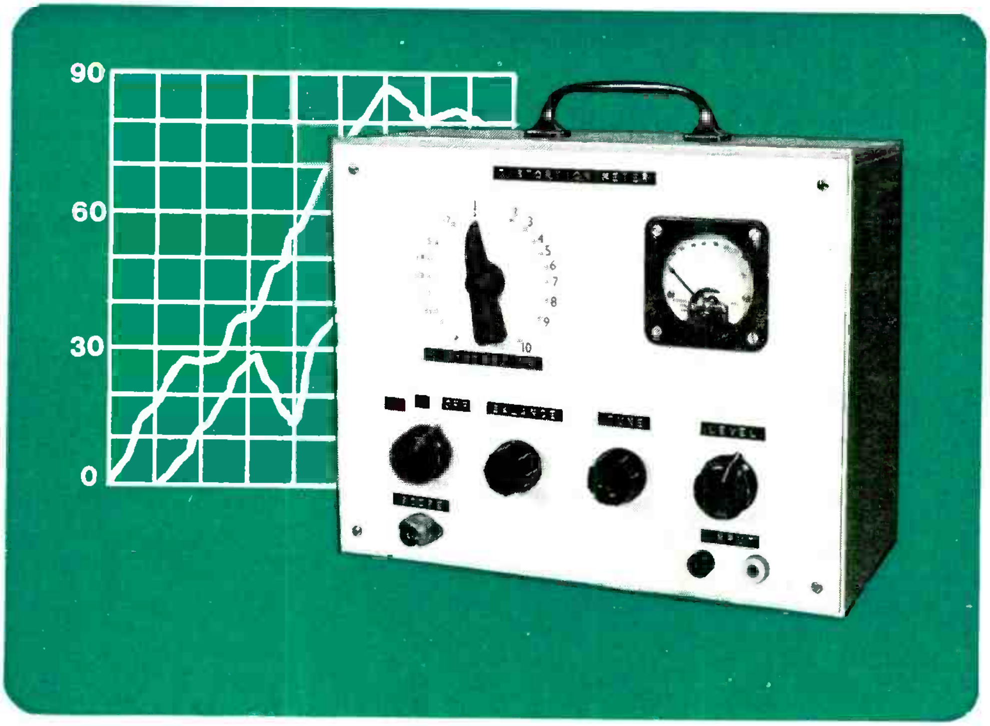
THE

RADIO CONSTRUCTOR

Vol. 23 No. 10 MAY 1970 3/6



SOLID-STATE DISTORTION METER

A simple design measuring directly, percentage distortion of A.F. amplifiers over the range 0.2% to 10% at 1,000Hz. Plans and Instructions inside

Special IN THIS ISSUE

FREE INSIDE
Detachable Plans for above Meter

EXCLUSIVE
Motoring Offer

New 1970 prices L.S.T. Electronic Components Ltd.

Type	Price
AC107	14/6
AC126	5/-
AC127	5/6
AC127Z	9/6
AC128	4/-
AC176	5/-
AC187	12/-
AC188	12/-
ACY17	5/-
ACY18	3/6
ACY19	4/5
ACY20	3/7
ACY21	4/-
ACY22	2/9
ACY40	3/-
ACY41	4/4
ACY44	8/-
AD140	11/-
AD149	11/6
AD161	6/-
AD162	6/-
ADT140	12/6
AF102	12/6
AF106	7/6
AF114	5/-
AF115	5/-
AF116	5/-
AF117	5/-
AF118	12/6
AF121	6/-
AF124	4/6
AF126	3/6
AF127	3/6
AF139	7/6
AF178	9/6
AF179	11/6
AF180	12/6
AF181	8/6
AF186W	9/-
AF186G	9/-
AF239	7/6
AFY19	22/6
AFZ11	8/-
ASY26	5/-
ASY27	6/-
ASY28	5/-
ASY29	6/-
ASZ21	7/6
AUY10	30/-
B2M	12/6
B3M	15/-
BC107	2/9
BC108	2/9
BC109	2/9
BC113	5/-
BC115	6/6
BC116	8/-
BC118	5/-
BC125	11/-
BC126	11/-
BC134	5/-
BC135	6/-
BC136	8/-
BC137	8/6
BC138	12/-
BC140	13/3
BC147	2/9
BC148	3/3
BC149	3/-
BC154	12/-
BC167	3/6
BC168	3/9
BC169	3/9
BC182L	3/-
BC183L	2/6
BC184L	3/-
BC212L	3/9
BCY10	10/-
BCY12	12/-
BCY30	5/-
BCY31	5/6
BCY32	10/-
BCY33	4/-
BCY34	5/-
BCY38	6/-
BCY40	10/-
BCY42	4/-
BCY43	4/-
BCY54	7/6
BCY70	4/6
BCY71	8/-
BCY72	4/-
BCY87	86/9
BCZ11	7/6
BD119	15/-
BD121	18/-
BD123	21/6
BD124	12/-

Type	Price
BF115	5/-
BF152	13/6
BF154	9/-
BF159	15/-
BF163	9/-
BF167	5/-
BF173	6/-
BF178	10/6
BF179	12/6
BF180	6/-
BF181	6/6
BF184	7/-
BF185	8/-
BF194	3/6
BF195	3/-
BF200	10/6
BFX13	5/-
BFX29	8/-
BFX44	8/-
BFX84	7/6
BFX85	9/-
BFX86	6/6
BFX88	5/-
BFY18	5/-
BFY50	4/6
BFY51	3/9
BFY52	4/6
BFY53	3/2
BFW57	6/-
BFW58	5/6
BFW59	5/-
BFW60	4/6
BSX19	3/6
BSX20	3/4
BSX21	7/6
BSX76	4/-
BSX77	6/-
BSX78	6/6
BSY27	4/-
BSY29	5/-
BSY32	5/-
BSY36	5/-
BSY37	5/-
BSY38	4/-
BSY95A	3/6
BSW41	8/6
BSW70	5/6
BTX39/600	120/-
BTX40/600	120/-
BTY87/150R	31/-
C106F1	9/-
C111	18/-
C111E	12/-
C400	9/-
C426	8/3
C444	9/8
D13T1	10/-
GET102	6/-
GET103	4/6
GET113	4/-
GET114	4/-
GET120	6/6
GET880	9/-
GET887	4/-
GET889	6/-
GET890	6/6
GET896	4/6
GET897	4/6
GET898	6/-
GEX 45/1	3/-
MAT100	5/-
MAT101	5/6
MAT120	5/-
MAT121	5/6
MJ400	21/6
MJ420	22/6
MJ421	22/6
MJ430	20/6
MJ440	19/6
MJ480	20/6
MJ481	27/-
MJ490	22/6
MJ491	29/6
MPF102	8/6
MPF103	7/6
MPF104	7/6
MPF105	8/-
MPS3638	6/6
NKT0013	9/6
NKT121	11/-
NKT122	8/-
NKT123	6/-
NKT125	5/6
NKT127	5/6
NKT128	5/6

Type	Price
NKT129	6/-
NKT141	7/-
NKT142	6/-
NKT143	5/6
NKT144	8/-
NKT161	6/-
NKT162	6/-
NKT163	5/6
NKT164	5/6
NKT165	6/-
NKT211	6/-
NKT212	6/-
NKT213	4/-
NKT214	4/-
NKT215	4/-
NKT216	10/-
NKT217	13/-
NKT218	5/3
NKT219	6/-
NKT221	5/6
NKT222	4/-
NKT223	3/6
NKT224	4/6
NKT225	3/6
NKT226	10/-
NKT227	5/6
NKT228	6/-
NKT261	4/3
NKT262	4/3
NKT264	4/3
NKT271	4/-
NKT272	4/-
NKT273	4/-
NKT274	4/-
NKT275	5/-
NKT276	3/6
NKT279A	2/6
NKT281	5/-
NKT301	16/-
NKT302	11/-
NKT303	10/-
NKT304	9/6
NKT351	8/-
NKT352	7/6
NKT401	17/6
NKT402	24/-
NKT403	15/-
NKT404	12/6
NKT405	15/-
NKT406	15/-
NKT451	12/6
NKT452	12/6
NKT453	10/-
NKT613F	5/-
NKT674F	5/-
NKT675	5/-
NKT676	5/-
NKT677F	5/-
NKT703	8/-
NKT713	7/6
NKT773	5/-
NKT10339	6/6
NKT10419	6/-
NKT10429	11/-
NKT10519	6/6
NKT16229	11/-
NKT20329	11/-
OC20	19/6
OC22	8/-
OC23	8/-
OC24	8/-
OC25	7/6
OC26	6/6
OC28	12/-
OC35	9/-
OC36	12/6
OC41	4/6
OC42	4/6
OC43	4/6
OC44	3/-
OC45	3/-
OC70	2/6
OC71	3/-
OC72	4/6
OC75	4/6
OC76	2/6
OC77	5/6
OC81	4/6
OC81D	3/-
OC82	5/-
OC82D	3/-
OC83	4/6

Type	Price
OC84	5/-
OC123	7/-
OC139	5/-
OC140	7/-
OC170	5/-
OC171	6/-
OC200	6/3
OC201	9/6
OC202	18/-
OC203	7/6
OC204	8/-
OC205	9/-
OC206	10/6
OC207	7/6
OC309	12/-
OCP71	19/6
ORP12	9/6
ORP60	8/-
ORP61	8/-
ORP63	9/-
P346A	5/-
RA5310AF	6/-
RAS508AF	15/-
S1M	19/-
S4M	33/6
ST140	3/-
ST141	5/-
ST2	9/9
T1407	9/8
TIP31A	19/6
TIP32A	22/6
TIS34	17/6
TIS44	1/9
TIS45	3/3
TIS46	3/3
TIS47	3/3
TIS48	3/3
TIS49	3/6
TIS50	5/6
TIS51	4/-
TIS52	4/-
TIS53	6/6
TIS60	6/6
TIS61	7/-
TSW30C	18/-
U23AAA	5/-
V205	20/-
V405A	9/3
XA102	6/-
XA702	15/-
XB113	5/-
ZE12V7	3/6
ZT22	19/-
ZT86	27/6
ZT2270	19/6
40250	12/6
40309	9/6
40310	13/-
40311	10/6
40312	13/6
40314	10/6
40315	10/6
40316	13/-
40317	11/-
40319	15/-
40320	10/6
40323	10/6
40324	12/6
40326	10/6
40329	7/6
40344	8/-
40347	9/6
40348	14/6
40360	11/6
40361	12/-
40362	14/-
40370	8/6
40406	16/-
40408	14/-
40467	16/6
40468A	16/6
40602	9/9
2G301	3/6
2G302	3/-
2G306	8/6
2G339A	5/-
2G371	3/-
2G371B	3/-
2G374	5/-
2G378	7/-
2G381	5/-
2N109	11/-
2N174	16/-
N2217	7/6
2N370	15/-
2N384	17/-

Type	Price
2N386	12/-
2N385A/	
2N388A	15/-
2N404	4/6
2N410	8/-
2N458A	25/-
2N511A	49/6
2N513A	122/6
2N599	10/-
2N601	25/-
2N657	20/-
2N696	4/-
2N697	4/-
2N698	6/-
2N706	2/6
2N706A	2/6
2N708	4/-
2N711	7/6
2N711A	7/6
2N715	7/6
2N716	7/6
2N743	4/6
2N744	6/-
2N753	5/6
2N914	4/6
2N918	7/6
2N929	5/6
2N930	7/6
2N1090	6/6
2N1091	6/6
2N1131	6/6
2N1132	8/-
2N1302	4/-
2N1303	4/-
2N1304	5/-
2N1305	5/-
2N1306	5/-
2N1307	5/-
2N1308	7/-
2N1309	7/-
2N1496	34/-
2N1507	4/8
2N1613	5/6
2N1671A	29/6
2N1711	6/6
2N1893	10/-
2N2147	17/-
2N2152	27/6
2N2148	12/6
2N2160	14/9
2N2243	26/-
2N2368	5/-
2N2369	5/-
2N2369A	5/6
2N2432	67/-
2N2484	8/-
2N2613	7/6
2N2614	4/-
2N2646	10/-
2N2711	6/-
2N2712	6/-
2N2713	5/6
2N2904	8/6
2N2904A	8/-
2N2905	10/-
2N2905A	8/-
2N2923	4/-
2N2924	4/-
2N2925	3/6
2N2926 Green	2/-
2N2926 Yellow	2/-
2N2926 Orange	2/-
2N2926 Brown	2/-
2N3011	12/6
2N3036	39/-
2N3053	5/-
2N3054	12/6
2N3055	15/-
2N3133	6/-
2N3135	6/-
2N3136	6/-
2N3235	28/6
2N3234	27/6
2N3391A	6/-
2N3392	5/-
2N3393	5/-
2N3394	4/9
2N3402	5/6
2N3403	5/6
2N3404	7/6
2N3414	5/6
2N3415	6/-

Type	Price
2N3416	7/6
2N3436	15/-
2N3525	21/9
2N3528	19/-
2N3606	5/6
2N3607	4/6
2N3702	3/3
2N3703	3/-
2N3704	3/3
2N3705	3/-
2N3706	2/9
2N3707	3/-
2N3708	2/-
2N3709	3/-
2N3710	3/-
2N3711	3/-
2N3819	8/-
2N3820	18/9
2N3826	6/-
2N3854	5/6
2N3854A	5/6
2N3855	5/6
2N3855A	6/-
2N3856	6/-
2N3856A	6/-
2N3858	5/-
2N3858A	6/-
2N3859	5/6
2N3859A	6/3
2N3860	6/-
2N3866	25/-
2N3877	9/-
2N3877A	9/6
2N3900	10/6
2N3900A	11/6
2N3903	7/-
2N3904	7/-
2N3905	7/6
2N2906	7/6
2N4037	15/-
2N4058	4/6
2N4059	5/-
2N4060	5/-
2N4061	4/-
2N4062	4/6
2N4284	3/-
2N4285	3/-
2N4286	3/-
2N4287	3/-
2N4288	3/-
2N4289	3/-
2N4290	3/-
2N4291	3/-
2N4292	3/-
2N4871	6/9
2N5027	10/6
2N5028	11/6
2N5029	9/6
2N5030	8/6
2N5172	3/-
2N5174	10/6
2N5175	10/6
2N5176	9/-
2N5232	5/6
2N5249	13/6
2N5249A	13/6
2N5305	7/6
2N5306	8/-
2N5309	12/6
2N5354	5/6
2N5355	5/6
2N5356	10/6
3N84	26/-
3N128	18/6
3N140	19/6
3N141	21/6
3N142	16/6
3N143	19/6
3N152	24/-
2S001	10/-
2S002	12/6
2S003	12/6
2S004	15/-
2S005	15/-
2S006	15/-
2S012	25/-
2S012A	22/6
2S017	15/-
2S018	17/6
2S019	19/6
2S104	12/6
2S301	8/6
2S302	7/6
2S303	10/-
2S304	12/6
2S306	15/-

Type	Price
2S320	9/-
2S321	6/-
2S323	10/-
2S701	8/6
2S703	12/6
2S720	25/-
2S732	8/6
2S1002	10/-
DIODES & RECTIFIERS	
AA119	2/-
AAY11	2/-
AAZ12	6/-
AAZ13	2/6
BA100	6/-
BA110	6/-
BA111	6/-
BA112	18/-
BA115	1/6
BA130	3/-
BAY31	2/6
BAY38	3/-
BY100	5/-
BY125	3/6
BY127	4/-
BY234	2/3
BYX10	3/-
BYX36/150	2/6
BYX36/300	2/10
BYX36/600	3/9
BYY21	25/-
BYY23	26/3
BYY25	31/9
BYY142	3/9
BYZ10	9/-
BYZ12	6/-
BYZ13	5/-
CG6E	4/-
CG61	2/6
CG62	2/6
CG63	2/-
CG64	2/6
EA403	3/6
EC401	5/-
EC402	4/8
EB383	3/6
GEX45/1	4/-
GJ3M	4/-
OA5	3/8
OA10	6/-
OA47	1/6
OA70	1/6
OA73	1/6
OA79	1/6
OA81	1/6
OA85	1/6
OA90	1/6
OA91	1/6
OA95	1/6
OA200	2/-
OA202	2/-
SD19	7d
TD716	12/-
1N34A	4/-
1N60	4/-
1N64	4/-
1N82A	9/6
1N87A	4/6
1N191	5/-
1N914	1/9
1N4001	2/-
1N4005	4/-
1N4007	5/-
1N4148	1/9
1S113	4/6
1S44	1/9
1S130	2/-
1S131	2/6
1S132	3/-
1S920	1/4
AAY30	1/9
RAS310AF	6/-

Tail End Offer
PBC108 Texas
Plastic BC108
1/9 each
to clear

LOWEST I.C. PRICES YET!

IC10	59/6	Sinclair IC amp.
PA230	20/-	IC Preamplifier
PA234	20/-	1 watt audio amp.
PA237	32/6	2 watt audio amp.
PA246	52/6	5 watt audio amp.
SL403A	49/6	3 watt Plessey amp.
TAA263	15/-	Mullard linear amp.
TAD100	45/-	IC receiver
TAA293	20/-	Mullard gen. purp. amp.
TAA310	30/-	Record/Playback preamp.
TAA320	13/-	MOS LF amplifier
SL702C	29/6	Plessey linear amplifier
3N84	26/-	Silicon controlled switch

Data sheets available on request—1/- per copy

PLEASE NOTE: Only new—full specification integrated circuits, no below-specification types.

FAIRCHILD MICRO-LOGIC

	1–6	7–11	12+
ul 900	9/9	9/-	8/-
ul 914	9/9	9/-	8/-
ul 923	12/6	11/9	11/-

Prices for 100+ and 1000+ on application.

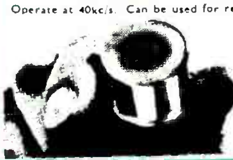
5 page data and circuits article—2/6
Plastic spreaders—1/6 each

ULTRASONIC TRANSDUCERS

Operate at 40kc/s. Can be used for remote control systems without cables or electronic links. Type 1404 trans-ducers can transmit and receive.

FREE: With each pair our complete transmitter and receiver circuit.

PRICE
£5.18.0 Pair
(Sold only in pairs)



ZENER DIODES

400mW 10% GLASS CASE
TEXAS Mfr.

1S2036	3.6 volt
1S2039	3.9 volt
1S2043	4.3 volt
1S2047	4.7 volt
1S2056	5.6 volt
1S2062	6.2 volt
1S2068	6.8 volt
1S2075	7.5 volt
1S2082	8.2 volt
1S2100	10 volt
1S2110	11 volt
1S2120	12 volt
1S2160	16 volt
1S2180	18 volt
1S2270	27 volt
1S2300	30 volt

PRICES: 1–24 3/6d; 25–99 2/9; 100+ 2/3d

2N3819 8/-
Texas FET
25 6/9 100+ 5/9

2N4871 6/9
Motorola unijunction
25+ 5/9 100+ 4/9

2N3055 15/-
115 watt silicon power transistor
25+ 13/- 100+ 11/-

IRC20 8/6
Int. Rectifier thyristor 200 piv. 1.2 amp. (similar C106B1)
25+ 7/9 100+ 7/-

BC107/8/9 2/9
NPN Planar transistors
BC107 & 9 25+ 2/5 100+ 2/2
BC108 25+ 2/3 100+ 2/-

BY127 4/-
Mullard Plastic HV rectifier 800 piv. 1 amp. (similar BY100, etc.)
25+ 3/3 100+ 3/-

2N2926 2/-
NPN Planar transistor
25+ 1/8 100+ 1/6

INFRA-RED DEVICES

56CAY 29/6
Gallium arsenide emitter

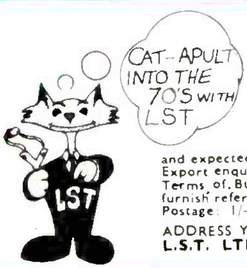
MGA100 35/-
Gallium arsenide emitter

31F2 28/6
Infra-red detector diode

AD161/2 10/-
Siemens/Telefunken NPN/PNP output pair
25+ 9/- 100+ 8/-

CR1-401C 10/-
400 PN 1 amp SCR.

CR1-051C 7/6
50 PIV 1 amp SCR.



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Surrey, CR2 ODE

MAIL ORDER ONLY. PROMPT SERVICE.
Orders over 10/- UK post paid. Discounts: Orders over £3, 10%; over £10, 15%.

NEW & PERFECT TRANSISTORS

AD161-2	12/–	HK041	2/6	2N3707	3/6
AF239	10/–	HK101	2/–	2N3794	3/–
B5000G	11/3	HK601	2/6	2N3983	6/6
BD121	18/–	IS44	1/4	2N4058	4/–
BC107	3/–	SF115	3/–	2N4285	3/–
BC168	2/3	TI407	6/6	2N4289	3/–
BC169	2/6	TIS60M	4/8	2N4291	3/–
BF167	5/3	TIS61M	4/11	2SB187	2/–
BF178	9/–	2N706	2/7	2SB405	5/–
BF225	5/–	2N2926G	2/6	2SD72	5/–
BFY51	4/6	2N3702	3/–	40468A	7/6
GET693	1/3	2N3704	3/6		

RECTIFIERS:

800piv, 500mA Si, IS557, 3/-; 50piv, 100mA, 1/-. Submin. Selenium Bridge, 30Vrms, 150mA dc, 3/6; Contact-cooled Sel. Bridge, 30Vrms, 700mA dc, 6/-. Silicon Bridge, 80Vrms, 1Adc, 10/-. All new and perfect.

NEW!

"IDENTICAL RESONATORS": new Brush Clevite Transfilters for do-it-yourself ceramic i.f. filters. Four of these plus seven fixed capacitors give razor-sharp selectivity to superhets with 455kHz i.f. Kit of 4 resonators and all capacitors, plus notes on use, **35/-.** Single resonators, **10/-** each, 4 for **30/-**

"R.C." MILLIVOLTMETER (Jan., p. 342). Our **AX10** Printed Circuit accommodates the main part of the circuit (not TR1). With layout drawing and hints, **15/-.**

COMPONENT KITS

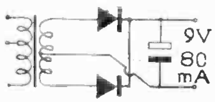
AMPLIFIER PACKAGES, Reliable and efficient, and still far cheaper than i.c.'s!

AX2 9V, up to 300mW **12/6**
AX3 9V, up to 800mW in 8 ohms **22/6**
AX4 24V, 5W, 8 ohms, 3W, 15 ohms **30/-**
AX5 12–15V, 3W, 3–5 ohms. NEW! **35/-**

'GEN' GALORE!

Regular customers know that we supply really practical data sheets with our mains transformers, component kits, ceramic resonators, f.e.ts, i.cs, etc. All part of the normal Amatronix service.

BUILD A MINI MAINS PACK



Components as shown, and hints **17/6.**

Mini Mains Transformers	30x30x37 mm		
MT7	7–0–7V	120mA	**13/6**
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Polystyrene: 160V, small, low-loss, tol. 1pF or 2½%. **New prices:** 10–1500pF, **1/-;** 2200–22,000pF, **1/6.** In stock: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 560, 680, 820, 1000, 1500, 2200, 3300, 4700, 6800, 8200, 10,000, 15,000, 22,000pF.
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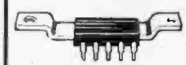

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ELECTRONIC SIREN MODULE

by

P. L. MATTHEWS

A neat and simple oscillator circuit which produces an a.f. output whose frequency continually rises and falls

The need often arises for a buzzer or alarm bell to operate in conjunction with a burglar alarm or similar circuit, but it is difficult to obtain a device producing a really distinctive sound. The transistorised siren module to be described will admirably fulfil this need as it produces a warbling sound similar to that of an American police car siren. Both the pitch and change of pitch can be adjusted indefinitely by suitable choice of components, and a useful feature is the independent control of the rise and fall of the note. The siren, which is built on a small piece of Veroboard, employs four general purpose silicon n.p.n. transistors and consumes about 5mA from a standard 9 volt battery. It is designed to feed into a power amplifier with an input impedance of 10kΩ or more. The prototype was connected to a 9 volt transistorised amplifier module and a series resistor was added to attenuate the signal and increase the effective load impedance accordingly.

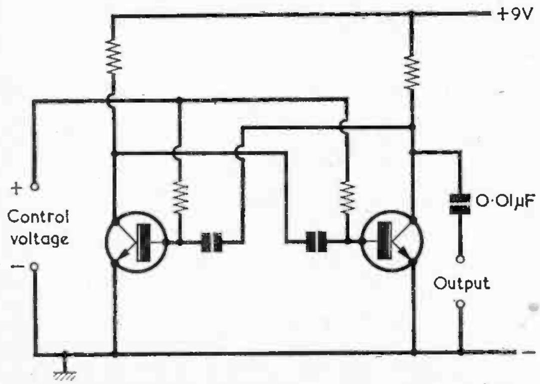


Fig. 1. The multivibrator shown here is capable of having its frequency of oscillation varied by alterations in control voltage. Virtually linear control of frequency is achieved for positive control voltages from 1 to 4 volts

CIRCUIT DESIGN

In order to simulate the changing pitch of a siren, it is necessary to develop an audio oscillator whose frequency can be varied by alteration of a control voltage. Fortunately, this is not difficult to arrange and most simple oscillator circuits can be adapted quite easily. The author selected the multivibrator circuit shown in Fig. 1 as a basis for the siren because it has several advantages over apparently simpler circuits such as blocking oscillators and RC ladder circuits. One such advantage is an approximately linear variation of frequency against control voltage. A second advantage is the low loading imposed on the control voltage source, which enables the voltage to be obtained across a capacitor without significant discharge. This is important as it simplifies the remaining circuitry, avoiding the need for a buffer amplifier. It can be seen, therefore, that the circuit of Fig. 1 provides a convenient basis for the development of the siren, and the next step is to generate a suitable periodic sawtooth waveform to control its frequency.

It is difficult and unnecessary to design complex circuitry to obtain a pure sawtooth waveform, and a simple method, which nevertheless produces a satisfactory result, will next be described. The circuit of Fig. 2(a) depicts a capacitor C which, via a resistor R, can be alternately charged from a battery or discharged. Fig. 2(b) shows the voltage across C as a function of time when the switch is set to charge for 5 time constants and then set to discharge for a further 5. The time constant, in microseconds, is of course the product of C in microfarads and R in ohms, and is the time taken for C to charge to 63% of E or, after having been fully charged, to discharge to 37% of E. We require a circuit which will produce a voltage varying from

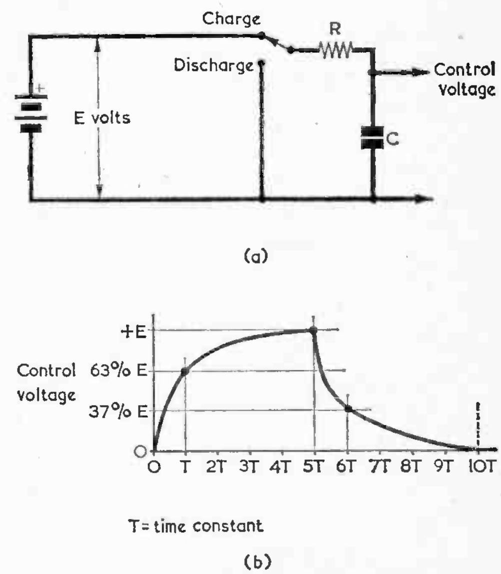


Fig. 2(a). One method of producing an approximately sawtooth waveform (b). The waveform provided by the switching circuit. The switch is set to 'Charge' from zero to 5T, then returned to 'Discharge' from 5T to 10T

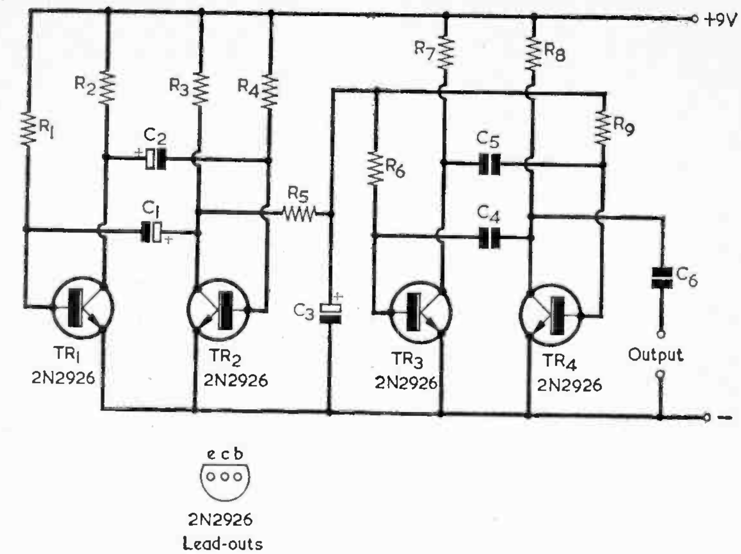


Fig. 3. Complete circuit of the siren module

a minimum of 1 volt to about 4 volts to obtain reasonable control of multivibrator frequency. Since this circuit will be operated from a 9 volt supply it is obvious that the capacitor must be charged for somewhat less than the time constant. The siren is intended to produce a rising pitch for about 1 second, whereupon it follows that a time constant of about this magnitude will be needed. The mechanical switch must also be replaced by an electronic equivalent, and this can be a second multivibrator.

It was decided to have the duration of the falling pitch shorter than that of the rising pitch. This is obtained by adjustment of the coupling capacitors in the controlling multivibrator so that their values are in the ratio 3:1.

The final circuit of the siren module is given in Fig. 3. It can be seen that TR1 and TR2 constitute the controlling multivibrator, with C1 controlling the duration of the falling pitch, and C2 the duration of the rising pitch. R5 and C3 serve to produce an approximate sawtooth waveform (with R3 entering

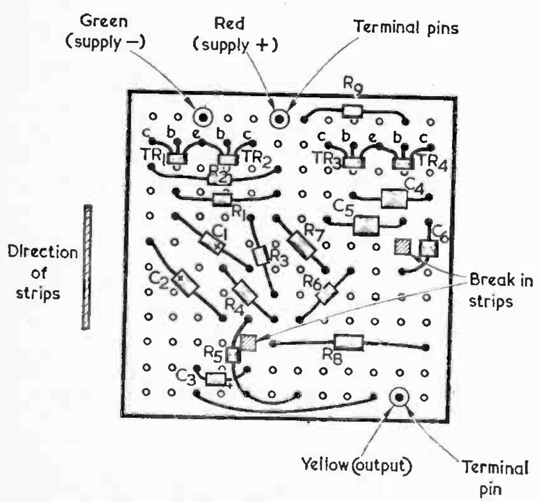


Fig. 4. The Veroboard assembly, as viewed from the component side. The terminal pin coded green provides one of the output connections in addition to the negative supply connection

COMPONENTS

Resistors
(All 10% ¼ watt)

R1	56kΩ
R2	4.7kΩ
R3	4.7kΩ
R4	56kΩ
R5	4.7kΩ (see text)
R6	56kΩ
R7	4.7kΩ
R8	4.7kΩ
R9	56kΩ

Capacitors

C1	5μF miniature electrolytic, 10V wkg.
C2	16μF miniature electrolytic, 10V wkg.
C3	100μF miniature electrolytic, 10V wkg.
C4	0.0068μF, paper or plastic foil
C5	0.0068μF, paper or plastic foil
C6	0.01μF, disc ceramic

Transistors
TR1 – TR4 2N2926 (see text)

Miscellaneous
Veroboard, 0.15in. matrix, 12 x 12 holes
3 Veroboard terminal pins
Sleeving, solder, etc.

the charge circuit when TR2 is cut off), the waveform being applied to the "signal" multivibrator as already described. The output signal is taken from the collector of TR4 via C6 and may then be applied to the subsequent amplifier.

