

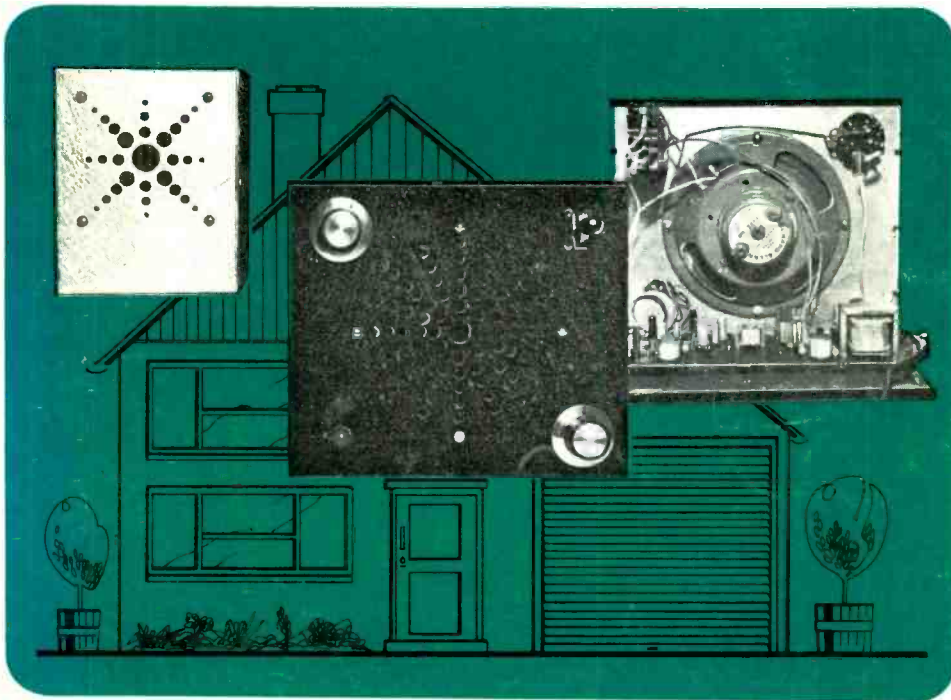
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Vol. 24 No. 4

NOVEMBER 1970

3/6



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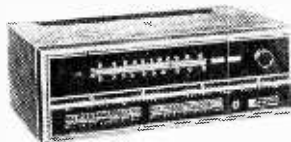
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AC107 7/4	BC171 5/2	BSY95A 2/11	GET113 4/2	NKT205 4/2	NKT703 8/2	5140 33/4	ZG378 7/2	2N2432 47/2	2N3858 5/2	251002 10/2
AC126 5/2	BC180 1/10	BTX39 6/0	GET134 5/2	NKT206 4/2	NKT710 5/10	51400 2/2	ZG381 5/2	2N2433 4/2	2N3859 5/4	251003 10/2
AC127 5/2	BC181 3/4	600 120/1	GET135 4/2	NKT207 4/2	NKT711 5/10	5141 5/2	ZG414 12/2	2N2434 7/10	2N3860 6/4	2N3861 13/9
AC127Z 9/6	BC184 3/4	BTX40 6/0	GET136 5/2	NKT210 4/2	NKT734 4/11	5172 9/9	2N174 10/2	2N2435 7/6	2N3862 4/3	2N3863 15/3
AC138 4/2	BC192 3/4	600 120/1	GET137 5/2	NKT211 3/9	NKT735 4/2	5183 4/2	2N175 7/6	2N2436 4/2	2N3863 4/3	2N3864 15/3
AC138 4/2	BC193 3/4	600 120/1	GET138 5/2	NKT212 3/9	NKT737 3/7	5183A 4/2	2N184 17/2	2N2437 10/2	2N3864 25/2	2N3865 10/9
AC187 4/2	BC193 3/4	600 120/1	GET139 5/2	NKT213 4/7	NKT738 4/2	5183B 4/2	2N186 12/2	2N2438 10/2	2N3866 25/2	2N3867 10/9
AC188 4/2	BC193 3/4	600 120/1	GET140 5/2	NKT214 3/5	NKT739 4/2	5183C 4/2	2N187 12/2	2N2439 10/2	2N3867 10/9	2N3868 10/9
AC179 5/9	BC193 3/4	600 120/1	GET141 5/2	NKT215 3/7	NKT740 4/2	5183D 4/2	2N188 12/2	2N2440 10/2	2N3868 10/9	2N3869 10/9
AC179 5/9	BC193 3/4	600 120/1	GET142 5/2	NKT216 3/7	NKT741 4/2	5183E 4/2	2N189 12/2	2N2441 10/2	2N3869 10/9	2N3870 10/9
AC179 5/9	BC193 3/4	600 120/1	GET143 5/2	NKT217 3/7	NKT742 4/2	5183F 4/2	2N190 12/2	2N2442 10/2	2N3870 10/9	2N3871 10/9
AC179 5/9	BC193 3/4	600 120/1	GET144 5/2	NKT218 3/7	NKT743 4/2	5183G 4/2	2N191 12/2	2N2443 10/2	2N3871 10/9	2N3872 10/9
AC179 5/9	BC193 3/4	600 120/1	GET145 5/2	NKT219 4/7	NKT744 4/2	5183H 4/2	2N192 12/2	2N2444 10/2	2N3872 10/9	2N3873 10/9
AC179 5/9	BC193 3/4	600 120/1	GET146 5/2	NKT220 4/7	NKT745 4/2	5183I 4/2	2N193 12/2	2N2445 10/2	2N3873 10/9	2N3874 10/9
AC179 5/9	BC193 3/4	600 120/1	GET147 5/2	NKT221 4/7	NKT746 4/2	5183J 4/2	2N194 12/2	2N2446 10/2	2N3874 10/9	2N3875 10/9
AC179 5/9	BC193 3/4	600 120/1	GET148 5/2	NKT222 4/7	NKT747 4/2	5183K 4/2	2N195 12/2	2N2447 10/2	2N3875 10/9	2N3876 10/9
AC179 5/9	BC193 3/4	600 120/1	GET149 5/2	NKT223 4/7	NKT748 4/2	5183L 4/2	2N196 12/2	2N2448 10/2	2N3876 10/9	2N3877 10/9
AC179 5/9	BC193 3/4	600 120/1	GET150 5/2	NKT224 4/7	NKT749 4/2	5183M 4/2	2N197 12/2	2N2449 10/2	2N3877 10/9	2N3878 10/9
AC179 5/9	BC193 3/4	600 120/1	GET151 5/2	NKT225 4/7	NKT750 4/2	5183N 4/2	2N198 12/2	2N2450 10/2	2N3878 10/9	2N3879 10/9
AC179 5/9	BC193 3/4	600 120/1	GET152 5/2	NKT226 4/7	NKT751 4/2	5183O 4/2	2N199 12/2	2N2451 10/2	2N3879 10/9	2N3880 10/9
AC179 5/9	BC193 3/4	600 120/1	GET153 5/2	NKT227 4/7	NKT752 4/2	5183P 4/2	2N200 12/2	2N2452 10/2	2N3880 10/9	2N3881 10/9
AC179 5/9	BC193 3/4	600 120/1	GET154 5/2	NKT228 4/7	NKT753 4/2	5183Q 4/2	2N201 12/2	2N2453 10/2	2N3881 10/9	2N3882 10/9
AC179 5/9	BC193 3/4	600 120/1	GET155 5/2	NKT229 4/7	NKT754 4/2	5183R 4/2	2N202 12/2	2N2454 10/2	2N3882 10/9	2N3883 10/9
AC179 5/9	BC193 3/4	600 120/1	GET156 5/2	NKT230 4/7	NKT755 4/2	5183S 4/2	2N203 12/2	2N2455 10/2	2N3883 10/9	2N3884 10/9
AC179 5/9	BC193 3/4	600 120/1	GET157 5/2	NKT231 4/7	NKT756 4/2	5183T 4/2	2N204 12/2	2N2456 10/2	2N3884 10/9	2N3885 10/9
AC179 5/9	BC193 3/4	600 120/1	GET158 5/2	NKT232 4/7	NKT757 4/2	5183U 4/2	2N205 12/2	2N2457 10/2	2N3885 10/9	2N3886 10/9
AC179 5/9	BC193 3/4	600 120/1	GET159 5/2	NKT233 4/7	NKT758 4/2	5183V 4/2	2N206 12/2	2N2458 10/2	2N3886 10/9	2N3887 10/9
AC179 5/9	BC193 3/4	600 120/1	GET160 5/2	NKT234 4/7	NKT759 4/2	5183W 4/2	2N207 12/2	2N2459 10/2	2N3887 10/9	2N3888 10/9
AC179 5/9	BC193 3/4	600 120/1	GET161 5/2	NKT235 4/7	NKT760 4/2	5183X 4/2	2N208 12/2	2N2460 10/2	2N3888 10/9	2N3889 10/9
AC179 5/9	BC193 3/4	600 120/1	GET162 5/2	NKT236 4/7	NKT761 4/2	5183Y 4/2	2N209 12/2	2N2461 10/2	2N3889 10/9	2N3890 10/9
AC179 5/9	BC193 3/4	600 120/1	GET163 5/2	NKT237 4/7	NKT762 4/2	5183Z 4/2	2N210 12/2	2N2462 10/2	2N3890 10/9	2N3891 10/9
AC179 5/9	BC193 3/4	600 120/1	GET164 5/2	NKT238 4/7	NKT763 4/2	5183AA 4/2	2N211 12/2	2N2463 10/2	2N3891 10/9	2N3892 10/9
AC179 5/9	BC193 3/4	600 120/1	GET165 5/2	NKT239 4/7	NKT764 4/2	5183AB 4/2	2N212 12/2	2N2464 10/2	2N3892 10/9	2N3893 10/9
AC179 5/9	BC193 3/4	600 120/1	GET166 5/2	NKT240 4/7	NKT765 4/2	5183AC 4/2	2N213 12/2	2N2465 10/2	2N3893 10/9	2N3894 10/9
AC179 5/9	BC193 3/4	600 120/1	GET167 5/2	NKT241 4/7	NKT766 4/2	5183AD 4/2	2N214 12/2	2N2466 10/2	2N3894 10/9	2N3895 10/9
AC179 5/9	BC193 3/4	600 120/1	GET168 5/2	NKT242 4/7	NKT767 4/2	5183AE 4/2	2N215 12/2	2N2467 10/2	2N3895 10/9	2N3896 10/9
AC179 5/9	BC193 3/4	600 120/1	GET169 5/2	NKT243 4/7	NKT768 4/2	5183AF 4/2	2N216 12/2	2N2468 10/2	2N3896 10/9	2N3897 10/9
AC179 5/9	BC193 3/4	600 120/1	GET170 5/2	NKT244 4/7	NKT769 4/2	5183AG 4/2	2N217 12/2	2N2469 10/2	2N3897 10/9	2N3898 10/9
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AC179 5/9	BC193 3/4	600 120/1	GET172 5/2	NKT246 4/7	NKT771 4/2	5183AI 4/2	2N219 12/2	2N2471 10/2	2N3899 10/9	2N3900 10/9
AC179 5/9	BC193 3/4	600 120/1	GET173 5/2	NKT247 4/7	NKT772 4/2	5183AJ 4/2	2N220 12/2	2N2472 10/2	2N3900 10/9	2N3901 10/9
AC179 5/9	BC193 3/4	600 120/1	GET174 5/2	NKT248 4/7	NKT773 4/2	5183AK 4/2	2N221 12/2	2N2473 10/2	2N3901 10/9	2N3902 10/9
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AC179 5/9	BC193 3/4	600 120/1	GET176 5/2	NKT250 4/7	NKT775 4/2	5183AM 4/2	2N223 12/2	2N2475 10/2	2N3903 10/9	2N3904 10/9
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AC179 5/9	BC193 3/4	600 120/1	GET178 5/2	NKT252 4/7	NKT777 4/2	5183AO 4/2	2N225 12/2	2N2477 10/2	2N3905 10/9	2N3906 10/9
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AC179 5/9	BC193 3/4	600 120/1	GET187 5/2	NKT261 4/7	NKT786 4/2	5183AX 4/2	2N234 12/2	2N2486 10/2	2N3914 10/9	2N3915 10/9
AC179 5/9	BC193 3/4	600 120/1	GET188 5/2	NKT262 4/7	NKT787 4/2	5183AY 4/2	2N235 12/2	2N2487 10/2	2N3915 10/9	2N3916 10/9
AC179 5/9	BC193 3/4	600 120/1	GET189 5/2	NKT263 4/7	NKT788 4/2	5183AZ 4/2	2N236 12/2	2N2488 10/2	2N3916 10/9	2N3917 10/9
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AC179 5/9	BC193 3/4	600 120/1	GET191 5/2	NKT265 4/7	NKT790 4/2	5183BB 4/2	2N238 12/2	2N2490 10/2	2N3918 10/9	2N3919 10/9
AC179 5/9	BC193 3/4	600 120/1	GET192 5/2	NKT266 4/7	NKT791 4/2	5183BC 4/2	2N239 12/2	2N2491 10/2	2N3919 10/9	2N3920 10/9
AC179 5/9	BC193 3/4	600 120/1	GET193 5/2	NKT267 4/7	NKT792 4/2	5183BD 4/2	2N240 12/2	2N2492 10/2	2N3920 10/9	2N3921 10/9
AC179 5/9	BC193 3/4	600 120/1	GET194 5/2	NKT268 4/7	NKT793 4/2	5183BE 4/2	2N241 12/2	2N2493 10/2	2N3921 10/9	2N3922 10/9
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AC179 5/9	BC193 3/4	600 120/1	GET198 5/2	NKT272 4/7	NKT797 4/2	5183BI 4/2	2N245 12/2	2N2497 10/2	2N3925 10/9	2N3926 10/9
AC179 5/9	BC193 3/4	600 120/1	GET199 5/2	NKT273 4/7	NKT798 4/2	5183BJ 4/2	2N246 12/2	2N2498 10/2	2N3926 10/9	2N3927 10/9
AC179 5/9	BC193 3/4	600 120/1	GET200 5/2	NKT274 4/7	NKT799 4/2	5183BK 4/2	2N247 12/2	2N2499 10/2	2N3927 10/9	2N3928 10/9
AC179 5/9	BC193 3/4	600 120/1	GET201 5/2	NKT275 4/7	NKT800 4/2	5183BL 4/2	2N248 12/2	2N2500 10/2	2N3928 10/9	2N3929 10/9
AC179 5/9	BC193 3/4	600 120/1	GET202 5/2	NKT276 4/7	NKT801 4/2	5183BM 4/2	2N249 12/2	2N2501 10/2	2N3929 10/9	2N3930 10/9
AC179 5/9	BC193 3/4	600 120/1	GET203 5/2	NKT277 4/7	NKT802 4/2	5183BN 4/2	2			

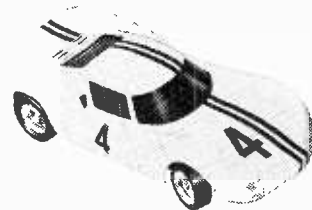
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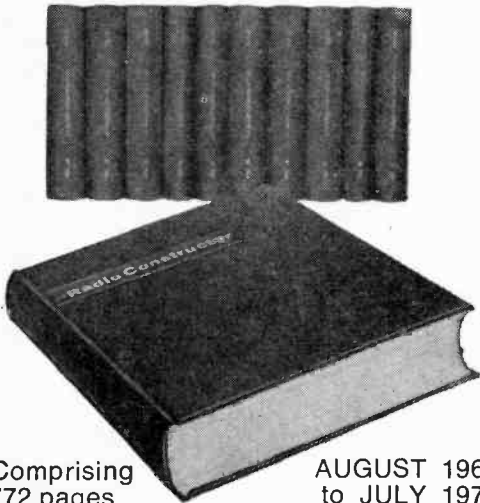
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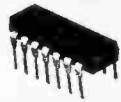
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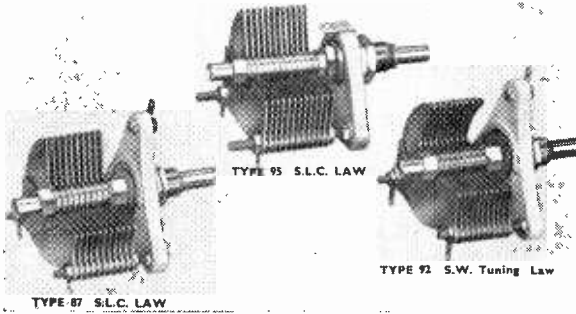
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BSY27	2/6	OC28	6/-
BSY28	2/6	OC35	5/-
BSY29	2/6	OC36	7/6
BSY95A	2/6	AD149	6/-
OC41	2/6	AUY10	25/-
OC44	2/6	2N3055	12/6
OC45	2/6	2S034	5/-
OC71	2/6	Diodes	
OC72	2/6	AA42	2/-
OC73	3/6	OA95	2/-
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OC81D	2/6	OA81	1/9
OC139	2/6	IN914	1/6

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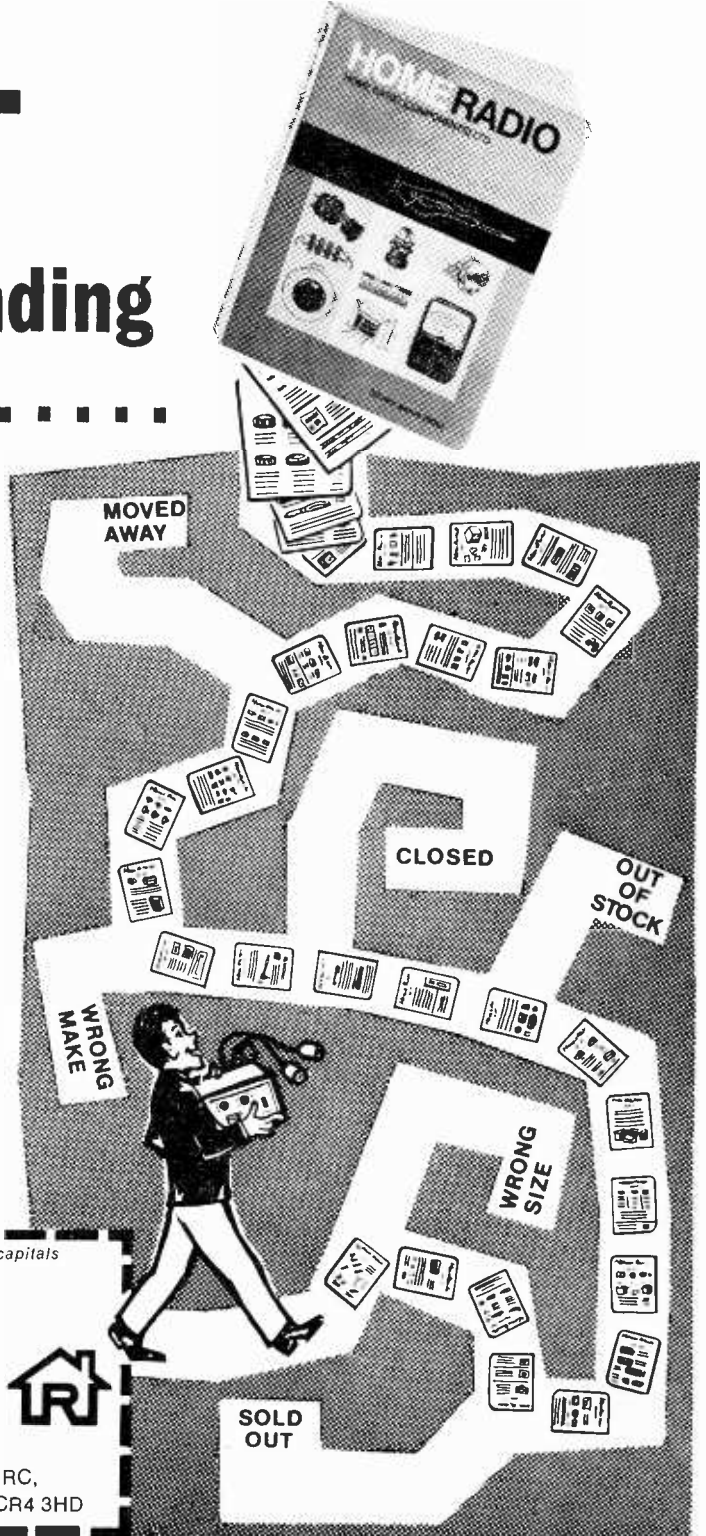
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# THE Radio Constructor



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NOVEMBER 1970

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# THE 'TRI-add' TUNER UNIT

by

F. G. RAYER, Assoc.I.E.R.E.

This article, which concludes the series describing the 'Tri-add' set of equipment, deals with the superhet tuner. This tuner is intended for operation with the 'Tri-add' main amplifier and, since it employs plug-in coils, may be constructed to cover a single broadcast band or the complete range from 150kHz to 31MHz

**T**HIS SUPERHET TUNER IS PRIMARILY INTENDED FOR use with the 'Tri-add' main amplifier, which was described in the first article of this series. It is plugged directly into the amplifier, from which it also draws current, whereupon loudspeaker reception of a considerable number of stations is possible.

The tuner is easy to construct, and employs miniature plug-in coils. This has the advantage of avoiding a bandswitch, with its numerous connections, and also allows the user to choose just those bands which are required. In some cases only medium wave coverage will be wanted, for the reception of the usual B.B.C. and other programmes. If so, only the medium wave coils need be obtained. Other users may want to tune short wave bands as well. Again, for some listeners the long wave band is of attraction, while other listeners may not wish to cover this band.

The tuner is constructed on a deep chassis, with all items except the valves, i.f. transformers, and coils underneath. No high tension circuits or other circuits where voltage is present appear above the chassis.

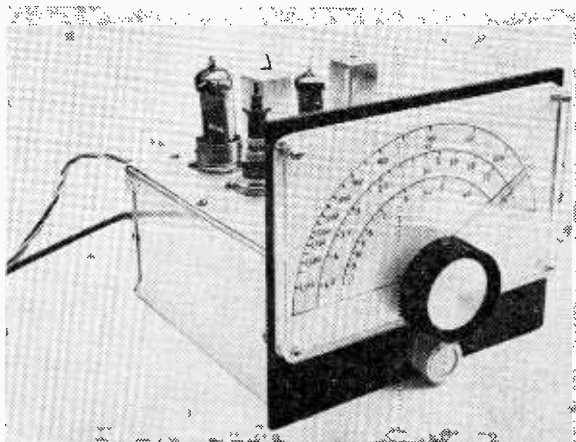
This is a safe and convenient arrangement, with easy access to the coils.

If the tuner is fitted in a cabinet, this will require a lift-up lid, unless reception is to be on one band only (probably medium wave). It will be noted that the panel dimensions can readily be changed to suit an existing case.

With the form of construction shown, the case is rather an unnecessary item. There is no wiring whatever above the chassis.

## CIRCUIT

Fig. 1 gives the circuit, which employs two valves and a semiconductor diode D1 for detection and automatic gain control. V1 is the frequency changer, operating in conjunction with aerial coil L1 and oscillator coil L2. VC1/VC2 is the ganged tuning



Front view of the tuner. The two-speed slow motion dial imparts a smart appearance

THE RADIO CONSTRUCTOR



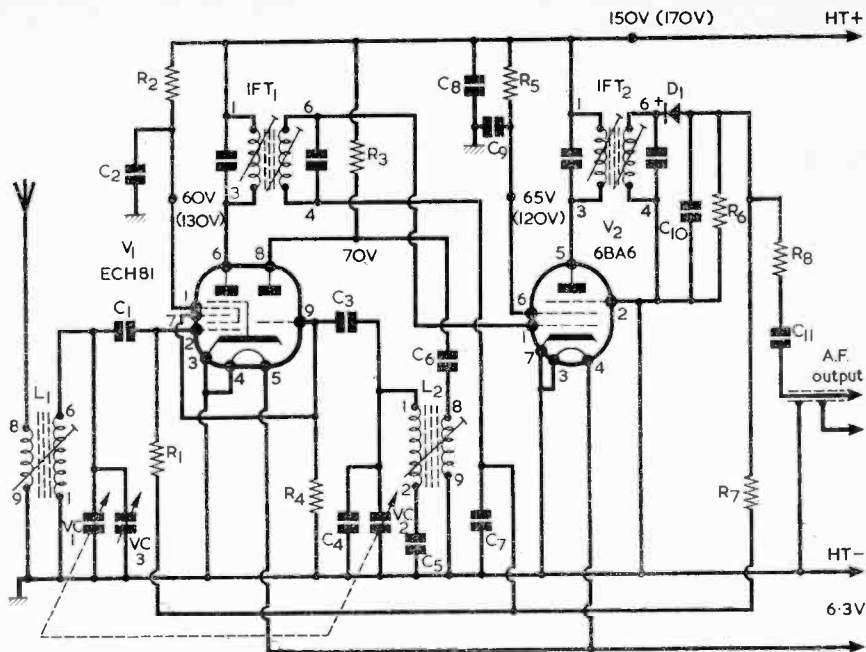


Fig. 1. The circuit of the radio tuner. C5 is the padding capacitor for the medium wave range, the padding for other ranges being discussed in the text

## COMPONENTS

### Resistors (All 10%)

R1	1M $\Omega$ $\frac{1}{4}$ watt
R2	22k $\Omega$ $\frac{1}{2}$ watt
R3	22k $\Omega$ $\frac{1}{2}$ watt
R4	47k $\Omega$ $\frac{1}{4}$ watt
R5	33k $\Omega$ $\frac{1}{2}$ watt
R6	270k $\Omega$ $\frac{1}{4}$ watt
R7	2.2M $\Omega$ $\frac{1}{4}$ watt
R8	22k $\Omega$ $\frac{1}{4}$ watt

### Capacitors

C1	200pF silver-mica
C2	0.01 $\mu$ F paper or plastic foil, 350V wkg.
C3	50pF silver-mica
C4	18pF silver-mica
*C5	350pF silver-mica, 2%
C6	200pF silver-mica
C7	0.05 $\mu$ F paper or plastic foil, 150V wkg.
C8	0.1 $\mu$ F paper or plastic foil, 350V wkg.
C9	0.01 $\mu$ F paper or plastic foil, 350V wkg.
C10	100pF silver-mica
C11	0.01 $\mu$ F paper or plastic foil, 150V wkg.

\*See text for padding capacitor values for Ranges 1, 3, 4 and 5.

VC1, 2 365 + 365pF 2-gang variable, Type 02 (Jackson Bros.)

VC3 50pF variable, Type C804 (Jackson Bros.)

### Inductors

L1	Aerial coil, ranges as required, Miniature Dual-Purpose (Valve) Blue (Denco)
L2	Oscillator coil, ranges as required, Miniature Dual-Purpose (Valve) Red (Denco)
IFT1	465kHz i.f. transformer Type IFT11 (Denco)
IFT2	465kHz i.f. transformer Type IFT11 (Denco)

### Valves

V1	ECH81
V2	6BA6

### Diode

D1	OA81
----	------

### Drive

Slow Motion Dial Type SMD2/BK (black knob) or SMD2/WH (white knob) (Electroniques)

### Valveholders

1	B9A skirted valveholder with screening can (for V1)
1	B7G skirted valveholder with screening can (for V2)
2	B9A valveholders (for L1 and L2)

### Chassis, Panel

'Universal Chassis' 6 x 6 x 3in., Cat. No. CU52 (Home Radio)  
Panel 6 $\frac{1}{2}$  x 5 $\frac{1}{2}$ in., or as required

### Miscellaneous

1 knob  
5-way tagstrip, centre tag earthed  
Aerial socket and plug  
Screened wire, solder tags, etc.



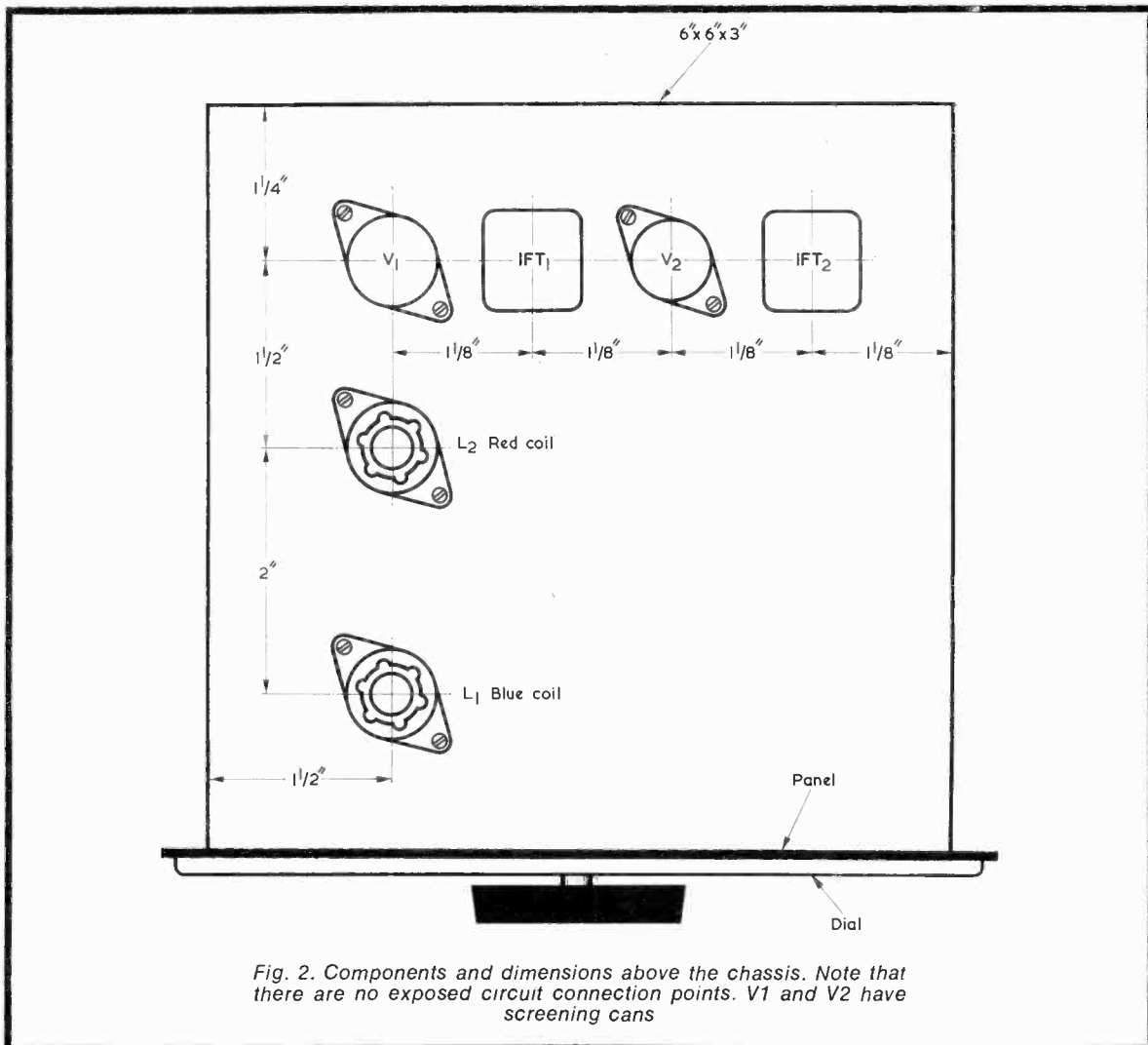


Fig. 2. Components and dimensions above the chassis. Note that there are no exposed circuit connection points. V1 and V2 have screening cans

capacitor. C4 takes the place of an oscillator circuit trimmer, and VC3 is a panel mounted aerial trimmer. This is a simple and effective arrangement which allows best results to be obtained with any aerial and pair of coils.

