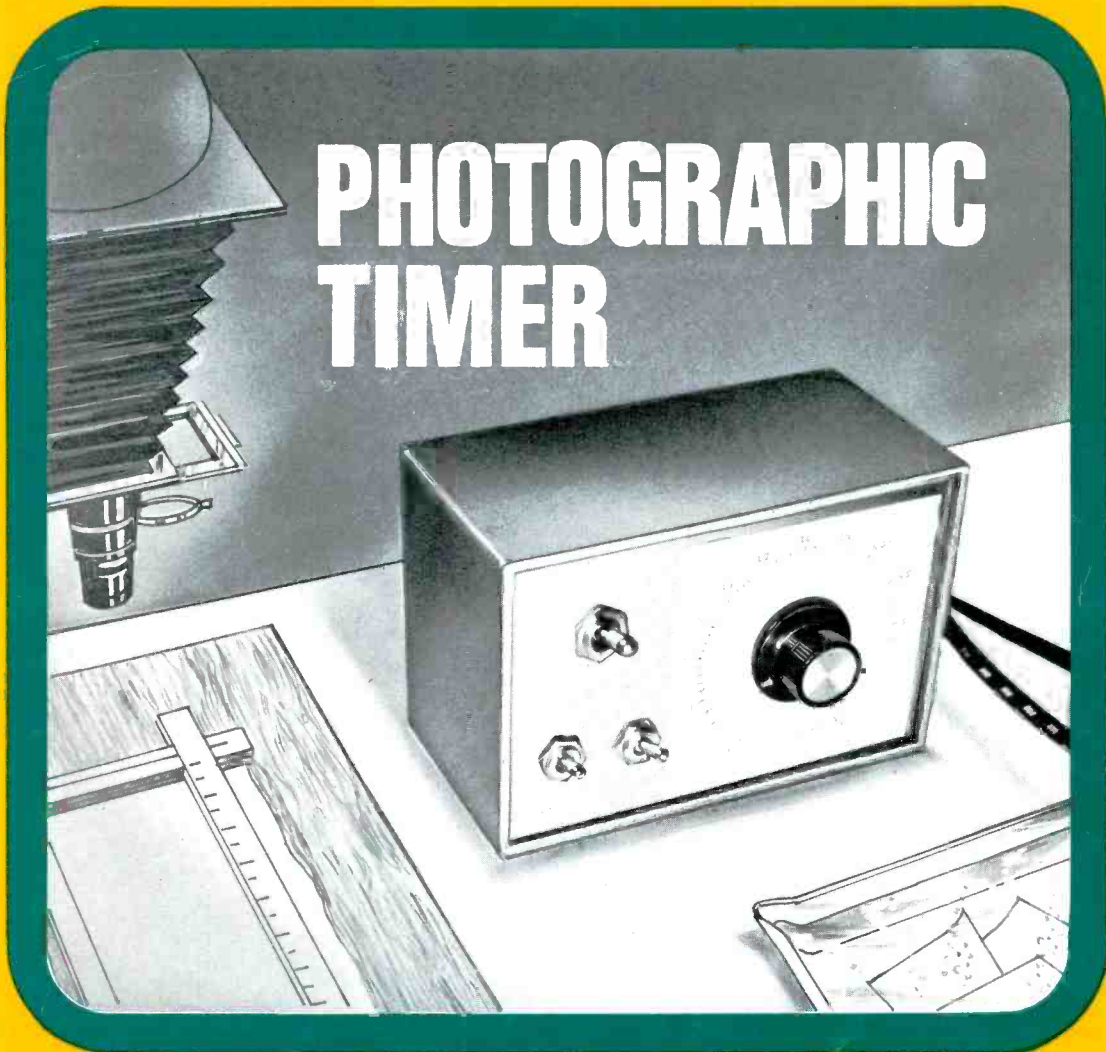


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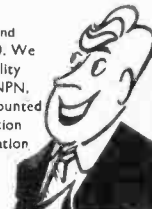
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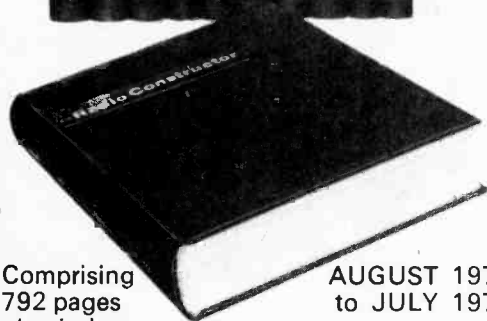
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U 17	30 Germanium PNP-AF Transistors TO-5 like ACY 17-22	0.55
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U 26	30 Fast Switching Silicon Diodes like 1N914 Micro-Min	0.55
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U 30	15 Plastic Silicon Planar Trans. NPN 2N2926	0.55
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200	0.27	0.32	0.51	0.54	0.62	0.67	0.87	1.76
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	0.66	0.61
	0.55	

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BA5	4"	2 1/2"	1 1/2"	41p
BA6	3"	2"	1"	34p
BA7	7"	3"	1 1/2"	90p
BA8	8"	4"	1 1/2"	84p
BA9	6"	4"	3"	54p

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50 For model N25 W	37p
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52 For model N25 W	37p

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PS 13	Jack Stereo Screened	0.29
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PS 15	Car Aerial	0.15
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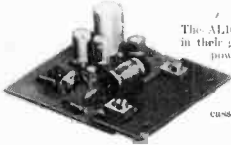
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AL10 AL20 AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

PARAMETER	CONDITIONS	PERFORMANCE
HARMONIC DISTORTION	$P_o=3$ WATTS $f=1$ KHz	0.25%
LOAD IMPEDANCE	—	8 - 16Ω
INPUT IMPEDANCE	$f=1$ KHz	100 KΩ
FREQUENCY RESPONSE ± 3 dB	$P_o=2$ WATTS	50 Hz - 20 KHz
SENSITIVITY for RATED O/P	$V_s=25V$ R.L. $f=1$ KHz	75mV R.M.S.
DIMENSIONS	—	3" x 2 1/4" x 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

PARAMETER	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (R.L. $f=1$ KHz)	3 watts R.M.S. Min.	5 watts * R.M.S. Min.	10 watts R.M.S. Min.

AUDIO AMPLIFIER MODULES

AL10 3 Watts	£2.19
AL20 5 Watts	£2.50
AL30 10 Watts	£3.01

PRE-AMPLIFIERS

PA12 (Use with AL10 & AL20)	£4.35
PA100 (Use with AL20 & AL30)	£15.15

POWER SUPPLIES

PS12 (Use with AL10 & AL20)	88p
SPM80 (Use with AL30 & AL30)	£3.25

TRANSFORMERS

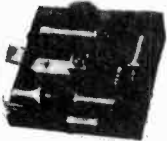
T461 (Use with AL10) p&p 15p	£1.38
T538 (Use with AL20) p&p 15p	£1.93
BMT80 (Use with AL30 & AL30) p&p 25p	£2.15

FRONT PANELS PA12 With knobs £1.00

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to mesh into most budget stereo systems. It is compatible with the AL10, AL20 and AL30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with 'Crimie' cartridges while the auxiliary input will suit most magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 162mm x 84mm x 35mm.

Frequency response	20Hz-50KHz (-30dB)
Bass control	± 12 dB @ 60Hz
Treble control	± 14 dB @ 14 KHz
* Input 1	Impedance: 1 M Ω , ohm.
	Sensitivity: 300 mV
Input 2	Impedance: 30 K ohms
	Sensitivity: 4 mV



EA1000 AUDIO AMP MODULE

Module Tested and Guaranteed.
Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.

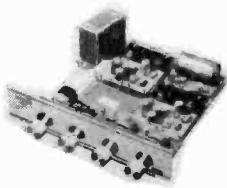
SPECIAL OFFER £2

The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Transformer, Power supply and Power Amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak
Freq. res. 25Hz-25KHz
Harmonic distortion typically 0.25% at 1 watt

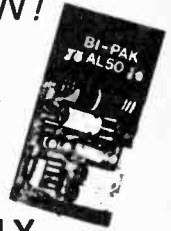
Input 1 (er.) 300mV into 1M
Input 2 (Aux.) 4 mV into 30K
Bass control ± 12 dB @ 60 Hz
Treble con. ± 14 dB @ 14 KHz



£13.48

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50W_{pk} 25w (RMS) 0.1% DISTORTION HI-FI AUDIO AMPLIFIER THE AL50



- ★ Frequency response 15Hz to 100,000 - 1dB. **ONLY**
- ★ Load - 3, 4, 8 or 16 ohms. **£3.58 each**
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- ★ Signal to noise ratio 80dB. ★ Overall size 63mm x 105mm x 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and ALSO was conceived to fill the need for all your A.F. amplification needs. FULLY BUILT - TESTED - GUARANTEED.



STABILISED POWER MODULE SPM80

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (rms) per channel, simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Main Transformer MT80, the unit will provide outputs of up to 15 amps at 35 volts. Size: 62mm x 106mm x 30mm.

These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address, Intercom Units etc. Handbook available 10p.

PRICE £3.25

TRANSFORMER BMT80 £2.15 p. & p. 25p.

STEREO PRE-AMPLIFIER, TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATION

Frequency Response	20Hz - 20KHz ± 1 dB
Harmonic Distortion	better than 0.1%
Inputs: 1. Tape Head	1.25 mV into 60KΩ
2. Radio, Tuner	35 mV into 60KΩ
3. Magnetic P.U.	1.5 mV into 60KΩ
All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1 dB, from 20Hz to 20KHz.	
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6.5	500	BT108	90p
6.5	500	BT101-500R	68p
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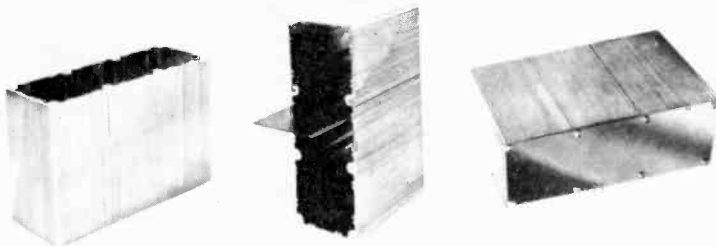
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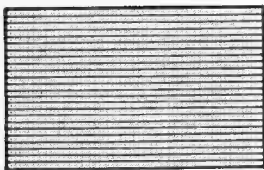
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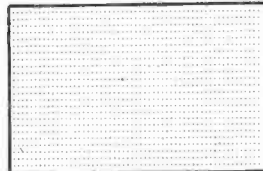
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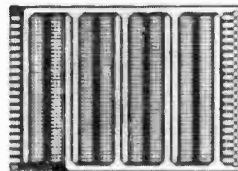
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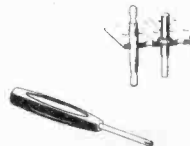
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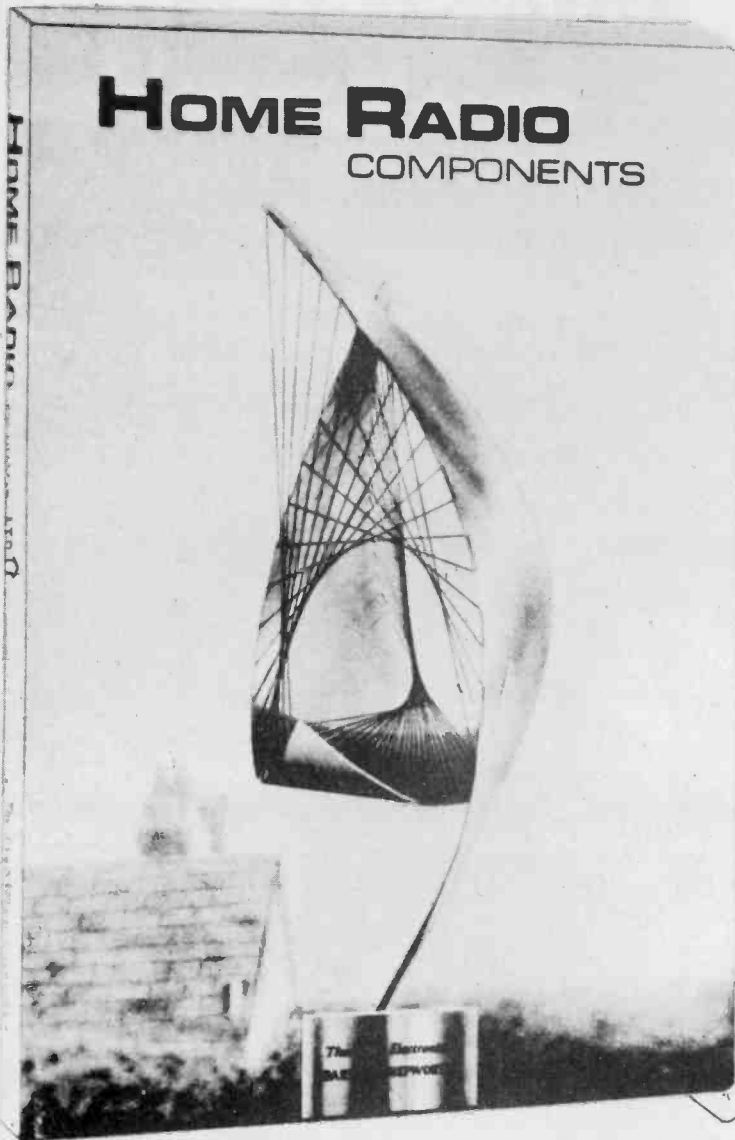
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RADIO & ELECTRONICS CONSTRUCTOR

NOVEMBER 1973

Vol. 27 No. 4

Published Monthly (1st of Month)
First Published 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone 01-286 6141 Telegrams Databux, London

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Annual Subscription: £2.70 (U.S.A. and Canada \$7.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers please pay by cheque or International Money Order.

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Production.—Web Offset.

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Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London, W9 1SN

The Radio & Electronics Constructor is printed by Carlisle Web Offset.

DECEMBER ISSUE WILL BE
PUBLISHED ON DECEMBER 1st

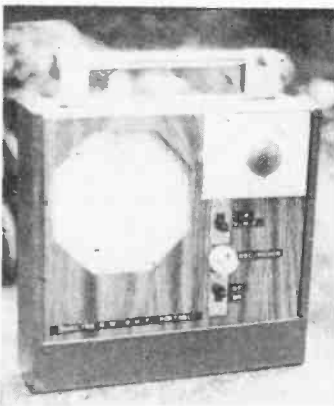
THE 'DUALINE' = M.W.-V.H.F. PORTABLE

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

Part 1

This unusual and ingenious design allows reception of medium wave a.m. and v.h.f. f.m. signals with band-switching carried out by a double-pole switch only. Four transistors are employed in the circuit. A concluding article will appear in next month's issue.

FOR SOME TIME THE AUTHOR HAS had it in mind to make a 2-wave-band portable receiver which would combine the selective properties of his 'Spontaflex Super-Alpha' circuit on medium waves with the markedly different 'Spontaflex' circuit used for v.h.f. Until he started to work things out on paper he expected unacceptable band-switching problems. However, it was found that band-switching was delightfully simple, the whole operation of changing from one circuit to the other, including a change of diode and reaction circuits as well as more fundamental items, being carried out by a standard 2-pole slide switch.



Front of the completed receiver with the telescopic aerial under its hook

BAND-SWITCHING

In the circuit diagram given in Fig. 1, switch S1 (a) (b) is shown in the medium wave position.

Received signals are tuned by L1 and VC1, L1 being mounted on a 4 in. length of $\frac{3}{8}$ in. ferrite rod. The input signal is applied to the base of TR1, and the output from this transistor appears across the network formed by R2, L3 and R3 in the emitter circuit. R3 is present to prevent a form of spurious oscillation which can otherwise take place if high gain transistors are used and the receiver is tuned to a point near the high frequency end of the medium wave band. The signal, amplified now in terms of current by TR1, passes through the v.h.f. coil L4, which offers negligible impedance at medium waves, and is then applied to the base of TR2. TR2 also functions as an emitter follower and its emitter current flows through D1 and D2 to the negative supply rail. D1 has C8 and R8 connected across it, and D2 is short-circuited, so far as radio frequencies are concerned, by S1(b).

Reaction takes place with the aid of L2, which is also wound on the ferrite rod and which is inductively coupled to L1. L2 is fed from the emitter circuit of TR2 via C7, which provides d.c. isolation, and the pre-set potentiometer VR1. The 6.8pF capacitor, C11, can be ignored at medium waves. The amount of feedback allowed is set up by VR1. VR2 is a panel reaction control and it varies the direct voltage available for the collector of TR2. This circuit point, in turn, provides base bias via R1 for TR1 and, consequently,

VR2 controls the amplification offered by both these transistors. Note that, with S1(b) in the medium wave position, R7 is in series with R9, thus reducing the maximum current which can be passed by TR2, while at the same time increasing the collector load resistance and consequently the audio gain offered. This balances with the situation given when v.h.f. is being received, and when a higher direct voltage is required at TR2 collector for satisfactory oscillation. As a result, maximum gain, around the onset of oscillation, is obtained on both medium waves and v.h.f. when VR2 is near its maximum setting. C8 and R8 apply a load across D1 which varies with frequency. Their values are chosen such that the oscillation point in the travel of VR2 remains fairly constant throughout the whole medium wave band. Without these components the method used to control reaction would not be very suitable, as there would be wide differences in direct voltage requirements throughout the range and there would be serious losses at some points of the band.

A.F. AMPLIFICATION

D1 demodulates the r.f. signal and also acts as a load for the resulting a.f., which passes through TR2. This transistor acts, at a.f., as a common base voltage amplifier. The output, at high impedance, from TR2 is across R9 plus R7, and it is applied back to TR1 which now acts as a common emitter amplifier. Since R2 is not bypassed, a fair degree of negative feedback takes place, and this raises

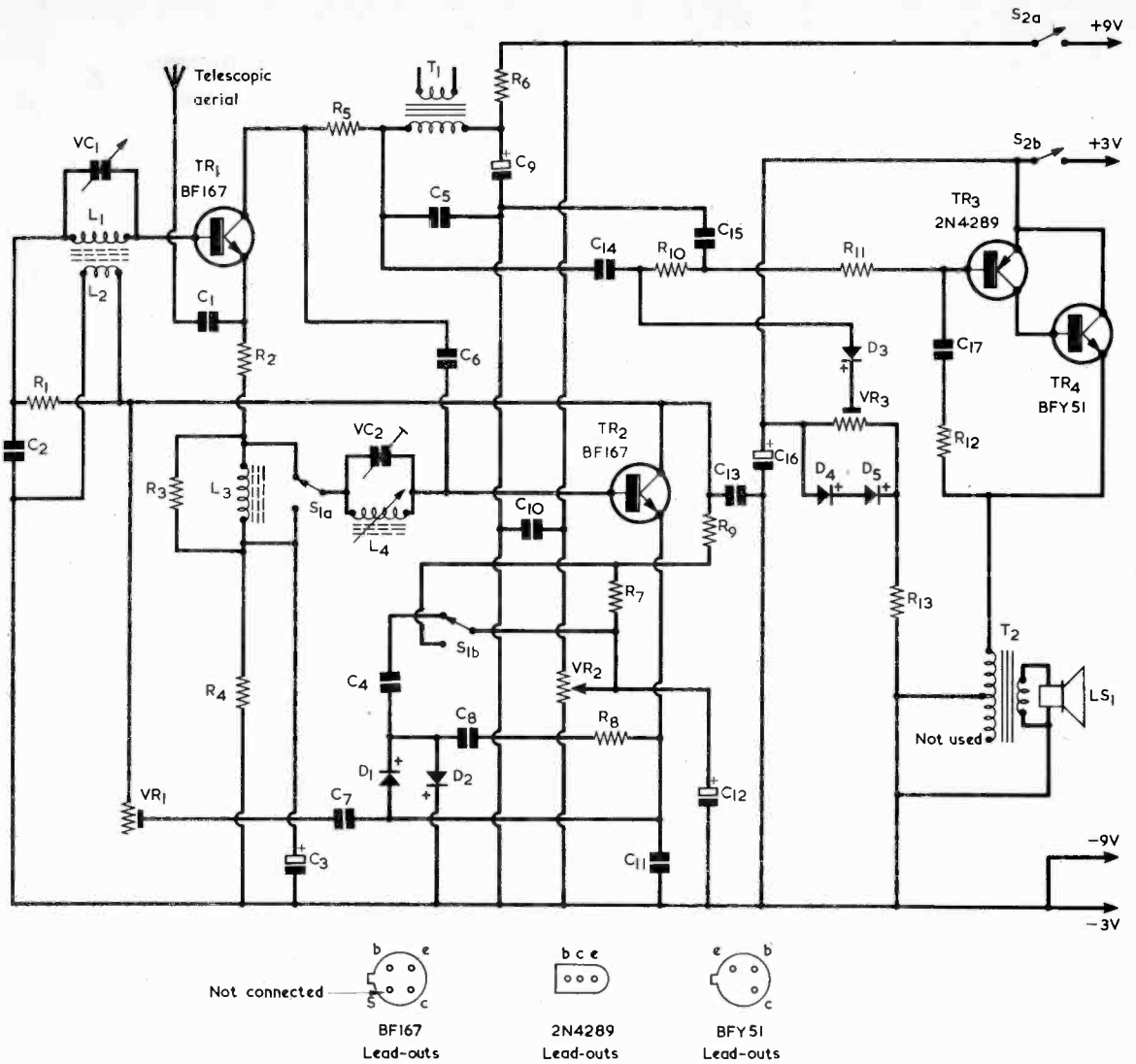


Fig. 1. Full circuit diagram of the 'Dualine' receiver

the input impedance of TR1 and enables it to match the output impedance of TR2.

The signal now appears across the large winding of transformer T1, and this allows reasonable amplification to be given even though negative feedback is present. T1 is a type which is normally employed for matching a crystal pick-up or microphone to the input of a transistor amplifier. From T1 the signal passes through the radio frequency filter given by R10, R11, C5 and C15, coupling being provided by C14. Bias for TR3 is settled by the network formed by VR3, D4, D5 and R13. The two diodes help to keep the voltage constant as the battery runs down. VR3 is set up so that a very small current passes through TR3

when no signal is present. Since the collector current for TR3 is the base current of TR4, VR3 is set up for about 8mA collector current in TR4 under quiescent conditions. When an audio signal is fed to the circuit a corresponding voltage is developed across D3, and this is added to the quiescent bias voltage to cause an increase of current through TR3 and TR4. On maximum a.f. peaks the current passed by TR4 may be near 100mA, but this will be only for very brief periods. The amplifier section of the receiver is, of course, that described in "The 'Sliding Junior' Amplifier", which was described in the June 1973 issue of *Radio and Electronics Constructor*.

Negative feedback is provided by

C17 and R12. Although feedback occurs at all audio frequencies, the value of C17 is such that there is a small increase in attenuation at the treble end of the spectrum. Feedback is very necessary across TR3 and TR4 to ensure that the direct bias voltage is always greater than the signal voltage.

The receiver uses two batteries. The PP3 battery which provides the 9 volt supply is cheap and is only called upon to pass about 500µA. The large No. 800 battery which gives the 3 volt supply is a very economical source of power. At the time of writing, the combined price for the two batteries is less than the cost of a single PP9 battery. There is a considerable advantage, especially when listening to

v.h.f. signals, in the fact that the radio frequency section of the receiver is completely unaffected by fluctuating voltage from an ageing battery in the audio section.

V.H.F. RECEPTION

Next, consider S1(a)(b) switched to the alternative position, for v.h.f. reception. The signal from the telescopic aerial is applied to TR1 through the isolating capacitor C1. TR1 functions as an aperiodic r.f. amplifier in the common base mode, the input signal appearing across R2 plus L3 and R3. Output is developed across R5 and is fed to the tuned circuit given by L4 and VC2. L4 is permeability tuned, a piece of ferrite rod being inserted into it or removed from it by means of a mechanical coupling with VC1. On v.h.f. VC1 acts as a mechanical device only, apart from the fact that its capacitance allows v.h.f. current to pass through it. Note that the 'dead' end of L4 and VC2 is now at earth

potential, so far as radio frequencies are concerned, due to the setting of S1(a).

When receiving v.h.f., TR2 is kept in a gently oscillating condition, and this local oscillation locks with the incoming frequency modulated signal. The presence of D2 in the emitter circuit allows synchronous detection to take place. It will be seen that D1 and D2 are still in series. The circuit would not function at v.h.f. with the OA10, D1, alone, but the presence of this diode in series with D2 does not upset the functioning of the latter, and this fact assists in keeping the band-switching arrangements simple. Oscillation takes place in the Colpitts mode, with C11 providing the necessary tap into the tuned circuit.

The signal audio frequencies produced pass through the circuit in the same manner as when this is switched to medium waves.

Before turning to constructional matters, it should be noted that the two

ferrite rods can be obtained from Amatronics Ltd., 396 Selsdon Road, South Croydon, Surrey, CR2 0DE. Amatronics Ltd., also supply the 'silicon bias diodes' required for D3, D4 and D5. The telescopic aerial type TA10 is available from Henry's Radio under this type number and from other stockists of Eagle parts.

CONSTRUCTION

The rest of this article and that to be published next month must be read before construction commences. Also, Figs. 2 and 3 must be studied in conjunction with each other. Positioning of components in Fig. 2 can be adjudged with the aid of the parts themselves, and this is one reason why it is necessary to know all details about these before starting construction work.

Cut out a square of $\frac{1}{4}$ in. plywood, to measure 8 in. by 8 in. Cut out a hole, slightly in excess of $\frac{3}{4}$ in. diameter with its centre $1\frac{1}{4}$ in. from the left-hand side and $1\frac{3}{8}$ in. from the top. This hole is for the flange of the epicyclic tuning drive for VC1, and the last two dimensions appear in Fig. 2. Remove an octagonal piece of plywood, as shown, for the speaker aperture. Its exact dimensions can be taken from the actual speaker to be used. Cut out two small rectangular holes to take the bodies of the two slide switches. These bodies pass through the plywood, and the securing screws for the switches are on the other side of the panel. The switches should be positioned so as to leave room for the potentiometer, VR2, between them. The body of VR2 should not have a diameter greater than $1\frac{1}{4}$ in., and a suitable type would be the R.S. Components moulded track potentiometer. Cut out a hole for the potentiometer bush.

