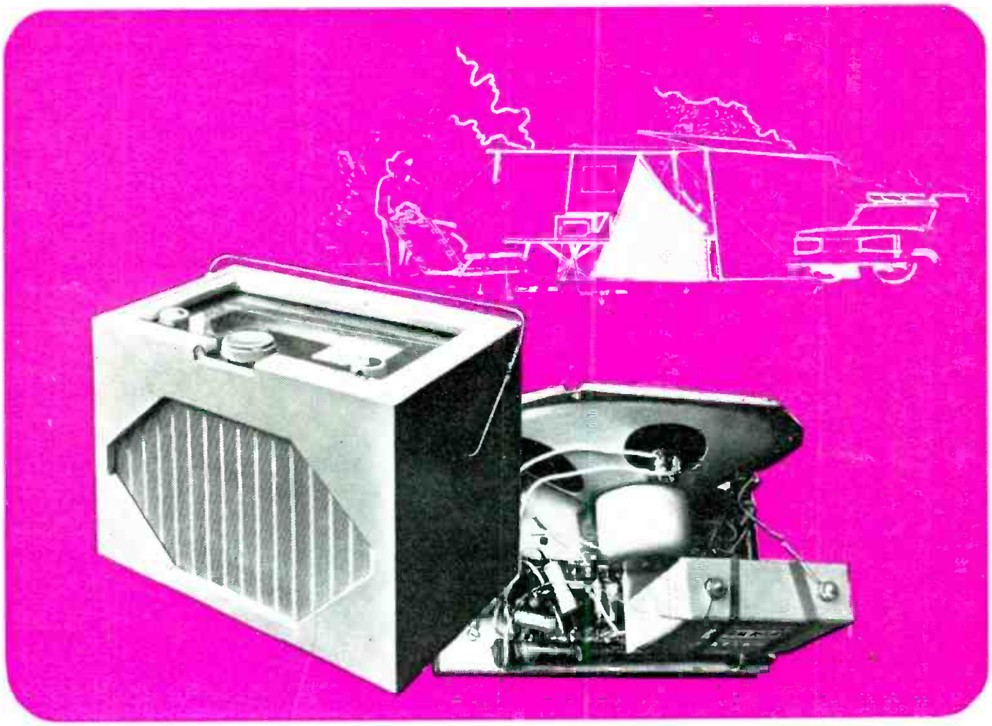
THE RADIO CONSTRUCTOR

Vol. 23 No. 9 APRIL 1970 THREE SHILLINGS



"FETAFLEX 4" TRANSISTOR PORTABLE RECEIVER

A sensitive and selective design incorporating an insulated gate f.e.t.

FEATURED IN THIS ISSUE

Dual-EL84 Hi-Fi Amplifier

Cassette Recorder Mains Unit

EXCLUSIVE

Workshop Equipment Offer

New 1970 prices LST Electronic Components Ltd.