V2 is the i.f. amplifier. A negative potential developed across R6 by rectification of signals by D1 is applied to both stages for a.g.c. purposes.

Audio signals are taken from C11 to a screened lead which is plugged into the 'Tri-add' amplifier. The latter has an audio gain control.

The tuner and amplifier together will be found to give very good reception of a large number of transmissions.

Brief notes on the bands which may be covered will be of aid when deciding which coils to obtain.

The coils are used in pairs, a 'Blue' coil being inserted in the L1 (aerial) position, and a 'Red' coil in the L2 (oscillator) position. One pair of coils is thus required for each waveband. All coils are in the Denco Miniature Dual-Purpose (Valve) series which plug into B9A valveholders.

Coils for five bands are available, as follows:

*Range 1.* 2,000-750 metres, or 150-400kHz. This is the usual long wave band.

*Range 2.* 580-194 metres, or 515-1.545kHz. This is the normal medium wave band, and would be chosen for general reception of B.B.C. and other broadcast transmissions.

*Range 3.* 180-57 metres, or 1.67-5.3MHz. This band is particularly useful for 160 and 80 metre amateur bands (actually 1.8-2.0MHz, and 3.5-3.8MHz). These frequencies are usually most active at week-ends.

*Range 4.* 60-20 metres, or 5-15 MHz. Many short wave transmissions fall in this band, which is probably most suitable for general short wave reception.



Range 5. 28–9.5 metres, or 10.5–31.5MHz. These high frequency signals are capable of very long distance results, depending on the time of day and other factors.



### PADDING CAPACITORS

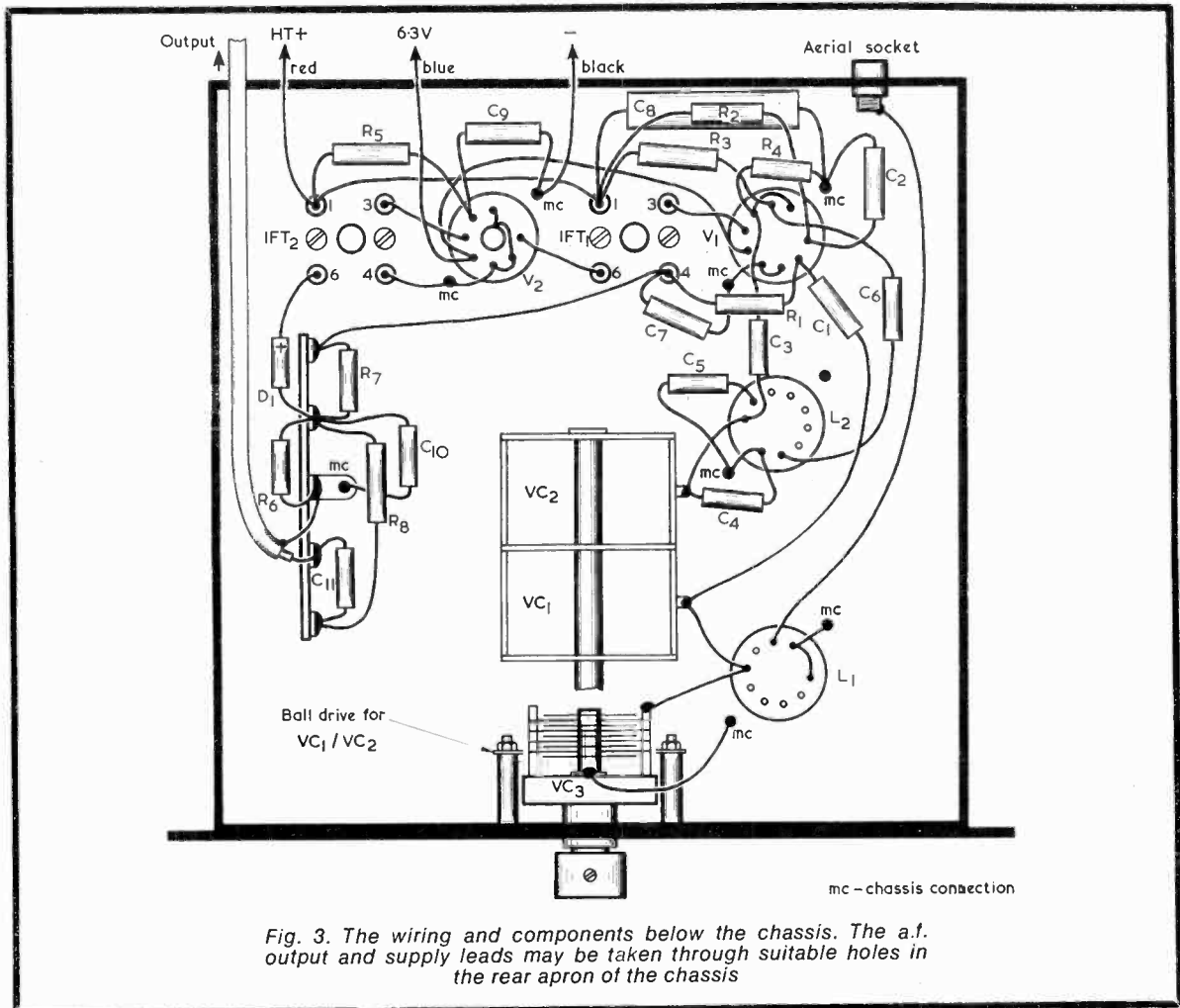
To ensure correct tracking between aerial and oscillator tuning, a padding capacitor is connected between the tuned winding of L2 and chassis on all ranges except Range 5. In Fig. 1 the padding capacitor is C5 and its value is 350pF. It is connected to pin 2 of the valveholder into which the coil is inserted, and is intended for Range 2 (medium waves). Fig. 1 does not show the padding capacitors for the other ranges, and these may be wired into circuit as required. There is, of course, no necessity to fit the padding capacitor for any range that will not be used.

If medium wave reception only is required there is, then, no purpose in adding other padding capacitors. But if other ranges are to be used as well, the oscillator coil holder must be wired to suit.

For Range 3, connect a 1,100pF capacitor between pin 3 and chassis. If a 1,100pF component is

not available it may be made up of a 1,000pF and a 100pF capacitor in parallel. For Range 4 the padding capacitor is 3,000pF, and is connected between pin 4 and chassis. For Range 5 no padding capacitor is required, and pin 6 is wired directly to the adjacent chassis tag. If Range 1 (long waves) is to be included the padding capacitor is 110pF, and it connects between pin 5 and chassis; also, join pins 1 and 7 of the holder with a short lead.

It will be noted that the various padding capacitors are connected to different pins of the coil holder. This is because the 'Red' coils are so designed that the correct padding capacitor is automatically brought into circuit when any coil is plugged in. All padding capacitors should be silver-mica with a tolerance of 2% or better.



## CHASSIS PREPARATION

Fig. 2 shows the top of the chassis, with dimensions. With a Home Radio 'Universal Chassis', the sides can be left off until wiring is completed, and makes assembly and soldering easier.

The holes for V1 valveholder and the coil holders are best made with a  $\frac{3}{4}$ in. diameter chassis cutter. A  $\frac{1}{2}$ in. chassis cutter may be used for V2 valveholder.

The 2-gang tuning capacitor occupies the position shown in Fig. 3, under the chassis. It is secured by two 4BA bolts, washers being added so that the capacitor is about  $\frac{1}{4}$ in. clear of the chassis. To locate the drive correctly, place the capacitor with its spindle against the front runner, not forgetting to include the washers which will be present later. Mark the position of the capacitor spindle. Remove the front runner and drill a small pilot hole. Also drill this small hole through the panel. Take the paper template supplied with the drive and align it with the pilot hole. The panel and chassis can then be drilled for the drive and dial. Exact instructions for fitting are given with the drive.

The drive mechanism and capacitor can then be fitted, and also the small aerial trimmer VC3.

## POINTS ON WIRING

All connections are shown in Fig. 3, with the padding capacitor, C5, for Range 2. Even if the tuner is to be used on all bands, it can first be tested on this band, and the other padding capacitors added later.

'MC' indicates solder tags bolted to the chassis. Run the heater, h.t. and a.g.c. wiring against the chassis. Leads to VC1, VC2, C1, C3, C6, V1 tag 6, V2 tag 5, and other circuit points where r.f. is present are kept a little clear of the chassis.

The diode D1 and several other items are assembled on the 5-way tagstrip. All components are positioned approximately as in Fig. 3.

Prepare a coaxial or screened lead with jack plug to fit the 'Tri-add' main amplifier. Solder the inner conductor to the tag supporting C11 (see Fig. 3) and the outer braiding to the adjacent 'MC' tag.

Also make up a 3-core flexible power cord, using red wire for high tension positive, blue for 6.3 volt, and black for the common chassis return. Connect

this as in Fig. 3 and add a multi-way plug to fit the power outlet socket of the amplifier.

## TEST VOLTAGES

The voltages given in Fig. 1 were taken with a  $10,000\Omega$  per volt meter. The lower voltage readings are with no signal tuned in. With a signal tuned in, the a.g.c. circuit reduces anode and screen-grid current, so that the voltages rise. Typical voltages under strong signal conditions are shown in brackets. Exact voltages depend on resistor and other values, but will generally be similar to those in Fig. 1.

A meter set to read about 20mA full-scale may be temporarily inserted in the h.t. positive connection, and used as a tuning indicator when aligning the i.f. transformers and coils. Adjustments will then be directed towards obtaining the lowest meter reading. This corresponds to maximum a.g.c. voltage, and thus optimum trimming condition.

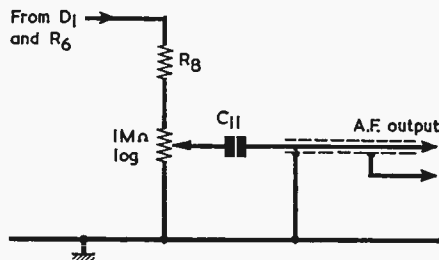


Fig. 4. Modified output circuit incorporating a volume control

## I.F. ALIGNMENT

Should a signal generator be available, the i.f. circuits can be aligned with its aid in the usual way, as also may the aerial and oscillator circuits.

Satisfactory alignment is, however, readily possible without a signal generator, as the i.f. transformers are already approximately set up when purchased. Use a properly shaped and completely insulated tool which fits the i.f. transformer cores.

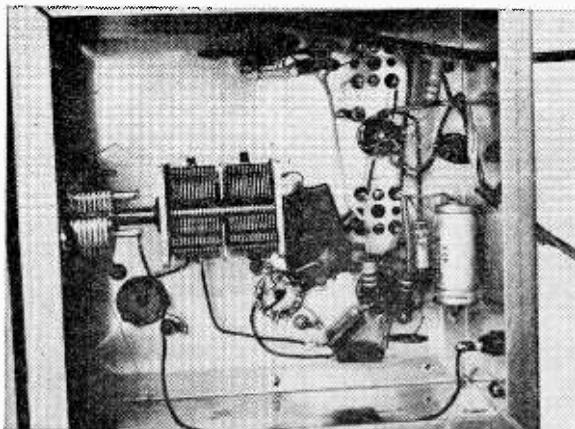
Fit the Range 2 coils and tune in a strong B.B.C. transmission. H.T. current, as shown by the meter placed in circuit, will fall. Tune for minimum current. Then carefully rotate the cores of the i.f. transformers to obtain the lowest possible current reading. Each of the four cores should be found to have quite a sharp tuning peak. These adjustments are actually carried out to obtain the highest a.g.c. voltage. Once the i.f. transformer cores have been dealt with, they are left and need no further adjustment.

## AERIAL AND OSCILLATOR

The coils are packed with the brass threaded rods screwed in, and these should first be unscrewed so that about  $\frac{1}{4}$ in. projects at the top.

Range 2 may be dealt with first. Tune in a transmission near the high frequency end of the band (VC1/VC2 nearly open) and rotate the control knob of VC3 for best results. Now tune to a station received near the low frequency end of the band (VC1/VC2 nearly closed) and adjust the core of L1 for best results. Repeat these procedures several times.

If frequency coverage is unsuitable, especially near



Underneath the chassis of the tuner

the low frequency end of the band, adjust the core of L2 to correct this, and re-adjust the core of L1 for maximum efficiency.

VC3 should have quite a sharp tuning peak, giving best reception throughout the whole band. This peak should *not* be obtained with VC3 either fully open, or fully closed. Provided VC3 can be tuned for a peak between the fully open and fully closed conditions, no loss of efficiency can arise due to misalignment. However, proper adjustment of the cores will reduce the need for frequent operation of VC3 when tuning across a band. After they have been correctly positioned, the cores can be locked with 6BA nuts.

Treat the other ranges one by one, in the same way. VC3 will be found useful to peak up signals on the short wave bands. Changes to the aerial also influence the setting of VC3.

The dial may be marked with frequencies, from known transmissions or with the aid of a signal generator.

### ALTERNATIVE USE

Though the tuner plugs directly into the 'Tri-add' amplifier, it will be appreciated that it could be used with other a.c. mains amplifiers.

The tuner should *not* be used with an a.c./d.c. amplifier, or with any equipment which does not have a transformer to isolate the chassis and other circuits from the mains.

A supply of about 10–15mA at 150–200 volts should be available for h.t. and 0.6A at 6.3 volts for the heaters.

Should an audio gain control be required on the tuner, place VC3 near L1, and fit a 1M $\Omega$  potentiometer to the left in Fig. 3, to give a balanced panel layout. Connect the potentiometer into circuit after R8, and connect C11 to the potentiometer slider. The circuit required is given in Fig. 4. ■

## MARCONI COLOUR CAMERA

The first customer for the revolutionary automatic colour television camera recently announced by Marconi is the BBC.

Subject to a successful outcome of field trials, the Corporation has expressed its intention to buy Mark VIII cameras for a new mobile unit for television news outside broadcast work.

The small size and weight of the Mark VIII and its camera cable are obviously attractive for this sort of application and the vehicle is planned to accommodate two of the cameras with associated vision mixing and sound pick-up equipment. A separate radio link vehicle will relay the signals back to base.

Many unique features make the Mark VIII the most advanced studio or outside broadcast television camera in the world. A specialised miniature computer built into the camera channel ensures that the picture quality will be set up and maintained at a higher standard than ever before possible, completely automatically, while the compactness and light weight of the camera will dramatically simplify the mounting of outside broadcasts from remote or difficult locations. The Mark VIII is capable of producing quality colour pictures in remarkably low light levels.

NOVEMBER 1970

# REMEMBER, REMEMBER

IT IS DURING THIS MONTH THAT WE ARE PLAINTIVELY asked by multitudinous small boys, rattling coins in tins to "remember, remember". Hopefully standing alongside an effigy outrageously imagined to be a likeness of you-know-who, they quizzically appraise each passer-by. Being the kind guys we are, a coin is dropped into the proffered tin, we feel all generous like and probably remember our youthful forays in search of an easy fleece – a golden one we hoped!

Many years ago now, a consortium of three financiers, each around twelve years old, returned from such a venture – the writer being one third of the triumvirate. All three then proceeded to engage in the unprincipled skulduggery of misappropriating the collected shekels into the 'wireless' components fund! After all, the financial steady state of the junk-box was better than that of the momentary big bang!

Our bucket shop was in reality a small shed at the bottom of the garden. Within this wooden structure, which had served in turn as a castle, pirate ship, bandits hideout, ranch and even as an airship, we had amassed two shakily built l-valve medium wave receivers. These, together with a varied selection of components, guilefully scrounged from our respective fathers and various uncles who had, it seems, once been engaged in the build-it-yourself boom of the 1920's, represented our most prized possessions. Originally a potting shed, it had long since become a plotting shed!

Our near blackmail of unsuspecting adults, although ostensibly connected with the annually celebrated seasonal plot was in fact intended for another purpose – the replenishment of our much depleted coffers – which would eventually result in the purchase of badly needed components.

We had set ourselves the herculean task of constructing a 3-valve receiver and our dark machinations had led us into devious ways of raising the wherewithal!

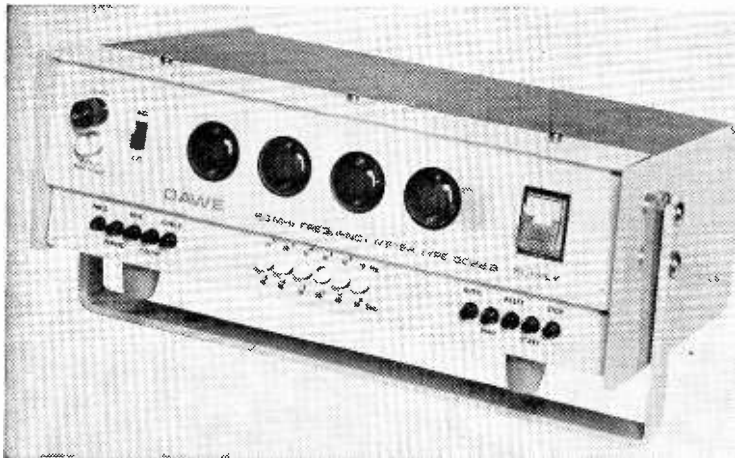
The coveted 'wireless' parts we desired were a Telsen coil and a Burndept dial. We also needed a new 2-volt accumulator – we could hardly continue surreptitiously swapping ours with that of an unsuspecting household – at any moment *that* plot might be thwarted!

Did we succeed? Not entirely, but then hope springs eternal in all of us I suppose. At least we did raise sufficient capital to purchase the coil. The dial and accumulator came into our possession later, the last mentioned being a gift from a sympathetic but long suffering uncle. It seems he too had once been guying and devoted the swag to the purchase of a wheel – not a catherine but a bicycle wheel!

In the next few weeks another fund raising activity would loom on the horizon – a Christmas carol party – I recall that we already had nefarious plans to divert the collection from Yuletide uses. We metaphorically rubbed our sticky palms together in Scrooge-like anticipation of the wealth that would, we hoped, come cascading into our pecunious tin – but you will be regaled with that saga next month! ■

211

## 50MHz COUNTER



Dawe Instruments (a member of the Simms Group of Companies) are selling a new 50MHz Counter, Type 3022B. At £185, this instrument sets a new price-performance standard for a low cost instrument.

The Type 3022B has four functions – Frequency, Period, Count and Time and gives full four-digit indication from zero to 50MHz with an input sensitivity of 250mV. Features included and not normally found on this class of counter are a.c./d.c. input selection and control over trigger level.

Internally the Type 3022B is constructed from plug-in replaceable printed circuit boards and all the components are accessible for ease of servicing.

The high performance of the Type 3022B is achieved using high speed t.t.l. microcircuits together with a field effect transistor input and tunnel diode trigger circuitry. All functions are selected by push buttons. The compactness of the instrument and its simple elegant layout ensures extensive use in the laboratory or in the field.

Dawe Instruments have recently published a handbook, "Ultrasonic Cleaning Techniques".

The use of ultrasonic cleaning in production and maintenance throughout Industry has expanded rapidly in the past few years. Dawe, leaders in the field, felt that it should make available a general guide to possibilities of the technique.

Written by D. Tadgell-Foster, Director and General Manager of the Company, the handbook sets out in simple terms the theory of the technique, the equipments available and many examples of the applications. The handbook, free on request, is not intended to be exhaustive but is a guide for production and maintenance engineers and explains the technique which amongst its unique features has a real basis of cost effectiveness.

The address of Dawe Instruments is Concord Road, Western Avenue, London, W.3.

## TURN IT DOWN

A radio listener who liked plenty of volume from the radio, adjusted his receiver to full blast in a room which had two windows.

Suddenly, through one window, came a brick with a note bearing the cryptic legend – "turn it down!"

As he cleared up the mess, the listener turned the volume down – whereupon a further brick came through the remaining window – with a note attached on which was written a laconic – "Thank you!"

Just another illustration of the fact that most lessons in life are painful?

## VOTED A SUCCESS

A new and highly successful contributor to BBC television coverage of the General Election was an electronic printer called ANCHOR – Alpha Numeric CHAracter GeneratOR. It gave full voting details of each constituency on the screen just one and a half seconds after the returning officer completed his announcement.

Eighteen months ago, Ray Taylor and David Kitson in the BBC Engineering Department were looking for a method of producing letters electronically, using parabolic and sawtooth waveforms to give perfect curves and diagonals.

Richard Francis, executive producer of the BBC Election Results programme, decided last January that ANCHOR was just what he was looking for, and asked whether it could be completed in time for a possible October election. In May came the announcement that the Election would be on June 18, and the Engineering Department moved into top gear to get ANCHOR working in time.

With characters the clearest of any similar device, ANCHOR was attached to the System 4-50 computer in the Baric Central London bureau. And, as a final refinement, the results on colour sets were shown in red, blue or green, according to which party won.

## MINISTRY ENCOURAGES RESPONSIBLE USE OF RADIO

The encouragement of a responsible use of radio was the underlying theme of the Ministry of Posts and Telecommunications' stand at the International Radio and Communications Exhibition.

The Ministry is the national authority for the allocation of radio frequencies in this country, where, as everywhere else in Europe, they are very overcrowded. The Ministry showed how these wavelengths must be shared between many services, such as aeronautical, broadcasting, maritime and land mobile services, radionavigation, radiolocation and communications satellites, and that they must be used in an orderly manner with the minimum of interference if the maximum benefit is to be obtained from them. It is for this reason that any use of radio or broadcasting equipment in this country must be properly licensed by the Ministry.



# COMMENT

## MORE ABOUT VIDEO DISCS

Following our announcement in *News and Comment* in our August issue of a European competitor to the American system of electronic video recording, we can now give our readers information on how it is done. The information is culled from a BBC overseas broadcast.

If you know how a gramophone record works, you may think this sort of TV recording is impossible. Even ordinary stereo music uses up something near the full potential of disc-recording techniques. A TV picture requires about 250 times more 'information', so an ordinary LP would not have the capacity.

The solution lies in a completely new principle. On a stereo LP, the stylus rests in the record grooves and is moved from side to side and up and down by 'wiggles' in the grooves. If the grooves were made finer to give more capacity they could not accept a reasonably cheap stylus. But on a Videodisk, picture and sound are recorded as a vertical movement of the groove, a 'hill and dale' effect. And instead of the stylus following this complete up-and-down movement it touches only the tops of the hills. The disc is made of soft but springy plastic, so the hill-tops bend over under the stylus and spring back upright as they emerge again. Each hill-top springing back sends a little shock wave up the stylus, to be converted into an electronic signal for the TV set.

Videodisks are thinner than music records but otherwise appear very similar.

## MINISTERIAL QUOTE

Mr. Christopher Chataway, Minister of Posts and Telecommunications, when opening the 1970 International Broadcasting Convention at Grosvenor House, Park Lane, London, commented that it was the third convention of its kind to be held in this country and that it grows in stature on each occasion.

"The one fact which emerges with crystal clarity from the most cursory glance at the material for the Convention is its fearsome complexity.

"It's hard for the layman to envisage that all those abstruse hieroglyphics, all that learned argument, all that inventiveness and expertise may well in due course be transformed into another piece of household equipment that will come to be regarded as utterly commonplace.

"And yet the whole history of broadcasting technology does, I suppose, represent a continuing conversion of the mysterious into the commonplace."

## LATE APPEARANCE

We regret the inconvenience caused to our many London readers by the late appearance on the book-stalls of our October issue.

This was entirely caused by the London Wholesale Houses dispute.

NOVEMBER 1970

## TORCH GLASSES



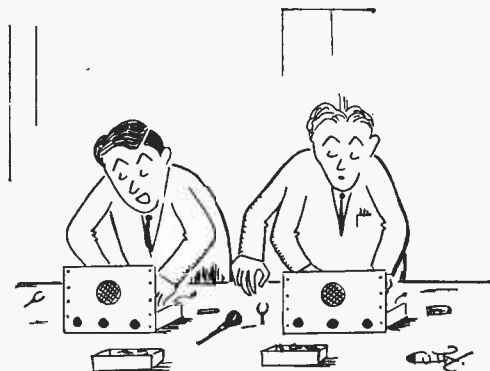
A practical aid with numerous uses is being marketed in the form of torch glasses by Freeline and exhibited at this year's London Motor Show.

The new product, called Lookylux which won a silver medal at the International Inventions Fair at Brussels, is made from robust thermoplast.

The torch glasses which provide a powerful focused beam with the turn of a rotary switch, is ideal for close-up precision work of any kind, as well as being a most useful aid when illumination is required at the same time as both hands are needed.

Motorists and vehicle repairers will find the glasses ideal as well as campers, electricians, radio constructors and do-it-yourself enthusiasts.

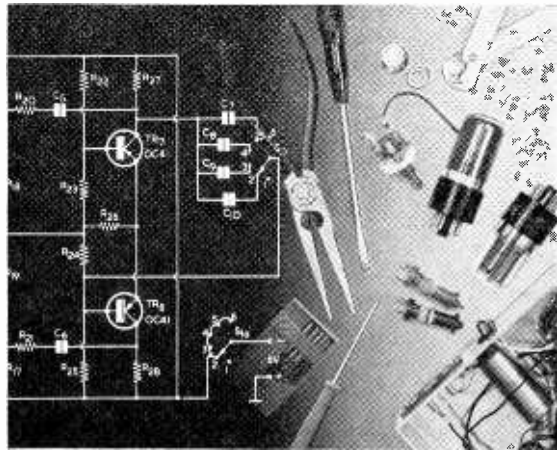
The glasses, in light grey, retail for 25s. per pair and use two easily-fitted standard U12 batteries. They are comfortable to wear with or without ordinary spectacles.



"I'll give you your due Fred, you're always ready to lend a mate a hand."

# efficient water level sensor

by G. A. FRENCH



DEVICES WHICH GIVE A VISUAL or audible indication when the surface of water in a container or other enclosed space rises above a predetermined level have many uses, these ranging from flood warning, through industrial and laboratory applications, to such domestic requirements as the unattended filling of a bath. The sensor unit which is described in this article has been specifically designed to offer the utmost in simplicity allied with reliability. The circuit is versatile and, by altering the value of one resistor can have its sensitivity either increased or decreased as required.

Before carrying on to details of the water level sensor, the writer would like at this stage to state, incidentally, that he feels a certain pleasure at the fact that this particular "Suggested Circuit" is No. 240 in the series. The "Suggested Circuit" feature has in consequence now been running, without a break, for 20 years.

## THE CIRCUIT

The circuit of the water level sensor appears in Fig. 1. In this diagram the two transistors, TR1 and TR2, are connected together in a combination which provides an exceptionally high degree of current gain. When 'conventional current' (assumed to flow from positive to negative) passes into the base of TR2, an amplified current flows into its collector from the base of TR1. TR1 functions as an emitter follower whereupon a further amplified current flows into its emitter via the load, which in the present circuit is the coil of a relay. The total current amplification given by the combination of TR1 and TR2 is approximately equal to the product

of their individual gains, and can in practice be of the order of 40,000 times. The relay coil shown in the diagram has a resistance of 500Ω, with the consequence that, when TR1 is fully bottomed, the current which flows in the emitter circuit of TR1 is, from Ohm's Law, 24mA. From the figures just mentioned, it follows that such a current can be

made to flow as the result of a base current in TR2 of less than 1μA.