Next cut out two pieces of plywood, each measuring 8 in. by $1\frac{1}{4}$ in. (As explained at the end of the article, the $1\frac{1}{4}$ in. dimension may need to be modified to suit the particular speaker used.) One of these pieces forms the top of the receiver and the other the base. Drill

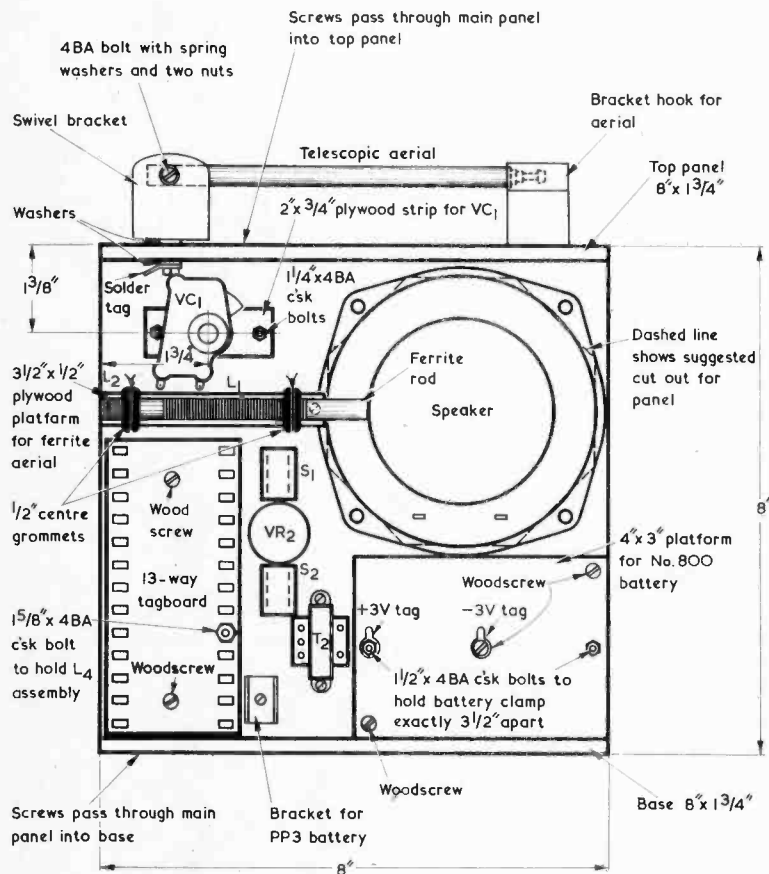
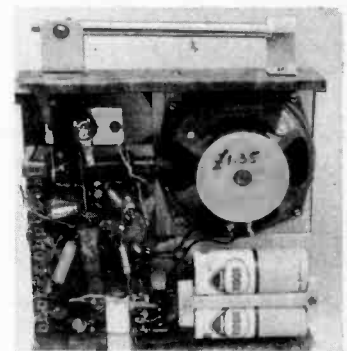


Fig. 2. Layout of the components behind the front panel before wiring



The rear of the receiver chassis

COMPONENTS

Resistors

(All fixed values $\frac{1}{4}$ watt 5%)

R1	10k Ω
R2	100 Ω
R3	2.7k Ω
R4	3.9k Ω
R5	1k Ω
R6	2.7k Ω
R7	150k Ω
R8	100 Ω
R9	33k Ω
R10	10k Ω
R11	1k Ω
R12	220k Ω
R13	1k Ω
VR1	2.5k Ω or 5k Ω , miniature skeleton pre-set
VR2	50k Ω potentiometer, linear, moulded track (see text)
VR3	1k Ω or 1.5k Ω , miniature skeleton pre-set

Capacitors

C1	3.3pF silvered mica or ceramic
C2	1,000pF silvered mica or ceramic
C3	125 μ F electrolytic, 2.5 V.Wkg.
C4	0.1 μ F polyester
C5	1,000pF silvered mica or ceramic
C6	1pF silvered mica or ceramic
C7	0.01 μ F polyester
C8	330pF silvered mica or ceramic
C9	125 μ F electrolytic, 10 V.Wkg.
C10	1,000pF silvered mica or ceramic
C11	6.8pF silvered mica or ceramic
C12	2 μ F electrolytic, 10 V.Wkg.
C13	1,000pF silvered mica or ceramic
C14	0.1 μ F polyester
C15	1,000pF silvered mica or ceramic
C16	800 μ F electrolytic, 4 V.Wkg.
C17	0.01 μ F polyester
VC1	100pF variable, solid dielectric, 'Dilecon' (Jackson Bros.)
VC2	12pF trimmer, Mullard tubular (Cat. No. VC88C, Home Radio)

Inductors

L1, L2	See text
L3	1.5mH choke, type CH5 (Repanco)
L4	See text
T1	Microphone transformer type TT53 (Repanco)
T2	Output transformer type MOP (Henry's Radio)

Semiconductors

TR1	BF167
TR2	BF167
TR3	2N4289
TR4	BFY51
D1	0A10
D2	1GP5 (R.S. Components) or OA80, OA81, OA90 or OA91 (Mullard)
D3, D4, D5	Silicon bias diodes (see text)

Switches

S1	d.p.d.t. slide switch
S2	d.p.d.t. slide switch

Speaker

LS1	3 Ω speaker, 5 in. round
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Aerial

	Telescopic aerial type TA10 (Eagle)
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Batteries

	9-volt battery type PP3 (Ever Ready)
	3-volt battery type 800 (Ever Ready)

Miscellaneous

	Slow motion drive type 4511/F (Jackson Bros.)
	18-way 'Standard' tagboard (R.S. Components)
	6-way 'Miniature' tagboard (R.S. Components)
	4 in. by $\frac{3}{8}$ in. ferrite rod (see text)
	1 $\frac{1}{2}$ in. by $\frac{3}{8}$ in. ferrite rod (see text)
	2 knobs
	PP3 battery connectors
	Plywood, Fablon or Contact, etc.

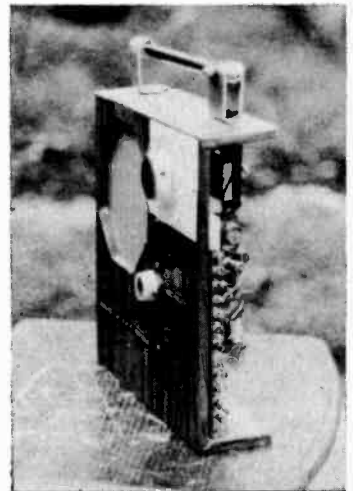
two 4BA clear holes in the piece which will be used as the top, the holes being 1 $\frac{1}{4}$ in. from the ends of the piece and situated midway between the long sides. These holes will take the bolts holding the swivel bracket and hook bracket for the telescopic aerial which, when not in use, becomes a carrying handle. Screw and glue the top and bottom pieces to the main 8 in. by 8 in. panel. Small wood screws should pass through the main panel into the edges of the top and bottom pieces.

Cut a rectangle of plywood 2 in. by $\frac{3}{8}$ in., and drill a $\frac{3}{8}$ in. hole in its exact centre. Also, drill two 4BA clear holes near the $\frac{3}{8}$ in. ends. VC1 will, later, be mounted on this plywood strip, as indicated in Fig. 2. Using the strip as a template, and with the centre of the $\frac{3}{8}$ in. hole over the centre of the $\frac{3}{8}$ in. hole in the main panel, mark out two corresponding 4BA clear holes in the main panel and then drill these out. Fit two 1 $\frac{1}{4}$ in. countersunk 4BA bolts through the holes in the main panel, with the ends pointing towards the reader (as in the view of Fig. 2). Fit a plain washer over each bolt and then

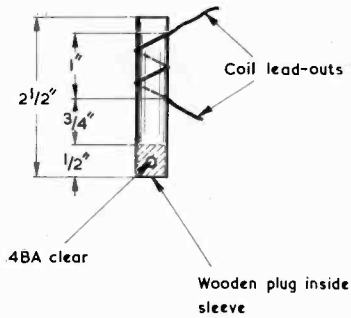
a nut, and tighten these up.

Next, temporarily mount the epicyclic drive on the inside of the main panel with its flange in the $\frac{3}{8}$ in. hole, and mark out a hole for a bolt to secure its anchor lug, (i.e. the lug which holds the drive body stationary when the drive is operated). Remove the drive and drill out this hole 6BA clear. Fit a short countersunk 6BA bolt through the main panel with its end towards the reader (as in the view of Fig. 2). Cover the outside of the wooden chassis which has now been made with Contact or Fablon.

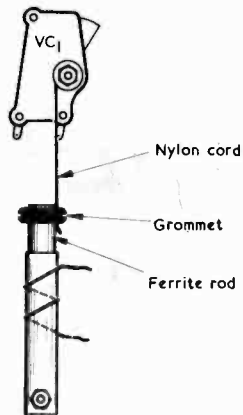
Next, fit the epicyclic drive permanently to the main panel, securing its anchor lug on the 6BA bolt just fitted by passing a plain washer and nut over the bolt. Cut down the spindle of VC1 so that it has a length of $\frac{1}{4}$ in., and fit VC1 to the $\frac{3}{8}$ in. hole in the 2 in. by $\frac{3}{8}$ in. strip of plywood. Put a nut on each of the 1 $\frac{1}{4}$ in. 4BA bolts and slip the 4BA clear holes in the 2 in. by $\frac{3}{8}$ in. strip over these bolts. Adjust the two nuts so that the spindle of VC1 fits correctly into the epicyclic drive, add two further nuts on the outside of the



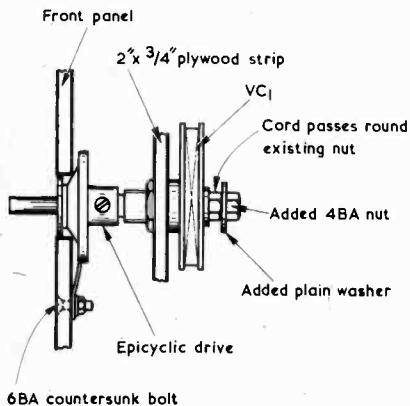
Side view of the chassis



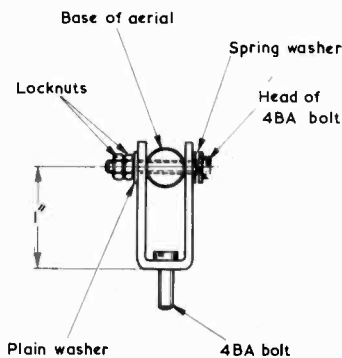
(a)



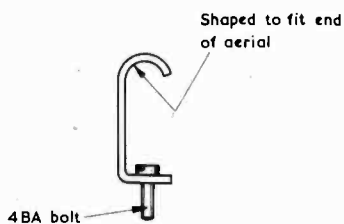
(b)



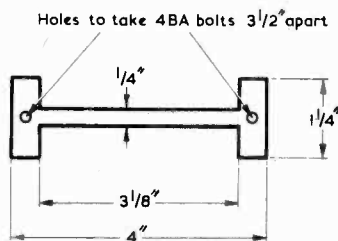
(c)



(d)



(e)



(f)

strip and tighten up. Tighten also the grub-screws in the epicyclic drive. The final arrangement is as in Fig. 3(c), (which omits the 4BA bolts) and there should now be a smooth slow-motion drive to VC1. To prevent possible damage during construction, adjust VC1 so that its vanes are fully enmeshed.

Cut out a strip of plywood measuring $3\frac{1}{2}$ by $\frac{1}{2}$ in. and screw it to the main panel in the position shown in Fig. 2, where it appears under the ferrite rod. Two pieces of nylon cord should be trapped between the strip and the main panel in positions where they can be later tied around the rod to hold it in position. This is achieved by passing grommets over the rod, the nylon cord lying in the grommet grooves. Take a piece of Fablon or Contact 4 in. long and $3\frac{1}{2}$ in. wide. Leave all the backing paper on except for a $\frac{1}{2}$ in. strip along one $3\frac{1}{2}$ in. end. Roll this into a sleeve around the 4 in. ferrite rod so that the uncovered edge is rolled on last, the sleeve then being secured by the adhesive on that edge. It should be possible for the sleeve to move along the rod in case this proves necessary later to give correct coverage of the medium wave band. Starting near one end of the sleeve, wind on 15 turns of 28 s.w.g. enamelled copper wire with each turn touching the next, and secure with tape. This is L2. Leave a space of $\frac{1}{2}$ in. and wind on 130 turns of the same wire, again with each turn touching the next, then secure with tape. This is L1. Pass two grommets with $\frac{1}{2}$ in. centre holes over the rod assembly and secure in place with the nylon cords as indicated in Fig. 2. It is in order for one or both of the grommets to be situated over the windings.

Cut out a rectangle of plywood measuring 4 in. by 3 in. This is the platform for the No. 800 battery. Fit two $1\frac{1}{2}$ in. 4BA countersunk bolts as shown in Fig. 2 and a round headed $\frac{1}{4}$ in. brass wood screw in the centre. Note that this screw and one of the 4BA bolts are fitted with solder tags for connections. When the battery is fitted, its negative terminal strip will press against the wood screw and its positive terminal strip against the 4BA bolt. Screw the 4 in. by 3 in. panel to the main panel. Cut out the section of plywood shown in Fig. 3(f). This is used to hold the No. 800 battery in position after it has been placed on the battery platform, and is secured by passing 4BA nuts over the ends of the $1\frac{1}{2}$ in. 4BA bolts fitted to that platform.

NEXT MONTH

Further constructional details will be given in Part 2, to be published next month. This will also give details of the v.h.f. coil, L4.

(To be concluded)

Fig. 3 (a). Details of coil L4
 (b). How the ferrite rod is moved in and out of L4
 (c). Adding the plain washer and extra 4BA nut to VC1 spindle
 (d). The swivel bracket for the telescopic aerial
 (e). The aerial hook. This should be shaped so that it holds the aerial parallel to the top panel of the receiver
 (f). The plywood piece which retains the 3 volt battery

EIGHT CHANNEL I.C. DECODER

by R. D. L. Mackie

Introducing COS/MOS logic to radio control systems

THIS ARTICLE DESCRIBES AN EIGHT CHANNEL integrated circuit decoder for digital proportional radio control which uses the latest technology to produce a small lightweight circuit consuming negligible power. The home builder now has the opportunity of employing a decoder which is significantly better in performance than most existing designs.

LOW POWER DIGITAL I.C.'s

Integrated circuits are becoming standard components of modern radio control systems. The packages used to perform logical operations have, however, usually been designed for high speed computers, and have certain characteristics which make them less than ideal for incorporation in radio control. To reach computer speeds (tens of MHz) current consumption has to be high. Noise immunity is relatively poor and, because switching times are so short, significant r.f. radiation is emitted. In short, these i.c.'s are meant to operate in a well controlled electrical environment – not normally found in models controlled by battery operated radio systems.

It is well known that field-effect transistors can be operated by extremely low currents, and that complementary types are available. It is now possible to fabricate i.c.'s containing complementary MOS field-effect transistors. R.C.A. in 1968 introduced COS/MOS (Complementary-Symmetry/Metal-Oxide-Semiconductor) i.c.'s and since then other manufacturers have brought out similar ranges.

COS/MOS type digital logic elements seem perfectly suited to model radio control applications because of their ultra low current consumption, moderate speed (few MHz), excellent noise immunity and operation from a single power supply of 3 to 15 volts. Many complex packages have already been produced, and prices are expected to tumble.

The circuit to be described provides from one to eight channels of proportional control when used in conjunction with a suitable transmitter, and should satisfy the needs of most modellers. It incorporates one i.c. and the current consumption of the complete circuit is only about 0.5mA, which is far lower than most decoders. The i.c. employed is the Motorola MC14015CL, and this is available in 1-off quantities or more from Jermyn Industries, Vestry Estate, Sevenoaks, Kent.

DIGITAL RADIO CONTROL

The servo position information in a modern proportional radio control link is usually carried via pulse width modulation; a series of such pulses (one for each servo) being transmitted several times per second. A typical receiver output for a four channel system is shown in Fig. 1(a). Notice the large time gap between the last pulse of one train and the first of the next. This is to allow the receiver to synchronise with the transmitter.

A vital link in the system is the decoder, which takes in the serial train of pulses from the receiver, separates them out and gives one to each servo in turn. In a typical decoder no great speed is required – pulses of about 1mS are common, though the electrical environment can be pretty hostile with battery volts dropping and servo motor noise everywhere. Performing this decoding function is, therefore, particularly suited to COS/MOS logic.

COMPONENTS

Resistors

(all 1/10 watt 10%)

R1	22k Ω
R2	220k Ω
R3	4.7k Ω
R4	270k Ω
R5	4.7k Ω

Capacitors

C1	0.22 μ F tantalum bead, 3 V.Wkg. or more
C2	1,000pF ceramic

Semiconductors

TR1	ZTX 500
TR2	ZTX 502
D1	OA91

Integrated Circuit

IC2	MC14015CL (Motorola)
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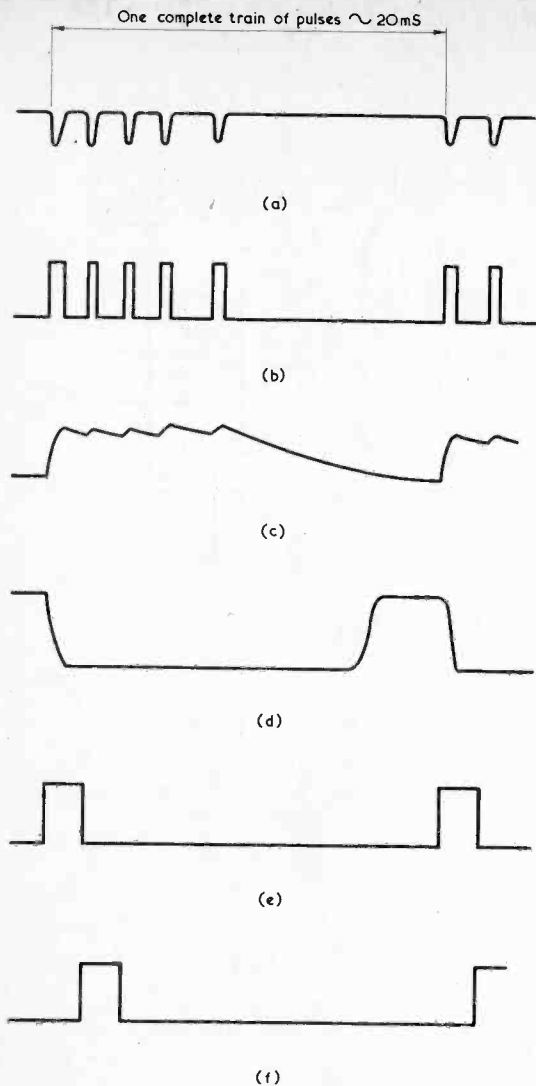


Fig. 1 (a). A typical receiver output
 (b). Clock pulses at the collector of TR1
 (c). Signal at the base of TR2
 (d). Data input (pin 7) to i.c.
 (e). Output 1 (pin 5)
 (f). Output 2 (pin 4)

CIRCUIT DESCRIPTION

The input must consist of negative-going capacitively coupled pulses, as supplied by many receivers, and the output consists of positive-going pulses capable of driving at least 200 microamps. The prototype was developed using a Classic Receiver and World Engines S4D servo amplifiers; the design being prompted by a strong desire to replace a decoder which used fragile silicon controlled switches. The MCI4015CL i.c. is a dual 4-stage shift register with parallel output capability, and is made by Motorola as one of their MCMOS range. The two halves are connected in series (pin 10 to pin 15) to produce an eight stage shift register. Data is clocked into the i.c. and through its eight stages on the positive-going edge of each clock pulse. That is to say, at the instant that the clock input (pins 2 and 9) goes from zero volts to 5 volts, whatever logic level existed at the data input (pin 7) appears now at output 1 (pin 5), and whatever level existed at output 1 now appears at output 2 (pin 4), and so on down the register. Hence the name 'shift register'.

Now, the principle of operation of the decoder is to present a high level voltage to the input of the shift register at the time of the first shifting pulse of a train, and a low level voltage for each of the remaining shift pulses. If this can be managed, then a high level voltage will appear at each of the outputs in turn; the duration of each output pulse being the time between the corresponding two shift pulses. These pulses then are the signals necessary to drive the servos.

The input pulses from the receiver are amplified and squared up by TR1. See the circuit diagram of Fig. 2. The resulting pulses (Fig. 1(b)) are the shifting pulses fed to the i.c. The remainder of the discrete components in the circuit integrate these pulses to produce the correct data input for the i.c. Just before the arrival of the first pulse of a batch, considerable time has elapsed since the last pulse of the previous batch, and so C1 has accumulated sufficient charge through R4 to cause TR2 to be turned on. The data input (pin 7) of the i.c. is thus held high. At the leading edge of the first pulse this high level is shifted into the first stage of the shift register,

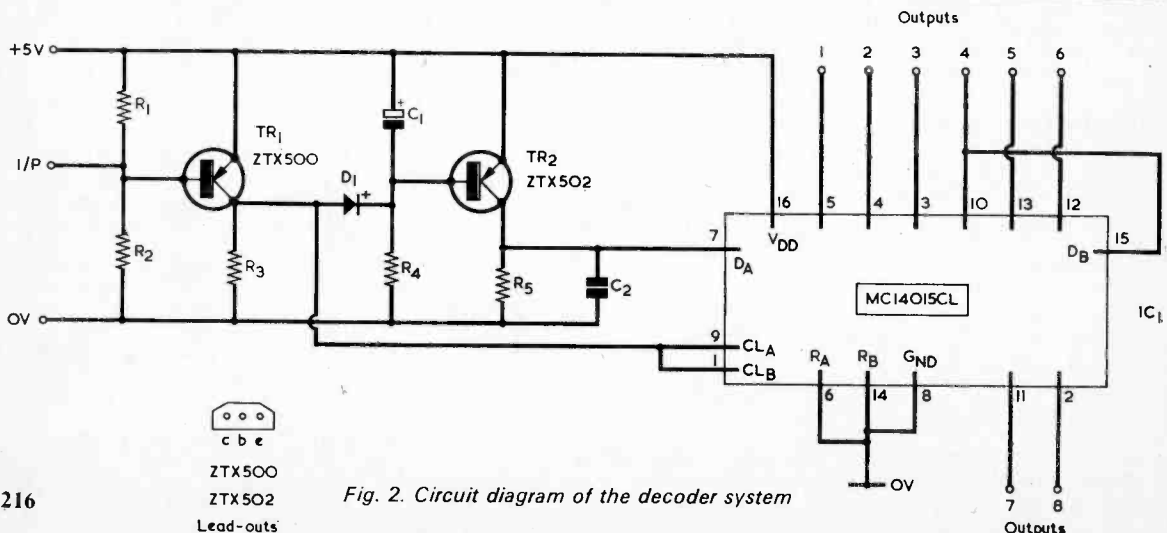


Fig. 2. Circuit diagram of the decoder system

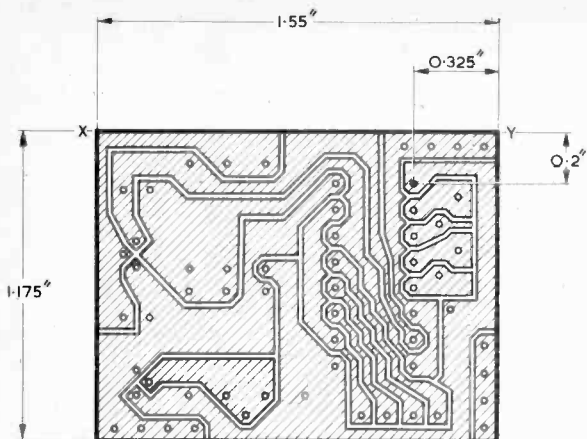


Fig. 3. A suitable printed circuit pattern, as seen from the copper side of the board

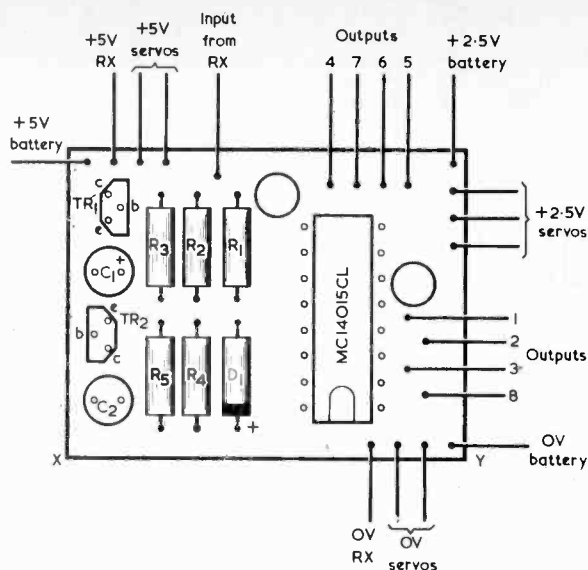


Fig. 4. The components side of the printed circuit board

making output 1 go high (see Fig. 1(e)). However, during this first pulse, TR1 is turned hard on and the diode, which is chosen to be a germanium type for low forward voltage, conducts and discharges C1. TR2 is therefore turned off, and the data input goes low. After the first pulse has passed, C1 again charges, but does not reach the turn-on voltage of TR2 before the second pulse arrives to cause discharge once again. This second pulse, therefore, clocks a low level into the i.c.'s first stage, and moves the high level state from stage 1 to stage 2 (see Fig. 1(f)). Further clock pulses merely shift this high level from stage to stage down the register. The data input goes high again only after a considerable gap in the input pulse stream, which is in fact provided by the transmitter before the next batch of pulses so that decoder and transmitter are synchronised. The function of C2 is to delay the fall of the high level of the data input until after the leading edge of the first clock pulse.

CONSTRUCTION

A printed circuit layout is shown in Fig. 3 and a component layout diagram in Fig. 4. The printed circuit board is too small, unfortunately, to be reproduced full size for tracing. Constructors making up a similar board should start by marking out the two rows of holes for the i.c. pins, these rows being spaced by 0.3 in. and the holes in each row spaced by 0.1 in. No special precautions have to be taken in the construction of this circuit. The letters 'X' and 'Y' in Figs. 3 and 4 identify the same side.