The transistors quoted are 2N2926, and it should be noted that this type has a maximum reverse base-emitter rating of 5 volts. As the reverse base voltage in the multivibrators approaches the supply voltage when the transistors cut off, there would appear to be a risk of breakdown. However, the question of using silicon transistors such as the 2N2926 in multivibrator circuits received an airing in the technical press some years ago, in which a leading semiconductor manufacturer was quoted as stating that all base to emitter limiting ratings are well below voltage breakdown. The prototype was run for several hours at 18 volts and no breakdowns occurred, and it would seem to be quite safe in practice to use 2N2926's in the present circuit with a 9 volt supply. In any event the choice of transistor is not critical and the constructor could employ silicon (or germanium) alternatives having a higher reverse base-emitter rating if so desired.

CONSTRUCTION

As mentioned earlier, the prototype was assembled on a square piece of Veroboard, this being of 0.15in. matrix and having 12 by 12 holes. It was cut from a larger sheet. Fig. 4 gives a view of the board as seen from the side on which the components are mounted. Three terminal pins of the type intended for use with Veroboard are fitted for battery and output connections. It will be found convenient to pass pieces of 1mm. plastic sleeving over the pins, these having different colours to assist identification later. In the diagram the battery negative pin is shown as green, the battery positive pin as red, and the output pin as yellow.

Construction is quite straightforward, it being necessary first to cut the board to size and make the two breaks in the copper strips, as shown. The pins and non-electrolytic capacitors can then be mounted, followed by the electrolytic capacitors and finally the transistors. Care should be taken to ensure that adjacent conductors, including metal transistor cases, do not come into contact with each other. Unnecessary heat due to excessive application of the soldering iron should also be guarded against, and the usual precautions taken when soldering the transistors.

CHECKING

After construction the siren module may be tested and checked. If the siren fails to function but is consuming a reasonable current, suspect the "signal" multivibrator and transistors TR3 and TR4. The normal collector voltage of these transistors will be in the region of 6 volts, varying in sympathy with the pitch. A high voltage reading indicates that no collector current is flowing. If the signal circuitry is functioning but the pitch is steady, check the "control" multivibrator and the coupling circuit.

To provide a narrower pitch range than in the prototype, the value of R5 may be increased to slow down the rate of charge and discharge of C3.

■

POLES

May and poles are traditionally lumped together, although it is many years now since such an erection, with its attendant colourfully dressed dancers and intertwining ribbons, have been seen on our village green—and more's the pity! It is said that tradition dies hard, but this one, together with its charming ceremony of crowning the equally charming May Queen, seems in the main to have almost passed softly away unnoticed. Perhaps one reason for this sad state of affairs is the difficulty of obtaining, locally at any rate, a wooden pole of suitable size.

Having worked up an over-sized enthusiasm to get cracking on Top Band, the obvious prerequisite to achieve anything like successful county chasing was a 132ft. skywire and it follows that this should have some means of support. It all seemed so simple at the time.

Parking unobtrusively beside a ramshackle shed, there issued from this the rending sound of bandsaws, whisps of sawdust and an individual whose crowning glory was a battered bowler hat that had obviously seen better days. "Wotcher want, mate," he growled through sawdust encrusted lips. "An aerial pole," I replied, hopefully. "Huh, yer won't get one of them things 'ere, but yer can try the orfice." He grimaced, jerked his grimy thumb in the direction of a nearby shed and derisively added: "They fink they know it all there, that lot do," with which parting shot Bowler Hat turned and vanished into the cloud of sawdust from whence he came.

The "orfice" proved to be a maze of interconnecting sanctums and finally, after brusque but poleless encounters with the denizens of two of them, the final arbiter of the pole quest was contacted. Located behind a desk of gargantuan proportions and visibly ensconced on a high stool reminiscent of Dickensian times, the worthy occupant of this "orfice" ruminated over my request at some length. I quickly discovered that everything about this character was long-suffering. Getting off his high stool, he towered above the dusty floor by at least 7ft.! Frowning down at me rather pityingly, I thought, he educated me in measured sonorous tone. "People don't use wireless poles these days," he said incredulously, "they use transistor sets". With the awful finality of that technical logic I found myself stumped! How could I explain the long and short of it to one so elevated in outlook?

From the ensuing lecture delivered by the High Priest of the Woodyard I gathered that a wood pole *could* be ordered from London but it *would* be an expensive transaction as a one-off affair. "Better get an ally pole from your TV aerial erector," Lofty advised. Stretching to *my* full height and gazing direct into his midriff I apologetically replied that I would, and was sorry to have bothered him with such a trivial matter.

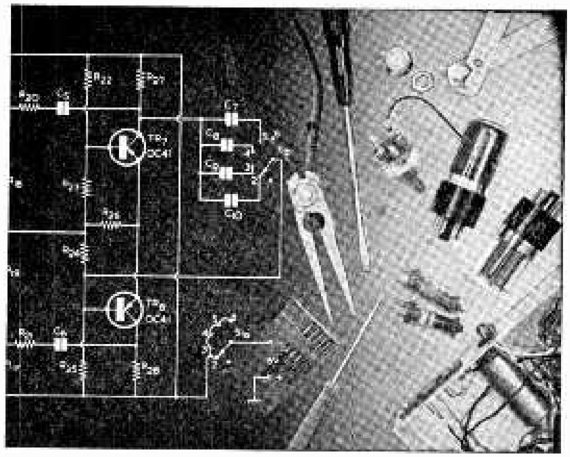
Returning to the car brought a final encounter with Bowler Hat. "'Ow jer git on, mate?", he enquired. "I didn't," I replied disconsolately. "I toldjer, didn't I," was the triumphant rejoinder. How was I to know that wood poles for aerials were unobtainable? Presumably this also applies to Maypoles!

C.W.

■

NEON-L.D.R. A.F. OSCILLATOR

by G. A. FRENCH



IN ELECTRONIC WORK WE TEND to fall into the habit of looking upon an oscillator as being essentially an amplifying device whose output is fed back to its input via a frequency-selective network, such a network normally comprising either capacitance and inductance (together with an inevitable small resistance) or capacitance and resistance. An alternative way of examining the oscillator feedback network is to assume that it causes a *time delay* to take place before a signal at the output of the amplifying device reappears at its input. This second concept is, perhaps, easiest to accept with an oscillator of the phase-shift variety. Here, an output signal is applied to a network of three or more series capacitors and shunt resistors, whereupon a time delay—dependent upon the values of the capacitors and resistors and equal to the time taken up by one half-cycle of the oscillation—occurs before the output signal is fed to the input.

The a.f. oscillator to be described in this article functions by virtue of a time delay inherent in one of the components employed, and its operation does not require capacitance either in conjunction with inductance or with resistance. The oscillator is extremely economical of components and, so far as the writer is aware, has not been previously described.

OSCILLATOR CIRCUIT

The basic circuit of the oscillator appears in Fig. 1. In this diagram a d.c. potential lying between 150 and 300 volts and of either positive or negative polarity is applied to a parallel combination of a light dependent resistor (l.d.r.) and a neon bulb, these being in series with a 470kΩ resistor. The oscillator output is taken from the 470kΩ resistor via a 0.01µF d.c. blocking capacitor. The light dependent resistor, or to give it its more recently acquired name, photoconductive cell, is illuminated by the neon bulb, and both are enclosed in a light-proof box.

The photoconductive cell is an ORP12 and, as most readers will already know, this exhibits a high resistance (of the order of 10MΩ) in complete darkness, and a low resistance (of the order of 75 to 300Ω) when fully illuminated. One of its two important functions here is to present a decreasing resistance when illuminated, and vice versa. An incidental characteristic of photoconductive cells of the ORP12 class is that these devices do not, when there is a change in illumination level, show an *immediate* decrease or increase in resistance. They are, instead, quite sluggish in operation, especially for resistance increase due to decrease of illumination. This sluggishness enables the ORP12 to perform its second important function in the present circuit, that of providing the necessary time delay to allow oscillation to take place.

Let us assume that the d.c. supply of Fig. 1 has just been applied. The ORP12, in the light-proof box, will be in darkness, and it exhibits a high resistance. The ORP12 forms one section of a potential divider, the other section being the 470kΩ resistor. Thus, when the supply is initially applied, the ORP12 allows the full striking voltage to appear across the neon bulb, whereupon the latter lights up and illuminates the cell. The resistance of the illuminated cell commences to decrease, causing the voltage across

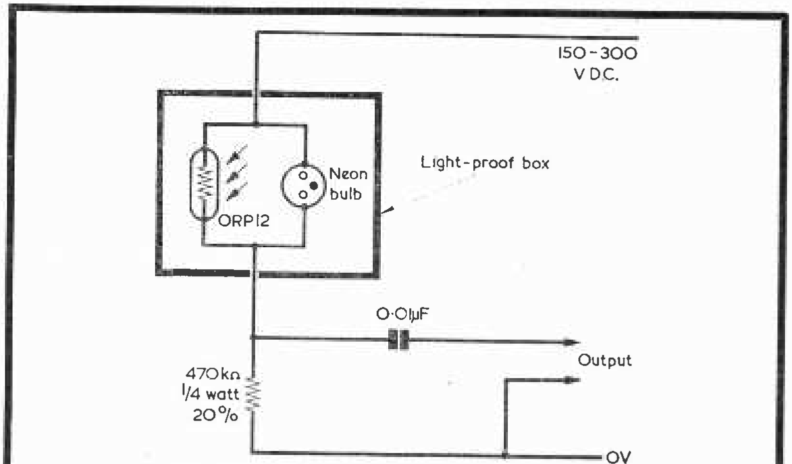


Fig. 1. The basic neon-l.d.r. oscillator circuit

the neon bulb to drop until it falls below the maintaining value. The bulb extinguishes, after which the ORP12 resistance starts to increase, reaching a value which is sufficiently high to enable the neon bulb to strike again and light up. The resistance of the once more illuminated ORP12 starts to decrease and a further cycle commences.

The length of each cycle depends upon the sluggishness of operation of the specific ORP12 employed. Several ORP12's, which had been purchased at various times from different retail sources in the past, were checked by the author in the prototype circuit and offered no significant alteration in performance. It would seem reasonable to assume, therefore, that equivalent results should be given with most, if not all, photoconductive cells of ORP12 type. The cycle length depends also upon the difference between the firing and maintaining voltages of the neon bulb, and here again there is a slight possibility that some discrepancy in results may be experienced with different bulbs. Since both the cell and the bulb are employed in the circuit because of characteristics which are incidental to their intended function, the oscillator has to be considered as being somewhat experimental in this respect.

The output of the oscillator is, of course, by no means sinusoidal. The prototype produced an a.f. tone at around 100Hz having a resemblance to the sawtooth offered by a relaxation oscillator, and with one pronounced pulse cycle due to the firing of the neon bulb. The frequency varied only slightly for supply voltages between 300 and 150, but dropped noticeably when the supply potential was reduced to values lower than 150 volts. At about 90 volts the oscillator produced pulses with a spacing of approximately 1 second, and it ceased to function when the supply potential was lowered further. The peak-to-peak amplitude of the oscillation is equivalent to the difference between the striking and maintaining voltages of the particular neon bulb employed, and is of the order of 4 to 6 volts. Over the supply voltage range of 90 to 300 volts the oscillator started reliably on application of the supply. With the circuit given in Fig. 1, the oscillator output should be applied to a high impedance, preferably at least 250kΩ, or its performance may be modified.

NEON BULB

The neon bulb is an inexpensive wire-ended component having two tubular electrodes. Suitable types are the Hivac type 16L or 34L available from Henry's Radio Ltd., or the bulb retailed under Cat. No. PL32A by Home Radio Ltd.

Since the neon bulb and the ORP12 are in parallel, it is a simple matter to fit them in their light-proof box. For best operation the neon bulb body should lay across the face of the ORP12, as in Fig. 2. This method of positioning allows the leads of the bulb to be soldered direct to the stouter lead-out wires of the photoconductive cell, as shown. The lead-out wires of the cell may then be anchored to suitable tags inside the box. Experiments with the circuit showed that oscillations could be obtained with the neon bulb spaced away from the ORP12 by as much as 1in. For best results, though, the closer positioning illustrated in Fig. 2 is to be preferred.

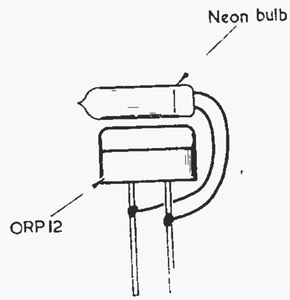


Fig. 2. For optimum results the neon bulb body should lie across the face of the ORP12, as illustrated here

The light-proof box need not be elaborate as the circuit is capable of working at low ambient lighting levels without enclosing the cell and bulb at all. For a quick check-up of the circuit in all but the brightest ambient lighting (as is given by direct sunlight) it is quite in order to fit the two components inside an empty matchbox, keeping the box in shadow by placing a sheet of cardboard or other opaque material over it. The only requirement of the light-proof box is that it should exclude sufficient light for the ORP12 to exhibit a resistance high enough to enable the neon bulb to strike. As an instance of what can be expected, the prototype oscillator functioned reliably when both the cell and neon bulb were completely exposed in the low ambient light level evident at dusk. It was interesting to note that oscillation could be stopped under these conditions by striking a match 18ins. away from the face of the photoconductive cell. There appeared to be little 'backlash' between the light level which stopped oscillation and that which enabled it to recommence, and the writer hopes to describe a precisely-operating light-controlled switch which takes advantage of this property in a future article.

ADVANTAGES AND DISADVANTAGES

Like all electronic circuits, the oscillator of Fig. 1 has advantages and disadvantages. Its main advantages are its considerable simplicity, and the small number of components it requires. Because of these two points, it may be assembled in full working order in a very short time. Also, it provides an a.f. output at a relatively high amplitude, and is not very critical so far as component values and supply voltage are concerned. Further, the supply polarity is unimportant, and the oscillator offers potential use in a light-operated switching device. A final advantage is that the current it consumes, being limited by the 470kΩ resistor, will always be considerably less than 1mA. The principal disadvantages are that the output is non-sinusoidal and its frequency cannot be varied (or, at least, cannot be varied if the circuit is to retain its simplicity), and that the supply voltage required is rather high.

oscillator output to grid and anode points in the equipment, using normal signal-tracing techniques. The oscillator output will be just audible if the probe is applied to the primary of a valve speaker transformer, and will be reproduced at more than adequate level when connected to an output valve grid. The 0.01μF capacitor shown in Fig. 3 should have a working voltage of at least 400 volts, to ensure that there is no risk of its breaking down if the probe is applied to anode circuits in the equipment under test. The 470kΩ resistor of Fig. 1 is replaced by a 500kΩ potentiometer in Fig. 3, this latter component functioning as an output amplitude control. If the potentiometer is set to a central position the probe may be applied to low impedance points without seriously affecting oscillator operation.

In Fig. 3, all the components are enclosed in a light-proof box, with terminals brought out for the two crocodile clip leads and the test prod lead. This method of assembly eases construction and still ensures that light is excluded from the photoconductive cell and the neon bulb. The box should be made of an insulating material

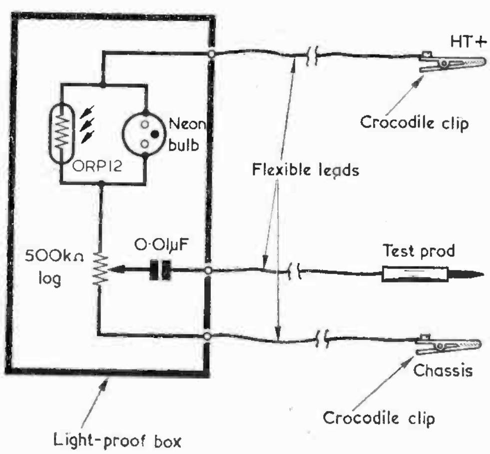


Fig. 3. One application for the oscillator is as an a.f. signal injector, whereupon it obtains its power supply from the equipment being tested

Apart from the normal applications to which any a.f. oscillator may be put, the circuit can be adapted for use as a servicing aid, as in Fig. 3. Here, the oscillator is intended as an a.f. signal injector for radio, television and a.f. amplifier equipment employing valves. The two crocodile clips are connected between chassis and the h.t. positive line of the equipment being checked, whereupon power automatically becomes available for the oscillator. The test prod may then apply the

and *not* of metal, since it can then be positioned on or near the chassis of the equipment under test without risk of shock or accidental short-circuit. The potentiometer may be fitted with a pointer knob backed by a scale graduated in even divisions from, say, 1 to 10. After familiarity with the device has been acquired, the scale will then provide a rough idea of the output level needed for application

(Continued on page 628)

SIMPLIFIED SOLID-STATE DISTORTION METER

by

G. A. STANTON, G3SCV

This simple design enables the percentage distortion of a.f. amplifiers to be measured directly over the range 0.2% to 10% at 1,000 Hz. Consumption from the self-contained 9 volt battery is 8mA only

READERS FAMILIAR WITH AUDIO SPECIFICATIONS will know that it is standard practice for these to include a figure indicating the total harmonic distortion. This is usually expressed as a percentage related to the rated output of the equipment concerned with a 1,000Hz test input. While other factors are obviously involved (e.g. frequency response, etc.) the distortion factor can be regarded as a guide to the goodness of audio equipment and the description high fidelity is normally reserved for equipment introducing less than 1% total distortion.

From this it will be obvious that in testing audio equipment some means of checking the total distortion is very desirable. Likewise when experimenting with audio circuits it is very useful to be able to compare results in terms of the distortion factor. Commercial distortion meters are available for this purpose but tend to be sophisticated instruments covering at least the audio spectrum, and because of this are relatively expensive. Consequently, they are rarely found outside the professional laboratory and the larger service department. The instrument to be described in this article is a simplified version designed to meet the needs of the home experimenter.

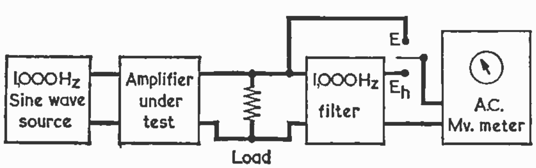


Fig. 1. A simple means of evaluating harmonic distortion

It enables distortion checks to be made at the standard 1,000Hz frequency and measurements to be made from 0.2% to 10%. Output is also provided for monitoring the distortion waveform on an external oscilloscope.

DISTORTION MEASUREMENT

A detailed analysis of harmonic distortion and its measurement is beyond the scope of this article, and the interested reader is referred to standard textbooks on the subject. The basic principles on which the present instrument works can be understood from a study of Fig. 1. Here, it will be seen, a 1,000Hz sine wave signal is fed to the amplifier under test; the output from the amplifier, which must be correctly loaded, is then passed via a selective filter to an a.c. millivoltmeter. A pure sine wave fed to a perfect amplifier would result in an amplifier output

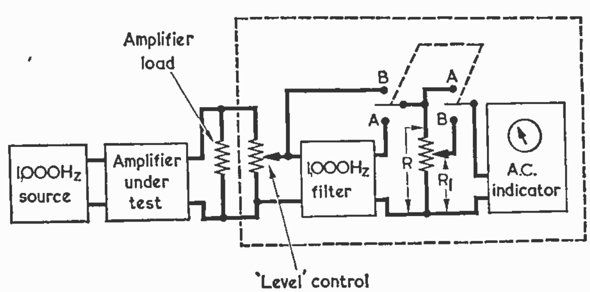


Fig. 2. An alternative approach which considerably eases performance requirements in the a.c. indicator

Cut along this line

SIMPLIFIED SOLID-STATE DISTORTION METER

Workshop plans presented free with the May 1970 issue of 'The Radio Constructor'

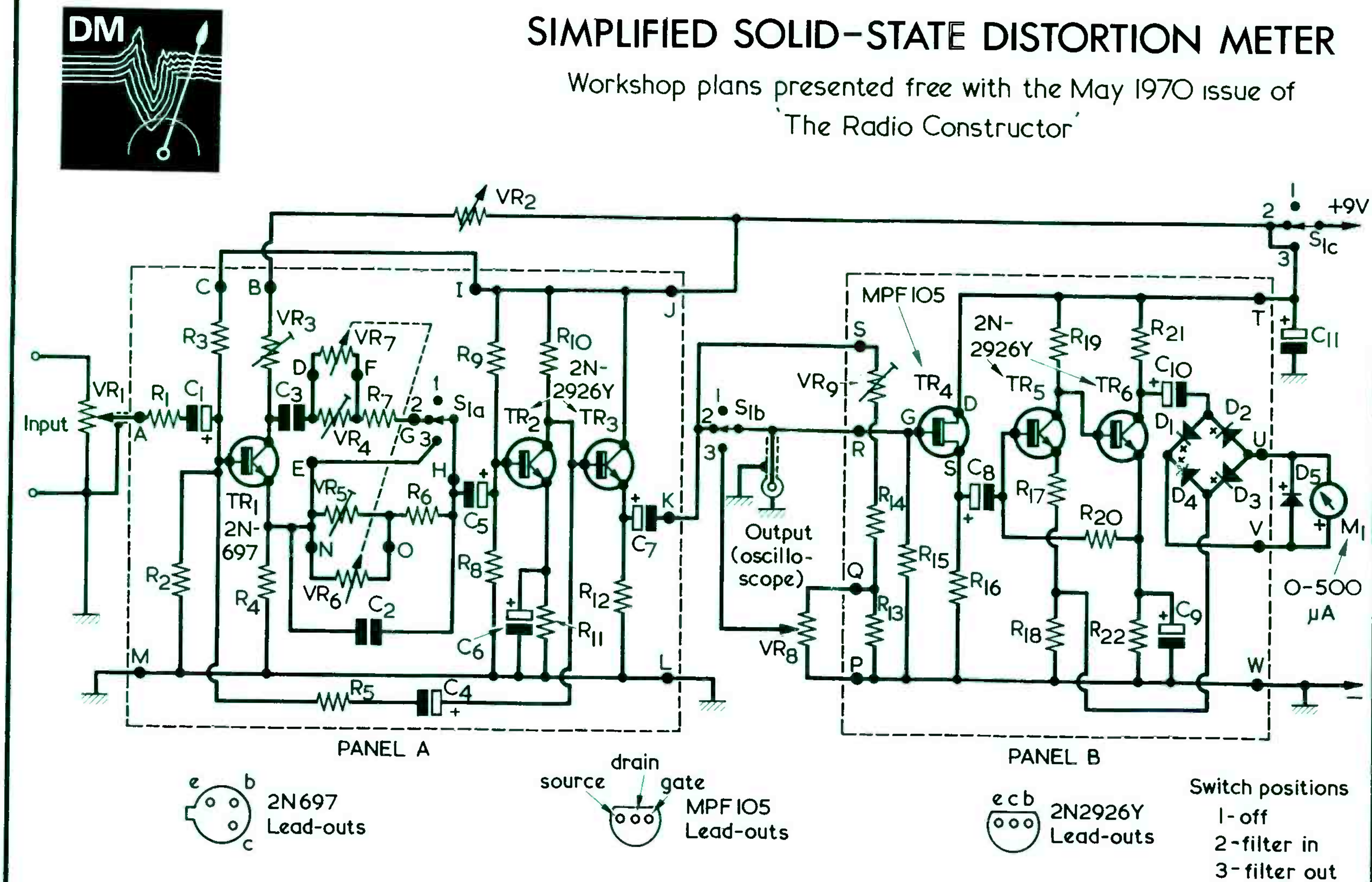


Fig.3. Complete circuit of the Distortion Meter described in this article

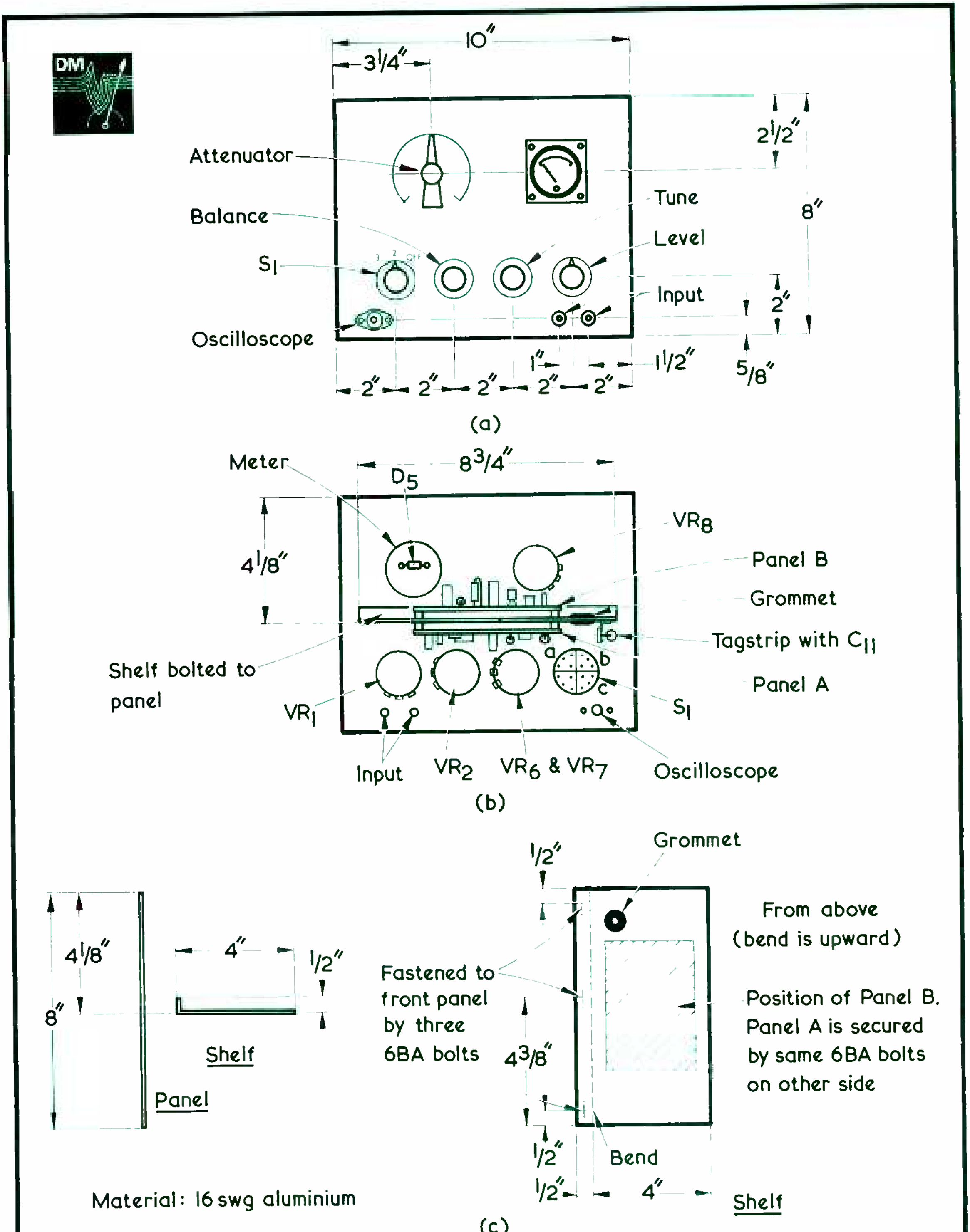


Fig. 4a Layout and control positions on the front panel
4b Layout of components and printed circuit boards behind the panel
4c Illustrating how the panel and shelf are assembled

consisting solely of the fundamental frequency (i.e. 1,000Hz). This in turn would be completely "absorbed" by the filter and the meter would remain at zero. In practice, of course, even the best amplifier will have some degree of non-linearity and the sine wave will become distorted. The output will then contain extraneous frequencies in harmonic relationship with the fundamental. The filter will absorb the latter but the harmonics will pass to the meter for measurement. The percentage harmonic distortion can be represented by the expression

$$\frac{Eh}{E} \times 100$$

where Eh is the voltage amplitude of the harmonics and E is the voltage amplitude of the sine wave signal.

This is of course an approximation, for the output of the amplifier will also include hum and noise. These are measured along with the harmonic content, but the accuracy will suffice for all but the most stringent tests, for which a more sophisticated instrument would be needed in any case.

The scheme indicated in Fig. 1 assumes the use of a wide range calibrated a.c. voltmeter which would be required to take measurements from 1mV or less to at least 10 volts. Such a meter is an expensive item but fortunately, by the use of a calibrated attenuator, a relatively simple indicating meter can be substituted. This is the practice followed in the instrument being described, and the method of operation can be seen in Fig. 2. A switch is so arranged that in position A the meter is connected directly to the output of the filter and indicates the amplitude of the harmonics present. The switch is then moved to position "B", whereupon the filter is bypassed and the meter connected to the attenuator. The attenuator is adjusted until the same indication is obtained on the meter; at this setting the ratio $\frac{R1}{R}$ equals $\frac{Eh}{E}$. The percentage distortion is thus $\frac{R1}{R} \times 100$, and the attenuator can be calibrated to read directly in terms of percentage distortion.

COMPONENTS

Resistors
(All fixed values ¼ watt 10% unless where otherwise stated)

R1	47kΩ
R2	4.7kΩ
R3	15kΩ
R4	1.2kΩ
R5	10kΩ
R6	2.2kΩ, 5% or better
R7	2.2kΩ, 5% or better
R8	4.7kΩ
R9	27kΩ
R10	4.7kΩ
R11	470Ω
R12	2.7kΩ
R13	120Ω, 5%
R14	910Ω, 5%
R15	1.5MΩ
R16	2.7kΩ
R17	33Ω
R18	5.6Ω
R19	6.8kΩ
R20	6.8kΩ
R21	680Ω
R22	330Ω
VR1	500kΩ pot, log track
VR2	200Ω pot, lin track
VR3	5kΩ pot, preset skeleton
VR4	5kΩ pot, preset skeleton
VR5	5kΩ pot, preset skeleton
VR6, 7	25kΩ + 25kΩ ganged dual pot, lin track
VR8	5kΩ pot, log track
VR9	250Ω pot, preset skeleton

Capacitors

C1	16μF electrolytic, 15V wkg.
C2	0.047μF polyester, 10% or better
C3	0.047μF polyester, 10% or better
C4	1μF electrolytic, 15V wkg.
C5	10μF electrolytic, 15V wkg.
C6	25μF elecrolytic, 15V wkg.
C7	32μF electrolytic, 15V wkg.
C8	16μF electrolytic, 15V wkg.
C9	32μF electrolytic, 15V wkg.
C10	16μF electrolytic, 15V wkg.
C11	250μF electrolytic, 15V wkg.