The transistor combination offered by TR1 and TR2 is an extremely useful one in circuits of the present nature. TR2 is a very high gain silicon n.p.n. transistor, and is available from Amatronix Ltd. TR1 is a high gain germanium p.n.p. transistor having relatively high voltage,

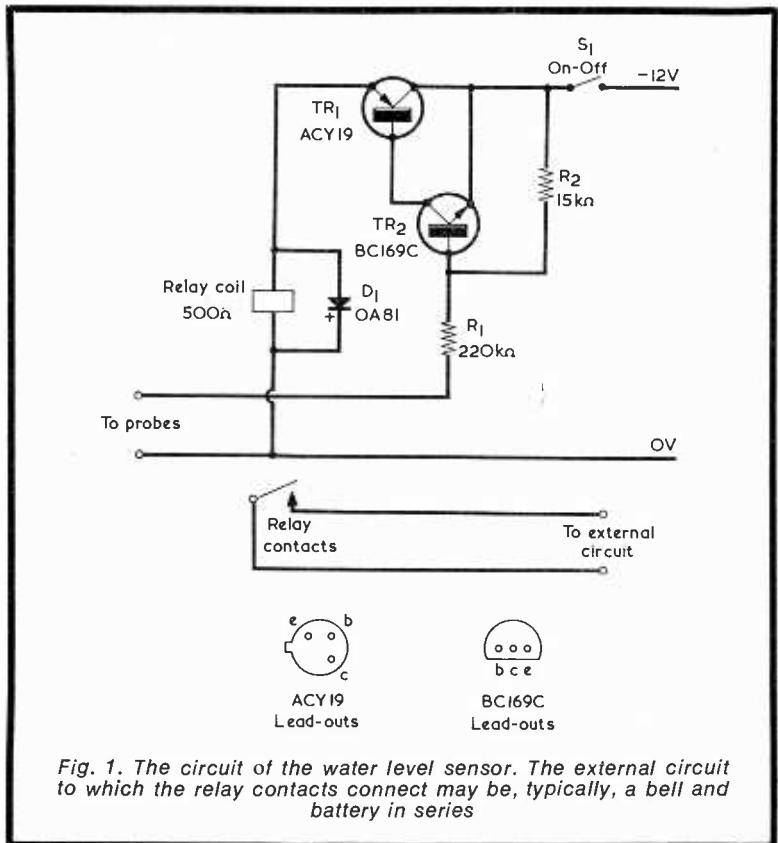


Fig. 1. The circuit of the water level sensor. The external circuit to which the relay contacts connect may be, typically, a bell and battery in series

current and power ratings, and it is particularly suited for the operation of small loads. It is a generally available type.

The water level sensor functions by reason of the fact that a resistance appears between two metal probes if they are immersed in any class of water other than pure distilled water. In Fig. 1 the resistance resulting from the immersion of two probes in water is applied, via the probe terminals, between the lower supply rail and the end of R1 which is remote from TR2. Resistor R2 is included to limit the sensitivity of the TR2 and TR1 combination. These transistors can only pass current when the voltage at the junction of R2 and R1 exceeds the forward voltage delay, of about 0.6 volts, which is given at the base-emitter junction of the silicon transistor, TR2. This figure of 0.6 volts is one-twentieth of the supply potential of 12 volts and, if the base current required by TR2 is assumed to be negligibly low, it can be seen that the relay should operate when the value of R2 is one-twentieth part of the sum of R2, R1 and the resistance offered to the probe terminals. The sum of these three resistances calculates out at 300k $\Omega$ , whereupon it follows that the resistance required at the probe terminals to operate the relay is 300k $\Omega$  minus (R2 plus R1), or 65k $\Omega$ . With the prototype circuit it was found that the relay operated for a maximum resistance at the probe terminals of 85k $\Omega$ , which agrees quite well with the theoretical calculations.

In use, the probe terminals can be connected to two probes mounted above the surface of the water whose level is to be monitored, as in Fig. 2. When the probe ends are above the surface of the water there is no circuit between them, whereupon no current flows into the base of TR2 and the relay in the sensor unit remains de-energised. Should the water level rise sufficiently high for the probe ends to become immersed below its surface, a resistance appears between the probes and the relay energises. Its contacts may then operate any external circuit which is connected to them, such a circuit consisting, typically, of a warning bell, buzzer or lamp in series with a battery. In industrial applications the relay contacts could, alternatively, cause a pump to be actuated which would automatically reduce the level of the water.

### THE PROBES

The prototype circuit was checked by using the bared ends of two thin pieces of p.v.c. covered flexible wire as probes, and it was found that the relay operated as soon as approximately  $\frac{1}{8}$  in. of each wire was immersed under the surface of the water. The latter was ordinary do-

mestic tap water and the probes were spaced 1 in. apart. In practice, the spacing of the probes is not particularly critical, the more important criterion being the area of contact between probe metal and water.

city and cheapness of the probes make it possible to replace them from time to time without undue trouble as a matter of normal maintenance.

The supports for each probe wire should be separate and as high above

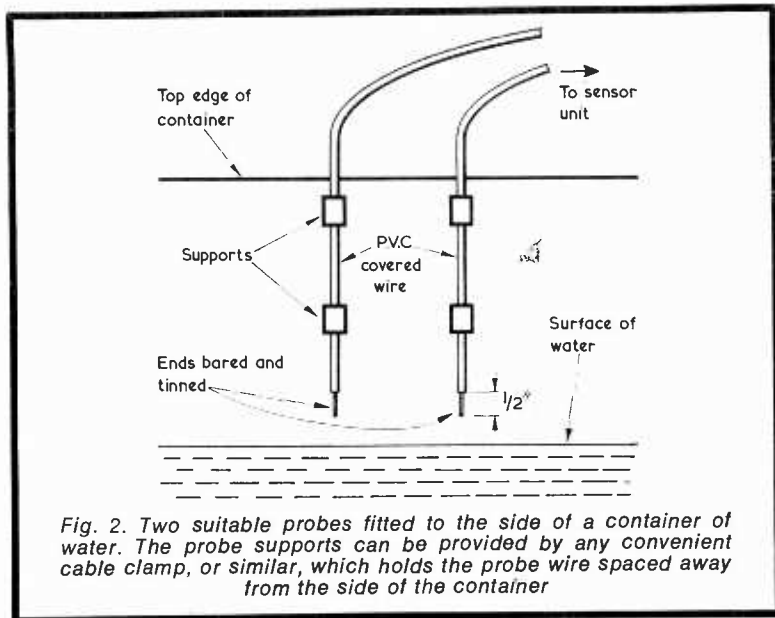


Fig. 2. Two suitable probes fitted to the side of a container of water. The probe supports can be provided by any convenient cable clamp, or similar, which holds the probe wire spaced away from the side of the container

This experience with the prototype shows that a practical pair of probes can be made up in the very simple manner shown in Fig. 2. Here, two lengths of flexible p.v.c. covered wire have the insulation stripped from the end  $\frac{1}{8}$  in., the protruding strands of wire then being tinned and soldered together by running a soldering iron over them. In most applications it is probable that the water level may,

the probe ends as can be reasonably arranged. This will reduce, or obviate, any leakage paths between the probe ends which might result from water remaining on the probe wires and supports if, at any time, the water rises above the probe ends and then subsequently subsides again. The spacing between probe ends may lie between 1 and 6 in. according to the space available in the container. A wider spacing helps

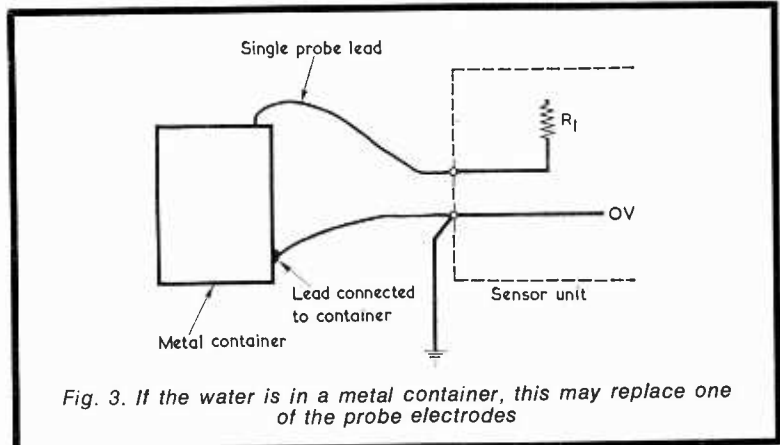


Fig. 3. If the water is in a metal container, this may replace one of the probe electrodes

on occasion, rise well above the bared ends of the probes, but it should cause little or no damage to the p.v.c. insulation above, this being particularly true if wire having thick p.v.c. insulation is employed. In any event, the simpli-

to reduce leakage paths after the water has risen and then subsided.

If the container holding the water is of metal an alternative approach consists of using a single probe only. The other probe electrode is replaced by the container itself, this

being connected to the lower probe terminal in the circuit of Fig. 1. The container may already be connected to earth by way of plumbing, etc., or an earth connection may be added, as shown in Fig. 3. The earth connection is, however, quite optional.

### COMPONENTS

So far as components are concerned, the two transistors in Fig. 1 have already been dealt with. The remaining semiconductor, D1, is merely a germanium diode whose function is to suppress the back e.m.f. generated in the relay coil if the current flowing through it should be abruptly cut off. It is important to connect D1 into circuit with correct polarity. If it is connected incorrectly, an excessively high current can be drawn from the supply when TR1 becomes conductive.

The relay coil employed in the prototype circuit was a P.O. 3000 type having a 500Ω coil. However, any relay capable of energising reli-

ably at 12 volts and having a coil resistance of 200Ω or more may be used. It must, of course, have contacts suitable for actuating the external warning or pump circuit.

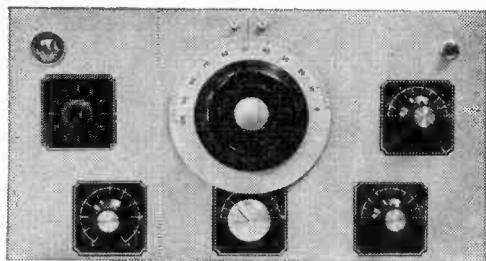
The supply can consist of a 12 volt battery or a 12 volt mains supply unit. The latter need not be well regulated provided that it offers 12 volts when the relay is energised. The current drawn from the supply when the probe ends are above the surface of the water is negligibly low, and consists merely of leakage current in TR1. When the probes are immersed, the current taken from the supply is that drawn by the relay coil. This fact demonstrates that, when using a battery supply, relays with higher resistance coils are preferable. If the relay operates a bell or buzzer it may be necessary to feed these from a separate battery or supply, in case the current interruptions due to the bell or buzzer contacts upset operation of the transistor circuit.

The two resistors, R1 and R2, can be 10% ¼ watt types. As already mentioned, the value of R2 controls

the sensitivity of the unit. If it is intended to monitor the level of nearly pure water, such as rain water in a clean container, it may be desirable to increase the value of R2 above that shown in Fig. 1, so that the sensor can respond to a higher resistance value between the probe terminals. The new value for R2 can easily be determined experimentally, and it should be remembered in this respect that the circuit has a considerable degree of sensitivity 'in hand'. In the same manner, if it is desired that the unit be less sensitive, so that it is actuated by a lower resistance between the probe terminals, this may be achieved by reducing the value of R2.

A final point is that the sensor unit must, of course, be positioned at a dry site, well clear of water and damp. The probe leads may be of any reasonable length, provided that they are well insulated and kept clear of unscreened mains wiring. Should mains hum pick-up be suspected, its effect may be reduced by connecting a 0.5μF capacitor across R2. ■

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# Addition computing circuit

by

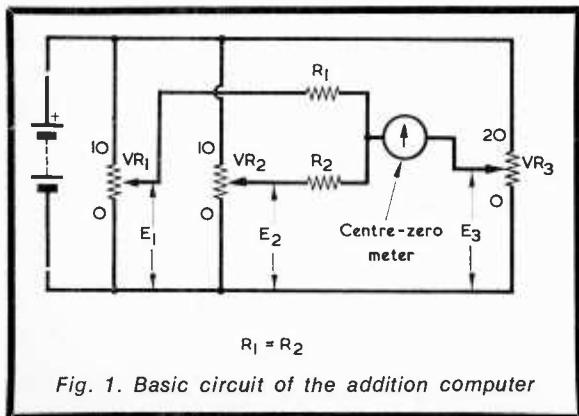
D. SNAITH

**A simple analogue computing device which enables the sum of two numbers to be determined. The basic circuit may be extended to permit three or more numbers to be added**

**S**IMPLE COMPUTING CIRCUITS CAN BE BOTH AMUSING and instructive to build up, and the circuit to be described is no exception. It enables the sum of two quantities to be found with the aid of three potentiometers and a null-indicating device. Apart from two fixed resistors whose values should be close to each other, none of the components required are particularly critical.

## BASIC CIRCUIT

The basic computing circuit is given in Fig. 1. Here, there are three linear track potentiometers, VR1, VR2 and VR3, and two fixed resistors, R1 and R2 are equal in value. The values of VR1 and VR2 are non-critical, the only proviso here being that the value of each must be much lower than that of R1 or R2. It is then assumed that current flowing in R1 or R2 is negligibly low compared with the standing current from the supply which flows along the tracks of VR1 and VR2. The value of VR3 need not be as low as that of VR1 and VR2 but it will be helpful in practice for it to be significantly lower than R1 or R2.



VR1 and VR2 have linear scale calibrations from zero to 10. Thus if, for example, either of these potentiometers is set to its central position, a pointer on its spindle will indicate '5'. VR3 also has a linear calibration, this extending from zero to 20.

To operate the circuit, VR1 and VR2 are set to the two figures it is desired to add. VR3 is then adjusted until the centre-zero meter indicates zero current. The sum of the two figures selected by VR1 and VR2 may then be read from the scale of VR3.

To perform a subtraction, VR3 is set to the higher number and either VR1 or VR2 to the figure it is desired to subtract from that number. The remaining potentiometer is then adjusted for zero current in the centre-zero meter, and the difference is read from the potentiometer scale.

The manner in which the circuit operates is illustrated by the calculations given in Fig. 2. Under balance conditions no current is drawn from the junction of R1 and R2 by the centre-zero meter, and it is obvious from inspection that, if voltage E1 is higher than voltage E2, the voltage at this junction (E3) is equal to E2 plus half the difference between E1 and E2. The consequent equation steps are given in Fig. 2(a). The calculations which apply when E2 is higher than E1 are given in Fig. 2(b). In both cases it can be seen that the value of E3 is always one-half the sum of E1 and E2. For the circuit to be used for computation, VR1 and VR2 then need to be given similar scales, and VR3 needs to be given a scale calibrated in units that are twice as large.

$E_3 = E_2 + \frac{E_1 - E_2}{2}$ $= \frac{2E_2 + E_1 - E_2}{2}$ $= \frac{E_2 + E_1}{2}$ <p style="text-align: center;">(a)</p>	$E_3 = E_1 + \frac{E_2 - E_1}{2}$ $= \frac{2E_1 + E_2 - E_1}{2}$ $= \frac{E_1 + E_2}{2}$ <p style="text-align: center;">(b)</p>
---	---

Fig. 2. After balancing, the voltage E3 is always equal to half the sum of E1 and E2. This relationship is calculated for the case where E1 is greater than E2 in (a), and for when E2 is greater than E1 in (b)

To take a numerical example of the manner in which the circuit works, let us say that the supply voltage is 10, that VR1 is set to figure '6', and VR2 to figure '2'. E1 is, then, 6 volts and E2 is 2 volts, whereupon the voltage at the junction of R1 and R2 (after balancing the circuit) will be 4 volts. The circuit is balanced when VR3 is set up to offer 4 volts to the centre-zero meter, whereupon VR3 slider is four-tenths of the way up its track. The corresponding point on the 0-20 scale of VR3 is '8', which is the sum of 2 and 6.

For the purpose of explanation in the example just given it was assumed that the supply voltage was 10. In practice, the supply voltage is unimportant because it is applied to all three potentiometers, with the result that E1, E2 and E3 all correspond to fractions of the same supply voltage.







**Q**  
**S**  
**X**  
by

**FRANK A. BALDWIN**

(All Times GMT)

● **AMATEUR BANDS**

Although comparatively little time was devoted to these bands, some improvement in Dx reception was noted – this being particularly apparent on Top Band with the absence of static ‘crashes’ and a lower noise level. We begin with –

**1.8MHz**

During several evenings around 2100 the following stations were logged at the CW end of this band.  
**CW:** EI5BW, GM3FSV, GM3HJB, GM3HLQ, GM3PFQ, GM3UYF, GW3NXI, GW3YUV/P, HB9IN, OK1AGU, OK1IM/P, OK2BFN, OK2BHT, OK3ZAR, OL5AMA, OL6AKP.

**7MHz**

Forty metres continued to provide some excitement at the LF end but for this, one must be around on the band at 2200 or so. Early mornings can also produce the goods at times. Apart from lots of W’s, the following were heard –  
**CW:** HI8NMA, KG4EO, PY2FCJ, VE8RX, VK3MR (7004kHz), VP9GD, YV4BEV, YV5BPG, 9H1BB.

**14MHz**

The usual hive of activity was apparent on this band. Under the blanket of E.European signals and several intruders at the LF end we found the following –

**CW:** AX2GR, HP1BR (14058kHz), JAØBD, KP4SV, KR6TK (14005 kHz), OX3AY, PJ2PS (14008kHz), TA2QR, ZC4IK, ZS1MH, 9J2TR, 9J2XZ, 9Y4EW.

**SSB:** AX3WQ, AX5NP, AX7GK, CR6MT, ET3DS, ET3US, FG7TD, HR2JMC, HT1HSM, JA2YT, KP4AST, PZ1BD, VK2FU, VK7AZ, VP8LK, ZS5DG, 6W8DY, 9Q5CO.

**21MHz**

This band, at least for the writer, is beginning to overshadow the attractions of ‘Twenty’. There is less QRM here than is apparent on 14MHz, less ‘pile-ups’ and better operating manners. This is most notable on the CW part of the band.

**CW:** CR6AL, CR6LS, CR7IZ, FM7WF, PJ2PS, ZC4BX, ZC4CB, ZE1BL, ZS5SY, ZS6AR, 9V1OJ, 9V1PA.

● **BROADCAST BANDS**

These bands continued to provide much of interest – more so than the Amateur bands with their stereotyped contacts and Donald Duck sound effects!

One of the most notable stations heard was Garoula on **5010kHz** in the Federal Republic of Cameroons. Logged at 2100 with chants in the Arabic style and with identification in French. Whilst not representing Dx in terms of distance, it is a most difficult station to receive, due to the fact that this channel is for the most part occupied by a utility transmitter. On the occasion mentioned, this latter station was off the air (a rare event) and Garoula was heard at good signal strength. Alan Thompson of Neath tells me that he managed to get a QSL from Garoula some two years ago – nice work!

Other notable events during the past few weeks has been the appearance of an unidentified station on **5044kHz**, although this has been known to vary between **5043** and **5045kHz**. Listen just below Lomé on **5047kHz** around 2000 to 2100. Using the French language, the station is suspected to be in Africa.

A Latin American station was heard by the writer on **4690kHz** and listed as unidentified. Alan Thompson gives the information that this station is Radio Reloj, Costa Rica. Sometimes uses the identification “R.Popular” – a ‘sister’ station.

What is the identification of the station under the West German transmitter on **1602kHz**? Listen around 2000 onwards. Would it be the Greek R.S. Amphissa? Alan doesn’t think so – what do you think?

4VEH Haiti is now audible again due to VOA schedule changes and may be heard on the ‘split’ frequency of **11833kHz** with identification in English at 0100. Alan Thompson logged this one a few weeks ago.

Enugu (ex-Biafra) is reported back on **7305kHz** and **6035kHz** to 2300 announcing as East Central State Broadcasting Service.

Glyn Morgan of Neath has heard VLT4 Brisbane on **4920kHz** at 0600. Considering the logging was made during the first week in September, rather early in the year for LF band Dx of this nature, it augers well for the S.E. Asian ‘season’ about to commence.

● **S.AMERICAN STATIONS**

**3380kHz 0346** OAX10 Chiclayo, Peru, with identification and

typical Andean music. Chiclayo is the chief town of the Lambayeque department.

**4765kHz 0330** ZYN37 Radio Feira de Santana, Brazil, with identification in Portuguese and Latin American music.

**4770kHz 0321** HCJF2 Radio Guayaquil, Ecuador, with Latin American music and identification. Guayaquil is a city in W.Ecuador on the Guayas River. It is a Pacific port and the largest city of Ecuador, being founded in 1535. Historic meeting between Bolivar and San Martin occurred here in 1822.

**4780kHz 0313** HCMQ1 Radio Atahualpa, Ecuador, heard with echo-effect identification and QRM from HRRZ(?) in background.

**4875kHz 0234** HCHE4 La Voz Esmeraldas, Ecuador, music in the usual LA style and identification.

**4895kHz 0230.** Radio Bare, Brazil, with station identification and ‘pop’ programme.

**5058kHz 0150** OAZ4A Radio Tarma, Peru, with identification in Spanish.

**6250kHz 0300** OAX7A Radio Cuzco, Peru, heard with two chimes and station identification, followed by a news summary.

● **AFRICAN STATIONS**

**3204kHz 1950** Ibadan, Nigeria, with a talk in English. This station welcomes reports and has been heard by Alan Thompson at 2200 in English.

**3285kHz 1947** SABC Johannesburg, heard with music programme.

**4815kHz 2043** Ouagadougou, Upper Volta, logged with African chants and shrill cries!

**4926kHz 2040** EAJ206 Radio Equatorial, Rio Muni, with music and songs.

● **BEGINNERS CORNER**

In the next few weeks try the following frequencies –

**7060kHz 1930** Peking, China, with tune “The East is Red” rendered on chimes, followed by identification in English and the French programme.

**7195kHz 2100** Monrovia (Voice of America transmitter) with identification, six ‘pips’ and news in English.

**11940kHz 1930** Bucharest with news in English.

**17920kHz 1340** Cairo with news in English. ■

# TWO-STAGE 'ADJUSTABLE ZENER'

by

G. W. SHORT

This 2-stage voltage stabilising circuit is capable of providing a wide range of output voltages. Circuit functioning is described, as also are the simple calculations needed to enable the stabiliser to offer an output of 9 volts at currents up to 200mA

THE IDEA OF USING A TRANSISTOR as a substitute for a zener diode was explored in the March, 1969 issue of *The Radio Constructor*.<sup>\*</sup> This article takes it a stage further, and shows how a combination of two transistors may be used when higher output power is required. The two-transistor zener, like its one-transistor brother, is adjustable to a wide range of voltages. Its major virtue is that the transistor which handles the bulk of the power need not have a high gain.

In the two-transistor circuit (Fig. 1), the series resistance R1 has exactly the same function as the series resistance in a zener stabilizer, i.e. it drops the excess voltage and limits the current to a safe value.

<sup>\*</sup>G. W. Short, 'Transistors As "Adjustable Zeners"', *The Radio Constructor*, March 1969.

The whole of the rest of Fig. 1 may be regarded as a sort of composite zener diode, which starts to conduct when the output voltage reaches the desired level, causing more current to flow in R1 and so limiting any subsequent rise of voltage.

## CIRCUIT OPERATION

The two-transistor circuit works in the following manner. Across the stabilised output is a potential divider, made up of R3 and R4, whose job is to apply a fraction of the output voltage to TR2. When the voltage across R3 exceeds the amount needed to bias the base-emitter junction of TR2 to conduction, the 'zener' comes on; i.e. TR2 and TR1 both conduct and limit any further rise of output.

Since the whole of the collector current of TR2 flows into the base

of TR1, the two transistors form a direct-coupled amplifier of which TR1 is the output stage. Thus TR1 handles most of the current. Even if both transistors have quite low gain the overall gain of the amplifier is high. It was shown in the earlier article that a current amplification factor of at least 200 is desirable: in the two-transistor circuit this is obtained if one transistor has a gain of 20 and the other a gain of more than 10, a very modest requirement. In practice, it is easy to obtain low-cost low-power p.n.p. transistors with high hFE, and one of these is used for TR2. A power transistor of comparatively low hFE may then be used for TR1.

## SETTING THE VOLTAGE

If the working base-emitter voltage of TR2 is known, the output voltage is easily calculated. In practice, the base-emitter voltage of any silicon transistor used in this circuit will be close to 0.65 volt. Using this value, the output voltage can then be estimated:

$$V_{out} = 0.65 \left( 1 + \frac{R_4}{R_3} \right) \text{ volts.}$$

Fine adjustment of  $V_{out}$  can be made by adjusting either R3 or R4. If R4 is increased, the output voltage rises. Adjusting R3 has the reverse effect, and an increase of R3 reduces  $V_{out}$ .

The component values specified for Fig. 1 give a nominal output (ignoring tolerances in R3 and R4 and assuming a base-emitter voltage of exactly 0.65 volt) of 10 volts. Measured output under no-load conditions with a practical circuit having a varying input voltage is shown in Fig. 2. In many practical cases the variation of output with fixed input but variable load is also of interest, and this is shown in Fig. 3, which has an expanded vertical scale to make the relatively

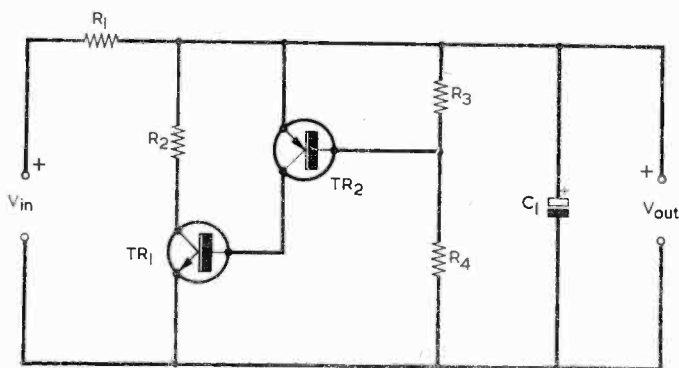


Fig. 1. The circuit of the 2-stage 'adjustable zener' stabiliser

## COMPONENTS

### Resistors

- (All resistors 5% tolerance)
- R1 100Ω, 4 watts (for 20V input) or 10 watts (for 30V input)
  - R2 39Ω, 2 watts
  - R3 390Ω, ¼ watt
  - R4 5.6kΩ, ¼ watt

### Capacitor

- C1 50μF, 25V wkg. (see text)

### Transistors

- TR1 BFY51, MC140, etc. (see text)
- TR2 2N4289, 2N4058, BC214, etc. (see text)

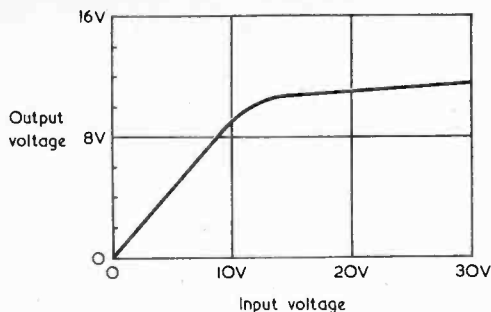


Fig. 2. Output voltage under no-load conditions for varying input voltage

small variations more readable.

The formula for  $V_{out}$  just given suggests that the output voltage depends only on the ratio of  $R_4$  to  $R_3$  and not on the absolute values of these two resistances. This is only true up to a point. It is essential that  $TR_2$  be voltage driven, not current driven. This implies that  $R_3$  should be very much less than the input resistance of  $TR_2$ . A simple rule of thumb for ensuring this is to make  $R_3$  plus  $R_4$  small enough to pass roughly as much current as the collector current of  $TR_2$ . If  $TR_2$  has a gain of more than about 200, it is safe to multiply the calculated values by about 5, as has been done in Fig. 1.

## POWER DISSIPATIONS

The purpose of  $R_2$  and  $C_1$  has not so far been discussed. The function of the capacitor is merely that of preventing high frequency oscillation, always a risk in high-current circuits using h.f. transistors.  $C_1$  is specified as  $50\mu F$  in Fig. 1, but in practice its value is not critical and any capacitance greater than  $1\mu F$  will be satisfactory. Resistor  $R_2$  limits the power dissipated in  $TR_1$ . Its inclusion can often save the constructor a lot of cash, by permitting a relatively low-power transistor to be used.

The optimum value of  $R_2$  is that which leaves just enough collector voltage on  $TR_1$  for this transistor to operate properly when passing the maximum current at which the circuit is intended to stabilise.

Suppose the maximum current (which flows in  $TR_1$  when no load is connected to the output) is 200mA. Then every  $5\Omega$  in  $R_2$  will drop 1 volt. If  $TR_1$  will work with only 1 volt on its collector at  $I_c = 200mA$ , and if the stabilised output is 9 volts, then  $R_2$  can be allowed to drop 8 volts, which means that  $R_2$  becomes  $40\Omega$ . (In practice the nearest preferred value

—  $39\Omega$  — may be used.) Now, the maximum power which  $TR_1$  has to dissipate is the power at which  $R_2$  drops just one half of the output voltage. Under these conditions,  $R_2$  and  $TR_1$  dissipate equal amounts of power, so by calculating the power in  $R_2$  we can also calculate the power in  $TR_1$ . In the

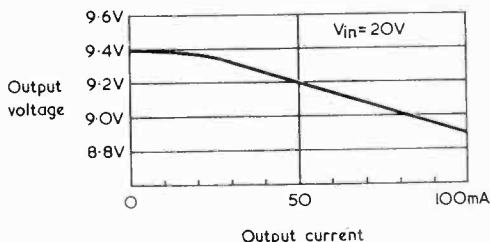


Fig. 3. Output voltage for varying load current

present case this is the power dissipated in  $40\Omega$  when 4.5 volts are applied, which comes to just over 0.5 watt. Thus  $TR_1$  need only have a permissible collector dissipation of 500mW, and there are plenty of cheap low-power transistors which will meet this requirement without even a heat sink. If, on the other hand,  $R_2$  were not included, the transistor would receive up to 9 volts at 200mA, which means a collector dissipation of 1.8 watts and calls for either a higher-powered transistor or a heat sink, or, very likely, both.

Naturally, this saving has to be balanced against the cost of  $R_2$ , which may not be negligible since it has to handle 8 volts when  $TR_1$  is fully on, and so must be rated at 1.6 watts or, say, 2 watts to be on the safe side. Before leaving the subject of power dissipations, the power rating of the series resistor  $R_1$  needs also to be con-

sidered. In theory,  $R_1$  need not withstand more than the difference between the unstabilised and stabilised voltages, but in practice there is always a risk of the output of the stabiliser being short-circuited. In this event the whole of the unstabilised voltage is applied across  $R_1$ , and the resistor should be rated accordingly. For example, if the unstabilised input is 20 volts and  $R_1$  is  $100\Omega$ , its power rating should be 4 watts or more. If the input is 30 volts,  $R_1$  should be rated at 10 watts.