AC107	14/6	BD123	21/6	NKT141	7/-	OC84	5/-	2N386	12/-	2N3416	7/6	2S320	9/-
AC126	5/-	BD124	12/-	NKT142	6/-	OC123	7/-	2N385A/		2N3436	15/-	2S321	6/-
AC127	5/6	BF115	5/-	NKT143	5/6	OC139	5/-	2N388A	15/-	2N3525	21/9	2S323	10/-
AC127Z	9/6	BF152	13/6	NKT144	8/-	OC140	7/-	2N404	4/6	2N3528	19/-	2S701	8/6
AC128	4/-	BF154	9/-	NKT152	3/6	OC170	5/-	2N410	8/-	2N3606	5/6	2S703	12/6
AC176	5/-	BF159	15/-	NKT161	6/-	OC171	6/-	2N458A	25/-	2N3607	4/6	2S720	25/-
AC187	12/-	BF163	9/-	NKT162	6/-	OC200	6/3	2N511A	49/6	2N3702	3/3	2S732	8/6
AC188	12/-	BF167	5/-	NKT163	5/6	OC201	9/6	2N513A		2N3703	3/-	2S1002	10/-
ACY17	5/-	BF173	6/-	NKT164	5/6	OC202	18/-		122/6	2N3704	3/3		
ACY18	3/6	BF178	10/6	NKT165	6/-	OC203	7/6	2N599	10/-	2N3705	3/-	DIODES &	
ACY19	4/5	BF179	12/6	NKT211	6/-	OC204	8/-	2N601	25/-	2N3706	2/9	RECTIFIERS	
ACY20	3/7	BF180	6/-	NKT212	6/-	OC205	9/-	2N657	20/-	2N3707	3/-	AA119	2/-
ACY21	4/-	BF181	6/6	NKT213	4/-	OC206	10/6	2N696	4/-	2N3708	2/-	AAY11	2/-
ACY22	2/9	BF184	7/-	NKT214	4/-	OC207	7/6	2N697	4/-	2N3709	3/-	AAZ12	6/-
ACY40	3/-	BF185	8/-	NKT215	4/-	OC309	12/-	2N698	6/-	2N3710	3/-	AAZ13	2/6
ACY41	4/4	BF194	3/6	NKT216	10/-	OCP71	19/6	2N706	2/6	2N3711	3/-	BA100	6/-
ACY44	8/-	BF200	10/6	NKT217	13/-	ORP12	9/6	2N706A	2/6	2N3819	8/-	BA110	6/-
AD140	11/-	BFX13	5/-	NKT218	5/3	ORP60	8/-	2N708	4/-	2N3820	18/9	BA111	6/-
AD149	11/6	BFX29	8/-	NKT219	6/-	ORP61	8/-	2N711	7/6	2N3826	6/-	BA112	18/-
AD161	6/-	BFX44	8/-	NKT221	5/6	ORP63	9/-	2N711A	7/6	2N3854	5/6	BA115	1/6
AD162	6/-	BFX84	7/6	NKT222	4/-	P346A	5/-	2N715	7/6	2N3854A	5/6	BA130	3/-
ADT140	12/6	BFX85	9/-	NKT223	3/6	RAS310AF		2N716	7/6	2N3855	5/6	BAY31	2/6
AF102	12/6	BFX86	6/6	NKT224	4/6		6/-	2N743	4/6	2N3855A	6/-	BAY38	3/-
AF106	7/6	BFX88	5/-	NKT225	3/6	RAS508AF		2N744	6/-	2N3856	6/-	BY100	5/-
AF114	5/-	BFY50	4/6	NKT226	10/-		15/-	2N753	5/6	2N3856A	6/-	BY125	3/6
AF115	5/-	BFY51	3/9	NKT227	5/6	SIM	19/-	2N914	4/6	2N3858	5/-	BY127	4/-
AF116	5/-	BFY52	4/6	NKT228	6/-	S4M	33/6	2N918	7/6	2N3858A	6/-	BY234	2/3
AF117	5/-	BFY53	3/2	NKT261	4/3	ST140	3/-	2N929	5/6	2N3859	5/6	BYX10	3/-
AF118	12/6	BFW57	6/-	NKT262	4/3	ST141	5/-	2N930	7/6	2N3859A	6/3	BYX36/	
AF121	6/-	BFW58	5/6	NKT264	4/3	ST2	9/9	2N1090	6/6	2N3860	6/-	150	2/6
AF124	4/6	BFW59	5/-	NKT271	4/-	T1407	9/8	2N1091	6/6	2N3866	25/-	BYX36/	
AF126	3/6	BFW60	4/6	NKT272	4/-	TIP31A	19/6	2N1131	6/6	2N3877	9/-	300	2/10
AF127	3/6	BSX19	3/6	NKT273	4/-	TIP32A	22/6	2N1132	8/-	2N3877A	9/6	BYX36/	
AF139	7/6	BSX20	3/4	NKT274	4/-	TIS34	17/6	2N1302	4/-	2N3900	10/6	600	3/9
AF178	9/6	BSX21	7/6	NKT275	5/-			2N1303	4/-	2N3900A		BYY21	25/-
AF179	11/6	BSX76	4/-	NKT276	3/6	TIS44	1/9	2N1304	5/-		11/6	BYY23	26/3
AF180	12/6	BSX77	6/-	NKT279A	2/6	TIS45	3/3	2N1305	5/-	2N3903	7/-	BYY25	31/9
AF181	8/6	BSX78	6/6	NKT281	5/-	TIS46	3/3	2N1306	5/-	2N3904	7/-	BYY142	3/9
AF186W	9/	BSY27	4/-	NKT301	16/-	TIS47	3/3	2N1307	5/-	2N3905	7/6	BYZ10	9/-
AF186G	9/	BSY29	5/-	NKT302	11/-	TIS48	3/3	2N1308	7/-	2N2906	7/6	BYZ12	6/-
AF239	7/6	BSY32	5/-	NKT303	10/-	TIS49	3/6	2N1309	7/-	2N4037	15/-	BYZ13	5/-
AFY19	22/6	BSY36	5/-	NKT304	9/6	TIS50	5/6	2N1496	34/-	2N4058	4/6	CG6E	4/-
AFZ11	8/-	BSY37	5/-	NKT351	8/-	TIS51	4/-	2N1507	4/8	2N4059	5/-	CG61	2/6
AFZ12	10/-	BSY38	4/-	NKT352	7/6	TIS52	4/-	2N1613	5/6	2N4060	5/-	CG62	2/6
ASY26	5/-	BSY95A	3/6	NKT401	17/6	TIS53	6/6	2N1671A		2N4061	4/-	CG63	2/-
ASY27	6/-	BSW41	8/6	NKT402	24/-	TIS60	6/6		29/6	2N4062	4/6	CG64	2/6
ASY28	5/-	BSW70	5/6	NKT403	15/-	TIS61	7/-	2N1711	6/6	2N4284	3/-	EA403	3/6
ASY29	6/-	BTX39/600		NKT404	12/6	TSW30C	18/-	2N1893	10/-	2N4285	3/-	EC401	5/-
ASZ21	7/6		120/-	NKT405	15/-	U23AAA	5/-	2N2147	17/-	2N4286	3/-	EC402	4/8
AUY10	30/-	BTX40/600		NKT406	15/-	V205	20/-	2N2152	27/6	2N4287	3/-	EB383	3/6
ATZ10	40/-		120/-	NKT451	12/6	V405A	9/3	2N2148	12/6	2N4288	3/-	GEX45/1	4/-
B2M	12/6	BTY87/150R		NKT452	12/6	XA102	6/-	2N2160	14/9	2N4289	3/-	GJ3M	4/-
B3M	15/-		31/-	NKT453	10/-	XA702	15/-	2N2243	26/-	2N4290	3/-	OA5	3/8
BC107	2/9	C106F1	9/-	NKT613F	5/-	ZE12V7	3/6	2N2368	5/-	2N4291	3/-	OA10	6/-
BC108	2/9	C111	18/-	NKT674F	5/-	ZT22	19/-	2N2369	5/-	2N4292	3/-	OA47	1/6
BC109	2/9	C111E	12/-	NKT675	5/-	ZT86	27/6	2N2369A	5/6	2N4871	6/9	OA70	1/6
BC113	5/-	C400	9/-	NKT676	5/-	ZT2270	19/6	2N2432	67/-	2N5027	10/6	OA73	1/6
BC115	6/6	C426	8/3	NKT677F	5/-	40250	12/6	2N2484	8/-	2N5028	11/6	OA79	1/6
BC116	8/-	C444	9/8	NKT703	8/-	40309	9/6	2N2613	7/6	2N5029	9/6	OA81	1/6
BC118	5/-	D13T1	10/-	NKT713	7/6	40310	13/-	2N2614	4/-	2N5030	8/6	OA85	1/6
BC125	11/-	GET102	6/-	NKT773	5/-	40311	10/6	2N2646	10/-	2N5172	3/-	OA90	1/6
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BC134	5/-	GET114	4/-		6/6	40314	10/6	2N2712	6/-	2N5175	10/6	OA95	1/6
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BC138	12/-	GET889	6/-		11/-	40319	15/-	2N2905	10/-	2N5249A		TD716	12/-
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BCY43	4/-	MPS3638	6/6	OC72	4/6	2G371B	3/-	2N3391A	6/-	2S017	15/-		
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BCY71	8/-	NKT122	8/-	OC77	5/6	2G381	5/-	2N3394	4/9	2S104	12/6		
BCY72	4/-	NKT123	6/-	OC81	4/6	2N109	11/-	2N3402	5/6	2S301	8/6		
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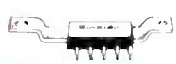