Semiconductors

TR1	2N697
TR2	2N2926 Yellow
TR3	2N2926 Yellow
TR4	MPF105
TR5	2N2926 Yellow
TR6	2N2926 Yellow
D1–D4	OA90
D5	OA85

Meter

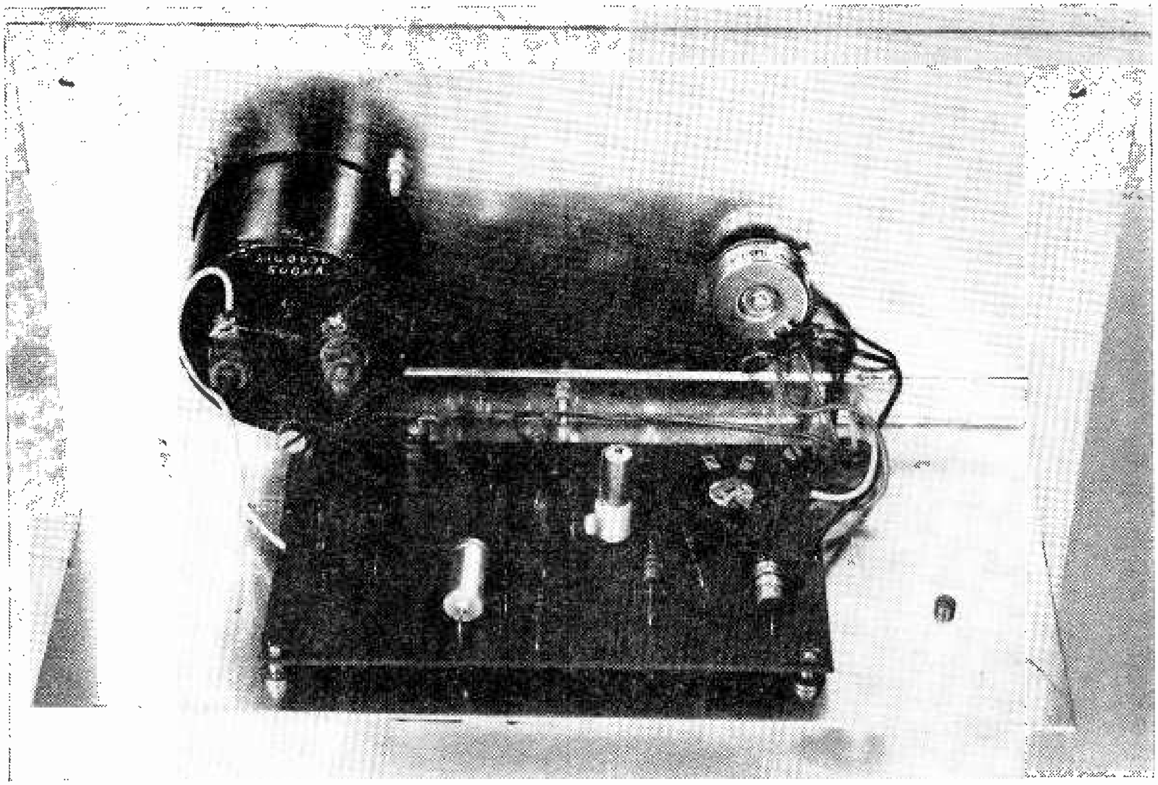
M1	0–500μA moving-coil meter

Switch

S1	3-pole 3-way miniature rotary (4-pole 3-way may be employed, if desired, with one pole unused)

Battery
9 volt battery (see text)

Miscellaneous
2 printed circuit boards
5 knobs (see Fig. 4(a))
1 coaxial socket
2 insulated sockets
1 4-way tagstrip
16 s.w.g. aluminium sheet
Grommet, nuts, bolts, etc.



View illustrating the upper side of the shelf, and showing the meter, the Level control potentiometer and Panel 'B'

CIRCUIT DIAGRAM

The complete circuit diagram is given in Fig 3, and is in two sections. The first is the filter section which is of the Wein Bridge type; one arm of this comprises C2 in parallel with VR5, VR6 and R6; the other arm consists of C3 in series with VR4, VR7 and R7. The values of these components are such that the filter can be balanced between 900Hz and 1,500Hz by means of the ganged potentiometer VR6 and VR7. The filter is switched in or out as required by S1(a), the filter being in circuit at position 2 of this switch and out of circuit at position 3. With the filter in circuit, TR1 operates as a phase splitter feeding the two arms of the bridge from its emitter and collector respectively. VR2 forms part of the collector load and assists in enabling the bridge to be accurately balanced. When the filter is switched out of circuit, TR1 operates as a simple emitter follower, passing the unfiltered signal to the base of TR2 which is a straightforward voltage amplifier. Negative feedback is provided by R5 and C4 connecting the collector of TR2 with the base of TR1. Feedback in this circuit is extremely important for two reasons: it reduces any distortion likely to be introduced by TR1 itself, but more important it considerably sharpens the filter null. Without feedback the filter "tuning" would be too broad and the harmonics reduced along with the fundamental. This would then give a false indication of the harmonic content and defeat the purpose of the instrument. VR1 controls the input and is used to set the level of the signal.

The second section of the instrument is the voltmeter circuit which consists of an f.e.t. source follower (TR4) and a two-stage amplifier. The f.e.t. provides the high impedance input essential for the correct working of the attenuator. Output is taken from the collector of TR6 via a full wave bridge rectifier to a standard 500μA moving-coil meter. The meter need not be calibrated and no attempt has been made to linearise the scale readings. The sensitivity of the section is such that full-scale deflection is obtained for an input to TR4 of approximately 3mV r.m.s. The meter is protected from severe overloading by a germanium diode (D5) connected across it.[1]

The two sections are coupled by S1(b), which is so wired that when the filter circuit is 'in' the output of TR3 is taken directly to the gate of TR4. With the filter 'out', the signal is taken to TR4 via the attenuator, this being formed by the network VR8, R13, R14, and VR9. VR9 is adjusted so that VR8 in parallel with R13 offers exactly one-tenth of the

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1 The meter employed by the author was an ex-W.D. type having a lower resistance, at approximately 100Ω, than that of many 0-500μA meters currently available on the home-constructor market. The author has checked the circuit with a higher resistance meter and it still functioned satisfactorily. If it is found, however, that the presence of D5 seriously restricts higher scale readings when a high resistance meter is employed, the single diode may be replaced by two or more similar diodes connected in series to offer an increased low current forward voltage.—Editor.

total resistance. VR8 then controls voltages up to 10% of the total present at point S in the diagram. For convenience VR8 should be a logrithmic type.

Power requirements are very modest, being 8mA from a 9 volt battery. Voltage readings to be expected at various points of the circuit are given in the Table. A third section of S1 switches the instrument on and off.

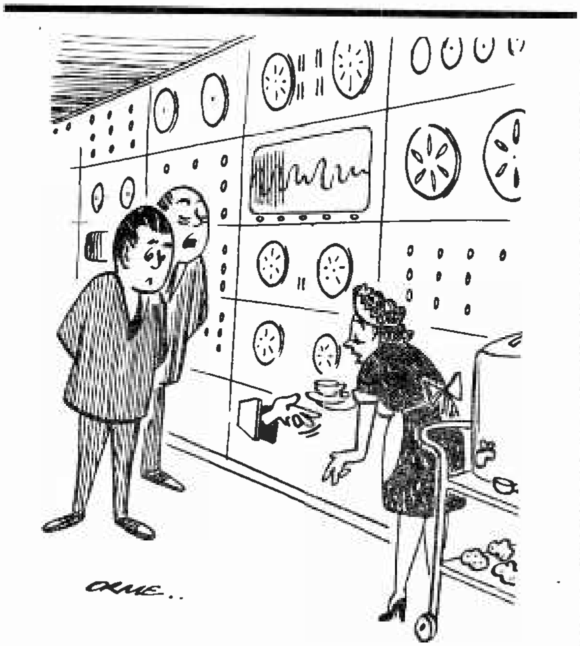
In Fig. 3, the two rectangles drawn in dashed line do not indicate screens; instead, they show the boundaries of the associated printed circuit panel assemblies. For convenience of presentation VR6, VR7 and S1(a) are drawn inside the Panel "A" rectangle, but in practice these components are external to the panel. The letter references apply to the printed circuit connections which are shown, later, in Figs. 5(a) and (b).

A minor point which needs to be mentioned is that the inset in Fig. 3 which shows the f.e.t. lead-outs indicates that the drain lead-out is in the centre, whereas some (but not all) Motorola literature shows the source as the centre lead-out. In practice, the source and drain of the MPF105 are interchangeable, since this is a symmetrical transistor. The 2N2926 Yellow transistors specified for TR2, TR3, TR5 and TR6 are the basic 2N2926 with an h_{fe} between 150 and 300. They are available from a number of suppliers, including Electrovalue, 32a St. Jude's Road, Englefield Green, Egham, Surrey.

(Continued on page 630)

THE 'DISCOVERY' S.W. RECEIVER

For the interest of all the many beginners who are known to have constructed this popular design, *Further Notes on the 'Discovery' Receiver* **will appear in the July issue – this providing full information on modifications increasing the versatility of the receiver.**



"We weren't able entirely to eliminate the human element!"

CURRENT SCHEDULES

Times = GMT *Frequencies = kHz*

★ CUBA

17705 Radio Havana (100kW) transmits an English programme to Europe from 2010 to 2140. Radio Havana can also be heard on **15345** from 1810 to 1855 in Arabic, 1855 to 2030 in Spanish, 2030 to 2110 in Arabic and from 2110 to 0010 in French. Also on **17885** in parallel.

★ ISRAEL

9009 'Kol Yisrael', Tel Aviv (7.5/50kW) now has an English service to Africa from 2015 to 2030 and an English service to Europe from 2015 to 2100.

★ MALAYSIA

7120 The BBC transmitter at Tebrau (7.5/75kW) relays the BBC World Service from 1300 to 1815 on this channel. On **7234** from 0900 to 1000 and from 1100 to 1115. On **9580** from 1345 to 1815. On **9725** from 0900 to 1000. On **9740** from 1345 to 1815. On **11750** from 0900 to 1815. On **11955** from 0900 to 1000 and from 1645 to 1815. On **15310** from 0900 to 1000. On **15434** from 1300 to 1330 and on **17880** from 0900 to 1330.

★ SWEDEN

9625 and **15315** The English language broadcasts of Radio Sweden, currently effective, are as follows – **9625** and **15315** (100kW) from 1100 to 1130 to Europe and N.E. America; **15105** and **21690** (100kW) from 1230 to 1300 to Far East and Africa; **15315** and **21585** (100kW) from 1400 to 1430 to S. Asia and N. America; **6065** and **11860** (100kW) from 1600 to 1630 to Europe and Middle East; **11705** and **15240** (100kW) from 1900 to 1930 to Middle East and Africa; **6065** and **11910** (100kW) from 2045 to 2115 to Europe and Far East; **11705** and **15310** (100kW) from 2245 to 2315 to Europe, S. America, Australia and N. Zealand; **11790** (100kW) from 0030 to 0100 to N. America; **9725** (100kW) from 0330 to 0400 to Western North America and on **17840** from 0515 to 0545 to S. Asia.

★ AUSTRALIA

The Darwin relay stations of Radio Australia carry programmes in English on Sundays from 2200 to 0800 on **21485**, from 2300 to 0030 on **15130** and from 0030 to 0800 on **15355** and **17715.** Daily English programmes may be heard from 0800 to 1130 on **15355** and from 0800 to 1000 and 1100 to 1330 on the new channel of **21485.**

★ REPUBLIC OF RWANDA

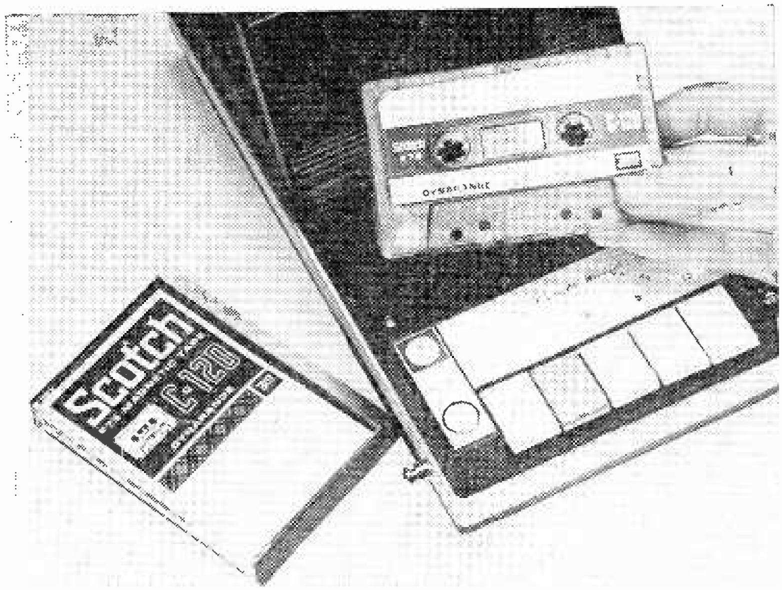
Radio Rwanda, Kigali, radiates programmes in English, French and Swahili from 0945 to 1045 on **15410** (250kW). At 1045 they announce continued transmissions on **6055** (50kW). The former channel then continues with a relay of Duetsche Welle.

★ SEYCHELLES

The FEBA transmitter at Victoria (2kW) is still testing on **11760** from 0030 to 0200 and on **15265** from 0205 to 0230 and 1300 to 1630. The regular transmitter will be in operation from May 3rd with a power of 40kW.

Acknowledgements to our own Listening Post and Swedish Dx'ers.

NEWS . . . AND .



The Scotch C-120 cassette, which gives two hours' playing time, uses Scotch low-noise Dynarange magnetic tape. The design is claimed to contribute towards longer recorder battery life

The range of Scotch magnetic tape cassettes has been expanded to include a two-hour version.

A feature of this new Phillips-compatible cassette – the Scotch C-120 – is an improved shim material which offers reliability while eliminating tape binding and jamming – previously a problem with ultra-thin tape.

The Scotch C-120 cassette retails at a recommended price of 33/6d.

As with the other cassettes in the range (the Scotch C-60 which gives 60 minutes recording and the Scotch C-90 giving 90 minutes) the new cassette is supplied in a durable hinged plastic case designed to protect the tape and provide easy storage.

INTERESTING MULLARD PAMPHLETS

The Mullard Educational Service has produced two new pamphlets, one entitled 'Introducing Thyristors' and the other describing how to build a simple, inexpensive, f.e.t. voltmeter.

The first pamphlet contains a brief description of the construction and operation of the thyristor. An explanation of the thyristor characteristic is followed by a section on the basic power control circuit and feedback control. The pamphlet ends with a short description of the diac and the triac.

The second pamphlet describes how to build a simple, inexpensive f.e.t. voltmeter. The meter has eight ranges, the smallest being 0 to 250mV and the largest 0 to 500V. Because it has a high input impedance of at least 10MΩ on each range, the instrument is suitable for measuring d.c. levels in transistor and valve circuits.

The meter described is not a sophisticated piece of equipment and no claim is made to its accuracy; it contains no close-tolerance resistors and the least expensive f.e.t. transistor (type BFW61) has been used. Nevertheless, the educational prototype has been in constant use since it was built twelve months ago. However, design information is given for those who wish to make a more accurate instrument.

Teachers, lecturers and others professionally concerned with science education can obtain sample copies of the pamphlets from the Mullard Educational Service, Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

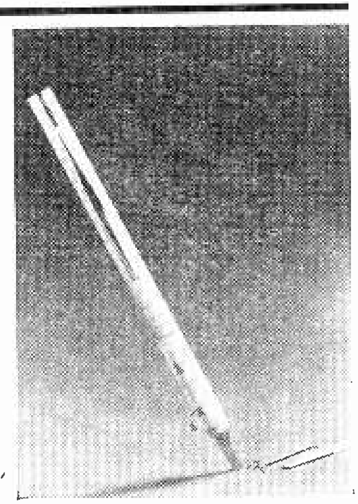
ALL-PURPOSE POCKET TOOL – THE REXEL VERSICUT

The Versicut, an ingenious multi-purpose pocket tool, costing only 7s. 6d. (recommended retail price), has recently been launched by Rexel Ltd. Shaped like an elegant chuck pencil, the Versicut is a knife blade, pin and two-width screw-driver in a single pen-size unit that slips conveniently into the pocket.

In the head of the Rexel Versicut is an engineered chuck mechanism, which is designed to grip the tool pieces, so that, in turn, the instrument becomes a screw-driver, piercing and probing tool, or a cutting device.

When not in use, the tool pieces either drop out of sight behind the chuck mechanism, or are contained in the hollow barrel. Changing the function of the Versicut or adjusting the length of the gripped item can be accomplished in seconds. While one of the tool pieces is in use, the other two remain in the barrel.

The Versicut is available from most stationers and department stores, and the price includes a spare knife blade. Packs of five individually wrapped replacement blades are available at 3s. 4d. (recommended retail price).



. . . COMMENT

BRITISH AMATEUR TELEVISION CLUB 21st ANNIVERSARY CONVENTION

The Convention will be held in Churchill College, Cambridge, and will start with a Get-together on Friday evening, 24th July.

On the Saturday morning the Exhibition of Amateur Equipment will open and there will be lectures, films, video tapes and a visit to a TV transmission equipment manufacturer.

In the evening there will be a Convention Dinner in Churchill College.

Sunday morning will continue with visits to Amateur stations, films, etc. In the afternoon there will be a B.A.T.C. Business Meeting (Members only), followed by tea.

The Conference registration fee is 15/- (£1 non-members), tickets for the dinner are 32/6 each and residential accommodation in the College will be available at £7.10s.0d., per person.

Fuller details from D. S. Reid, 71a Rose Valley, Brentwood, Essex.

MUSIC FROM AN INVISIBLE SOURCE

A new device which reproduces music through a variety of ordinary household materials from an apparently invisible source is now available. Called the Sound Scan Capsule, the unit may be concealed in the ceiling, under floorboards, or behind doors, to envelop the whole room in an even volume of music no matter where the listener may be standing or sitting.

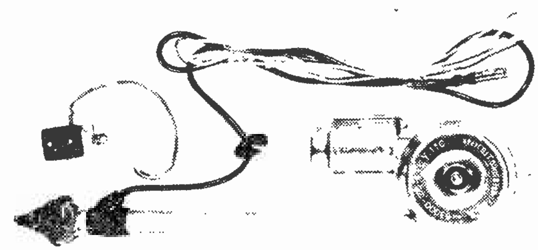
This effect is achieved simply by linking the unit to the output socket of any record player (mono or stereo), tape recorder, or amplifier with from 1½ to 12 watt output. The capsule will work on almost any flat surface such as a table, picture or window, and will diffuse sound over large areas – up to 2,000 square feet in ideal circumstances. It is weather-protected, will play underwater and comes with a five-year warranty.

Measuring about 4in. in diameter and less than 2in. in depth, the Sound Scan Capsule is technically known as an audio-transducer. It was invented in the U.S.A. where it has been successfully marketed by Photo-Scan International of Los Angeles, manufacturers of electronic systems to combat shoplifting and pilferage.

At present, the Capsule – which costs a recommended £10 retail – is being demonstrated to the public at Selfridges and Gamages in London, and major stores in the Home Counties and the South of England. It will eventually be available throughout the country from radio and electrical shops.

Further details from: Mr. Colin Stewart, Sound Scan Ltd., Oakwood House, 63 Pound Lane, Marlow, Bucks. Tel: Marlow 6655.

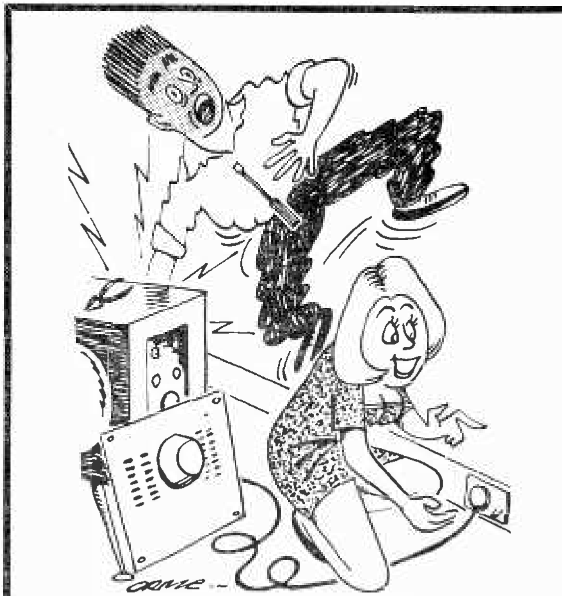
NIPPON DENSO AERIAL



This new aerial is of very compact and robust construction. Its underwing length is 13½in., its mast (four section chromium) is 36in. long and the motor is a powerful permanent magnet type of small dimensions.

It is supplied complete with a spring loaded 2-way control switch, but there is an interesting optional switch which can be connected so that it gives overall control of the radio as well as the aerial.

The retail price of the aerial, complete with standard control switch, is £9 9s. 0d. and the optional extra switch, £2 18s. 0d.



"Oh, look – it was only that it wasn't switched on !"

BBC World Radio Club

The *World Radio Club* is one of the BBC's world service programmes and was first radiated in July of 1967. The object of the Club is to cater for an audience generally interested in radio but with SWL's specially in mind and to pass on technical information in an easily understood manner in addition to Dx tips, etc. Some of the programme content includes information about technical achievement in the field of communications with the emphasis placed on British innovations and the BBC's own contribution to the science.

The degree of understanding of the technical programme content tends to vary in differing countries and when such items are included due consideration is given to the technical development and understanding in such areas—especially those at present underdeveloped. Such technical material is rightly presented in simple, uncomplicated English, even when describing the very latest communication equipment.

Programme content has been varied from that of simple short wave aerial arrays to basic communication receiver operation and techniques. Advice on how best to operate the equipment which many listeners possess and how to further improve the results are often broadcast. The first principles of radio communication have also been a feature of the programme.

Perhaps the most interesting part of the programme is the *Dx News Bulletin*. With all the resources of the BBC Monitoring Service at their disposal the Club is able to present up to the minute reports on station frequencies, call signs and other material of interest to the Broadcast band Dx'er. The *Dx News Bulletin* is only part of the programme in order that other interesting subjects may be covered in the allotted quarter-hour on the air.

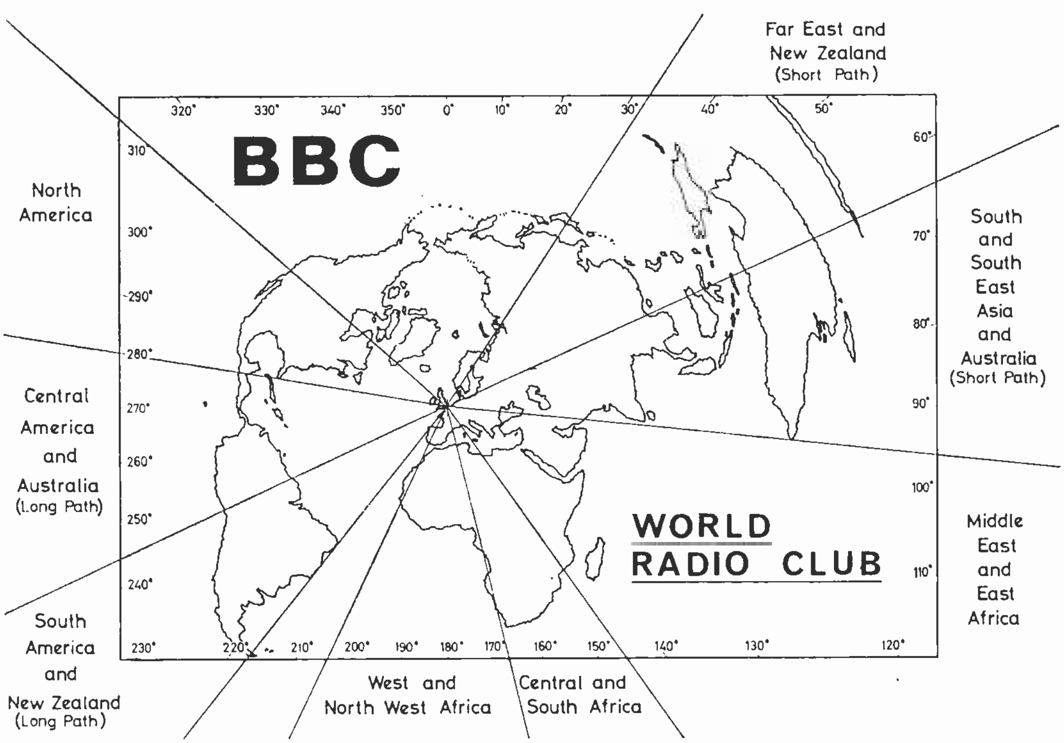
Members of the *World Radio Club* receive frequency charts and are eligible to enter Club competitions and such members number many thousands.

The Club receives many letters from listeners all over the world and, in conformity with BBC practice, answers each and every letter. Some of the most interesting are answered over the air. It was in March, 1968, that the BBC first issued a QSL card to listeners reporting on the short wave transmissions.

RECENT PROGRAMME

A recent programme content provides some idea of the interests covered.

Opening with a five-minute talk on the life of Michael Faraday, there followed *Band Scan* at 0820 GMT. This part of the programme, as its title implies, presents the results of a listening session over a chosen range of Broadcast band frequencies at a given time. That chosen for this particular programme was from 7100 to 7300kHz and consisted of a list of various stations logged during an operating session commencing at 2000GMT.



Doug Crawford, World Radio Club compère

None of the stations mentioned were by any means of Dx standard, but considering the band and the time chosen this was not surprising. For the beginner, *Band Scan* would be of interest in bringing to his notice just how many countries could be logged with fairly simple equipment at the time stated. This part of the programme lasted approximately five minutes and was followed by a short talk on constructing an amateur band transmitter until 0828 GMT. The remaining two minutes were devoted to a conversation between the two listeners who had conducted *Band Scan*. Mentioning that logging South American stations was a favourite facet of short wave listening for them, and with which they would deal the following week, an admission was made by one that the more difficult to receive Far Eastern Station "always just miss my receiver".

EDITOR'S NOTE

The statement is somewhat surprising for a short wave listener reporter to utter. Our own Listening Post has regularly logged and reported such stations, having even taped some of them during the recent 'season' for reception of Far Eastern transmissions. Such stations as Nusantara .Tiga, Medan, Indonesia, on 5084kHz closing at 1600GMT; Djambi, Indonesia, on 4927kHz closing at 1600GMT; Phnom Penh, Cambodia, on 4907kHz as early as 1345GMT; Foochow, China, on 4975kHz at 1525 GMT; Singapore on 5055kHz at 1540GMT; Hanoi, North Vietnam, on 4823kHz at 1410 GMT; Penang, Malaysia on 4790kHz at 1530GMT; and Palembang, Indonesia, on 4855kHz at 1455GMT. Additionally, stations in India, Ceylon and the Maldive Islands have also been logged.

WHEN TO LISTEN

For those who would like to listen to *World Radio Club*, the broadcast times are—Sundays at 0815 GMT, Mondays at 1445GMT, Thursdays at 1245 GMT and Fridays at 2345GMT. The writer regularly listens on Sunday mornings at 0815GMT (0915 clock time) on 15070kHz. ■

NOW HEAR THESE

Times = GMT *Frequencies = kHz*

● **BRAZIL**

ZYZ32 Radio Rural Brasileira (7.5kW) listed on **15105** has been heard on **15095** around 2000 to 2100 hrs. with announcements in Portuguese. The station location is Porto Alegre and not Rio de Janeiro.

● **TIAWAN**

BED60 Taipei, the Voice of Free China is being heard regularly from 1800 to 1900 on **15125** (100kW). BED39 Taipei (50kW) is in parallel on **17720.**

● **COSTA RICA**

TIFC Faro del Caribe (Lighthouse of the Caribbean) San José on **6037** (2kW) has been heard, on extended schedule, with an English programme at 0400 on Sundays.

● **HAITI**

4VEH Cap-Haitien now transmits an English programme at midnight on **9770** (0.5kW). Also in parallel on **11835** (2.5kW).

● **PAKISTAN**

An unidentified station radiating Asian-type programmes has been under observation by our Listening Post since late February on **3940** from around 1600 to close down at 1730. This unlisted station has now been identified as Peshawar.

● **UNITED ARAB REPUBLIC**

English programmes from Cairo may now be heard on **9740** from 2145 to 2300. Reports are requested and the address is – U.A.R. Broadcasting Corporation, POB 566, Cairo, Egypt.

● **TURKEY**

Radio Ankara may be heard with an English programme from 2200 to 2230 on **15160** (100kW) and from 1415 to 1445 on **17820** (100kW). A new 250kW transmitter will be in operation later this year.

● **PORTUGAL**

CSA66 Lisbon has been heard with an English programme from 1400 to 1425 on **17895** (50/100kW).

● **VATICAN**

Vatican Radio has been logged with a programme in English from 1500 to 1515 on **9645** (100kW).

● **YUGOSLAVIA**

Radio Belgrade heard with a programme in English and newscast at 1530 on **9620** (100kW).

● **CANADA**

Sackville heard with a programme in English at 2125 on **11905** (50kW).

● **EL SALVADOR**

YSS Radio Nacional de El Salvador, San Salvador has an English and French transmission from 2200 to 2230 on **5980** and **9555** (5kW). Schedule is from 1700 to 0500.

● **GHANA**

Accra may be heard with a talk in English and station identification at 2230 on **4915** (10kW).

● **LIBERIA**

Radio St. Elwa, Monrovia has been logged at 0640 with an English programme and station identification on **4770** (10kW).

Acknowledgements to our own Listening Post and Swedish Dx'ers. ■

INCREASING TRANSISTOR RADIO COVERAGE

by

C. F. DOREY

The frequency range of a transistor portable radio may be extended to cover 1,570 to 3,800kHz, thereby taking in the 160 and 80 metre bands as well as the 'Trawler Band', by mixing on the second harmonic of the oscillator. The receiver to be modified must, of course, have sufficient space to accommodate the extra switch and ferrite rod required, and it will be necessary to have a signal generator available

THIS ARTICLE WILL SHOW HOW A TRANSISTOR portable radio can be modified to go beyond providing entertainment broadcast reception and function as a simple and inexpensive receiver up to 3.8MHz. In its modified form it will be more suitable for this purpose than, say, an ordinary broadcast receiver employed with a converter for "Trawler Band" reception. The simple theory underlying the modification will also be dealt with.

EXTENDING FREQUENCY COVERAGE

Extended frequency coverage can be achieved by using the second harmonic of the local oscillator as it is tuned over its normal medium wave range. No additional coil or switching is required in the oscillator circuit, but a switch is added to bring in a new ferrite rod aerial in place of the medium wave windings on the existing ferrite rod. In this article, the new frequency range thus obtained will be referred to as the "Trawler Band".

The switching circuit employed with the writer's receiver is illustrated in Fig. 1. S1 is the existing medium and long wave switch, and now selects long waves on position "L" and either medium waves or "Trawler Band" on position "MT". When the additional switch, S2, is set to position "M", the medium wave tuned and base coupling windings are connected into the same medium wave circuit as existed before the modification. The author's receiver has a coaxial socket for an external aerial, and S2(c) and S2(d) couple this to the "car aerial coupling

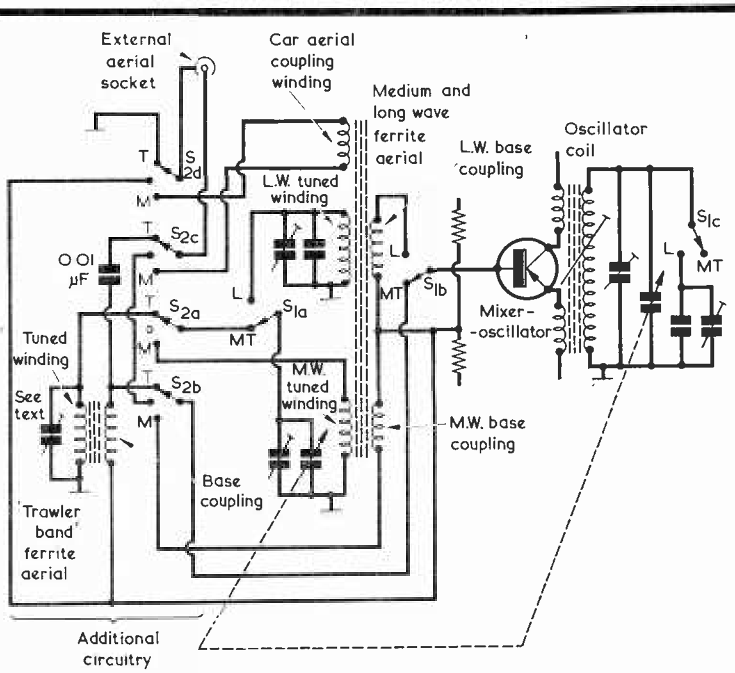


Fig. 1. The components for 'Trawler Band' reception added to a typical transistor portable aerial stage

winding" on the existing medium and long wave ferrite aerial. Setting S2 to "T" causes the existing aerial tuning capacitor to be coupled across the tuned winding of an added "Trawler Band" ferrite aerial, and the base of the mixer-oscillator transistor to be connected to a base coupling winding on this ferrite aerial. At the same time, S2(c) enables an external aerial to be coupled via a 0.01μF capacitor to the non-earthy end of the "Trawler Band" base coupling winding. S2(d) connects the outer contact of the external aerial socket to chassis.