## OTHER OUTPUTS

The stabiliser of Fig. 1 will deliver 9 volts, 200mA maximum from an input of 30 volts, and 100mA maximum from an input of 20 volts. Changing either the voltage or the maximum current involves the re-calculation of all the resistances and dissipations, and should not be attempted except by constructors who know exactly how to do it, since errors, even small ones, can be fatal in power circuits.

Shunt stabilisers like the present

circuit do not lend themselves well to use in variable voltage supplies. For variable voltage output a series stabiliser is a much better proposition, though it is more complex, especially if it is to be protected against accidental short-circuits and overloads. It is hoped to describe a simple series stabiliser incorporating protection in a future article. ■

## MODERN MANNERS ?

**'For years I have watched on television how grown-ups and children grab greedily at chocolates, biscuits, soups and other food of all kinds. But I have never once heard anyone say Please or Thank you for anything. It is just grab and guzzle. What sort of example is that for our children?'**

*A speaker in BBC Woman's Hour*

# TWO TRANSISTOR AMPLIFIER

by  
H. WILLIAMS

Intended specifically as a bench aid for servicing or experimental work, this sensitive little a.f. amplifier can be assembled in a small case complete with battery and loudspeaker

HIGH QUALITY AND HIGH OUTPUT ARE NOT ALWAYS required from an audio amplifier and it is very easy and cheap to build a small amplifier with high gain which will drive a loudspeaker at an acceptable listening level. The amplifier described here has an output of about 100mW, which is more than adequate for test-bench purposes. If it is built into a small box with speaker, volume control and battery as described it will be an invaluable asset on the test bench.

## THE CIRCUIT

The amplifier, whose circuit is shown in Fig. 1, employs two high-gain transistors directly coupled. Since the overall gain of these transistors can (theoretically at least) approach 810,000 and is thus

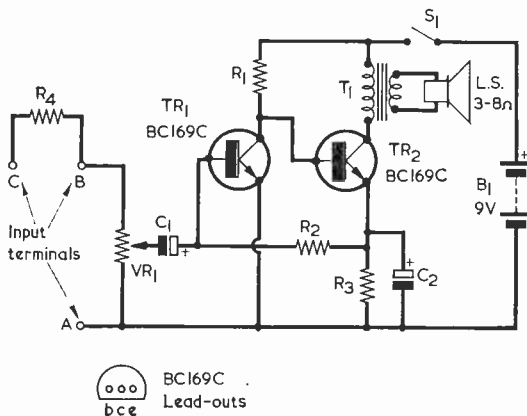
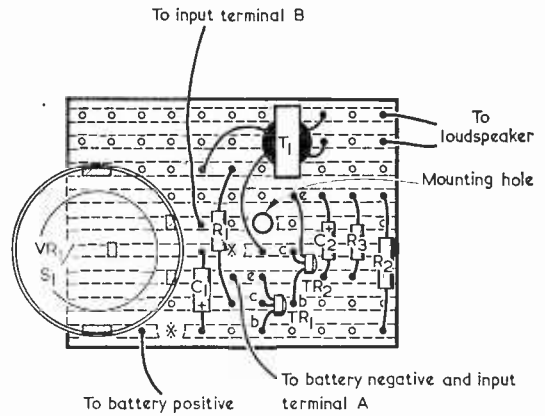


Fig. 1. The circuit of the 2-transistor amplifier



\* Break in copper strip

Fig. 2. The components mounted on the Veroboard. This view shows the component side of the board with the copper strips underneath

far more than is required, a considerable degree of negative feedback is provided, making use of the "surplus" gain to improve quality. The negative feedback is obtained by coupling TR1 bias resistor,

## COMPONENTS

### Resistors

(All fixed values  $\frac{1}{4}$  watt 10%)

- R1 100k $\Omega$
- R2 5.6k $\Omega$
- R3 100 $\Omega$
- R4 1M $\Omega$
- VR1 5k $\Omega$  edgewise control potentiometer, log track, with switch S1

### Capacitors

- C1 4 $\mu$ F electrolytic, 12V wkg.
- C2 4 $\mu$ F electrolytic, 12V wkg.

### Transformer

- T1 Miniature transistor output transformer, approx 4.5:1 (see text)

### Transistors

- TR1 BC169C
- TR2 BC169C

### Switch

- S1 s.p.s.t., part of VR1

### Battery

- B1 9-volt battery type PP3 (or PP9, etc.)

### Loudspeaker

- Miniature moving-coil, 3-8 $\Omega$

### Miscellaneous

- Veroboard, 0.15 matrix, 9 by 11 holes (see Fig. 2)
- 3 insulated terminals
- Small box (material and dimensions as required)

R2, to the emitter of TR2. Connecting the bias circuit in this manner also adds d.c. stabilisation to the circuit, the provision of which can be a problem when high-gain transistors are directly coupled.

The presence of the  $4\mu\text{F}$  capacitor, C2, in a feedback circuit of this type may appear unusual. However, if no capacitor were present there would be a considerable degree of feedback and gain would be very low. At the same time, if a high value capacitor of the order of  $200\mu\text{F}$  were connected, there would be no a.f. feedback at all and overloading on small inputs could result. The value specified for C2 was found experimentally for best results, and allows just the right amount of feedback to be applied. Although the circuit is, in theory, frequency selective, the audible response obtained in practice is fairly flat and is more than adequate for the purposes for which the amplifier is required.

An output transformer is employed to match to a  $3\Omega$  or an  $8\Omega$  loudspeaker. It is perfectly possible to connect an  $8\Omega$  loudspeaker directly between the positive rail and the collector of TR2 but since the amplifier is operating in Class A (that is, current is being passed by TR2 irrespective of signal input) it means that d.c. is also passed through the speech coil, pushing it in or pulling it out depending upon the way it is connected.  $8\Omega$  loudspeakers are usually on the small side and this "biasing" of the speech coil can cause distortion and inefficiency.

Decoupling of the supply rails is not really necessary.

## CONSTRUCTION

All the components are mounted on a small piece of Veroboard, 0.15in. matrix and 9 by 11 holes.

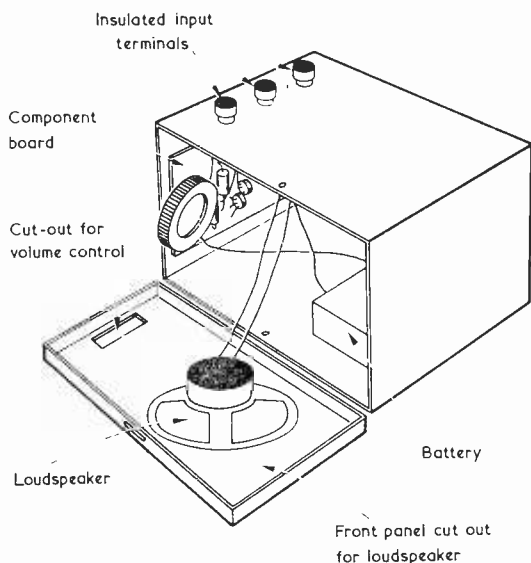
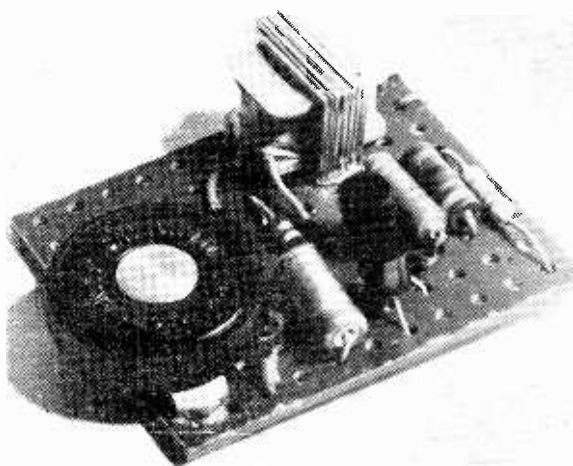


Fig. 3. The completed amplifier may be housed in a small wooden or metal case of suitable size to take the loudspeaker and battery

NOVEMBER 1970



Component assembly on the Veroboard is neat and simple

Fig. 2 shows the component layout and connections. The output transformer used in the author's version was a really miniature one and fitted nicely on the board, but larger ones may require repositioning. The ratio required is of the order of 4.5:1, but is not really critical. A suitable standard component which could be employed is the Radiospares T/T2, using one half of the primary winding. This transformer is larger than the one used by the writer.

An edgewise volume control was employed as this can be easily fitted onto the Veroboard, but of course any type would do. There are two types of control available, one has the connecting pins at right angles to the plane surface and the other has them in line with the plane. The former type (which is available from Henry's Radio, Ltd., as Type VC200) is the easiest to mount by far as the pins slip into the board. The holes for mounting will have to be slightly enlarged—especially for the switch contacts.

If desired, the board can be mounted in a small box of appropriate size to take the battery and the loudspeaker. A suitable method of assembly is shown in Fig. 3, in which the board is secured to one side of the box. The edgewise potentiometer protrudes through a rectangular cut-out in the lid.

Since the prototype was required primarily for bench use the input was provided in the form of screw terminals on the box top for rapid connection. Three terminals are provided, with R4 connected between two of them as indicated in the circuit diagram. R4 is included since the amplifier is very sensitive and, although the negative feedback will allow for a considerable degree of overloading, high level signals will still, as with any other amplifier, result in distortion. R4 is intended to function as a simple attenuator in conjunction with the volume control. The non-earthly input connection to the amplifier can be made to either side of this resistor.

The sound quality provided by the amplifier is surprisingly good, certainly good enough to check through an amplifier under test for distortion.





## S.E. Asian Quest

(1)

- ★ CAMBODIA      ★ LAOS
- ★ MALAYSIA      ★ THAILAND

Asia, the world's largest continent, has an area of approximately 16,700,000 square miles and a population estimated at something like 1,600,000,000 – more than half the world's total. South East Asia is defined as comprising Burma, Thailand, Indonesia, Philippine Islands, Cambodia, Laos, Vietnam, Malaysia and Borneo – the latter including North Borneo, Sarawak and Brunei. It is to this South Eastern part of Asia that experienced Broadcast band Dx'ers turn their attention at this time of the year, the 'season' for reception situated within this area now being in full swing.

For the less experienced SWL, this article presents information which it is hoped will arouse interest and cause the receiver dials to be set on some of the listed frequencies at the times stated. S.E. Asian Quest 2 – Burma, Indonesia, Philippines and Vietnam, will be published next month.

The reception and successful identification of low powered signals from the exotic S. E. Asian area on the low frequency bands represents an operating feat of no mean order. Generally speaking, to log such stations one must have an aural sense able to attune to signals through heavy interference from adjacent utility transmitters and have equipment which exhibits a high degree of efficiency. However, with a little luck, there is no reason why the comparative beginner, equipped with a modest communications receiver and an efficient aerial and earth system, should not 'have a go' at the reception of S. E. Asian stations.

### WHEN?

In general terms, the 'season' for Asian reception, especially on the low frequency bands (60, 75 and 90 metres) extends from around mid-September through to late March. The period offering the best chances is that from early December to late January when the signal path is open for a longer period of time than the remainder of the 'season'.

Dealing with time periods (GMT), those from 1300 to 1700 and from around 2200 through to 0800 or so, are favourable given the right propagation conditions.

## CAMBODIA

This country has an area of 67,000 square miles and a population of 4,952,000 approximately. The capital is Phnom-Penh, the country being bordered on the North by Laos, on the East by South Vietnam, on the South by the Gulf of Siam and on the West by Thailand. Cambodia is situated on a saucer-shaped plain drained by the Mekong river and is surrounded by mountains.

Broadcasting in Cambodia is controlled by Radiodiffusion Nationale Khmère, a government agency. The currently listed short wave channels are shown in Table 1.

TABLE I

Freq.	Station	Power
4907kHz	Phnom-Penh	15kW Home Service
6090kHz	Phnom-Penh	50kW International
9695kHz	Phnom-Penh	50kW Service

Although officially listed on 9695kHz, the transmitter was reported last year as being on 9698kHz.

From Table I, it might be thought that the best chance of Cambodian reception would be on either of the two International Service channels, especially in view of the radiated powers shown. In fact, as is often the case in the short wave world, things turn out differently in practice! The 6090 and 9695kHz channels are also occupied by other powerful transmitters, therefore the most likely frequency on which to hear Phnom-Penh is, in fact, 4907kHz. It is this channel which is most reported by SWL's, being logged by the writer on many occasions last year.

The schedule of Phnom-Penh on 4907kHz is from 2300 to 1700GMT and as is the case with all Far Eastern stations, the best time for reception is when most, or all, of the signal path is in darkness. At this time of the year (November) this is from around 1500 to 1700GMT close-down and from sign-on at 2300 to 0830GMT fade-out.

The station identification, in French, is "Ici Phnom-Penh, La Voix du Cambodge" ("This is Radio Phnom-Penh, the Voice of Cambodia").

During the late afternoons, Phnom-Penh can be heard with a drama in Cambodian, the dialogue often being interspersed with the sound of clashing gongs and cymbals. Once heard, a Cambodian drama will be instantly recognisable on other occasions! The address for reports is – Radiodiffusion Nationale Khmère, 28 Avenue Preah Mohaksatryany Kossomak, Phnom-Penh.

### LAOS

With an area of 89,000 square miles and a population of 2,000,000 approximately, this country is bounded by China in the North, Vietnam in the East, Cambodia in the South and Thailand in the West. The terrain is rugged with dense forests, although level along the Mekong river area. The royal capital is Luang Prabang.

Laos is undoubtedly one of the most rarely heard countries in the South East Asian complex and the time period for possible reception of the government station at Vientiane, for listeners in the U.K., is short

-- from around 1330 fade-in, if conditions are ideal, to 1430GMT sign-off. The frequency is 6130kHz, a crowded channel, and the power is 25kW.

Station announcements are in French and Laotian. Listen for the French "Ici la Radiodiffusion Nationale Lao". The address for reports is - Radiodiffusion Nationale Lao, Vientiane. Count yourself fortunate indeed if you hear this one!

Operating also from Laos are stations belonging to the Pathet Lao, the guerilla organisation. These stations have been heard on various channels and announce in French as "La Voix du Pathet Lao". Two of the channels they have used are 6199 and 7310kHz, although these frequencies are subject to some 'wandering' at times. Listen around 1430 to 1530GMT.

## MALAYSIA

The Federation of Malaysia has an area of 129,775 square miles and an estimated population of 8,487,000. Bounded on the North by Thailand, on the East by the South China Sea, on the South by Singapore and on the West by the Strait of Malacca and the Adaman Sea, the capital is Kuala Lumpur. The Federation was formed in 1963 by the states of Malaya, Singapore (withdrew 1965) and the former colonies Sarawak and Sabah (formerly North Borneo). Malay is the official language and Islam the official religion.

**TABLE II**

<i>Freq.</i>	<i>Station</i>	<i>Power</i>
6100kHz	Kuala Lumpur	100kW
6175kHz	Kuala Lumpur	100kW
7220kHz	Kuala Lumpur	100kW
11900kHz	Kuala Lumpur	100kW
15280kHz	Kuala Lumpur	50kW

*Remarks:*

English programme from 0625 to 0855GMT. News at 0630 and 0830. On all channels.

Malaysia is one of the less difficult countries of South East Asia to hear on the short waves. Radio Malaysia uses many channels, some of these being occupied by the Home Service in the Malay, English, Chinese and Indian languages. The best channels for the comparative beginner to log Malaysia are those of the Overseas Service and these are listed in Table II.

The interval signal of Radio Malaysia is the first bar of the National Anthem "Negara Ku" rendered on chimes and the identification announcement, in English is "This is the Voice of Malaysia". In Malay it is "Ini-lah Suara Radio Malaysia". The address for reports is - R. Malaysia, Federal House, P.O. Box 1074, Kuala Lumpur.

Other channels on which Radio Malaysia may be heard are listed, together with the language used, in Table III.

In addition to the foregoing Malaysian transmitters, the BBC maintain a Far Eastern station at Tebrau which relays the BBC World Service and services to Asia in the various languages of the region. The BBC will verify reception reports on this station and the address is - C.E.X.B., BBC, Bush

(Continued on page 226)

# NOW HEAR THESE

Times = GMT

Frequencies = kHz

## ● MALDIVIVE ISLANDS

The English programme from the Maldivive Islands are now from 1515 to 1730 on 4740 (30kW). Also reported on the unlisted off-band frequency of 14310.

## ● POLAND

Radio Harcerska (Polish Pathfinders Station) has a daily transmission, except Mondays, from 1100 to 1700 on 6850.

## ● CAPE VERDE ISLANDS

Radio Clube de Cabo Verde can be heard in Portuguese from 2145 to 2300 on 3883 (5kW) but is listed on 3960.

## ● CONGO BRAZZAVILLE

La Voix de la Revolution Congolaise regional station at Point Noire can be heard with good signals until sign-off at 2000 on 4843. Sign-on is at 0500.

## ● ECUADOR

La Voz de Galapagos has been logged on 6245 from 0345 till 0401 sign-off, no National Anthem.

Radio National Espejo, Quito, has moved from 4680 to 4647.

Radio Iris, listed on 3372, has been heard on 3380 and is sometimes on 3381.

## ● GABON

La Voix de la Renovation Gabonaise has a new regional station on 9555 and can be heard around 0630.

Libreville can be heard around 0500 on 4777 (100kW); also logged at 2100 on this channel.

## ● PERU

OAX6Z Radio Moquegua has been heard around 0200 on 4825 (0.5kW). OAX8R Radio San Jose, Iquitos, may be heard signing off at 0600 also on 4825 (1kW).

OAX10 Chiclayo was logged at 0345 with station identification on 3380 (1kW).

OAZ4A Radio Tarma, heard at 0150 with station identification on 5058 (1kW).

OAX7A Radio Cuzco may be logged with chimes and station identification (repeated often) around 0300 on 6250 (1kW).

## ● LAOS

A station operated by 2nd Army at Long Chen has been reported on 4500 with news in vernacular at 2258 and a time signal of five 'pips' at 2300.

## ● UGANDA

Kampala can be heard most evenings. Listen on 4976 (3/8kW) around 2115 at which time a programme of songs in English, with announcements was heard.

## ● FEDERAL REPUBLIC OF CAMEROON

When listening for the above station also listen out for the adjacent 4972 (30kW) Radio Yaounde. Programmes are in French, English and vernaculars.

Acknowledgements to our own *Listening Post and SCDX*.

## S.E. ASIAN QUEST

(Continued from page 225)

House, London W.C.2. The channels used by this station, are listed in Table IV.

**TABLE III**

<i>Freq.</i>	<i>Station</i>	<i>Power</i>	<i>Language</i>
4790kHz	Penang	10kW	Malay
4845kHz	Kuala Lumpur	50kW	Indian
4985kHz	Penang	10kW	English
5965kHz	Kuala Lumpur	100kW	Malay
6025kHz	Kuala Lumpur	50kW	Chinese
7110kHz	Kuala Lumpur	10kW	Chinese
7200kHz	Penang	10kW	Malay
7295kHz	Penang	10kW	English
9515kHz	Kuala Lumpur	50kW	Malay
9660kHz	Kuala Lumpur	10kW	English
9710kHz	Penang	50kW	Malay

**TABLE IV**

<i>Freq.</i>	<i>Station</i>	<i>Power</i>
3915kHz	Tebrau	7.5kW
6080kHz	Tebrau	7.5kW
7120kHz	Tebrau	7.5kW
7235kHz	Tebrau	7.5kW
9570kHz	Tebrau	7.5kW
9580kHz	Tebrau	7.5kW
9725kHz	Tebrau	7.5kW
9740kHz	Tebrau	7.5kW
11750kHz	Tebrau	7.5kW
11850kHz	Tebrau	7.5kW
11955kHz	Tebrau	7.5kW
15310kHz	Tebrau	7.5kW
15435kHz	Tebrau	7.5kW
17880kHz	Tebrau	7.5kW
21590kHz	Tebrau	7.5kW

### THAILAND

Officially termed Pathet Thai (Kingdom of the Free), Thailand has an area of 198,300 square miles and an estimated population of 25,520,000. Formerly known as Siam, the capital is Bangkok. Bordered on the West and North West by Burma, on the North East and East by Laos and Cambodia and on the South by the Gulf of Siam and Malaya, the heart of the country is the central plain, watered chiefly by the Menam Ghaio Phraya into many irrigation and drainage canals. The official language is Thai, formerly termed Siamese.

Undoubtedly, the channel offering the best chance of receiving Thailand is HSK9 11910kHz (100kW) with its English Service to North America from 0415 to 0515GMT.

The short wave outlets of the Thai National Broadcasting Station are listed in Table V. The announcement to listen for is – "This is the Overseas Broadcasting Station of Thailand". The address for reports is – Overseas Broadcasting Division, Public Relations Department, Bangkok.

In addition to the above, other stations in Thailand are operated by the Thai Ministry of Education, these operating on 3202kHz (2kW) and 6060kHz (2kW).

**TABLE V**

<i>Freq.</i>	<i>Station</i>	<i>Power</i>
4830kHz	HSKB Bangkok	5kW
6070kHz	HSK5 Bangkok	1kW
6160kHz	HSK4 Bangkok	1kW
7115kHz	– Bangkok	2.5kW
7305kHz	– Bangkok	2.5kW
11910kHz	HSK Bangkok	100kW

Another transmitter of interest is that operated by the Thai Television Company on 6010kHz (10kW) and 7105kHz (1kW). The former channel is crowded with other, more powerful, transmissions and the writer has so far been unable to log the programme. Strange to relate, the lower powered 7105kHz channel has been logged by the writer on two occasions within the last two years!

### NOTE

It should be noted by the beginner – old timers are well aware of the pitfalls – that both the frequencies and time schedules mentioned are subject to change, although the information given in this article is, to the best of the writer's knowledge, correct at the time of writing.

A further hazard is that the political situation in some countries of South East Asia is in a state of flux – therefore the speed of events may well overtake the written word!

There is, of course, much more that could be written about South East Asian stations but the allotted space does not allow a more thorough treatment of the subject. It is hoped that the notes given here will inspire more SWL's to take up the absorbing hobby of Broadcast band listening and join in the S. E. Asian Quest.

(To be concluded)

## BBC STEREOPHONIC BROADCASTS

The regular vhf Radio 3 stereo broadcasts now provide a service to a potential audience of about 32½ million listeners in the south-east, midlands and north of England.

Additional stereo studio equipment continues to be installed. These extra facilities have enabled a 100% increase in stereo output to be achieved, in comparison with that in 1968, with an average now of over fifty hours each week. Almost half of this is BBC-produced material. This year, almost all the Promenade Concerts have been broadcast in stereo. Also, more drama is being produced in stereo and as many as possible of the Sunday evening drama productions in Radio 3 are now in stereo. The midland, north and Scottish regions are now contributing recorded stereo material to the network. Additionally, 'Jazz Club' on Sunday evenings (Radio 2) is being regularly transmitted in stereo on Radio 3.

THE RADIO CONSTRUCTOR

## MULLARD EDUCATIONAL SERVICE

A new book published by the Mullard Educational Service contains twenty electronic experiments that have formed the subjects of pamphlets issued over the past ten years. The experiments have been designed to familiarise students with electronic theory and practice while building useful equipment. For example, the first experiment describes the construction of a double-beam simulator for producing two independent beams on a simple oscilloscope; and the next a one-megohm-per-volt d.c. voltmeter. Power supply units, oscillators (a.f., r.f. and micro-wave) and an oscilloscope are made in other experiments. The critical potentials in gases, Hall effect,

and logic gates are subjects that are also dealt with.

Intended for the use of apprentices and students of electronics, the book could be an asset to lecturers and teachers of these subjects. It could also help home constructors to build their own test equipment – power supply units, voltmeters and oscilloscopes – as well as various control circuits.

The book, entitled “Educational Electronic Experiments” costs 10/- post free (cash with order) and can be obtained from Mullard Educational Service, Mullard Ltd., Mullard House, Torrington Place, London, WC1E 7HD.

# SPECIAL REPEAT

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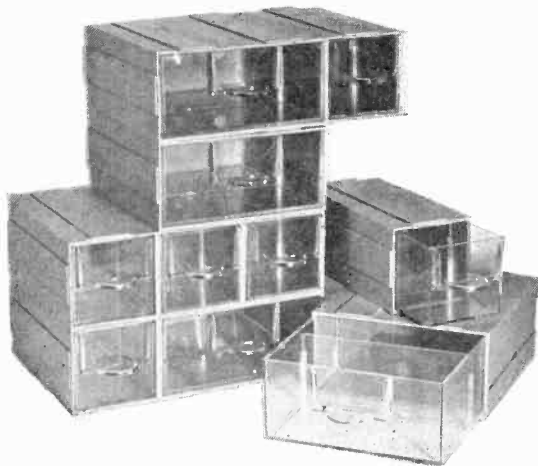
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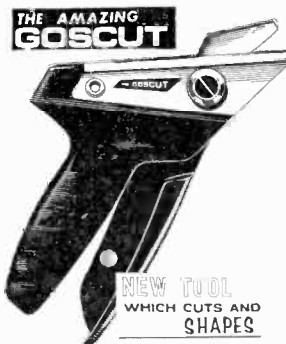
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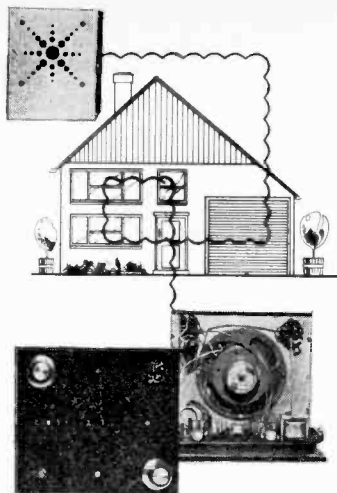
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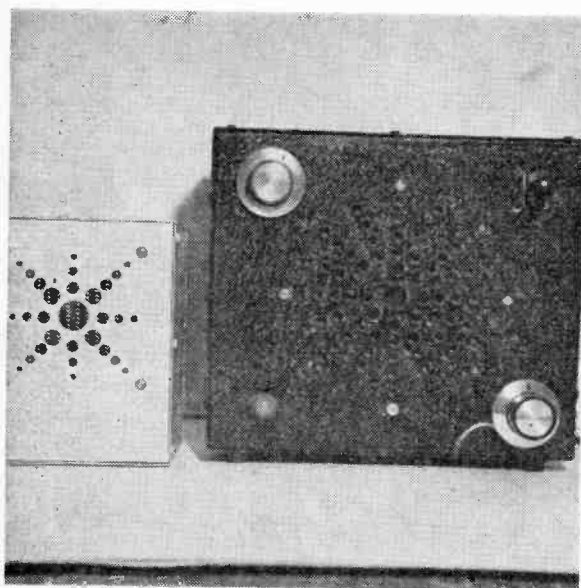
H. T. I

A simple but effective intercom unit communication between one Master both Slave positions may be switch

THE UNIT ABOUT TO BE DESCRIBED WAS BUILT TO provide an inexpensive, but reliable, method of communication between the author's workshop and the front door and living room.

The circuitry is entirely conventional. It works well and has proved over a period of time to be very dependable, the amplifier having at one period been inadvertently left switched on for the better part of a week. Being conventional means, also, that many of the components may already be in the constructor's spares box, as well as being inexpensive to buy should the necessity arise.

The switching has the merits of simplicity and reliability. The more usual "call" facility was omitted in this design, as its inclusion was not, after due investigation, found to be necessary - for the author's own particular requirements anyway.



The Master unit and, to the left, a Slave loudspeaker. The two top controls on the Master unit are S1 (left) and S2 (right). At the bottom are the neon lamp and VR1

## THE CIRCUIT

The circuit, shown in Fig. 1, is fairly straightforward. Transformer T1 is a special component designed to match a 3Ω speaker, when used as a microphone, into the base circuit of a transistor. Here, it couples to the first transistor, TR1.