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1S2056	5.6 volt
1S2062	6.2 volt
1S2068	6.8 volt
1S2075	7.5 volt
1S2082	8.2 volt
1S2100	10 volt
1S2110	11 volt
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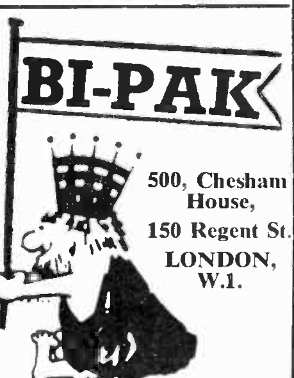

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U9	20 Mixed Volts 1 watt Zener Diodes	10/-
U11	30 PNP Silicon Planar Transistors TO-5 sim. 2N1132	10/-
U13	30 PNP-NPN Sil. Transistors OC200 & 2S104	10/-
U14	150 Mixed Silicon and Germanium Diodes	10/-
U15	30 NPN Silicon Planar Transistors TO-5 sim. 2N697	10/-
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV	10/-
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10/-
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	10/-
U19	30 Silicon NPN Transistors like BC108	10/-
U20	12 1·5-amp Silicon Rectifiers Top-Hat up to 1,000 PIV	10/-
U21	30 A.F. Germanium alloy Transistors 2G300 Series & OC71	10/-
U23	30 Madt's like MAT Series PNP Transistors	10/-
U24	20 Germanium 1-amp Rectifiers GJM up to 300 PIV	10/-
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U26	30 Fast Switching Silicon Diodes like IN914 Micro-min	10/-
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc., 8 Assorted Pieces	20/-
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Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

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100	5/-	100	6/6	100	10/6
200	7/-	200	7/6	200	11/6
400	8/6	400	9/6	400	13/6
600	10/6	600	11/6	600	15/6
800	12/6	800	14/-	800	18/-

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100	12/6	50	23/-
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200	1/9	4/-	4/9	20/-
300	2/3	4/6	6/6	22/-
400	2/6	5/6	7/6	25/-
500	3/-	6/-	8/6	30/-
600	3/3	6/9	9/-	37/-
800	3/6	7/6	11/-	40/-
1000	5/-	9/3	12/6	50/-
1200	6/6	11/6	15/-	

TRIACS

VBOM	2A (TO-1)	6A (TO-66)	10A (TO-48)
100	14/-	15/-	22/6
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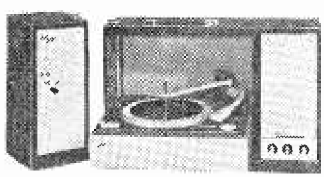