The central position of S2 is employed for a purpose not connected with the present modification. It causes the external aerial socket to be connected direct to the base circuit of the mixer-oscillator transistor. This is intended for use with short wave converters having an output tuned coupling circuit tuned to the first i.f. of the converter and receiver combination. It allows the converter output to be applied directly to the mixer-oscillator, thereby obviating the interference that would result if the receiver ferrite rod were left in circuit.

As will be noted, the basic functions of the switching circuit of Fig. 1 are, first, to switch in a new ferrite tuned circuit; second, to switch in a new ferrite base coupling winding; and third, to provide a means of coupling an external aerial to the new base coupling winding by way of an 0.01μF capacitor. The constructor should be readily able to devise a similar switching circuit for receivers whose existing switching arrangements vary from the particular example given in Fig. 1. The facility offered by the central position of S2 is not necessary for the present modification. It may be omitted, if desired, whereupon S2 can be a 2-way instead of a 3-way component.

SECOND HARMONIC OPERATION

Operating with the oscillator second harmonic has been used in commercial broadcast receivers, and is said to be capable of a sensitivity only 0.5dB down on the medium wave sensitivity of the receiver.

Coverage up to 3.8MHz is desirable, to include the 80 metre Amateur band, and for this the highest local oscillator frequency required is given by:

$$2fo - 3{,}800 = 470$$

where fo is the oscillator frequency in kHz, and the receiver i.f. is 470kHz.

Therefore,

$$fo = \frac{470 + 3{,}800}{2} = 2{,}135\text{kHz.}$$

The corresponding highest signal frequency with the aerial switch in the medium wave position is given by

$$fs = 2{,}135 - 470 = 1{,}665\text{kHz.}$$

The receiver must be aligned to place the high frequency end of the medium wave band at this point or slightly above. Although the top end of the medium wave band is usually reckoned to be 1,640 kHz, the new value of 1,665kHz should be attainable by adjustment of the oscillator trimmer capacitor; if necessary the oscillator coil core can also be adjusted, thus sacrificing a little low frequency end coverage of the medium and long wave bands. (In a transistor receiver the long wave band often uses the medium wave oscillator coil with extra capacitance added across it.) Let us assume that the low end of the medium wave band will be reached, after this adjustment, at 550kHz.

Then, the oscillator frequency will be 550 + 470, or 1,020kHz. The corresponding signal frequency on the new waveband will be

$$(2 \times 1{,}020) - 470$$
$$= 1{,}570\text{kHz.}$$

Thus the new wavebands will consist of a medium wave band of 550 to 1,665kHz and a "Trawler Band" of 1,570 to 3,800kHz.

Since the new band has the lower ratio of maximum to minimum frequency it will be easy to arrange for the correct swing by putting extra capacitance across the tuned winding of the new aerial. The value of this capacitance will be low enough to be provided by a small trimmer, the correct setting of which can be found by experiment. It can be shown (see Appendix) that, with a 208pF tuning capacitor the additional capacitance required is 16.5pF. This may be obtained by means of a 30pF trimmer, the exact setting of which can be found by experiment. If a larger tuning capacitor, of 408pF, is employed, the additional capacitance calculates at 33.5pF and may be provided in practice by a 50pF trimmer.

FERRITE AERIAL TURNS

It is easiest to introduce a completely new ferrite rod to carry the "Trawler Band" tuned aerial winding. The coupling between this winding and those for the medium and long wave bands will then be very small, and troubles due to self-resonance of one winding within the coverage of another will be avoided.

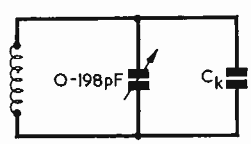


Fig. 2. Basic tuned circuit, as used for calculating the added capacitance required across the 'Trawler Band' tuned aerial winding

The number of turns required for the tuned winding will depend on the dimensions of the ferrite rod and the type of ganged capacitor used in the receiver to which it is added. In the author's receiver, with a signal gang section of 408pF, and a rod of ⅜in. diameter and 8in. long, the tuned winding required 17 turns. The wire employed was 9/46 s.w.g. stranded. This arrangement had an unloaded Q value of 140 at 4MHz and 220 at 1.55MHz (as measured on an Advance T2 Q-meter). If the more common 208pF tuning capacitor is used with the same ferrite rod, about 25 turns will be required. (Since the capacitance is halved the inductance must be doubled, and L varies as n^2. Thus the number of turns must be multiplied by $\sqrt{2}$.) Some final slight experimental adjustment of turns will, in any event, be very probably needed.

It was reckoned that the input impedance of a typical transistor mixer on the new band would be about 1kΩ. A resistor of this value was connected across coupling windings of various numbers of turns and it was found that 1½ turns loaded by 1kΩ gave loaded Q values of 72 at 4MHz and 140 at 1.55MHz, i.e. it reduced the Q roughly to half its unloaded value. Thus, near-optimum power transfer is obtained and the working Q is not too low to give reasonable protection against spurious responses, such as medium wave broadcast station breakthrough, which is a hazard with this type of mixer operation.

In general, the number of turns on the base coupling winding should be about one-twelfth of those on the tuned winding. In consequence, a coil with 25 turns on the tuned winding will require a base coupling winding of 2 turns. More turns than this may increase the signal at the mixer input, but will also increase the loading of the mixer on the tuned winding and reduce its working Q value.

CONSTRUCTION

The coil should be wound, single layer, on a former made by wrapping a strip of brown paper about 2in. wide several times around the ferrite rod. The winding should be carried out with a tension such that the completed coil and former assembly will slide fairly easily on the rod, thereby allowing a certain amount of inductance adjustment. It is suggested that coils should first be wound dry and the ends secured by elastic bands until the correct number of turns for the tuned winding has been found experimentally. Then a final winding should be made, the turns being painted with low loss varnish as they are put on. A suitable varnish can be made by breaking up a piece of clear polystyrene and dissolving the pieces in benzene. (Benzene can be bought from a chemist.) Benzene is the only common solvent for polystyrene which is non-polar, i.e. contains no (OH) molecules. It will produce a varnish which has low loss properties at r.f. and so will not lower the Q of the completed coil.

The mixer base coupling winding should be wound over or adjacent to the earthy end of the tuned winding.

Since the local oscillator sweep is the same for the 1,570 to 3,800kHz band as for the medium wave band, the receiver need only be calibrated for frequency on the broadcast bands. Dial readings for "Trawler Band" frequencies can then be calculated.

APPENDIX

We will next give an example of the calculation of additional capacitance across the aerial tuned circuit for a frequency coverage of 1,570 to 3,800kHz. A tuning capacitor of 10–208pF will be assumed.

In Fig. 2 the coil is tuned by a 10–198pF variable capacitor, the 10pF minimum being taken up in Ck, which is the *total* fixed capacitance.

Since f varies as $\frac{1}{\sqrt{C}}$,

$$\frac{f\ max}{f\ min} = \sqrt{\frac{198 + Ck}{Ck}}.$$

At the same time, for medium wave coverage,

$$\frac{f\,max}{f\,min} = \frac{1{,}665}{550} = 3.03.$$

Thus,

$$\frac{198 + Ck}{Ck} = 3.03^2 = 9.18.$$

$$198 = 8.18Ck$$

$$\therefore Ck = 24pF \text{ (approx.)}$$

For coverage of the new band,

$$\frac{f\,max}{f\,min} = \frac{3{,}800}{1{,}570} = 2.42.$$

So that (where C'k is the new total fixed capacitance),

$$\frac{198 + C'k}{C'k} = 2.42^2 = 5.9.$$

$$\therefore C'k = \frac{198}{4.9} = 40.5pF \text{ (approx.)}.$$

Thus, 16.5pF must be added and a 30pF trimmer would be suitable, the exact final setting being found by experiment. ■

REVERBERATION UNIT MARK 2

Regular readers will recall the 'Transistorised Reverberation Unit' which was described in the July 1969 issue of The Radio Constructor. The specialised components for this unit, or a complete kit of parts, have been available from Wilsic Electronics Ltd.

Wilsic Electronics have now produced a Mark 2 version of the reverberation unit, this differing slightly from the design described in the July 1969 issue. The main change is the provision of a single printed circuit for the electronic components, this replacing the previous main amplifier with separate pre-amplifiers and tagstrip assemblies. The stage line-up and operating principles remain unchanged, and all transistors are silicon devices.

The Mark 2 Reverberation Unit is now available in kit form from Wilsic Electronics Ltd., 6 Copley Road, Doncaster.

NORTH DEVON AMATEUR RADIO CLUB

The meetings of this club, newly formed, are held on the second and fourth Wednesday in each month at 7.30BST at 'Crinnis', High Wall, Sticklepath, Barnstaple.

At 6.30BST, prior to the general meeting, a study group for the RAE (including a morse class) is held.

The next meetings will be held on 10th June (Lecture) and 24th June (Informal).

All are welcome and further enquiries should be directed to the Hon. Sec., H. G. Hughes, G4CG.

HUBBLE BUBBLE— TOIL AND TROUBLE

Most of us I suppose engage in toil of one sort or another and have our share of trouble. Some have toil and trouble over it, others have trouble and toil over it, whilst many must be saddled with both sets of harness. Most of us wish we were entirely free of these twin afflictions which, like Tweedle-Dum and Tweedle-Dee, always seem to go together. It is probably symptomatic of human nature to envisage a world in which the denizens are complete strangers to the terrible twins of T and T! A world in which it would be impossible for the Wicked Witch to mutter the incantation "Hubble bubble, toil and trouble!" However, our world is as it is and not as we would like it to be.

We even have T & T in our home workshops. Take, for example, that latest multi-transistor or valved monstrosity spread out across the workbench. There it crouches menacingly, stubbornly refusing to work despite all efforts, glowering balefully and somewhat defiantly whilst, it seems, silently challenging us to make the *Thing* ackle!

With what high hopes we set out on some of these constructional projects – only to sometimes find that all our *initial* efforts are to no avail. We read the article in one of the excellent monthly journals, study the circuit and decide enthusiastically that this is the very project for us, that this is the design we have been waiting for and impetuously conclude that it is imperative we build it without delay. The snag is that *Trouble* besets us from the outset!

We must first obtain the components either by personally shopping around or by studying a catalogue and ordering through the post. One particular component it seems is either "temporarily out of stock and there is a long time delay before replenishment", or "it is out of production and discontinued" and/or "the specification has been changed". "Would we accept the enclosed component as a substitute?" Having reluctantly decided that we would, we now ruefully wonder if this particular component is the cause of all the head-scratching and the wilful refusal of our latest 'dear-to-one's-heart-project' to function properly – if at all!

Why is it, we ponder sadly, that the Editorial Staffs of radio magazines don't ensure that all components are currently obtainable when the article is published. The answer is, of course, that they do just that – the trouble lies not with the hard working Editorial Staffs but with factors outside their control. Manufacturers rarely inform them when a component is withdrawn from production, etc., despite the fact that it appears in their current catalogue – the main checking source!

During the inevitable delay from article checking to the time of publication it sometimes happens that the component in question vanishes from the scene – in which case not only is the constructor in trouble – so are the luckless Editorial Staffs who, by this time, most likely are bemoaning their fate! Despite the toil and trouble of checking catalogues, letter writing and telephone calls – all to ensure availability – the component then does the vanishing act!

Life isn't easy, it seems, either for Editorship or Readership – whichever course we sail we can all founder on the twin rocks of *Toil* and *Trouble*. *Hubble bubble!*

C.W. ■

Q S X

by **FRANK A. BALDWIN**

(All Times GMT)

● AMATEUR BANDS

Dx activity has been high on these bands in recent weeks with both s.s.b. and c.w. signals coming through at very good signal strengths. Any short wave listener who has been active over the period will have found plenty of interest in the Dx fare provided. We commence with—

1.8MHz

Top Band continued to carry Dx signals at the c.w. end of the band as the following shows—

CW: EUROPEAN
DL9KRA, EI9J, GI3JXS, GM3EZQ, GM3FSV/A, GM3IAA, GM3IGW/A, GM3TMK, GW3UCB, GW3UPK, HB9CM, HB9NL, HB9QA, OE1KU, OH2VO, OK1AF, OK1AHH, OK1AR, OK1ARB, OK1ARZ, OK1ATG, OK1ATP, OK1ATY, OK1AUK, OK1AUN, OK1AWQ, OK1AZZ, OK1DVK, OK1FBP, OK2BFN, OK2BMR, OK3CDO, OL5ACY, OL5AMT, OL6AKP, OL6AMB, OL6AMQ, OL7AM, OL8ANL, 4U1ITU, (U.N. Geneva).

CW: USA
K1BPW, K2GNC, K2IXJ, W1BB/1, W1HGT, W2GLL, W4BGO.

3.5MHz

CW: WB2IZG, WA3HOM, WA3NAZ, W3BY, WA4HAA, WA4LCO.

The s.s.b. end of this band continued to hold up for Dx signals especially around 0400 to 0600hrs.
SSB: HK3WO, HP1JC, K2DPA, K3UZE, TG9EP, VE1AMJ, VE2OB, W2AC, W2JBU, WB2LWH/VP9, W3BLS, W3GM, W4FIB, W4JNJ, W4NQM, W4RDV/P/VP9, W4ZFH, WA8OBG, WA8TPV, WA8VMQ, YV5BWG, 4X4BL.

7MHz

CW: AP5HQ, CO2DC, CO3DB, CO7VJ, CR6CA, CX2AN, K4BUR, PJ2HT, PY7CY, VE2BKA, W1MBB, WA2THA, W3HDQ, W3HQA, WA5GNM, W9JJX.

14MHz

As is usual, this band continued to carry most of the traffic and could be relied upon to provide Dx reception almost around the clock. One half-hour spent on the c.w. end of the band during the first week in April, from 2030 until 2059hrs, operating over the 14015 to 14075kHz range, produced the following — JA1KRU, JA8FGG, JH1BYJ, OX3UD, PY5ASN, PY7IHO, ZM3BJ, ZS3CV and 6W8CQ.
CW: AP5HQ, AX2EK, AX3LV, CE3CF, CR6AL, CR6CA, CR6GO, CX4CO, ET3USA, HS4ABV, JA2SFB, JA6KYS, JW7UH, KB6AG, KH6AG, KH6SP, KL7JDO, KP4ABD, KV4AB, LU6AX, OA4MS, OX3UD, OY1R, PJ2HT, PY6FI, PY7AEW, PY7AHO, PZ1NC, TG4SR, VK3KF, VK3MR, VQ8CR, ZC4BX, ZE1DL, ZL2CBO, ZM2CH, ZM3GQ, ZS3AG, ZS6ED, ZS6JK, 5S3KJ, 5V3RT, 5Z4KL, 9V1PB.
SSB: AX3BCM, CR6LF, HK4CAV, HP2EF, JX4YM, KV4AB, LU6AEC, OA4KY, PY7AL, VP2AZ, YA1HD, YS1ASE, ZL2JO, ZS1GP, ZS1HL, ZS1JA, 5Z4KM, 8P6AZ, 9L1RP, 9Y4MM.

HS4ABV gave his QTH as N.E. Thailand and his QSL manager as W5PJR. OA4KY gave his QTH as POB 538, Lima.

21MHz

CW: JA2AUB, KZ5KBN, LU3DD, PY2DRP, TG4SR, XE1JO, ZC4CB, ZS6AR.
SSB: EL8RL, KG4AA, XE1FR, ZS6OS.

That completes the Amateur band roundup, except for a brief visit to **28MHz** which produced, on c.w., HC1TH, PJ2HT and ZE1DC.

Before going on to the Broadcast bands, I should thank Dick Donald, ZL1AYH, for sending along his QSL card consequent upon his callsign appearing on this page. Dick tells me it is his pleasure to QSL all SWL's who care to send him, a report. The address is: 27 Tauranga Road, Waihi, New Zealand.

● BROADCAST BANDS

The season for reception of the South American stations is now upon us as the following report illustrates. The best listening times for S. American reception is from midnight to 0500hrs.

3940kHz 1700 Peshawar, Pakistan, with Asian-type music and 6 'pips' followed by newscast in dialect. Closes at 1730. This station is unlisted and was finally identified after many listening sessions over a period of 3 weeks!

4690kHz 0500 San Jose, Costa Rica, with Latin American songs and the identification "Radio Reloj".

4712.5kHz 0315 HCAV3 Loja, Ecuador, with Latin American songs and music. Identification as "Radio Luz y Vida".

4755kHz 0415 HJKC Bogota, Colombia, radiating typical S. American music with identification as "Emisora Nuevo Mundo". Bogota is the capital city, located in E. Cordilleras 9,000ft. above sea level.

4770kHz 0330 HCJF2 R.Guayaquil, Ecuador, featuring a programme of Latin American music. Coca Cola advert and identification at time stated.

4795kHz 0400 HIAS Santa Domingo, Dominican Republic, with identification as "Onda Musical" followed by 'pop' records.

4906kHz 0420 HJAG Barranquilla, Colombia, with Latin American music and identification as "Emisora Atlantico". Identificatison again repeated at 0435. This station is listed as inactive! Barranquilla is a port near the mouth of the river Magdalena.

4915kHz 0415 HJSG Valledupar, Colombia, radiating songs, music in the usual exotic style and station identification as "Radio Guatapuri".

4920kHz 0625 YVKR Caracas, Venezuela, with a programme of 'pop' music and identification. Caracas is the capital city located 8 miles inland from its port, La Guaira.

4955kHz 0347 HJCQ Bogota, Colombia, with 3 chimes, identification and closing down.

4960kHz 0345 YVQA Cumana, Venezuela, heard with 4 chimes and station identification. Cumana is on the north coast of Venezuela.

4995kHz 2210 ZYX2 Goiania, Brazil, with newscast in Portuguese. Goiania is the capital city of the mountainous and forested Goias State in central Brazil and is situated on the Vermelho river.

5045kHz 0450 CP38 La Paz, Bolivia, with Latin American music and identification "Radio Altiplano". La Paz is the capital city of the department of that name and the seat of government, although the legal capital is Sucre. The Department is traversed by the high Andean range – hence the station identification.

5093kHz 0402 HJGG Bogota, Colombia, with newscast in Spanish, 3 chimes and identification.

● BEGINNERS CORNER

This month we present for beginners firstly two easily received stations and two that will prove more difficult.

9665kHz 1600 Stockholm, Sweden, with news in English.

17880kHz 0745 CSA45 Lisbon, Portugal, with the English programme.

11795kHz 2130 WINB Red Lion, Pennsylvania, USA, with identification.

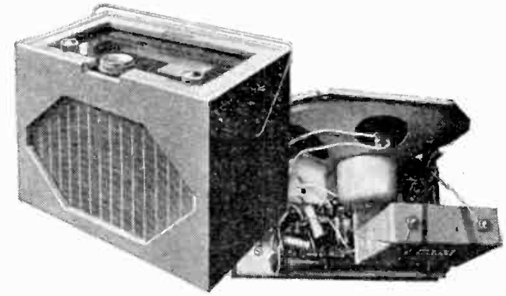
9485kHz 1445 Radio Pakistan with Asian type music. Identification and news in English at 1500. This is a new and unlisted channel.

● ASIAN STATIONS

Should any beginner wish to try these, here are some recently logged — **9480kHz** 1505 Peking; **11705kHz 1230** Tokio; **15013kHz 2000** Hanoi; **17795kHz 0804** Peking and **17855kHz 0758** Tokio.

At the times stated, NHK Tokio can easily be recognised by the tinkling musical box interval signal and identification in English, Hanoi features a programme in English, whilst more difficult to identify, Peking radiates programmes in a Chinese dialect. ■

THE "FETAFLEX 4" TRANSISTOR PORTABLE



(Part 2)

by

SIR DOUGLAS HALL, K.C.M.G., M.A.(Oxon)

In this concluding article our contributor describes the assembly and setting up of the "Fetaflex 4" receiver. Also dealt with is the construction of a neat functional cabinet which can be readily made up in the home workshop

WITH THE "FETAFLEX 4" design it is essential that the relative positions of L1, L2 and L3 be correct when laying out the receiver. Apart from that, the exact positioning of components is not unduly critical provided common sense is used, and convenience may dictate slightly different positions for some parts from those in the author's layout, which is illustrated in Fig. 3.

Most of the components are mounted on a 16-way groupboard (cut down from a Radiospares "Standard" 18-way groupboard) which is fitted on a piece of plywood, 8in. by 5in. as shown in Fig. 3. T1 may be fixed in position with adhesive, as it is very light. T2 is mounted on the plywood, a convenient method consisting of passing screws through solder tags soldered to the feet of its clamp, the feet being bent through 90 degrees.

Ferrite aerial coil L1 has 55 turns of 32 s.w.g. enamelled wire, close-wound on a paper sleeve able to slide along a 6in. by $\frac{3}{8}$in. ferrite rod. L2 has 200 turns of 38 s.w.g. enamelled wire close-wound on a similar sleeve able to slide along a 5in. by $\frac{3}{8}$in. rod. (The 5in. rod is available from G. W. Smith and Co. (Radio) Ltd., 3 Lisle St., London W.C.2.) The rods have rubber

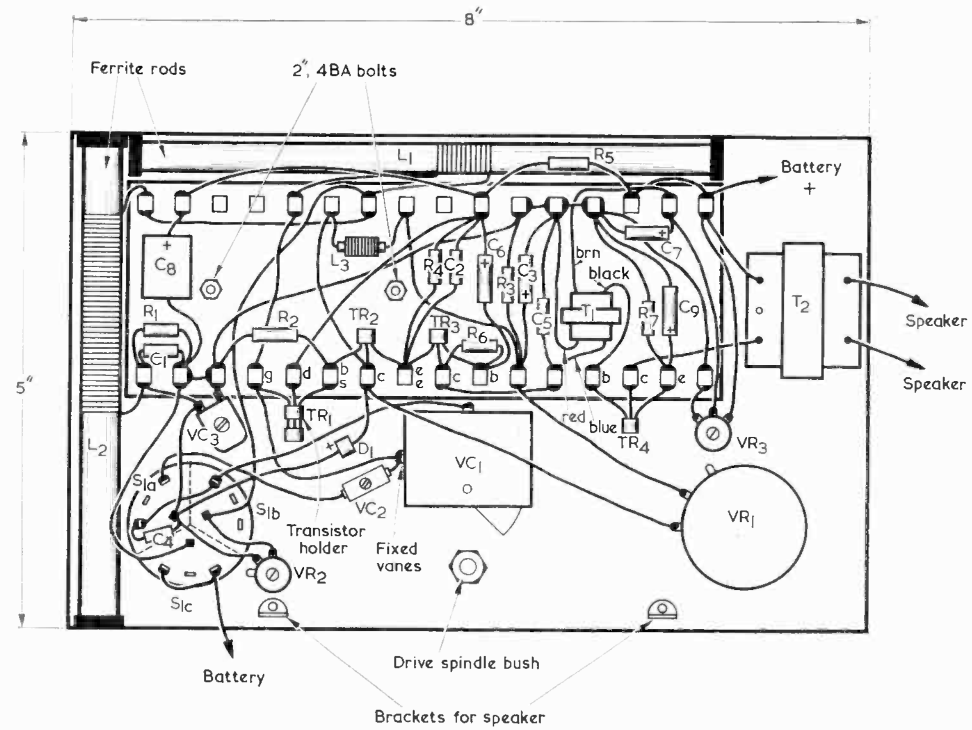


Fig. 3. Layout and wiring diagram

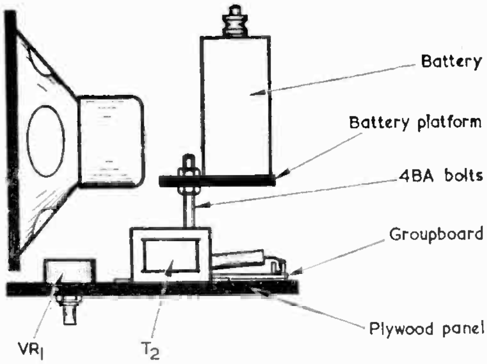


Fig. 4. Detail showing the position taken up by the battery platform

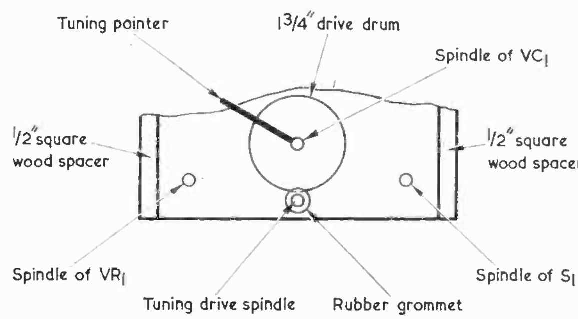


Fig. 5. How the tuning drive is assembled

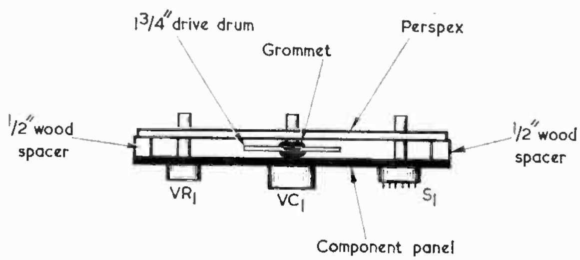


Fig. 6. Side view, showing the Perspex panel

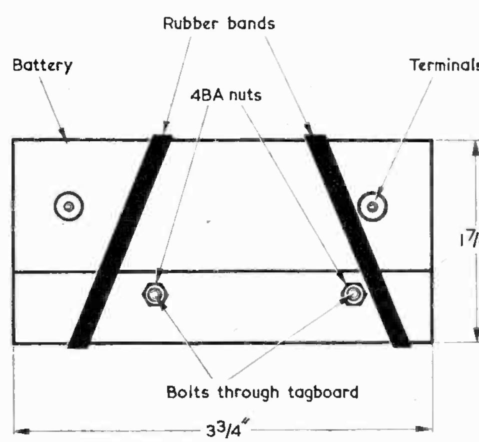


Fig. 7. Top view of the battery on its platform

grommets fitted at each end which are tied with cord (not wire) through suitable small holes in the plywood panel. L3 is mounted as shown, so that the axis of its core is parallel to the axis of L1.

The gate insulation of TR1 can be broken down very easily by static voltages, or by the voltage on the tip of an unearthed soldering iron. Because of this a transistor holder is included in the Components List, and this *must* be used. Make all the connections for TR1 to this holder and then insert the f.e.t. afterwards. In this circuit no connection is made to the substrate lead-out of TR1.

Switch S1 is shown as a 3-pole 3-way miniature rotary switch in Figs. 2 and 3. However, it will probably be found easier to obtain a 4-pole 3-way miniature rotary switch and such a component can, of course, be used with one of the poles ignored. Before wiring the switch into circuit identify, with a continuity meter or by visual inspection, the outside tags which correspond to the individual switch arm tags. The relative tag positioning may vary, with some switches, from that shown in Fig. 3.

It may be necessary to shorten the spindle of VC1 to ensure that it does not foul the underside of a Perspex panel which is fitted after the receiver has been set up. Details of the panel and its mounting are given later under "Tuning Drive", and the information given there should be read before cutting the capacitor spindle. The spindle should be cut before the capacitor is mounted in position. Use a junior hacksaw with the unwanted length of spindle held securely in a vice.

Note the two 2in. 4BA bolts which pass through appropriate holes in the tag board. These serve to hold the board to the plywood panel, and will later take a small platform on which the battery is held in place, as illustrated in Fig. 4. The bolts should be in position before any components are wired in. Note also the small brackets for holding the 8 by 5in. speaker in place. The exact positions for these brackets will depend on the spacing between the two holes in the speaker frame through which this component will be bolted to the brackets. The shape and depth of the speaker may also determine, to some extent, the exact positions of the holes through the panel required to take S1, VC1 and VR1. Thus, the speaker should be temporarily placed in position to assist in marking out the holes for these three components.

A drive is required for VC1, and this is discussed later.

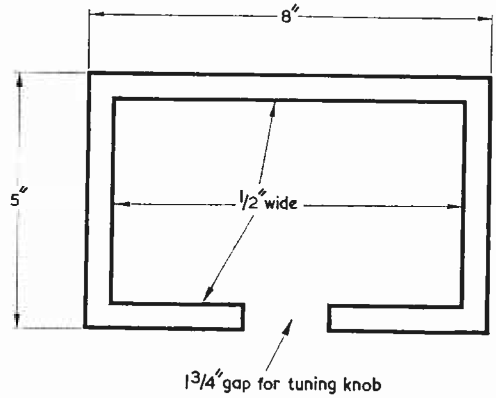


Fig. 8. This plywood frame fits over the Perspex panel

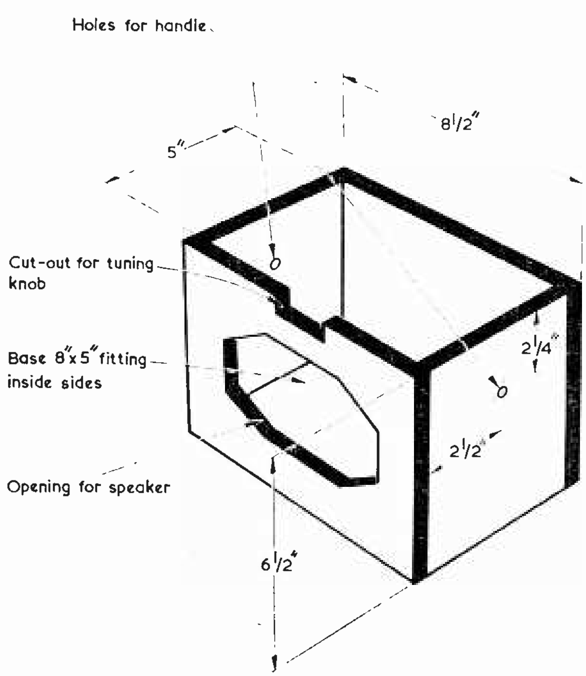


Fig. 9. The receiver cabinet. The dimensions given here are for guidance and may require slight modification

SETTING UP

When construction has been completed as shown in Fig. 3, the receiver may be set up. At this stage the speaker is connected but not mounted in position. The battery platform is also not fitted.

VR3 should be initially adjusted so that its slider is at the end of the track connected to the negative supply line. A No. 126 4.5 volt battery is connected up with a meter, set to give a clear reading of 26mA, inserted in the positive lead. Switch on and adjust VR3 so that a reading of 26mA is shown and held after the receiver has been switched on for about 10 minutes, then switch off again.

Next, L1 should be set at the extreme right hand end of the rod (right hand as shown in Fig. 3), VC3 adjusted to about half of full tightness, and VC1 set with its vanes about three-quarters enmeshed. Switch S1 to medium waves. There may be oscillation, even with VR1 at or near zero resistance, in which case remove L1 from the rod, turn it through 180 degrees and replace it on the rod. Alternatively, change over the connections to the leads of L1. If oscillation still takes place with VR1 set well back, move L1 towards the middle of the rod until

(Continued on page 627)

Cover Feature

C.R.O. BEAM S

Incorporating standard parts in a simpl
a single-beam oscilloscope to display
sam

P. CAIRNS, A.I

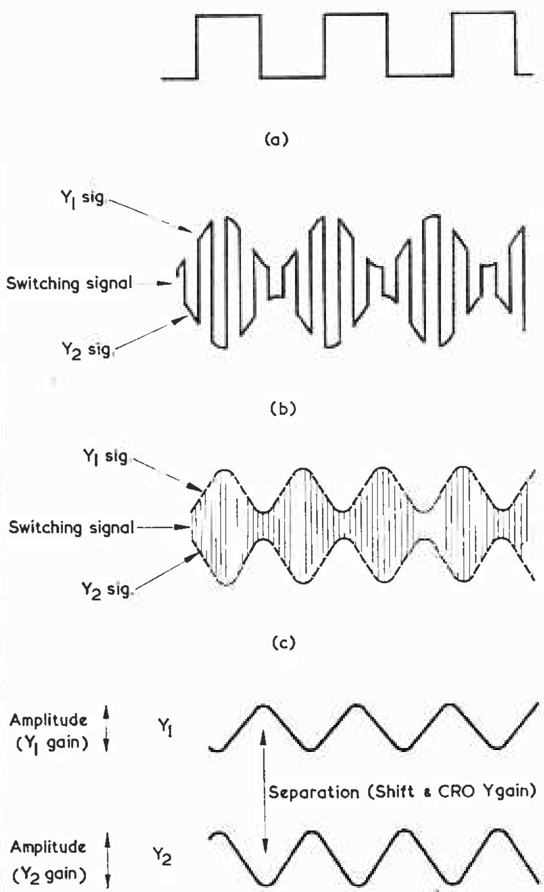


Fig. 1(a). The basic switching waveform
(b). Showing the effect of sampling two traces with the aid of the switching waveform. Trace frequency here is only slightly lower than switching frequency
(c). A 'dotting' effect is evident for a lower trace frequency, and the switching waveform is not clearly discernable
(d). The 'dotting' effect and switching waveform disappear at still lower trace frequencies. The two traces now appear continuous, due to persistence in the human eye and the c.r.t. phosphor

THIS ARTICLE DESCRIBES A SIMPLE THOUGH USEFUL transistor beam switching unit suitable for use with almost all types of cathode ray oscilloscope. As may be observed from the accompanying specification, it compares favourably with many much more complex circuits which have been produced from time to time. Like all beam switching circuits it has very definite limitations but should still prove very useful for low frequency and audio work by allowing the more basic facilities of a double-beam oscilloscope to be utilised with a single-beam instrument. Such a device is particularly useful for the direct observation of phase shifts between signals and simultaneous input-output levels in low frequency and audio circuits.