The i.c. has built-in anti-static protection circuitry, but it would still be wise to handle it as little as possible before it is soldered in. The board is small and so a miniature soldering iron is essential. The two large holes in the printed circuit are for the passage of input and output wires, if necessary. ■

BOOK REVIEW

THEORY AND PRACTICE OF MODEL RADIO CONTROL By Paul Newell, B.Sc.
136 pages, 150 x 207mm. (5½ x 8¼ in.) Published by Radio Control Publishing Co. Ltd. Price £2.25

Model radio control techniques have developed at an almost fantastic pace over the last twenty years, and control equipment now takes advantage of such advanced components as digital computer integrated circuits. A mental effort is needed to visualise the earlier pioneering days, in which transistors were unheard of and typical receivers were 2-valve superregenerative types, complete with filament and h.t. batteries.

One of the most important changes in the model control scene was brought about by the gradual introduction of proportional control. This is a sophisticated method of control and is not readily comprehended by the newcomer to the hobby. The book under review sets out to overcome this lack of understanding and may well be the first single volume to cover all aspects of proportional equipment design.

After a short chapter on the earlier days of radio control the book describes the nature of proportional, then proceeds to discuss transmission methods, digital and analogue techniques, components, digital transmitters, digital receivers, digital decoders, digital servo amplifiers, battery chargers and fault finding. There are also several appendices describing the author's 'Microtrol' 5-channel system.

The book is profusely illustrated with photographs and diagrams, and offers an excellent source of enlightenment to the keen radio control enthusiast. If necessary it may be purchased direct from the publisher at 64 Wellington Road, Hampton Hill, Middlesex, for the cover price plus postage, which for U.K. readers is 13p.

UPDATING 70 CABLE TV SYSTEMS

Three thousand council homes in the London Borough of Hillingdon are having their cable television facilities upgraded to provide colour reception under a refurbishing contract worth nearly £40,000 awarded EMI by Hillingdon council. About 70 separate communal television aerial systems, serving mainly low-rise housing estates and multi-storey blocks of flats, are involved and these vary in size from one system linking six elderly people's flatlets to a network having over 350 subscribers.

The work is being carried out by EMI Service, a division of EMI Sound & Vision Equipment Ltd., which is based within the Borough of Hillingdon - at Hayes, Middlesex.



EMI Service will have six mobile installation teams working on the project. The photograph shows one of the teams about to start refurbishing work on a cable television system serving five buildings, containing 32 flats and maisonettes, in Waterloo Road, Uxbridge.

THE FUTURE OF 'OSCAR'

OSCAR 6 is beginning to show signs of "running down". Its nickel-cadmium batteries have been subjected to heavy usage and in spite of altering the operating schedule to give a shorter, more frequent charge-discharge cycle, this is beginning to tell on them. The operating schedule has been further modified so that only South to North passes are activated for QSO's. However, the planned one year lifetime for OSCAR 6 will certainly be achieved and may even be exceeded.

OSCAR 7, the next in the Amateur Radio Satellite series, is designed for a lifetime of three years. It is planned to have two translators, one with an input on 432 MHz and output on 2 metres and the other with an input on 2 metres and output on 10 metres. The first of these translators, has already been completed in Germany, having been designed and constructed by a team headed by Karl Meinzer, DJ4ZC. The frequency range is 432.125 to 432.175 MHz in, and 145.925 to 145.975 MHz out; with a beacon on 145.980 MHz.

The 2 to 10 metre unit is in process of construction by AMSAT in the USA. The exact input and output frequencies of this unit are still under consideration.

In view of the fact that a thousand or more users of OSCAR 6 have invested time and money in equipping their stations for the present Satellite, the policy for future satellite design is to bear this in mind, so that, as far as possible, existing equipment can be used subsequently for communication through future satellites.

It is hoped OSCAR 6 will continue in service, until the launch of OSCAR 7, which is planned for early next year.

TRAVELLING SCHOLARSHIP

The Institute of Electrical and Electronics Engineers, the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers are financing a travelling scholarship of £300 for visit(s) to foreign electrical or electronic research or manufacturing establishments by a postgraduate student.

The purpose is to promote an exchange of research and technological ideas and to foster a closer relationship between young engineers in different countries.

Candidates must submit a programme for their visit(s) by 31st December 1973, and the award will be made to the candidate whose programme is judged most likely to promote the objects of the scholarship.

Entrants must be Student or Graduate Members of one of the institutions.

Further information and entry forms from Prof. C. W. Turner, Dept. of Electrical & Electronic Engineering, King's College, Strand, London. WC2R 2LS.

RADIO & ELECTRONICS CONSTRUCTOR

COMMENT

RANDOM NUMBER SELECTOR

A novel electronic equipment, available in kit or fully assembled form, has been introduced by Micro Electronics, 51 Mexfield Road, London SW15 2RG. Referred to as the 'Minicomp 100', it incorporates two Nixie display tubes, seven logic i.c.'s, three transistors and various other components, and it presents random numbers within a preselected range. Thus, it may be set up to produce random numbers up to 36 for roulette, up to 6 for dice, up to 57 for pools draw predictions and up to 99 for bingo and other number games.

The equipment is built into an attractive case measuring approximately 7 by 5 by 3 ins., and it is powered by 240 volts 50Hz or 110 volt 60Hz mains. In the kit form, assembly is eased by the provision of three printed circuit boards.

'Minicomp 100' is, in effect, a miniaturised ERNIE, and it should be of particular attraction for organisers of party games, fetes and bazaars, and for any other pursuit which involves a completely random selection of numbers.



B.A.E.C. EXHIBITION 1973

This year's Exhibition reflected the increased and more widely dispersed membership of the British Amateur Electronics Club.

There were many more exhibits from members, and an instance of the wider membership was the exhibit from the Guildford and District Group, a Coincidence Detector.

A pleasing result of the exhibition was a record sum of nearly £500 being raised for the benefit of the Cancer Research Campaign.

IN BRIEF

■ The Amateur Radio Mobile Society are establishing an annual award to perpetuate the memory of Maurice Margolis, G3NMR.

Maurice Margolis was a very enthusiastic and hard-working member of the society and for many years, together with his wife Sylvia, edited and produced the society's journal *Mobile News*.

■ INTER NAVEX - The International Audio-Visual Aids Conference and Exhibition 1973, attracted an attendance of more than 11,000 which is said to surpass the attendance at any similar exhibition anywhere in the world.

Next year the exhibition, INTER NAVEX 74, will be held from 16th to 19th July at Olympia.

■ Sinclair Radionics have invested in a Computer Automation Alpha 16 minicomputer to help them to prove the design of their next two pocket electronic calculators, one of which is expected to be launched early next year.

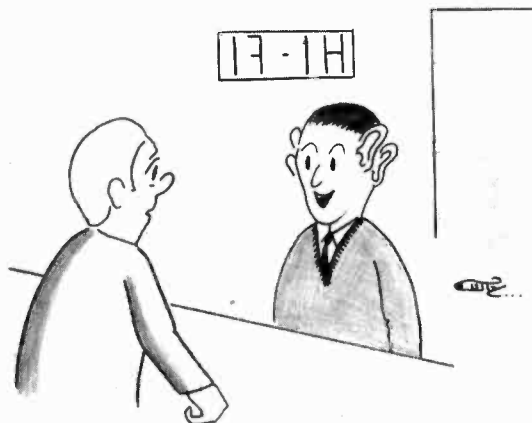
■ The Radio Society of Great Britain have stated that their accounts for the financial year ended 30th June 1973 are likely to show a surplus of £4,000 or more.

■ AMF Potter and Brumfield have now opened a new manufacturing facility at Skelmersdale, Lancashire. Occupying 6,000 sq. feet of floor space, this modern plant will considerably increase their manufacturing capacity for relays and associated products.

SINCLAIR INTRODUCE NEW AMPLIFIER

Project 80, claimed as the world's most advanced hi-fi modules, were introduced by Sinclair Radionics at the 1973 Audio Fair. This new range of modules, designed for the home-constructor, replaces the established Project 60 series.

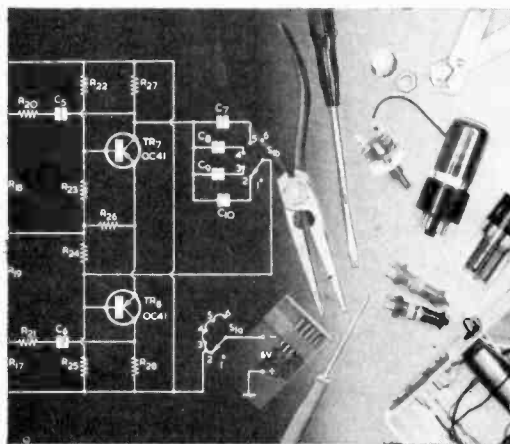
Comprising pre-amplifier and control unit, active filter unit, two power amplifiers, three alternative stabilized power supply units, FM tuner and stereo decoder the Project 80 features compact electronics to give an ultra-slim module profile 50mm high by 20mm deep which opens up a whole new range of installation possibilities. The units, which can be used individually or partially grouped to give flexibility, have a two year guarantee. Prices range from £11.95 for the pre-amplifier and control unit to £4.98 for the PZ5 power supply unit (exclusive of VAT).



"A pair of quadraphonic earphones please."

ISOLATED TRIAC CIRCUIT

by G. A. FRENCH



The triac offers many advantages so far as the switching of a.c. mains loads is concerned, and it lends itself very readily to applications in which an a.c. load can be turned on and off by a transistor control circuit. Several recent articles in the 'Suggested Circuit' series have described units capable of operating in this manner, these being 'Automatic Lamp Switch' (Suggested Circuit No. 271) and 'Triac Timer' (Suggested Circuit No. 274). These articles appeared in the June 1973 and September 1973 issues respectively. Basically similar methods of triac control have been described by other writers and have appeared in the technical press.

LACK OF ISOLATION

IN GENERAL, TRIAC CIRCUITS WITH transistor control have the basic form shown in Fig. 1. In this diagram, the a.c. mains is applied to the triac and the load (assumed here to be a lamp) in series. The a.c. mains is also applied to the transistor control section, which it powers by means of a step-down transformer and a rectifier circuit. When it is desired to have the triac conduct, a direct voltage of the order of 10 volts is applied via a conducting transistor in the control circuit to the gate and Main Terminal 1 of the triac, current being limited by a series resistor. The series resistor may, typically, have a value of 300Ω .

A disadvantage with the circuit of Fig. 1 is that, since the transistor control circuit output has to connect to the Main Terminal 1 of the triac, one of the control circuit supply rails

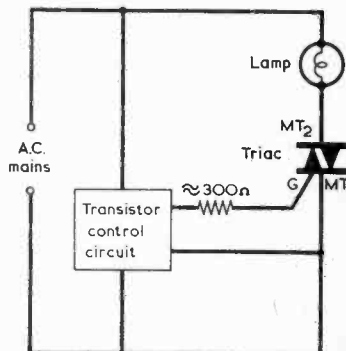
is coupled direct to one side of the a.c. mains. As a result, all the components in the control circuit are at, or close to, mains supply potential, and it is necessary to provide all consequent precautions against accidental shock.

This month's 'Suggested Circuit' illustrates a method of operating a triac which enables the transistor control circuit to be completely isolated from the mains supply, whereupon one of its supply rails may be earthed and the possibilities of shock are reduced. The present design is not primarily intended as a modification for the two previous 'Suggested Circuit' articles, but more as an approach which can be employed in the future. The circuit is based on the assumption that the control circuit causes an output transistor to become

fully conductive when it is desired that the triac be turned off, and this is not, of course, a difficult matter to arrange.

The operation of the circuit can best be understood by first examining the theoretical version shown in Fig. 2. Here, the a.c. mains is applied, as in Fig. 1, to the series combination of the triac and the load which, again, is assumed to be a lamp. The mains is also applied to the step-down transformer T1, which offers a secondary voltage of some 10 to 15 volts. This secondary voltage is rectified by diodes D1 to D4, the rectified negative voltage being common with the chassis on which the transistor control circuit components are mounted. The positive rectified voltage appears at the junction of D1 and D3 and, with respect to

Fig. 1. The essentials of a circuit in which a transistor control unit operates a triac



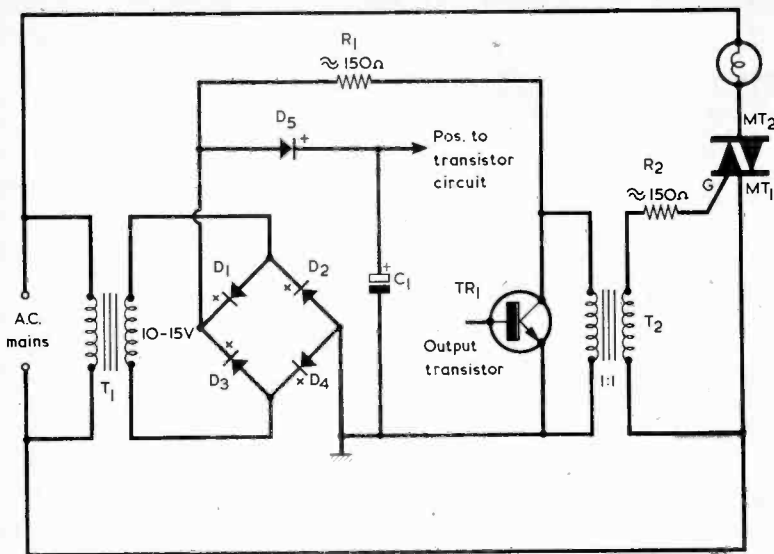


Fig. 2. A theoretical approach towards obtaining isolation of the transistor control circuit from the mains supply

on the primary would be similarly limited. In practice a peak voltage of around 1 volt or less could be expected. It would still be possible for TR1 to effectively short-circuit the half-cycles at T2 primary if it were turned hard on, but the drop in half-cycle voltage would only be from about 1 volt or less to the saturation voltage of the transistor. A much more dramatic voltage drop is given when R2 is included, as in the diagram. The voltage amplitude of the half-cycles at T2 primary then drops from around half the value they have at the junction of D1 and D3 to the saturation voltage of the transistor when the latter is turned on. This large change in voltage at T2 primary ensures much more reliable control of the triac.

It is also necessary for R1 to be in circuit, because it acts as a current limiter. If R1 were omitted and R2 increased to 300Ω, it would be necessary for TR1, when turning on, to directly short-circuit the half-cycles from the low impedance transformer and rectifier circuit, and this would clearly be an impossible task.

ISOLATING TRANSFORMERS

It can at once be seen that complete isolation is provided in Fig. 2 between the mains supply and the transistor control circuit. Supply coupling to the transistor circuit is by way of the isolating transformer T1, and output coupling to the gate and Main Terminal 1 of the triac is by way of isolating transformer T2.

In practice it is necessary for T2 to be a component having insulation between primary and secondary which is suitable for mains voltage. The voltages on the primary have relatively low peak values and the transformer needs only a small number of turns in its primary and secondary. Low impedance speaker isolating transformers with ratios of 1:1 and insulation suitable for mains voltage are available, and it is possible that one of these could be employed for T2. The writer has not checked operation with such a transformer, however, and cannot comment on the results which could be obtained. He was, in any case, able to make up a working version of Fig. 2 employing a normal mains transformer. This has a secondary voltage of 125-0-125 volts at 50mA, and is an R.S. Component 'Midget Mains 250 volt' transformer. The transformer also has a 6.3 volt heater winding, which is ignored here, and primary taps at 205, 225 and 245 volts. Despite the fact that the windings of this transformer are run at a much higher turns per volt figure than they are designed for, the transformer functions very well in the circuit. It is possible that other mains transformers with similar voltage ratings could be employed, provided they have approximately the same winding resistances.

The practical triac control circuit made up by the writer is shown in

chassis, consists of a series of positive half-cycles, as illustrated in Fig. 3. These half-cycles are applied via D5 to the reservoir capacitor C1, which charges to nearly their peak value. The smoothed direct voltage across C1 is employed to power the transistor control circuit.

The presence of D5 ensures that current cannot flow back from C1 to the junction of D1 and D3 when the voltage at this junction is lower than that at the positive terminal of C1. In consequence, the circuit is capable of producing both a smoothed direct voltage and a series of positive half-cycles.

The positive half-cycles are fed via R1 to the primary of transformer T2. It is assumed in Fig. 2 that this is a 'perfect' component having zero resistance in its windings. An alternating voltage at 100Hz is induced in its secondary winding and this is applied, by way of R2, to the gate and Main Terminal 1 of the triac. Since the alternating voltage in T2 secondary is in phase with the half-cycles in its primary and, therefore, with the half-cycles of the a.c. mains applied to the triac and lamp, the triac is capable of being triggered on over very nearly the whole period of each half-cycle,

and the lamp is lit at full brilliance.

The output transistor, shown in Fig. 2 as TR1, couples to the transistor control circuit such that it is non-conductive when it is desired that the triac be turned on. In these circumstances, the transistor has no effect on the triggering of the triac, and this functions in the manner which has just been described.

When it is desired to turn the triac off, the transistor control circuit causes TR1 to become fully conductive, whereupon it effectively short-circuits the half-cycles applied to the primary of T2, and the alternating voltage at T2 secondary is reduced to a negligibly low level. The triac does not then conduct and the lamp extinguishes.

Since T2 is a 'perfect' component, the 300Ω current limiting resistor of Fig. 1 can now appear as the two 150Ω resistors, R1 and R2. It is desirable to employ two resistors instead of one for the following reasons. If R1 were made 300Ω and the secondary of T2 were connected direct to the gate and Main Terminal 1 of the triac, the amplitude of the alternating voltage at the secondary would be limited to the maximum forward voltage between the gate and Main Terminal 1 of the triac. The amplitude of the half-cycles

Fig. 3. The voltage at the junction of D1 and D3 consists of a series of positive half-cycles



Fig. 4. T1, here, is a filament transformer offering 12.6 volts, this being given actually by two 6.3 volt windings in series. It is necessary to use a filament transformer, or a transformer having a secondary current rating of 0.5A or more, because quite high peak currents can flow in the series resistor R1, and it is desirable to have good supply voltage regulation. Resistor R1 is now reduced to 68Ω and R2 is deleted as a physical resistor. It is found that the 0 to 245 volt winding of the transformer employed for T2 has a resistance of 40Ω and that half the 125-0-125 volt winding has a resistance of 150Ω. These resistances may be

gives reliable results in combination with these winding resistances, and the total effective resistance is of a comparable order with the 300Ω previously mentioned.

The transformer is connected such that one 0-125 volt winding functions as the primary and the 0-245 volt winding functions as the secondary. This gives a step-up in voltage of about 1:2, a factor which improves triac operation.

The circuit worked with complete reliability, the triac turning on when the base of TR1 was unbiased, and turning off when TR1 base was biased by a forward current of around 10mA.

ally, that the triac can be turned on harder if the leads to the 0-245 volt winding are transposed. Constructors should try the effect of transposing these connections before considering the assembly complete.

It can be assumed that, if TR1 is suddenly made non-conducting in order to turn the triac on, ringing voltages will appear in the relatively high inductance windings of T2. Such ringing voltages do appear, but they are heavily damped by the forward triac gate impedance across the 0-245 volt winding and by the fact that any positive excursion of the upper end of the 0-125 volt winding is limited to slightly more than the positive voltage on C1 by R1 and diode D5. In practice, the ringing voltage exists for a very short period immediately after TR1 turns off, and this causes a small burst of minor interference to be heard in a radio receiver which is switched to long waves and held near the triac wiring. After this, the triac settles down to normal working and creates no interference. There is no noticeable flickering in the bulb due to the ringing. Incidentally, this last point demonstrates that a portable transistor radio can be quite a useful item of test equipment when checking experimental triac circuits!

The triac employed in the practical circuit is the R.C.A. 40430. It can be mounted on a small flat heat sink about 1½ in. square. The five diodes can all be small silicon types, such as the 1N4002 specified in the diagram. The controlled lamp was rated at 100 watts.

The final component to discuss is transistor TR1. When this is conducting, it has to pass the peak currents of the positive half-cycles from the junction of D1 and D3. Allowing for forward voltage drop in two silicon rectifiers, these pulses have a peak voltage of about 16.5 volts, whereupon the peak current is limited by R1 to approximately 240mA. The peak power in TR1 is given when half the supply voltage is dropped across it. In a correct design, TR1 should be taken rapidly through the half-voltage point both on turning off and turning on, but it is useful to ascertain the half-voltage dissipation even if only to guard against a fault condition which would cause such a voltage to be present. Allowing for silicon rectifier voltage drop, the r.m.s. voltage at the junction of D1 and D3 is about 11.4 volts, whereupon the half-voltage dissipation becomes the square of 5.7 divided by 68 (the resistance in ohms of R1, whose dissipation will be the same as that in the transistor). The resultant figure is 480mW. The peak current of 240mA prohibits the use of small transistors of the BC107 class, and the author employed a power transistor type BD124 for checking the circuit. The low dissipation does not necessitate this being mounted on a heat sink.

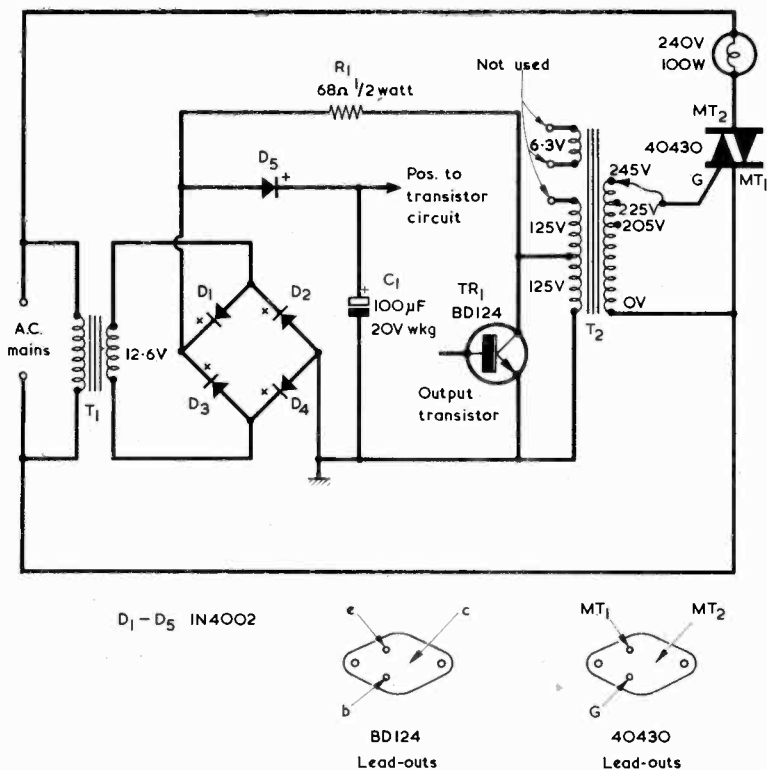


Fig. 4. A practical working triac control circuit with complete isolation from the mains

depicted as physical resistors of the same value in series with the windings, and they consequently appear between the switching transistor, T1, and the Main Terminal 1 and gate of the triac. In practice, the value shown for R1

When the triac was turned on it was effectively conductive over virtually the complete half-cycle periods, and short-circuiting the Main Terminals 1 and 2 caused no noticeable increase in lamp brightness. It may be found, incident-



Q S X

By

FRANK A. BALDWIN

(All Times GMT)

The material published in this article on alternate months is mainly intended for the more advanced broadcast band SWL but not necessarily for the 'top flight echelon' which exists both in this country and abroad – they require no assistance from me in the unearthing of their Dx. Elsewhere in this issue *SHORT WAVE NEWS* caters for the large majority of SWL's who no doubt also find something of interest to them on this page.

What have we to say this month? Well, prior to early September, when the USSR station in conformity with the winter schedule commenced operations on **4920**, we logged VLM4 Brisbane on the channel at 2000, at which time full identification, good morning greetings and a news-cast could be heard.

During the summer months, Brisbane can be almost a nightly visitor to the shack and, when this is so, try a quick visit to **4890** in the hope of logging Port Moresby in Papua (but see below). Should you be fortunate in logging the foregoing, the three card trick (if you QSL) would be to fine up the dial on **3925** in the hope that VLK3 Port Moresby would come up trumps. Impossible? Well, we try from time to time but so far the deal is against us. Recently however Dame Fortune smiled on us to the extent that we did hear a mere whisper of the news in English from VLK3 at 2003, the weak signal fading completely by 2010. VLM4 on **4920**, although scheduled to open at 2000, does in fact open some ten minutes or so earlier and often features military marches or light music until the station announcements at 2000.

What are the snags to the above apart from the prevailing conditions? In practice it will be found that the **3925** channel is surrounded, and often occupied, by a veritable sea of QRM. A contiguous 'open' carrier LF and a CW transmission HF of channel virtually stipulate that the receiver must be operated in its most selective mode, the hope remaining that the small gap between the QRM is clear.

The **4890** channel of VLT4/K4 Port Moresby has, for the past three months or so, presented an additional snag to the Dxer over and above those already apparent (Dakar etc.) but one which has some recompense in that Radio Bangladesh from Dacca is active on the frequency. Positive identification of the latter can be made at 2059 with the announcement in English 'This is the Overseas Service of Radio Bangladesh', followed by the news, usually until around 2107 at which time there is a talk about some aspect of Bangladesh affairs.

During this month (November) the short path signal route is almost, but not quite, in total darkness from Port Moresby to the U.K. at 2000, but with the USSR station on **4920**, we still have no chance of a running flush of success.

● SINGAPORE

From Papua, across Celebes, Borneo and the South China Sea lies Singapore at the head of the Straights of Malacca. Singapore, on the LF bands, can be heard on **5052** (subject to variation at times) with its English Service normally scheduled from 2230 to 1630 although we recently heard them at 2219, probably on extended schedule for some special reason.

Alternatively, Singapore can be logged on **5010**. We heard them at 2201 with a programme of light orchestral music after Garoua had closed with the Cameroon National Anthem at 2200.

● PAKISTAN

A much nearer proposition for the Dxer on the LF bands is Radio Pakistan on **4815** at 1800 with a newscast in English until around 1812 when station identification is made and sign-off with the National Anthem. On **4875** however (same times and details) sign-off does not include the National Anthem, at least on the occasions we have heard them.

● INDIA

AIR Delhi on the LF bands can be found on **3905** and has been heard here in the U.K. around 1820 by the writer recently when a programme of

Indian songs and music was logged.

● MALAYSIA

Kajang operates on **4845** where they can be heard opening with the service in Tamil at 2200, the difficulty here being the teletype transmitter sometimes occupying the same channel at the same time.

● CHINA

Once termed the Sleeping Giant, China, in the form of Radio Peking, can often be heard on **4905** in the evenings, being last logged here at 2149 with a talk in Chinese.

