimmer has been employed here. The output may be applied to an a.f. amplifier or to a crystal earphone, and a suitable aerial connected. VR1 is set for maximum a.f. output. The tuner is then switched on and the 2-gang capacitor adjusted in search of a signal. It should be possible to tune in a few stations. For the best sensitivity, VR2 is turned as fully clockwise as possible before instability occurs. This will show up as a sudden increase in noise as VR2 is turned clockwise. The author did not find the setting required in VR2 to be too critical so long as a good aerial signal was present.

The r.f. amplifier is adjusted for maximum signal by adjusting VC3 with a plastic trimming tool. The effect of opening out or contracting the turns of L1 can also be tried. It should be mentioned that this adjustment will not have a very marked effect on sensitivity as the tuning of the r.f. stage is very broad.

The prototype has been found to be extremely sensitive for such a simple circuit. When the author's tuner was initially tested, an aerial consisting of two crocodile clip leads joined end to end was connected to the centre contact of the coaxial socket and, once the circuit had been properly adjusted; this produced a well limited signal. The author lives 25 miles from the transmitter, and the tuner was in a ground floor room. The signal to noise ratio of the tuner is extremely good, and frequency stability is more than adequate.

(*Concluded*)

MIDLAND NATIONAL AMATEUR RADIO

AND ELECTRONICS

EXHIBITION

The Amateur Radio Retailers Association held their Third Annual Exhibition, at the Granby Halls, Leicester during the first weekend in November.

The event was well up to the standard set by the two previous ones, and we understand that the attendances comfortably exceeded those of the previous years. Again there was a good balance between new equipment on display, and components and used equipment.

Exhibition of this nature give an excellent opportunity for seeing much of the new equipment available and making an appraisal of prices and developments between the various makes of equipment offered. There is such a variety of equipment available for the radio and electronics enthusiast these days that choosing what seems to fill one's needs best is often difficult, and the display of current and new products at this Exhibition was most helpful in making comparisons. Prices varied from extreme to extreme – you could pay up to £800 for a shortwave receiver and £105 for a 'Squeeze' Morse Code Keyer! It was interesting to note that on one surplus equipment Stand, antique radio receiving equipment was being offered for sale! You could buy a '1920 vintage' domestic radio receiver, with horn speaker for about £15. Is this going to be the next 'craze'?

Much of the new transmitting and receiving equipment for the radio amateur has digital readout facilities, which is an attractive feature likely to encourage those with longish pockets to seriously consider changing their existing equipment.

Interesting sidelines of the amateur radio scene were being demonstrated, such as SSTV – Slow Scan TV – and Teleprinting, and it was good to see that the Shortwave Listener was not forgotten.

The Granby Halls are a good location for an exhibition of this nature, and there is plenty of space available, in spite of the many stands and large numbers of visitors, to see what one wanted and to stand around and meet and chat with friends who, apart from contacts 'on-the-air', one only gets the opportunity of meeting at events of this kind.

The organisers are once again to be congratulated for putting on an excellent show.

ALTERNATIVE SPEAKER FEED CIRCUIT

By N. R. Wilson

A method of speaker coupling which can offer potential advantages.

THE USUAL CIRCUIT FOR FEEDING A SPEAKER FROM THE output of a transistor amplifier is by means of a series capacitor, as shown in Fig. 1. The series capacitor can, typically, be 1,000μF or more. In some instances this method of connection can cause a heavy surge of current to flow in the speaker immediately after the amplifier has been switched on. The amplifier output point rises quickly to half the supply rail voltage, and there is then a relatively high current in the speaker as the series capacitor charges up.

ALTERNATIVE APPROACH

If the amplifier standing output voltage is governed by a potential divider across the supply rails at an earlier stage, it is possible that a reduction in switch-on surge current can be achieved by using the alternative coupling arrangement shown in Fig. 2. The earthy side of the speaker is now returned to the junction of two equal value electrolytic capacitors connected in series across the supply rails. These two capacitors perform the secondary function of providing a bypass capacitance across the supply rails which is equal to half the capacitance of either. The speaker is now connected direct to the amplifier output point and is coupled to the amplifier earth via the two capacitors.

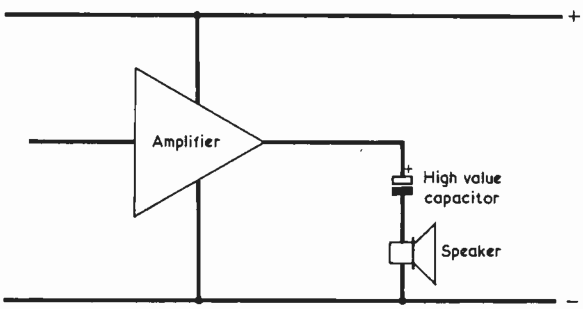


Fig. 1. The usual method of coupling an amplifier to its speaker.

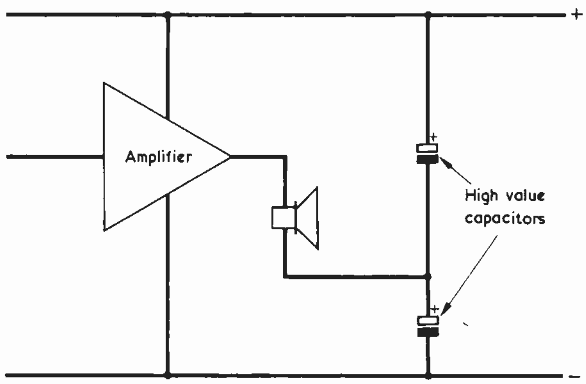


Fig. 2. An alternative approach discussed in the text. The two capacitors have equal values.

On switch-on, the two electrolytic capacitors charge up to the full supply voltage. As their values are equal, it can be reasonably expected that their junction will be at about half the voltage which appears across their outside terminals during the period of the charge. At the same time, the amplifier output voltage, being potential divider controlled, will be at approximately half the voltage across the supply rails as the two capacitors charge up to the full supply voltage value.

Thus, as the amplifier supply voltage rises to its full level after switch-on, the amplifier output and the junction of the two capacitors both carry about half the rail voltage at all instants during the period of charge. The result, theoretically at any rate, is the elimination of the switch-on current surge in the speaker.

There are snags, of course, the most obvious one being that it is difficult to obtain two electrolytic capacitors of precisely the same capacitance because of the wide tolerance on value of these components. Also, the voltage at the amplifier output, even when potential divider controlled, will not be at exactly half the supply rail voltage during the period when the capacitors charge up.

Nevertheless, the circuit approach is of interest and could well merit the attention of the experimenter who likes to develop his own amplifier designs ■

LIGHT-EMITTING DIODES

By R. J. Caborn

Some unusual circuits incorporating small light-emitting diodes.

LIGHT-EMITTING DIODES, OR L.E.D.'S, HAVE REDUCED IN cost dramatically over the last few years. At the time of writing, small red l.e.d.'s are retailing at between 20p and 30p, whereupon they become attractive for experimental applications.

FORWARD CHARACTERISTIC

The author has not seen any published forward current – forward voltage curves for small l.e.d.'s and so he decided to check the forward performance of some diodes for himself. The diode type he chose was the Texas Instruments TIL209. This is a red diode rated at 40mA maximum, and the manufacturer specifies the static forward voltage as 1.6 volts typical and 2 volts maximum at a forward current of 20mA.