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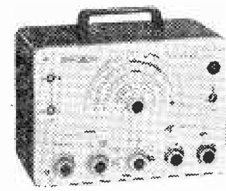

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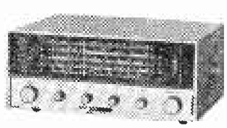

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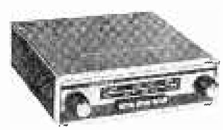

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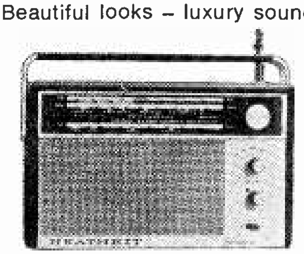

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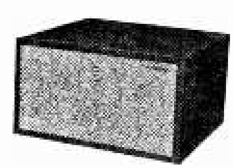

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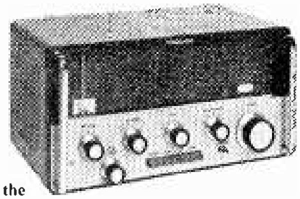

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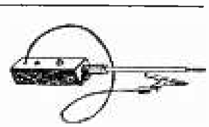

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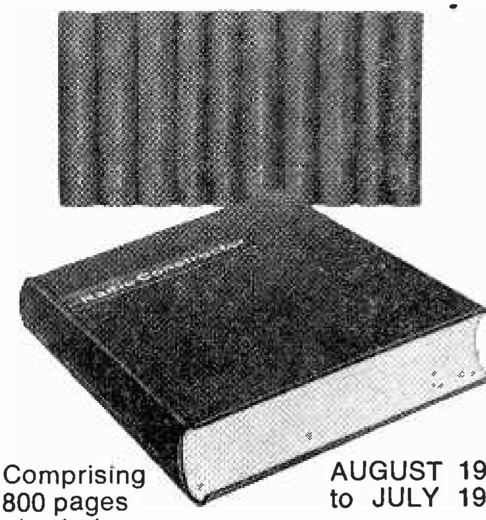

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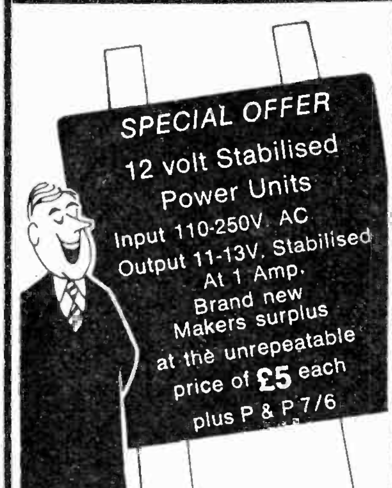

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THE Radio Constructor

Incorporating THE RADIO AMATEUR

APRIL 1970

Vol. 23 No. 9

Published Monthly (1st of Month)
First Published 1947

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9

Telephone
01–286 6141

Telegrams
Databux, London

Annual Subscription 42s. (U.S.A. and Canada $5) including postage. Remittances should be made payable to "Data Publications Ltd.". Overseas readers please pay by cheque or International Money Order.

Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. Queries should be submitted in writing and accompanied by a stamped addressed envelope for reply.

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

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Production.—Letterpress.

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Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London W.9.
The *Radio Constructor* is printed by Kent Paper Company Ltd, London and Ashford, Kent.

MAY ISSUE WILL BE PUBLISHED ON MAY 1st

DUAL-EL84 HI-FI AMPLIFIER

by

J. HOSSACK

Our contributor describes a high-performance a.f. amplifier offering outputs at up to 10 watts. A particularly attractive feature is the inclusion of a self-balancing phase inverter stage which ensures that correct push-pull drive is achieved with standard components

In these days of transistor supremacy, it is not surprising that some of the more valuable characteristics of valves are forgotten or overlooked by many constructors – for example, their ability to handle large signals with no significant deviation from linearity. Valve circuits for a.f. amplification are a case in point. Nowadays, one thinks immediately of OC35's (or their silicon equivalents) when considering making up a straightforward audio amplifier, forgetting that, as recently as a few years ago, a single valve of the ECL82 type would have been the natural choice, providing on its own all the audio power required for domestic use when fed directly from the average pick-up or radio tuner.