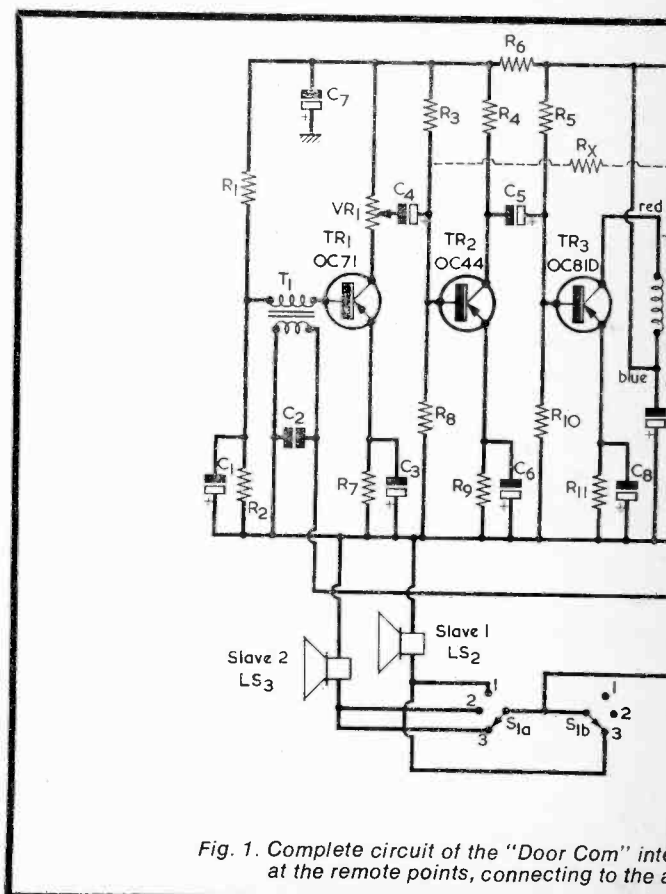


Fig. 1. Complete circuit of the "Door Com" intercom system, showing the remote points, connecting to the a

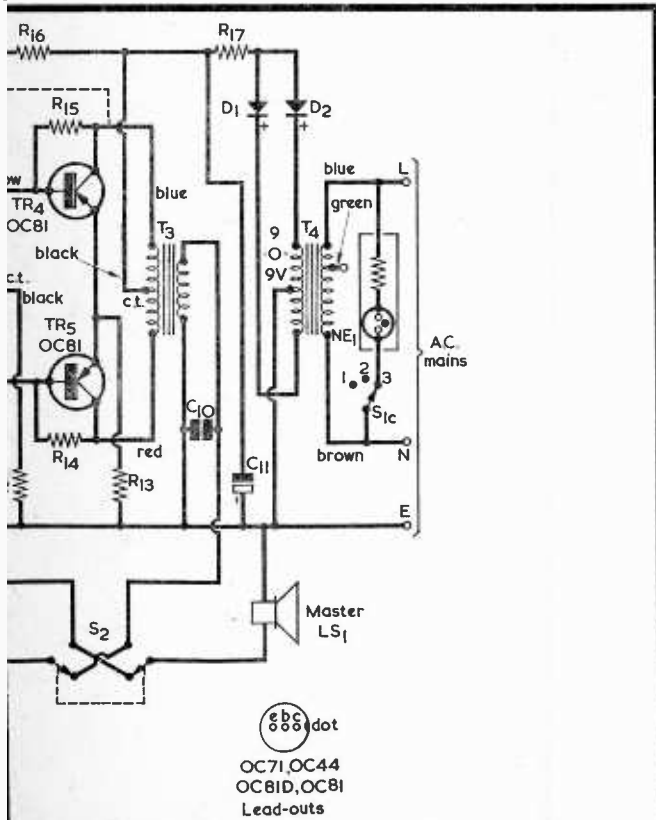
# DR COM"

## WHEN

The "Door Com" allows loudspeaker and two Slave positions. If desired, into the system at the same time

Bias for TR1 is given by the potential dividing resistors R1 and R2, and by the emitter resistor R7. C1 bypasses the earthy side of T1 secondary, so permitting the maximum transfer of signal current from the primary to the base of TR1. R7 is bypassed by C3.

The volume control VR1 forms the collector load



om unit. The two Slave speakers are mounted plifier and switching unit via twin cable

NOVEMBER 1970



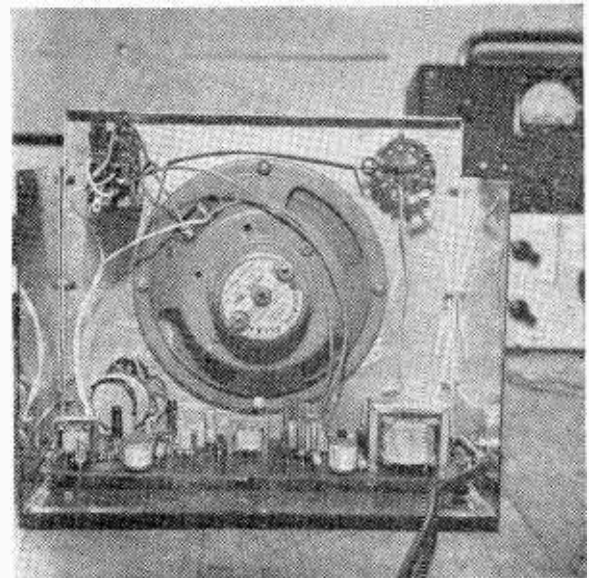
Cover Feature

of TR1, the signal tapped off its track being fed to the base of TR2 via C4. Again, bias and stabilisation is provided by means of a potential dividing network, R3 R8, and by the emitter resistor R9, which is bypassed by C6. The supply voltage to TR1 and TR2 is decoupled from that to the driver and output stage by R6 and C7.

C5 couples the collector of TR2 to the base of the driver transistor TR3, which is stabilised by R5, R10 and the emitter resistor R11, the latter being bypassed by C8.

T2 is the driver and phase splitting transformer, with its primary forming the collector load of TR3, and its secondary feeding the bases of the output transistors. Bias for the output transistors TR4 and TR5 is obtained by means of the two collector-to-base resistors, R14 and R15, and by R12. This method of biasing was chosen in preference to the more usual potential dividers as it allows a small amount of negative feedback to be introduced, via R14 and R15, from each collector to its own base. TR4 and TR5 should, if possible, be a matched pair.

Additional extra negative feedback can also be introduced by means of a resistor, shown in broken line in the circuit and designated Rx, from one side of the primary of T3 back to the base of TR2. The degree of feedback obtained depends on the value of this resistor, and 100kΩ is suggested as a starting point since this was the value used in the prototype. Since



Illustrating how the printed circuit board fits into the cabinet

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Rx is effectively in parallel with R3 at zero frequency, it will affect the magnitude of the collector current of TR2, which should normally be centred at 1mA. If heavy feedback is required the value of this new resistor will need to be significantly lower than 100kΩ, whereupon the value of R3 must be approximate to the value of 39kΩ quoted for R3 on its own in the Components List.

It is normal practice in audio circuits handling speech to curtail the bass response in order to improve intelligibility. This practice has been followed to a moderate extent in the present design by choosing rather low values for the interstage coupling capacitors, and also for the emitter bypass capacitors.

In any high gain amplifier non-linearity in amplitude response is present to a greater or lesser extent. The effect of this non-linearity is to allow detection to occur of any r.f. signal introduced into the input and, if the r.f. is modulated, to allow a consequent audio signal to appear at the loudspeaker. During preliminary development work it was found that the leads linking the Master to the two Slave speakers picked up enough r.f. signals to cause a nuisance. The inclusion of C2 reduced this pickup to negligible proportions. In cases where it is not effective, an r.f. choke in series with the non-earthly input lead should prove helpful.

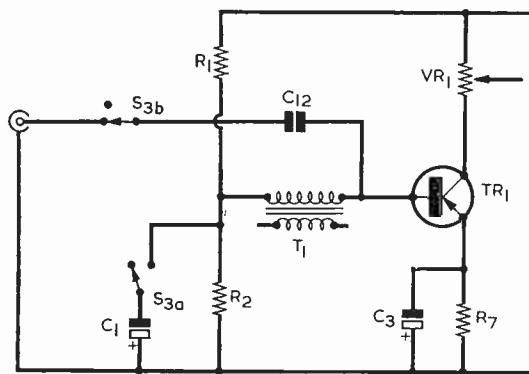


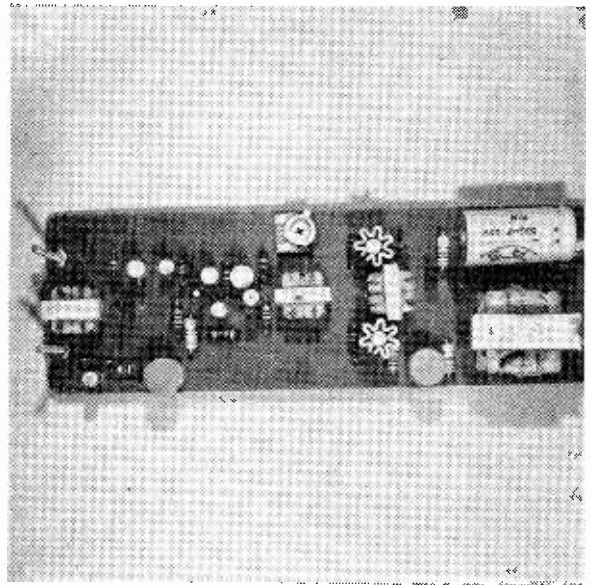
Fig. 2. If desired, a third switch can be added as shown here, thus enabling the unit to operate as an amplifier in addition to its use as an intercom

## SWITCHING

So much for the amplifier, and we come next to the switching. In the prototype a jack type lever switch of the type associated with manual telephone exchanges was used for the changeover switch S2, this being biased to remain in the Listen position. Alternative types of switch can include a spring loaded double pole double throw toggle switch or a double pole double throw push-button.

In order to preclude any possible misunderstanding, it might be helpful to state at this point that the Talk position is given when the Master, at the amplifier, is talking to a Slave station, and Listen is given when the Master listens to a Slave.

S2, therefore, is the Talk-Listen switch, and is shown in the Talk position in Fig. 1. The other switch, S1, has three positions. In position 1 it selects Slave speaker No. 1, in position 2 it selects Slave



The printed board assembly. A preset variable resistor was fitted in the R12 position instead of a fixed resistor when this photograph was taken

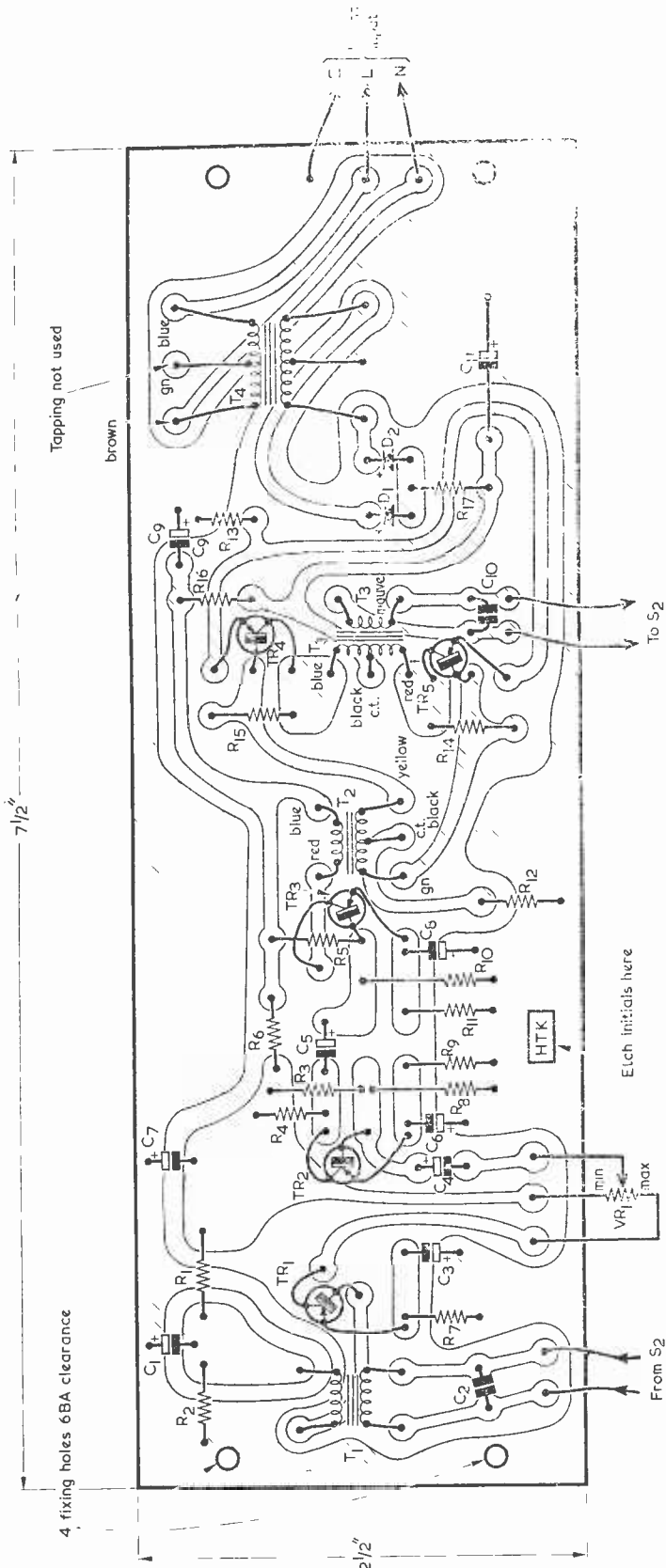
speaker No. 2, and in position 3 it places both Slave speakers in parallel. This last position is principally for Listen purposes, and has permitted the more usual Call facilities to be dispensed with, since in practice it is very easy to distinguish which speaker is in use. Having established the speaker in use, S1 is then switched over so that that speaker alone is in circuit. The third pole of the switch, S1(c), switches on a neon mounted on the front panel in position 3 to indicate that both speakers are in parallel.

Fig. 2 shows how the unit can be modified so that an external signal can be fed in, thus allowing it to be used for a number of purposes such as signal tracing or record player amplification, etc. The input impedance is fairly low, being that associated with a common emitter base input circuit. The working voltage of C12 depends on the circuit connected to the input socket. No polarity marking is given in Fig. 2 for C12, as the polarity with which it is connected will also depend on the circuit coupled to the input socket.

## PRINTED CIRCUIT BOARD

The amplifier, without the modification shown in Fig. 2, was built on a printed circuit board measuring 2½ by 7½ in., as shown in Fig. 3. Due to the fact that it connects between two points that are well spaced out in the stage layout, no provision is made for the feedback resistor Rx to be connected to the print through holes in the board in the same manner as the other components. It is, instead, soldered directly onto the copper side of the board between the collector of TR4 and the base of TR2. This is a reasonable approach in practice, especially since the value of Rx is experimental.

Fig. 3. The printed circuit board, as seen from the copper side. This is reproduced full size and may be traced



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- R1 68kΩ
- R2 12kΩ
- R3 39kΩ
- R4 2.7kΩ
- R5 68kΩ
- R6 220Ω
- R7 1kΩ
- R8 10kΩ
- R9 1kΩ
- R10 22kΩ
- R11 1kΩ
- R12 82Ω
- R13 4.7Ω
- R14 8.2kΩ
- R15 8.2kΩ
- R16 150Ω
- R17 4.7Ω
- Rx 100kΩ or as required (see text)
- VR1 5kΩ potentiometer, log track

**Capacitors**

(All electrolytics 15V wkg. unless otherwise stated; 100V wkg. printed circuit type or as available.)

- C1 8μF electrolytic
- C2 0.05μF paper
- C3 8μF electrolytic
- C4 2μF electrolytic
- C5 2μF electrolytic
- C6 8μF electrolytic
- C7 100μF electrolytic
- C8 8μF electrolytic
- C9 100μF electrolytic
- C10 0.05μF paper
- C11 500μF electrolytic, 25V wkg.
- C12 8μF electrolytic if used - see text)

**Transformers**

- T1 Transformer type TT52 (Repanco)
- T2 Transformer type TT45 (Repanco)
- T3 Transformer type TT46 (Repanco)
- T4 Mains transformer, secondary 9-0-9V 80mA, type MT9 (Osmor)

**Semiconductors**

- TR1 OC71
- TR2 OC44
- TR3 OC81D
- TR4 OC81
- TR5 OC81
- D1, D2 Silicon rectifiers, 50 p.i.v., 400mA minimum.

**Switches**

- S1 3-pole 3-way, rotary
- S2 2-pole 2-way, spring-biased (see text)
- S3 2-pole 2-way slide (if used - see text)

**Neon**

- NE1 240V panel mounting neon assembly, complete with integral series resistor

**Loudspeakers**

- LS1 3Ω, 5in. round
- LS2 3Ω, 3in. square
- LS3 3Ω, 3in. square

**Miscellaneous**

- 2 knobs
- 2 heat sinks or clips
- Printed circuit board
- Wire for connection to Slave speakers
- Material for cabinets

In Fig. 3 the components are shown in circuit symbol form and the view is with the copper side towards the reader. If the constructor likes to add a distinctive personal touch he can include his initials in the copper pattern, as the author has done in Fig. 3. If in doubt, the secondary winding of T1, that which connects to the base of TR1, is the high resistance winding.

Other forms of construction, such as Veroboard, can be used with equal success, so long as one or two provisos are borne in mind. As with all moderate and high gain amplifiers, the "straight line" form of construction is advisable, with the input and output at opposite ends of the board. Adjacent transformers must be mounted with their axes mutually at right angles. Ignoring these basic principles can result in an amplifier that is permanently unstable.

In the prototype, TR4 and TR5 were fitted with heat sinks in the interest of long-term cool running. If sinks of the required size cannot be obtained, suitable alternatives are heat clips type H.13 from Henry's Radio.

**CHECKING THE AMPLIFIER**

Connect VR1 to the board, then connect a Slave speaker via its wiring to the input points and the Master speaker to the output points. Remember that there will be acoustic feedback if the audible output from one speaker can be picked up by the other. Using jumper wires, connect the right hand input

point and the right hand output point (i.e. the point nearer C11 in both instances) to the adjacent copper area at earth potential. Switch on and find the value required in feedback resistor Rx which gives the amplifier gain desired. Adding Rx should cause volume to decrease; there is a slight possibility that an incorrect component in the T2 position might result in volume increasing, or oscillation, when Rx is added. Should this occur, Rx should be connected to the collector of TR5 instead of to the collector of TR4.

The cabinet in which the printed board, the Master speaker, and associated switches are contained can be made to suit individual tastes. The prototype cabinet was made from 20 s.w.g. aluminium and measured 8 in. square by 4 in. deep. The finish was black crackle, and the cabinet was connected to the mains earth. The general disposition of components within the cabinet can be seen in the photograph.

When installing the circuit board in the cabinet, keep the input and output leads from the board to S2 separate. Although there was no trouble with the prototype there is a possibility that instability may occur due to stray capacitive coupling between input and output circuits, or that a feedback howl may become evident when switching from Talk to Listen, and vice versa. Should either or both these effects occur, reverse the input connections to T1 at the board by taking the earthing jumper wire to the other input point and the non-earthly wire from S2 to the previously earthed input point.

# 'GO - NO-GO' DIODE TESTER

by

J. JOHNSTONE

This ingenious test circuit allows diodes to be checked for all basic characteristics in one step

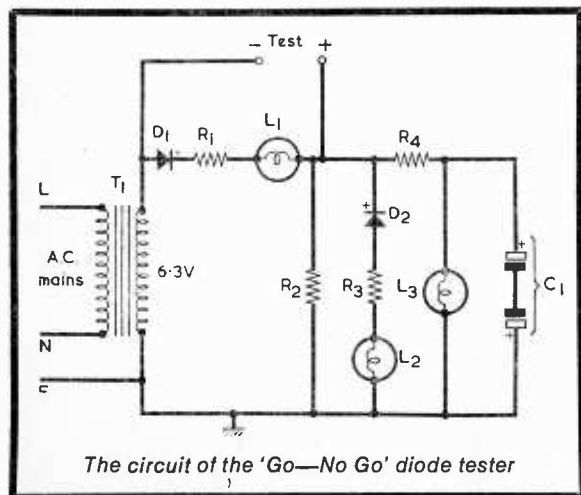
ANYONE WHO HAS TESTED A NUMBER OF DIODES WITH an ohmmeter will know how tedious it can be. The simple tester described here was developed to speed up the process, and gives a clear indication of the four possible states which can exist when a diode is connected across the terminals. The action of the circuit is explained below.

**Open Circuit.** L1 lights.

On positive half cycles L1 is lit via D1, R1, R2. The positive voltage across R2 back biases D2, and is too low to light L3.

**Good Diode.** L3 lights.

D1, R1, L1, are all shorted by the device under test. The positive voltage developed across R2 is now high enough to charge C1, and light L3.



NOVEMBER 1970

## COMPONENTS

### Resistors

(All resistors 1 watt 10%)

R1	10Ω
R2	30Ω
R3	10Ω
R4	12Ω

### Capacitor

C1 2 x 5,000μF, 6V wkg., connected as shown to form a 2,500μF unpolarised capacitor

### Transformer

T1 Mains transformer, secondary 6.3V 200mA (minimum current rating)

### Diodes

D1, D2 Type 5D1 (International Rectifier) or similar

### Lamps

L1, L2, L3 pilot lamps, 6V 0.06A

### Miscellaneous

1 red terminal  
1 black terminal  
3 lampholders  
Tagstrip, case, wire, etc.

**Short Circuit.** L2 lights.

D1, R1, L1, are again shorted, and the full a.c. voltage is developed across R2. D2 passes the negative half cycles, and L2 lights. C1 appears as a low impedance shunt across L3.

**Reverse Polarity.** All lamps light.

L1 lights on positive half cycles, negative half cycles pass through the diode under test and light L2. Also C1 is charged to light L3.

## CONSTRUCTION

The terminals and lampholders were mounted on the front panel of a small metal case. The transformer, and a short length of tagstrip were fastened to the base of this case. The two capacitors which comprise C1 were wired up to the tagstrip, and for extra security tied down with lacing cord. The other components were wired between the transformer secondary and the case were earthed by the mains lead.

The rectifier type 5D1 specified in the Components List for D1 and D2 has a p.i.v. of 100 volts and a maximum forward current (average) rating of 600mA. Any small rectifier diode of similar rating could be used instead. ■

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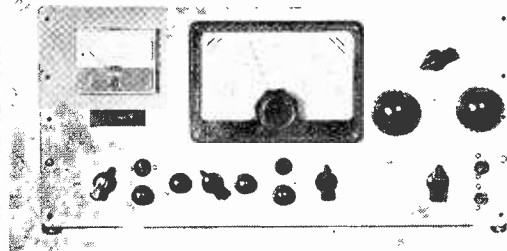
The President of the Institution of Electrical Engineers for the Session 1970/71 is The Rt Hon Lord Nelson of Stafford MA (Cantab) Hon D.Sc. (Aston & Keele), C.Eng FICE., Hon F.I. MechE, FIEE FRAeS; Chairman, General Electric and English Electric Companies Limited.

He took office as IEE President on 1 October 1970.

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# RADIO CONSTRUCTOR

## DECEMBER ISSUE



### THE 'VENTURER' TRANSMITTER

This comprehensive a.m./c.w. design covers all bands from 10 to 160 metres inclusive and incorporates switched band change and p.a. drive peaking.

### THE 'MINIFLEX' Mk. III MEDIUM/LONG WAVE TUNER

Using a minimum of components, this development from the author's original 'Miniflex' design provides continuous tuning over the medium and long wave bands. Particularly ingenious are the methods employed for obtaining regeneration and waveband switching.

### HIGH ACCURACY THERMOSTAT

By taking advantage of a differential comparator integrated circuit, this thermostat can maintain temperature control within one-seventh of one degree Centigrade. Intended for temperature control of photographic baths for colour printing, it has many other applications where a close control of temperature is required.

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# CURRENT SCHEDULES

Times = GMT

Frequencies = kHz

## ★ AUSTRALIA

The English service of R. Australia to the U.K. and Europe is now on **9730** and **11710** at 0645. The Mid-Pacific Islands Service is now on **5995** (which replaces **7205**) from 0830 to 1215. The **17740** channel has been replaced by **17795** for the N. American Service from 0100 to 0300. The parallel frequencies of **15320** and **21740** remain unchanged. From 1500 to 1730 R. Australia is now on **11740** and the new outlet of **11880**. A new programme in Vietnamese is radiated from 2130 to 2230 on **11790** and **15225**. Another new outlet is on **15295**, a 50kW relay from Darwin.

## ★ MOZAMBIQUE

Test transmissions have been heard at 1800 from Radio Clube de Mozambique new regional station at Beira on **4935**. The schedule is from 1500 to 1900.

## ★ NORWAY

Radio Norway has added a new transmission to its schedule. From 0500 to 0630 to East Africa, the Pacific and North America on **9550**, **9645** and **21730**.

## ★ NEPAL

Radio Nepal has replaced **7120** with **7165**. The External Service is on Tuesdays and Saturdays only from 1350 to 1420 on **7165** and **11970**.

## ★ NIGERIA

The Eastern Central State Broadcasting Service, identifying as ECBS, is now on the air from 0500 to 2200 on **7315**. This replaces the former Radio Biafra. Radio Nigeria, Enugu, can be heard signing on daily at 0500 on **6035**. Radio/TV Kaduna radiates on **6090** and **9570**.

## ★ RHODESIA

Radio Rhodesia has returned to the 120 metre band and the African Service can be heard at sign-on at 0330 and from 1630 to 2010 on **2335**. An English programme is broadcast on this channel from 2010 to 2200 on Saturdays only.

## ★ YEMEN

Radio Sanaa is back on **5804** where it has been logged at 0400. Radio Sanaa can still be heard from 1600 to 2200 on **4937**.

## ★ SYRIA

Damascus can be heard on **9670** instead of **15165** with the European Service from 1730 to 2100.

## ★ CUBA

The "Voice of Vietnam" is a 15 minute programme from Radio Havana this being part of the daily English transmission to Europe from 2010 to 2140 on **17885** (formerly **17840**). The English service to North America from 0058 to 0600 is now on **11960** instead of **9525** and **11865**. The **11760** channel remains unchanged.

## ★ CHINA

Radio Peking can be heard in English on **9965** at 2030 and on **15030** at 2000. Many additional channels are used.

*Acknowledgements to our own Listening Post and SCDX.*

THE RADIO CONSTRUCTOR

# F.E.T. TIMING CIRCUIT

by

R. B. GRAY

**By taking advantage of the extremely high input resistance of a field effect transistor, this timer offers very long periods with a low value timing capacitor. Of particular value is the repeated accuracy of timing periods**

**T**HIS UNIT, WHICH UTILISES AN N-CHANNEL F.E.T. can give timing periods from less than one second to several hours. It is designed to be operated from the local mains supply, and external circuits are controlled by its internal relay. The original timer was used to operate an enlarger and is accurate enough to be used as a process timer demanding consistent results.

## CONVENTIONAL TIMERS

The two great disadvantages of conventional transistorised timers are overcome in this circuit. The input impedance of a transistor, compared with that of a valve, is very low. Because of this a relatively low value of charging or discharging resistor is required in conventional transistor timers to minimise the shunting effect of the input resistance of the first transistor. In order, then, to obtain timing delays of reasonable length a large value of timing capacitor has to be employed. These capacitors are high value electrolytic components of the order of  $100\mu\text{F}$  or so. It can thus be seen that the calibration accuracy of transistorised timers is very low, first because the input impedance and hence the shunting effect of the transistor varies with time and temperature and, second, because the leakage and value of electrolytic capacitors vary with age.

Both of these disadvantages can easily be overcome by presenting an extremely high input impedance to the timing circuitry, and a device which fulfils this requirement admirably is the field effect transistor. An f.e.t. is incorporated in the timer described in this article. The design also provides sharp action of the relay to eliminate errors during short timing periods, and a single push-button start for the timing circle rather than a charge-time switch for controlling the capacitor.

## FIELD EFFECT TRANSISTOR

It will be helpful, at this stage, to briefly examine the basic operation of the field effect transistor.

While the normal junction transistor is a current operated device, this is not true of the field effect transistor. The n-channel f.e.t. used in this timing circuit, consists of a bar of n-type material which has contacts at either end, these being known as the source and drain electrodes. Situated between these

terminations is a p-n junction formed by the n-type material of the channel and a p-type material, the gate, on which is mounted a third electrode. This third electrode controls the flow of current between the other two.

When the p-n junction is reverse biased, as in Fig. 1, the resultant depletion region extends through the n-type material to a degree determined by the reverse bias voltage, thus effectively narrowing the channel width. Since the conductance of the channel is proportional to its width the drain current drops with negative gate voltage. At a certain gate voltage known as the pinch-off voltage the effective channel width thickness is reduced to zero and no current flows.

The gate current flowing when the p-n junction is reversed biased is merely the leakage current of the junction and can hence be made very small. The input resistance is thus very high indeed, being of the order of  $10^8$  to  $10^{10}$  ohms.

## THE CIRCUIT

Turning now to the timer itself, we may examine the full circuit of this and its power supply, as shown in Fig. 2. In this diagram all relay contacts are illustrated in the de-energised position.

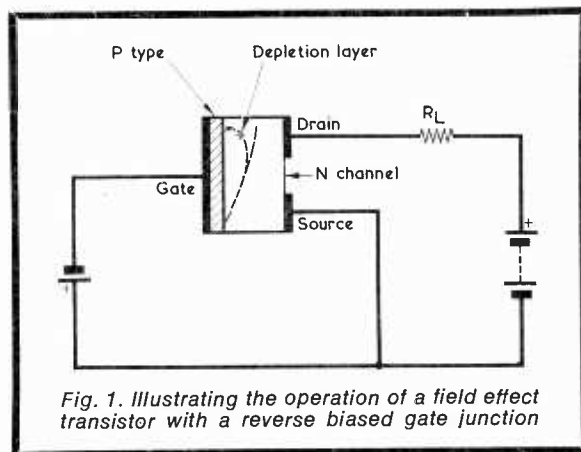


Fig. 1. Illustrating the operation of a field effect transistor with a reverse biased gate junction



It can be seen that, when the relay is de-energised, no bias is applied to the f.e.t., TR1 and it conducts, holding on the Darlington pair TR2 and TR3 which in turn leave TR4 non-conducting. Thus, the relay remains de-energised.

R6 is included in circuit to limit the initial charge current. Also, contacts A3 of the relay open and break the external circuit.