Several regional stations can also be heard but I should warn that the exact locations of these are somewhat uncertain, those quoted here being as listed. There is for instance Lanchow on **4865** which we have heard several times from 2100 onwards, or Foochow on **4975** at 2134 with YL singing and the very appealing Chinese music. The latter of these two stations is the most difficult to receive and conditions for Far East reception must be good before any hope of success.

Turning nearer home we have –

● AFRICA

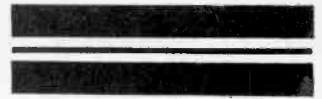
An interesting exercise one evening this month would be for the reader to tune to **3970** for Radio Buea, Cameroon. We have logged them many times from early June when, presumably, they commenced a service in English from 2030 to 2200. Usually they are in the clear (more or less) from around 2130 and often present country and western records in the programme format. The news is at 2145 read by male announcer whilst, at 2200, identification and closing announcements are by the female of the species, National Anthem and carrier off being at 2202. One of the most interesting of the African stations and well worth listening for.

In the Congo, Point Noire is a regional station relaying Brazzaville (according to the schedule) between 0500 and 2000 in French and various local languages. Not an easy one to log by any means on the regular **4843** channel, it was something of a surprise to hear them in the clear from 2216 through to past 2230 with typical African chants, drums and with announcements in a vernacular, obviously (or is it?) on extended schedule for some particular reason.

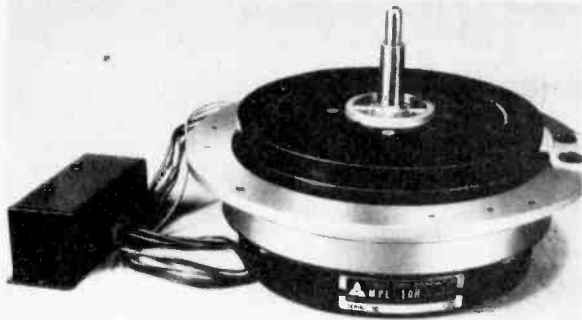
In Upper Volta, Ouagadougou (not surprisingly once quoted in a short wave listener publication as 'you know where') programmes mainly in French and can often be heard after 2030 on **4815** if the co-channel QRM allows.

SABC Johannesburg on **4875** is often worth a visit in the late evenings. Often heard with light orchestra music any time from 2030 onwards and for some odd reason, at least in the writer's experience, more often with piano solos. Perhaps it is the favourite instrument of the programme controller!

New Products



TURNTABLE MOTOR



The Micro-motors division of Matsushita Electric Industrial have perfected a new direct-drive motor for use in record reproducing equipment, the MPL 10H, now available from Symot Ltd., 17 Market Place, Henley-on-Thames, Oxon.

It has many advantages over conventional systems, the most important being a significant improvement in its wow and flutter specifications due to the elimination of all belts and pulleys and the slow rotational speed of the motor. The claimed figures, with suitable turntable fitted, are: wow and flutter - less than 0.03% WRMS; rumble - better than 60dB.

Other advantages are better speed stability through the use of a 15 volt stabilised DC power supply which isolates the motor from mains frequency and voltage fluctuations.

The motor employs electronic commutation thus dispensing with the problems of noise and wear associated with the brushes. The speed change from 45 to 33½ rpm is achieved through electronic switching, removing the need for mechanical linkages.

QUADRAPHONIC EARPHONES

Among the many new products in Eagle International's 1973 hi-fi catalogue are the FF.29 four-channel headphones. Four 50mm transducers are carefully angled in such a way that the effect achieved is similar to strategically-placed loudspeakers.

Using two coded jack plugs, the FF.29 is compatible with practically all quadraphonic systems. They are also ideally suited for use with Eagle's own AA.26 quadraphonic adaptor, which will convert any stereo installation into a 4-channel system with the addition of an extra pair of speakers.

Brief specification:

Frequency range:	20 to 20000Hz
Impedance:	8 ohms per channel
Matching impedance:	8 to 16 ohms
Controls:	Stereo/4-channel switch
Rec retail price:	£16.80 (excl. VAT)



INSTRUMENT CASES

Daturr Ltd. have introduced a new approach to the design of 19" instrument cases. Instead of having conventionally removable front and rear panels, the Daturr cases have fixed front and rear panels with the top, bottom and side panels detachable. The front and rear panels are made from 3mm aluminium and are joined by heavy aluminium extruded depth sections. Daturr claims that this form of construction gives a very strong and rigid case but also allows easy access to all parts of the case for construction and servicing.

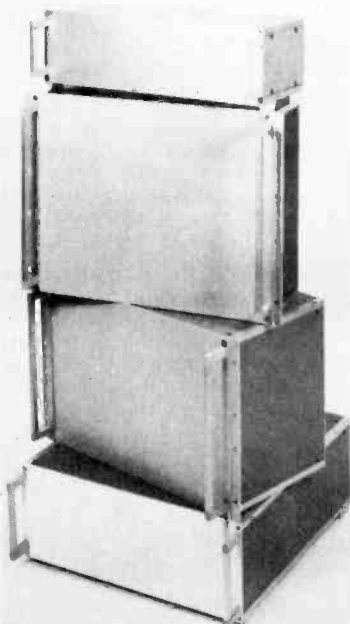
The steel side, top and bottom panels are double folded to make a stiff panel which is claimed to eliminate rattles, bowing and the flimsy appearance of many standard instrument cases. Elegant handles are fitted as standard and moulded feet are supplied with bench top cases.

There are four depths and seven front panel heights making 28 sizes of case in either bench top, 19" rack mounting or, if panels are not needed, open chassis configuration. Mounting rails and mounting chassis are available as standard and are attachable to ready drilled fixing holes.

The standard finish is Daturr blue textured acrylic stove enamel, with the extrusions anodised. Front and rear panels are left bare for punching and engraving.

Prices range from £12.00 to £24.00 for single items according to size.

For further information contact Daturr Ltd., Market Road, Richmond, Surrey.



'NOTES FOR NEWCOMERS'

By P. T. Jenkins

A quick look at some of the abbreviations which tend to confuse the beginner.

THE NEWCOMER TO ELECTRONICS HAS TO OVERCOME several hurdles before he can fully come to grips with the subject, and not least of these is the proliferation of abbreviations which are currently in use. These abbreviations can be very disconcerting to the beginner who encounters them for the first time and who does not have anyone available to explain what they mean. A mildly complicating factor is that, so far as the home-constructor world is concerned, there are one or two non-engineering terms and abbreviations which have, like Topsy, 'just grown' with the years.

So let's take a look at the abbreviations which are most frequently encountered in our hobby.

DIRECT AND ALTERNATING CURRENT

We can start right at the beginning with d.c., or direct current, which is the sort of current you get from a battery. Alternating current, or a.c., is the type of current you get from your electric mains supply, and it differs from d.c. because its polarity changes continually so that one terminal is first positive, then negative and then positive again. There are some further allied abbreviations which you'll encounter less frequently. These are d.v., for direct voltage, and a.v., for alternating voltage. The force which causes a current to flow in a circuit is the electromotive force, or e.m.f., and this is measured in volts. The existence of this term explains why voltage is often expressed in formulae by the letter E. We often, rather loosely, use the term 'voltage' instead of e.m.f. Potential difference, or p.d., is expressed in volts and defines the difference in potential between two points. In Fig. 1 we have a 3 volt battery and a 9 volt battery, both of which have their negative terminals connected to a common line. The p.d. between their positive terminals is 6 volts. Similarly, the p.d. between the positive terminal of the 3 volt battery and the common line is 3 volts.

When we turn to alternating currents and voltages we enter a very rich field so far as abbreviations are concerned. This is because all the signals encountered in radio, from those picked up by the aerial to those which actuate the loudspeaker, are alternating in character.

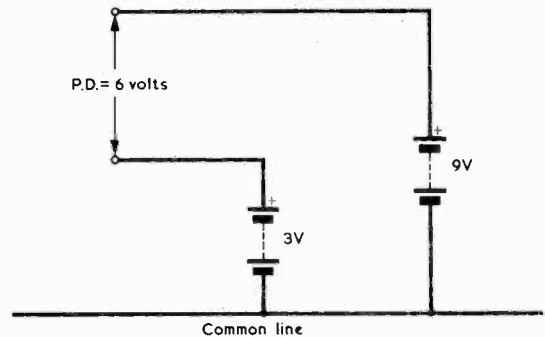


Fig. 1. An example illustrating the concept of potential difference

The alternating mains supply voltage in the U.K. changes at one terminal from positive to negative then back to positive again 50 times a second. In consequence we may say that the supply has a frequency of 50 cycles per second, and this may be abbreviated to 50c/s. Somewhat tiresomely, however, it was decided in the U.K. and America some years ago to drop the term 'cycles per second' and to use the word 'Hertz', abbreviated to Hz, instead. A frequency of 1Hz is the same as a frequency of 1 cycle per second.

Alternating current frequencies which, when reproduced via a loudspeaker or similar device, can be heard by the ear are referred to as the audio frequency, or a.f., range. This range varies for different people because some can hear higher or lower frequencies than others, and it can be loosely defined as extending from about 50Hz to about 20kHz, or 20,000Hz. The radio frequency, or r.f., range encompasses all frequencies which can be emitted by a transmitter, and at present covers an exceptionally wide range, from lower than 10kHz to greater than 100,000MHz, or 100,000 millions of Hz. (At 1 million MHz we enter the region of infra-red rays!)

**TABLE
STANDARD FREQUENCY RANGES**

<i>Frequency Sub-division</i>	<i>Frequency Range</i>	<i>Corresponding Wavelengths</i>
Very low frequencies (v.l.f.)	below 30kHz	above 10,000 metres
Low Frequencies (l.f.)	30 to 300kHz	10,000 to 1,000 metres
Medium Frequencies (m.f.)	300 to 3,000kHz	1,000 to 100 metres
High frequencies (h.f.)	3 to 30MHz	100 to 10 metres
Very high frequencies (v.h.f.)	30 to 300MHz	10 to 1 metres
Ultra high frequencies (u.h.f.)	300 to 3,000MHz	10 to 1 dm.
Super high frequencies (s.h.f.)	3,000 to 30,000MHz	10 to 1 cm.
Extremely high frequencies (e.h.f.)	30,000 to 300,000MHz	10 to 1 mm.

So far as domestic radios are concerned we use the terms long waves, or l.w., medium waves, or m.w., and short waves, or s.w. These are, perhaps, rather old-fashioned because they refer to radio signals in terms of wavelength, a practice which was prevalent in the earlier days of radio. Nowadays, we refer in most instances to radio signals in terms of frequency, and the accompanying table shows the standard international nomenclature, with abbreviations, used for frequency subdivisions of transmitted radio signals. (As you can see, they had to scratch around for adjectives when the higher frequency bands were opened up!) The use of the series 3, 30, 300, etc., in the frequency column may appear a little odd until the corresponding wavelengths are examined. These run in a more rational series of decades of 10. (Radio signals travel at a velocity of 300 million metres per second. A 300MHz signal allows 300 million cycle 'crests' to pass a fixed point in one second, whereupon the spacing between successive 'crests', or the wavelength of the signal, is 1 metre. Using a similar explanation, it can be seen that a 30MHz signal has a wavelength of 10 metres, and so on.)

Transmitted sound entertainment signals are modulated with the a.f. programme material it is desired to broadcast. If the strength, or amplitude, of the r.f. signal is so modulated, the system becomes an amplitude modulation, or a.m., one. When it is the transmitted frequency that is modulated, we have a frequency modulation, or f.m., system. Simple morse transmission, in which the transmitter sends out an unmodulated signal when the morse key is pressed down, is known as c.w., for 'continuous wave'. This is a legacy from the very early days of radio when only morse was employed and where there were other, long since outmoded, methods of producing an r.f. signal.

In a simple t.r.f., or tuned radio frequency, receiver, the incoming r.f. signal passes through one or more tuned circuits to the detector, which extracts the a.f. modulation. In the more complicated superhet receiver the incoming signal is changed to another frequency, which is also in the r.f. range, before it is fed to the detector. The second frequency is the intermediate frequency, or i.f., and the tuned circuits which handle it are known as i.f. transformers, or i.f.t.'s.

Before World War II, a.f. signals were referred to as low frequency, or l.f., signals, and r.f. signals as high frequency, or h.f., signals. Although now out of date, this practice may still be encountered occasionally. Otherwise, 'l.f.' and 'h.f.' may be used as relative terms, and we can refer, correctly, to such things as the l.f. and h.f. ends of a band of frequencies. The abbreviations l.f. and h.f. can, also correctly, be employed when referring to the appropriate sub-divisions in the standard frequency range table.

Television gives us v.f., for video frequency. This applies to picture information signals. A minor head-scratcher amongst the frequency abbreviations is zero frequency, or z.f. This apparent impossibility may be encountered in the specification of an amplifier whose output is proportional to the input even when the latter is static. If the highest frequency the amplifier can handle is, say, 10kHz, it may be stated to have a range of 'z.f. to 10kHz'.

OTHER ABBREVIATIONS

In valve receivers and amplifiers, the anode supply voltage was referred to as the high tension, or h.t., voltage. The low tension, or l.t., voltage was that which supplied the valve filaments, and there was also a grid bias, or g.b., supply. Nowadays, with transistors, the collector supply voltage is referred to as VCC. Television receiver picture tubes require very high voltages of the order of 14,000 volts or more, and these are described as extra-high tension, or e.h.t., voltages.

Toggle switches have a number of abbreviations. Fig. 2. shows single pole single throw (s.p.s.t.), single pole double throw (s.p.d.t.), double pole single throw (d.p.s.t.) and double pole double throw (d.p.d.t.) switches. The term 'changeover' is often used instead of 'double throw'.

Textile coverings for coil winding wire are commonly abbreviated and, in home-constructor publications, we find s.c.c. (single cotton covered), d.c.c. (double cotton covered), s.s.c. (single silk covered) and d.s.c. (double silk covered). We are, here, living a little in the past because most modern textile covered wires are either s.r.c. (single rayon covered) or d.r.c. (double rayon

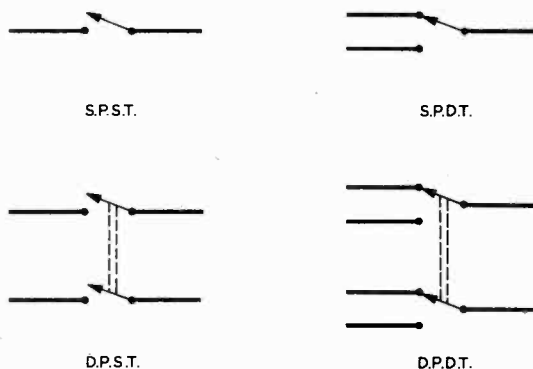


Fig. 2. Four different types of toggle switch. In the double pole types the two arms are ganged together

PHOTOGRAPHIC TIMER

THIS TIMER USES SOLID STATE CIRCUITRY THROUGHOUT, incorporating an i.c. operational amplifier, two transistors and a triac. The timing capacitor is a non-electrolytic type, giving a good resettable period as well as a high level of long term stability. A triac is used to control the enlarger lamp in preference to a relay, as it has the advantages of instantaneous operation, small size and no moving parts to wear out.

TIMING PERIOD

By adjusting the value of the timing capacitor, the timing range of the unit can be varied widely. The prototype uses a 0.22 μ F capacitor which gives a timing range of approximately 0 to 55 seconds. Some photographers may prefer a higher maximum time than this, and by changing the value of this component to 0.47 μ F a maximum timing period of 90 to 95 seconds is obtained.

An internal stabilized power supply unit is incorporated and this uses an inexpensive 6.3 volt heater transformer. The completed unit is housed in a home-built cabinet.

The circuit of the timer is given in Fig. 1, and that of the power supply unit in Fig. 2. The output from the supply unit is 12 volts regulated.

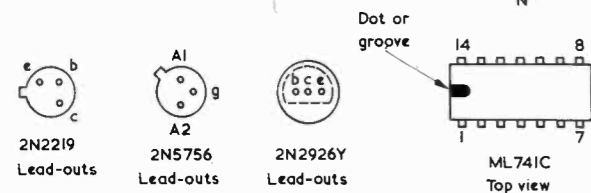
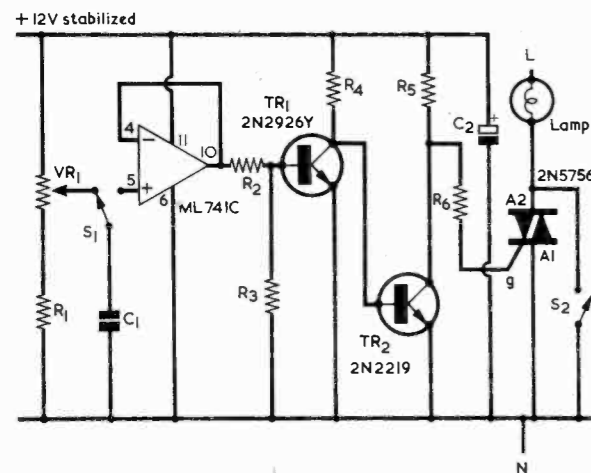
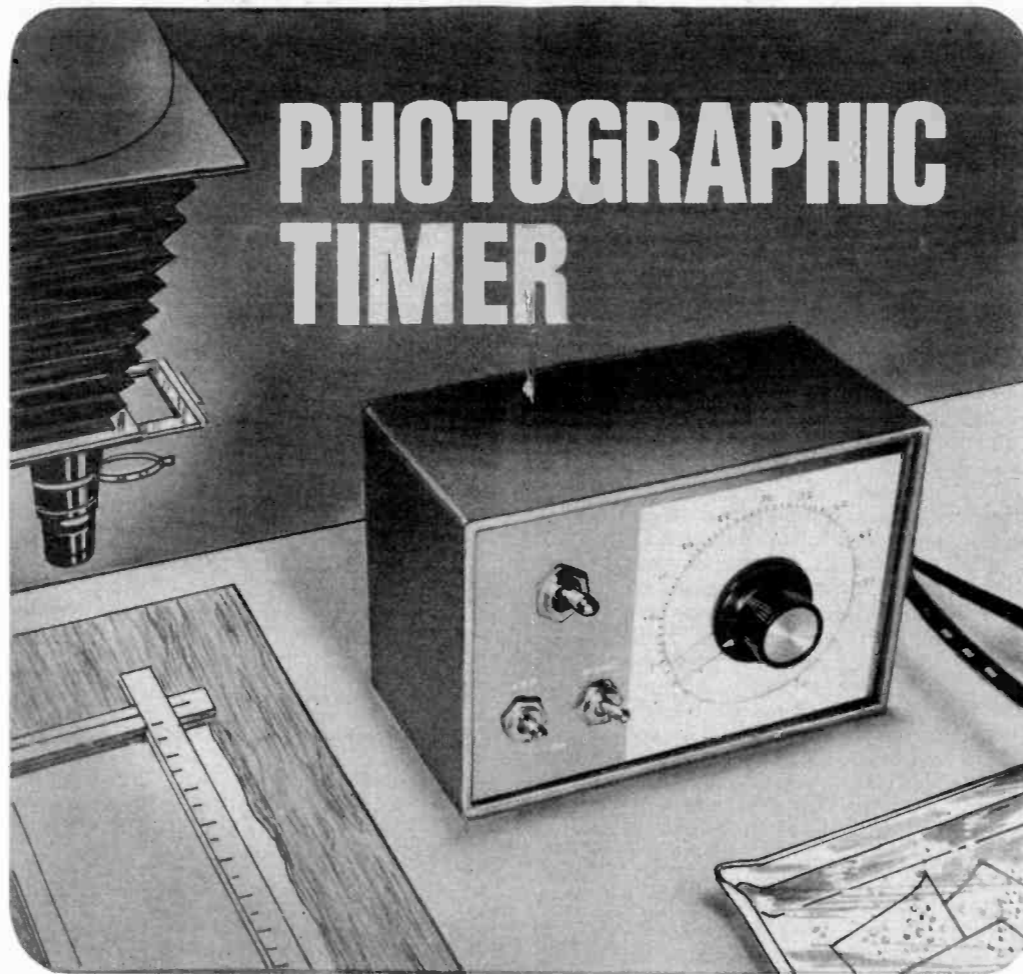


Fig. 1. The circuit of the timer section of the unit



Incorporating an integrated circuit, two transistors and a triac, the timer described here offers continuously variable timing periods for the control of an enlarger lamp.



Cover Feature

by R. A. Penfold

COMPONENTS

Resistors
(All fixed values $\frac{1}{4}$ watt 5% unless otherwise stated.)

R1	2.4k Ω
R2	4.3k Ω
R3	2.2k Ω
R4	2.2k Ω
R5	390 Ω
R6	220 Ω
R7	100 Ω $\frac{1}{4}$ watt
VR1	10k Ω potentiometer, linear, carbon or wire-wound

Capacitors

C1	0.22 μ F, plastic foil (see text)
C2	50 μ F electrolytic, 15 V. Wkg.
C3	125 μ F electrolytic, 10 V. Wkg.
C4	125 μ F electrolytic, 10 V. Wkg.

Transformer

T1	6.3V heater transformer (see text)
----	------------------------------------

Semiconductors

TR1	2926 Yellow
TR2	2N2219
D1, D2	Silicon rectifiers, 50 P.I.V., 250mA minimum
D3	Zener diode, 12 V 1W, 5%
Integrated circuit type ML741C or equivalent	
Triac type 2N5756 (R.C.A.)	

Switches

S1	s.p.d.t. toggle
S2	s.p.s.t. toggle
S3	d.p.s.t. toggle

Miscellaneous

- 1 knob and cursor
- Veroboard, 0.1in. matrix (see Fig. 4)
- 5-way tagstrip
- 3-way tagstrip
- Insulated tag
- Material for case and panel

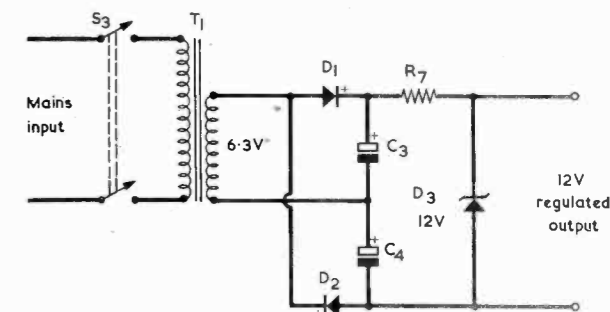
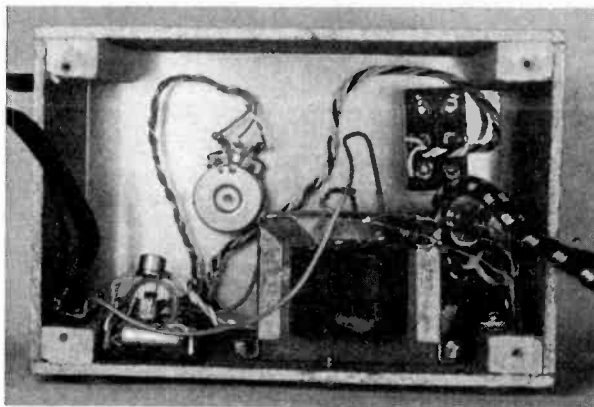


Fig. 2. The power supply circuit



The interior of the timer housing. The Veroboard assembly is to the left of the transformer

Referring to Fig. 1, when S1 is set to the left-hand position timing capacitor C1 will charge with negligible delay to the voltage given on the slider of VR1.

The ML741C integrated circuit is wired as a unity gain voltage follower. Being an operational amplifier it has two inputs, an inverting and a non-inverting one. In this configuration the inverting input is connected to the output, thus giving 100% negative feedback. This means that the circuit will have unity voltage gain, with a very high input impedance and a low output impedance.

TR1 and TR2 are connected as a trigger circuit. When there is a low voltage with respect to the negative line at TR1 base this transistor is turned off and TR2 is turned hard on. A very low voltage is therefore present at the gate of the triac and it is, in consequence, turned off. The enlarger lamp does not light.

If S1 is now set to the right-hand position the charged capacitor becomes connected across the input of the integrated circuit. The output of the i.c. swings to the same voltage as that across C1 and trips the trigger circuit. TR1 now turns on and TR2 turns off. The voltage at the gate of the triac swings to a high level, the device switches on and the enlarger lamp lights.

C1 next begins to discharge into the integrated circuit, but this has an input impedance of many megohms and C1 discharges very slowly. Eventually, the voltage across C1 and, therefore, that at the input of the trigger circuit falls to the level at which the trigger turns off, causing the triac to switch off and the enlarger lamp to extinguish.

The time taken for the timing capacitor to discharge to a point where the lamp turns off depends on the voltage set on the capacitor by VR1. If it has a voltage set on it which is only fractionally above that at which the trigger operates, the time will be only a fraction of a second. If, on the other hand, the capacitor is given the full supply voltage, nearly a minute will elapse before the end of the timing period. The length of the timing period is, in consequence, set up by VR1

To start the timing period again it is merely necessary to switch S1 back to the left-hand position, readjust the setting of VR1 if a different timing period is required, and then switch S1 back to the right-hand position.

Switch S2 turns the enlarger lamp on and off independently of the rest of the circuit, and enables the enlarger to be focused. C2 is the supply bypass capacitor and is an essential component. Without it there may be spurious flashes from the enlarger lamp. It is also possible for the input wiring to the integrated circuit to pick up mains hum when S1 is in the left-hand position, resulting in the lamp being lit at half-brilliance. This is due to positive half-cycles of the mains voltage coupling to the i.c. input, and will not be evident if mains wiring is kept well clear of the i.c. input and of the wiring to S1.

The enlarger lamp controlled by the prototype had a wattage of 75 watts. Circuit operation with more powerful lamps has not been checked.

POWER SUPPLY UNIT

The timer circuit could be battery operated but, since a mains supply is already present in the circuit it would seem more practical to use a mains supply unit. The circuit of the supply unit appears in Fig. 2. A stabilized supply must be used since fluctuations in the supply voltage would result in variations of the timing period.

T1 is a 6.3 volt heater transformer, the output from which is taken to the voltage doubling circuit given by D1, D2, C3 and C4. Examination of this circuit will show that it consists of two half-wave circuits of opposite polarity, the rectified voltages across the reservoir capacitors, C3 and C4, being added in series to obtain the required voltage doubling. R7 and zener diode D3 cause the output to be stabilized at a nominal 12 volts.