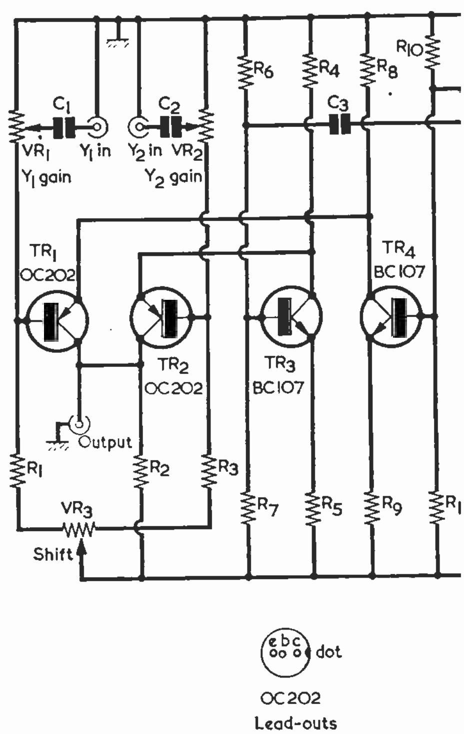


Fig. 2. Complete circuit dia

WITCHING UNIT

circuit, this beam switching unit allows two completely separate traces at the time

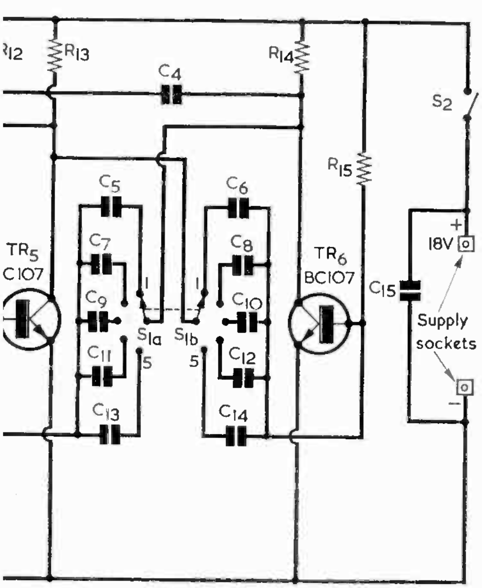
y

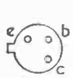
.I.P.R.E., G3ISP

DESIGN APPROACH

When considering the design of a circuit of this nature many conflicting factors have to be allowed for. Basically, no form of beam switching can be considered as a satisfactory substitute for a double-beam oscilloscope employing a double gun or beam splitting cathode ray tube; at best it is only a compromise. This does not detract, however, from the fact that in certain situations some method of beam switching will achieve results which could otherwise not be easily obtained on a single-beam instrument.

Beam switching is basically a method of sampling two (or sometimes more than two) signals and displaying them simultaneously but separately on a





BC107
Lead-outs

n for the beam switching unit

COMPONENTS

Resistors
(All fixed values ½ watt 5%)

R1	22kΩ
R2	1.5kΩ
R3	22kΩ
R4	560Ω
R5	270Ω
R6	68kΩ
R7	5.6kΩ
R8	560Ω
R9	270Ω
R10	68kΩ
R11	5.6kΩ
R12	56kΩ
R13	5.6kΩ
R14	5.6kΩ
R15	56kΩ
VR1	10kΩ potentiometer, linear, wire-wound
VR2	10kΩ potentiometer, linear, wire-wound
VR3	100kΩ potentiometer, linear, wire-wound

Capacitors
(All paper capacitors 50V wkg.)

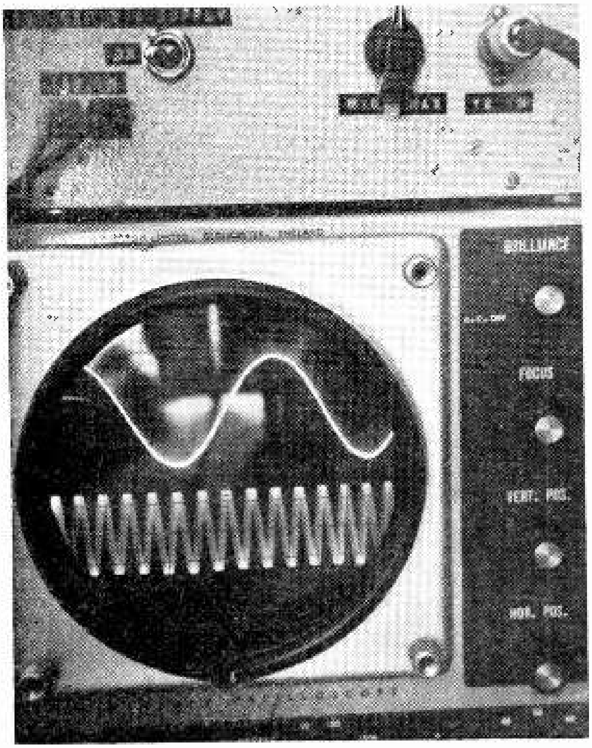
C1	2.2μF, paper
C2	2.2μF, paper
C3	1μF, paper
C4	1μF, paper
C5	0.01μF, paper
C6	0.01μF, paper
C7	0.0047μF, paper
C8	0.0047μF, paper
C9	0.0022μF, paper
C10	0.0022μF, paper
C11	0.001μF, silver-mica
C12	0.001μF, silver-mica
C13	470pF, silver-mica
C14	470pF, silver-mica
C15	0.5μF, paper

Transistors
TR1, TR2 OC202 (Mullard)
TR3-TR6 BC107 (Mullard)

Switches
S1 (a) (b) 2-pole 5-way, Yaxley
S2 s.p.s.t., toggle

Sockets
3 coaxial sockets
2 single insulated sockets (for Belling-Lee O-Z plugs, or banana plugs)

Miscellaneous
Printed circuit board or Veroboard (see text)
4 pointer knobs
Cabinet, 8 x 6 x 6in., Type W, H. L. Smith & Co. Ltd.
Aluminium sheet for sub-chassis



The beam switching unit in action. Here, an oscilloscope simultaneously displays two completely separate traces

single-beam deflection system. This is achieved by having two identical amplifiers which are alternately switched on and off at a frequency much faster than the frequency of the two input signals being applied to the amplifiers. By using a square wave having a fast rise and fall time a small portion of each input signal is alternately displayed on the top and bottom edges of the square wave. The faster the switching frequency compared with the signal frequency, the cleaner the display appears on the tube face. As the signal frequency approaches the switching frequency a definite dotting appears on the display, thus limiting the use of the device to the lower frequency range.

The design of a beam switching unit for the display of high frequencies involves much more complex circuits, with an attendant increase in expense, and in practice is very seldom an economic proposition. The method by which a beam switching display functions is illustrated in Fig. 1 (a) to (d). The fact that the alternate gaps in the upper and lower traces are not noticeable with a high signal to switching frequency ratio is due to the comparatively long persistence of the human eye and also, to some extent, to the phosphor persistence of the cathode ray tube.

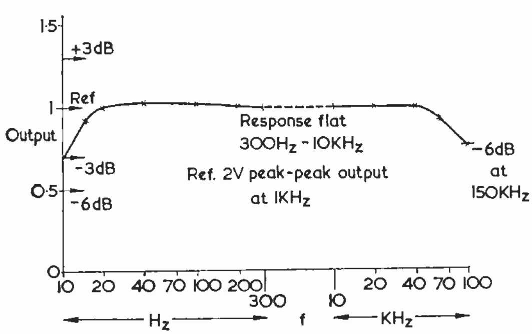


Fig. 3. Response curve of the protype Y amplifiers

In practice, switching speeds in the order of fifteen to twenty times the signal frequency are necessary if a useful display is to be obtained. Other features which are desirable with beam switching circuits are independent gain controls on both signal inputs, provision for selecting a number of different switching speeds and a shift control which allows the upper and lower traces to be either transposed or superimposed, one over the other. There should also be the minimum of interaction between the two amplifiers and their controls. A reasonable frequency response is also desirable, despite the frequency limitations of these units, as it is often desired to display square waves with quite fast rise and fall times. Also, the amplifiers have to cope with the relatively fast switching times. A small degree of gain in the amplifiers is often an advantage though of rather less importance than the other features mentioned.

Despite its simplicity and the fact that only six transistors are used, the circuit shown in Fig. 2 achieves, to a greater or lesser extent, all of the above requirements. The relatively low gain of X2 per channel is accompanied by a good bandwidth, being only 3dB down at 100kHz. As signal frequencies much higher than 2kHz are approaching the upper useful limit of the unit, such a bandwidth is adequate for the display of square and pulse waveforms. A complete frequency response characteristic is shown in Fig. 3. Switching speeds are covered in five switched steps from 2 to 40kHz. Both amplifiers have independent gain controls while a shift control allows both traces to be transposed or superimposed at will. The output switching pulse is of sufficient amplitude to allow two 4-volt peak-to-peak signals to be displayed simultaneously without overlapping. Throughout the design, components of standard type only are used.

SPECIFICATION

Maximum input per channel: 2V peak-to-peak
Maximum output per channel: 4V peak-to-peak
Gain per channel: X2
Maximum switching amplitude: 8V peak-to-peak
Frequency response per channel: –3dB at 10Hz and 100kHz; –6dB at 150 kHz. (See Fig. 3)
Input impedance per channel: 5kΩ approx. at 1kHz
Output impedance: less than 1kΩ
Beam switching speeds: 2kHz to 40kHz in 5 steps
Supply: 18V d.c. from internal battery or external supply; drain 25mA
Dimensions: Height 6in., width 8in., depth 6in.

CIRCUIT OPERATION

The functioning of the circuit, shown in Fig 2, may be explained in the following manner. TR5 and TR6 form a conventional astable multivibrator,

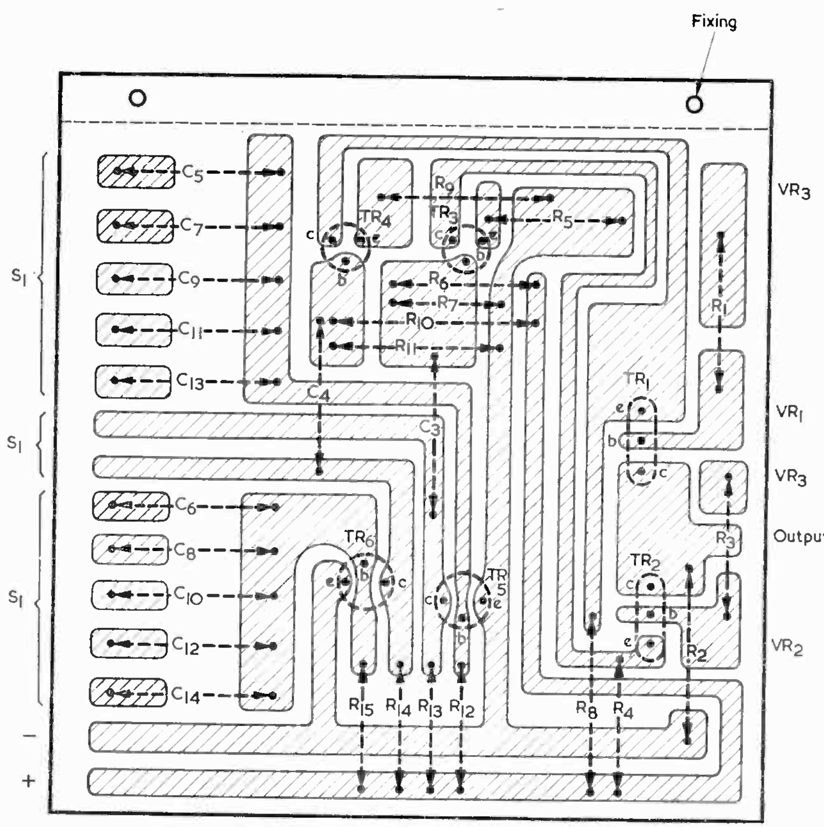
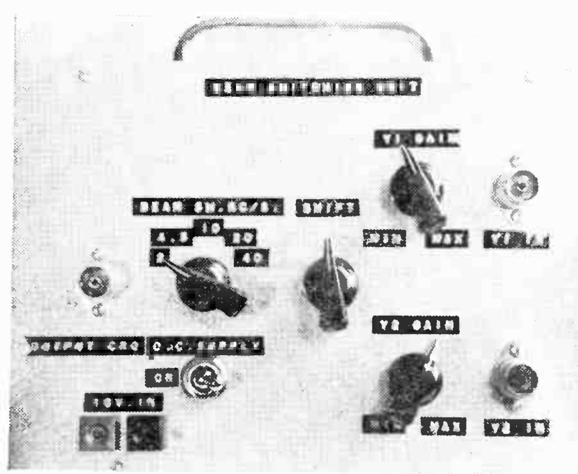


Fig. 4. The printed circuit board viewed from the copper side. This is reproduced full size and may be traced. Connections from the board to external components follow the circuit diagram of Fig. 2

the various switching speeds being selected by S1, which selects the capacitors C5 to C13 in one bank and C6 to C14 in the other bank. These alter the time constant and thus the switching speed of the circuit. A square wave is thus developed across each load resistor, R13, R14, in turn, each transistor being alternately switched on and off. The outputs obtained at the collectors are two square waves which are effectively 180° out of phase. These are coupled to the two switching transistors, TR3 and TR4, by the coupling and d.c. blocking capacitors. C3, C4. These are of sufficiently large value to maintain a good low frequency response and so preserve a good waveform.

The resistor dividers, R6-R7, and R10-R11, keep the bases of TR3 and TR4 at a fixed d.c. level and provide biasing. The emitter resistors R5 and R9 provide a large measure of negative feedback and maintain the emitters at a fixed potential above the negative supply line, while the output signal is developed across the load resistors R4 and R8. These resistor networks maintain the selected d.c. conditions of the transistors and allow an output waveform of large amplitude and fast rise and fall time to be made available for driving the amplifier stages. The signals applied to the bases of TR3 and TR4, being quite large in amplitude, ensure that these switching transistors are driven very hard between their on and off conditions. The waveform obtained at the collectors of these transistors are therefore a larger and squarer (faster rise and fall) replica of the multivibrator outputs. Thus



Front panel of the prototype switching unit when TR3 is cut off TR4 is bottomed and vice versa, the transition between these two states being very fast and the frequency of transition being dependent upon the frequency of the multivibrator.

TABLE

CIRCUIT MEASUREMENTS

Frequencies. Measured frequencies of beam switching speeds: (1) 1,920Hz; (2) 4,330Hz; (3) 9,360Hz; (4) 20.24kHz; (5) 41.51kHz.

Impedances. Measured input impedances at 1kHz (VR1, VR2 at max. settings): Y1, 4.6Ω; Y2, 4.8kΩ. Measured output impedance at 1kHz: 820Ω.

Voltages. All voltages measured with 20kΩ/volt instrument and are with respect to positive line. Gain controls at minimum, shift control central and fastest switching speed (5) selected.

D.C. supply	–18V
TR1, TR2 base	–2V (–1.2 to –5.3V for full turn of VR3)
TR1, TR2 collector	–14.5V (–11.5 to –14.8V for full turn of VR3)
TR3, TR4 collector	–5.7V (–5.5V to –7.3V for full turn of VR3)
TR3, TR4 emitter	–15.6V
TR3, TR4 base	–17.3V
TR3, TR6 collector	–13.4V

Current. Measured current drain from 18V supply: 25.8mA

Transistors TR1 and TR2 are the signal amplifiers. The two input signals for display are fed via the blocking capacitors C1, C2, to the gain controls VR1, VR2, and so to the bases of the transistors. The gain controls, R1, R3 and VR3 form the divider network for maintaining the d.c. conditions on the two bases and supplying the necessary d.c. bias. In this case, however, the positive ends of the dividers are commoned into the shift control VR3. This allows the standing d.c. level on either base to be raised or lowered by a fixed amount. As one base is raised the other is lowered by a corresponding amount and vice versa. The two collectors are connected to a common load, R2, across which the composite output signal is developed and fed to the c.r.o. input.

The standing d.c. voltage on the common collector output of TR1 and TR2 is blocked by the Y amplifier input capacitor in the c.r.o. In the case of oscilliscopes with switched d.c. or a.c. inputs, the a.c. input is of course selected.

It will be noticed that TR1 and TR2 are p.n.p. transistors and are thus complementary to the switching transistors, which are n.p.n The emitters of TR1 and TR2 can therefore be d.c. coupled to the collectors of the switching transistors. Thus R4 and R8 are not only the collector loads of the switching transistors but act as emitter resistors for the signal amplifiers. This allows a measure of negative feedback to be applied to the amplifiers as they are switched. Since TR3 and TR4 are being alternatively driven on and off, the emitters of TR1 and TR2 will be switched on and off in turn. The two amplifiers will therefore be driven on and off and so provide the desired beam switching effect.

The unit is fed from an 18 volt d.c. supply, either an external power unit or two 9 volt batteries in series being used. As the current drain is only in the region of 25mA and beam switching units are generally used only intermittently, two batteries of the type employed for transistor radios will last quite some time. The d.c. supply is decoupled by C15 and if an internal battery is used the sockets provided for an external supply allow the battery voltage to be checked without removing the unit

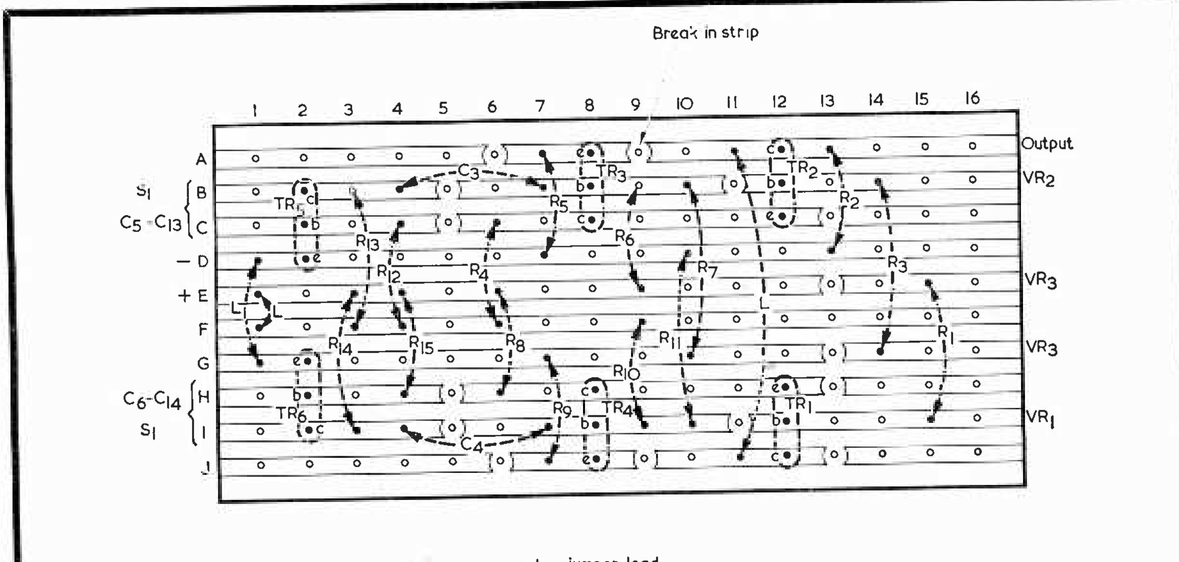


Fig. 5. An alternative Veroboard layout, also viewed from the copper side of the board

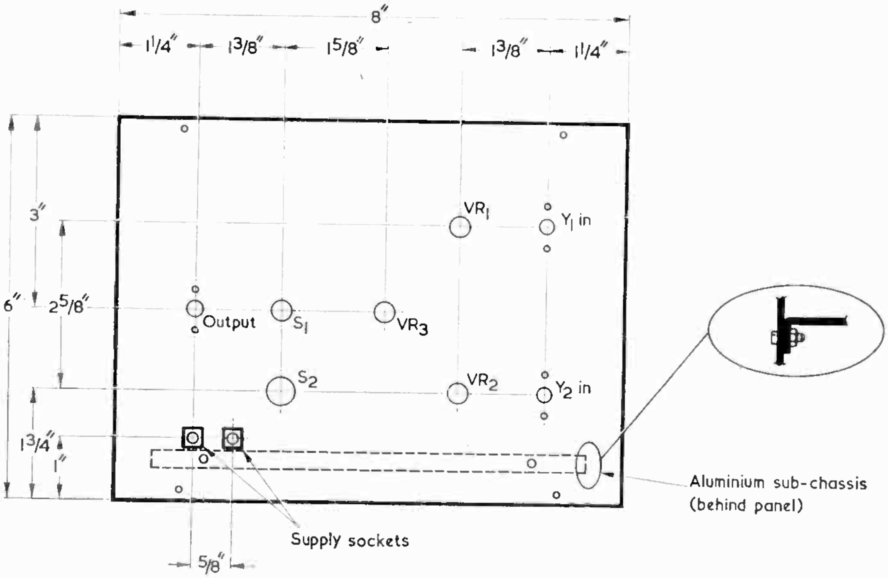


Fig. 6. Drilling dimensions and component layout for the front panel. A side view showing the method of securing the sub-chassis is given in the inset

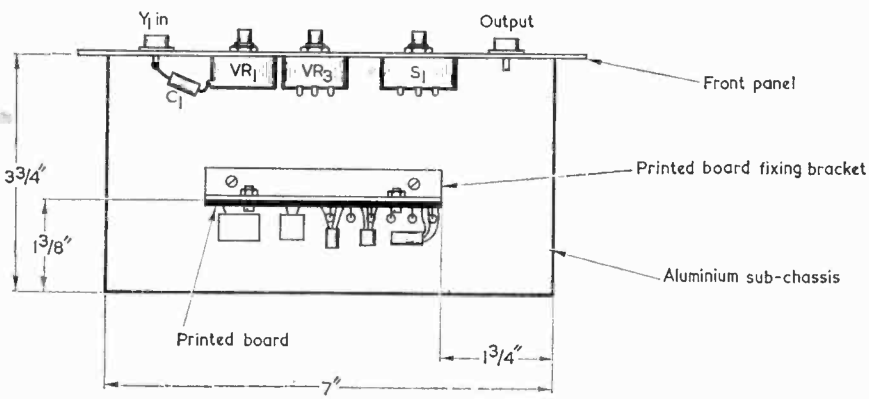


Fig. 7. Top view of the assembly with a printed circuit board

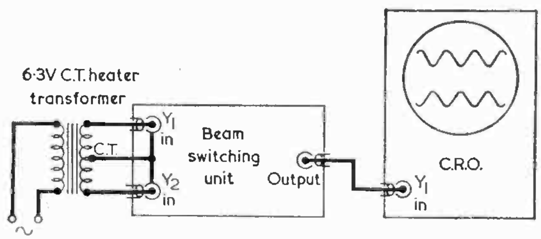


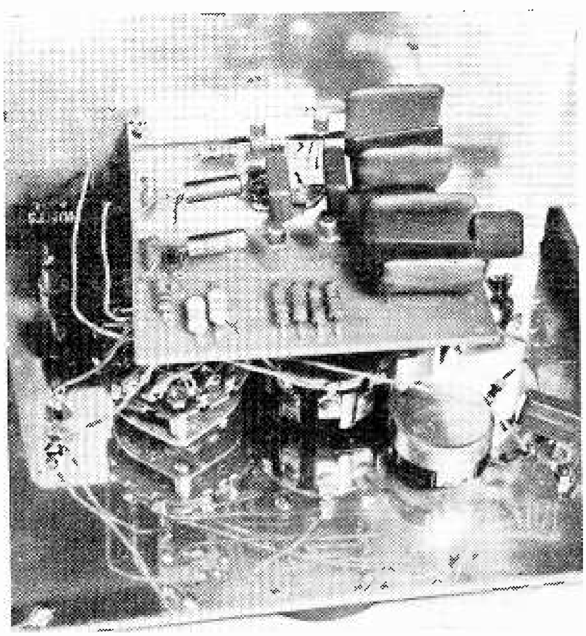
Fig. 8. A simple method of checking the beam switching unit

from its case. If desired, C15 may be connected, alternatively, after switch S2.

VR1 and VR2 are specified as wirewound since these types normally last longer, from the physical wear and tear point of view, than carbon track potentiometers. They also produce less noise. Tests showed that any inductance introduced by wirewound potentiometers in the VR1 and VR2 positions had no noticeable effect on the performance of the circuit.

CONSTRUCTION

The construction of the beam switching unit is quite straightforward. While the type of cabinet used by the writer is quoted in the Components List, any form of cabinet and layout may be used to suit individual requirements. There is nothing particularly critical about the layout and construction. Most of the smaller components are best mounted on printed circuit board or Veroboard, full details together with component layout for both types of board being illustrated in Figs. 4 and 5. An alternative method, though not so neat, is to mount all the components on a large tag board or tag strip. Provided interconnecting wires are kept as short as possible no fall-off in performance should be noticed. Indeed, the original model for checking circuit operation was constructed by the writer in this fashion without any problems being encountered.



A view behind the panel, showing the position taken up by the printed circuit board

The Veroboard employed by the author for the layout shown in Fig. 5 had a matrix of 0.2in. However, the more readily available 0.15in. Veroboard may be employed instead, if desired. It should be mentioned that the collector of the BC107 is common with its case.

The front panel layout with relevant dimensions is shown in Fig. 6. All necessary front panel wiring is connected before the printed board of Veroboard and its associated sub-chassis are mounted. The board, complete with components, is mounted by means of a small angle bracket to a flat aluminium sub-chassis having a lip bent along one edge for clamping to the front panel by means of 6BA screws. This is shown in Fig. 7. As may be seen, the actual component board is mounted edgewise on the chassis and parallel to the front panel. Connections between the board and front panel components are as short and direct as possible.

The multivibrator capacitors, C5 to C14 are mounted on the board when a printed circuit is used, but not when Veroboard is employed. In the latter case they are mounted directly on the switch wafer. This method of wiring reduces the size of the Veroboard which would otherwise be necessary.

Final embellishments in the way of rubber feet and carrying handle may be added as desired.

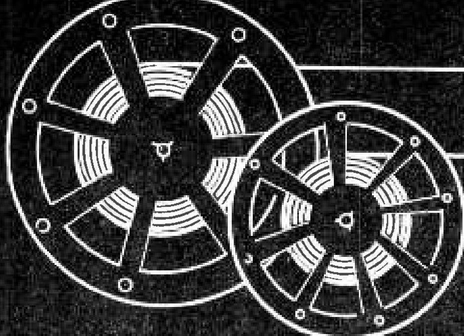
TESTING AND SETTING UP

No elaborate testing or setting up should be necessary. Before switching on, however, check the circuit wiring and transistor connections, remembering that both p.n.p. and n.p.n. types are used. Connect the output of the switching unit to the c.r.o. Y input, the Y sensitivity of the oscilloscope being set to about 0.5 to 1V/cm. The trigger or sync. control should be set for internal operation and the c.r.o. time base to a relatively slow speed, 10 to 50 millisec./cm being suitable. The Y shift control on the switching unit should be set to either extreme of its travel, the two Y gain controls being set to about mid-point. The switching speed is set to position 4 or position 5.

When the unit is switched on, two separate time base lines should be observed on the oscilloscope. The shift control on the switching unit should allow these lines to be superimposed or changed completely over, upper to lower and vice versa. With the shift control set to one extreme the oscilloscope Y gain should be adjusted to give a suitable separation on the tube face. The brightness should be kept as low as possible to prevent "haze" between the upper and lower beams.

Two low frequency signals can now be applied to the Y1 and Y2 inputs to try out the unit, the 50Hz output from a centre-tapped heater transformer secondary being ideal. This circuit can be connected up as shown in Fig. 8. With the two signals applied, the Y1 and Y2 gain controls are adjusted until both traces are of the same amplitude and the lowermost sections of the upper signal are not quite overlapping the uppermost sections of the lower signal. No clipping should be present under these maximum signal conditions. The shift control will allow the vertical positions of the two signals to be changed with respect to one another. If the beam switching speed is reduced the "dotting" effect mentioned earlier can be observed.

Having satisfactorily completed these tests the instrument is ready for use, and should prove a useful and reliable accessory for any oscilloscope. As an aid to servicing or fault-finding, measurements taken throughout the circuit are listed in the accompanying Table. ■



UNDERSTANDING TAPE RECORDING

by W. G. Morley

This is the first of a new series which sets out to describe, in simple terms, exactly what occurs during the processes of recording and playing back a signal on a tape recorder. The article published this month discusses the function of recording, and deals also with constant current drive and the frequency response required in the recording amplifier

THE DOMESTIC TAPE RECORDER has nowadays become such an accepted feature of modern life that there must be very few people who, even if they have not actually operated a recorder, have not at least observed one in use.

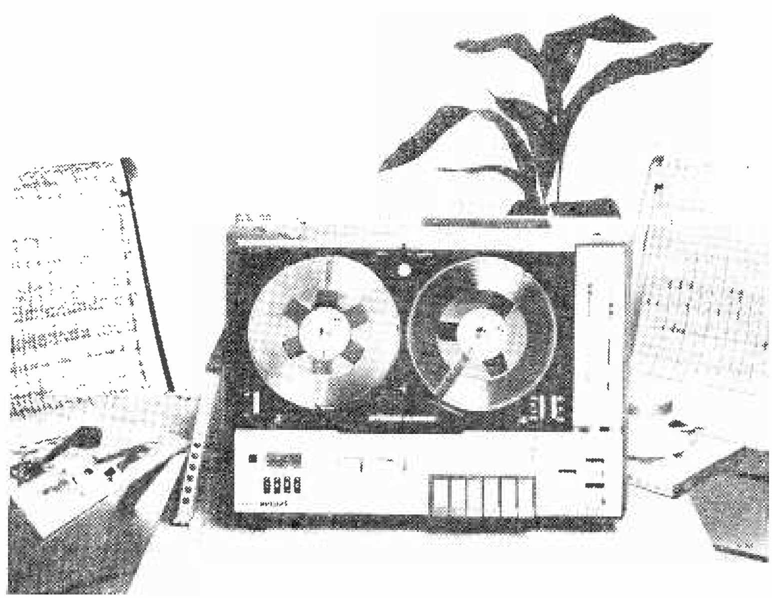
The fundamental steps involved in the use of a tape recorder are simple and well-known. If we have a recorder of the familiar domestic type and wish to employ this for recording say, a spoken message, we commence by switching the instrument to the 'Record' function. A motor causes the magnetic recording tape to be drawn across the *record-playback head* of the recorder, and we then speak into its microphone. When we have finished we switch the recorder so that it re-winds the tape after which, having selected the 'Playback' function, we run it past the record-playback head once more. We are then able to hear the message we have previously recorded from the loudspeaker of the recorder.