The diode D1 is reverse biased across the relay and protects TR4 by suppressing any high voltage

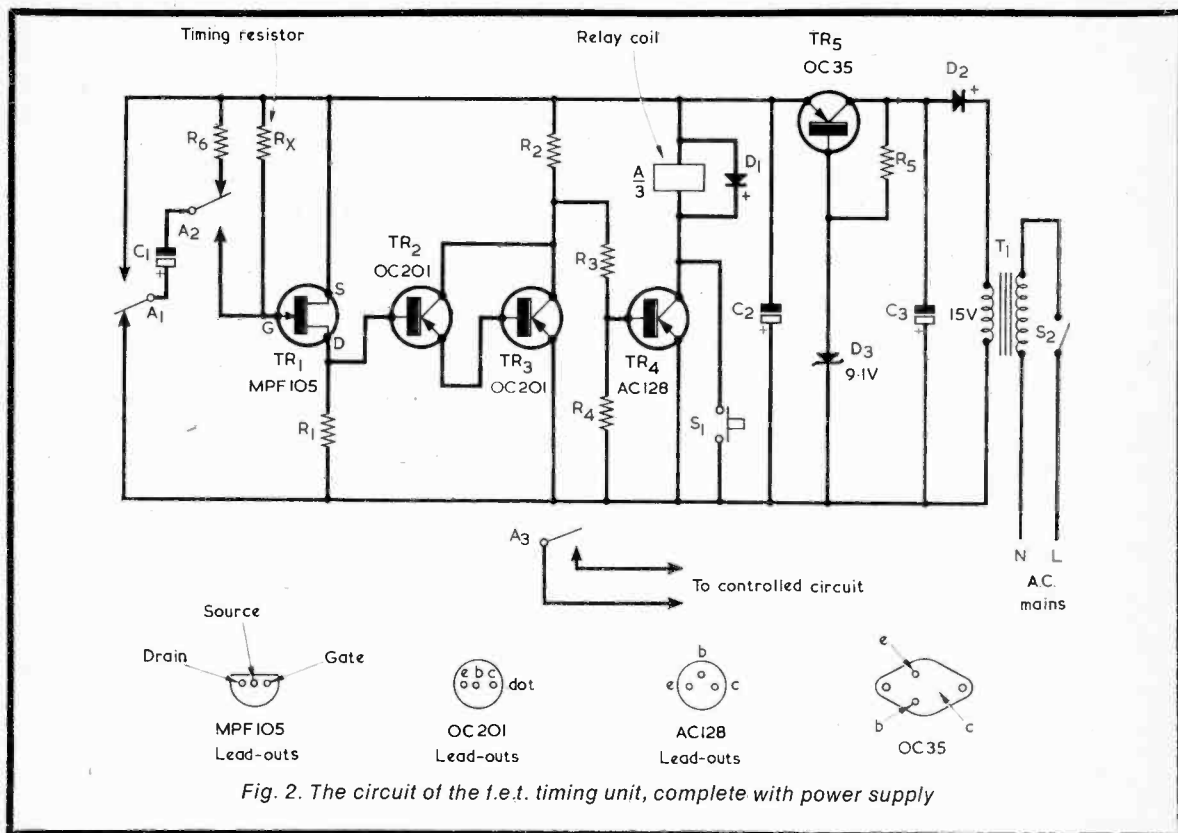


Fig. 2. The circuit of the f.e.t. timing unit, complete with power supply

When the push-button S1 is operated the relay is energised, and its contacts A3 complete the external circuit being timed. At the same time, contacts A1 and A2 transfer the timing capacitor C1 from the supply rails to the source and gate of the f.e.t. in such a manner that the p-n junction becomes reverse biased. The reverse bias at the junction is greater than the pinch-off voltage needed to reduce the drain current to zero and the channel stops conducting. This switches off the Darlington pair and leaves TR4 conducting, thus holding the relay on. The timing capacitor is discharged by the timing resistor Rx and, when the voltage across it is reduced below the pinch-off voltage of the f.e.t., the channel begins to conduct. Because the Darlington pair has such a high gain (the gain approximating to the product of the individual gains of the transistors) a small change in drain current, and hence base bias, results in a very large change in the current flowing in the collector circuit of the pair. The conductance of the Darlington pair switches off TR4 almost immediately and the relay is de-energised very rapidly. It is this sharp circuit action which eliminates errors in the timing period due to mechanical deficiencies in the relay.

Relay contacts A1 and A2 now reconnect the timing capacitor C1 across the supply rails. Resistor

transients produced by the rapid action of the relay.

The power supply is fairly conventional, the output being series regulated by means of a 9.1 volt zener diode in the base circuit of an OC35. The output voltage is taken between the emitter of this transistor and the positive line. Loads in excess of 100mA can be placed on the output with negligible change in output voltage, making the supply ideal for providing power to external circuits if required.

## TIMING RESISTORS

In its original application as a photographic enlarger timer the value of Rx (which is changed by a single pole 12 way rotary switch) was determined in such a manner that each increase in exposure time gave the same effect as opening the aperture of the enlarger lens by half a stop, i.e. if the lowest value of Rx is in the first position of the range switch and gives a time of t seconds then the second position gives 3t seconds, the third 2t seconds and so on.

The timing resistors are represented in Fig. 2 by the single resistor Rx as it is anticipated that constructors will have their own ideas on the method of timing control to be used. That employed by the author illustrated in Fig. 3, in which the single pole

## COMPONENTS

### Resistors

(All resistors,  $\frac{1}{4}$  watt 10%)

R1	1.8k $\Omega$
R2	2.2k $\Omega$
R3	3.9k $\Omega$
R4	3.3k $\Omega$
R5	1.6k $\Omega$
R6	4.7 $\Omega$
Rx	Timing resistor network (see text)

### Capacitors

C1	4 $\mu$ F 15V wkg. tantalum or paper
C2	100 $\mu$ F electrolytic, 15V wkg.
C3	250 $\mu$ F electrolytic, 30V wkg.

### Semiconductors

TR1	MPF105
TR2	OC201
TR3	OC201
TR4	AC128
TR5	OC35
D1	OA81
D2	Silicon rectifier, p.i.v. 50, 500mA
D3	9.1V zener diode, 400 mW

### Transformer

T1	Mains transformer, secondary 15V 1A (see text)
----	---

### Switches

S1	push-button, press to make
S2	s.p.s.t., toggle

### Relay

6-volt relay, 300 $\Omega$  coil, 2 changeover contact sets, one normally open contact set (see text)

12 way switch offers 12 separate timing periods in the progression just referred to. It so happened, with the particular timing capacitor and f.e.t. used, that a timing resistance of 1M $\Omega$  gave a delay of five seconds. The length of the delay varies linearly with timing resistance whereupon the remaining resistors had proportionate values. These were calculated at 200k $\Omega$  for one second. Thus, a 75 second delay required a resistance of 75 times 200k $\Omega$ , or 15M $\Omega$ , and so on. As the author had low tolerance components only to hand, quite a few of the timing resistors were made up of series or parallel combinations to achieve the desired delay.

Constructors building the timer should initially ascertain by experiment the timing resistance required to achieve a five second delay, and then work from this figure accordingly. Resistance values should be near to the 200k $\Omega$  per second figure encountered by the author. If desired, a suitably calibrated variable resistor could also be incorporated in the timing resistance circuit.

Timing resistances of 30M $\Omega$  (corresponding to 150 seconds in the prototype) and higher are quite feasible if attention is paid to the maintenance of good insulation in the switch and wiring. As a test of operating efficiency, the circuit was checked over and over again with a 30M $\Omega$  resistor and gave an accuracy of better than 1%.

As a further demonstration of the high value of input impedance of the f.e.t., one of the positions of the timing switch was temporarily left open-circuit and the timing cycle started. After eight hours the cycle had still not terminated so an estimate of the charge left in the capacitor was made. This result gave a reckoning of greater than 15 hours for the open-circuit timing cycle. The capacitor employed in the C1 position for this experiment and for general operation of the timer was a tantalum component.

## COMPONENTS

Most of the components are standard types and are readily available. Transistor TR1, the f.e.t., can be obtained from a number of suppliers including L.S.T. Electronic Components, Ltd.

The relay employed in the prototype circuit was a miniature 6 volt type with 300 $\Omega$  coil, together with two sets of changeover contacts and one normally open contact. It is available from Newcross Radio, Oldham Road, Manchester. If an alternative relay is employed its coil resistance should not be less than 150 $\Omega$ .

The mains transformer had a secondary voltage of 15. However, this voltage is not critical and a 17 volt one amp charger transformer could be used

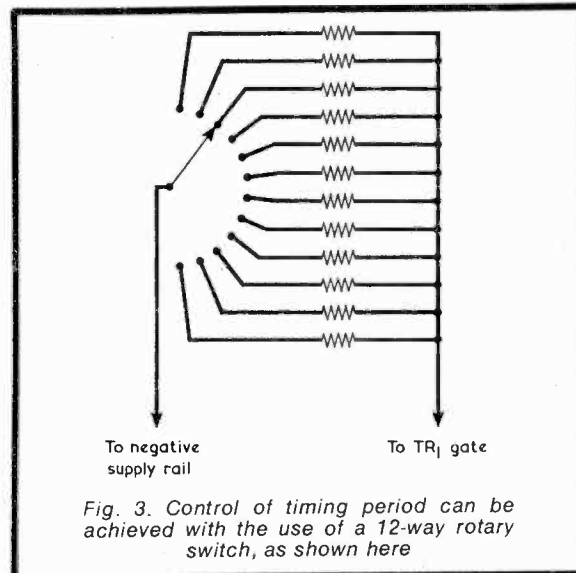


Fig. 3. Control of timing period can be achieved with the use of a 12-way rotary switch, as shown here

instead. With such a transformer TR5 will dissipate about  $\frac{1}{4}$  to  $\frac{1}{2}$  watt when the specified 300 $\Omega$  relay is energised, and would not require a heat sink.

During construction and wiring, the usual care should be taken to avoid applying excessive heat to the transistor lead-outs. The f.e.t. leads should be soldered with an earthed soldering iron.

## ITT THERMISTORS

The Taunton-based Thermistor Product Division of ITT Components Group Europe has won a contract to supply the British Post Office with thermistors worth in excess of £50,000.

This is the latest in a series of orders for ITT thermistors to be used for maintaining security on shared or party telephone lines, by using the thermistor's ability to absorb unwanted signals in its high resistance condition.

# TRANSFORMER DESIGN FOR MAINS DRIVEN BRIDGES

by

A. M. SELICK, A.M.I.E.R.E.

**Resistance-capacitance measuring bridges which are energised by a 50Hz voltage derived from the a.c. mains often show a poor performance when measuring capacitance under 100pF. Our contributor demonstrates that this shortcoming can be traced to the mains transformer, and describes a transformer design which overcomes it**

A POPULAR FORM OF RESISTANCE-CAPACITANCE measuring bridge takes the basic form illustrated in Fig. 1. An alternating voltage (normally 50 volts r.m.s.) obtained from a mains transformer is applied to the bridge, which is balanced for a null indication in the usual way. A typical practical example of such a bridge appears in Fig. 2, in which the bridge is balanced by VR1 for a null indication in the "Magic Eye", VI. The unknown resistor or capacitor is connected to the terminals shown as "X", and its value is read from a calibrated scale fitted to VR1. Resistors R1 to R6 and capacitors C1 to C4 are the "standards". Component values are given in the accompanying Components List\*.

## TRANSFORMER CAPACITANCE

It is often considered that bridges, such as that of Fig. 2, which operate from the 50Hz mains via a mains transformer are not suitable for measuring capacitor values lower than 100pF because inaccuracies may be introduced due to the relatively high self-capacitance in the mains transformer between the secondary supplying the bridge and the core and the other windings. These considerations might cause a would-be builder to hesitate before deciding to con-

struct this type of instrument, but if a few simple techniques are incorporated it will be found that capacitances down to the order of 5pF can be measured with complete reliability.

The writer's experience with this type of bridge includes the building of four models each with a different layout and mains transformer. Although all were satisfactory on the resistance and higher capacitance ranges the performance of the first two was poor on the 100pF range. In particular the checking of capacitors below 100pF was, at the best, merely an estimation of the balance point due to the confused pattern displayed by the "Magic Eye". After further experiment, and the elimination of other possible causes, the origin of the trouble was assumed to lie in the transformer self-capacitance. This, in itself, could not be eliminated but its effect on the bridge circuit could be minimised by suitable screening. A new and somewhat elaborately screened transformer was therefore built and incorporated in the third instrument, which proved entirely satisfactory in operation. Capacitances down to the order of 5pF could be measured with relative ease while a sharpening of definition at balance was observed on the higher capacitance ranges.

In this form the instrument served for several years but was eventually rebuilt with a smaller and simpler transformer which experiment and experience had suggested was possible and which proved equally as satisfactory in use as its predecessor.

It should be mentioned at this point that descriptions of mains driven bridges of the type with which we are now dealing have appeared in the technical press from time to time. There are minor variations in circuitry or component values in these bridges but, to the writer's knowledge, no special measures have been recommended to prevent transformer self-capacitance from affecting performance nor has any optimum design of transformer been suggested.

In consequence, and since the self-capacitance of a transformer is dependent on its physical dimensions and winding arrangements, it follows that differences in performance between one instrument and another may arise due to variations in transformer design.

In the fortuitous case performance may be satisfactory although no special precautions are taken

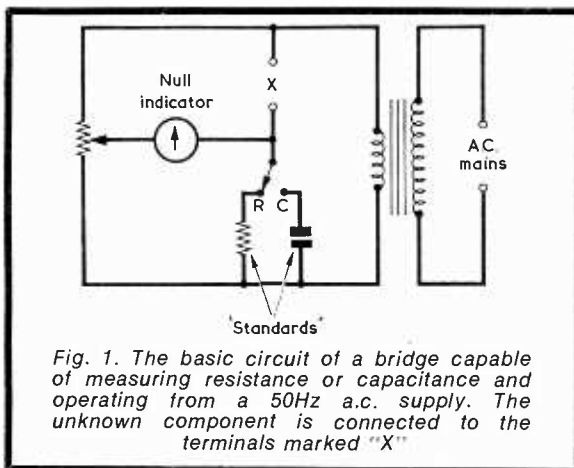


Fig. 1. The basic circuit of a bridge capable of measuring resistance or capacitance and operating from a 50Hz a.c. supply. The unknown component is connected to the terminals marked "X"

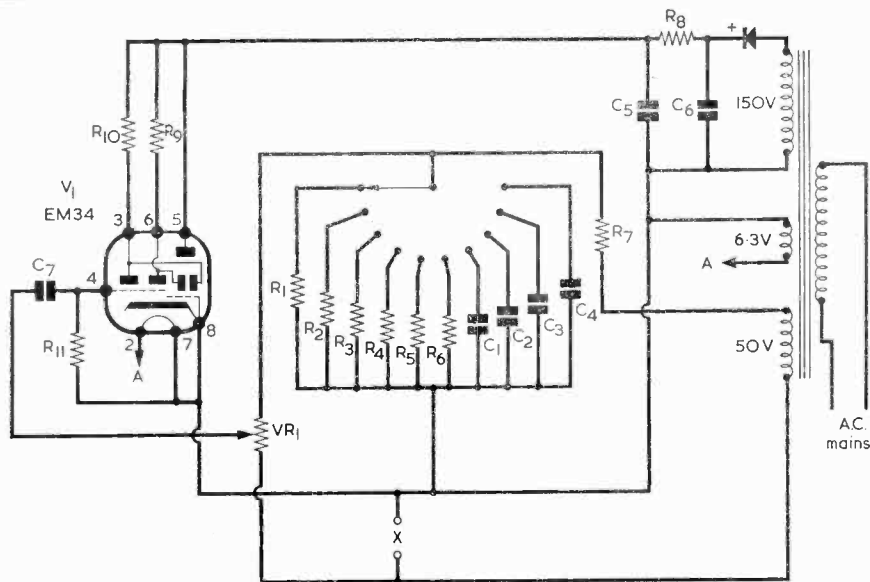


Fig. 2. A practical resistance-capacitance bridge incorporating a "Magic Eye" as null indicator

#### Resistors

R1	1M $\Omega$	1%	$\frac{1}{4}$ watt
R2	100k $\Omega$	1%	$\frac{1}{4}$ watt
R3	10k $\Omega$	1%	$\frac{1}{4}$ watt
R4	1k $\Omega$	1%	$\frac{1}{4}$ watt
R5	100 $\Omega$	1%	$\frac{1}{4}$ watt
R6	10 $\Omega$	1%	$\frac{1}{4}$ watt
R7	10k $\Omega$	20%	$\frac{1}{2}$ watt
R8	10k $\Omega$	20%	$\frac{1}{2}$ watt
R9	1M $\Omega$	10%	$\frac{1}{4}$ watt
R10	1M $\Omega$	10%	$\frac{1}{4}$ watt
R11	2.2M $\Omega$	10%	$\frac{1}{4}$ watt
VR1	5k $\Omega$		wirewound linear

## COMPONENTS

#### Capacitors

C1	0.001 $\mu$ F	1%	silver mica or paper
C2	0.01 $\mu$ F	1%	silver mica or paper
C3	0.1 $\mu$ F	1%	paper
C4	1 $\mu$ F	1%	paper
C5, 6	1 $\mu$ F or larger		(may be electrolytic)
C7	0.1 $\mu$ F		paper

#### Valve

V1	EM34
----	------

but in other instances the effect of self-capacitance acting across the bridge arms may impair the accuracy with which the bridge can be balanced. Suspicions regarding the usefulness of this type of bridge for the measurement of low value capacitances are therefore not without foundation.

### BASIC FACTORS

The detailed study of transformer self-capacitance is a somewhat tedious process but a general appreciation of the basic factors involved will be sufficient to cover the present case.

In any iron cored transformer capacitances exist between the turns and layers of each winding, between windings and between windings and core. Capacitances are also reflected from one winding to another by the turns ratio and due to winding resistances and dielectric losses should be regarded as impedances rather than pure reactances. Therefore, looking into a secondary winding we "see" a reflected impedance and not a pure reactance.

If the winding is used to energise a bridge circuit this impedance is thrown across the bridge arms and

may, depending on its magnitude and phase relationships, affect the accuracy with which the bridge can be balanced.

A typical transformer driven bridge circuit with the various internal capacitances shown conventionally in lumped form appears in Fig. 3. It is, however, more appropriate to visualise the system as a network of impedances. Only two windings are shown although there may be others on the same core and each will contribute its quota of self-capacitance to the whole.

Referring to Fig. 3, the offending capacitance is that appearing between the two windings and an obvious step is to place an earthed screen between them and thus eliminate direct capacitance between the pair.

The capacitance then "seen" by the bridge arms is that between the winding and the screen and will be virtually a pure reactance. Also, if the secondary is symmetrically wound the capacitance will be balanced across the bridge arms and appear as C1 and C2 in Fig. 3. Under these conditions the balancing of the bridge is unaffected by the presence of C1 and C2 although it may be necessary to earth the chassis in order to stabilise the instrument as a whole.

## ELECTROSTATIC SCREENS

Electrostatic screens are most commonly found in mains transformers where they are placed between the primary and secondary windings to shield the latter from direct mains capacitance. The screen comprises a single earthed turn of thin copper or brass strip with insulated ends and of full winding width.

An alternative method of achieving the same end is to place the heater winding next to the primary. Heater windings are almost invariably earthed either at one end or at a centre tap and being of low impedance act as an effective electrostatic screen. The heater winding in the transformer to be described is used in this manner.

## TRANSFORMER DESIGN

The design of a mains transformer is normally a problem involving the balancing of numerous conflicting technical demands with the economics of the case, having regard to the performance required from the component and the conditions under which it will be used.

From the point of view of amateur transformer building it is often expedient to adopt a more liberal but less economical design for the sake of ease in construction. For example, heavier wire gauges than are strictly necessary might be used in order to ease the winding process. This, in turn, might call for larger core dimensions.

For hand winding on a simple machine 38 s.w.g. enamelled wire would appear to be about the smallest gauge which can be wound in the amateur workshop without undue tedium. Given a true-running spindle and bobbin, 36 s.w.g. wire can be wound without great difficulty while the process naturally becomes easier as the wire size increases.

A suitable transformer for the present application made up on a  $\frac{3}{8}$  in. stack of Pattern 101A Silicor 107/0.014 in. laminations. The dimensions of which are given in Fig. 4. Unfortunately, it is difficult for the

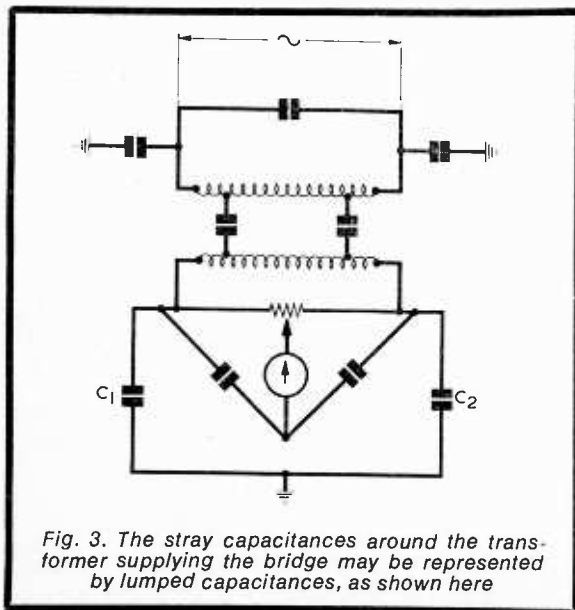


Fig. 3. The stray capacitances around the transformer supplying the bridge may be represented by lumped capacitances, as shown here

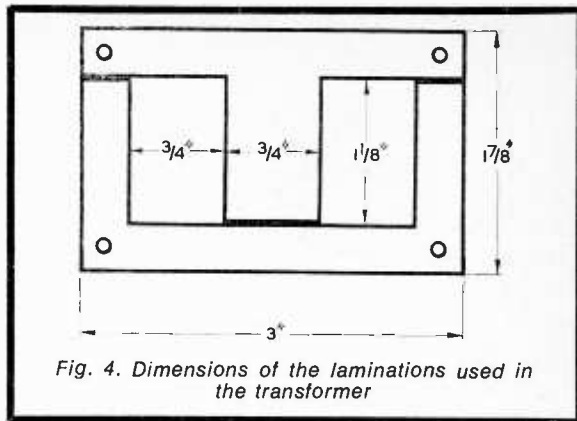


Fig. 4. Dimensions of the laminations used in the transformer

amateur to purchase these laminations in small quantities at low cost but it should be possible to obtain laminations from discarded transformers or other sources which are approximately similar in size. The winding details which follow apply specifically to the Pattern 101A laminations but the knowledgeable amateur should be able to adapt them to alternative laminations. It is necessary to ensure that the centre limb core area (width of centre tongue of lamination multiplied by stack height) is equal to or greater than the figure quoted for the Pattern 101A laminations.

TABLE I

Winding	Turns, Wire Gauge
Primary 250V	2,500 turns of 36 s.w.g. enamelled wire in 23 layers. Tapped as required at 220 and 240V.
L.T. 6.3V 2A	68 turns of 28 s.w.g. enamelled wire.
H.T. 150V 5mA	1,620 turns of 36 s.w.g. enamelled wire in 15 layers.
Screen	1 turn copper foil approx. 0.005 in. thick; full winding width and insulated ends; connection for earthing.
Bridge 50V 5mA	540 turns of 36 s.w.g. enamelled wire, wound and connected as in Fig. 5.

No. 36 s.w.g. enamelled wire is used for the primary, h.t. and 50 volt bridge windings and 28 s.w.g. enamelled wire for the l.t. (heater) winding. Primary and secondary ends should preferably be brought out at opposite ends of the bobbin.

A full 1 in. winding length will be available after allowing for end cheeks and will accommodate approximately 110 turns per layer of 36 s.w.g. wire. All windings are layer wound.

The general specification will then be:  $\frac{3}{8}$  in. stack of laminations as above; Centre limb area: 0.65 sq. in.;

Efficiency: 85% assumed; Primary turns per volt: 10; Secondary turns per volt: 10.8.

The windings are then wound on in the order shown in Table I.

Insulation between primary and l.t. windings is given by three layers of empire cloth, with a turn of paper over the l.t. winding to give a smooth bed for the following section. There should be two layers of empire cloth between the other sections. Also, there should be one turn 0.005in. tissue paper between winding layers.

If the winding depth permits, the insulation over the screen may be built out with half a dozen turns of stout writing paper to reduce capacitance between the 50 volt winding and the screen.

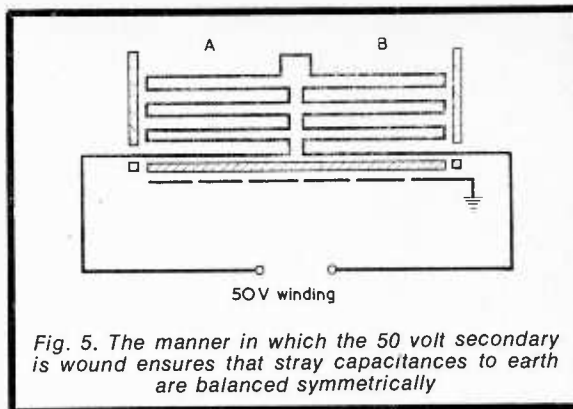


Fig. 5. The manner in which the 50 volt secondary is wound ensures that stray capacitances to earth are balanced symmetrically

TABLE II

Item	Details
Core	1in. stack laminations, Pattern 101A
Wire	For primary, h.t. and bridge windings, 34 s.w.g. enamelled wire; for l.t. winding, 28 s.w.g. enamelled wire
Turns per volt	Primary, 8.8; secondaries, 9.5.
Windings	Primary, 2,200 turns; L.T., 60 turns; H.T., 1,425 turns; Screen, as for previous transformer; 50V, 475 turns.

An allowance of 0.05in. has been made for the bobbin sleeve thickness and with careful winding

and smooth laying on of insulation the completed winding assembly should fit comfortably into the core window space.

It will be noted that this transformer not only provides the 50 volt winding for the bridge but also offers h.t. and heater voltages as well. The two ends of the electrostatic screen must, of course, be insulated from each other or the screen will constitute a shorted turn.

Of particular importance is the manner in which the 50 volt secondary is wound, this being illustrated in Fig. 5. Half of the total turns are wound in each section, section B being wound in the reverse sense to section A. This method of winding ensures that capacitances to earth are balanced symmetrically.

Some readers may, in the interests of easier winding, prefer a specification calling for a slightly larger core, less turns per volt and a heavier wire gauge. In such cases the design given in Table II should prove suitable. Insulation requirements are the same as for the previous transformer. 8oz. of 34 s.w.g. enamelled wire will be sufficient. ■

## CAN ANYONE HELP?

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

**Newmatic 'Ten Four' Car Radio.** — B. Marshall, 54 Belfast Road, Bangor, Co. Down, N. Ireland — service sheet or circuit or any details of this receiver.

**Mullard Valve Tester Type E7600.** — G. A. Young, 5 Hawthorne Road, Old Leake, Nr. Boston, Lincs — circuit diagram or any information.

**Jason J2-10 Mk3 Amplifier.** — A. J. Dodd, 77 Clayton Road, Newcastle-under-Lyme, Staffs. ST5 3NE — circuit diagram urgently required, loan or purchase.

**Transceiver No. 31, Mk2.** — N. Blakeney, Ashdown House West, Dane Hill, Haywards Heath, Sussex — borrow or purchase handbook and details of suitable power supply.

**Hallicrafters TW-500 Portable Receiver.** — F. W. Luff, 44 Ashford Road, London, N.W.2. — circuit diagram, service sheet or manual.

**Ace Radiogram Model 3459.** — M. J. Levy, 19 Totternhoe Close; Kenton, Middx. — service sheet or manual.

**Indicator Unit Type 1-152-AM.** — T. J. Johnson, 98 Burrow Road, Chigwell, Essex — circuit diagram or any information.

**Hammarlund Super-Pro Receiver.** — R. Bould, 33 Tyne Gardens, Crookhill, Ryton-on-Tyne, Co. Durham — manual, circuit diagram or any information on this communications receiver (octal-based valves, plug-in coils). ■





# UNDERSTANDING TAPE RECORDING

*by W. G. Morley*

**This further article in our short series on tape recording deals with superimposition, switched equalisation filters, multi-track recording, and head azimuth and height adjustments**

**I**N LAST MONTH'S ARTICLE IN THIS series we commenced an examination of the ancillary stages of the tape recorder, dealing first with the erase oscillator and then carrying on to record level indicators. We discussed the three basic types of indicator, these comprising the neon bulb indicator, the electron beam tube indicator and the moving-coil meter indicator. We saw that the last two types of level indicator offer a performance which is superior to that of the neon indicator, whose only significant advantage is the low cost of the components it requires.

We now turn our attention to other aspects of the recorder.

## SUPERIMPOSITION

A feature which is provided in some recorders is a switching circuit which enables a new recording to be superimposed upon an existing one. This facility is provided by the simple process of switching off the a.c. input to the erase head when superimposition is required.

The basic switching circuit employed is shown in Fig. 1, where it will be seen that on 'Superimpose' the output from the erase oscillator is coupled to a load resistor instead of to the erase head. The switch employed may be a conventional 2-position component or it may be a push-button which selects 'Superimpose' when pressed. If a tape carrying a previous recording is fed through the machine when the switch is in the 'Normal' position the previous recording is erased. If

the switch is set to 'Superimpose', however, the previous recording remains on the tape and a new recording can be superimposed on it. The process results in a partial erasure of the previous recording due to the bias voltage which is still fed to the record head, and this point has to be borne in mind when carrying out the superimposition. In some recorders, the bias voltage fed to the record head is reduced when 'Superimpose' is selected, thereby lessening the erasure effect.

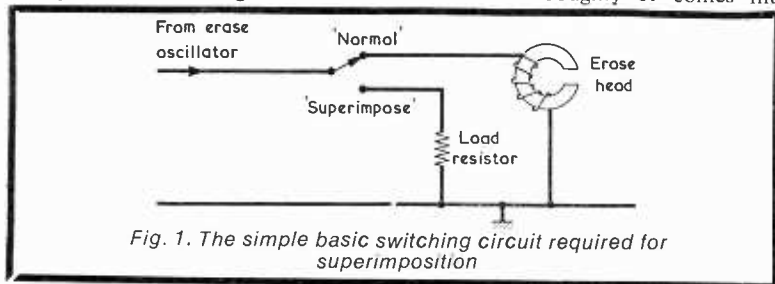
If the design of the erase head and its pressure pads (i.e. the felt pads which press the tape against the head) allows, it is possible to obtain superimposition on a recorder which is not fitted with a superimpose switching circuit. In this case, superimposition is achieved by physically separating the tape from the erase head gap by spacing it off with a piece of card or similar material. It must be emphasised that an operation of this nature should be carried out with care since it is possible to cause damage to the head surface if this is handled roughly or comes into

contact with any abrasive material. Also, the pressure pad springs may suffer damage if the pads are excessively displaced.