The author checked the forward voltage across four of these diodes for forward currents from zero to 30mA and in all cases obtained the characteristic shown in Fig. 1 with hardly any noticeable spread. The l.e.d. commences to emit visible light at about 1.5 volts forward voltage, after which the forward voltage becomes 1.55 volts at 1mA and 1.6 volts at 5mA. The forward voltage then increases very slowly to 1.7 volts at 30mA.

The characteristic from 5 to 30mA exhibits an extremely low slope resistance, and this can be considered as 0.1 volt divided by 25mA, or 4Ω. It becomes feasible, therefore, to give consideration to the idea that an l.e.d. could be used not only to provide an indication that an instrument is switched on but also to give a low stabilized voltage for use in that equipment as well. A typical circuit giving a stabilized voltage of about 1.6

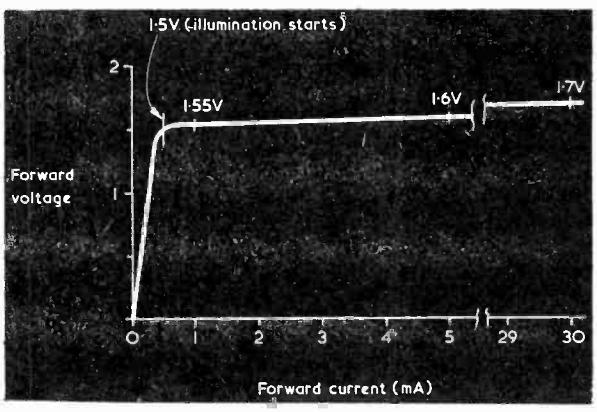


Fig. 1. The forward current – forward voltage characteristic of a group of l.e.d.'s checked by the author.

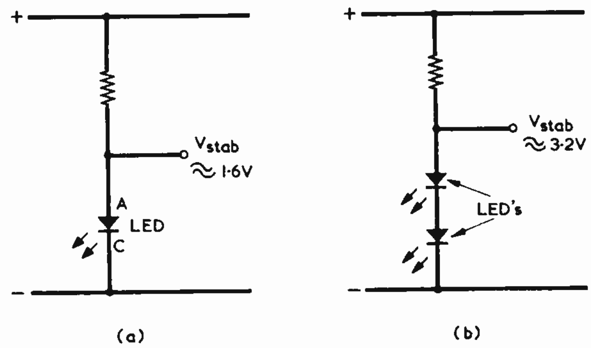


Fig. 2(a). An l.e.d. having the characteristic shown in Fig. 1 is attractive for use in a low voltage stabilizing circuit. This diagram also identifies the anode and cathode of the device symbol.
(b). Two l.e.d.'s in series give a higher stabilized voltage.

volts is shown in Fig. 2(a). Two l.e.d.'s in series, as in Fig. 2(b), provide a stabilized voltage of twice the value, together with a regulation resistance of 8Ω. This regulation resistance is far lower and the stabilizing performance is much better than are given by a standard 3.3 volt zener diode. In Figs. 2(a) and (b) the series resistor may have a value which causes a current of between 5 and 30mA to flow in the diode or diodes.

Before concluding on this particular subject it must be emphasised that the characteristic shown in Fig. 1 is *not* a manufacturer's curve, but is purely a curve arising from the author's experience with a few red l.e.d.'s of the type stated. Since the primary function of an l.e.d. is to provide visible light within the voltage and current ranges specified by the manufacturer, there is no guarantee that any particular l.e.d. will offer a similarly low slope resistance, and the stabilizing circuits shown in Figs. 2(a) and (b) have to be looked upon as being experimental.

SWITCHING CIRCUIT

The fact that a red l.e.d. (having a performance similar to those checked by the author) commences to emit light at 1.5 volts and then stabilizes at 1.6 to 1.7 volts makes possible the interesting circuit shown in Fig. 3.

When in this diagram switch S1 is closed, LED2 becomes illuminated. The voltage of around 1.6 to 1.7 volts which is dropped across this diode appears also across D1 and LED1. However, D1 is a silicon rectifier

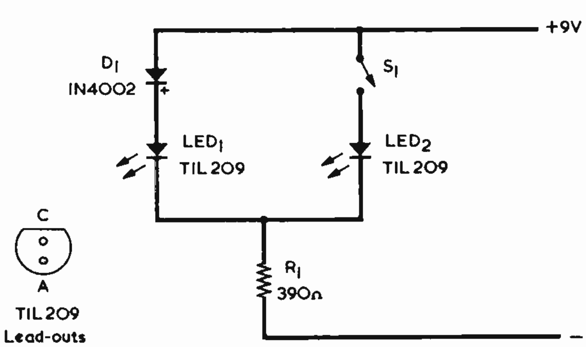


Fig. 3. In this circuit LED2 lights up when S1 is closed and LED1 lights up when S1 is open.

and cannot pass forward current until there is a forward voltage of about 0.6 volt across it. In consequence, LED1 does not light up. When the switch is opened, LED2 extinguishes and LED1 becomes illuminated, since there is now no restriction on the voltage across this l.e.d. and D1.

Fig. 3 is a technical novelty but it could have a minor application as a continuity tester by removing S1 and connecting two test leads in its place. LED1 then lights up when there is no circuit between the two test leads, whilst LED2 lights up if they are short-circuited together. The l.e.d.'s light up immediately current flows through them, and the fact that one l.e.d. extinguishes and the other lights up when the test circuit is made or broken gives a more readily noticeable indication of test conditions than would be given by, say, a battery and filament bulb or by an ohmmeter. Care should be taken to ensure that the test leads are not accidentally connected to a source of voltage which could apply a reverse voltage across LED2 exceeding its maximum reverse rating of 3 volts.

BATTERY VOLTAGE MONITOR

An l.e.d. may be employed to monitor the battery supply voltage in an item of equipment, giving an indication when the voltage is too low for proper functioning

A very simple circuit suitable for equipment having a nominal 9 volt supply is shown in Fig. 4. Here, a zener diode is connected in series with the l.e.d. and its series resistor, whereupon small changes in battery voltage cause relatively large changes in l.e.d. current.

With a 6.2 volt zener diode, as shown, the circuit of Fig. 3 performed in practice in the following manner. A voltage of 9.6 volts caused an l.e.d. current of about 17mA to flow; 9 volts a current of 11mA; and 8.5 volts a current of 4mA. The l.e.d. extinguished when the supply voltage dropped to 8 volts. Thus, the circuit is capable of indicating when the battery voltage is 8 volts or less. If indication were required at a lower voltage, a zener diode with a smaller voltage rating could be employed and a new value found for R1. The latter should be such that l.e.d. current is about 10 to 15mA at a voltage of 9 volts less 1.6 volts (dropped in the l.e.d.) and the zener voltage. In Fig. 4 the voltage across R1, when the supply is 9 volts, works out at 9 minus 1.6 and 6.2, or 1.2 volts. The calculated l.e.d. current with a supply at 9 volts is thus 12mA. In practice the current varies slightly from the calculated value due to tolerances in the zener diode and the series resistor.