RECORDING AND PLAYBACK

The electronic circuits we have set up in this simple example of tape recorder use are illustrated, in very simplified form, in the block diagram of Fig. 1. In Fig. 1(a) we have the situation where we record the message. Here, the electrical output of the microphone is applied to the input of an a.f. amplifier, an amplified signal being then passed to the record-playback head. This carries out the recording function and causes the signal to be recorded on the tape. Fig. 1(b) shows what occurs when we play back the recording. The record-playback head now provides a playback function, and its output is fed to an a.f. amplifier. The amplifier then drives the loudspeaker.

An amplifier is required for both the record and playback processes. It is necessary for recording partly because the electrical output from the microphone in Fig. 1(a) is not sufficiently large to be applied directly to the record-playback head; and it is necessary for playback partly because the output from the record-playback head in Fig. 1 (b) is not powerful enough to drive the loudspeaker.

Up to now we have referred to recorders having a single record-playback head which is capable of both recording the signal onto the tape and of retrieving it afterwards during playback. The use of a single dual-function head in this



An excellent example of modern styling and engineering. This is the Phillips mains operated stereo tape recorder type N4500, which is designed to very high standards and incorporates a pre-amplifier unit manner is very common in lower-price domestic recorders. More expensive instruments, and particularly those intended for 'professional' applications, frequently have separate record and playback heads, one being designed to offer optimum performance for recording and the other to offer optimum performance for playback. However, it is possible to obtain extremely good results with a single record-playback head, and the obvious economy which results makes the use of such a head attractive for machines intended for the domestic market. (Before leaving this particular subject it may be added, incidentally, that the use of separate record and playback heads enables a recording to be monitored whilst it is being made. This is done by positioning the playback head so that the tape passes over it after leaving the record head.)

Since an amplifier is required both for record and for playback, a useful saving in costs may be effected by employing a single amplifier for both functions. A typical instance, as encountered in domestic recorders, is shown in Fig. 1(c) where either the record or playback process is selected by means of a multi-section 'Record-Playback' switch. When 'Playback' is selected the record-playback head is coupled to the amplifier input, whilst the loudspeaker is connected to the amplifier output. When 'Record' is selected, the microphone is connected to the amplifier input and the record-playback head to an auxiliary output (obtained normally at a point immediately preceding the output stage) from the amplifier. Thus nearly all of the amplifier stages that are used to amplify the playback signal are brought into use to amplify the record signal as well, and a significant economy is achieved. More expensive recorders may have separate record and playback amplifiers, each being designed for optimum results for their particular function.

The simplified block diagrams in Fig. 1 omit a second head, which is found in all standard recorders. This precedes the record-playback head (or both the record and playback heads if these are separate) and is referred to as the *erase head*. Its primary function is to erase any previous signal that may be present on the tape when a recording is being made, and its method of operation will be described in a later article. Another omission is that the Record-Playback switch in Fig. 1 (c) does not include a section for altering the frequency response of the amplifier when it is changed from one of its two functions to the other. As we shall see in this and next month's article, it is necessary for the amplifier to have quite different frequency responses for the record and playback functions if the overall response from record to playback via the recording on the tape is to be kept 'flat'. When separate record and playback am-

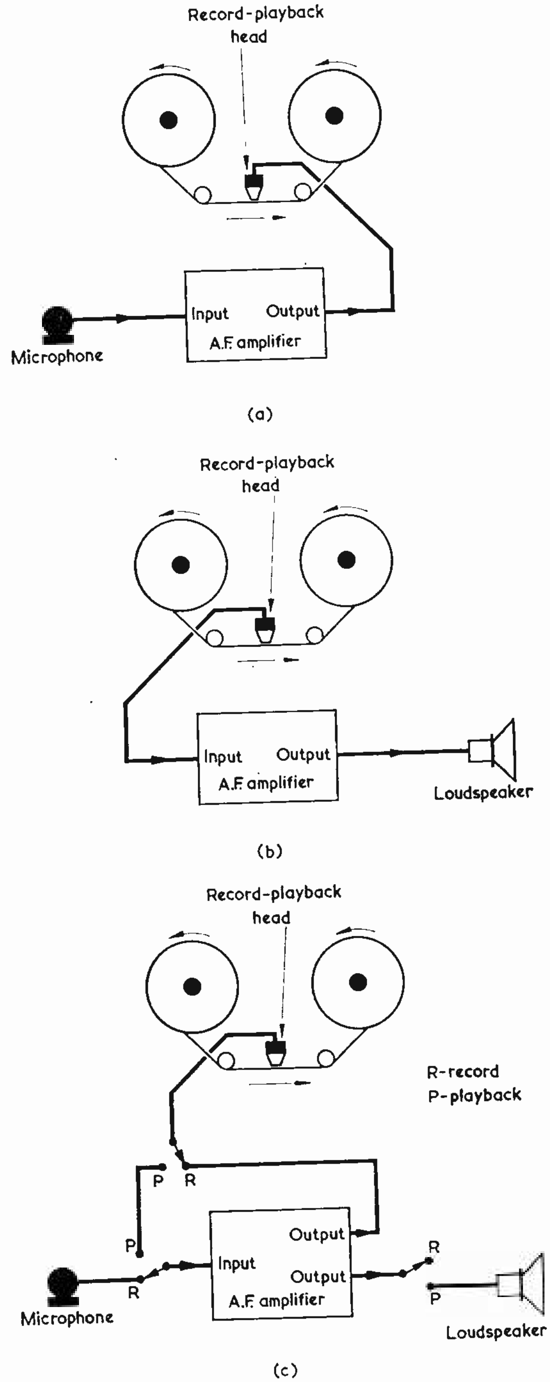


Fig. 1. Illustrating, in very simplified form, the processes involved in recording when using a recorder with a common record-playback head. In (a) a recording is being made whilst, in (b), it is being played back. In domestic recorders most of the stages in the a.f. amplifier are common to both functions and (c) shows, in theoretical form, how the requisite function switching could be carried out

plifiers are used, they may each be permanently provided with frequency-selective filter circuits which provide the response applicable to their function.

THE RECORDING PROCESS

The fundamental process of recording a signal on magnetic tape can be explained with the aid of Fig. 2(a). Here we see the record head (which, in domestic tape recorders of the type we have just discussed, will also serve as playback head) and the magnetic tape The core of the head consists of a ring of magnetic material having a very narrow gap across which the tape is drawn. There is also a gap at the rear of the head, the purpose of which will be dealt with in a later article. Thin shims (i.e. thin slips to fill up the spaces) of non-magnetic metal are inserted in these gaps. The head core is made of a 'soft' magnetic material, the term 'soft' in this context inferring that the material demagnetises readily after having been magnetised. A typical construction for the head core would comprise a stack of laminations made from similar metal to that used for the cores of a.f. transformers. A coil is wound around the two halves of the core. In consequence, if an alternating current, such as that provided by an a.f. signal, is caused to flow through the coil, a corresponding magnetic field appears at the gap across which the tape travels. This gap is very narrow (typically 0.0002 in. with a record-playback head) and its length is at right angles to the direction of travel of the tape, as shown in Fig. 2(b).

The tape, which is about ¼in. wide, consists of a plastic base coated on one side with magnetic iron oxide in the form of very tiny particles suspended in a binding medium. Unlike the magnetic material of the head, the iron oxide offers 'hard' properties, and does not readily demagnetise after having been magnetised. The oxide coated side of the tape is held firmly in contact with the gap of the head by means of a pressure pad made of felt or similar resilient material. To ensure good mechanical contact between the tape and the head gap the head surface at the gap is smooth and highly polished.

Let us now see what happens if we feed a signal current through the coil of the head whilst the tape is drawn past the gap. For convenience we may choose a sine wave having a relatively low frequency, and we turn next to Fig. 3 which illustrates the effect on the tape resulting from the application of this sine wave current. In Fig. 3(a) we see the sine wave at zero level, whereupon no current flows in the coil and zero magnetising force is exerted on the 'soft' core of the head. In Fig. 3(b) we see the sine wave at an intermediate value between zero and peak, whereupon a current flows in the coil and a magnetising force is exerted on the core. Lines of magnetic force (which by convention are assumed to flow from South to North within the body of a magnet, as the head core now effectively is) appear in the core. In Fig. 3(b) they are, for convenience, represented by a single line. At the gap they pass through the oxide coating of the tape since this offers a much higher permeability (i.e. it allows a much higher flux density to appear in it) than does the shim of non-magnetic metal in the gap. In consequence, the iron oxide suffers magnetisation at this point. The arrow drawn inside the tape indicates tape magnetisation which has already taken place, this commencing immediately after the sine wave amplitude rose above zero. Fig. 3(c) shows the situation a little later. The tape has moved further forward and the sine wave is now at its maximum amplitude. Magnetisation of the tape oxide with the field flowing in the same direction continues to take place, this time at maximum level.

As the tape continues to pass over the gap it will continue to be magnetised with the field in the direction shown until, when zero signal amplitude is reached once more at the end of the half-cycle, no magnetising force is exerted on the core of the head. During the following half-cycle the same process will be carried out, but the field will be in the opposite direction.

Since the iron oxide on the tape is a 'hard' magnetic material it retains the magnetism imparted to it during the half-cycle of the sine wave. If we were to draw a graph showing the strength of the magnetism retained in the oxide over a number of cycles, we would find that the tape oxide exhibits maximum magnetisation at the same time as the input signal exhibits maximum amplitude. Also, that when the signal goes through zero level so also does the magnetisation and that when the signal changes polarity the magnetisation follows suit.

Such a graph can be considered to represent the state of affairs shown in Fig. 4, in which it is

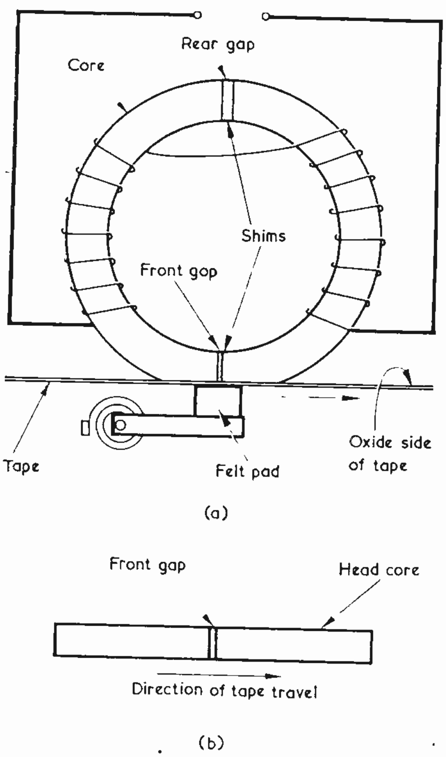


Fig. 2(a). The basic construction of a record or playback head, or of a head combining both functions. The felt pad presses the tape against the front gap of the head

(b). End view of the head, illustrating that the gap length is at right angles to the direction of tape travel

assumed that a series of bar magnets has been created in the oxide of the tape due to the process of magnetisation. The length of each of these 'magnets' corresponds to one half-cycle of the signal fed to the record head, whilst the length of two magnets corresponds to a full cycle. There are, of course, no actual magnets inside the tape oxide; instead there is a remanent magnetic field whose direction and amplitude continually change along the length of the tape. Also, the analogy is not perfect because actual bar magnets would exhibit maximum field strength at their extremities, whereas the 'magnets' in the tape have zero field strength at their extremities. Nevertheless, it is very convenient to talk in terms of individual bar magnets since this concept assists in explaining some of the further basic factors in tape recording which will next be dealt with.

The length of each magnet produced in the tape under the conditions shown in Fig. 3 was considerably greater than the width of the gap. If we increase the frequency of the signal applied to the record head the length of each magnet will become smaller because it is produced in a shorter section of the tape. If we continue to increase the frequency we shall eventually arrive at the situation where the length of each magnet is not very much greater than the width of the gap itself. As frequency rises towards this state of affairs, the simple principle of tape magnetisation illustrated by Fig. 3 tends to be replaced more and more by a much more complex process in which a section of the tape can be subjected to magnetising forces of different magnitude and, even, polarity during the period in which it travels across the gap. This effect will, obviously set a limit to the highest frequency which can be usefully recorded on the tape. A more important effect, though, is that as magnet length in the tape oxide decreases there is a continually increasing tendency for the oxide material to demagnetise after it has left the gap. The shorter magnets are unable to maintain the permanence exhibited by the longer magnets which were created at the lower signal frequencies. The demagnetising effect starts to become apparent at a frequency well below the highest frequency which may be recorded on the tape, becoming progressively more pronounced as the frequency approaches this level. Falling-off in recording efficiency at the higher frequencies is dictated partly by the onset of the complex magnetising process previously mentioned, but it is mainly due to self-demagnetisation in the tape. Speaking in very approximate terms, the highest frequency at which useful recording may be carried out is given when the magnet length in the tape is of the order of ten times the width of the record head gap.

Additional factors which also limit recording efficiency at the higher frequencies include eddy current losses in the record head and fall-off in performance, as frequency increases, in the magnetic material of the head core. These particular high frequency losses are,

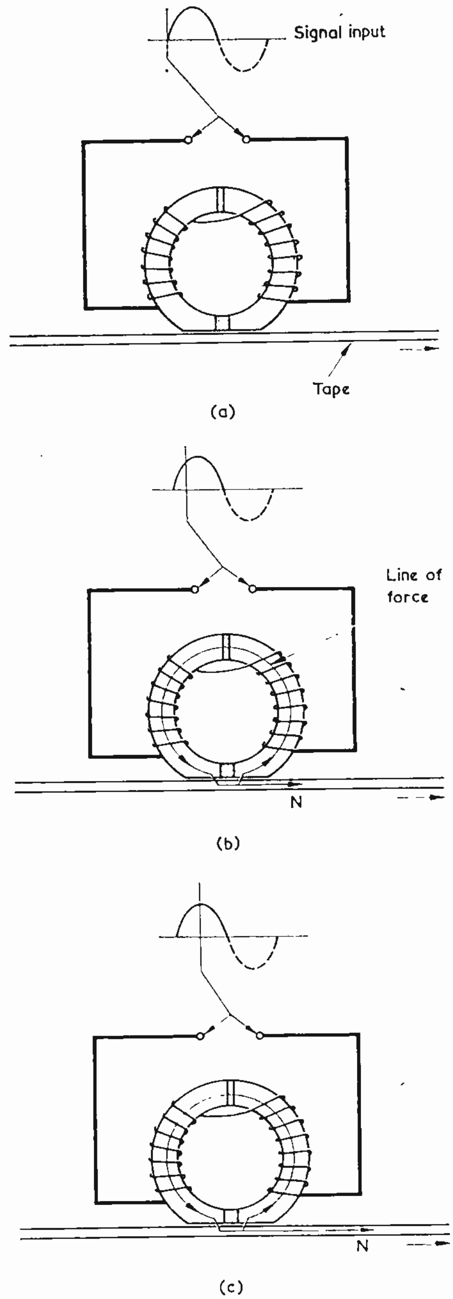


Fig. 3(a). When the signal input current is at zero, no magnetising force is imposed on the record head core

(b). As the signal current increases from zero a field is set up in the core, the lines of force flowing through the oxide coating of the tape as it passes over the gap. The arrow inside the tape indicates magnetisation which has already taken place

(c). At maximum signal current amplitude the tape coating undergoes maximum magnetisation however, a function of record head design rather than of the actual process of recording onto the tape.

The maximum useful recording frequency can be raised by the very simple process of increasing the speed at which the tape is drawn past the record head gap. If tape speed is doubled so also, at any given frequency, are the lengths of the magnets created within its iron oxide surface. It follows that the recording frequency may then itself be doubled before the same degree of tape demagnetisation occurs. This is largely borne out in practice. The more commonly encountered tape speeds in domestic equipment are $7\frac{1}{2}$ in. per second (usually abbreviated to i.p.s.), $3\frac{3}{4}$ i.p.s. and $1\frac{7}{8}$ i.p.s. With good head design it is possible to record up to frequencies, in kHz, which are one to two times the i.p.s. figure. Thus, one could expect to record up to some 3.75 to 7.5kHz at a tape speed of $3\frac{3}{4}$ i.p.s., and up to some 7.5 to 15kHz at a tape speed of $7\frac{1}{2}$ i.p.s. More expensive machines may feature tape speeds of 15 i.p.s. and 30 i.p.s., these offering further enhanced high frequency performance (although head losses here may cause the upper frequency limit to be somewhat less than double the i.p.s. figure). Another tape speed. encountered in equipment which is not usually expected to offer a wide frequency range, is 15/16 i.p.s.

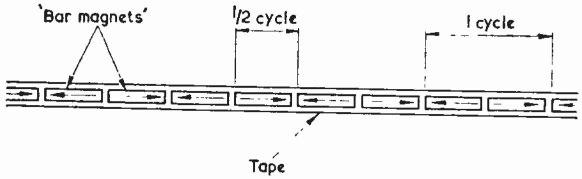


Fig. 4. A useful analogy is given by the assumption that the process illustrated in Fig. 3 has created a number of 'bar magnets' inside the tape, as shown here. The arrow inside each 'magnet' indicates direction of field

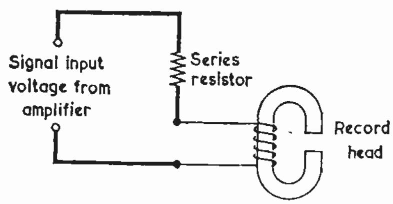


Fig. 5. 'Constant current' record head drive may be achieved with the aid of a high value series resistor

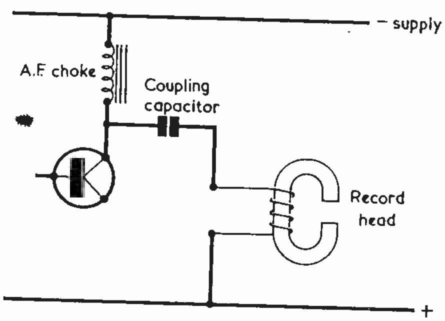


Fig. 6. A method of obtaining 'constant current' drive when the available supply voltage is low. The transistor is in the a.f. amplifier stages of the recorder

RECORDING CHARACTERISTIC

In general, magnetic tape tends to overload at about the same magnetising level, irrespective of frequency. Disregarding for the moment the self-demagnetising effect in the tape which takes place at the higher frequencies it is, in consequence, desirable to arrange matters such that the tape magnetising force falls in the same range of amplitudes at all frequencies that are intended to be recorded. This requirement can be met by ensuring that the frequency response of the recording amplifier, as expressed in terms of the *output current flowing in the record head coil*, is 'flat' over the recording frequency range. It is important to note the emphasis on record head current, because the magnetising force exerted on the record head is proportional to the *current* which flows in its coil, and not to the voltage appearing across that coil or to the power dissipated in it.

A record head is essentially an inductive component, which means that it offers an impedance that increases with frequency. In consequence, it is very common practice to feed a record head via a series fixed resistor having a value which is well in excess of the difference between the head impedances at the maximum and minimum recording frequencies. The circuit is shown in Fig. 5. Due to the presence of the high value series resistor, very nearly the same current flows in the head winding for the same input voltage, regardless of frequency. A head drive circuit of this nature is referred to as a 'constant current' circuit, because the head current tends towards a constant current (for the same input voltage) throughout the frequency range. In mains-driven recorders, the head drive voltage may be obtained from the anode of a voltage amplifier valve or from the collector of a transistor. In the former case, the value of the series resistor is usually of the order of 100 to 200kΩ, whilst in the latter it is of the order of 20 to 50kΩ, thus reflecting the lower impedances at which transistors work. The head will, itself, also have a lower impedance winding in the transistor recorder. At first sight, the presence of the series resistor might give the impression that a high proportion of output recording power is lost due to the signal voltage that is dropped across it. In practice, this loss is not of great importance because satisfactory recording may be achieved when the a.f. power fed to the combination of head and series resistor is of the order of 25mW only.

The low supply voltage available with battery-operated transistor recorders makes it difficult to employ a series resistor for constant current drive, since it is impossible to obtain a sufficiently high signal voltage amplitude. An alternative approach consists of developing the record head drive voltage across an a.f. choke, as shown in Fig. 6. The choke offers a low impedance at low frequencies and a high impedance at high frequencies. As a result a low signal voltage is available for the record head at low frequencies and a high signal voltage at high frequencies, whereupon the circuit approximates to constant current operation.

In discussing the drive to the record head we have, so far, ignored the falling-off in recording efficiency at the higher frequencies due to tape self-demagnetising and allied effects. To overcome these, the 'flat' response of the amplifier is modified by introducing a boost at the higher frequencies. This counterbalances the effect of self-demagnetisation in the tape (and of the other high frequency losses) and enables the magnetisation of the tape to be constant over most of the frequency range of the recorder. Since high frequency losses appear in the playback process also, the high frequency boost on record may be made even greater than is needed to overcome tape self-demagnetisation. The risk of tape overload under these conditions is negligibly low because the relative strength of high frequency signals in the audio spectrum is usually much less than that of signals at the medium and lower frequencies.

A typical recording characteristic is given in Fig. 7(a). As may be seen this is virtually 'flat' up to some 1kHz, after which there is quite a considerable treble boost extending to +15dB. (=5.62 times, in terms of voltage or current) at 10kHz. Recorders having more than one tape speed may modify the treble boost for each speed, a typical example being shown in Fig. 7(b). As will be seen, less treble boost is applied as the tape speed increases.

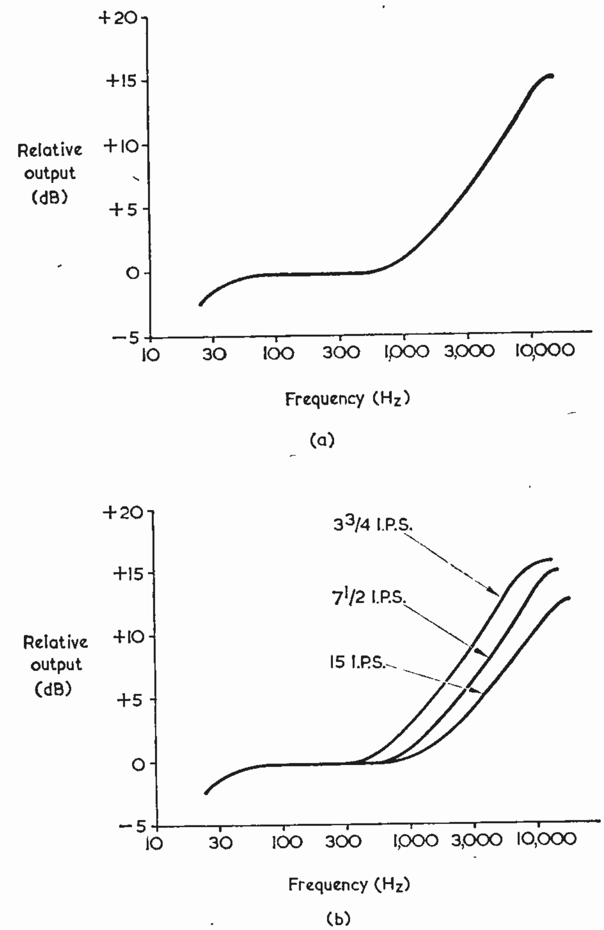


Fig. 7(a). Representative curve illustrating the treble boost that is applied in a tape recorder amplifier during recording
(b). The degree of treble boost may be varied in recorders offering more than one tape speed

NEXT MONTH

In next month's issue we shall examine the process of playback and shall deal with the equalising response characteristics which are employed to provide a 'flat' response for the overall process of recording and playback.

CLANDESTINE STATIONS

The clandestine station Voice of the People of Thailand has been heard at 1600GMT on 6035kHz.

Radio Liberation, another clandestine transmitter, has been heard from 2000 to 2030GMT in French to Europe, and to S.E. Asia, from 1920 to 2000GMT on 10224kHz. Also from 2230 to 2300 on 7416, 10224 and 21000kHz.

THE 'DISCOVERY' S.W. RECEIVER

In the circuit diagram of this receiver, published on page 465 of the March issue, the stick-on symbol for C6 was accidentally removed, and that for R2 damaged, during the block making process. All our circuit diagrams are processed through five separate checking stages. The accidental damage occurred subsequent to the scrutiny procedure.

"FETAFLEX 4" TRANSISTOR PORTABLE

(Continued from page 613)

oscillation does not start without VR1 being near its maximum position. If oscillation does not start with VR1 at maximum, twist L3 a little one way or the other, until oscillation takes place. Remember that L1 is fitted in the right direction when moving it toward the centre of the rod reduces the tendency to oscillate. Now open the vanes of VC1 fully, or nearly fully, and adjust VC3 to a point where oscillation starts smoothly with VR1 advanced about two-thirds of the way towards maximum. Enmesh the vanes of VC1 again and make any small adjustment to the position of L1 as may be necessary, then re-open the vanes of VC1 and adjust VC3 if necessary. Note that movement in L1 has the greater effect at the low frequency end of the scale, and adjustment to VC3 has the greater effect at the high frequency end. Each adjustment has some effect throughout the tuning range.

When L1 and VC3 are both correctly adjusted, and L3 is oriented to best advantage, oscillation should start at the high frequency end of the scale with VR1 set about two-thirds of the way towards maximum, and at the low frequency end with VR1 nearly at maximum, there being a need to advance VR1 progressively, as VC1 is turned throughout its movement. An indication that VC1 has too high a capacitance will be failure to obtain oscillation at all with VC1 fully open, this being combined with lack of selectivity. Uncontrollable oscillation with the vanes of VC1 open means that VC3 has too low a capacitance. If by any unlikely chance the best setting for VC3 should appear to be lower than the minimum capacitance it can offer, C1 can be reduced in value to, say, 300pF. Similarly C1 can be increased to 750pF if best results are obtained with VC3 screwed up tight.

Now turn S1 to long waves and adjust VR2 so that its slider is central on its track. Set VC1 with its vanes slightly enmeshed, to the equivalent of about 225 metres on the medium wave band. Adjust VC2 until Radio 2 is received. Adjust VR2 so that oscillation comes in smoothly. Try moving L2 along the rod for best results, and try also reversing the direction of L2 on its rod or changing the connections to its leads. These adjustments will have less effect when receiving Radio 2 than similar adjustments had with L1 on the medium wave band. No adjustments should be made to L1 and VC3 when setting up for Radio 2. It is just possible that some distortion will be present, particularly on Radio 2, which can be removed by reversing the connections to the red and blue leads of T1, though this action is not likely to prove necessary.

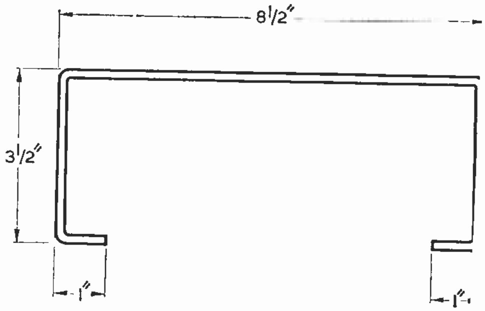


Fig. 10. The carrying handle is made of stiff wire, as illustrated here

TUNING DRIVE

The tuning drive for VC1 is obtained by fitting a standard cord drive drum over its spindle and coupling a second spindle to it in the manner shown in Fig. 5. A rubber grommet, having a diameter which allows it to be a tight fit over the drive spindle, bears against the edge of the drum on VC1 spindle, enabling a simple and effective tuning drive to be obtained. The author used a drum with a diameter of 1¾in. but a 1½in. drum should be equally suitable. The drive spindle requires a bush and this may be salvaged from an old component or purchased new. (A suitable bush is the Home Radio Cat. No. DL52C). The bush is positioned to provide the required mechanical coupling between the drive spindle and the drive drum, with the rubber grommet pressing hard up against the drum. When drilling the hole for the bush take care not to damage any component, including in particular the moving vanes of VC1. A suitable pointer may be secured to the drive drum in any convenient way. For instance, the grub-screw of the latter may be replaced by an ordinary screw with a nut passed over its threads. After tightening the screw the nut can then secure a pointer wire.

A Perspex panel measuring 8 by 5in. fits over the plywood panel as shown in Fig. 6. Three holes are required in the Perspex panel for the spindles and it is spaced off with ½ by ½in. wood spacers. The tuning scale is marked out on a piece of white card and is glued to the plywood panel, the underside of the Perspex panel being partly masked to hide the tuning drive and to provide a window for the scale. A suitable masking material is Fablon, possibly in a contrasting colour to that of the cabinet. The spindle of VC1 should have been previously shortened if necessary, to ensure that it does not foul the underside of the Perspex panel.

BATTERY AND CABINET

The battery is held in position as shown in Fig. 7. The small plywood platform illustrated here is cut and drilled and is then slipped onto the two 4BA bolts shown in Fig. 3, with 4BA nuts beneath and above. The nuts are adjusted such that when the battery is in position and held by the rubber bands shown, the receiver is capable of standing upright, the battery terminals forming feet on one side and the unsecured long edge of the speaker providing support on the other.

The Perspex panel of Fig. 6 next has affixed over it the plywood frame illustrated in Fig. 8. A suitable cabinet can be made from ¼in. plywood, as shown in Fig. 9. Before the pieces for this cabinet are cut out the reader should take accurate measurements of the receiver "chassis", as some speakers may have slightly different dimensions from that used by the author, and the original plywood panel may not have been cut exactly to size. The dimensions in Fig. 9 are mainly intended for guidance and they should be modified as required in practice. Although not shown in Fig. 9 it is advisable to fit a small wooden pad at the inside base of the cabinet to take the centre of the battery and thereby relieve pressure on its terminals. This may necessitate slightly re-adjusting the 4BA nuts which secure the battery platform. Note the cut-outs, both in Fig. 9 and Fig. 8, for the tuning knob. These allow a knob of reasonable diameter to be used. The cut-out in Fig. 9 should match up to that in Fig. 8. A suitable speaker fabric should be secured behind the cabinet speaker aperture. The "chassis" slips in through the top of the cabinet.

The cabinet, and the frame in Fig. 8, can be covered with Fablon for a neat finish. A stiff wire carrying handle may be made up to the dimensions given in Fig. 10.

RECEIVER PERFORMANCE

The sensitivity of the prototype "Fetaflex" receiver is very good, being comparable to that given with the author's "Spontaflex" S.A.4 Transistor Portable (described in the May 1968 issue). Selectivity is unusually good for a single tuned circuit receiver though it is not, perhaps, quite as sharp as with the S.A.4, which was quite exceptional in this respect.

Selectivity is partly dependent on the use of the M3 diode specified. Although the receiver will work with a silicon diode, such a diode will cause a marked fall off in selectivity.

Signal-to-noise ratio is particularly good, being better than with the S.A.4 design and better than that given by the average small superhet, which this design outperforms in nearly all respects except adjacent channel selectivity with powerful local stations.

With a new battery TR1 and TR2 will take about 4mA between them. The distribution of current will depend on the exact characteristics of the semiconductors used, but may be expected to be about 2mA each. TR3 should pass about 120μA, and the base current of TR4 plus current drawn by VR3 will account for about 1mA. TR4 passes 21mA, making for a total of about 26mA as already mentioned. Undistorted output is about 45mW (dissipation by TR4 being 90mW) which is ample for many purposes provided a sensitive speaker is employed.

(concluded)

NEON L.D.R. A.F. OSCILLATOR

(Continued from page 595)

to one, two or more stages of audio amplification.