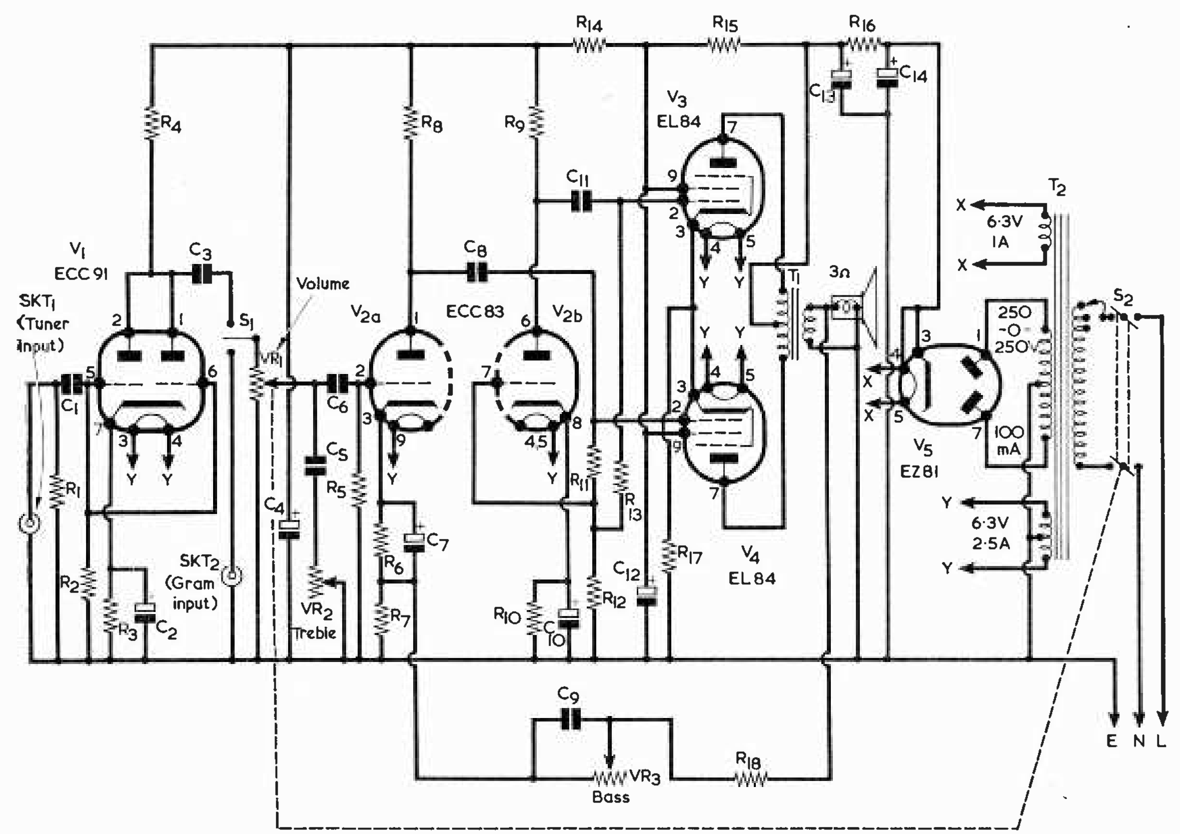
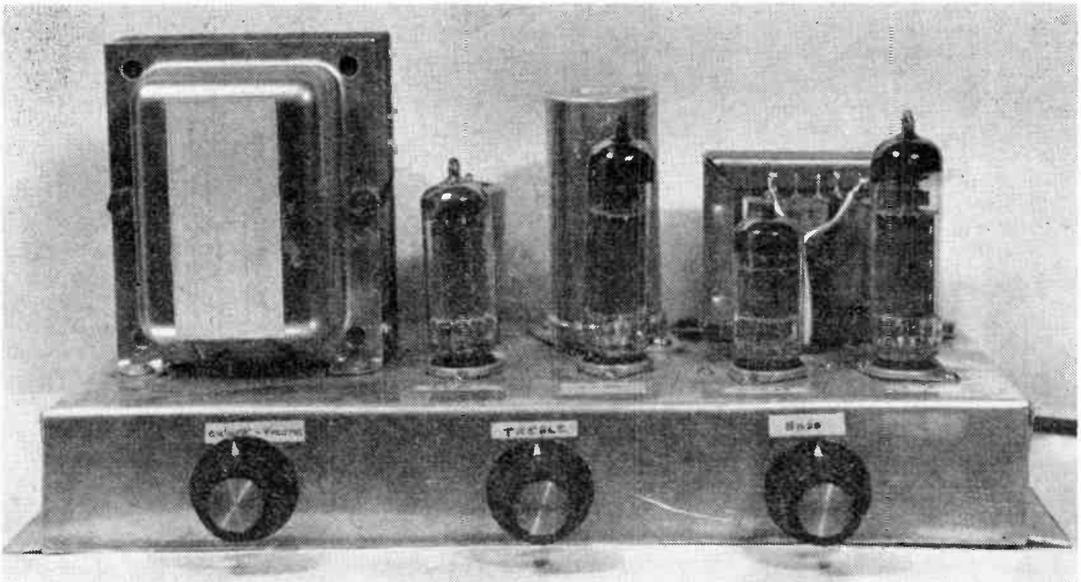


Fig. 1. The circuit of the amplifier. The self-balancing phase inverter circuit appears around V2(b)



Front view of the amplifier, showing the simple uncluttered layout

COMPONENTS

Resistors

(All fixed values $\frac{1}{2}$ watt 10% unless otherwise stated)