COMPONENTS

The 6.3 volt heater transformer used in the power supply section may be any small component having a 6.3 volt secondary rated at 1 amp or more, such as the Home Radio Cat. No. TH5B. The component used in the prototype was a non-standard type. The diodes D1 and D2 can be any silicon rectifiers with a p.i.v. of 50 volts or more and a minimum forward current rating of 250mA. Types 1N4002 would be a suitable choice. The zener diode may be a Mullard BZX61/C12.

The integrated circuit used by the author was an ML741C. Any 741 op-amp in 14 pin dual-in-line may be employed here. It is possible that different specimens of op-amp may offer varying discharge currents for the timing capacitor, with the result that the timing periods given may vary from those obtained by the author. Should this occur the value of capacitor C1 may need to be altered accordingly. The component used here should be a good quality plastic foil capacitor.

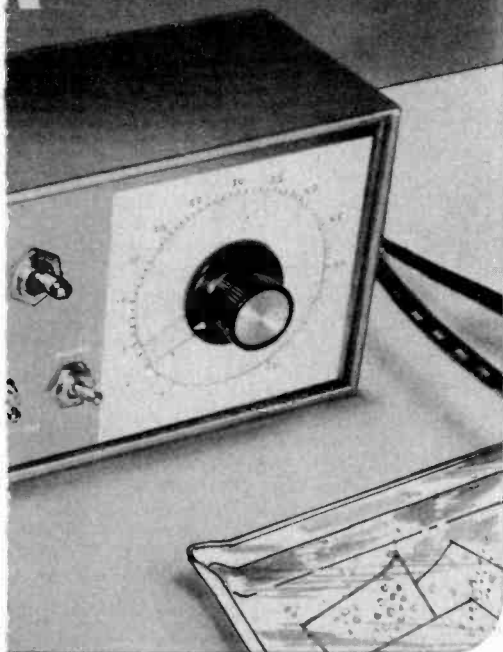
The 2N5756 triac may be obtained from Arrow Electronics Ltd., 7 Coptfold Road, Brentwood, Essex.

Finally, it is necessary to provide VR1 with a cursor to indicate its position on the scale. This may be a home-made Perspex item, which is fixed with adhesive to the back of the knob fitted to this potentiometer. Alternatively, a large pointer knob can be employed.

CONSTRUCTION

A home-made cabinet, constructed from hardboard with an insulated front panel is used to house the unit. Before making the cabinet ensure that there is room inside an internal width of 5½in. to take the particular heater transformer to be employed, two ½in. square battens and a piece of Veroboard about 1.2in. wide. If the transformer happens to be bulky it may be preferable

GRAPHIC



Integrated circuit,
a triac, the timer
offers continuously
adjustable control
methods for the control
of the device.

by R. A. Penfold

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(All fixed values $\frac{1}{4}$ watt 5% unless otherwise stated.)

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Veroboard, 0.1in. matrix (see Fig. 4)
5-way tagstrip
3-way tagstrip
Insulated tag
Material for case and panel

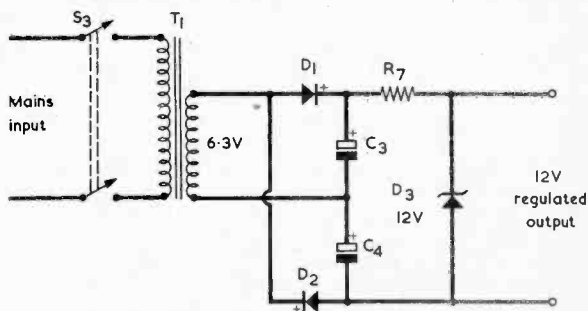


Fig. 2. The power supply circuit

THIS TIMER USES SOLID STATE CIRCUITRY THROUGHOUT, incorporating an i.c. operational amplifier, two transistors and a triac. The timing capacitor is a non-electrolytic type, giving a good resettable period as well as a high level of long term stability. A triac is used to control the enlarger lamp in preference to a relay, as it has the advantages of instantaneous operation, small size and no moving parts to wear out.

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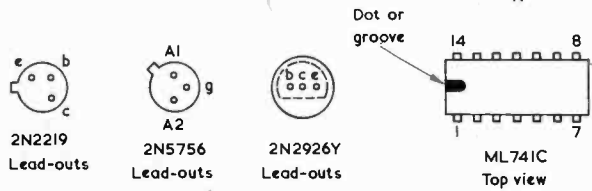
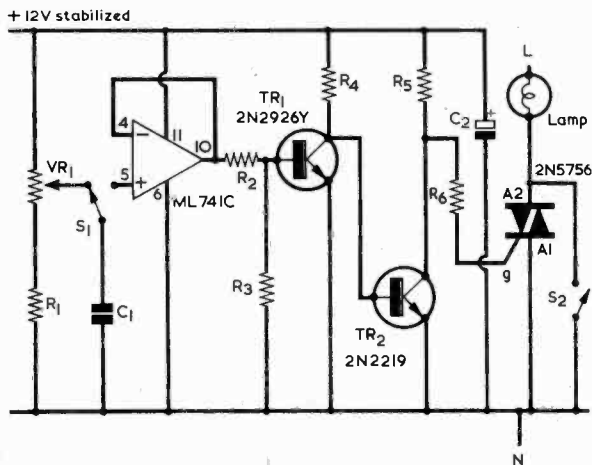
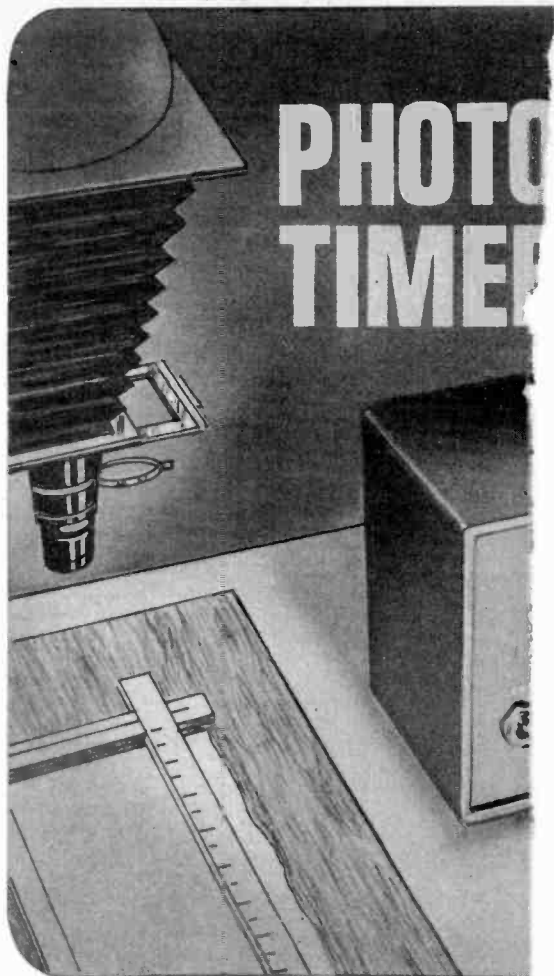


Fig. 1. The circuit of the timer section of the unit



Incorporating an two transistors and described here of variable timing peri of an enlarger lamp



covered). For normal home constructor applications either s.c.c., s.s.c. or s.r.c. wire can be used when any one of these three is specified. Similarly, d.c.c., d.s.c. or d.r.c. wire can be used when any one of these three is called for. Another anomaly in the home-constructor world is the use of the word 'Paxolin'. This is actually an outdated trade-name for the product, and an engineer would refer to the material by the far less euphonious initials s.r.b.p. These stand for synthetic resin bonded paper.

The letters p. and n. used for transistors do not represent abbreviations but refer to types of semiconductor material. Material of the p. type has positive mobile charges and material of the n. type has negative mobile charges. Transistor small signal current transfer ratio (current gain) in the common emitter mode with the output short-circuited is known as hfe. The current gain for the same mode under d.c. conditions (i.e. collector current divided by base current) is h_{FE}. Transistors have a constant hfe at low frequencies, and this starts to fall as frequency increases above a certain point. The frequency at which the transistor hfe falls to 3 decibels below its low frequency figure is referred to as fhfe. We don't meet fhfe very often but we do meet ft.

The term ft is equal to fhfe multiplied by the low frequency hfe figure. For approximate work, ft can be looked upon as the frequency at which hfe falls to 1.

We had to introduce decibels in the last paragraph, and these are abbreviated to db or dB. Decibels represent a ratio, and the fall of 3db just mentioned corresponds to a drop in current of 30%.

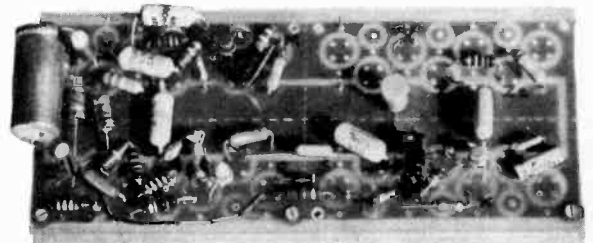
There are still several of the more common abbreviations outstanding, so let's finish with a few more taken at random. Automatic gain control, or a.g.c., is a system which keeps the output of a receiver or amplifier nearly constant despite changes in input signal level. With earlier sound radio receivers, this used to be known as automatic volume control, or a.v.c. The letters r.m.s. stand for 'root mean square', and apply to alternating currents or voltages. The r.m.s. value of an alternating current or voltage is the same as that of a direct current or voltage which produces an equal amount of heating in a resistive load. With meters we encounter f.s.d., which stands for full-scale deflection, as is given when the needle points to the highest figure on the scale.

Finally there is the immortal Tommy Handley's 't.t.f.n.'. Which stands, of course, for Ta-Ta For Now!

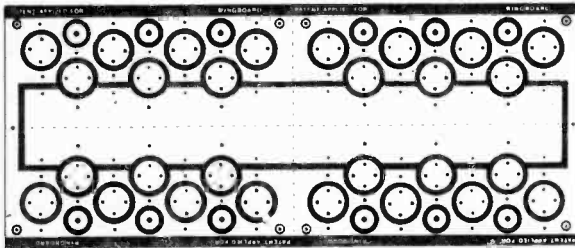
Product Review—'RINGBOARD' PRINTED CIRCUITS

'RING BOARD' PRINTED CIRCUITS REPRESENT A NEW approach to the transference of a theoretical electronic circuit to its practical equivalent on a printed board. One of the accompanying illustrations shows the copper pattern which is employed, whilst the other shows an electronic assembly wired up on a 'Ring Board'.

It will be seen that a basic aspect of the printed board is the provision of a number of circles, or rings, each being pierced with four holes for component lead-outs. The rings are intended to provide common connections where these are called for in a circuit. To take an example, the base of an amplifying transistor in the common emitter mode may have connected to it a coupling capacitor, an upper bias resistor and a lower bias resistor. One ring can accommodate all these four connections. Neighbouring rings take further points of



A circuit assembled on a 'Ring Board'. The copper pattern is visible through the glass fibre printed circuit base



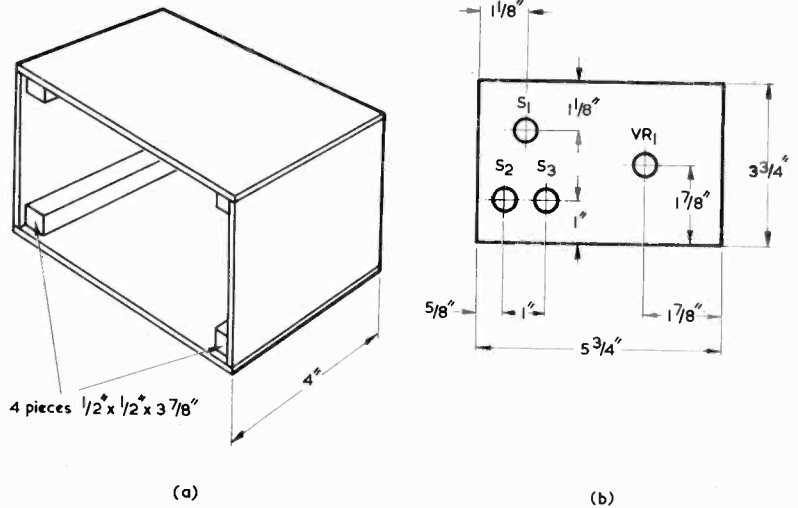
The copper pattern employed in a 'Ring Board' printed circuit

common connection, and so on until the complete circuit is laid out on the board.

Further provided are smaller rings with single holes near the edges of the board. Pins can be fitted to these for external connection to potentiometers, inputs, outputs and the like. There are also two large conducting areas, one of these being the rectangular area at the centre. The other is the area which surrounds this and all the rings. These two areas carry the supply for the circuit.

The boards can be cut along the dashed lines to make half-boards or quarter-boards. The insulating material is fibre glass, which enables the printed pattern to be observed from the component side. The boards are currently available from Ring Board Printed Circuits, 259 Chesterfield Road, Sheffield, S8 0RT.

Fig. 3(a). The sides, base and top of the case are made of hardboard. Dimensions are discussed in the text
(b). The front panel. This should be made of Paxolin or a similar insulating material



to slightly increase the $5 \frac{1}{4}$ in. width indicated in Fig. 3(b) accordingly.

Details of the case sides, top and bottom are given in Fig. 3(a), and the first step is to make these up. They are then glued to four $\frac{1}{2}$ by $\frac{1}{2}$ in. corner pieces which are each $3 \frac{7}{8}$ in. long. The corner pieces are $\frac{1}{8}$ in. shorter than the hardboard panels, thereby enabling the front panel to be slightly recessed into the cabinet. The internal width and height of the cabinet should be just slightly in excess of $5 \frac{1}{4}$ and $3 \frac{3}{4}$ in. respectively in order to allow the front panel to be a comfortable fit. The front panel is secured with four countersunk wood screws passed through into the corner pieces.

The rear panel, which is not shown in Fig. 3, is made from hardboard and is fastened to the rear of the case in similar manner. Its width and height may be slightly less than the outside width and height of the case.

The front panel should be made from an insulating material such as Paxolin, and it is cut out as indicated in Fig. 3(b). The prototype employed an aluminium panel but, due to the small clearances in potentiometer VR1 and the fact that its track is virtually at mains potential, it is considered that an insulated panel would be better from the point of view of safety.

The main circuit is assembled on a piece of Veroboard of 0.1 in. matrix, this having 25 by 11 holes, with the copper strips running lengthwise. The board assembly, shown from the components side, appears in Fig. 4. Before mounting any components the copper strips should be cut at the points indicated in the diagram, and the two mounting holes drilled for 8BA clearance.

In the prototype the i.c. was not mounted in a holder, but a holder (such as that available from Henry's Radio) whose pins have the same spacing as the i.c. pins could be employed if desired. When the i.c. is mounted direct, due care not to damage this component through overheating should be taken when soldering it into circuit. The three link wires are of thin gauge, and they should be insulated to prevent accidental short-circuits.

Since the mains is connected to the board any mistakes in the assembly here could prove disastrous, and wiring, connections and breaks in the copper strip should be double-checked to ensure that all is correct.

It is also necessary to check that no adjacent copper strips are short-circuited together by blobs of excess solder. Thin resin-cored solder and a small iron are essential for wiring up the board.

When completed, the board is mounted to the right of the case bottom, as seen from the front. Its length is from front to rear, the end with the i.c. being to the front. Flying leads connect to S1, S2, VR1, the mains neutral lead, the lamp and, when it is fitted, the power supply output. All these connections are as indicated in the circuit diagram of Fig. 1. The board is spaced away from the bottom surface of the case by suitable insulated pillars.

The 8BA mounting bolts should be countersunk types, with their heads recessed on the outside of the case. These heads should be covered with Araldite or a

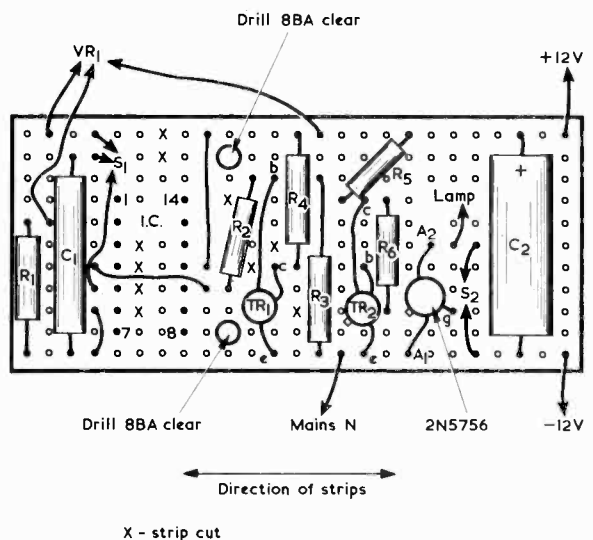


Fig. 4. The Veroboard assembly, as seen from the components side

similar epoxy adhesive to ensure that they cannot be touched.

There should be ample space for the power supply components on the left hand side of the case, also as seen from the front. The components, apart of course from the transformer, are mounted on a 5-way tagstrip, as illustrated in Fig. 5. This tagstrip is screwed to the $\frac{1}{2}$ by $\frac{1}{2}$ in. wooden runner alongside the transformer. A 3-way tagstrip screwed to the $\frac{1}{2}$ by $\frac{1}{2}$ in. runner at the right anchors the mains input lead. The lead to the lamp picks up its live connection from S3, and its neutral, switched, connection from the appropriate flying lead from the Veroboard panel. A 1-way insulated tag may be used to accommodate this connection.

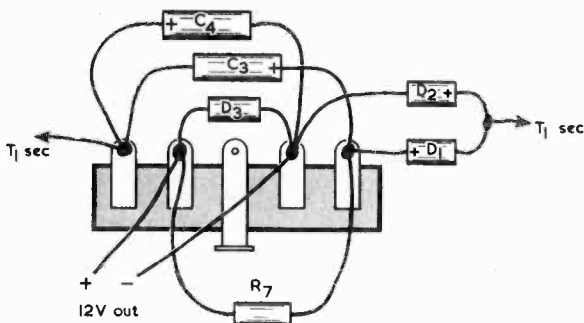


Fig. 5. Apart from the transformer, all the power supply components are wired on a small tag-strip, as shown here

CALIBRATION

Calibration of the timer is rather a long process, but there is no short-cut here. Initially check the longest timing period given, this occurring when the slider of VR1 is at the end of its track which connects to the positive supply. If this is of the order of 50 to 60 seconds then C1 has the appropriate value for operation with the specific integrated circuit employed. If the timing period is too long C1 may be reduced in value and if it is too short C1 may be increased in value. It is doubtful whether such changes in value will be required, but they are mentioned for the sake of completeness. As was stated at the beginning of this article, C1 may have been given a value of $0.47\mu\text{F}$ to obtain a timing period of some 90 to 95 seconds, and the same remarks concerning adjustment of its value, if necessary, still apply.

When satisfied with the overall timing period, a scale can be made up, the main calibration points being found by trial and error. These periods are checked against another timer, a stop-watch or a watch having a sweep second hand. Intermediate calibration points can then be estimated and marked in.

The scale should be made as large as possible to obtain the highest accuracy.

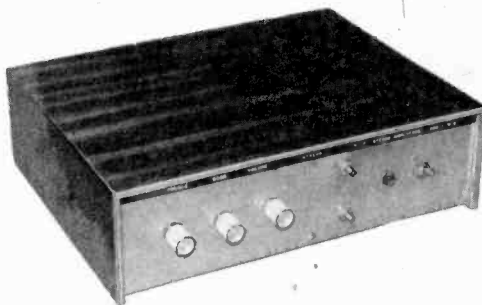
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RANDOM LIGHT DISPLAY

by M. Smith

How to obtain independent flashing with any number of mains lamps.

IN A PREVIOUS ISSUE A RANDOM FLASHING LIGHT DISPLAY was described which incorporated four bimetallic or 'flasher' light bulbs.* The bulbs employed were the small 6 volt types which are intended to function as flasher lamps for Christmas tree lights.

A greater light intensity can be obtained by using mains lamps for the actual display, these being controlled by the low voltage bimetallic bulbs. The only extra parts required are a triac of suitable rating for each mains lamp and a power supply for the low voltage bulbs.

THE CIRCUIT

The circuit for a single flasher unit is shown in Fig. 1. The mains lamp, LP2, and the triac are wired across the mains supply in series, and the triac gate is connected to the flasher bulb LP1. The power supply can be a large 6 volt dry battery or accumulator, as in Fig. 2(a), or the secondary of a 6.3 volt heater transformer, as shown in Fig. 2(b).

The operation of the circuit is quite simple. The effective resistance between the gate and Main Terminal 1 of the triac is quite low and, when the flasher bulb is alight, almost all the low supply voltage appears across the bulb. The bulb current flows between the gate and

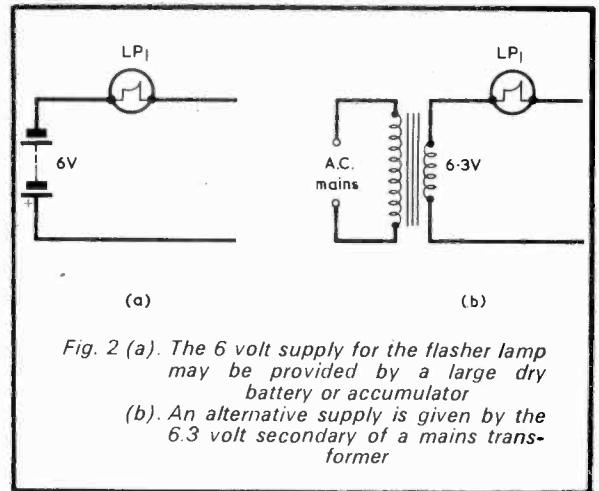


Fig. 2 (a). The 6 volt supply for the flasher lamp may be provided by a large dry battery or accumulator
(b). An alternative supply is given by the 6.3 volt secondary of a mains transformer

* D. P. Newton, B.Sc., 'Electric Art Mobile', *Radio & Electronics Constructor*, October 1972.

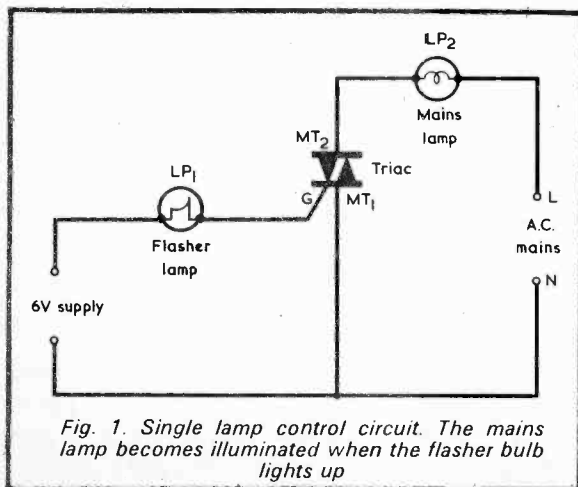


Fig. 1. Single lamp control circuit. The mains lamp becomes illuminated when the flasher bulb lights up

the Main Terminal 1, causing the triac to conduct and to turn on the mains lamp LP2. When the flasher bulb is alight its bimetallic strip heats up and, after a period, the bulb turns off and becomes open-circuit. The gate current in the triac then ceases to flow and it becomes non-conductive, causing the mains lamp LP2 to be extinguished.

As the flasher bulb cools its bimetallic strip once more makes contact and it lights up again. The triac is once more triggered on and the mains bulb illuminated. The overall effect is that the mains bulb flashes on and off 'in phase' with the small flasher bulb.

THE DISPLAY

If a stud-mounted triac is employed, the flasher bulb may be mounted and connected to it in the manner shown in Fig. 3. Alternatively, the flasher bulb can be fitted to a normal bulb-holder and wired up in conventional manner. It must be remembered that the Main Terminal 2 of the triac is at mains live potential when the flasher bulb is off and at mains neutral potential when the flasher bulb is on. The triac must, in consequence, be mounted on a suitable insulating material.

Several flasher bulb and triac units can be used together, as illustrated in Fig. 4, to give a visual 'psychedelic' display. The four main lamps will turn on and off in random manner, independent of each other.

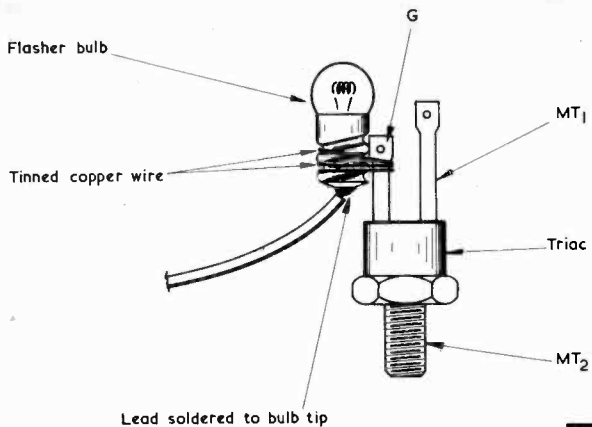
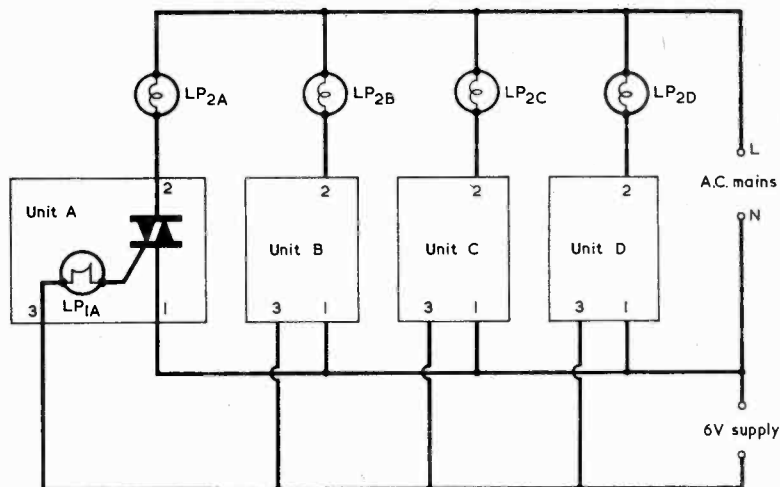


Fig. 3. If desired, each flasher bulb can be secured to the gate terminal of its triac in the manner shown here

Fig. 4. Any number of light control circuit units may be employed. Here, Units B, C and D have the same internal circuit as Unit A. A single low voltage supply feeds all the units



Lights are mounted on reflective back board

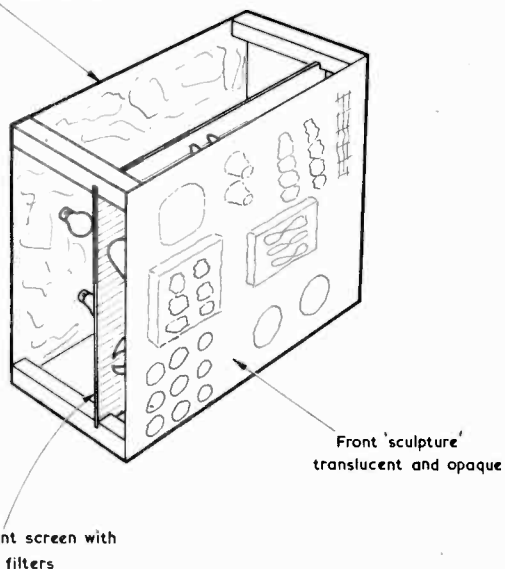


Fig. 5. Presentation of the display depends on individual taste. The basics of the author's display are illustrated here

The 6 volt supply should have a current capability of 500mA per unit. Thus, when there are four units, as in Fig. 4, the 6 volt supply should be rated at 2 amps or more.