As a final point, the writer would like to refer to the experience of one reader who built up an earlier 'Suggested Circuit' which similarly incorporated a small wire-ended neon bulb. It was found that neon bulb operation in this circuit became erratic when the bulb was maintained in *complete* darkness. This effect can occur with some neon bulbs of the type used here, these requiring a small amount of incidental light for initial ionisation. Should it be found that the present oscillator circuit functions satisfactorily at low ambient light levels but shows evidence of irregular operation when completely enclosed, it is permissable to provide a small aperture in the light-proof box to ensure that the neon bulb is not in the totally dark condition. There was, incidentally, no evidence, with the prototype circuit that this precaution would be needed.

ELECTRONIC CHRONOMETERS

Whilst electronics have spread rapidly during the past few years to almost every aspect of ships' equipment, one of the items which has undergone little change until recently is the ship's chronometer. Although not such an essential piece of navigational equipment now that radio time signals can be received in almost every part of the high seas, it is still carried as the navigational timepiece by practically every ship engaged in ocean crossings.

During the last few years very successful crystal-controlled, electronic chronometers have been developed to the point where they are now commercially available.

The basis of these new chronometers is a quartz crystal-controlled transistorised oscillator circuit which can be sufficiently well temperature compensated to enable accuracy of time-keeping to be maintained to within one-hundredth of a second per day over wide changes of atmospheric temperature. Furthermore, these instruments do not have to be mounted in gimbals, as are the conventional clockwork chronometers, to protect them from the effects of vessel motion but can, if desired, be mounted horizontally or vertically in instrument panels.

These electronic chronometers are powered by miniature dry cells enclosed in the instrument casing and are thus independent of the electric power supply.

Another system which has also been successfully developed for similar electronic time-keeping uses a miniaturised tuning fork maintained in oscillation by an electronic circuit powered by self-contained miniature batteries. This system is used in the Bulova Accutron Marine Navigating Clock shown in the illustration. ■

SIMPLIFIED SOLID-STATE DISTORTION METER

Continued from page 601

CONSTRUCTION

Construction is straightforward, a panel-shelf arrangement being used as indicated in Fig. 4. All the components are standard, the larger ones being mounted directly on the front panel and most of the smaller on the two printed circuit boards. The layouts of these are given in Figs. 5(a) and (b), which show the boards from the copper side. These boards are reproduced full size and the copper pattern may be traced from the diagrams. The filter circuit panel ("A") is mounted on the lower side of the shelf and the voltmeter panel ("B") on top. Figs. 5(a) and (b) show the orientation of the panels by indicating the edge which is nearest the front panel. Both panels, it will be noted, are secured by the same four 6BA bolts, each panel being kept clear of the shelf by suitable metal spacers. In order to ensure correct alignment of the printed boards it is recommended that both panels be drilled together, i.e. the panels clamped with the copper sides in contact. This operation should be carried out before etching. The author has also found it convenient to drill the fixing holes for the various preset potentiometers before marking out the circuit boards. No measurements are given for these components because the exact dimensions will depend upon the make of components used. It is immaterial which of the two connections to a preset potentiometer mounted on a panel is made to the slider or to the track, and the constructor may choose that which is most convenient in practice.

A small 4-way tagstrip positioned as shown in Fig. 4(b) provides a mounting for C11. The battery leads may also be anchored to this tagstrip or to the switch tags, as convenient. Any small 9 volt battery capable of fitting in the space available under the shelf (such as an Ever Ready PP6) may be used, this being clamped inside the cabinet.

The wiring external to the printed circuit boards follows the circuit diagram of Fig. 3. Chassis connections to points "M", "L" and "W" are automatically made via the mounting 6BA bolts and spacers. Wires connecting to other points on the boards may be soldered direct to the copper or, preferably, passed through small holes drilled for them in the boards and then soldered.

The Input connection is provided by two insulated sockets mounted on the front panel, these connecting to the outside tags of VR1 by short unscreened leads. The slider of VR1 connects to point "A" of Panel "A" by way of screened cable. The braiding of this cable connects to a chassis tag under the 6BA securing nut adjacent to point "A" and, at the other end, to the earthy Input socket. The Output socket is a coaxial socket and it connects via screened cable to the appropriate tag of S1(b). The braiding is earthed by way of a chassis tag under one of the socket securing nuts.

A piece of matt white Formica board, cut slightly smaller than the front panel and mounted on it will give a good finish to the instrument, and also provide a good surface for the attenuator calibrations. Exact dimensions of the front panel will depend upon the meter used. In the prototype this was an ex-W.D. type with a 2in. scale. The case for the prototype was made of wood with dimensions appropriate to the size of panel and the rear projection of the shelf.

CALIBRATION

Before connecting VR8 into the circuit, this component will require calibration for use as the attenuator. This can be carried out in one of two ways. In the first a suitable ohmmeter (e.g. the appropriate range of a multimeter) or resistance bridge is connected between the central and earthy terminals of the potentiometer. The scale is then marked at 500Ω intervals between 5kΩ and 500Ω and at 50Ω intervals between 500Ω and zero. The shape of the scale will be similar to that given in Fig. 6, which also indicates the corresponding values of percentage distortion.

A more accurate method of calibration requires a high resistance voltmeter (i.e. an instrument with at least 20,000 ohms per volt sensitivity) and a 10 volt d.c. supply, a variable voltage transistor type power pack being ideal for the latter. The outer terminals of VR8 are connected to the 10 volt source, and the voltmeter to the central and earthy terminals. The scale is marked at 1 volt intervals from 10 volts to 1 volt and at 0.1 volt intervals from 1 volt to zero. Fig. 6 again gives the relationship between the voltage markings and percentage distortion.

After calibration is complete VR8 is connected into the circuit, and the preset component VR9 adjusted. For this operation S1 is set to the "Off" position and a convenient d.c. voltage applied between point S and the chassis. A voltmeter is connected across VR8, and VR9 is adjusted until the voltmeter reads exactly one-tenth of the total voltage applied.

The final adjustments, before the instrument is ready for use, concern the preset potentiometers in the Wein Bridge network—VR4 and VR5. These are easily adjusted with the aid of an ohmmeter. With the ganged control at maximum resistance the meter is connected across VR6, and VR5 is adjusted for a reading of exactly 1,200Ω. The operation is repeated with the ohmmeter across VR7, VR4 being set for the same reading.

With a battery connected, the instrument switched to the "Filter In" position, and a 1,000Hz input, the level control is set for full scale deflection on the meter. Rotation of VR6/VR7 will now produce a dip in the meter reading. With VR2 set at its mid-point, VR3 is carefully adjusted to produce the maximum dip. As the null point is reached it will be necessary to progressively increase the level of the input. Final adjustments are made with VR2. Once set, VR3 should not require further attention. The instrument is now ready for use.

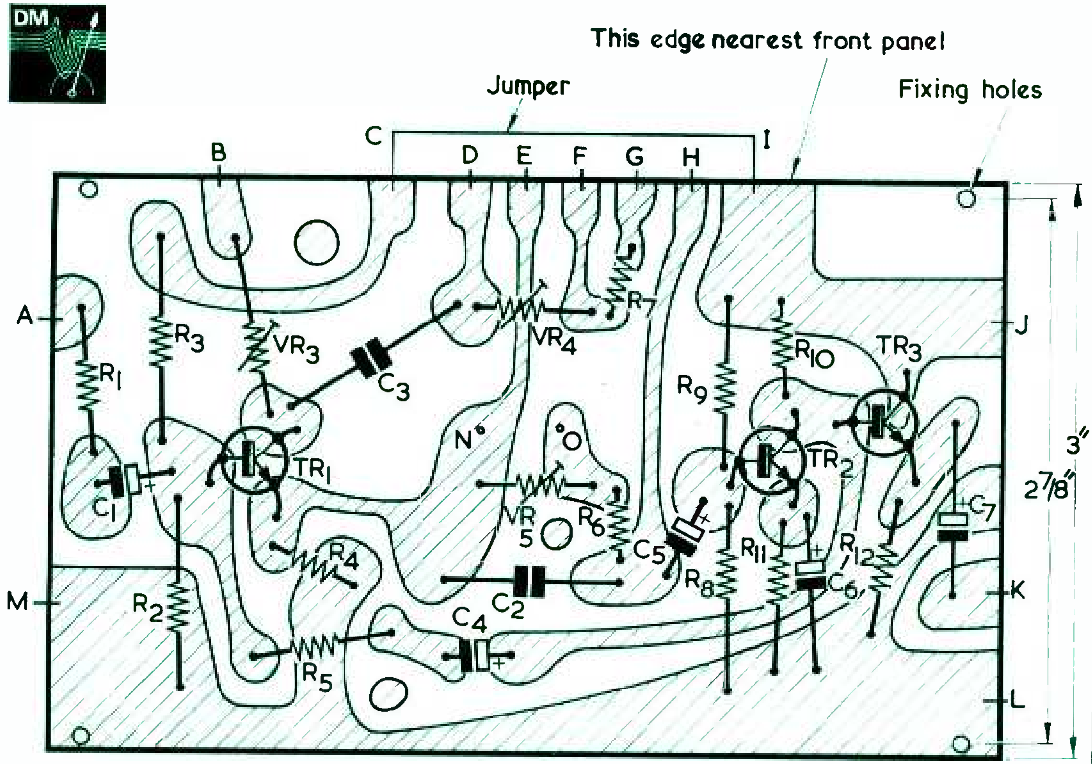


Fig.5a. Layout of components on Panel 'A', as viewed from the copper side of the board

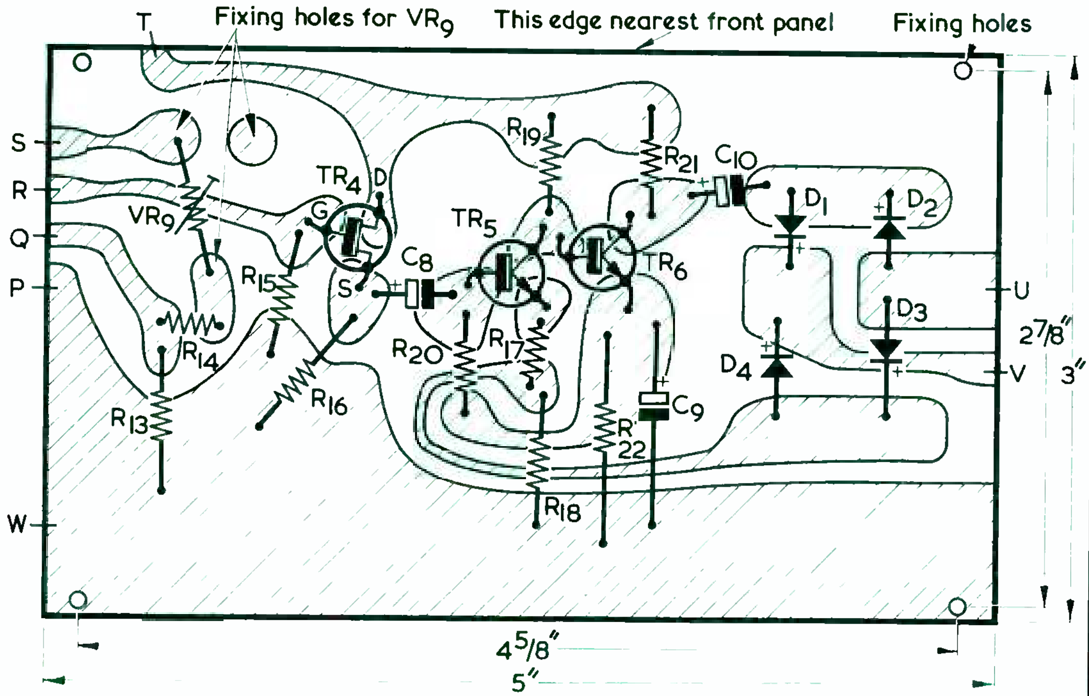


Fig.5b. The components on Panel 'B'. Again, the copper side of the board is towards the reader

Cut along this line

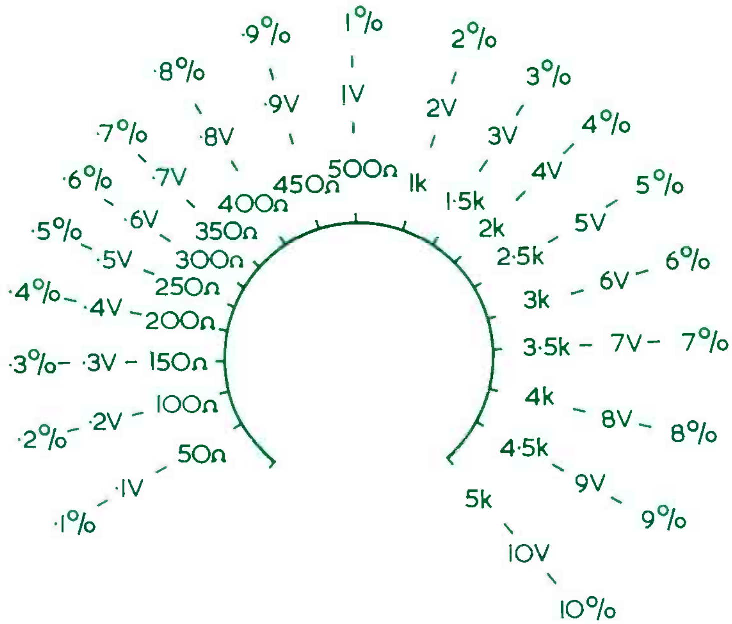


Fig.6 The attenuator control may be calibrated in terms of resistance or voltage readings. This diagram shows the corresponding percentage points for either method of calibration

TABLE

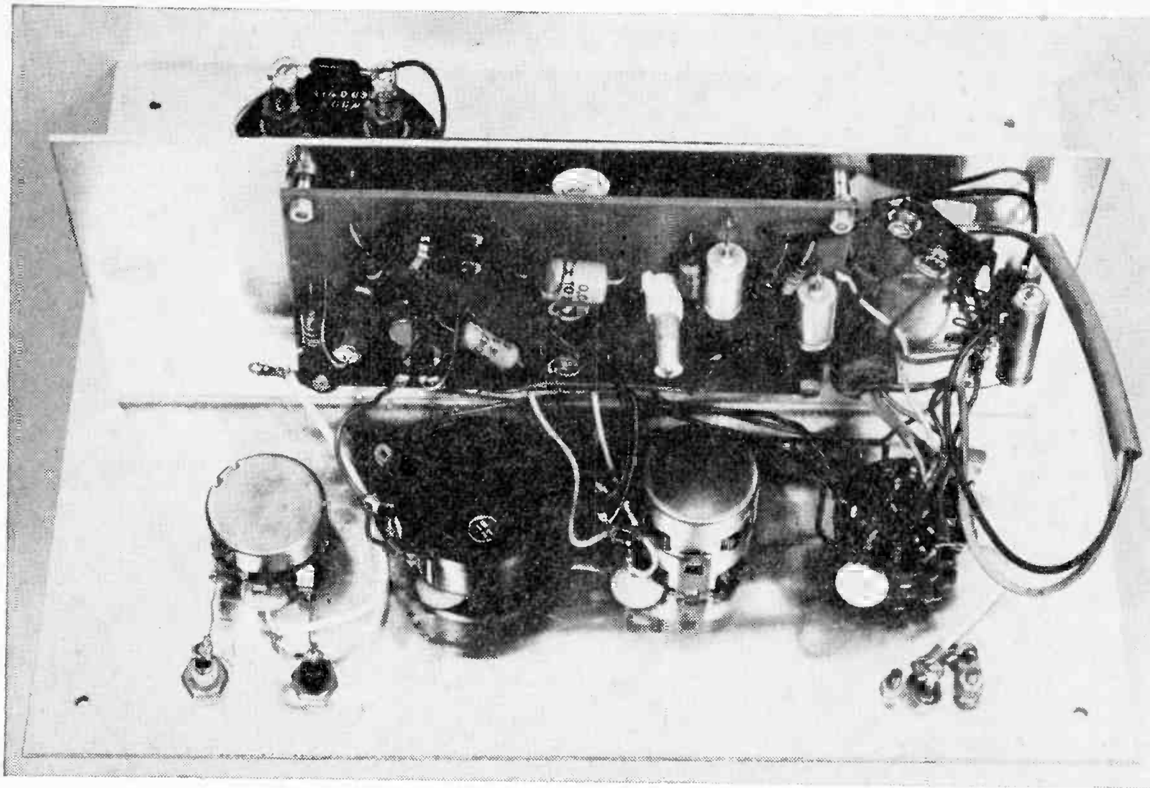
Prototype Voltage and Current readings

TR_1	V_c =	5·5 V
	V_b =	1·6 V
	V_e =	1·0V
TR_2	V_c =	4·5 V
	V_b =	1·1 V
	V_e =	0·5 V
TR_3	V_c =	9V
	V_b =	4·5 V
	V_e =	3·8 V
TR_4	V_d =	9V
	V_s =	3·5 V
TR_5	V_c =	1·5 V
TR_6	V_c =	5·5 V
	V_b =	1·5 V
	V_e =	0·75V

Total current = 8mA

Input to MPF105 (TR_4) for full deflection is approximately 3mV r.m.s. at 1,000 Hz

All voltages taken with valve voltmeter (11MΩ input)



The lower side of the shelf, with Panel 'A'. Note the battery-connector at the end of its two flying leads

USING THE METER

In use, the equipment under test is set up according to design with an appropriate resistive load (i.e. 3Ω, 15Ω, etc.) connected to its output. A 1,000Hz test signal is fed to the amplifier input and adjusted to produce the rated output. The Distortion Meter is connected across the amplifier load and switched to the "Filter In" position. The balance and tuning controls are carefully adjusted for minimum reading on the meter; after which the "Level" control (VR1) is set for a convenient reading which is then noted. The Distortion Meter is now switched to the "Filter Out" position and the attenuator adjusted to produce the same reading on the meter, care being taken not to disturb any of the other settings. The percentage distortion can then be read directly from the attenuator scale.

It will be obvious that the test signal must iteslf be above reproach and should itself be checked by the Distortion Meter. A good quality source is called for but the generator need not be elaborate, and a fixed frequency type producing a low distortion sine wave would be ideal.

It should also be noted that the "Level" control should be set as low as convenient during the test in order to prevent any possibility of overloading the input stage of the Distortion Meter. Overloading this stage would, of course, introduce extra distortion and invalidate the test.

To conclude, a few practical results can be mentioned to illustrate the instrument in use. The Distortion Meter gave the distortion present at the output of a B.S.R. L.O.50A audio generator as 0.75%. Calculations based upon measurements taken with a T-Bridge filter gave the figure as 0.8%. The Meter took approximately two minutes to use; the calculations about fifteen! With an oscilloscope coupled to the Distortion Meter outlet socket, the distortion waveform was seen to be composed mainly of second and third harmonic but with an amount of radio frequency; the latter due to the fact that the L.O. 50A is a beat frequency type of generator. With a tuned L.C. filter in the output of the generator, the Distortion Meter showed that the distortion was reduced to 0.3%.[2]

Using the Distortion Meter, a standard type of valve amplifier, with an EL84 output stage, was found to have just over 2% distortion, which the oscilloscope revealed to be mainly of third harmonic. Calculations based upon the T-Bridge filter gave the figure as 2.1%. Again the Meter took two minutes to operate and the calculations fifteen.

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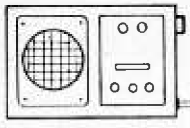
2 It should be noted that the Output socket of the Distortion Meter couples direct to the gate of the f.e.t., TR4. Care should be taken to ensure that no voltages are applied to this socket which could cause breakdown in the transistor.—Editor.

In your workshop



Whilst an Englishman's home may not, these days, be as much his castle as it used to be, a service engineer's junk-box still remains his own private and highly personal treasure trove. With this fact in mind we can readily appreciate the sense of affront Dick experiences when Smithy callously decides that the contents of his assistant's own junk-box are long overdue for clearing out

"DASH IT ALL SMITHY," protested the outraged Dick, "what you propose to do is nothing short of a violation of my rights as a citizen."

"On the contrary," retorted Smithy sternly, "what I intend to do is entirely within my authority."

"Aren't I," asked Dick belligerently, "to have any privacy in this Workshop at all?"

"Not," returned Smithy, "so far as that overflowing junk-box you keep on your bench is concerned. I'm sick to death of hearing you spend one half of the day chucking stuff into it, and the remaining half of the day scrabbling around inside it for odds and ends which shouldn't have been put there in the first place. You must have enough rubbish in that box to start your own refuse collection. Dash it all, I've never seen you empty it out once over all the years you've been working here!"

Smithy drew breath.

"So," he finished, "if you won't clear it out, then I'm jolly well going to clear it out for you myself."

"*You've* got a junk-box."

"I," Smithy corrected him primly, "maintain a *spares* box. What's more, I sort it out every month to see what's worth keeping and what needs throwing out. Also, the stuff I do keep goes into properly labelled containers which enable me to locate what I want without delay."

SPARES BOX SYSTEM

Proudly, the Serviceman indicated a neat array of tins at one end of the shelf behind his bench. "Most of the stuff I hang on to," he went on, "falls into the hardware category, and consists of odd nuts and bolts, small metal brackets and things like that. The whole point behind my scheme is that I can always find anything I want with the minimum of delay or difficulty."

"I suppose," said Dick condescendingly, "you could say that that *is* one way of tackling the junk problem. But what about the time you waste sorting things out so that they can be put into their separate tins?"

"The time I waste?" repeated Smithy incredulously. "The way I deal with my spare bits and pieces doesn't waste time, it *saves* it, mate. If I've got any odds and ends left on my hands when I'm concentrating on a job I just put them in the spares box and forget all about them. Then, about once every month, I sort out what's collected in the box during the period. This sorting out process only takes about half-an-hour or so."

"Ah" broke in Dick triumphantly, "now that's where my system beats yours. I never sort out anything in my junk box ever, which means that whenever I want anything it's *always* there!"

"That statement," said Smithy, rising decisively from his stool, "just about clinches the matter. Your junk-box is going to be cleared out, Dick, and it's going to be cleared out right now."

Dick returned to the attack.

"Is nothing sacred?" he wailed. "A service engineer's private junk-box is something which is personal to him."

"I don't care," returned Smithy doggedly. "I've made up my mind and I'm not going to change it."

Ignoring Dick's continued protestations, Smithy unfolded a newspaper and laid it out flat on his bench. Watched by his mutinous assistant, he reached to the rear of Dick's bench and pulled forward a large wooden box with an open top. Staggering under its weight, Smithy carried it over to his own bench and, with one decisive gesture, up-ended it onto the newspaper. There was a shattering crash as a myriad of pieces of metal, plastic and glass cascaded onto his bench, to form a precarious pyramid. Several dozen screws rolled off the newspaper and clattered onto the floor. They were closely followed by a large bulbous valve on a British 4-pin base, which imploded loudly as it struck the Workshop linoleum. The contents of the box had, apparently, been hovering around critical mass; albeit in a condition of stability until disturbed. Suddenly, a dense mushroom cloud of fine dust appeared above the heap on Smithy's bench, then gradually commenced to diffuse through the Workshop.

Smithy retreated hastily.

"Ye gods," he spluttered. "This is the biggest accumulation of rubbish I've ever seen in all my life."

Dick surveyed his prized collection, now rudely exposed to the public gaze, with an air of resignation.

"All I can say," he remarked, shrugging his shoulders, "is that when I start to collect junk, I certainly make a proper job of it."

"I'll say you do," grunted Smithy. "This must be the most unsavoury and insanitary heap of debris I've ever clapped my eyes on."

By now the cloud of dust had begun to disperse, and Smithy edged warily towards the pile.

"Right," he announced briskly. "Now, let's see what we've got here."

Smithy gazed at the wide diversity of objects he had emptied out onto his bench.

"I must say that you do go in for variety," he remarked, a grudging note of admiration entering his voice. "Where did all these transformer lams come from?"

"Lams? Oh, you mean laminations! They're from an old mains tranny I stripped down way back in 1965 or 1964."

"Couldn't you," asked Smithy a little testily, "have kept them all together in a little cardboard box or something?"

"So far as I remember," replied Dick airily, "I did originally put them in a neat little pile in the corner of the junk-box. Since then, though they've tended to get distributed a bit."

"You can say that again," returned Smithy shortly. "Well, I'll put them on one side as I come to them."

Smithy placed about a dozen laminations tidily at the edge of his bench, then dug into the junk once more.

"What are these?"

"What are what?"

"These cylinders of fluff with wires poking out each end."

"Those," replied Dick with dignity, "are 0.01μF wax covered paper capacitors which I snipped out of an old TV."

"Then, said Smithy decisively, "they can be ditched right here and now. To start off with, you should always look upon old wax covered paper capacitors with suspicion, especially if they're ex-equipment and have therefore been subjected to a number of heating and cooling cycles. This is because they tend to become leaky more frequently than the plastic or metal cased types. However, so far as these particular specimens are concerned there's no point in even worrying about their internal leakage. The leakage path on the outside through the grime and dust which has got stuck onto the soft wax covering will be more than conductive enough to render them unserviceable. Blimey, more laminations!"

Smithy threw the capacitors of hirsute appearance into his rubbish bin, after which a further pile of laminations clattered on top of those already stacked on the edge of his bench.

WIRE-WRAP TAGS

Smithy once more delved into the pile.

"Blow me," he commented. "What's this?"

"That?" replied Dick, turning his attention reluctantly to the object Smithy had produced. "Why, it's just the edge of a broken printed circuit board, that's all."

"What on earth," asked Smithy, holding up the jagged-edged piece of Paxolin, "did you want to keep *this* for?"

"Because it's got a neat row of tags on it," explained Dick. "I'd intended—when, that is, I could snatch a fleeting second from my onerous duties repairing radios and TV's—to cut off the broken edge with a hacksaw and then use that bit of Paxolin as a tagstrip. Incidentally, there weren't half some queer connections to those tags originally. The wires were merely twisted around them without being soldered at all. I just peeled them off."

"These," pronounced Smithy, looking at the tags more closely, "are wire-wrap tags."

"Wire-wrap tags?"

"That's right," confirmed Smithy. "Wire-wrap tags have been used quite a lot in domestic TV sets. If you look at each tag closely you'll see that the bit which takes the wire has a rectangular cross-section with quite sharp corners. (Fig. 1(a)). The wire connecting to it is wound on it under tension with a special wire-wrap tool."

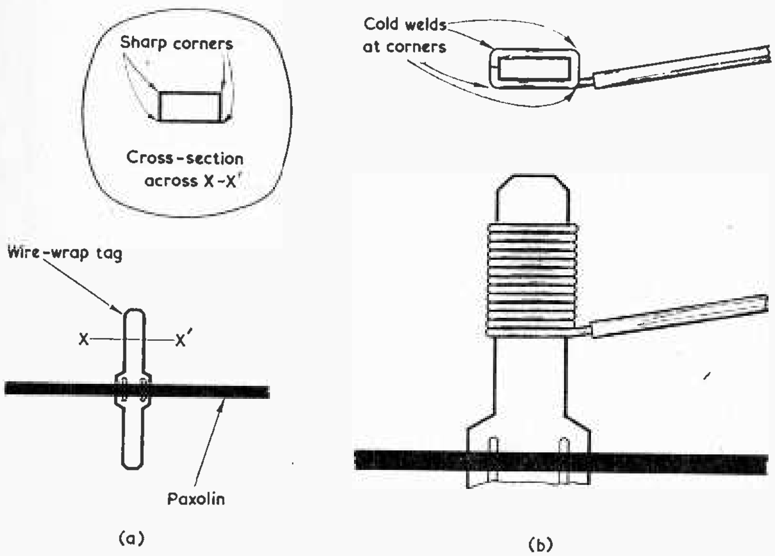


Fig. 1(a). The basic shape and cross-section of a wire-wrap tag (b). Side and top views, showing how the connecting wire is wrapped around the tag

"No solder?"

"None at all," said Smithy. "Due to the shape of the tag and the tension on the wire when it's wrapped round it, you get cold welds at each corner. (Fig. 1(b)). The joints are said to be more reliable than those you get with ordinary soldered joints. In fact, wire-wrap tags are used quite extensively at telephone exchanges and places like that instead of soldered tags."

"That's news to me," remarked Dick. "What happens if you have to take the existing wire off a wire-wrap tag and then put a new one on in its place? Do you just twist the new wire round the tag?"

"Oh no," replied Smithy, shocked. "You can't make a wire-wrap joint without using the proper wire-wrap tool. If you ever have to disturb a wire-wrap joint you afterwards treat the tag as though it were an ordinary solder tag, and solder all the connections that are made to it. Hallo, what have we here?"

Amidst a flurry of laminations, Smithy unearthed a cylindrical aluminium component having a diameter of about 3 ins., and with a hole passing through its centre. At one end were three mounting brackets spaced at 120° intervals.

"It's a TV focus magnet assembly," volunteered Dick.

"So I see," agreed Smithy thoughtfully. "This is the type which used two ceramic ring magnets, each of which exhibited one pole on one of its plane surfaces, and the other pole on the other plane surface." (Fig. 2(a)).

"That's right," put in Dick eagerly. "The assembly fitted over the neck of the c.r.t. and you adjusted the magnetic field it exerted on the beam in the tube by varying the distance between the two magnets. (Fig. 2(b)). The magnets had similar poles facing each other, whereupon the intensity of the field inside the tube neck could be altered until it produced correct focus on the screen."

"These focus assemblies are a bit out of date now," commented Smithy, "seeing that modern tubes use electrostatic focusing. Still, they're worth stripping down, if only for the sake of the magnets. The ceramic magnets that are used in them are extremely powerful and they're just the job for mounting on the back of the bench for holding things."

"What sort of things?"

"Small ferrous objects of the type that are always getting lost," replied Smithy. "Paper clips, razor blades and things like that. (Fig. 2 (c)). When you've finished with any of these you just chuck it in the general direction of the magnet. The magnet is so strong that the object shoots straight towards it and is then conveniently kept available for the next time you need it."

Dick picked up the focus assembly and carried it purposefully back to his own bench.

"I'll strip this down later on," he called out. "You can have one of the magnets for your own bench, Smithy."

"Fair enough," said the Serviceman. "Incidentally, if you're unlucky you may find that the magnets are secured inside the assembly with adhesive, whereupon you may not be able to remove them. In most of these assemblies, though, the magnets are held down by means of simple clamps which can be readily unscrewed."

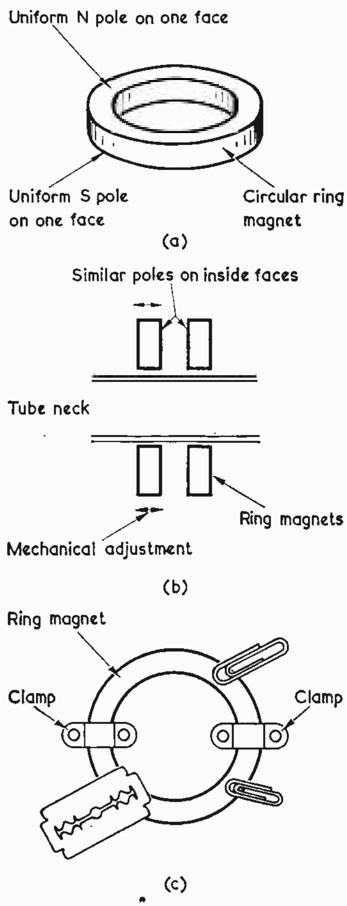


Fig. 2(a). Before the general use of electrostatic focus cathode ray tubes in TV receivers, magnetic focus assemblies employed ceramic ring magnets, as here

(b). The distance between the two magnets in a focus assembly was adjusted to vary the focusing field inside the tube neck

(c). The magnets from discarded assemblies are very powerful, and are extremely useful for holding razor blades and similar ferrous items which normally tend to get lost

As Dick returned to Smithy's bench he found the Serviceman busily probing further into the contents of his junk-box. The Serviceman had already salvaged a sizeable quantity of nuts, bolts, washers and similarly useful items of hardware. The stack of laminations at his side had grown to about an inch in height. As Dick sat down alongside him, Smithy contemptuously threw into his rubbish bin a ½ watt carbon resistor, whose lead-out wires protruded by slightly less than 1/32in.