R1 100kΩ
R2 100kΩ
R3 3.3kΩ
R4 330kΩ
R5 2.2MΩ
R6 1.5kΩ
R7 100Ω
R8 220kΩ
R9 220kΩ
R10 1.5kΩ
R11 680kΩ
R12 1MΩ
R13 680kΩ
R14 10kΩ
R15 1.5kΩ 2 watt
R16 180Ω 5 watt
R17 150Ω 5 watt
R18 5.6kΩ
VR1 1MΩ potentiometer, log track, with switch S2
VR2 1MΩ potentiometer, log track
VR3 50kΩ potentiometer, log track

Capacitors

(All capacitors 350V wkg. unless otherwise stated)

C1 0.01µF
C2 25µF electrolytic, 6V wkg.
C3 0.02µF
C4, C12 16 + 16µF, dual electrolytic, tag ended
C5 470pF silver-mica (see text)
C6 0.005µF
C7 25µF electrolytic, 6V wkg.
C8 0.02µF
C9 0.05µF (see text)
C10 25µF electrolytic, 6V wkg.
C11 0.02µF
C13, C14 50 + 50µF, dual electrolytic, upright mounting, with clip

Transformers

T1 Push-pull output transformer, primary impedance 8kΩ, see text
T2 Mains transformer. Secondaries (minimum currents): 250–0–250V 100mA; 6.3V 2.5A C.T.; 6.3V 1A

Valves

V1 ECC91
V2 ECC83
V3 EL84
V4 EL84
V5 EZ81

Switches

S1 Slide switch, d.p.d.t. (only 1 pole used)
S2 Mains switch, d.p.d.t., part of VR1

Miscellaneous

4 B9A valveholders
1 B7G valveholder, with skirt and screening can
Output socket or terminal strip
3 knobs
Screened cable
Chassis
4 4-way tagstrips (see text)
Wire, nuts, bolts, etc.

In principle, transistors possess the advantage of small size; however, this advantage can prove somewhat illusory in circuits of the type under consideration, since the bulky power supply and large heat sinks required for power amplification detract considerably from their portability for this purpose. Therefore, other things being equal, valves present a perfectly logical choice, and no apology is made for describing this rather novel medium-power amplifier based on their use.

AMPLIFIER PERFORMANCE

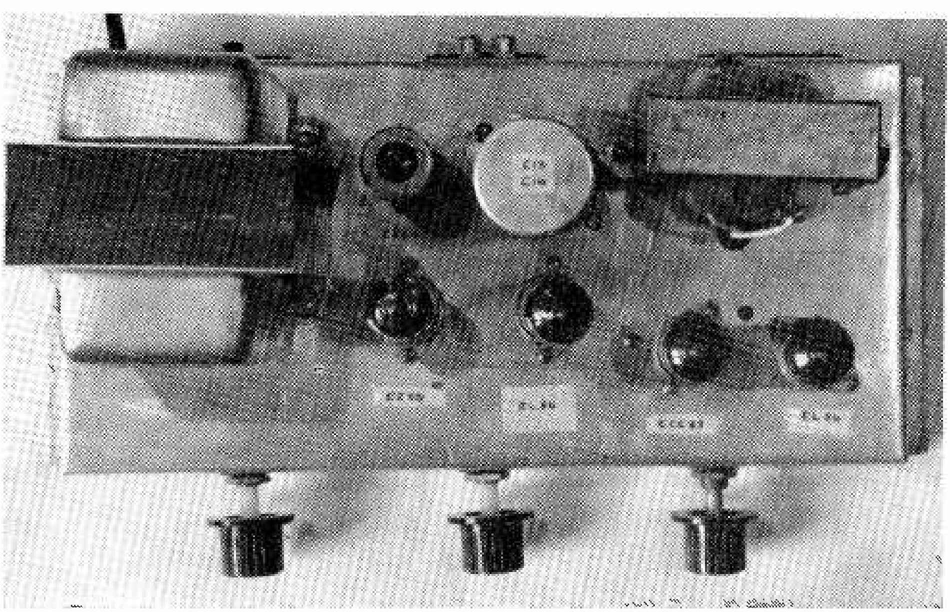
Basically, the amplifier is capable of providing an output of 8 to 10 watts, from two independent inputs, with less than 1% harmonic distortion, thus representing a distinct improvement over the simple one-valve amplifier referred to above. The cost is not excessively high in relation to the quality of output. It should be borne in mind that quite a fair proportion of the expenditure on any amplifier is involved in the power supply. Thus, by providing, at the outset, a mains transformer of ample reserve power, push-pull operation with its attendant advantages can be incorporated without too much extra expense. And push-pull operation, when used with a good-quality output transformer and comprehensive smoothing and decoupling, can bring the performance into the high-fidelity class. Despite these factors, the present circuitry has been kept remarkably straightforward, and overcrowding of components has been avoided by the use of a layout as 'open' as possible without wasting too much space.

One of the features of the design is the use of a self-balancing inverter, based on the 'Floating Paraphase' principle, for correct phasing of the push-pull input signals. In practice, this circuit is surprisingly non-critical towards component value variations or valve ageing. A few experiments with different resistors in the phase inversion network have indicated that, even with deviations of as much as 100% from the specified values, no substantial inequality occurs in the input signals to the two output valves. This is clearly a useful feature for the home constructor lacking equipment or facilities for precise balancing. In the author's opinion, one possible reason for this stability is the presence of selective feedback, as will be mentioned in the next section.