The triacs used by the author were surplus types. A stud-mounting type suitable for controlling lamps up to 100 watts is the SC35D, available from Henry's Radio Ltd. This triac is rated at 400 volts and a current of 3 amps. A large safety margin is desirable if the device is used, as here, without a heat sink.

The main lamps can be coloured, or filters can be placed in front of them. As each lamp flashes independently the colour pattern will change. Further effects can be obtained by using patterned screens, mirrors and moulded translucent plastics.

The author employed 40 watt lamps and these provide ample illumination for a display measuring 1 metre by 1 metre by ¼ metre deep. An idea of what can be made up is given in Fig. 5. Readers will doubtless have their own ideas here.

The circuitry involved is simple, yet the results are quite effective and the variations of display techniques limitless. An important point is that all the components in the control units, together with the flasher bulb supply, are at mains potential, and they *must* be mounted in a suitable case which ensures that there is no risk of accidental shock.

The 6 volt flasher bulbs are available from any electrical suppliers, including Halford's stores, and are sold, on individual cards, as 6 volt flasher lamps for Christmas tree lights.

Radio Topics

By Recorder

MANY THINGS, INCLUDING MY Uncle Herbert's stint in the Home Guard, are claimed to have been instrumental in winning World War II, and one contender for this distinction which merits a high level of credibility is the plastic, polythene. It has been said that had not polythene, or to give it its more correct name, polyethylene been made available in adequate quantities during the early part of the War we might not have had an insulation sufficiently efficient to withstand the very high voltages appearing in airborne radar equipment.

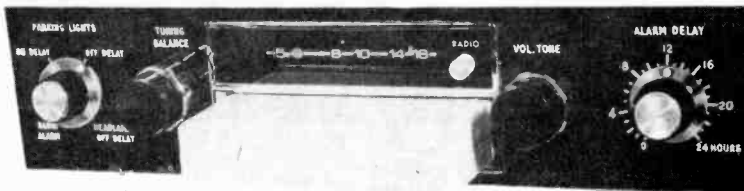
Be that as it may, and returning to more peaceful fields, it is an undeniable fact that, without polythene and all the other plastics, the whole world of electronics would have foundered in its own complexities decades ago. (And that last sentence shows that I can mix metaphors with the best of them.)

PLASTIC FOIL CAPACITORS

These thoughts are prompted by a recent reader's query to this office asking advice concerning the type of capacitor to use when a 'plastic foil' component is specified in a Components List.

This query raised a few nostalgic memories in my mind and I dug out some old copies of *The Radio Constructor* for the years of 1954 and 1955 to see what types of capacitor we were specifying then for values of around 0.005 to 0.5 μ F. We used to call them 'condensers' in those days and, as old hands will have already guessed, capacitors of these values were called up as paper types. The dielectric was, of course, wax impregnated paper.

Nowadays, the paper capacitor has been very largely superseded by capacitors having plastic dielectrics. One of the most prominent of these is polyester and this appears in polyester foil capacitors and in metallised foil



A car radio/cassette player incorporating the Eremco LR171E timer i.c. and associated controls. These provide a radio alarm and automatic switching of parking and head lights

capacitors. Polycarbonate is a more recent arrival, and polycarbonate capacitors are capable of squeezing a relatively high capacitance value into quite a small package.

The paper capacitor has not entirely disappeared from the scene and there are quite a few perfectly good paper capacitors in the 'tubular' style still knocking around. An interesting continued use for paper is given in 'mixed-dielectric' capacitors. These have a mixed paper and polyester dielectric, thereby conferring on the paper the advantages given by polyester. One supplier of mixed-dielectric capacitors is R.S. Components, who list a range for these components of 0.001 μ F to 0.47 μ F.

Another capacitor using plastic dielectric is the polystyrene capacitor. Polystyrene capacitors have the familiar rolled construction with a lead-out at each end, offer a very high insulation resistance and are particularly good in r.f. circuits. They can be obtained in values as low as 10pF and as high as 0.01 μ F. In general, polystyrene capacitors are bulkier than polyester, metallised foil or mixed-dielectric capacitors of the same value and, because of this, would not normally be used in circuits in which either of the other types could be employed.

In consequence, and returning to the reader's query which started off these notes, the general term 'plastic foil capacitor' can be considered as applying to a polyester, a metallised polyester foil or a mixed-dielectric type. Unless otherwise specified, any one of these capacitor types can be employed. Polycarbonate capacitors are more frequently employed in the

home-constructor sphere where higher values, of the order of 0.47 μ F to 15 μ F, are required.

I.C. TIMER

One of the accompanying photographs shows the new Eremco integrated circuit timer type LR171E. This device, in a standard 14 pin dual-in-line package, is available from Electrical Remote Control Company Limited, P.O. Box 10, Bush Fair, Harlow, Essex, CM18 6LZ, and offers timing periods from 5 milliseconds up to 4,000 hours.

This exceptionally wide range of timing periods is achieved by a combination of analogue and digital techniques. The i.c. incorporates an RC oscillator running with an external timing resistor and capacitor, the output of which is coupled to a 12-stage binary counter. The latter offers a run of 2 to the power of 12, or 4,096, and the controlled circuit is operated when the RC oscillator has passed through this number of cycles. The outputs of the ninth, tenth and eleventh dividers are also brought out to pins, and these allow separate timed outputs to be given at one eighth, one quarter and one half of the full period. The device is compatible with t.t.l., and can drive thyristors and triacs directly.

The chip includes a digital to analogue converter and its own supply regulator. The converter enables a 0-1mA meter to be coupled to the device, this giving a linear indication of the amount of time elapsed, with 1mA corresponding to the end of the timing period. The regulator allows a wide variety of supplies to be employed. These range from operation with a standard d.c. supply to operation direct from the 240 volt a.c. mains via a half-wave diode rectifier, a smoothing capacitor and a series resistor. Supply current is typically 5mA plus the current required to operate external controlled devices.

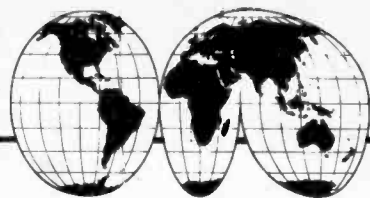
It is estimated that the timer, which employs the Ferranti C.D.I. (Collector Diffusion Integration) process, has a large number of applications in the domestic field as well as in industry. The i.c. also has many uses in the car, and the second photograph illustrates a car radio/cassette player incorporating an LR171E function switch and time setting control. These provide controls for radio alarm and for such things as 24 hour control, both switching on and off, of parking lights. ■



The Eremco LR171E dual-in-line integrated circuit. This functions as a comprehensive timing device, offering timing periods from 5 milliseconds up to 4,000 hours

SHORT WAVE NEWS

FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT

Frequencies = kHz

Radio Pakistan operates on several differing short wave outlets but one that may interest some Dxers is that on a measured **6257** (47.94 metres) where it may be heard at 1800 with a newscast in English until sign-off (no National Anthem) at 1810. The channel however is a difficult one with attendant QRM from OYE 21 Schulungsender on **6255** (47.96m).

Radio Bangladesh can be heard on the LF bands on **4890** (61.35m) where we recently logged them at 2033 radiating the Bengali Service until 2059 when station identification was given in English as "This is the Overseas Service of Radio Bangladesh", this being followed by a newscast in English until 2109. The schedule in English is -

CURRENT SCHEDULES

● BANGLADESH

From 0230 to 0300 on **11650** (25.75m) and on **15520** (19.33m); from 1230 to 1300 on **15455** (19.41m) and **17690** (16.96m) although we recently measured this latter channel as **17691.5**. From 1845 to 1900 and from 2100 to 2200 on **4890** (61.35m) and on **9495** (31.59m).

● AUSTRALIA

Radio Australia radiates a programme in English for the U.K. and Europe from 0645 to 0745 on **9570** (31.35m) and on **11765** (25.50m).

● CANADA

Programmes in English from Radio Canada International for Europe are broadcast daily from 0700 to 0730 on **6125** (48.97m) and on **9655** (31.07m); from 1217 to 1315 on **15325** (19.57m) and on **17820** (16.83m); from 1515 to 1522 (Newscast) on **15325**, **17820** and on **21595** (13.89m); from 2115 to 2158 on **11845** (25.32m), **15325**, and on **17820** (Saturday and Sunday from 2100 to 2158).

● NETHERLANDS

The weekdays English transmissions from Radio Nederland to Europe is as follows - from 0930 to 1050 on **6045** (49.62m) and on **7210** (41.60m); from 1830 to 1950 on **6020** (49.83m), **6085** (49.30m) all the foregoing from Lopik, and on **11730** (25.57m) from Bonaire, Netherlands Antilles, commencing 4th November.

On Sundays, the "Happy Station Programme", in English to Europe from 0930 to 1050 on **6020**, **6045** and on **7210**; from 1400 to 1520 on **6020**; from 1830 to 1950 on **6020** and on **6085**.

● WINDWARD ISLANDS

Radio Grenada can be heard with a programme for the U.K. from 1945 to 2130 on **15105** (19.86m).

● KUWAIT

Radio Kuwait radiates a programme in the English Service from 1630 to 1900 on **15415** (19.46m).

● NORTH KOREA

Radio Pyongyang transmits a number of schedules in English but that directed to Europe is from 2000 to 2200 on **6576** (45.62m) and on **11535** (26.00m).

● GHANA

"The External Service of Radio Ghana - The Voice of the Revolution" may be heard in English for Europe from 2045 to 2215 on **9545** (31.43m) and on **15285** (19.62m).

Accra can also be heard in English to East Africa from 1400 to 1430 on **15285** (19.62m); to West Africa from 1400 to 2215 on **6130** (48.93m); from 1445 to 1530 on **15285**, **21545** (13.92m) and on **21720** (13.81m) to Central, South and East Africa and Australasia; from 1645 to 1730 on **15285** to East Africa; from 1815 to 1900 on **15285** to East Africa and from 2000 to 2100 on **11850** (25.31m) to North America and the Caribbean.

● CAMEROON

Radio Buea radiates a programme in English from 2030 to 2200 on **3970** (75.56m).

● UNITED ARAB AMIRATES

For those who wish to log the United Arab Emirates (programmes in Arabic) tune to **9620** (31.18m) from 1930 to 1950 (for instance) for a newscast from Abu Dhabi.

Or try **6040** (49.66m) from 2030 to 2040 for a newscast from Radio Dubai.

AROUND THE DIAL

Migrating to the 15MHz band you may log -

● WINDWARD ISLANDS

Radio Grenada (see Current Schedules) on **15105** (19.86m) heard here at 2120 with 'pops', commercials, station identification and sign-off at 2130, no National Anthem.

● BRAZIL

PRB23 Radio Panamericana, Sao Paulo, with sports commentary in Portuguese and station identification at 2216, on **15135** (19.82m). In a recent issue of a continental SWL publication (and likely to be copied elsewhere) this station has been listed as being inactive on this channel, which statement does not agree with my observations - a not unusual occurrence!

RADIO & ELECTRONICS CONSTRUCTOR

ZYR216 Radio Clube Ribeirao, Preto, at 2118 with the almost inevitable sports commentary (listen on Sunday evenings for them) on a measured **15416** (19.46m).

● **GHANA**

Accra with African songs and music (to East Africa – see Current Schedules) at 1821 on **15285** (19.62m).

● **KUWAIT**

Radio Kuwait at 1858 on **15415** (19.46m) with identification after the programme in English and sign-off at 1901. (See Current Schedules).

11MHz BAND

Emigrating to this band you will probably hear –

● **NORTH KOREA**

Radio Pyongyang on **11535** (26.00m) at 1957 with identification “Ici Pyongyang” and closing announcements in the French programme. Identification in English at 2000, National Anthem, programme review, newscast and feature programmes in the English Service (see Current Schedules).

● **INDIA**

All India Radio, Delhi, in the General Overseas Service at 1900 on **11620** (25.81m) with the news in English till 1905, station identification then feature programmes.

● **TUNISIA**

Tunis with Arabic music and songs, ideal for those with tape recorder, at 1938 on **11970** (25.06m).

● **PAKISTAN**

Radio Pakistan at 2030 on **11860** (25.29m) with identification “Ici Radio Pakistan” after local music programme.

● **CHINA**

Radio Peking at 2047 on **11445** (26.21m) with a talk in the German programme. Also on **11515** (26.05m) at 1830 with sign-on, “East is Red”, then into Arabic till sign-off at 1923.

● **W. GERMANY**

Deutsche Welle at 2000 on **11785** (25.45m) with the news in English to Africa till 2018, into French at 2020 after identification.

10MHz BAND

Contemplating this portion of the dial you can log –

● **IRAQ**

Baghdad at 1946 on a measured **9737** (30.81m) with a newscast in English and a talk about Cambodian affairs.

● **ISRAEL**

Tel Aviv at 2031 on **9785** (30.65m) with a talk on the housing problem in Israel and views of tourists on life in that country.

● **INDIA**

AIR Delhi at 2000 on **9525** (31.49m) with the world news in English after identification.

● **CLANDESTINE**

“Voice of the People from the Heart of the Arabian Peninsular” at 1830 on **9573** (31.33m) with harangue in Arabic, local music at 1832 then further tirade at 1834.

18MHz BAND

Elevating up to here, the following were observed –

● **CZECHOSLAVAKIA**

Prague at 1815 on **17840** (16.81m) with a programme in English to Africa and Asia about African affairs in general.

● **ECUADOR**

HCJB Quito at 2035 on **17850** (16.80m) with a programme in English, identification at 2045 then into French, in parallel on **11730** (25.57m) and **15300** (19.60m).

● **ALGERIA**

Algiers at 2050 on **17790** (16.86m) with a programme of Arabic songs and music.

● **CANADA**

Sackville at 1220 and at 2045 on **17820** (16.83m) with the world news in English.

5MHz BAND

Exacerbating though the band may be, it does, and can, produce some of the best Dx in the business –

● **FRENCH GUYANA**

Cayenne at 0149 on **4972** (60.33m) with a local musical programme and announcements in French.

● **SINGAPORE**

Singapore at 2224 on **5010** (59.88m) with light orchestral music (often heard after Garoua closes at 2200).

● **SRI LANKA**

Colombo at 1822 on **4902** (61.19m) with continuous chanting by Buddhist monks in special all-night service operated on full moon day.

● **REUNION ISLAND**

St. Denis at 1742 on **4807.5** (62.40m) with piano music, male and female announcers in French.

● **S. YEMEN**

Aden at 1846 on **5060** (59.28m) with Arabic music and songs, into talk at 1850.

● **HONDURAS REPUBLIC**

HRPL3 Radio Progresso at 0137 with typical LA music and songs, station identification at 0140 during programme announcement on **4920** (60.98m).

● **CHINA**

Location uncertain but listed Fukien, at 2020 on **4840** (61.98m) male and female alternately in Chinese. According to schedule, not on this channel at this time!

● **MALAYSIA**

Kajang at 2203 on **4845** (61.91m) with talk in Tamil, Indian-type songs and music at 2205.

● **N. VIETNAM**

Hanoi at 2212 on **4892** (61.32m) with gymnastic exercises set to music.

AUDIO SIGNAL GENERATOR

By M. G. Lewis

An ingenious Wien bridge a.f. signal generator in which amplifier gain is maintained at the requisite level by an automatic gain control circuit. Frequency coverage is from around 10Hz to 73kHz.

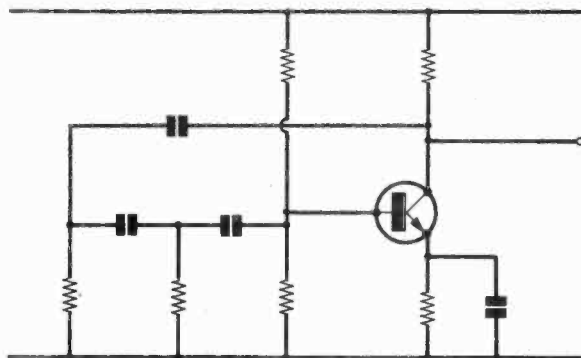
SECOND TO A MULTIMETER THE MOST USEFUL PIECE OF test equipment for the radio enthusiast is probably the signal generator. The r.f. signal generator can consist of little more than a tuned circuit oscillator and it can give excellent performance due to the inherent filtering action of the high-Q tuned circuit. A good audio generator is not so easily constructed. The simple circuits such as the blocking oscillator and the multi-vibrator do not produce a sinusoidal waveform and their use is limited to little more than signal tracing. The R-C oscillator circuits are the only ones which offer any hope of satisfactory use as audio test instruments for distortion and frequency response testing. Such circuits are the phase shift oscillator (Fig. 1(a)) and the Wien bridge oscillator (Fig. 1(b)).

It is the writer's experience that these circuits give a sinusoidal output which is only slightly distorted, but that the output voltage varies with frequency. Another observation is that the valve circuits generally worked better than their transistor counterparts.

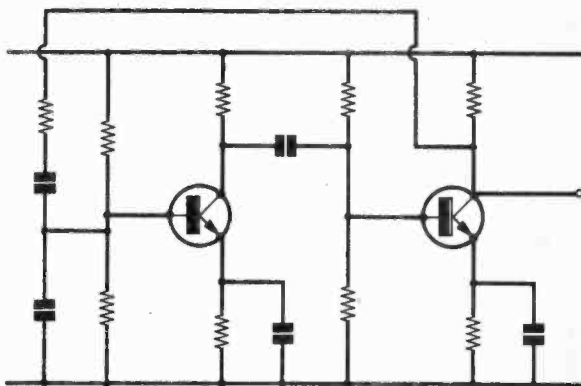
AMPLITUDE STABILIZATION

The disparity between the performance of the valve and transistor circuits is a consequence of the non-linearity of the transistor characteristic. The grid voltage-anode current curve for a valve is nearly linear (Fig. 2), whilst the corresponding characteristic for the transistor is sharply curved (Fig. 3). It is the non-linearity of the valve or transistor characteristic which controls the amplitude of oscillation in circuits such as those in Fig. 1. The effective gain (the slope of the curve) falls at the end of the characteristic and this prevents the amplitude of oscillation rising too high. The non-linearity of the valve is just sufficient to control the amplitude without allowing the introduction of severe distortion. The transistor, on the other hand, sharply distorts one part of the waveform before it exercises any control over the rest of it, and a distorted output waveform results.

What is required in a transistor oscillator is an independent means of controlling the amplitude of oscillation so that the amplitude can always be kept at a



(a)



(b)

Fig. 1. Two basic R-C oscillator circuits. That in (a) is a phase shift oscillator and that in (b) is a Wien bridge oscillator

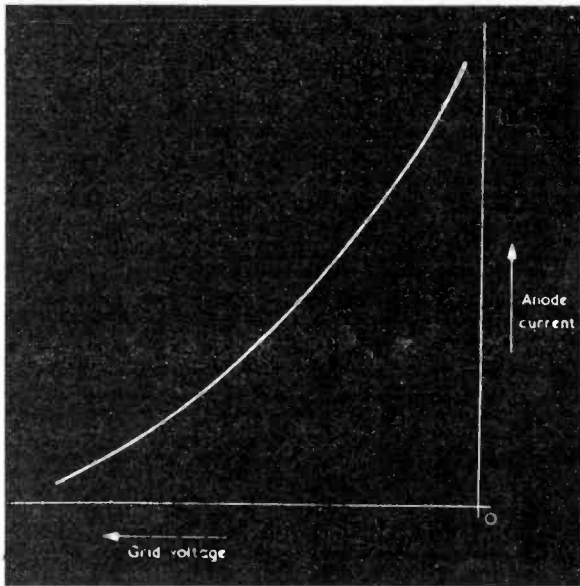


Fig. 2. The anode current-grid voltage characteristic of a valve. Anode current falls smoothly as the grid goes negative

certain level below that at which distortion occurs. A number of audio signal generators have been produced which incorporate a thermistor to control the amplitude. The thermistor is wired in a negative feedback loop, driven by the signal. If the signal is too high the thermistor is heated and its resistance falls, increasing the feedback and reducing the level of oscillation. However, the thermistor has several disadvantages. It has a definite thermal time constant and it cannot be used if the circuit is to work at a frequency lower than the corresponding roll-off frequency. Also its resistance at any power level is fixed and this makes it somewhat

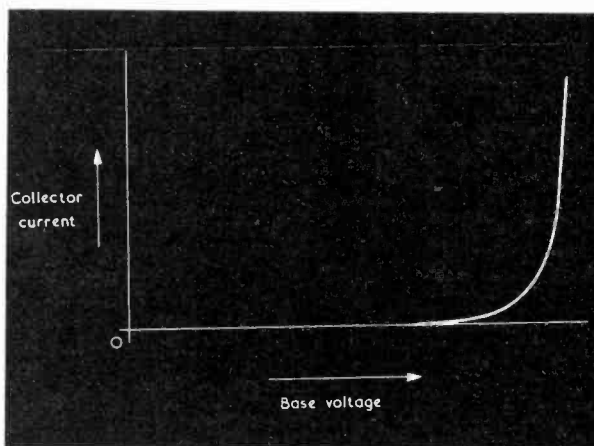


Fig. 3. The markedly non-linear collector current-base voltage curve of a transistor

difficult to adjust the signal level in the oscillator. Perhaps most important to the enthusiast is the fact that the device is relatively expensive.

A more fruitful approach is to design an oscillator with an a.g.c. system. The output signal is rectified and smoothed with as long a time constant as necessary. The d.c. voltage thus obtained is then compared with a reference voltage and the excess is used to control the loop gain at the oscillator. The gain control exploits the non-linearity of the transistor which is so troublesome in the uncontrolled circuits where the signal level is high. It is an oscillator of this controlled type which is described in the present article.

PRINCIPLE OF OPERATION

The oscillator is shown schematically in Fig. 4 where the biasing components have been omitted for simplicity. The R-C network is a Wien bridge. This network has the property that at only one frequency is its phase shift equal to zero. At this frequency it attenuates the signal to one-third. The oscillator must therefore contain an amplifier with zero phase shift and a gain of three times. The first transistor, TRA, acts an emitter follower buffering the network with a voltage gain of one and feeding the signal through RE1 to the emitter of TRB. RE2 is chosen to be large compared with the emitter

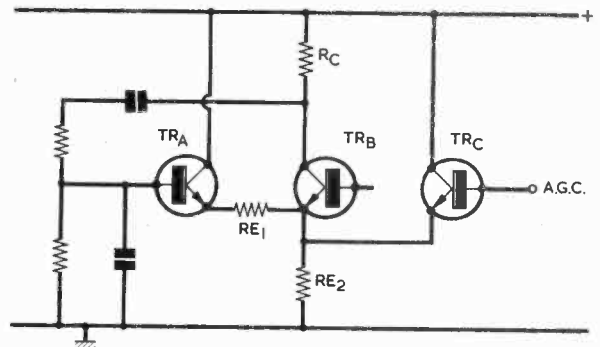


Fig. 4. Illustrating the basic mode of operation of the audio signal generator

impedance of TRB and all the signal current passes into the emitter of TRB. TRB is a common base amplifier with a current gain of one, and all the emitter current then passes from the collector into RC. The voltage developed across RC is then used to drive the network. Each transistor gives an output in phase with its input and thus the signal has the correct phase for oscillation to occur. As the same signal current passes through RE1 and RC the gain of the amplifier is approximately $RC/RE1$, and if these resistors are in the ratio of just greater than 3:1 the first two transistors and the network constitute an oscillator.

It is necessary to consider the transistor characteristics in detail to understand the working of the a.g.c. system. The transistor is non-linear and its parameters vary with

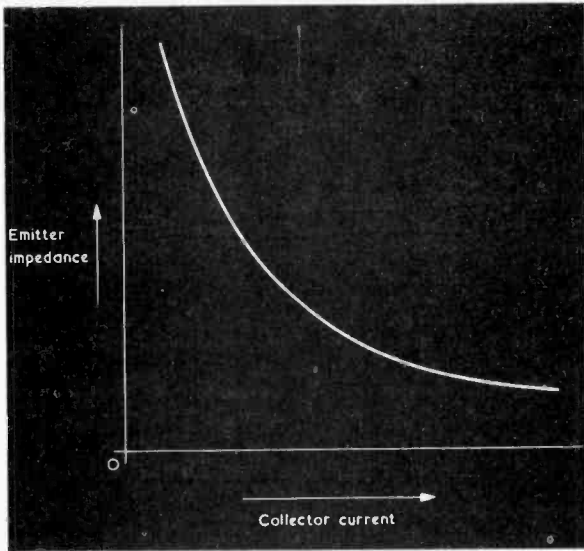


Fig. 5. Characteristic curve showing the relationship between emitter input impedance and collector current

the operating current. Fig. 5 shows the variation of the emitter impedance with the collector current. It will be seen that the impedance falls as the collector current is increased. Note that, in Fig. 4, the emitter of TRC is connected to the emitter of TRB. The signal current flowing in RE1 is shared between the emitters of TRB and TRC in the inverse ratio of their impedances. If TRC is not conducting, its impedance is very high and all the current flows into TRB as described above, and the circuit oscillates. If TRC is now made to conduct, its impedance falls and some of the current flows into it. As the total current is limited by RE1 only a fraction is left for TRB and the amplitude of oscillation is reduced. The action can be considered as though TRC were 'stealing' the signal current intended for TRB. It only remains to rectify the output signal and use it as an a.g.c. voltage controlling TRC and the circuit becomes a stabilized oscillator.