The circuit of Fig. 4 has the disadvantage of drawing

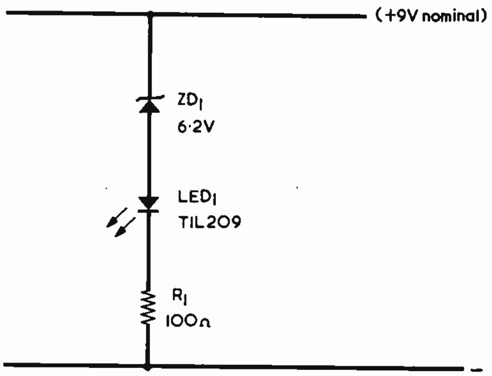


Fig. 4. A simple circuit in which an l.e.d. is used to monitor battery supply voltage.

a relatively large current when the battery voltage is near its nominal value. This disadvantage could be overcome by inserting a push-button between the positive rail and the zener diode (or anywhere else in the series circuit) this button being pressed whenever it is desired to check battery condition. A second disadvantage with Fig. 4 is that the l.e.d. becomes progressively dimmer as battery voltage falls.

The somewhat more complex circuit shown in Fig. 5 overcomes both these objections. In Fig. 5 the l.e.d. does not become illuminated until the battery voltage falls to a predetermined level. The only current drawn from the supply at levels above that at which the l.e.d. lights up is, in consequence, quite low. In practice it is approximately 2mA.

When the battery voltage is above the predetermined level sufficient current flows into TR1 base via ZD1 and R1 to cause this transistor to bottom. Its consequent low collector voltage then keeps TR2 turned off and the l.e.d. is extinguished. As battery voltage falls so also does the voltage at the lower terminal of the zener diode. Eventually a voltage is reached where there is insufficient current in TR1 base to keep this transistor fully conductive; its collector current falls and base current flows into TR2. TR2 turns on and the l.e.d. lights up to indicate that the battery voltage has fallen to the predetermined level.

There is no regeneration between TR1 and TR2, but the very high overall gain which is given when TR1 is turning off and TR2 is turning on is sufficient to give an abrupt illumination of the l.e.d. when the battery voltage reaches the predetermined level. If, for some reason, the battery voltage increases, the l.e.d. will extinguish in an equally abrupt manner.

The voltage level at which the circuit operates can be pre-set by adjusting R2. With the author's unit it was found that when the potentiometer was set to insert its full resistance into circuit the l.e.d. became illuminated at a battery voltage of 6.7 volts. With R2 set very near minimum resistance the circuit operated at a supply voltage of 10 volts. Intermediate settings for R2 select intermediate voltages for circuit operation. Obviously, voltages in excess of 9 volts will not be required, whereupon part of the track of R2 is not used. However, it is so easy to set up this potentiometer that there is no point in inserting a fixed resistor in series with it to ensure that all its track is usefully employed.

To set up R2, a supply voltage equal to that at which it is required the circuit to operate is applied. R2 is initially set to insert maximum resistance into circuit, after which it is slowly adjusted to insert continually decreasing resistance. A setting will then be found at which the l.e.d. abruptly lights up. This is the required setting for the potentiometer.

Capacitor C1 is connected across R2 to prevent r.f. oscillation during the instant of change-over in the circuit. Such oscillation is possible if R2 is set to insert a high level of resistance into circuit. Should it be desired to have the circuit operate at a lower predetermined voltage than a value of about 6.7 volts, as was given with the author's circuit, a zener diode having a smaller voltage rating should be employed.

The l.e.d. in Fig. 5 will not be illuminated at very low supply voltages. However, such voltages will be so small that the supplied equipment will, in most instances, similarly not operate.

In the circuits of Figs. 3, 4 and 5, the fixed resistors are ¼ watt components. In Fig. 5, R2 may be a skeleton potentiometer. The zener diode in both Figs. 4 and 5 can be rated at 200 to 400mW. ■

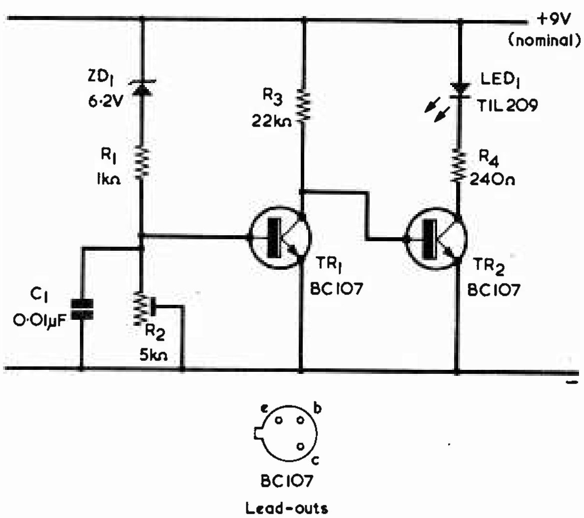
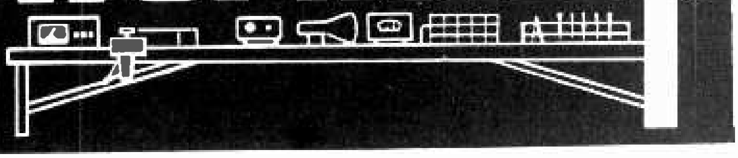


Fig. 5. A more efficient voltage monitor circuit incorporating two transistors.

In your workshop



This month, Smithy the Serviceman, together with his able assistant, Dick, starts the New Year with the construction of a simple inexpensive electronic voltmeter. This offers ranges from 0-1 to 0-500 volts, and has an input resistance of 15MΩ on all ranges.

"A HAPPY," ANNOUNCED DICK, "AND Preposterous New Year to you, Smithy!"

"And," returned Smithy, "the same to you, my boy."

The pair beamed benevolently at each other as they took off their raincoats and hung them up behind the workshop door. Smithy rubbed his hands together briskly and gazed around him. The workshop still bore the ravages of their pre-Christmas burst of activity, during which a disproportionately large number of sets had decided, in the period leading up to Christmas Day, to join the ranks of the unserviceable. Since then, however, several days off and a week-end of blessed peacefulness had intervened, and Dick and Smithy had spent only one short desultory morning in the workshop clearing up odd jobs before embarking on New Year's Eve.

Now, on the second day of the year, they had arrived together. In the workshop, test equipment was still stacked untidily on both their benches, and these were liberally littered also with odd spare components. Also present were Dick's Christmas decorations: the two paper chains which hung from corner to corner, the cotton-wool snow on the windows, the huge plastic Santa Claus on the wall above Smithy's bench and the equally enormous rubber reindeer on the wall above Dick's.

ELECTRONIC VOLTMETER

"Blimey," commented Dick lazily. "The place looks a bit of a shambles, doesn't it?"

"It must do," replied Smithy with an air of equal indolence, "if *you* notice it."

"Do you realize," continued Dick, "that there isn't a single set in for repair?"

"Isn't there? Then that's a highly satisfactory state of affairs."

"Stap me," said Dick, surprised. "I don't think I've ever heard you say anything like that before. You're usually going up and down the agony column if we haven't got half the neighbourhood sets lined up to be fixed."

"They'll soon start coming in," replied Smithy sagely. "What I'm pleased about is the fact that we *have* got a few hours spare. We can use that time to make up a little project I've been thinking about during Christmas."

"A project, eh? This sounds interesting."

"It should be," confirmed Smithy. "I've worked out all the circuit details and all that's now required is the actual building."

"What's it to be? A bit of test gear?"

"That's right," stated Smithy. "It's going to be a low cost knockabout electronic voltmeter with a very high input resistance."

"That will certainly be useful here," stated Dick warmly. "Can I have a look at the circuit?"

Smithy opened a drawer in his bench and produced a sheet of paper with a circuit diagram on it. (Fig. 1.)

"Here it is," he announced. "If you come on over I'll explain how it works."