CIRCUIT DESCRIPTION

Fig. 1 shows the complete theoretical circuit of the amplifier. No claim is made for any phenomenal degree of gain; in fact, very high gain is unnecessary with an amplifier designed for normal domestic use. The high-level (Gram) input to SKT2 has an impedance of 700kΩ and is suitable for matching to a good-quality ceramic pick-up, full power output being easily obtained with an input of about 250mV. The signal is fed via VR1, C6 and VR2 to the grid of the left-hand triode of V2. The average cheap crystal cartridge has a rather higher output than that just stated, and normally requires some treble lift for optimum tone balancing. However, the standard of quality obtained does not really warrant the use of a high-fidelity amplifier, and therefore, if the constructor is proposing to use this type of pick-up he must be prepared to tolerate some degree of 'boominess' due to the uneven response of the cartridge coupled with the extended amplifier bass response. Excellent results have been obtained from a GP96 ceramic cartridge, as used in the Garrard SRP12 record deck. Treble tone control is provided by VR2 and C5. As is explained later, when final testing is discussed, the value of C5 may be varied to suit different requirements.

The low-level (Tuner) input to SKT1 passes via C1 into an ECC91 double triode (V1) whose two sections are connected in parallel. This somewhat unconventional arrangement was adopted for the following reasons. Firstly, as the signal at this point normally consists of the output from a radio tuner



The chassis, as viewed from above

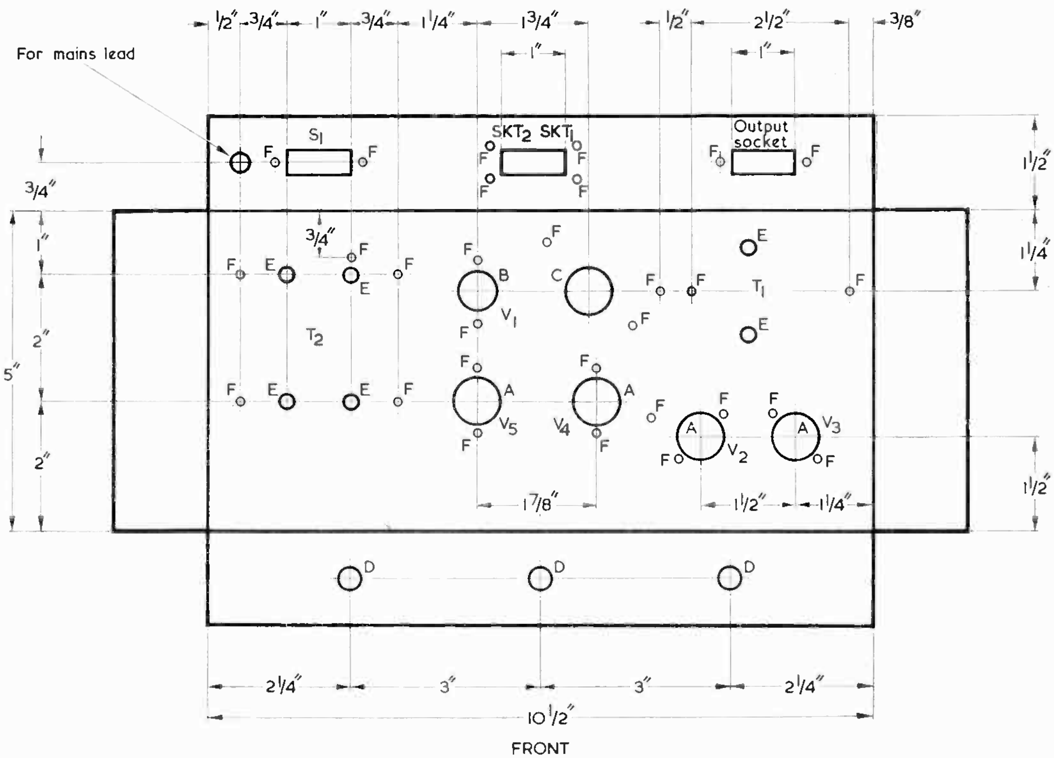


Fig. 2. Drilling dimensions for the chassis. As is described in the text, some of the dimensions may require slight alteration for components other than those used in the prototype. The hole letter references are also explained in the text

(a.m. or v.h.f.), it is not always possible, despite a.g.c., to keep the voltage to a pre-determined limit, so that overloading can easily occur. The amplifier volume control has, of course, no effect at this part of the circuit. This overloading can be minimised by employing a valve at this point which is capable of handling a reasonably large signal. Admittedly, the gain is not as great as would be obtained by using, for example, an EF86 low-noise audio pentode. If, therefore, maximum gain is desired from a consistently low input signal, there should be no difficulty in substituting the latter valve for the ECC91 specified, remembering that a 9-pin valveholder will now be required. Sensitivity should then be in the region of 5 to 10mV instead of the 30 to 40mV for full loading given with the present arrangement.