CIRCUIT DETAILS

The full circuit of the audio signal generator is shown in Fig. 6. The network consists of a two-gang 220k Ω potentiometer (VR1) and four pairs of capacitors selected by a 2-pole 4-way switch to give four frequency ranges. The low frequency end of each range is obtained when each section of the potentiometer is at maximum resistance. The frequency at the high frequency end of each range (where the potentiometer sections are at zero resistance) is governed by R1 and R2. The value of R1 was chosen to be 12k Ω as it is driven from R6 (3.3k Ω) and the effective resistance of the combination is about 15k Ω and equal to R2.

TR1 and TR2 are both emitter followers giving an input impedance sufficiently high not to load the network. The bias for these transistors is derived from the potential divider R7 and R8, decoupled by C9 and fed through the network. The signal is passed through R4 to the emitters of TR3 and TR4. Here it is shared according to the a.g.c. voltage and the required portion passes through TR3 to the load resistor R6 and hence

COMPONENTS

Resistors

(All fixed values $\frac{1}{2}$ watt 5%)

R1	12k Ω
R2	15k Ω
R3	1.5k Ω
R4	560 Ω
R5	1k Ω
R6	3.3k Ω
R7	5.6k Ω
R8	1k Ω
R9	3.3k Ω
R10	47k Ω
R11	5.6k Ω
R12	1.5k Ω
R13	2.2k Ω
R14	220 Ω
VR1	220 + 220k Ω dual-gang potentiometer, linear or log (see text)
VR2	500 Ω potentiometer, wire-wound

Capacitors

C1	100pF
C2	0.001 μ F
C3	0.01 μ F
C4	0.1 μ F
C5	100pF
C6	0.001 μ F
C7	0.01 μ F
C8	0.1 μ F
C9	50 μ F electrolytic, 16 V.Wkg.
C10	10 μ F electrolytic, 16 V.Wkg.
C11	50 μ F electrolytic, 16 V.Wkg.
C12	1 μ F plastic foil (see text)
C13	50 μ F electrolytic, 16 V.Wkg.

Semiconductors

TR1-5	BC108 or 2N3708 (or similar n.p.n. silicon planar transistors)
D1	OA81
D2	OA81

Switches

S1(a)(b)	2-pole 4-way rotary
S2	s.p.s.t. toggle or rotary

Battery

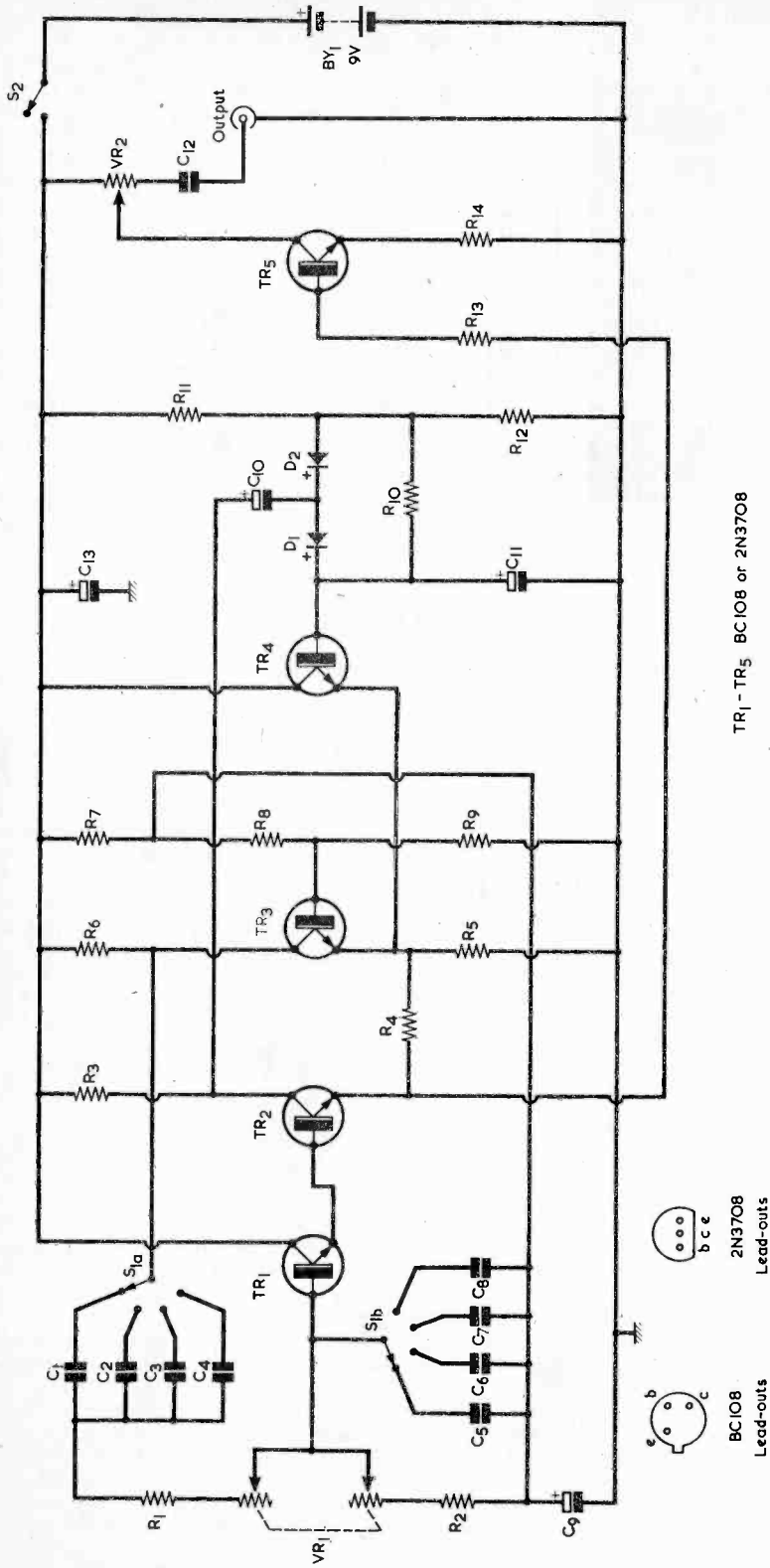
BY1	9-volt battery
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Miscellaneous

Coaxial socket
Battery connectors
Knobs, as required
Metal case with front panel
Nuts, bolts, wire, etc.

back to the network. Note that R6 is approximately six times the value of R4 so that a gain of three is obtained when one half of the signal passes into TR3. The base of TR3 is biased by the potential divider R8 and R9.

The a.g.c. system takes its signal from the collector of TR2 via C10. This point is chosen in preference to the collector of TR3 because TR2 offers a measure of buffering between the oscillator and the rectifier. If the output were taken from TR3 the non-linear conduction



TR₁ - TR₅ BC108 or 2N3708

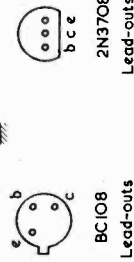


Fig. 6. Complete circuit diagram for the audio signal generator. VR1 is a dual-gang potentiometer, both sections of which insert resistance into circuit as the spindle is turned clockwise

of the diodes would distort the waveform fed back to the network and hence distort the output. The diodes, D1 and D2, act as a voltage doubler rectifier and generate a positive bias for TR4. A slight standing bias is already provided by R11 and R12 but this is not sufficient to make TR4 conduct. If this bias were not provided the signal level required to make TR4 conduct would be so high that the oscillator would distort. The level of oscillation can in fact be adjusted by altering the ratio of R11 and R12. C11 smooths the a.g.c. voltage applied to the base of TR4 and is chosen so that the time constant is long enough to smooth even the lowest frequency.

The output from the oscillator can be taken from any point in the loop. The emitter of TR2 was chosen for two reasons. The impedance here is low and the effect of the load will be least. Also the d.c. voltage is about 3 volts and is suitable for direct coupling to the buffer amplifier TR5. This has a low gain but prevents changes in load impedance altering the frequency or causing distortion. It also allows the use of a constant impedance attenuator VR2. The d.c. component is removed by C12. It should be noted that the impedance of this capacitor is greater than 500Ω at the lowest operating frequency, and if the signal generator is required to drive a 500Ω load at a frequency of less than 1kHz the value of C12 should be increased to 500μF. The writer chose to use a value of 1μF to avoid the long time constant which would result when the instrument was connected to a high impedance load as was often the case with the prototype. The circuit is powered by a 9V dry battery.

TABLE I
Frequency Coverage

(VR1 = 200 + 200kΩ - see text)

Network capacitor	Maximum frequency	Minimum frequency
100pF	73kHz	6kHz
0.001μF	9.7kHz	750Hz
0.01μF	950Hz	75Hz
0.1μF	100Hz	10Hz

PERFORMANCE

The frequency ranges obtained with the prototype are given in Table I. These were given with a 200 + 200kΩ potentiometer in the VR1 position. However dual-gang potentiometers of this value are not readily available on the home constructor components market and it is for this reason that VR1 is specified in the Components List as 220 + 220kΩ (which may be obtained in both linear and log from Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey). When a 220 + 220kΩ potentiometer is employed the minimum frequency for each range will be about 10% lower than is shown in Table I. With the 200 + 200kΩ potentiometer there is a good overlap between ranges (which will be slightly increased with a 220 + 220kΩ component) and the total coverage extends from 10Hz to 73 kHz. The writer was fortunate in being able to borrow a digital frequency meter to calibrate the instrument. If the reader cannot obtain access to such an instrument or to another signal generator he can use an oscilloscope and calibrate the lower frequency range using Lissajous

figures generated with the 50Hz mains. (See Fig. 9.) An approximate calibration for the medium frequency ranges is then obtained by multiplying the frequency by ten for each range. The network capacitors, C1 to C8 inclusive, should be of close tolerance. It is possible to use 1% silvered mica capacitors for the values up to 0.01μF and 1% polystyrene or polyester for the 0.1μF values. Suitable capacitors should be reasonably easy to obtain. Avoid using 1,000pF ceramic capacitors of the type employed for TV decoupling purposes, as these have very wide tolerances.

VR1 may be either a linear or a log component, the latter giving less scale cramping at one end. If a log potentiometer is used it should be connected such that the sections insert increased resistance into circuit as it is turned clockwise.

The output voltage obtained was variable from zero to 0.5 volt peak-to-peak at a supply voltage of 9 volts. The oscillator will function without distortion for supply voltages varying from 6 volts to 15 volts, but it should be noted that the buffer amplifier, TR5, introduces distortion at the higher output levels when the supply voltage is greater than 9 volts. As the circuit is directly coupled the bias levels are important, and a voltage analysis is given in Table II. The current consumption is 16mA at

TABLE II
Voltage Analysis

(Readings were obtained on a 10kΩ/V meter switched to 10V f.s.d. Measured battery voltage = 8.9 V. Frequency 1kHz. Output control set half way. TR1 base voltage not measured due to meter loading; voltage at junction of R7 and R8 = 4.0 V. All voltages with respect to chassis.)

Transistor	TR1	TR2	TR3	TR4	TR5
Emitter voltage	3.5	3.0	2.0	2.0	2.2
Base voltage	—	3.5	2.6	2.6	2.8
Collector voltage	8.9	6.2	7.2	8.9	6.6

9 volts, of which 10mA is taken by the buffer amplifier.

The degree of compensation for supply voltage changes obtained in this oscillator would never be achieved in an unstabilized oscillator. The action of the a.g.c. system may well be seen if the output signal is monitored on an oscilloscope as the generator is switched on. The signal voltage rises rapidly, overshoots and then settles to a stable value.

An interesting incidental aspect of the a.g.c. system is that it allows an external voltage source to control the level of oscillation. If the signal generator is set to a fairly high frequency and a low frequency signal is injected into the base of TR4 from an external source it will have the effect of modulating the high frequency. The modulation voltage may be injected into TR4 base via a 1μF capacitor but the signal is then severely attenuated by the a.g.c. smoothing capacitor, C11. A more satisfactory method is to inject the modulating signal through C11, using the circuit shown in Fig. 7. An input of 1 volt r.m.s. achieves about 30% modula-

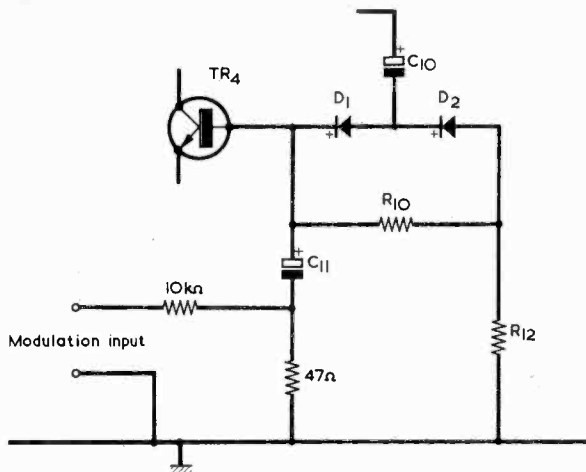


Fig. 7. An incidental facility is the ability to inject a modulating signal. For this, the circuit is modified in the manner shown here

tion and appreciably more can be obtained without serious distortion. As TR3 and TR4 share the same source of emitter current, the modulation signal may also be applied to TR3 base via a $1\mu\text{F}$ capacitor. This achieves a very high modulation sensitivity.

The modulation facility makes the circuit a useful instrument in the production of radiophonic music.

The more experienced constructor may find it worth noting that the circuit can be simplified if a fixed frequency low output oscillator is required. TR5, the buffer amplifier can be omitted and the signal output taken via a $22\text{k}\Omega$ resistor from the emitter of TR2. Also, TR1 can be omitted provided that the network resistors replacing VR1, R1 and R2 are no greater than $22\text{k}\Omega$. It is necessary in this case to reduce the bias voltage at the junction of R7 and R8 by 0.6 volt by changing the values of these two resistors.

CONSTRUCTIONAL DETAILS

Constructional details are left to the reader, who may care to employ one of the several metal cases that are currently available. As a guide to what is required, the prototype was built in an aluminium box measuring about 6 by 4 by 4 in. All the components except the battery were fixed to the front panel so that this could be

removed from the case without disconnecting any wires. The front panel layout is as shown in Fig. 8. Behind the panel the network capacitors, C1 to C8, were grouped around the range switch, the resistors R1 and R2 were mounted on the dual-gang potentiometer, and all the other components save the output capacitor C12 were mounted on a tagboard held perpendicular by means of brackets, to the panel. C12 was mounted between VR2 and the output socket. The frequency scale was drawn on a piece of paper glued to the panel and then protected by a Perspex disc, 3 in. in diameter, locked under the fixing nut of the dual-gang potentiometer. Similar paper scales were used on the range switch and output control. Further details are left to the constructor, who may choose the style of construction and degree of finish himself.

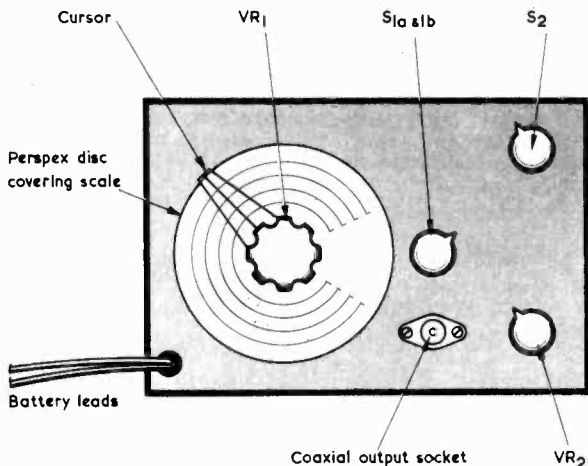


Fig. 8. A suitable front panel layout

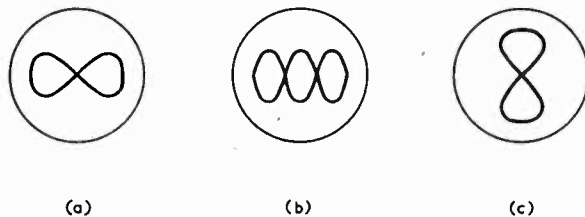
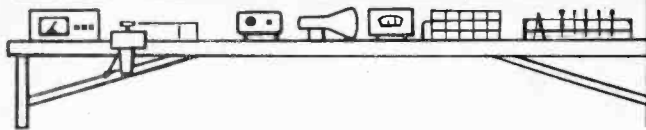


Fig. 9. Oscilloscope Lissajous figures define the relationship between two frequencies. The number of 'loops' at the top represent the frequency applied to the vertical plates, and the number of 'loops' at the side represent the frequency applied to the horizontal plates. In (a) the vertical frequency is twice the horizontal frequency and in (b) the vertical frequency is three times the horizontal frequency. In (c) the vertical frequency is half the horizontal frequency

CONCLUSION

The writer has tried many other designs for an audio signal generator but with little success. The reliability of the present instrument has been demonstrated over several months and it has filled a long felt need in the writer's workshop.

In your workshop



This month Smithy the Serviceman introduces his assistant, Dick, to some of the more unusual circuits employed in transistor portable radios incorporating short wave ranges.

"I THINK," SAID DICK CONTENTEDLY, "I'll start the afternoon by fixing that little a.m.-f.m. set that's sitting on the rack there."

Smithy's assistant pointed lazily at a small portable radio, from the top of which protruded a few inches of telescopic aerial.

Dick had reason for his contentment. Although a cold and blustery November wind whirled and scurried outside, all was warm and cosy inside the Workshop. Further, he had had an extremely satisfying morning, and had successfully achieved repairs on so many items of domestic electronic equipment that even Smithy had been forced to express reluctant praise. And finally he had just consumed a lunch consisting of a large cheese and pickle sandwich, a large egg and cress sandwich, a large salami sandwich, a Kunzle Showboat cake and an orange, all washed down with a large can of Pepsi-Cola, and was now experiencing the comfortable feeling of one who has eaten expansively and well.

SHORT WAVE RECEIVER

Smithy glanced at the radio indicated by his assistant.

"That," he remarked mildly, and in a tone of equal contentment, "is not an a.m.-f.m. radio."

Smithy also had good reason to be pleased with himself. Like his assistant, he had been able to repair a large number of sets during the morning, with the result that the 'For Repair' racks, on which stood the receiver referred to by Dick, were now agreeably sparse of work. This meant that

he would have a chance during the afternoon to catch up with some of his much neglected paperwork. In accord with Dick he had also lunched well, albeit less colourfully, and had partaken of a Wall's pork pie, two brawn sandwiches and a Lyons Individual Fruit Pie. As ever, the liquid complement of his meal was the inevitable tea, and his battered and disgraceful tin mug, just filled to the brim at the motley collection of utensils maintained near the Workshop sink, now stood steaming on his bench alongside him.

"That set," returned Dick, "must be an a.m.-f.m. job."

"Why must it?"

"Because it's got a telescopic aerial poking out of it. An a.m.-f.m. set uses a ferrite aerial for a.m. and a telescopic aerial for f.m."

"True."

"Then why," persisted Dick, "do you keep on saying that this one isn't an a.m.-f.m. set?"

"Because," explained Smithy, "it's a long, medium and short wave model instead."

"Oh."

Somewhat deflated, Dick turned to the Serviceman.

"Does that mean," he queried, "that it uses a ferrite rod aerial for long and medium waves, and the telescopic aerial for short waves?"

"That's pretty well the size of it," replied Smithy. "As it happens, there's quite a lot of difference between manufacturers in the design approach of these long, medium and short wave

portables, but virtually all of them have a telescopic aerial for short wave reception."

"We don't," remarked Dick, "get a lot of long, medium and short wave portables in this country, do we?"

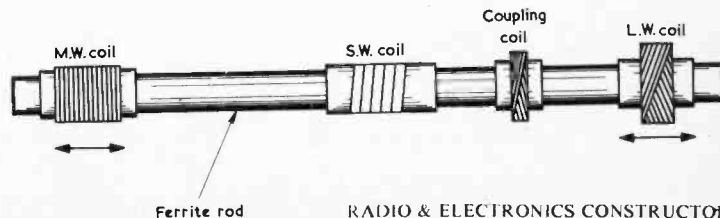
"I wouldn't be too dogmatic about that," replied Smithy cautiously, "because there are quite a lot of imported ones knocking about. I'll agree, though, that U.K. manufacturers turn out far more a.m.-f.m. sets for the home market than sets with short wave bands."

"Fair enough," commented Dick. "Incidentally, why do these sets need a telescopic aerial for short waves in any case? Couldn't the short wave aerial coil be wound on the same ferrite rod as the medium and long wave aerial coils?"

"It can be," said Smithy, "and this course is adopted with a few models. A typical example consists of putting the short wave aerial coil in the middle of the ferrite rod and the medium and long wave coils at the two ends. There's also an aerial coupling coil from the car aerial socket on the rod, this being positioned close to the short wave coil. Each of the long, medium and short wave coils incorporates a winding for coupling to the base of the input mixer-oscillator transistor, and these are switched in by a wavechange switch in the usual manner. The short wave coil also has a second coupling winding, which connects to the telescopic aerial." (Figs. 1 and 2.)

Dick visualised this concept for some moments.

Fig. 1. In some long, medium and short wave portables, the short wave coil is fitted on the ferrite rod.



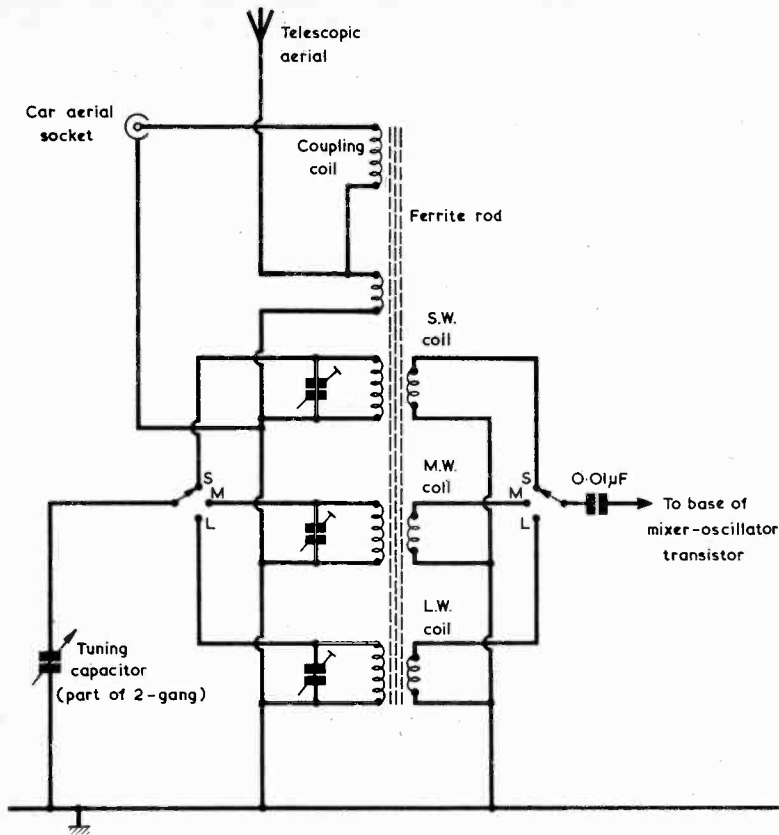


Fig. 2. The ferrite rod assembly of Fig. 1 can appear in a circuit of the type shown here. Note that the short wave coil has an input and an output coupling winding and that the medium and long wave coils have a single output coupling winding each. The variable capacitor is the aerial section of the receiver 2-gang capacitor

"I suppose," he stated, "that you adjust the inductance of the medium and long wave coils by moving them along the rod."

"You do," confirmed Smythy.

"How do you adjust the inductance of the short wave coil? You can't move it around much if it's at the centre of the rod."

"One method of doing this," said Smythy, "is to move the actual coil turns around on the former. You close them up if you want to increase inductance and open them out if you want to decrease inductance."

"I see," commented Dick. "It seems a bit puzzling to me that even though the short wave coil is wound on the ferrite rod, there's still a telescopic aerial."

"The telescopic aerial is needed," explained Smythy, "because signal pick-up by a ferrite rod aerial on short waves is not as high as it is on medium and long waves. The material employed in ferrite rods tends to be less effective and to offer increasing damping as signal frequency goes up. This effect can be offset by using a special

grade of ferrite having lower permeability, which means that you have to wind on more turns for the same inductance. This lower permeability type of rod is used when a short wave coil is put on it."

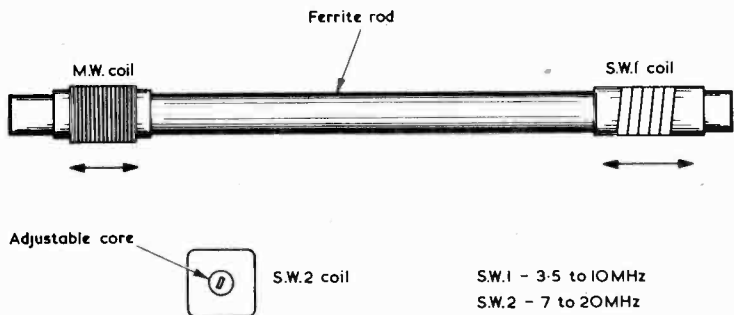


Fig. 3. In some receivers having a medium and two short wave bands, the aerial coil for the lower frequency short wave band may be fitted on the ferrite rod, with the aerial coil for the higher frequency short wave band in a separate screening can. The wave ranges shown are typical

"Blimey," remarked Dick, impressed by this information. "I didn't know you could have different grades of ferrite rod material. I thought an aerial rod was just made of ferrite, period!"

"Most of the ferrite rods you bump into are of a standard grade and permeability," stated Smythy. "They're intended for medium and long wave reception mainly, and are very effective at these frequencies. But they're not so good for short waves."

SEPARATE COILS

"I suppose," said Dick ruminatively, "that, if it's only a few sets which have the short wave aerial coil wound on the ferrite rod, the majority of these sets use separate screened aerial coils for the short wave ranges."

"That's right," confirmed Smythy. "The medium and long wave coils are on the ferrite rod and the short wave coil or coils are in separate cans."

Smythy thought for a moment.

"There are," he continued, "one or two variations on this theme, though. You might, for instance, have a set with a medium wave band and two short wave bands, one short wave band being for say, 3.5 to 10MHz, and the other for something like 7 to 20MHz. The aerial coil for the lower frequency short wave band could be on one end of the ferrite rod, the medium wave aerial coil on the other end, and the aerial coil for the higher frequency short wave band in a separate screening can. In this case the inductance of the aerial coil for the lower frequency short wave band can be adjusted by sliding it along the rod." (Fig. 3.)