Eagerly, Dick picked up his stool and seated himself alongside the Serviceman. He glanced at the circuit.

"At first sight," he remarked, "it looks as though you've got some sort of bridge arrangement with a meter strung between two f.e.t.'s."

"That's a fairly close description," stated Smithy. "The first thing I want to point out is that the two f.e.t.'s are both MOSFET's. That word is an abbreviation for Metal Oxide Silicon, or Semiconductor, Field Effect Transistor. With normal depletion f.e.t.'s the gate is an infusion of opposite polarity semiconductor material in the main channel, but with a MOSFET the gate is a layer of metal which is completely insulated from the channel by a very thin layer of silicon oxide. Because of this it is possible to employ a MOSFET in a voltmeter circuit in which you forget all about current flow in the gate. You just think in terms of voltage only."

"Where," asked Dick suspiciously, "is the snag?"

"The only snag," replied Smithy, "is that the very thin MOSFET gate insulation can be easily broken down by a high static voltage. So you have to take special precautions when connecting a MOSFET into a practical circuit, and particularly when you apply a mains soldering iron to the gate lead-out."

"This must lead to a lot of trouble when MOSFET's are being handled by retailers and people like that."

"Not really," replied Smithy. "When MOSFET's are in store or in transit they have the gate lead-out short-circuited to the other lead-outs. A typical method of providing the short-circuit is to fit a small springy wire clip round the leads. This is then removed when it is desired to use the MOSFET."

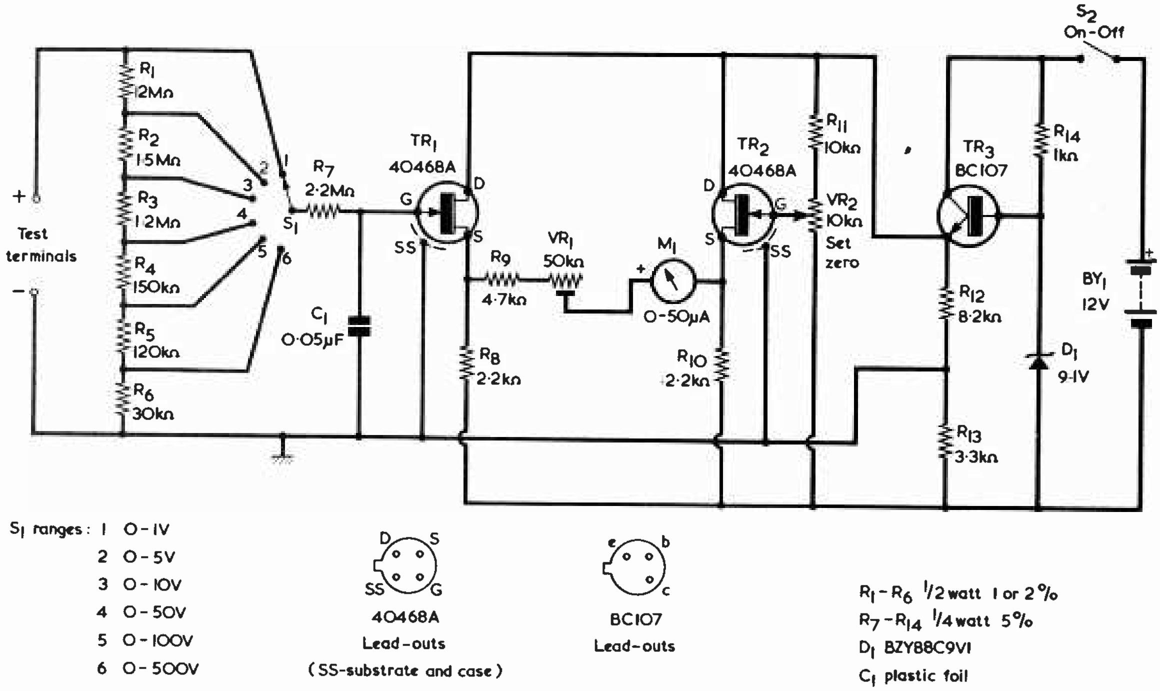


Fig. 1. The circuit of the electronic voltmeter. The MOSFET's in the TR1 and TR2 positions are available from Henry's Radio Ltd. The zero set control, VR2, has a wide range to accommodate spread in the MOSFET's. R11 and VR2 are later removed and a set zero control circuit with a lower range is connected in their place

VOLTMETER OPERATION

"Fair enough," said Dick. "Well, let's get down to this voltmeter of yours."

"Okey-doke," replied Smithy equably. "I'll deal quickly with the power supply arrangement first. The voltmeter is fitted with a 12 volt battery, and the positive terminal of this connects, via the on-off switch S2, to the simple voltage regulator given by zener diode D1 and transistor TR3. A stabilized voltage of about 9.1 volts appears across the diode and this is applied to the base of TR3. TR3 acts as an emitter follower, and a stabilized voltage of about 8.5 volts is then available at its emitter for the voltmeter circuits. Okay up to now?"

"Sure," said Dick. "I'm a bit puzzled, though, by the fact that you've shown a chassis connection which doesn't go to either the negative or the positive supply rail."

"That chassis connection," explained Smithy, "provides a common return with the negative input test terminal. It connects to the junction of R12 and R13, and these hold it at about 2.4 volts positive of the battery negative terminal."

"These two resistors have fairly high values," said Dick critically. "Won't they cause the negative and positive battery rails to be floating?"

"Not really," replied Smithy. "The standing current in R12 and R13 is 0.7mA, and this is more than enough to hold the battery negative and positive rails rock steady with respect to chassis potential. The current drawn from the junction of these two resistors by the circuit to the left of them is virtually zero, and it consists only of leakage current between the substrates and the channels of the MOSFET's. A MOSFET substrate, incidentally, is merely a layer of semiconductor material having opposite polarity to that in the channel. The MOSFET's we are using here are R.C.A. 40468A's and, with these, the substrate lead-out is also common to the metal case. In consequence, we can earth the substrates and the cases to the chassis line."

"I see," remarked Dick. "Let's carry on to the part of the circuit which includes the 50μA meter you've marked as M1."

"Well, now," said Smithy. "This meter couples between the two MOSFET sources and, in conjunction with the series resistors R9 and VR1, acts as a voltmeter. Both of the MOSFETS are source followers. A source follower is rather like a valve cathode follower because, when the gate goes positive so also does the source, and also because the source has a potential which is positive of that on the gate. Now, TR1 couples to the voltage which is to be measured and, if that voltage is zero, TR1 gate is at chassis potential. Typically, the source voltage is then some 3.5 to 4 volts positive of the negative supply voltage from the battery. If the voltage at TR1 gate with respect to chassis is zero then we want the 50μA meter to read zero too, and so we adjust VR2 until the source of TR2 is at the same potential as the source of TR1. VR2 then becomes the set zero control for the electronic voltmeter and it's mounted on the front panel. Okay?"

"Yes, that seems fair enough," replied Dick. "Under these conditions you'll be getting about the same current flowing in R10 that you do in R8, won't you?"