"Dash it all, Dick," grumbled Smithy, as he reached into the heap once more, "I've never ever seen so much muck before. Yeuk, what's *this* revolting mess?"

Smithy picked up another transformer lamination, to find a further half-dozen laminations adhering loosely to it by means of a sticky mass of yellow gelatinous material. Whilst the shuddering Serviceman held the first lamination up in the air, the weight of the remaining laminations caused the viscous coagulation which bonded them together to slowly extend in length until it became stretched out in the form of a thin string. Smithy gazed at this phenomenon with fascinated aversion, then started as the string suddenly snapped and he was left holding the single lamination on its own. The released laminations returned to their previous junk-box companions with a clatter, followed by a little puff of dislodged dust.

With an expression of acute disgust, Smithy threw the lamination he was holding into his refuse bin.

"Blimey," he gasped. "I'm going to have nightmares tonight, that's for certain. Just what *was* that horrible sticky wodge of stuff?"

Dick frowned.

"Search me, Smithy," he replied. "I never knew I had that in there. Wait a minute, though!"

Suddenly, his brow cleared.

"I remember what it was now," he went on cheerfully. "If you can cast your mind back you may recall that I had a very heavy cold three or four Christmasses ago. I'd just started sucking this cough lozenge when I had an uncontrollable urge to sneeze."

Dick leaned forward, picked up the laminations which were still held in the sticky embrace of the congealed yellow substance, and regarded the latter with affection.

"I've often wondered," he remarked, "just where that cough lozenge *did* get to."

REFRACTIVE INDEX

Irascibly, Smithy snatched the laminations from his assistant's hand and cast them into his bin.

"Well, we know where it went now," he said irately. "Let's see what further abominations we can unearth from the contents of this Pandora's box of yours."

Once more, Smithy attacked the heap of component parts which had been deemed worthy by Dick to share the dusty comforts of his junk-box. The collection of salvaged laminations and small items of hardware on Smithy's bench grew, interrupted on frequent occasion by a grunt of disapproval and the disposal of some hapless component into his refuse bin.

"There's a piece of glass rod here," said Smithy suddenly. "Now, I wonder what you intended to use this for."

Although Dick had largely forgotten his original indignation at Smithy's cavalier action in investi-

"What," he growled, "is so special about it?"

"It gives different degrees of refraction," explained Dick, "for different colours of light."

"Well," remarked Smithy, unwillingly allowing his curiosity to rise. "All glass does that to a small extent, doesn't it?"

"Not as much as that sample of glass you've got there," stated Dick. "The refraction shown by the particular glass that rod is made of varies as much as 180 degrees from one colour to the next."

"Come off it," snorted Smithy. "A statement like that cannot possibly be true."

"Yes it can," persisted Dick. "And, what's more, I'll prove it to you! Let's borrow your note-pad for a moment."

Reluctantly, Smithy passed his pad over to his assitant.

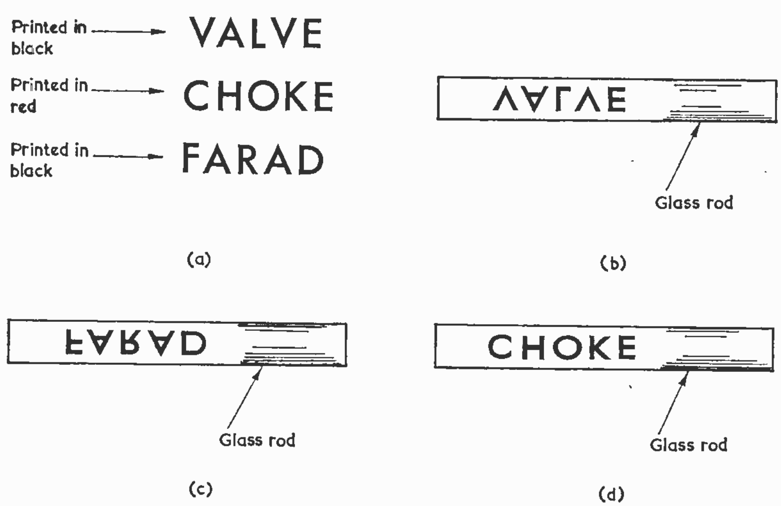


Fig. 3. An interesting exercise in refraction, employing a glass (or Perspex) rod of circular cross-section as a lens. In (a) three words are printed on a sheet of paper, two in black and one in red. When viewed through the glass rod the two words in black appear inverted ((b) and (c)) whereas the word in red appears as printed. This experiment (which can be extremely puzzling to the uninitiated) may be readily repeated by readers

gating the contents of his junk-box, a feeling of affront still prevailed. As he looked at the rod Smithy held up in the air a sudden, and immediately suppressed, gleam came into his eye.

"That," he remarked mysteriously, "is not an *ordinary* glass rod."

"Isn't it?" queried Smithy. "It looks perfectly ordinary to me. Just a round solid glass rod about 4 inches long and ⅜ inch in diameter."

"I'm not talking about its dimensions," returned Dick airily. "I'm talking about the glass itself. It's the glass that's special."

Smithy squinted suspiciously at the rod.

"Right," said Dick, reaching in his pocket and taking out two ball-point pens. "Now I'll print three words on this pad, two in black and one in red. The actual words don't matter, so let's choose some that have to do with electronics. At the top I'll print the word 'VALVE' in black. Then I'll print 'CHOKE' in red and, finally, put 'FARAD' at the bottom, in black. All right?" (Fig.3(a)).

"I can't see anything wrong so far," grunted Smithy distrustfully. "What happens next?"

"I'd like you," said Dick, "to hold that glass rod over the paper so that it's level, horizontal and about half an inch away from the paper surface. First pass it over the top word in black. Now, what do you see?"

"What I'd expect to see," growled Smithy impatiently. "The word 'VALVE' upside-down," (Fig.3(b)).

"Now do the same over the bottom word in black."

"The same thing happens," said Smithy irritably. "This time, it's the word 'FARAD' which is inverted." (Fig.3(c)).

"That inversion," remarked Dick knowledgeably, "is given because those two words are printed in black. Now, hold the glass rod over the word that's printed in red."

Smithy held the rod over the central word, glanced down at it then exclaimed with astonishment. (Fig.3(d)).

"Blow me," he gasped, "the word's right way up!"

With an expression of incredulity Smithy examined the glass rod closely. This enterprise yielding no clue he held the rod over the paper once more, then passed it slowly over the three printed words on its surface.

"This," he muttered to himself, "just *cannot* be happening."

"I told you," said Dick triumphantly, "that that rod was made of special glass. But you wouldn't believe me, would you?"

"I still don't," returned Smithy flatly. "But at the same time I don't know why it inverts only the two words printed in black and not the one printed in red."

Yet again, the frowning Serviceman passed the rod over the three words. Scowling ferociously, he gazed deeply at the paper and then at the rod. Suddenly, he gave vent to a great roar of laughter.

"You *crafty* devil," he chuckled. "You certainly had me on the hook there for a bit, didn't you?"

"D'you see how it's done?"

"I do," grinned Smithy. "And I'll also agree that you succeeded in putting one over on me as well. You will, of course, get the same effect with any solid glass rod of about the same diameter."

"That's right," agreed Dick. "A solid Perspex rod will do it just as well, too. For best results you want to print the letters so that their height is a little less than the diameter of the rod."

"Very good," commended Smithy. "Very good, indeed. Well, after that little diversion let's get back to this junk of yours."

RESISTANCE BOX

Smithy cleared some further laminations from the pile, abstracted a few more nuts and bolts, then picked out about a dozen panel-mounting potentiometers.

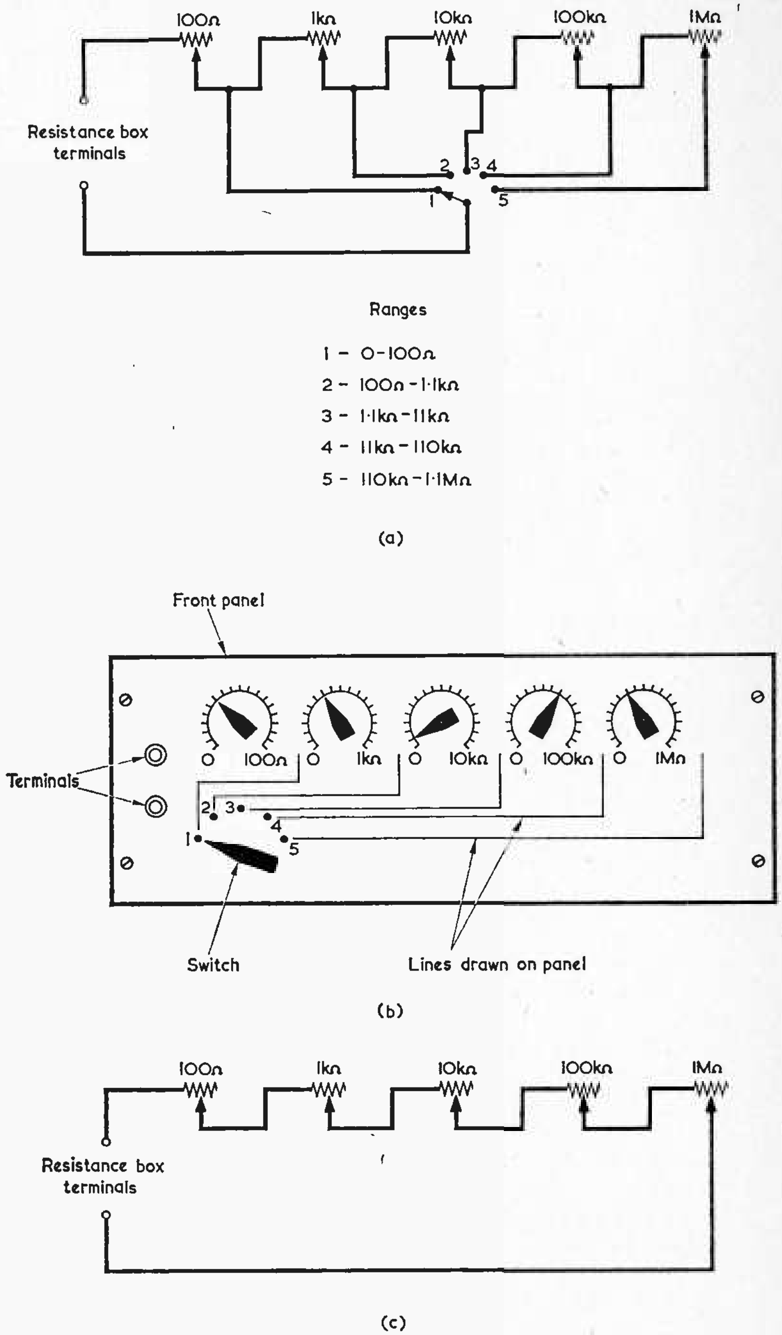


Fig. 4(a). A simple resistance substitution box. All the potentiometers have linear tracks. The function of the switch is to cut out of circuit the potentiometers having track values higher than the resistance required across the terminals; this fact is reflected in the range figures quoted

(b). A suitable front panel layout. The lines drawn on the panel illustrate graphically the potentiometers that are switched into circuit

(c). Dick's alternative circuit, which omits the switch, is not satisfactory in practice

"Why, that's interesting," he remarked. "You've got quite a lot of pots here which look pretty new to me. Funnily enough, they're all linear track types. Let's have a look at their values."

Smithy examined the potentiometers carefully.

"There's quite a nice little run of values as well," he resumed, laying the potentiometers on his bench in a row. "Amongst them, there's a 100Ω, a 1kΩ, a 10kΩ, a 100kΩ and a 1MΩ."

"I didn't know I had all those," admitted Dick. "They must have gone into the box at different times and somehow managed to find the same level afterwards."

"If they're in working order," remarked Smithy musingly, "you could make them up, together with a single pole 5-way switch, into a simple little resistance substitution box."

"Could I?" asked Dick. "How?"

Smithy retrieved his note-pad, removed the top sheet on which Dick had printed his three words, two in black and one in red, then scribbled out a circuit on the sheet underneath. (Fig. 4(a)).

"Here we are," he remarked. "This circuit is for a simple resistance substitution box offering continually variable resistance values from about 10Ω to about 1.1MΩ. You need five linear track pots, with values respectively of 100Ω, 1kΩ, 10kΩ, 100kΩ and 1MΩ. What you do is to mount the pots on the panel of a suitable box, then fit them with pointer knobs and scales. (Fig. 4(b)). Each scale is calibrated in terms of the resistance the particular pot behind it inserts into circuit, the calibration being carried out with the aid of a testmeter switched to read ohms, or of any other resistance-measuring instrument."

"What's the function of the 5-way switch?"

"To select the range of resistance you want to appear at the two terminals of the box," replied Smithy. "If, for instance, you want a resistance in the range of 1.1 to 11kΩ you set the switch to Range 3. The 100Ω, 1kΩ and 10kΩ pots are then in series and the total resistance appearing across the terminals of the box is equal to the sum of the resistances shown on the scales of these three pots."

Dick looked impressed.

"It occurs to me," he said, after a moment's thought, "that you could do all this without a switch at all. All you need to do is simply connect all the pots in series."

Dick picked up Smithy's pad and sketched out a further circuit. (Fig. 4(c)).

"This," he announced, "is what I have in mind. If you want resistances up to say 10kΩ, all you need then do is to set the 100kΩ and 1MΩ pots to zero and adjust the 100Ω, 1kΩ and 10kΩ pots to the value you require."

"In theory that's fine," replied Smithy. "But in practice it wouldn't work."

"Why not?"

"Because ordinary panel-mounting pots of the type we're discussing here don't always give zero resistance when their spindles are turned fully to the limits of their travel. What usually happens is that a small amount of the track is still left in circuit. The resistance offered by that small section of the track doesn't upset the operation of the pot in its normal application because it's usually a tiny fraction of the overall track resistance. But in the present application that small amount of resistance could upset things completely. Let's say, for instance, that when the 1MΩ spindle is turned fully anti-clockwise, the resistance between the slider and the appropriate end terminal is 100Ω. This is negligibly low compared with the full track resistance of 1MΩ. In the present circuit, though, that 100Ω would completely upset the accuracy of results given with the 100Ω and 1kΩ pots. A further argument against omitting the switch is that the minimum resistance obtained with the 1MΩ pot wouldn't always be constant in any case; it's so very tiny compared with total track resistance that you're bound to get variations in its value."

"You've got me convinced," grinned Dick. "In other words, you adjust the switch so that the minimum number of pots is employed for setting up the resistance you require."

"That's right," confirmed Smithy. "Not only would a resistance box of this nature use up those gash pots you've had lying around all those years, but it would also be quite a useful bit of experimental gear in its own right. Anyway let's get some more of this junk of yours cleared out."

HIDDEN OCCUPANT

Smithy had been automatically sorting out further components from the heap on his bench as he spoke. When he turned his full attention to the parts left on his newspaper he was surprised to find how much progress he had made. Only about a twentieth part of the original mass of components remained.

"Laminations, laminations, laminations," he grumbled, as he added several dozen more to what had now become quite an impressive pile at his side. "These darned transformer lams seem to have got in everywhere amongst this rubbish. Why, here's another dozen, all spread out. Ooh, my Gawd!"

Smithy suddenly snatched back the hand which had been on the point of picking up the laminations. He clutched Dick's arm in panic.

"What on earth's up?"

"There's a *thing* in there amongst those lams," whispered Smithy. "A horrible, stealthy, hairy thing. It just slithered under the top lam as I put my hand out towards it."

Unconcernedly, Dick poked his finger at the lamination in question.

"For heaven's sake," gasped Smithy, "have a care, boy. Who knows what nameless horror lies lurking amongst those lams?"

"Corluvaduk," said Dick in disgust. "What's all the fuss about? It's probably only a spider."

"A spider? A *spider?* What species of spider is it that can live all these years on bits of brass and copper and tin and p.v.c.?"

"He's probably been living on all the other insects that are left in there."

Smithy's lower jaw sagged and he gazed at the remaining junk with revulsion.

"I'm not," he remarked resolutely, "going to entertain a whole crowd of insects on *my* bench."

With a shrinking gesture, Smithy carefully gathered up the four corners of the newspaper on his bench, then used this to carry its burden of electronic and entomoid scrap through the door of the Workshop. The hasty banging of the dustbin lid outside next proclaimed that Smithy, as befits any honest ratepayer, had decided to entrust his difficulties to the good offices of the local Cleansing Department.

This is, perhaps, a fitting moment at which to leave our pair as, after having satisfactorily settled the problem of Dick's junk-box, they turn their energies to the more prosaic and predictable pursuit of repairing faulty radio and television receivers. There remains only the question of those words in black which were inverted by Dick's glass rod, and of that in red which was not. Readers who have not already spotted the simple secret of this phenomenon have merely to do a little inversion of their own in order that they may read what follows.

LETTER INVERSION

The word 'CHOKE' was, of course, inverted by the glass rod in just the same way as were the other two words. However, the individual letters in 'CHOKE' are symmetrical about their horizontal centre line and appear the same after they have been inverted. Other letters offering the same result are B, D, I and X.

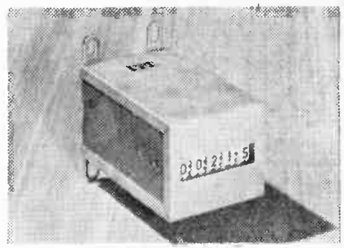
CURRENT TRENDS

ITT Components Group Europe are now introducing a range of high-quality, low-cost electric counters to the U.K. market. Basic models are:

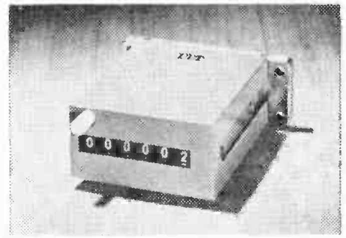
E507 ELECTRIC COUNTER

A compact, reliable 5-digit electric counter. Tamperproof and non-resetting, it is well suited to vending application. Standards models designed to UL specifications are available for normal d.c. voltages and 240V 50/60Hz, but other voltages and frequencies can be supplied. Count pulse length may be from 50 ms upwards; minimum pulse off time is 50 ms.

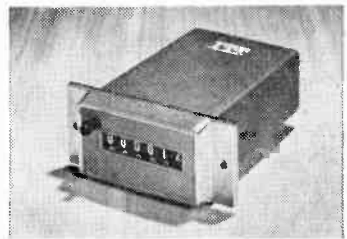
The frame is finished in bright aluminium, and base or panel mounting variants are offered. Operating ambient temperature range is 0°F to 160°F. The unit will count accurately at speeds up to 600 counts per minute through a minimum life of one million counts. Power consumption 3.6 watts.



The E507 Electric Counter



The E602 Electric Counter



The E610 Electric Counter

E602 ELECTRIC COUNTER

A high-speed 6-digit counter with pushbutton quick reset (instant zeroing). Speed is up to 1,000 counts per minute and life is conservatively rated at 10 million counts. It can be actuated by any switch, relay, photoelectric or other circuit breaking device that makes and breaks without chatter, minimum duration for both make and break being 30 ms.

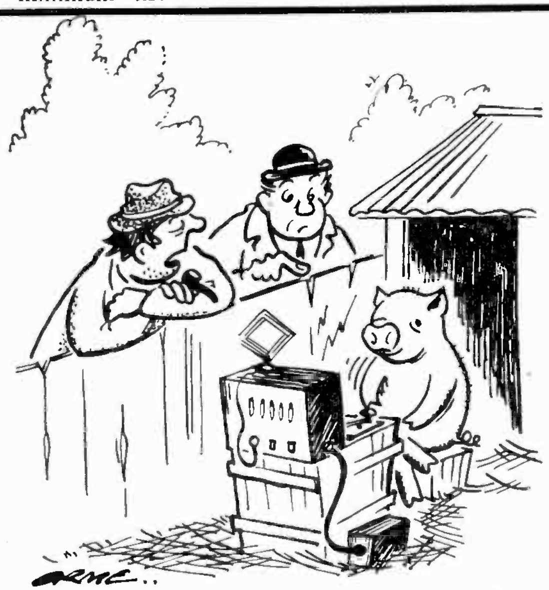
Power consumption is 6 watts and the counter is available in 6V. 12V, 24V, 48V and 100V d.c. ratings, and 100V, 120V, 200V and 240V 50/60 Hz a.c. ratings. It meets a wide range of requirements on laboratory equipment, office machines, coin-operated machines and many kinds of industrial machines.

E610 & E410 ELECTRIC COUNTERS

Very fast counters intended for long service. The 6-digit E610 is rated at 2,100 counts per minute, the E410 at 1,200, and conservative life rating in each case is 30 million counts. Both feature pushbutton quick reset (instant zeroing), and are available for base or panel mounting.

Consuming 5 watts at 6V, 12V, 24V, or 48V d.c. as required, they can be actuated by any chatter-free switch or circuit breaking device. Minimum pulse on time for the E610 is 19 ms, minimum pulse off time is 9.6 ms. Corresponding times for the E410 are 25 ms and 25 ms.

Both counters have die-cast housing with nickel-plated aventurine finish. They provide a wide range of requirements for built-in counters on industrial, laboratory and office equipment, coin-operated machines, and conveyor lines. From: ITT Components Group Europe, Trading Services, Edinburgh Way, Harlow Essex. Telephone Harlow 26811, telex 81146.



"Do you mean to say you've never heard of a ham radio operator?"

SGS PUBLICATIONS

Two publications – 'Industrial Discrete Devices' and 'Integrated Circuits' – are now available from SGS (United Kingdom) Ltd. 'Industrial Discrete Devices' lists all SGS discrete semiconductor devices (diodes, transistors and phototransistors) intended for industrial applications, together with full details of characteristics and operating conditions. A short section at the beginning of the publication enables specific devices to be located quickly in terms of the more important characteristics and applications. 'Integrated Circuits' has a similar section at the beginning for location of integrated circuits, then gives full information on all SGS integrated circuits, including linear and logic units. Both publications may be obtained from Data Services Department, SGS (United Kingdom) Ltd., Planar House, Walton Street, Aylesbury, Bucks. The price of each is 21s.

LONDON AMATEUR RADIO MOBILE RALLY

The Ealing and District Amateur Radio Society is holding its first Mobile Rally on 10th May, 1970 at Hanwell Community Centre, Westcott Crescent, Hanwell, London, W.7. The rally is believed to be the first ever held in London.

LATE NEWS

★ AMATEUR BANDS

● SWITZERLAND

4U1ITU has been heard on Top Band cw and also on 21Mhz. QTH given as U.N. Geneva.

● PORTUGUESE GUINEA

CR3KD heard using cw and ssb modes on 14MHz band.

● 3.5MHz

Dx activity at the ssb end of the band still continues apace during the early mornings. Heard recently were – HC2GG/1, OA4LNA, OA8V, PZ1AH, VO1FX, W3GQF, W4OKZ and W4RDD/VP9.

● SENEGAL

Very active on 14MHz cw recently has been 6W8DQ. If you can work him under the 'wolf-pack' QRM you'll be lucky!

★ BROADCAST BANDS

● LEBANON

Beirut (100kW) now broadcasts to Africa from 1830 to 2030 on **15350** and to S. America from 2300 to 0100 on **17715.** The service to N. America from 0230 to 0300, in English, on **11790** remains unchanged.

● PAKISTAN

Another new channel has been observed by our Listening Post (see Now Hear These, April issue) and was first heard early in February. Now identified as Peshawar on **3940,** with Indian-type music at 1640. At 1700 a newscast in Urdu is preceded by 6 'pips'. Closes at 1730.

● HAITI

Radio Lumiere has increased power to 10kW. Listed on **2410,** schedule from 1000 to 0300 and **9635,** schedule from 1300 to 0330, both with a power of 250 watts.

● INDIA

All India Radio is currently installing two new 100kW transmitters for European coverage. Tests are expected to commence next month. Reports will be required.

● MALTA

Duetsche Welle is to set up a relay station for services directed to Africa mainly in the Arabic language.

● VENEZUALA

Radio Barquisimeto is reported to have increased power from 10 to 15kW. R. Barquisimeto operates on **4990** and **9510kHz.** On the former channel the schedule is from 1000 to 0400GMT and on the latter from 1200 to 0300GMT. The address is – Apt. 567 y 576, Barquisimeto and verification is by QSL card.

● CUBA

Radio Havana (50kW) has changed frequencies for the English to N. America programme and is now on **9550** and **11970,** replacing **9525** and **11860.**

● SYRIA

Damascus (50kW) has moved back to **15165** from **9670,** broadcasting to Europe in German at 1830, French at 1900 and in English at 2030 to 2200 sign off.

Acknowledgements to our own Listening Post and Swedish Dx'ers. ■

RADIO CANADA

On February 25th, Radio Canada celebrated its 25th anniversary. Plans for the development of CBC's short wave transmitters, located at Sackville, New Brunswick, include the installation of five 250kW transmitters to supplement the three 50kW units which have been in operation since 1945. The aerial arrays will be improved to handle the increased power.

Owing to financial restrictions, the improvements will have to be phased over a period of some four to five years. Two of the new higher-powered transmitters however should be in operation early next year. For the initial transmitting period of from twelve to eighteen months, these new transmitters will only radiate programmes directed to Europe.

In 1945, when the Canadian Broadcasting Corporation began regular international short wave broadcasts of the twenty countries engaged in this activity Canada was in the forefront. At the present time there are about 150 countries having international broadcasting services and Canada has slipped out of the top 50 in terms of numbers and powers of transmitters. The Radio Canada transmitters operated for seven hours daily in 1945 but today they are on the air for 22 hours every day serving not only the International Service but also the Northern and Armed Forces Services. ■

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(Continued on page 645)

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(Continued from page 643)

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(Continued on page 647)

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(Continued from page 645)

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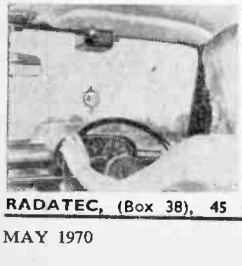

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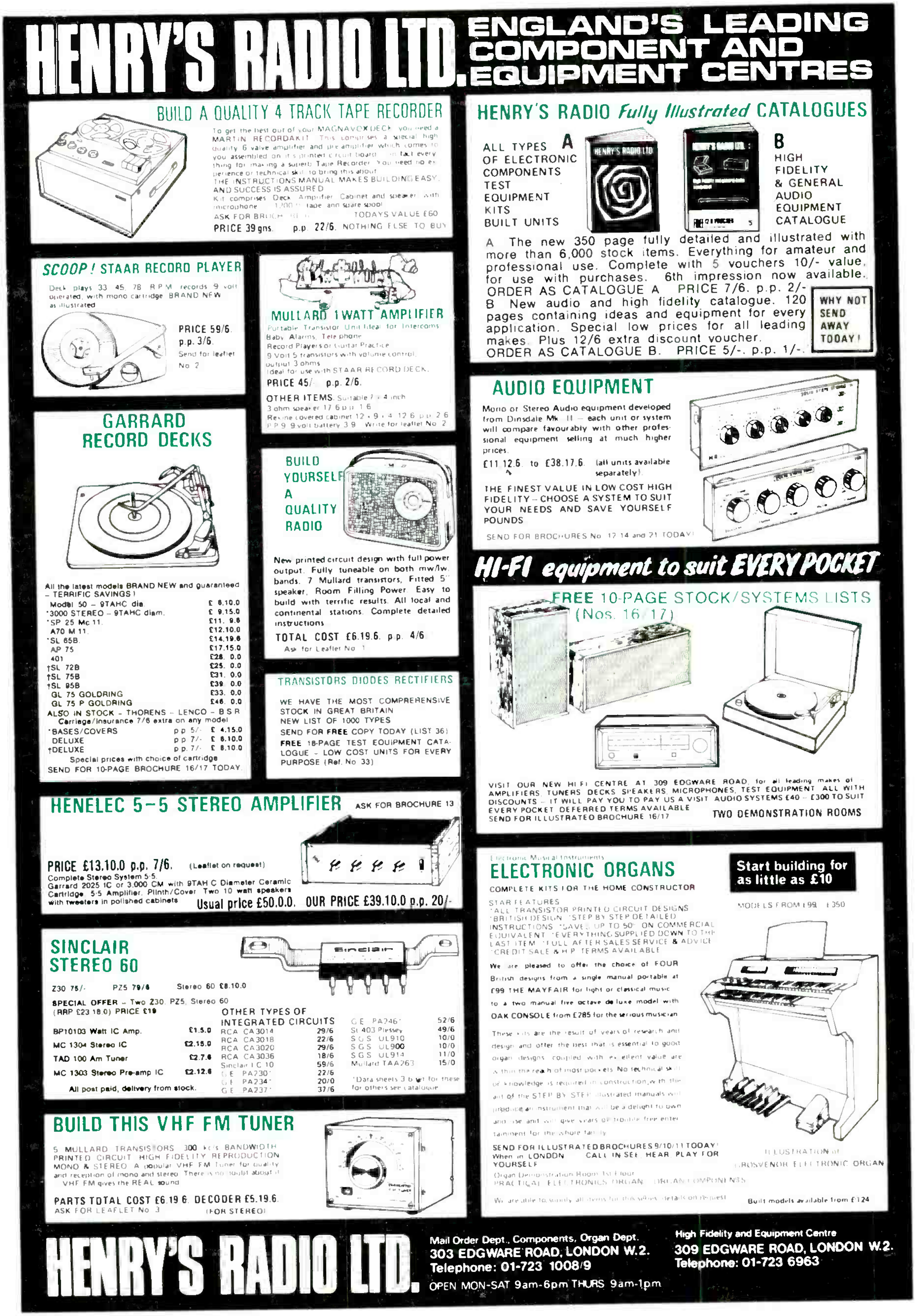
RADIO CONSTRUCTORS DATA SHEET 38

ABBREVIATIONS—A to L

The Table lists the more commonly employed abbreviations, from A to L inclusive, which are encountered in electronic work.

A	ampere
a.c.	alternating current
a.f.	audio frequency
a.f.c.	automatic frequency control
a.g.c.	automatic gain control
Ah	ampere-hour
a.m.	amplitude modulation
a.n.l.	automatic noise limiter
a.t.u.	aerial tuning unit
a.v.	alternating voltage
b.f.o.	beat frequency oscillator
B.S.S. or B.S.	British Standard Specification
C	capacitor or capacitance
C.C.S.	continuous commercial service rating
c.g.s.	centimetre-gramme-second system of units
c.o.	crystal oscillator
c.r.o.	cathode ray oscilloscope
c.r.t.	cathode ray tube
c/s	cycles per second (now superseded by Hz)
c.w.	continuous wave
dB or db	decibel
d.c.	direct current
d.c.c.	double cotton covered
d.p.d.t.	double pole, double throw
d.p.s.t.	double pole, single throw
d.r.c	double rayon covered
d.s.b.	double sideband
d.s.c.	double silk covered
d.v.	direct voltage
e.c.o.	electron-coupled oscillator
e.h.f.	extremely high frequency
e.h.t.	extra high tension
e.m.f.	electromotive force
e.m.u.	electromagnetic unit
e.r.p.	effective radiated power
e.s.u.	electrostatic unit
eV	electron-volt
F	farad
f	frequency
f.c.	frequency changer
f.m.	frequency modulation
f.s.d.	full-scale deflection (meter)
f.s.k.	frequency-shift keying
f.w.	full wave
gc	conversion conductance
gm	mutual conductance
H	Henry
h.f.	high frequency
h.t.	high tension
h.w.	half wave
Hz	Hertz (= 1 cycle per second)
I	current
i.c.w.	interrupted continuous wave
i.f.	intermediate frequency
i.f.t.	intermediate frequency transformer
i.s.b.	independent sideband
J	Joule
K	Kelvin (absolute) temperature
kHz	kilohertz (= 1,000 cycles per second)
kV	kilovolt
kVA	kilovolt-ampere
kVh	kilovolt-hour
kW	kilowatt
kΩ	kilohm
L	inductor or inductance
LC ratio	inductance/capacitance ratio
l.f.	low frequency
l.s.	loudspeaker
l.w.	long wave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