Smythy picked up his mug and took a copious draught of its contents.

"Ah, that's better," he remarked, smacking his lips noisily. "A drop of good stuff, that!"

Dick hastily averted his glance and returned to the subject of short wave reception.

"Is the telescopic aerial," he asked.

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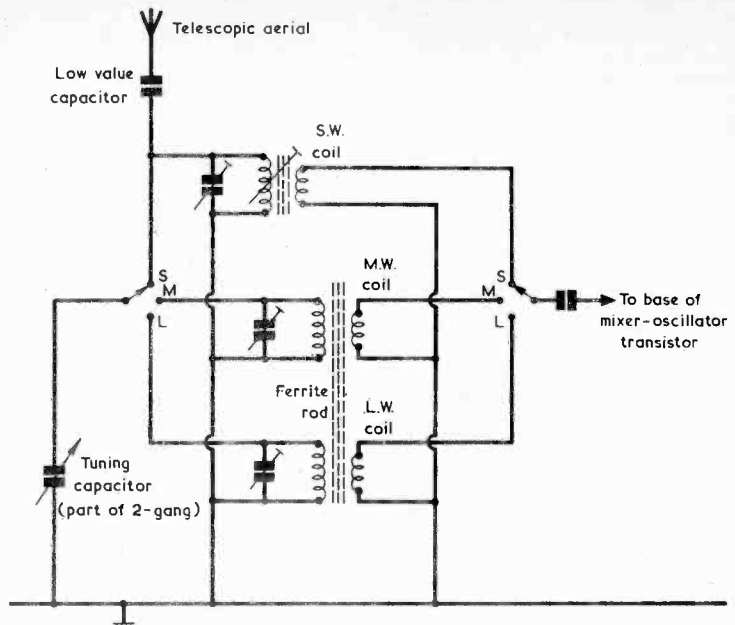


Fig. 4. The telescopic aerial usually couples to the non-earthed end of the short wave tuned coil via a low value capacitor (of the order of 5pF) or by a direct connection

"always coupled to the tuned short wave aerial coil via a coupling coil? Like it was in the first case you described, where the short wave coil was in the middle of the ferrite rod?"

"Oh no," replied Smithy. "The telescopic aerial is much more frequently coupled either direct, or via a low value capacitor, to the hot end of the short wave aerial tuned coil." (Fig. 4.)

"Stap me," said Dick, surprised. "That's a funny way of doing things, isn't it?"

"Not really. Why should it be?"

"Well, the aerial inputs on the short wave sets I've played around with in the past give quite a loose coupling to the tuned coil, and always by way of a coupling coil. If you have a direct connection to the tuned coil you're going to both damp it and detune it."

"That," remarked Smithy, "would quite definitely happen if the aerial you're using is a large one of the type a serious short wave listener with a communications receiver would employ. But with these portable radios the telescopic aerial, when fully extended, is only a few feet long. The damping imposed by an aerial as short as this will be minimal. Also, its capacitance to chassis will be a few picofarads only, and this can be allowed for by having the aerial fully extended when lining up the trimmer across the aerial coil. Admittedly the capacitance to chassis will vary if people or large metal objects approach the aerial too closely, but in general it will be left in the clear. Another reason for having a direct coupling to the

aerial tuned coil is precisely because the aerial is so small. The amount of signal it can pick up is limited, and so a really tight coupling is required."

"It sounds as though you have to be careful if you connect a larger aerial to the telescopic one in order to get greater range."

"You're right there," confirmed Smithy. "Connecting a large aerial to the telescopic one will damp and detune the aerial tuned circuit considerably. If a larger aerial is available it should, with these portable receivers, be coupled to the telescopic aerial via a low value capacitor of, say, 5pF or so."

BASE COUPLING CIRCUIT

Smithy once more picked up his mug and drank from it lustily. Dick looked at him with distaste.

"Ye gods," he commented disgustedly. "We used to have a machine in our district for sucking out the drains which made just the same noise that you do drinking tea."

"Nonsense, lad," retorted Smithy sharply. "I have a natural affinity with tea and I like to get as much of it inside me as I possibly can."

The Serviceman drank again, then replaced his mug on the bench beside him. Decisively, he stood up and walked towards the filing cabinet in which the service manuals were kept. After some searching he picked out a service sheet and carried it over to Dick's bench.

"Now here," he remarked, "is a rather unusual aerial input circuit, and it's employed in a portable receiver

having medium and long wave bands and two short wave bands."

Smithy opened the manual at the circuit diagram and indicated the aerial input section. (Fig. 5).

"Ah," said Dick eagerly. "Now let's take a look at this. The aerial input section seems fairly easy at first sight. Starting with the Short Wave 2 band, I see that the telescopic aerial couples via a 6.8pF capacitor to the top end of L6, this being tuned by the 255pF variable capacitor. Which will, of course, be one section of the receiver 2-gang."

"It will."

"Good," said Dick, encouraged. "Now there's a coupling coil, L7, one end of which goes to a 2,000pF decoupling capacitor. The other end goes via a section of the wavechange switch to the base of the mixer-oscillator transistor. Well, that seems easy enough."

"Okay. Go on."

Dick threw a sudden doubtful glance at the Serviceman.

"You've got something hidden up your sleeve here," he announced suspiciously. "Still, I suppose I'd better press on. I'll do the Short Wave 1 band next. Why, this is just the same as the Short Wave 2 band! When the wavechange switch is set to the Short Wave 1 band, the aerial couples via the 6.8pF capacitor to the top of L4, which is again tuned by the 255pF variable capacitor. The coupling coil L5 then connects to the base of the mixer-oscillator transistor. Again, dead easy!"

"What about the car aerial socket?"

"The car aerial socket? Oh yes, well this is coupled to the telescopic aerial on both the short wave bands. This means that the car aerial can be coupled to the short wave coils via the 6.8pF capacitor. The car aerial will have a much higher capacitance to earth than the telescopic aerial, but the 6.8pF capacitor shouldn't allow this to detune the short wave aerial tuned circuits too seriously."

"Fine," said Smithy heartily. "Now go on to medium and long waves."

"All right," replied Dick, with a voice which still betrayed a certain dubiety. "To start off with, when the wavechange switch is set to medium or long waves the car aerial socket is connected to the coupling coil on the ferrite rod. Which represents standard practice, of course. Also, the upper terminal of the 255pF variable capacitor connects to the upper end of the medium wave tuned winding. The lower end of the medium wave winding goes to the top end of the long wave tuned winding. This is shorted out on medium waves, and is brought into circuit on long waves."

Dick paused.

"I'm nearly finished now," he called out enthusiastically, his confidence patently rising. "The next thing is that the bottom end of the long wave tuned winding, or the bottom end of the medium wave tuned winding when medium waves is selected, goes to the 2,000pF decoupling capacitor

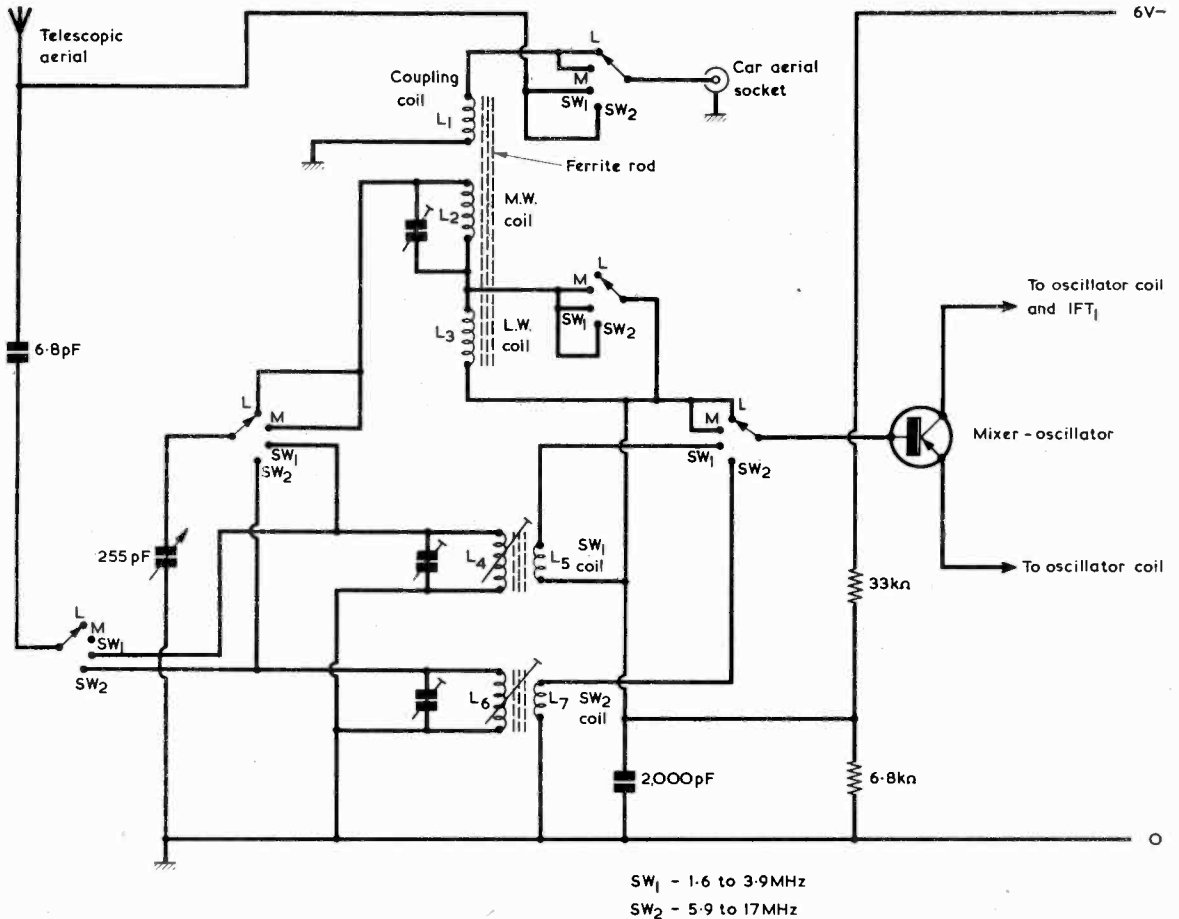


Fig. 5. An unusual aerial input circuit for a receiver with two short wave ranges. This is a simplified version of the circuit employed in the Ferguson Model 3120, the simplification consisting mainly of showing rotary instead of press-button wavechange switching

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and it then connects . . ."

Dick's voice trailed away.

"Let's try that again," he resumed.
"Now the bottom ends of the long and
medium wave windings go to the
2,000pF decoupling capacitor and also
connect to the . . ."

Again, Dick's voice faltered off into
silence.

"What's up, laddie?" said Smithy
in a commiserative tone.

"I can't say it," wailed Dick, "I
just can't say it!"

"Can't say what?"

"I can't say what happens here!"

"Try it."

"Oh, all right," said Dick, drawing a
deep breath. "Here goes, then. The
bottom end of the long or medium
wave tuned winding goes to the
2,000pF decoupling capacitor and then
also connects to the base of the mixer-
oscillator transistor!"

"Very good," remarked Smithy
approvingly. "I couldn't have
expressed it more clearly myself."

"But it's crazy, Smithy. You can't
feed the base of a transistor from a
decoupling capacitor!"

"It's done here."

"That's what makes it so crazy.
A decoupling capacitor is supposed to
act as a short-circuit to signal voltages,
not to provide coupling."

"The way in which the capacitor
works," replied Smithy, "depends on
its value and the frequency that's
applied to it. Now, the overall short
wave coverage of this receiver is from
about 1.5 to 15MHz, and at these
frequencies a capacitance of 2,000pF
offers reactances of some 50 to 5 ohms.
Not exactly a dead short, but near
enough to one to hold down the lower
ends of the two short wave coupling
windings which feed the base of the
mixer-oscillator. The bottom long
wave and top medium wave fre-
quencies are of the order of 150kHz
and 1.5MHz, and the corresponding
reactances given by the 2,000pF
capacitor range from 500 to 50 ohms.
These reactances are ten times higher
than those for the short wave ranges
and can be considered as being suffi-
ciently high to enable a signal to appear
across the 2,000pF capacitor which is
capable of being fed to the base of the
transistor."

"I don't understand that," said
Dick, frowning. "You'll have to
explain all this a bit more deeply."

Smithy took out a ball-pen and
traced out the basic circuit of the
medium and long wave aerial tuning
arrangements. (Fig. 6(a).)

"If you follow the medium and long
wave circuit through," he remarked,
"You'll see that the 2,000pF capacitor
forms part of the aerial tuned circuit,
whereupon some of the aerial signal
voltage must appear across it. Since
the signal voltage across the capacitor
is at low impedance, it is suitable for
application to the base of the
transistor."

BOTTOM-END COUPLING

Dick shrugged his shoulders.

"I still don't get it," he said help-
lessly. "It seems to be such an unusual
way of doing things."

"It is unusual," concurred Smithy,
"but that doesn't mean to say that it
isn't practicable. Look at this."

Smithy scribbled a circuit in the
margin of the service manual. (Fig.
6(b)).

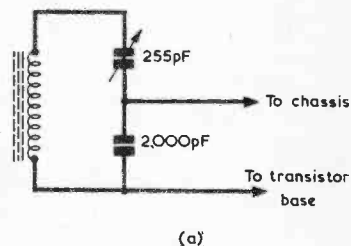
"Now here," he announced, "we
have a ferrite rod aerial tuned circuit.
And we tap into the coil at a point near
the earthy end to obtain a feed for the
base of the first transistor of the
associated receiver. Is that okay?"

"Why, of course it is. That's quite a
normal circuit."

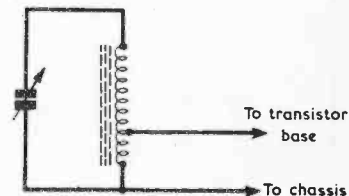
"Very well then," continued Smithy.
"What we're doing here is to take a
low impedance tap from the inductive
side of the tuned circuit. With the
2,000pF capacitor arrangement we're
doing the same sort of thing but this
time we're taking a low impedance tap
from the capacitive side of the tuned
circuit. It's just as simple as that."

Dick looked once more at the circuit
with the 2,000pF decoupling capacitor,
and gradually his furrowed brow
cleared.

"Ah, it's beginning to make sense at
last," he said in a relieved tone. "To
take the explanation a stage further,



(a)



(b)

Fig. 6(a). If the basic medium
and long wave tuned circuit
of Fig. 5 is redrawn like this,
it can be seen that the
coupling to the transistor
base and chassis is taken
from a tap in the capacitive
side of the tuned circuit
Fig. 6(b). A more familiar
arrangement, in which the
tap is taken from the induc-
tive side of the tuned circuit

there's going to be the same signal current circulating in the capacitive half of the aerial tuned circuit as there is circulating in the inductive half, so there's no reason why a low impedance output shouldn't be taken from the capacitive side instead of from the inductive side."

"Exactly," stated Smithy. "Actually, however, the two circuits are not quite identical. With the inductive tap the inductance ratio between the tapped section of the coil and the total coil remains constant at all settings of the tuning capacitor. When the capacitive tap is used, the ratio between the tapped capacitance and the total capacitance varies as the tuning capacitance changes. This doesn't stop the idea from working quite well in practice. Funnily enough, this circuit reminds me of a medium and long wave aerial input coupling circuit we used in the old days with the cheaper valve mains radios."

Smithy picked up his tin mug and noisily drained it.

"What," said Dick, suppressing his shudders, "sort of circuit was that, Smithy?"

"Get me some more tea," replied Smithy, "and I'll tell you."

Dick rose and picked up Smithy's mug gingerly, then obediently recharged it from the teapot at the Workshop sink.

"Blimey Smithy," he remarked, as he returned with a fresh cargo of steaming hot tea, "don't you think it's about time you cleaned up this repulsive mug of yours."

"Of course not," retorted Smithy. "A bit of lining from previous lots of tea helps to flavour the existing lot."

"There must be half the germs known to mankind running around in the darned thing," complained Dick. "I bet that if you took that mug out of the country and then tried to return with it, they'd keep it in quaran-

tine for six months before they let you have it back again."

But Smithy was too busily engaged in assuaging his thirst to pay any attention to his assistant's comments. He next returned his mug, its contents considerably depleted, to the surface of his bench, then wiped his lips with the back of his hand.

"Now, where was I?"

"You were talking," said Dick quickly, anxious to bring his own thoughts away from the more repellent of Smithy's habits, "about a method of aerial coupling which was used with old valve mains sets."

"Ah yes, so I was," replied Smithy. "Well, this is what used to be called 'bottom-end' coupling, and it worked basically like this."

Smithy drew a further circuit in the margin of the service manual. (Fig. 7 (a).)

"This circuit also takes advantage of a low impedance tap in the capacitive side of the aerial tuned circuit," he remarked, "but in this case the tap allows a low impedance input to be provided. The capacitor was usually somewhat higher in value than 2,000pF and would typically be 5,000pF."

"What was the advantage of this method of coupling?"

"It dispensed with separate coupling coils," replied Smithy, "And it also, in consequence, simplified wavechange switching. Since the input was at low impedance it was essential for the receiver chassis to be at earth potential for radio frequencies. An effective earth connection was, however, automatically provided, because the circuit was used in a.c.-d.c. sets which had the chassis common to one side of the mains supply. A minor snag was that it was necessary, in practical versions of the circuit, to provide two extra capacitors and a resistor."

Smithy added these components to

his last sketch. (Fig. 7(b)).

"The 10kΩ resistor and 0.01μF capacitor I've put in here," he went on, "are to reduce mains modulation, the effect of which is to cause the reproduced signal to have a 50Hz gurgle superimposed on it. This could occur if the mains were connected so that the chassis was at live and not neutral potential. The 0.002μF capacitor is merely a mains isolating capacitor. Although this circuit was used before ferrite rod aerials appeared on the scene, it still represents an excellent way of providing external aerial coupling to a modern medium and long wave receiver having a ferrite aerial."

VARIABLE RESISTOR FINE TUNING

"That's something I hadn't heard of before," remarked Dick. "Getting back to present-day transistor portables with short wave bands, are there any other unusual points about these?"

"Nothing I can think of at the moment," replied Smithy, pondering. "Wait a minute, though, there is one other unusual circuit I've encountered with these sets. It consists of a fine tuning arrangement for short waves which incorporates a variable resistor."

"Hey?"

"I'm not joking," said Smithy, chuckling at Dick's surprise. "The circuit is very simple and employs a variable resistor in series with a fixed capacitor of around 2.2pF, these being connected across the oscillator section of the receiver 2-gang tuning capacitor. Here's the circuit."

Again Smithy scribbled in the margin of the service sheet. (Fig. 8.)

"The method of operation of this circuit," he remarked, "is pretty obvious. When the variable resistor inserts maximum resistance, the total impedance offered by the resistor and the 2.2pF capacitor in series is very

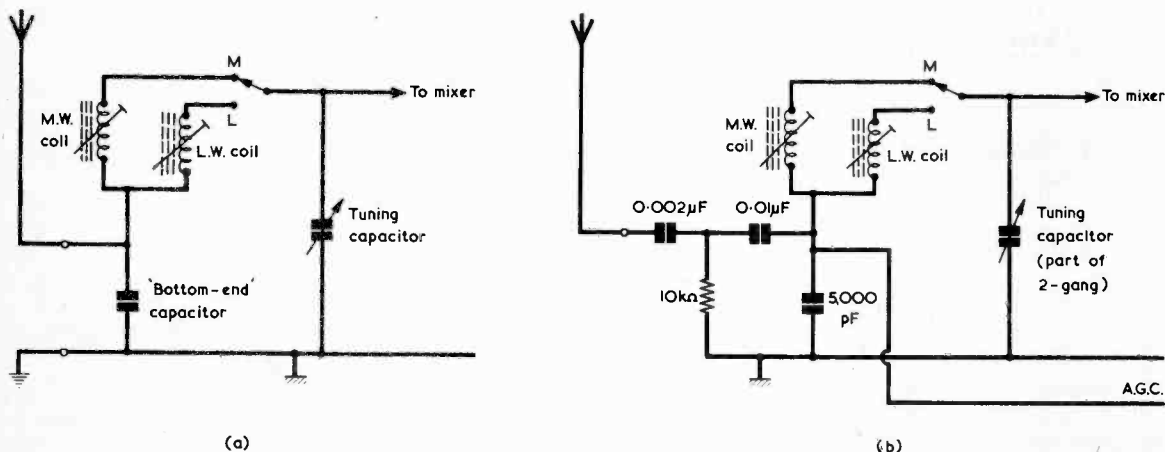


Fig. 7(a). A 'bottom-end' aerial input circuit in its basic form
 (b). A practical version of the 'bottom-end' circuit. This causes the aerial to be isolated and prevents mains modulation

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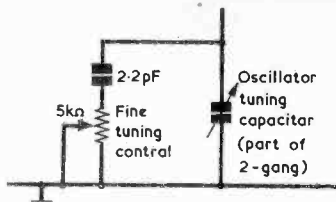


Fig 8. A short wave fine tuning control incorporating a variable resistor. This circuit has been employed in some Philips portable radios

high, and there is negligible detuning of the frequency selected by the main oscillator tuning capacitor. When the variable resistor inserts zero resistance the 2.2pF capacitor is effectively connected directly across the main oscillator tuning capacitor and shifts the tuned frequency accordingly. Intermediate settings of the variable resistor will cause intermediate shifts of frequency. The advantages to this

arrangement as compared with a straightforward 2.2pF variable capacitor are, I presume, given by the facts that a variable resistor is physically more robust than a variable capacitor and that it is easier to fit into a particular control panel layout. The circuit wiring has still, of course, to be just as short as when a variable capacitor is employed."

With a familiar gesture of finality, Smyth placed his now emptied mug on his bench, then glanced at his watch.

"Right, back to work now," he announced officiously. "We're at least five minutes overdue."

"Well, don't get all bossy about it," returned Dick aggrievedly. "Strikes me that there are too many Chiefs and not enough Indians around here. Hey, where are you going?"

Smyth folded his arms and assumed a stern expression.

"Me heap big Chief," he pronounced sonorously. "Me go now to wig-wam."

"To wig-wam?"
"Yes," replied the grinning Serviceman. "Big Chief go to teepee." ■

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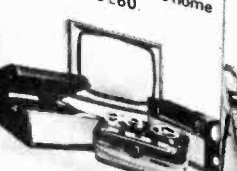
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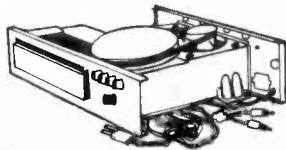


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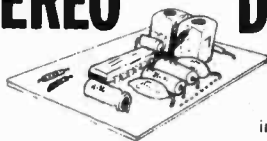
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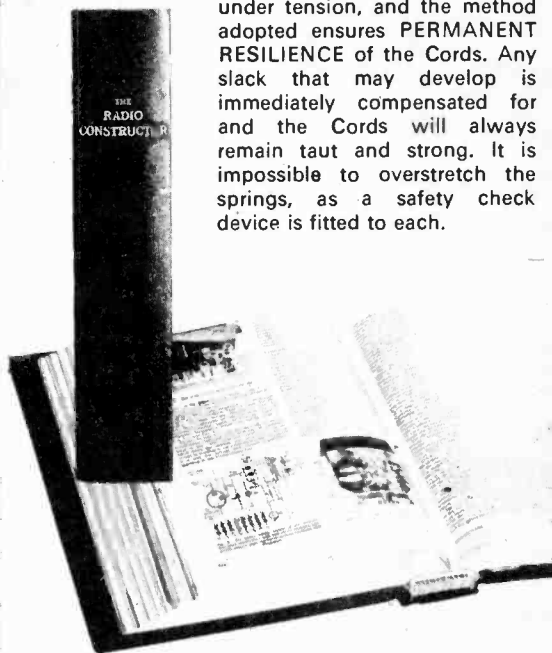
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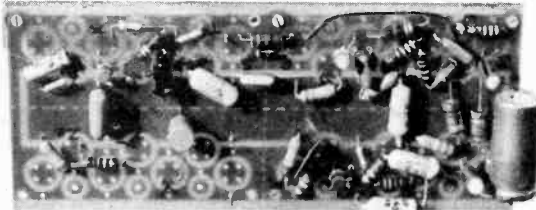
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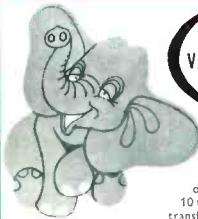
FREQUENCY-WAVELENGTH TABLE 1

The first five entries list wavelengths of radio frequencies from 0.1MHz (= 100kHz) to 1,000MHz, after which wavelengths are given for frequencies from 1 to 5.2MHz. Use the appropriate factor for frequencies in other decades; thus, 31MHz corresponds with 9.67 metres. The list will be completed in the next Data Sheet.

Frequency (MHz)	Wavelength (metres)	Frequency (MHz)	Wavelength (metres)	Frequency (MHz)	Wavelength (metres)
0.1	3,000	1.7	176	2.9	103
1.0	300	1.8	167	3.0	100
10.0	30	1.9	158	3.1	96.7
100.0	3	2.0	150	3.2	93.7
1,000.0	0.3	2.1	143	3.3	90.6
1.0	300	2.2	136	3.4	88.0
1.1	273	2.3	130	3.5	85.7
1.2	250	2.4	125	3.6	83.3
1.3	230	2.5	120	3.7	81.0
1.4	214	2.6	115	3.8	78.9
1.5	200	2.7	111	3.9	76.7
1.6	187	2.8	107	4.0	75.0
				4.1	73.1
				4.2	71.4
				4.3	69.7
				4.4	68.2
				4.5	66.7
				4.6	65.2
				4.7	63.8
				4.8	62.5
				4.9	61.2
				5.0	60.0
				5.1	58.6
				5.2	57.7

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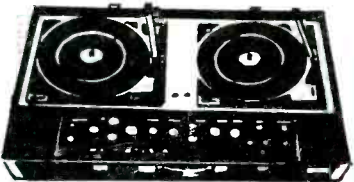
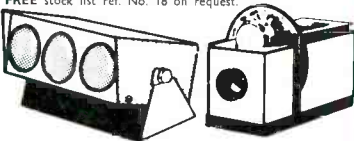


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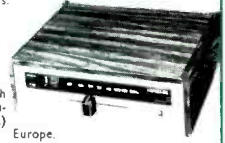
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