"That's right," concurred Smithy. "The two MOSFET's will both be passing the same channel current and we can reasonably expect that any changes in performance in one due to ambient temperature variations will be at least partly balanced out by a similar change in the other. If any small changes *do* occur, they can be corrected by readjusting the zero set control with the test terminals short-circuited. You'll notice that VR2 can take the gate of TR2 all the way from the negative battery line to half the stabilized voltage. I found in a few preliminary experiments with these

MOSFET's that this wide range was needed in practise to take up spread in different 40468A's. Anyway, we've now established that VR2 is the zero set control, and it is adjusted so that the 50μA meter reads zero when there's no test voltage applied to the gate of TR1. As you'll see later, we'll be changing the zero set circuit for one having a smaller range, but don't bother your head about that for the moment."

TEST VOLTAGE

"What happens," asked Dick, "when a test voltage is applied?"

"Ah," said Smithy. "What happens then is that the test voltage takes the gate of TR1 positive of chassis. The source of TR1 also goes positive, whereupon the needle of the 50μA meter is deflected away from zero to the right. Now it's necessary at an early point in the design of an electronic voltmeter like this to make an arbitrary choice of the voltage at TR1 gate which will cause the 50μA meter to give full-scale deflection. I settled here for 1 volt, and this figure fits in nicely with the voltage range resistor network which is switched by S1."

"I suppose," remarked Dick, "that the purpose of VR1 is to set up the 50μA meter so that it reads f.s.d. when there's 1 volt positive on TR1 gate."

"That's correct," agreed Smithy. "VR1 need only be set up once, and a small skeleton pre-set pot can be used here."

Dick gazed at the circuit with increasing interest.

"What," he asked, "about the voltage range resistors?"

"Do you mean R1 to R6?"

"I do."

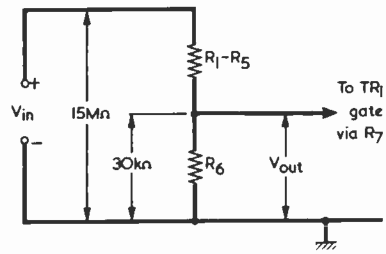
"Those resistors," explained Smithy, "present a resistance of 15MΩ to the test terminals on all voltage ranges. All we have to do then is simply tap TR1 gate into suitable points along the resistor chain by means of the range switch, S1. The chain uses preferred resistor values, which should make it easy to obtain R4, R5 and R6. It will be harder to obtain single resistors for R1, R2 and R3, though, because close tolerance values above 1MΩ are more difficult to find. If necessary, R1, R2 and R3 can each consist of two or more close tolerance resistors in series."

"That seems reasonable enough," commented Dick. "How exactly does the voltage range circuit work?"

"Let's say," replied Smithy, "that we put the range switch, S1, to the 500 volt range. This means that the 50μA meter should give full-scale deflection when a voltage of 500 is applied to the test terminals. Now, we know that the meter gives an f.s.d. reading when the gate of TR1 goes positive by 1 volt, and so it is obvious that the range switch must now tap off one five-hundredth part of the voltage on the test terminals."

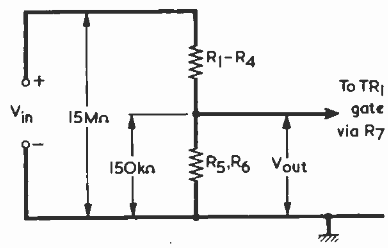
Smithy pulled his note-pad towards him and scribbled out a circuit. (Fig. 2(a).)

"If you add up the values of R1 to R6," he went on, "youll see that they



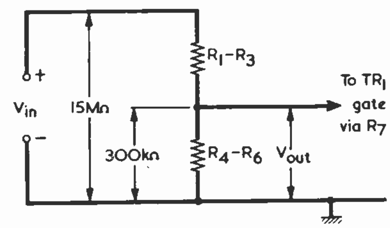
$$\frac{V_{out}}{V_{in}} = \frac{30k\Omega}{15M\Omega} = \frac{1}{500}$$

(a)



$$\frac{V_{out}}{V_{in}} = \frac{150k\Omega}{15M\Omega} = \frac{1}{100}$$

(b)



$$\frac{V_{out}}{V_{in}} = \frac{300k\Omega}{15M\Omega} = \frac{1}{50}$$

(c)

Fig. 2(a). With S1 in position 6 the range resistors shown here are selected. These allow one five-hundredth part of the input voltage to be applied to the gate of TR1.
(b). The input resistor values which are selected for the 0–100 volt range
(c). The input circuit given when the 0–50 volt range is switched in

come to the 15MΩ figure I mentioned just now. So the voltage across the 30kΩ resistor will be 30kΩ over 15MΩ, or one five-hundredth part, of 500 volts. In consequence, 1 volt is applied to the gate of TR1."

"I see," grunted Dick thoughtfully. "Incidentally, doesn't that 2.2MΩ resistor in series with the gate of TR1 have any effect on the voltage?"

"It has no effect at all," replied Smithy. "Everything in TR1 gate circuit operates simply in terms of voltage. You can short out that 2.2MΩ resistor when the voltmeter is giving a reading, and the reading won't alter one little bit."

"Then why have the 2.2MΩ resistor in the circuit in the first place?"

"In company with C1," explained Smithy, "it forms a simple protection circuit for the gate insulation of TR1. These two components ensure that any transient voltages or spikes at the test terminals won't reach the gate, where they could otherwise break down the gate insulation."

"I'm with it now," said Dick. "How about the 100 volt range?"

"This time," replied Smithy, "S1 selects R5 and R6 in series, and these have a total value of 150kΩ. A figure of 150kΩ over 15MΩ corresponds to a fraction of one-hundredth. Thus, one hundredth part of 100 volts is applied to the gate of TR1, and gives an f.s.d. reading in the meter. If 50 volts is applied when the 50 volt range is selected, the voltage applied to TR1 gate is that across R4, R5 and R6 in series. These total up to 300kΩ, which means that one fiftieth part of 50 volts is fed to TR1 gate." (Figs. 2(b) and (c).)

"Blow me," said Dick, impressed. "Those resistor values certainly fit neatly into place. Let's see what happens with the 10 volt range. This gives us R3 to R6 in series and these add up to, let me see now, 1.5MΩ; 1.5MΩ is one-tenth of 15MΩ and so we must get f.s.d. in the meter when there's 10 volts across the test terminals." (Fig. 3(a).)

"If you look at the 5 volt range next," said Smithy, "you'll find that the total resistance given by R2 to R6 is 3MΩ." (Fig. 3(b).)

"And that," chimed in Dick, "means that one-fifth of the test voltage is applied to TR1 gate. Finally, when the 1 volt range is selected the positive test terminal just goes direct to the gate of TR1, so that this time a test voltage of 1 volt gives the f.s.d. reading in the meter." (Fig. 3(c).)

CONSTRUCTION

"Exactly," concurred Smithy. "The delightful part of the range switch calculations is that everything is in terms of voltage with no current flow at all. Well now, Dick, how about embarking on your first constructional job for the New Year?"

"My trusty soldering iron," responded Dick, "is, as ever, at the ready."

"Good," said Smithy. "I've collected all the bits and pieces you'll need, including a metal box to act as a case for the voltmeter."