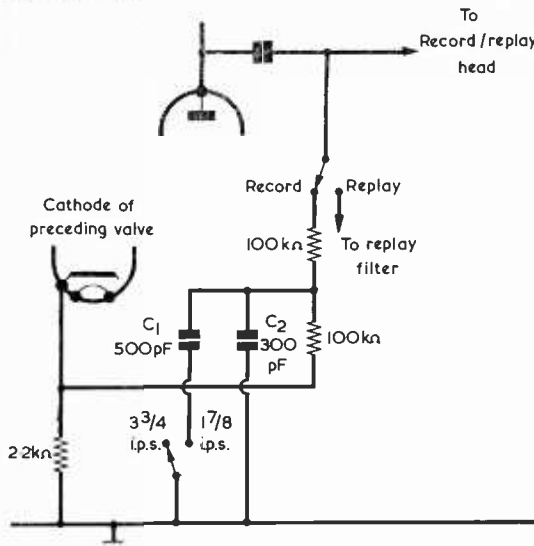
## TAPE SPEED COMPENSATION

When we introduced the complete tape recorder amplifier circuit (in the September issue) we assumed, for simplicity of explanation, that the recorder was a machine having a single speed only. In consequence the equalising filter circuits (which provide treble boost during record, and bass boost during replay) had fixed component values to suit the particular tape speed employed.

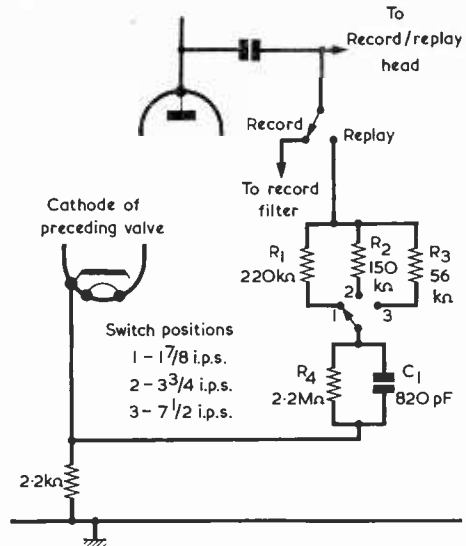
If the recorder has more than one tape speed the equalisation circuits require switching circuits to modify the response offered at the different tape speeds. In a relatively low cost 2-speed machine the primary requirement is that treble boost on record is increased at the lower speed and a common approach with such recorders is to use a 2-position switch to achieve this end. A typical basic circuit is illustrated in Fig. 2(a), in which additional capacitance is connected into the negative feedback filter coupling the anode of the valve feeding the record head back to the cathode of the preceding voltage amplifier. It will be recalled (from the article in the September issue) that treble boost is achieved by causing less negative feedback to occur at the higher frequencies. Setting the switch in Fig. 2(a) to the lower tape speed causes C1 to be connected across C2, thereby reducing the high



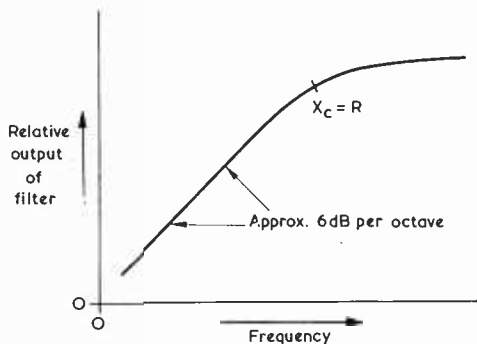
*Fig. 1. The simple basic switching circuit required for superimposition*



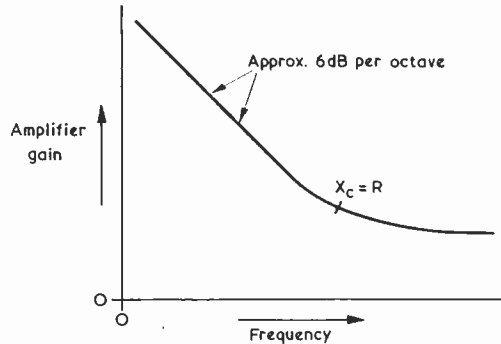
(a)



(b)



(c)



(d)

Fig. 2(a). A switching circuit which increases high frequency boost when a lower tape speed is selected

(b). A replay equalising filter switching circuit intended for three tape speeds. This is employed in the Ferguson Model 3214 4-track recorder and other B.R.C. models

(c). The attenuation offered by the filter of (b). The curve approaches flattening off at the frequency where the reactance of the capacitor ( $X_c$ ) equals the series resistance

(d). The amplifier gain resulting from the attenuation curve of (c)

frequency feedback signal. The tape speeds shown for the two switch positions are  $1\frac{7}{8}$  and  $3\frac{3}{4}$  i.p.s., these being typical of what is offered by a lower cost 2-speed recorder. Usually, in a recorder of this nature, no alteration is made to the replay characteristic for the two different speeds.

The basic switching circuit shown in Fig. 2(a) may be readily adapted for more comprehensive recorders having three tape speeds. Such recorders also incorporate a switching circuit to alter the bass boost playback characteristic at the different tape speeds. A typical switched replay filter encountered in some B.R.C. tape recorders is shown in Fig. 2(b), this catering for tape speeds of  $1\frac{7}{8}$ ,  $3\frac{3}{4}$  and  $7\frac{1}{2}$  i.p.s. Ignor-

ing for the moment the  $2.2M\Omega$  resistor R4, the filter circuit consists basically of a resistor (R1, R2 or R3) and a capacitor (C1) in series between the output anode and the preceding cathode. At frequencies where the reactance of the capacitor is considerably greater than the series resistance the filter offers an attenuation increase of nearly 6dB per octave as frequency decreases, this increase in attenuation being due to the fact that the reactance of a capacitor is doubled when frequency is halved. At higher frequencies, where the reactance of the capacitor becomes comparable with the series resistance, the altering reactance of the capacitor has less effect and the change of attenuation with change of frequency be-

comes lower than 6dB per octave. At higher frequencies again, where the reactance of the capacitor becomes considerably lower than the series resistance, the attenuation is very nearly constant for all frequencies in the range. The general attenuation curve is shown in Fig. 2(c). Since the attenuation offered by the resistor and capacitor appears in a negative feedback circuit in the tape recorder replay amplifier, the final result is that overall amplifier gain increases as attenuation increases, resulting in the complementary curve shown in Fig. 2(d). As may be seen, this curve enables the bass boost required during replay to be achieved up to the frequencies where the reactance of the capacitor approaches the

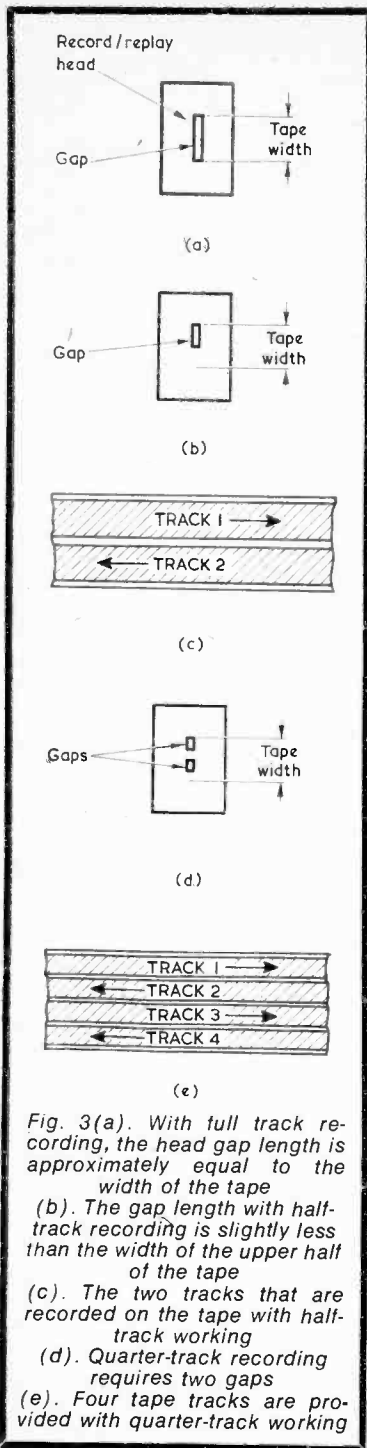


Fig. 3(a). With full track recording, the head gap length is approximately equal to the width of the tape

(b). The gap length with half-track recording is slightly less than the width of the upper half of the tape

(c). The two tracks that are recorded on the tape with half-track working

(d). Quarter-track recording requires two gaps

(e). Four tape tracks are provided with quarter-track working

series resistance. Above this point the curve starts to flatten off.

In the filter circuit of Fig. 2(b) the capacitance remains unaltered, and the switch selects different values of series resistance. Making the assumption that bass boost ceases, approximately, at the fre-

quency where the reactance of the capacitor ( $X_c$ ) equals the value of the series resistance, it will be found by calculating from the component values shown that this frequency is 880Hz with the switch set to  $1\frac{1}{2}$  i.p.s., is 1,300Hz with the switch set to  $3\frac{1}{2}$  i.p.s. and is 3,500Hz with the switch set to  $7\frac{1}{2}$  i.p.s. Thus, bass boost ceases at around 880Hz at  $1\frac{1}{2}$  i.p.s., at around 1,300Hz at  $3\frac{1}{2}$  i.p.s., and at around 3,500Hz at  $7\frac{1}{2}$  i.p.s. Readers who have retained earlier issues will find that this performance corresponds, in general, with the typical replay amplifier response curves shown in Fig. 3(b) on page 693 in the June issue.

The examination of the filter circuit of Fig. 2(b) we have just carried out has ignored the presence of the  $2.2M\Omega$  resistor across the capacitor. The function of this component is to modify the response by reducing the attenuation offered by the filter at around 100Hz.

The switched filter circuits we have just considered are representative of the designs likely to be encountered in most tape recorders. As is to be expected, many circuits will exhibit variations in detail and in component values.

## MULTI-TRACK RECORDING

Early domestic tape recorders em-

ployed a record/replay head having a gap whose length was approximately equal to the width of the tape, as shown in Fig. 3(a). Such a head provides *full track* recording. Later recorders adopted the *half track* head shown in Fig. 3(b), the gap in this head extending over slightly less than the upper half of the tape. With half track recording the tape initially passes over the head gap in the same way as with full track working, but the recording is impressed on the upper half of the tape width only. When all the tape has been used it is removed from the machine and the two spools are changed over. The tape may then be drawn over the head once more, whereupon what was previously the lower half of the tape width now passes over the head gap and a further recording may be made. The two tracks on the tape are as illustrated in Fig. 3(c).

A further development in the domestic recorder field was the introduction of *quarter track* heads. Here, there are two gaps in the record/replay head, each with its own core and coil, and they take up the positions shown in Fig. 3(d). Four tracks are given with quarter track recording, and they appear on the tape as illustrated in Fig. 3(e). Commencing with the upper record/

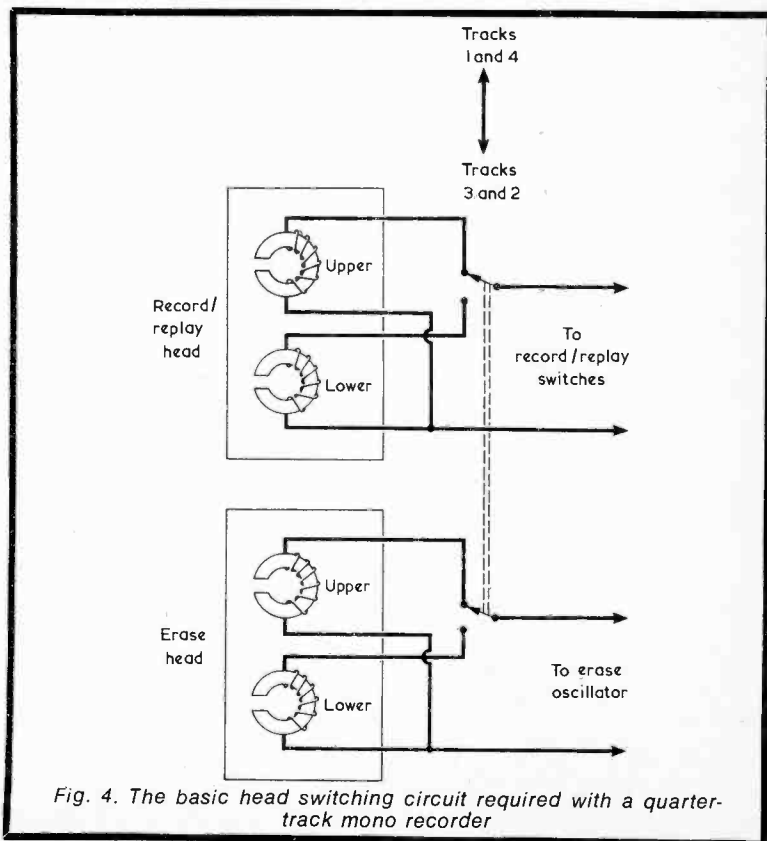


Fig. 4. The basic head switching circuit required with a quarter-track mono recorder

replay head coil in circuit the tape is drawn past the head, allowing track 1 to be recorded. The tape is then removed from the machine and the spools changed over, whereupon track 4 is recorded next. By changing over the spools again and switching to the lower record/replay head winding it next becomes possible to record track 3, after which, after a further change over of spools, track 2 becomes available.

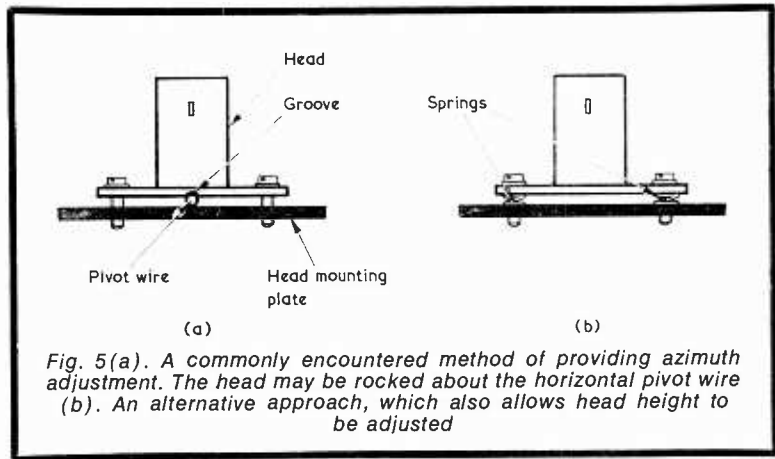
For a single channel mono recording, half track working results in a doubling of the useful length of a tape. Similarly, the useful length of a tape becomes quadrupled with quarter track operation. All else being equal, half track and quarter track recording offers considerable economies in tape usage.

We have referred to the various tracks of the tape in terms of the recording process. The same tracks are, of course, used for replay, employing in the case of quarter track working the appropriate record/replay head coil. In half track recording the erase head has the same construction as the record/replay head, and its gap covers the upper half of the tape width. The erase head for quarter track recording has the same construction as the quarter track record/replay head and the two erase gaps, each with its associated core and coil, appear in the same positions relative to the width of the tape.

There is no necessity for track switching with half track recording, as the single half track record/replay head coil and single half track erase head coil connect directly to the recorder amplifier circuits in the same way as do the coils of full track record/replay and erase heads. With quarter track recording it is necessary to switch from one set of head coils to the other, a typical switching circuit being shown in Fig. 4. Note that one switch position offers tracks 1 and 4, whilst the other offers tracks 3 and 2.

Both half track and quarter track working may be used for stereo recording and reproduction. In this instance the half track record/replay head coil will require two gaps, each with its associated core and coil. If the machine is to be used for stereo work only, the erase head may have a single gap covering the full width of the tape. For half track stereo recording track 1 carries one channel and track 2 the other channel. When carrying out quarter track stereo recording, one channel can be carried by track 1 and the other by track 3. After this the spools may be changed over, allowing the two channels to be carried by tracks 2 and 4.

Some quarter track mono recorders have facilities which allow both record/replay head coils to be coupled together. This enables a



stereo tape to be replayed over the mono amplifier of the recorder, the two stereo channels being combined at the common connection from the head coils to produce a mono signal.

From the point of view of performance it would probably be true to say that, with modern tape and heads, half track recording presents little degradation in recording and replay quality as compared with full track recording. There can, however, be a small but significant loss in signal/noise ratio when using quarter track recording.

As a final point of terminology whilst dealing with multi-track recording, the term *two track* is frequently employed instead of 'half track'. So, also, is the term *four track* instead of 'quarter track'.

### HEAD AZIMUTH AND HEIGHT

For correct recording and replay it is necessary for the sides of the gap in the record/replay head to be exactly perpendicular to the direction of travel of the tape. The need for this angular relationship can be readily visualised if one considers a single cycle of high frequency sound recorded correctly onto the tape. If the tape is drawn past a replay head whose gap is truly perpendicular to the travel of the tape, the magnetic field across the width of the tape corresponding to the start of the cycle will be simultaneously applied to the entire length of the head gap and will induce maximum voltage in the head coil. If the head gap is slightly tilted from the perpendicular, the magnetic field at the start of the cycle will reach the leading end of the gap first and will then be subsequently applied to the remaining parts of the gap. As the tape passes over the head the consequent different levels of magnetic flux and different magnetic polarities at the head gap will be self-can-

celling and the voltage induced in the head winding will be reduced in amplitude or may not appear at all. It follows that any tilting of the replay head results in a reduction of the higher frequencies when playing a tape that has been recorded under proper conditions.

An important point here is that a given angle of tilt in the replay head results in less high frequency loss with half track recording than is given with full track recording. The high frequency loss is lower, again, with quarter track recording. Returning to the high frequency cycle just mentioned, this is because the delay between the magnetic field due to the start of the cycle reaching the leading end of the gap and then the trailing end is reduced.

An unfortunate feature is that replay head tilt results in less high frequency loss if the same head is used both for recording and for replay, since the recorded field across the width of the tape will have the same tilt as has the head gap. Such conditions are liable to exist in a tape recorder which is used to replay only the tapes that have been recorded on it. The loss of high frequencies will, then, only become noticeable if an attempt is made to replay a tape recorded on another machine.

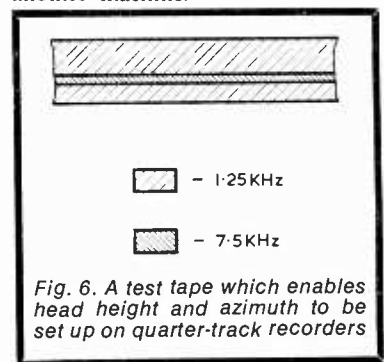


Fig. 6. A test tape which enables head height and azimuth to be set up on quarter-track recorders



The Sony tape recorder Model TC106. This is a 2-track 3-speed mono mains-powered instrument with an output of 8 watts. Tape speeds are  $7\frac{1}{2}$ ,  $3\frac{3}{4}$  and  $1\frac{7}{8}$  i.p.s.

Setting up a record/replay head for correct angular relationship with the direction of tape travel is referred to as the head *azimuth* adjustment. A conventional head assembly is provided with a means of setting up azimuth, this frequently being provided by two screws which enable the head to be

rocked on a central horizontal pivot provided by a length of wire. The latter may be phosphor-bronze or a similar hard material. See Fig. 5(a). Alternatively, the head assembly may be secured against compressed springs, as in Fig. 5(b).

Azimuth adjustments are carried out by replaying a special test tape

carrying a high frequency tone and adjusting for maximum output from the head. The correct azimuth setting is somewhat critical and the adjustment has to be carried out with reasonable care. Since it is difficult to judge a maximum sound level by ear, the output of the replay head should be monitored by a suitable meter coupled into the recorder amplifier at a convenient point.

The height of the record/replay head is of importance with half track and quarter track recorders – particularly the latter. With quarter track recorders the height of the head is frequently made adjustable by mounting it on compressed springs, as was shown in Fig. 5(b). Setting up to the correct height can be achieved with the aid of a special test tape, an example of which is shown in Fig. 6. The tape shown in Fig. 6 has a 7.5kHz tone recorded on a band situated centrally in track 3, all the remainder of the tape carrying a 1.25kHz tone. The recorder to be set up is switched to track 3 and the height of the record head adjusted for minimum 1.25kHz tone. The tape also permits azimuth adjustments, which are made for maximum amplitude of the 7.5kHz tone.

#### NEXT MONTH

In next month's issue we shall devote our space to specific design features of tape recorders employing transistors. ■

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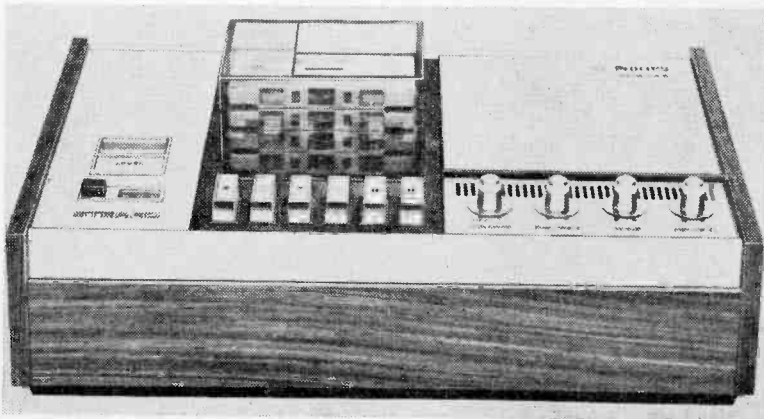
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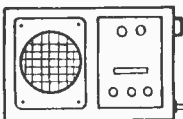
with loudspeakers £95

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THE RADIO CONSTRUCTOR

# In your workshop



This month Smithy the Serviceman, aided as always by his able assistant Dick, settles down to a little development work. The outcome is a plug-in a.f. filter unit for short wave c.w. reception, the unit incorporating regenerative feedback to provide a high degree of selectivity

“PRIVATE JOBS,” SAID SMITHY sternly, “are not allowed.” “Oh, come off it, Smithy,” protested Dick. “I’ve done quite a few private jobs in the Workshop during the past, and you never uttered a dickey-bird then.” “Maybe I didn’t,” conceded Smithy. “But that’s only because I considered the jobs to be of an instructive and educational character, and because there was no official work to do.” “Well, this job,” retorted Dick defensively, “is of an instructive and educational nature.” “Show me.”

## C.W. PHONE FILTER

Dick reached into the large cardboard box he had pulled out from under his bench and produced the object he had hoped to work on. His untidy bench presented an incongruous background to the elegant gilded figurine table lamp standard which he placed carefully on its surface. The slender statuette which constituted the main part of the standard held her hand up high, supporting an old-fashioned brass bulb holder in a manner reminiscent of the trade-mark of Columbia Pictures, Inc.

“What about this, then?” said Dick proudly. “There’s none of your Woolworth’s stuff here, mate.” “Don’t tell me that standard is yours.”

“It belongs to my Aunt Ermytrude,” explained Dick. “She’s got a house which is full of objay darts just like this.”

“What were you going to do with it?”

“I was going to spend the last

hour before packing-up time,” said Dick, “in doing her a favour by re-wiring it. Incidentally, there’s something funny about my Aunt Ermytrude. Everybody in the family goes out of their way to do favours for her, yet when I ask them why they all look mysterious and change the subject. I can’t,” he concluded aggrievedly, “ever conceive of anyone in my family doing favours for me.”

“If you play your cards right,” chuckled Smithy, “your day will come. Anyway, expensive as that lamp standard obviously is, it’s still not going to be re-wired during Workshop time. Apart from the fact that such a task hardly falls into the educational category, we’ve got another job to do.”

“But we’ve finished all the sets for today,” objected Dick. “There’s not a single u/s set outstanding.”

“Perhaps not,” returned Smithy, “but the job we’re going to do doesn’t consist of set repairing. It consists, instead, of a little bit of development work.”

“Development work?” queried Dick. “What are we going to develop?”

“We’ve got to develop a simple a.f. filter unit for a rather important geyser who’s lately been getting keen on amateur short-wave listening. He wants additional selectivity for c.w. signals.”

“Blimey,” remarked Dick, surprised at this unexpected turn of events. “Making up a filter unit is a bit out of the ordinary for us, isn’t it?”

“It is, rather,” agreed Smithy. “But it should be an interesting job, nevertheless. So far as I’m concerned, I’m all for it. I like designing and building little electronic gadgets.”

“So do I,” concurred Dick enthusiastically. “What exactly is this filter unit supposed to do?”

“It’s intended to pick out a c.w. tone from a lot of other c.w. tones,” replied Smithy. “As you know, a morse, or c.w., signal picked up on a short wave communications superhet is turned to an audible tone by means of the b.f.o. in the receiver, the b.f.o. being set up to give a nice comfortable note in the headphones or speaker. A c.w. signal which is close to the desired one can also pass through the receiver i.f. stages, but it is then reproduced at a different audio frequency.”

“Yes, I know all that,” replied Dick, a little impatiently. “And I’ve done enough playing around on the short wave bands to know what c.w. signals bunched together sound like.”

“Good,” commented Smithy. “Well now, it’s possible to add further selectivity to a standard short wave

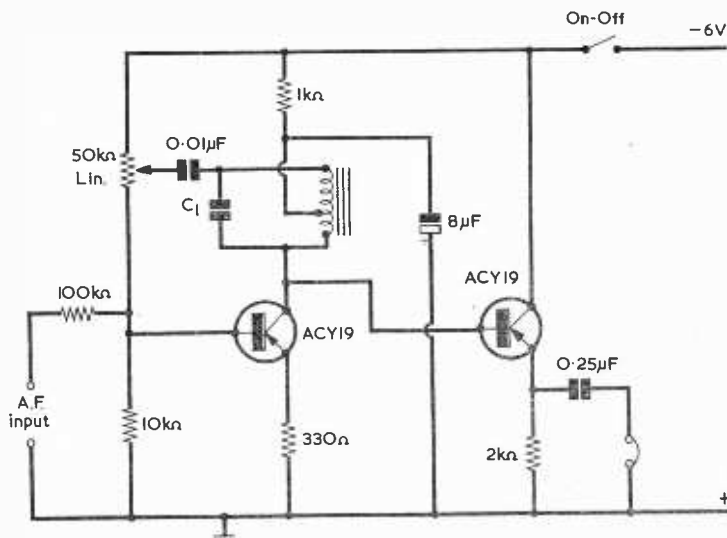


Fig. 1. The original a.f. filter unit circuit devised by Smithy. The headphones are high resistance types

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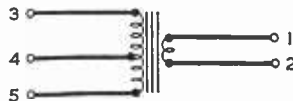
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receiver for c.w. reception by adding, after the detector, an a.f. filter which passes a small band of audio frequencies only and which offers a high level of attenuation to all the others."

"This," remarked Dick uncertainly, "sounds a bit complicated to me. Won't an a.f. filter of this nature mean that a modification has to be made to the innards of the receiver?"

"Not with the circuit I've got in mind," stated Smithy. "This is going to be an add-on filter unit which comes between the audio output of the receiver and a pair of high resistance 2,000 $\Omega$  headphones. The phones will plug into the filter unit, and the filter unit will plug into the phone jack in the set. If all goes well, the unit should pass audio frequencies in a small band centred on approximately 1kHz and attenuate all the rest."



Sec. 1 and 2

Pri.(33:1) 4 and 5

Pri.(55:1) 3 and 4

Pri.(90:1) 3 and 5

Fig. 2. Connections to the Elstone valve speaker transformer type MO/T. (This is available from Home Radio under Cat. No. TO12)

#### A.F. REGENERATION

"It certainly sounds an attractive idea," said Dick keenly. "I suppose what will be required here is a coil and capacitor to form a tuned circuit at the desired audio frequency."

It was obvious that, by now Dick had completely forgotten the lamp standard belonging to an aunt of many favours.

"It will use a coil and parallel capacitor to provide frequency selection," confirmed Smithy. "But I want to go a little further than just using a simple tuned circuit on its own. What I propose to do is incorporate regeneration so that the effective Q of the a.f. tuned circuit can be raised to a much higher level than it would have without such regeneration."

"Have you worked out a circuit yet?"

"Only in basic theoretical form," replied Smithy. "There are quite a few points in it that will have to be sorted out in practice, so what I'm going to do, with your aid, is to make up the circuit in temporary

lash-up form and then sort out these outstanding points. After that, the unit can be assembled in permanent form and finished off properly. Anyway, here's the idea, as I've dreamed it up so far. As you'll note, the whole thing is powered by a 6-volt battery, which should be more than adequate for a unit of this nature."

Smithy handed Dick a piece of paper, which bore the circuit he had worked out. (Fig. 1). Dick looked at it closely and frowned.

"How exactly," he asked eventually, "does it work?"

"Start off," said Smithy, "by looking first at the capacitor I've marked C1, together with the iron-cored coil. These form the tuned circuit which is resonant at the audio frequency we want the filter unit to pass."

"What's the value of C1?"

"That," replied Smithy, "is one of the things we'll have to find out with the aid of the lash-up circuit. We'll carry out the time-honoured process of trying, different values of capacitance until we find the one which gives the right frequency."

"What about the iron-cored coil, then?"

"I've got that here," said Smithy, reaching over and picking up a small transformer from his bench. "I've been hunting around amongst our spares and I've found a nice inexpensive little valve output transformer whose primary should be just the job for that iron-cored coil. This is an Elstone transformer type MO/T, and its primary is tapped to give different ratios. We shan't make any connections to its secondary."

Smithy showed Dick the transformer and pointed to the ratio combinations printed on the outside of its windings (Fig. 2).

"This transformer," continued Smithy, "connects in the collector circuit of the first transistor in the unit. If we take the collector to tag 5 and the negative supply to tag 4, we have an iron-cored coil with a tap which is a little closer to the collector end than it is to the other end. The tuning capacitor, C1, connects across the whole winding" (Fig. 3).

"Fair enough," commented Dick, returning to the circuit diagram Smithy had previously given him. "Now, why have you got that 0.01 $\mu$ F capacitor connected from the top end of the iron-cored coil to the slider of the 50 $\Omega$  pot?"