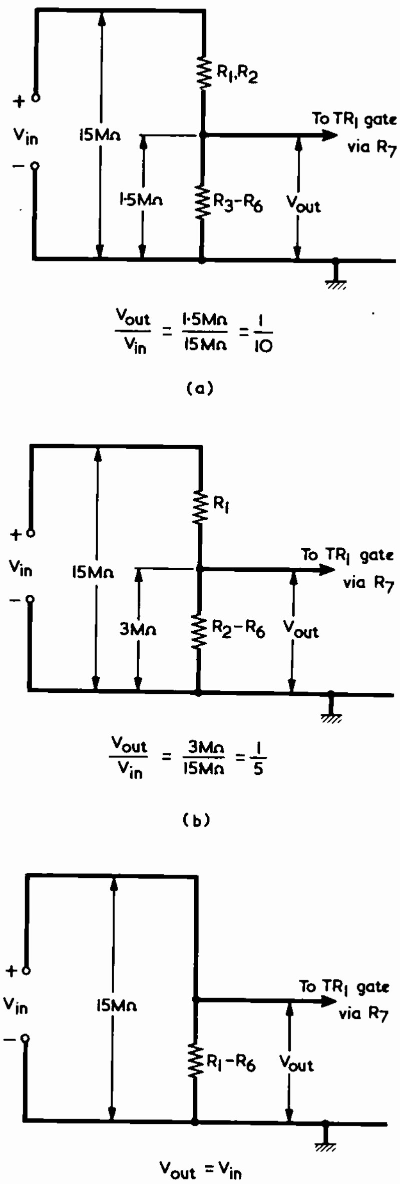


Fig. 3(a). Input resistor values for the 0–10 volt range
(b). One-fifth of the input voltage is applied to TR1 gate on the 0–5 volt range
(c). On the 0–1 volt range the positive test terminal couples direct to the gate of TR1

"Wouldn't a plastic case be just as good?"

"A metal case is better," said Smithy. "The input circuit is at such a high impedance that it's desirable to have it screened. In consequence, all the parts can be fitted inside the metal case with only the positive and negative test terminals on the outside. The metal case is common with the negative test terminal and to the chassis symbol in my circuit diagram."

"What about the 12 volt battery?"

"A couple of 6 volt PP1 batteries in series will do nicely here," said Smithy. "These won't be excessively bulky and they should give a pretty long life since the current drawn from them at 12 volts is only about 8mA."

Smithy reached to the back of his bench and pulled forward a cardboard box.

"Here you are," he said, handing this over to his assistant. "You'll find all the components here. The layout of the parts inside the case isn't critical, and I'll leave you to sort that out."

Dick looked through the contents of the box.

"Hello," he said, "you've put in a couple of 4-way transistor holders and a 2kΩ pot."

"The holders are for the two MOSFET's," explained Smithy. "The idea is that we fit the MOSFET's to these holders after all the wiring has been completed. This reduces the risk of gate insulation breakdown. We'll use the 2kΩ pot later, and I should add that the wiring to R11 and VR2 need only be of a temporary nature at this stage."

Cheerfully, Dick took the cardboard box and Smithy's circuit over to his bench. It was not long before the workshop resonated to the screech of Dick's electric drill as he made a series of holes near the periphery of that needed for the meter cut-out. Smithy breathed a sigh of relief as the last hole was drilled, but the ensuing silence was soon shattered by the rasp of Dick's half-round file as he started cleaning up the meter hole. Shuddering, Smithy cast his eyes around for a task that would take his mind off the ear-splitting racket from Dick's bench. He spotted the two Christmas paper chains and decided that now would be as good a time as any to take these down.

He carried his stool over to a corner of the workshop and, standing on this, attempted to unfasten the end of one of the paper chains. It seemed to be secured very firmly to the wall and his efforts eventually ended with him tearing the chain at the point where it left the wall. Mystified, he attempted to remove the chains at the other three corners but met with similar results. There were, now, four small torn pieces of gaily coloured paper stuck, apparently immovably, to the wall at each corner of the workshop. The centres of the two paper chains were fixed to the flex of the light in the middle of the ceiling, and Smithy decided next to remove them from this point. He ended with four separate segments of paper chain, leaving two fragments of brightly coloured paper adhering, seemingly for ever, to the flex.

Scratching his head, Smithy took his stool back to his bench and pondered the situation. It was some time before he realised that the sounds of metal-work from his assistant's bench had ceased.

"Hey, Smithy!"

The Serviceman dismissed the mystery of the paper chains from his mind and walked over towards his assistant. The latter had already started on the wiring of the voltmeter. The 0–50μA meter, the two switches, the zero set potentiometer and the test terminals were already fitted to the front panel, and Dick had mounted a number of small tagstrips on the rear surface of this to take the remaining components.

"Any problems?" asked Smithy.

"Only with R1, R2 and R3," replied Dick. "What have you provided for these?"

"Ah yes the high value resistors," responded Smithy. "Well, I was lucky enough to obtain a single close tolerance 1.5MΩ resistor for R2. R3 will have to be a 1MΩ and a 200kΩ resistor in series. The best I could do for R1 was four separate 3MΩ resistors, and these can also be connected in series."

"Righty-ho," said Dick obligingly. "I thought I'd have to do something like that from the resistors you'd put in the box. It won't be long now before I get this job completed."

FINAL TESTS

Smithy leaned over Dick's bench, watching his assistant as he briskly carried out the remainder of the wiring. And, indeed, it was not long before Dick proudly pronounced that the last solder joint had been completed. Smithy carefully checked the wiring, connected up the two PP1 batteries and switched on. Taking up the leads of Dick's testmeter he checked the voltage between the negative battery terminal and the emitter of the BC107. The meter indicated a comforting 8.6 volts. Smithy switched off the battery again.

"The voltage stabilizing part is all right," he announced. "Let's fit the MOSFET's to their holders."

He took up the two 40468A's, removed the lead-out short-circuiting wires and carefully fitted them into the transistor holders. He next set VR1 to insert maximum resistance into circuit, adjusted VR2 to mid-travel and switched on. The needle of the 0–50μA meter moved over to just below full-scale deflection. Smithy adjusted VR2 and soon had the meter giving a zero reading.

"Blimey," remarked Dick, "that set zero control is pretty fierce, isn't it?"

"It is rather," agreed Smithy. "As I said earlier on there's a very wide spread in these MOSFET's so far as gate-to-source voltage is concerned. There is, even, a slight risk with some MOSFET's that you won't be able to get a zero reading within the range of VR2. If this occurs the best plan is to swap the two MOSFET's over and try again. Anyway, the next job is to set up VR1. All we need here is a 3 volt battery, a pot having any value between 500Ω and 20kΩ and the use of your testmeter to indicate the input voltage."

Smithy quickly found a potentiometer and battery and connected these up to produce a test voltage of 1 volt, as monitored by Dick's testmeter. He then connected the electronic voltmeter to this 1 volt source, selected the 0–1 volt range and adjusted VR1 for an f.s.d. reading in the electronic voltmeter. He disconnected the electronic voltmeter, rechecked the setting of its zero set potentiometer and coupled it to the 1 volt source once more. He then gave VR1 a final adjustment and switched off the meter. (Fig. 4.)

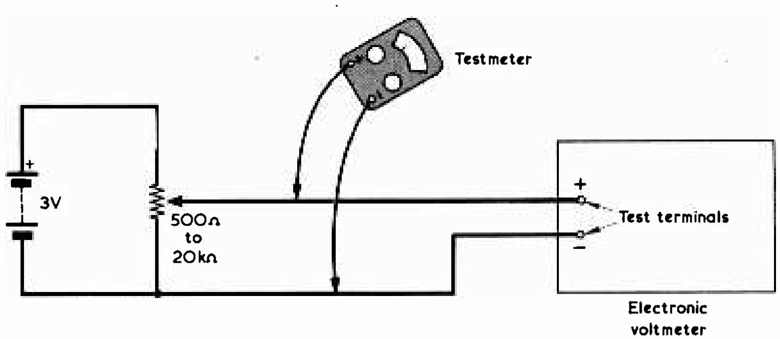


Fig. 4. VR1 is set up by applying a test voltage of 1 volt, as monitored by another voltmeter. The electronic voltmeter is switched to the 0–1 volt range during this operation

"There you are," he announced, "all we now need to do is to make a change to the circuit around VR2."

"Is that," asked Dick, "why you said that I should wire in R11 and VR2 temporarily only?"

"It is," confirmed Smithy. "It's necessary for VR2 to have a wide range initially in order to cater for MOSFET spread. But, after VR1 has been set up, this wide range is undesirable because it can result in high currents flowing in the 50μA meter. So what you do now is measure the resistance between the emitter of TR3 and the slider of VR2, and between the slider of VR2 and the negative side of the battery. You then fit a 2kΩ or a 2.2kΩ pot in place of the 10kΩ one, and put fixed resistors on either side of it having values which will enable this to give a zero reading when it's at about the centre of its travel." (Fig. 5.)

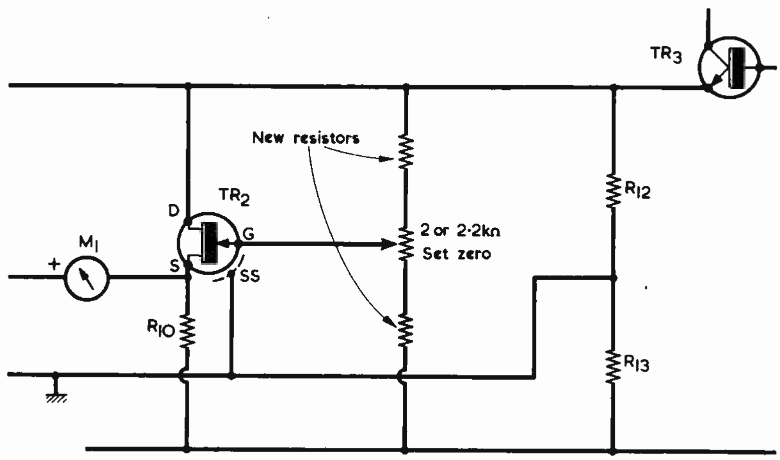


Fig. 5. The final set zero control circuit. The two added fixed resistors have values to suit the particular MOSFET employed in the TR2 position

"I'll soon get that done," said Dick, reaching for his testmeter.

"I should remove TR2 from its holder whilst you're making these circuit changes," advised Smithy. "There's no point in taking risks with its gate insulation."

"Okey-doke," said Dick cheerfully, as he removed the MOSFET.

He applied the test prods of his meter to the electronic voltmeter.

"There's 13kΩ between the emitter of TR3 and the slider of VR2," he called out. "And there's about 7kΩ between the slider of VR2 and the battery negative line."

"That sounds reasonable," remarked Smithy. "What you now need to do is to change R11 to 12kΩ, put in the 2 or 2.2kΩ pot in place of VR2, and insert a 6.2kΩ resistor between the bottom of VR2 track and the negative battery line."

Dick walked over to the spares cupboard and returned with the two fixed resistors.

Smithy looked on as Dick made the circuit alterations for the new zero set control. A thought occurred to him.

"I've been taking down the paper chains you put up for Christmas," he remarked, "and I just couldn't unfasten them at all. How did you secure them to the walls and to the light flex?"

"I stuck them there."

"What with?"

"Araldite."

"Oh."

Smithy looked at the rubber reindeer above Dick's bench. Standing up, he grasped one of its back legs and tugged. The figure changed in shape but still remained tenaciously secured to the wall. Smithy released the leg, whereupon the reindeer snapped back smartly to its original form.

"Did you," asked Smithy, "stick this reindeer in place, too?"

"Yes, I did," replied Dick absently, busy with his soldering iron.

"What with?"

"Araldite."

The Serviceman gazed doubtfully at the apparently immovable rubber figure. The first tremors of foreboding arose in his mind.

"I've wired up the new set zero circuit," announced Dick. "Let's try it out."

He refitted the MOSFET to its transistor holder and switched on. This time the set zero control was much easier to adjust and caused far less meter deflection.

"Very good," commented Smithy. "We were a bit lucky there. We might have had to fiddle around a bit with the values of these extra fixed resistors before we got them right."

"Well," said Dick, "that's one electronic voltmeter all complete and working."

But Smithy had become preoccupied with other matters. He pointed a finger at the plastic Santa Claus above his bench.

"Did you fix that in place with Araldite, too?"

"I did."

Smithy walked over to his bench and, reaching up, caught hold of the beard of the Santa Claus. The plastic figure did not have the elasticity of the rubber reindeer but, as Smithy pulled, it slowly changed shape. The head moved outwards towards Smithy, and the front of the body became distorted downwards. The figure still stayed firmly affixed to the wall. When, eventually, the despairing Serviceman released the beard, the head started to return, very slowly, towards its original position. But Smithy had overstrained the plastic and the head finally took up a crooked sloping posture reminiscent of a body on the gibbet. The face was twisted out of shape, too; where previously there had been a beatific smile the mouth now exhibited a salacious leer of unplumbable corruptness.

Smithy reeled back from this dreadful Santa Claus.

HAIRY OUTLOOK

But his cup of woe was not yet replete. He suddenly caught sight of the windows, each pane of which had its complement of imitation cotton-wool snow. Impulsively, he dashed over to the nearest window and scrabbled feverishly at the cotton-wool balls. Each left a circle of matted fibre stuck irremovably to the glass.

"Ye gods," wailed the stricken Serviceman. "Hairy windows next! How could you *do* it, Dick?"

"It was easy," replied Dick airily. "I just stuck the cotton-wool on with what was left of the Araldite. I must admit that I hadn't realised it would stick so strongly as it has, though."

Men can always adjust to a changed environment and, as the day proceeded, Smithy found that he could still carry on in the appallingly altered workshop.

Provided, that is, he didn't raise his eyes above bench level or attempt to look out of the windows. ■

Radio Topics

By Recorder

F.M. RADIO SUBSYSTEM

The rather striking photograph which accompanies my notes this month aptly demonstrates thc performance capabilities of the SGS-ATES integrated circuit type TDA 1200. This provides a complete subsystem for the amplification and detection of f.m. signals.

The i.c. incorporates a three-stage 10.7MHz amplifier complete with its own limiting stage and quadrature detector, and has an internal supply voltage regulator. It enables controlled inter-signal muting (squelch) to be carried out, and it provides a detected audio output, an a.f.c. output and a delayed a.g.c. output for the receiver f.m. tuner. Further facilities are outputs for the switching of a stereo decoder and for the driving of a tuning meter.

The main performance features claimed for the i.c. are high limiting sensitivity, high a.m. rejection, high audio output, low capture ratio, and low distortion due to the high level of linearity in the detector.

The TDA 1200 is encapsulated in a 16 lead dual-in-line plastic package. Its manufacturers are SGS-ATES Group of Companies, Via C. Olivetti, 1, 20041 Agrate Br., Milan, Italy.