"That 50 $\Omega$  pot explained Smithy, "is the regeneration control. As soon as its slider starts travelling down from the top end of the track it causes more and more signal energy from the upper end of the iron-cored coil to be applied to the base of the first transistor."

THE RADIO CONSTRUCTOR



"Stap me, so it does," exclaimed Dick, seized by sudden revelation. "Why, I've just realised that the first transistor is in a Hartley oscillator circuit, with the iron-cored coil acting as the tapped winding in the tuned circuit."

"I was wondering," commented Smithy drily, "how long it would be before you realised that you were looking at an oscillator. Anyway, as you so perceptively remark, the circuit around C1 and the iron-cored coil is a Hartley oscillator, and its feedback can be adjusted by means of the 50kΩ pot. In the present application the filter will be used with this tuned circuit just below the oscillation point, whereupon it should allow the first transistor to offer a high degree of gain at the tuned circuit resonant frequency. An important point which has to be considered next is that it's very probable that, in practice, the circuit will go into oscillation with the pot slider only a little way down the track. This is another question which can be settled with the aid of a lash-up circuit. If oscillation does come on too early, I'll reduce the pot value and insert a fixed resistor into circuit below it to make the overall resistance up to 50kΩ again."

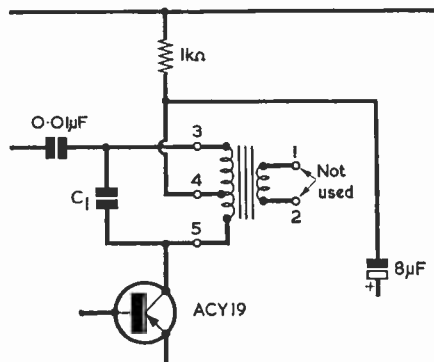


Fig. 3. How the Elstone transformer is connected into the filter unit circuit

"Oh, I see," responded Dick. "Incidentally, why did you choose a value of 50kΩ in the first place?"

"Because it's a suitable value for the base bias network," replied Smithy. "The first transistor is a fairly high-gain germanium type and I want it to pass around 2 to 3mA collector current to bring it on to a reasonably linear part of its characteristic. Also, I want its collector to sit at about 3 volts above the lower supply rail. The 1kΩ resistor in the negative supply to the transformer primary, plus the couple of hundred ohms or so of winding resistance between its terminals 4 and 5, should give about 3 volts at the collector with the transistor current I'm aiming at. Ignoring

base current for the moment, the 50kΩ pot and the 10kΩ resistor below it will cause about 1 volt to be applied to the transistor base, whereupon its emitter will sit at around 0.8 volts. If we take the base current flowing through the 50kΩ pot into account, a more realistic figure for emitter voltage will be 0.75 volts. A current of 2.5mA causes a voltage drop of 0.75 volts in 330Ω, which is why I've chosen 330Ω for the emitter resistor."

"Gosh, Smithy," said Dick admiringly, "you're really with it on these bias resistor values."

"I won't say," replied Smithy hastily, "that that 330Ω value will be *exactly* right, but it provides a good enough starting off figure and there's no trouble involved in altering it slightly in the practical version of the circuit, should this prove necessary."

Dick looked closely at the circuit again.

"There's something else that's beginning to puzzle me a bit," he said slowly. "Why is the collector circuit of the first transistor decoupled by the 1kΩ resistor and the 8μF capacitor?"

"They're not decoupling components," said Smithy. "they're a dropping resistor and a bypass

capacitor. Before I can explain why they're there, I must first point out that the second transistor is an emitter follower, whose function is to isolate the headphones from the feedback circuit. It also presents a relatively high impedance to the collector of the first transistor. Now, when the first transistor is handling a high level signal its collector will swing both positive *and* negative of the potential on the negative plate of the 8μF capacitor. This is because the collector load is an inductor. If the collector were supplied directly from the negative supply rail the emitter follower, which is supplied from the same rail, wouldn't be able to follow its negative excursions. With the cir-

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cuit as shown in my diagram, where the presence of the 1kΩ resistor should cause the collector of the first transistor to sit at around three volts, this collector can swing both positive and negative by up to nearly two volts, and the emitter follower will be able to handle all this range of voltage."

"Blimey," said Dick, regarding the voltage-dropping 1kΩ resistor with new respect, "you've certainly worked out this circuit well."

"We don't," pointed out Smithy with his customary caution, "really know whether it will work; yet. However, before we get down to trying it out in practice, there's a further little bit I want to explain. This concerns the function of the 100kΩ resistor in series with the input to the base of the first transistor. The 100kΩ resistor is intended to provide attenuation and to isolate the base from the a.f. output circuit of the receiver to which the unit is connected."

Smithy paused for a moment to collect his thoughts.

nant frequency than it does at all other frequencies. Okay?"

### PRACTICAL VERSION

"Sure," said Dick enthusiastically. "Shall I get on with building up the circuit now, Smithy?"

"Yes, please," replied the Serviceman. "But only in temporary form. We may have to make quite a few alterations to it before we finally get it going properly. For the time being, you can put a 0.01μF capacitor in the C1 position. That transformer primary is bound to resonate at some audio frequency with 0.01μF across it."

After a little searching, Dick produced a small bare chassis having a quantity of conveniently positioned holes of varying diameters spread around its top surface. He quickly mounted a few small tagstrips onto this, and proceeded to wire up Smithy's circuit on them.

The Serviceman watched silently as his assistant proceeded diligently with his task. Absent-mindedly,

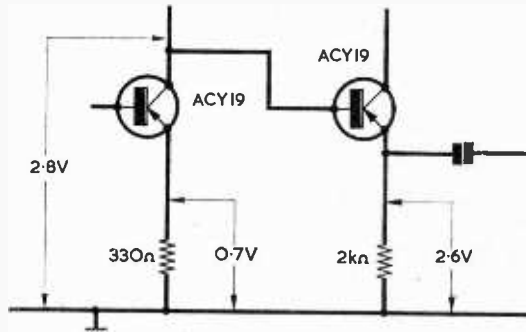


Fig. 4. Emitter and collector voltages in the practical version of the filter unit. Roughly the same voltages should be given in other units built up to the same circuit

"That seems," he resumed, "to cover all the details, so we can now look at the operation of the unit as a whole. The a.f. output from the receiver is applied to the 100kΩ resistor, whereupon an attenuated version appears on the base of the first resistor. If the slider of the 50kΩ pot is at the top of its track there is no regeneration. The first transistor then merely amplifies the signal and applies it to the second transistor, which drives the phones. Due to the amplification provided by the first transistor the a.f. level in the phones should be roughly of the same order as the output from the receiver. We next adjust the slider of the 50kΩ pot, taking it slowly downwards and thereby increasing regeneration. This will gradually increase the effective Q of the tuned circuit until, when the regeneration is just below oscillation point, the circuit should offer considerably more gain at the reso-

Smithy allowed his eyes to stray towards the figurine lamp standard, which had now been pushed unceremoniously to one end of Dick's bench. A sudden thought struck him.

"What was it," he asked, "that you said just now your aunt's house was full of?"

"It's full of all sorts of things," replied Dick in a preoccupied tone, as he concentrated on soldering a 0.01μF capacitor across the Elstone output transformer primary. "Pictures, statues, vases, all sorts of things like that."

"Yes," persisted Smithy, "but you used a particular phrase to describe them."

"I called them 'objay darts'. Classy things like that are always called 'objay darts'."

"Oh."

Smithy absorbed this information. Philosophically, he told himself that one learns something new every day.

"All finished," called out Dick suddenly.

Smithy dismissed his preoccupation with the possessions of Dick's aunt, and turned his full attention to the chassis on his assistant's bench. Despite the fact that Dick had carried out the wiring on a temporary basis only, the layout was still very neat and tidy. An expression of approval appeared on Smithy's face.

"I'm glad to see," he commended, "that you've included the on-off switch in this lash-up version of the circuit. It's always bad policy to omit an on-off switch in any temporary rig. Not only does the switch allow you to disconnect the supply without trouble whenever you want to make an adjustment, but it also enables you to turn off the power darned quick when things go wrong!"

Dick looked pleased at this unexpected praise.

"The service I provide," he stated modestly, "is never anything less than the best."

"Humph," grunted Smithy. "Well, that's as maybe. Anyway, let's take some voltage measurements. Turn the slider of the 50k $\Omega$  pot up to the top of its track, switch on and measure the voltage between the positive supply rail and the collector of the first transistor."

"Righty-ho," said Dick obligingly. "Just a minute while I get my testmeter set up. Ah, here we are, it's 2.8 volts." (Fig. 4).

"Good," remarked Smithy, pleased. "Not too far from my reckoning at all. What's the voltage at the emitter?"

"Half a jiff," said Dick, moving his negative test prod. "That one's 0.7 volt."

"Fine," said Smithy, carrying out a rapid mental calculation. "A voltage of 0.7 across the 330 $\Omega$  resistor means that the first transistor is drawing just a little more than 2mA. These voltages are near enough to what I had in mind, when I worked out the circuit, to allow us to look upon the bias component values as being finalised. So no alterations are required there. What's the voltage on the emitter of the second transistor?"

Dick quickly took the requisite measurement.

"It's 2.6 volts," he replied.

"Which is, of course, to be expected," commented Smithy. "Seeing that we've got 2.8 volts on the collector of the first transistor. The emitter resistor for the second transistor is 2k $\Omega$ , so this transistor is drawing 1.3mA. The total consumption of the filter unit at six volts then works out at approximately 3.5mA, which isn't too bad at all. Right now, let's next see if the circuit is amplifying. Put the phones on, Dick!"

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Dick donned the headphones with alacrity. Picking up a screwdriver, Smithy held his finger against the metal blade and touched the screwdriver tip against the base of the first transistor.

"Hear anything?"

"Quite a definite crackle," announced Dick, "together with a slight hum when the screwdriver was in contact with the base connection."

"Things," said Smithy, "are getting better and better. We'll next see how the circuit behaves when you take it up to oscillation point. Don't have the phones directly over your ears for this test, Dick, as the a.f. output when the circuit oscillates may be pretty high."

Dick eased the headphones away from his ears and cautiously advanced the slider of the potentiometer. After a moment even Smithy heard the audio tone which was reproduced by the headphones.

"It's a bit fruity," remarked Dick. "If I was listening to c.w. signals I'd prefer a higher audio frequency than this."

"So would I," agreed Smithy. "Take the 0.01 $\mu$ F capacitor out of the C1 position and try a 0.005 $\mu$ F one instead."

"Okeydoke," replied Dick obediently, putting down the headphones and reaching for his soldering iron.

The pair eventually settled at 0.004 $\mu$ F, given by two 0.002 $\mu$ F capacitors in parallel, as providing an acceptable frequency close to 1kHz.

## FINAL TEST

"Unfortunately," replied Smithy, "we haven't got a short wave set available. And we haven't even got a variable frequency audio signal genny, so that we could see whether the unit really is selective of audio frequencies. Not to worry, though - I'll soon rig up a variable frequency audio input to finally check this unit."

Smithy took a transistor radio from the 'Repaired' rack, took off its back and quickly soldered two leads to its speaker. He connected these to the input of the filter unit, switched on the receiver, set it at a low volume level and tuned it to Radio 2 on 200kHz.

"Put the slider of that 50k $\Omega$  pot back to the top of its track," he said. "You should then be able to hear this transmission quite clearly on your phones."

Dick adjusted the potentiometer, donned the phones and gave a thumbs-up sign.

"The programme's coming through fine," he remarked. "There's just a bit of top cut."

"That will be due to C1," responded Smithy. "I'll give you a variable frequency tone now."

The Serviceman looped a short length of insulated wire over the long wave ferrite aerial coil in the transistor receiver, coupled the output of Dick's signal generator to this and to the receiver chassis, then swung the generator, unmodulated, on either side of 200kHz. (Fig. 5). A heterodyne of

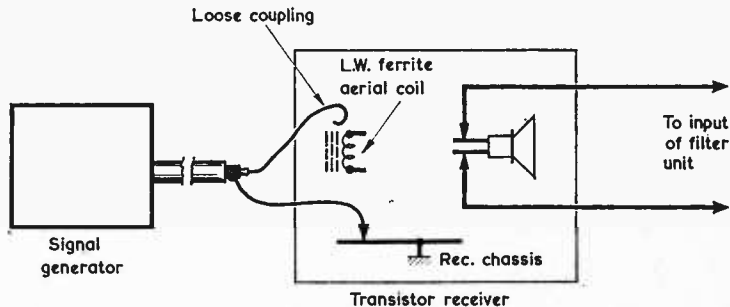


Fig. 5. Smithy rigged up a makeshift variable frequency audio source in the simple manner shown here

"What I like about this circuit," said Dick as he experimentally turned the spindle of the 50k $\Omega$  potentiometer, "is the smoothness of control and the complete absence of backlash. You can bring the feedback right up close to oscillation point, and you can tell that the unit is frequency selective in this condition because you then hear that ringing sort of noise you get with crystal i.f. filters. Let's bung a c.w. signal into this gubbins and see how it works!"

varying frequency was audible from the speaker of the receiver.

"Right," said Smithy. "I'll now leave it to you to see if you can set that lot up for optimum reception of the audio frequency at which C1 and the output transformer primary are resonant."

Dick adjusted the 50k $\Omega$  potentiometer, bringing the filter unit just below oscillation point. He then very carefully set up the signal generator frequency so that the heterodyne from the receiver was at

the resonant frequency of the filter unit tuned circuit. Frowning, he reduced the volume level from the transistor receiver. After a few final adjustments he took off the phones and handed them to Smyth. "It works beautifully," remarked Dick. "Just listen to that!"

Smyth put the headphones over his ears. Whereas the sound from the transistor radio loudspeaker consisted of the transmitted programme with a relatively quiet heterodyne, the heterodyne tone in the earphones completely predominated, the programme material being very much relegated to the background. Smyth adjusted the signal generator frequency, taking

20kΩ pot and a 27kΩ fixed resistor. These will be near enough to 50kΩ in series. The use of a 20kΩ component will open out the pot travel available before oscillation commences, and there will still be a good bit left in hand to accommodate falling battery voltage with age. And I think I'll make the emitter resistor of the second transistor a pot instead of a fixed resistor. This will enable us to have a volume control at the filter output. If we can't get hold of a log track pot in 2kΩ, a linear 2kΩ pot should suffice for the rudimentary control that's required here. After having said all that, let's draw up the final circuit."

Smyth returned to his bench and

to get the results that we did. The second transistor isn't so critical, and pretty well any a.f. transistor offering a reasonably high gain should cope here instead of the ACY19 I've shown. The input to the filter unit should preferably be obtained from a low impedance point in the communications receiver with which it is used, and any receiver output at speaker impedance should be quite satisfactory."

"This has certainly been an interesting project," said Dick warmly. "What's more, it's taken us up to the end of work time very nicely."

## SPARE TIME WORK

Dick's eye fell on the lamp standard at the end of his bench.

"Blow me," he grunted. "I'd forgotten all about that table lamp. I'll have to re-wire it in my spare time now. Can I stay in the Workshop and do it here?"

"By all means," replied Smyth affably. "Indeed, I'd like you to. You'll keep me company, as I've got a little job to do myself as well."

"What's that?"

"Making up this filter unit circuit in its final permanent form," said Smyth cheerfully. "In fact I'm very obliged to you for the help you've given me with it."

Dick eyed the Serviceman with sudden suspicion.

"There's something fishy here," he pronounced accusingly. "You wouldn't normally be putting in overtime on a job like that. Who is the bloke who wants this filter unit?"

"I must admit," replied Smyth evasively, "that I have recently become interested in amateur short wave listening. It's an old hobby of mine which I've started taking up again."

"Don't tell me," persisted Dick, "that that filter unit is intended for you."

"Seeing," said Smyth, "that you put it that way, yes."

"Well, I'm darned," retorted Dick with disgust. "Not only do you stop me doing a private job for myself in Workshop time, but you actually have the brass nerve to con me into doing one for you!"

"Perhaps, perhaps," said Smyth soothingly. "But what you tend to forget is that I'm Management whilst you're Staff."

"So far as I can see," snorted Dick bitterly, "the only attributes that Management need in order to succeed are dead craftiness and low cunning."

"True," said Smyth, nodding his head gravely as he gathered up Dick's temporary version of the filter unit and carried it over to his own bench, "very true."

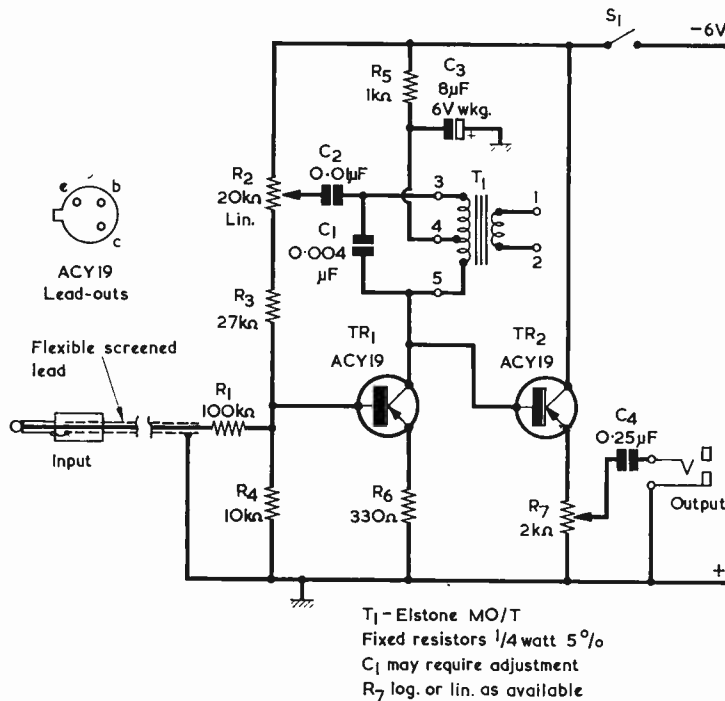


Fig. 6. Circuit of the finalised a.f. filter unit. The input jack plug is intended to connect to the receiver headphone socket

the heterodyne away from the filter unit resonant frequency. The heterodyne rapidly diminished in level, and only reappeared at full intensity when Smyth returned the signal generator to its previous setting.

## TIDYING UP

"That," he remarked in a satisfied tone, "seems to be it, then. This filter unit works very nicely indeed, particularly if the a.f. input to it is kept at a low level. Let's finally tidy up the circuit. I see that oscillation starts with the slider of the 50Ω pot advanced only about a fifth to a quarter of the way down its track, so we'll replace it with a

busied himself with sketching out the circuit. (Fig. 6).

"Here it is," he remarked, passing it over to Dick. "That's the final developed circuit, all complete."

"It looks simple enough, doesn't it?" said Dick. "Any comments to make on component values?"

"Only a few," said Smyth. "If anyone else were making up the circuit he may possibly find it necessary to adjust the value of C<sub>1</sub> to provide the tone he requires. This will allow for personal preference and for slight variations in inductance between different transformers of the type we've used. The first transistor should be an ACY19, or a pretty close equivalent,

# LATE NEWS

Times = GMT

Frequencies = kHz

## ★ AMATEUR BANDS

### ● MALDIVE ISLANDS

VS9MQ heard on 14026 c.w. at 1955, VS9MZ heard on 14050 c.w. at 1925 and on 21010 c.w. at 1745.

### ● CUBA

CO3VM heard at 2135 on 14080 c.w. QTH as Havana.

### ● SURINAM

PZ1AV heard at 2115 on 14030 c.w.

### ● BOTSWANA

A2CAU heard on 14045 c.w. at 1025.

### ● SAO THOME

CR5SP heard on 14168 s.s.b. at 0630, on 14180 s.s.b. at 1820, on 21230 s.s.b. at 1423 and on 21387 s.s.b. at 1515.

### ● SUDAN

ST2SA operates on 14021, 14040 and 14075 c.w. between 0300-0400 and 1300-1500. Also heard on 21035 c.w. at 1500.

### ● NEW CALEDONIA

FK8AU heard on 14114 s.s.b. at 1945.

### ● EAST MALAYSIA

9M6HM heard on 14110 s.s.b. at 1815, on 14140 s.s.b. at 1835, on 14150 s.s.b. at 2020 and on 14209 at 1450.

### ● PITCAIRN ISLAND

VR6TC heard on 14174 s.s.b. at 0655.

## ★ BROADCAST BANDS

### ● AFGHANISTAN

Radio Kabul broadcasts to Europe on 11790 (50kW) and 15265 (100kW) in German at 1730 and in English at 1800.

### ● CEYLON

Radio Ceylon can be heard in English from 1100 to 1130 on 17745 (35kW).

### ● CHINA

Peking can be heard in English from 1400 to 1500 on 15095.

### ● KUWAIT

Radio Kuwait has now changed back to the old channel of 15405 (250kW) from 15343. Signs on at 1600 and changes to 11845 at 1900 until sign-off at 2100 with programs in English.

### ● POLAND

The Third National Program is now on the air from 0357 until 2300 weekdays and on Sundays from 0457 to 2300 on 6020, 6095, 7180, 9570, 9715 and 15100.

### ● SOLOMON ISLANDS

VQO7 Solomon Islands Broadcasting Service is now broadcasting on the new channel of 7235 from 0615 to 1130 in parallel with VQO3 on 3995.

### ● ANGOLA

CR6RH Radio Clube Huila can be heard on 5025 (1kW) around 2015.

### ● JORDAN

Much in the news recently, Amman can be heard on 9530 (100kW) with news in English at 1500.

*Acknowledgements - Our Listening Post, ISWL and SCDX.* ■

## GALAPAGOS ISLANDS

As mentioned in *Now Hear These* in this issue, *La Voz de Galapagos* can now be heard in Europe owing to a frequency change from 6170kHz to 6255kHz. The Archipeligo has country status, a new one for Broadcast band listeners. Close down has been heard between 0400-0430 on weekdays, 0445 Saturdays and 0500 on Sundays. On average, station identification is given every ten minutes.

Station callsign is HCVG8, power 5kW and the address is - Mission Franciscana, Isla San Cristobal, Archipeligo de Galapagos, Ecuador.

These volcanic islands (twelve large and hundreds small) lie in the Pacific Ocean 600 miles west of Ecuador. Only five of the islands are inhabited.

NOVEMBER 1970

## LAST LOOK ROUND

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(Continued on page 257)

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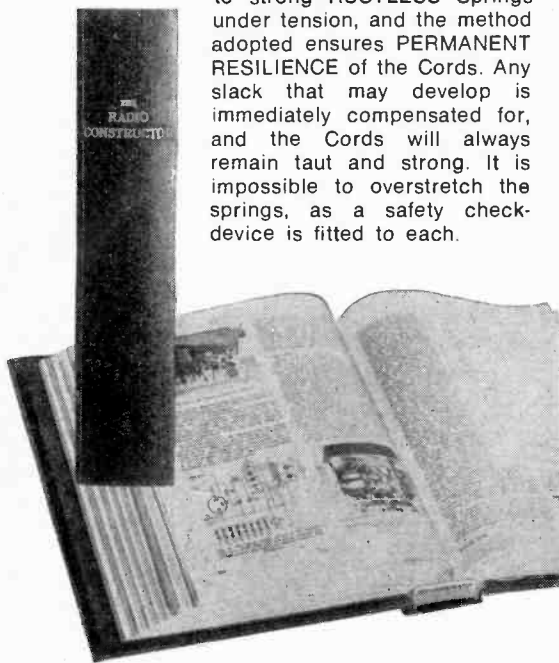
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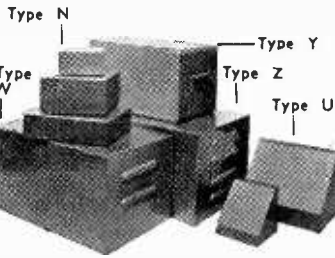
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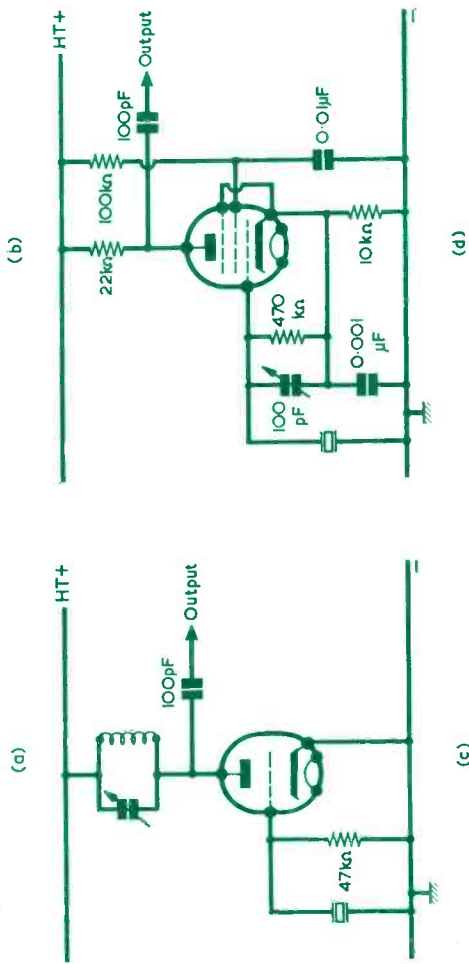
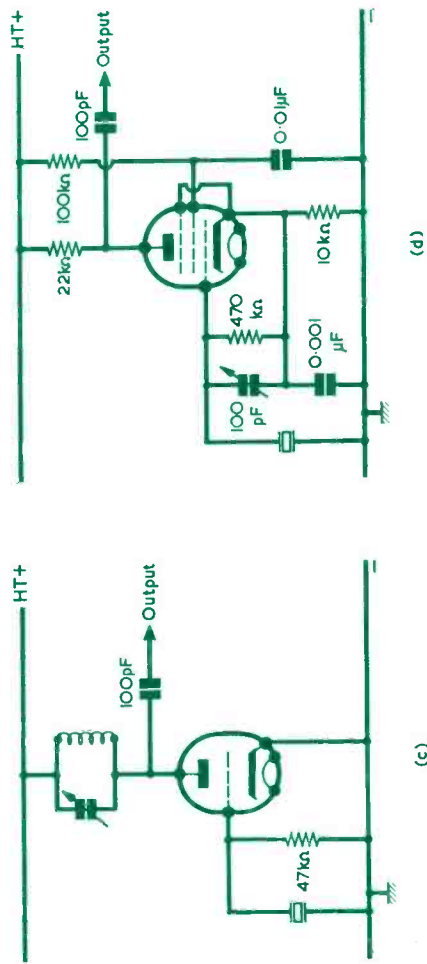
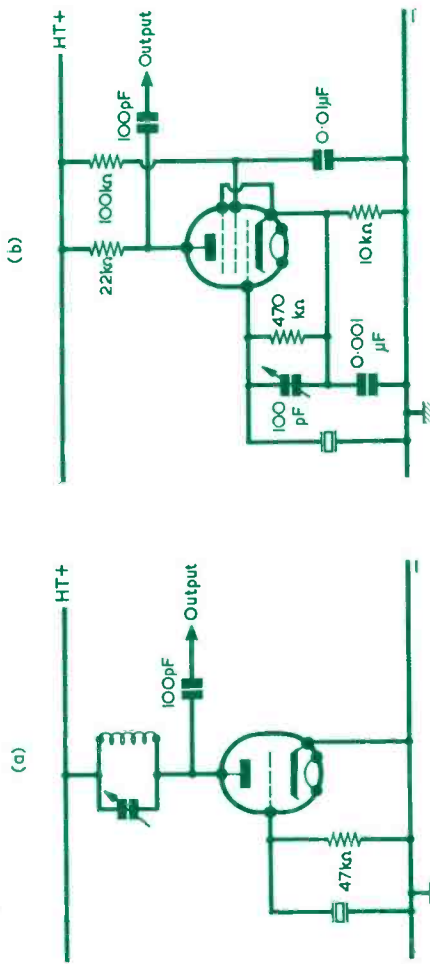
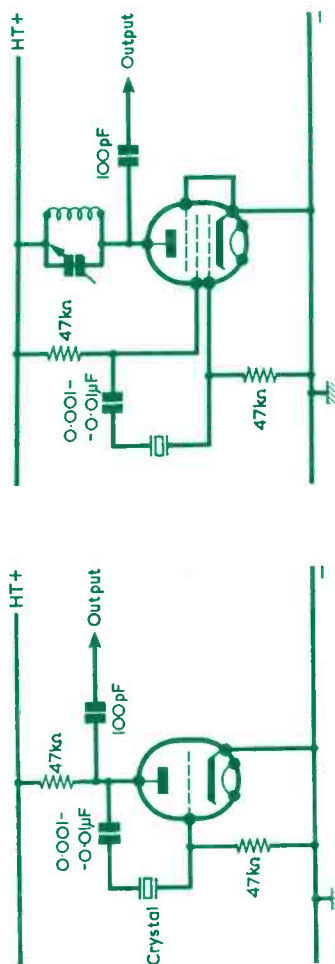
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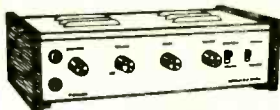




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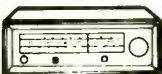


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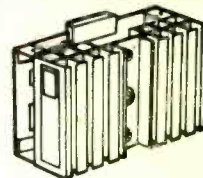
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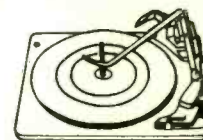
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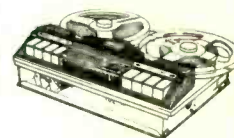
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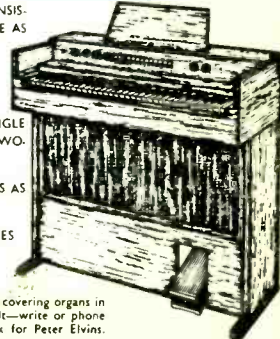
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