PIPED RADIO

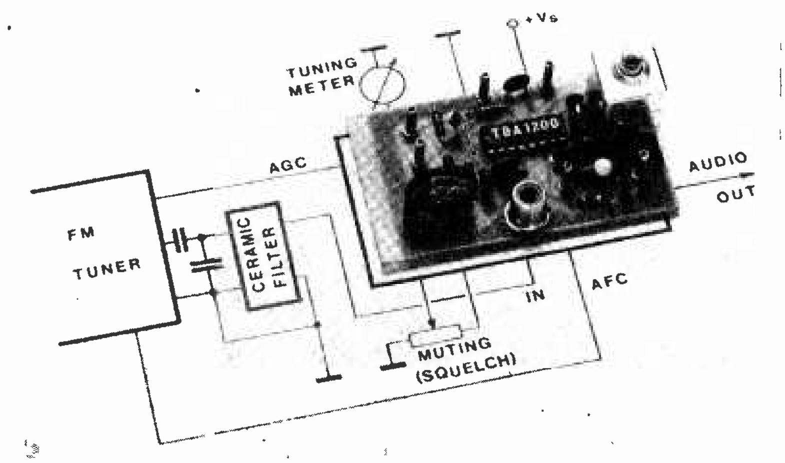
The following story is quite true and it was recounted to me by a service engineer friend of mine.

Whilst calling on a family recently about a matter unconnected with work he noticed a length of rubber garden hose running along the carpet in one of their rooms. On investigating further he found that one end of the hose led to a leg of an easy chair then travelled up its side to terminate at the top of the chair back. In the other direction the rubber hose went to the leg of a table nearby then carried on up to and over its surface. On the table was a medium sized radio, over the loudspeaker aperture of which had been taped the open end of a large tin funnel. The garden hose had been passed over the narrow section of the funnel.

On enquiring, my friend found that an elderly man in the family was rather deaf. In the past he had been in the habit of turning the radio on at full volume, thereby sending his next-door neighbours spare. The funnel and hose pipe was his answer to the problem, since it enabled him to run the set at a reasonable volume whilst he sat in the chair with the hose pipe end held near his ear. What frequencies finally emerged after passing through the combination of funnel and hose pipe is a matter of conjecture but the old chap who used the contraption seemed to be quite satisfied.

Indeed, he walked into the room whilst my friend was there and proudly surveyed his handiwork.

"The neighbours don't bang on the wall any more now," he remarked contentedly.



The TDA 1200 integrated circuit shown here provides all the active components needed in an f.m. receiver between the tuner and the a.f. amplifier stages. It is manufactured by SGS–ATES

ROTARY SWITCH WIRING

The appeal of our hobby is, I sometimes feel, that whilst many aspects of it are quite simple, a job now and again crops up which is surprisingly difficult to carry out. I recently had to devise a rather complicated 6-way switching circuit for a project I'm working on, and I started by getting out pen and paper and working out the simplest form the circuit could take up. This is usually quite an enjoyable task, especially if there are a number of different possible combinations of switch connections. I got things down to a 4-pole 6-way circuit then, after a little head-scratching, to a 3-pole 6-way circuit. After that I looked around to see if I could find a suitable switch. I did, in 4-pole 6-way! It was a miniature rotary switch with two wafers, each offering 2 poles and 6 ways.

Anyway, I proceeded to wire up the 3-pole version of the circuit, as I wasn't going to throw away all that brain activity even if it did mean that one of the switch poles would be unused. And, after my first wiring error, I decided to get my testmeter out. I then used it, switched to read ohms, as a continuity tester to ensure that each tag I connected up to was the right one.

It is, in fact, surprising how easy it is to make a mistake when wiring a new circuit to a miniature rotary switch having a large number of tags. It is necessary to remember all the time that clockwise rotation of the knob whilst looking at the front means anti-clockwise rotation of the contacts whilst looking at the rear. When locating the contacts visually from the rear there is a continual temptation to fall into the trap of counting off the tags in the wrong direction. The best plan is to do what I belatedly did, and that is to use a continuity tester with one clip coupled to the arm of the particular pole that is being wired up, and then set the switch knob to the position to be wired up whilst actually looking at the knob from the front. The corresponding fixed contact can then be found with complete certainty by means of the continuity tester.

Wiring up with a continuity tester may take a little longer but at least it proceeds without error, and there is a hidden bonus in that the switch contacts are themselves being automatically tested at the same time as the wiring is being carried out. ■

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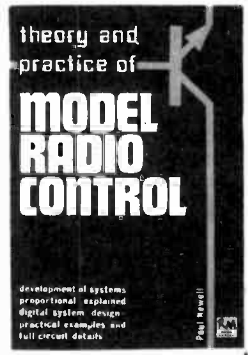

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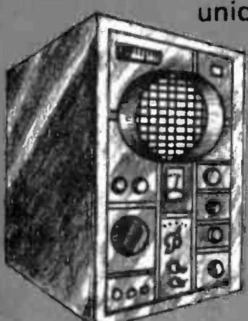

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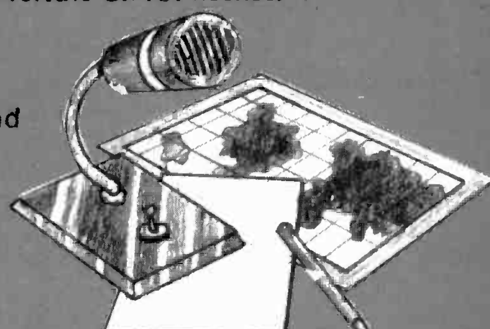

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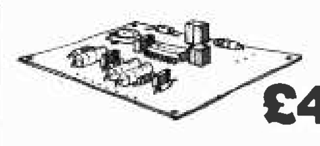

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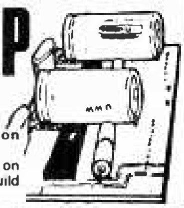

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(Continued on page 381)

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(Continued from page 380)

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D.S.C. WIRE COIL LENGTHS

The Table lists lengths, in inches, of close-wound coils using d.s.c. (double silk covered) enamelled copper wire. Thus, a 70 turn coil of 28 s.w.g. wire has a length of 1.3in. Similar coil lengths will be given with d.r.c. (double rayon covered) enamelled wire.

Wire Gauge (s w g)	10 Turns	20 Turns	30 Turns	40 Turns	50 Turns	60 Turns	70 Turns	80 Turns	90 Turns	100 Turns
16	0.71	1.4	2.1	2.8	3.6	4.3	5.0	5.7	6.4	7.1
18	0.53	1.1	1.6	2.1	2.7	3.2	3.7	4.2	4.8	5.3
20	0.41	0.82	1.2	1.6	2.1	2.5	2.9	3.3	3.7	4.1
22	0.33	0.66	0.99	1.3	1.7	2.0	2.3	2.6	3.0	3.3
24	0.27	0.54	0.80	1.1	1.3	1.6	1.9	2.1	2.4	2.7
26	0.22	0.44	0.66	0.88	1.1	1.3	1.6	1.8	2.0	2.2
28	0.19	0.37	0.56	0.74	0.93	1.1	1.3	1.5	1.7	1.9
30	0.16	0.32	0.48	0.63	0.79	0.95	1.1	1.3	1.4	1.6
32	0.14	0.28	0.43	0.57	0.71	0.85	1.0	1.1	1.3	1.4
34	0.12	0.25	0.37	0.49	0.62	0.74	0.86	0.99	1.1	1.2
36		0.22	0.32	0.43	0.54	0.65	0.76	0.86	0.97	1.1
38		0.18	0.27	0.36	0.45	0.54	0.64	0.73	0.82	0.91
40		0.16	0.24	0.31	0.39	0.47	0.55	0.63	0.71	0.79