Secondly, the use of a triode (or, rather, two parallel triodes) obviates the harmonic distortion resulting from the slight non-linearity which appears in multi-grid valve characteristic curves. Finally, the smaller glass envelope of the triode enables a reduction of hum level to be achieved, due to the tighter screening by the valve can. In fact, despite the apparently vulnerable position of V1 adjacent to the mains transformer, hum from the low-level input is approximately equal to valve noise at 35 to 40dB down.

PHASE INVERTER

The ECC83 double triode (V2) serves a dual function as signal amplifier and phase inverter. The left-hand, amplifier, section couples directly to the bottom EL84 grid, and a portion of this output is also fed into the right-hand triode via R11 and R12, these acting as a potential divider. In a conventional simple phase-inverter circuit, the output from this second triode would then pass directly to the top EL84 in anti-phase, the values in the potential divider just mentioned being adjusted to precisely counterbalance the gain of the valve. In the present circuit, R12 would have had a value, typically, of about 30kΩ. Careful adjustment of this resistance network would be necessary to enable equal inputs to the output valves to be achieved, and the arrangement would be rather susceptible to valve ageing or other unbalancing influences.

In the case of the present phase inverter, the trick is to provide in the first instance for a much larger input to the second portion of V2 than is actually required. By contrast with the above situation, R12 is now, in fact, slightly larger than R11. The extra amplification provided by this section is then counterbalanced by having a large degree of negative feedback from C11 via R13, which also forms a portion of the grid resistance for the top EL84. Ideally, this is made equal to its corresponding element, R11, in the opposite output valve. It was found that a little experimentation was initially necessary to determine optimum component values; but, once these had been chosen, the circuit proved to be remarkably stable. Incidentally, it should be mentioned that the description just given, like that of most circuits other than the simplest, is not quite precise – the pundits would hasten to produce a more accurate, elegant, and almost certainly more complicated explanation of how the inversion of phase is actually achieved. However, the author is quite happy to settle for the simplified version !

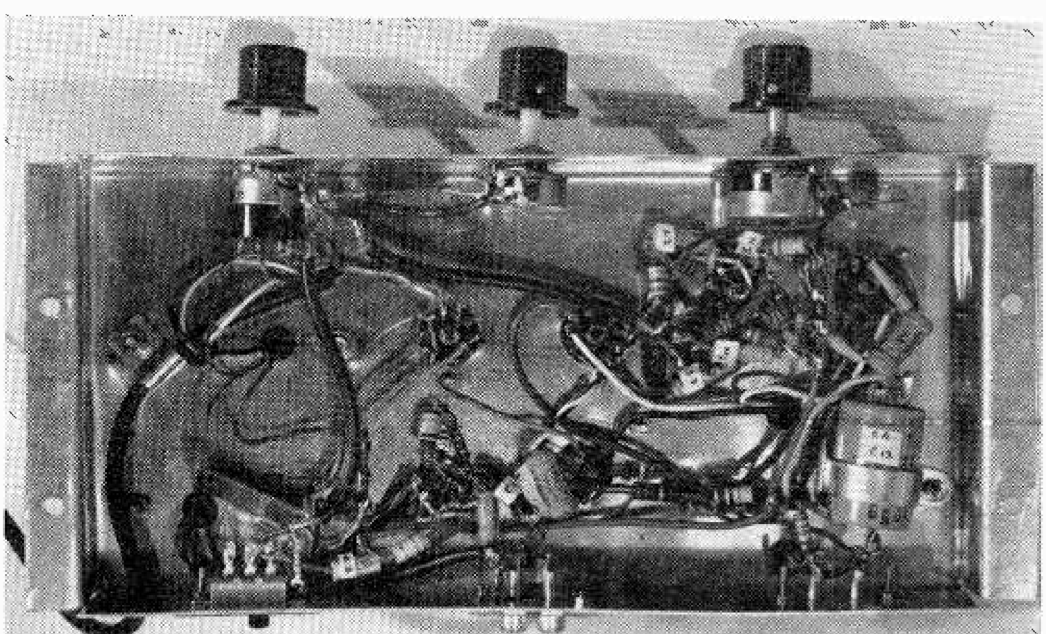
There is one important practical point which concerns the quality of capacitors C8 and C11. These must be good quality types completely free from dielectric leakage since, apart from preventing accurate anti-phasing of signal inputs, any serious shortcomings in this respect may actually result in positive feedback at certain frequencies, producing spurious r.f. oscillation. This condition is immediately recognised by inequalities in the currents through the two halves of V2 and/or the output pentodes. The remedy – as the author discovered, to his cost, after an initial hook-up of this circuit – is to avoid using untested components salvaged from the junk-box !

OUTPUT STAGE

From the inverter stage onwards, the amplifier is quite conventional, and little further comment is necessary. The common cathode bias resistor, R17, is left un-bypassed since, in true Class A push-pull, the audio voltage across it is negligible. Negative feedback, taken from the secondary of the output transformer to V2(a) cathode via R18, is used also to provide bass boost. The extent of the boost is determined by VR3 and C9 in parallel. It is possible to increase the maximum boost obtainable by decreasing the value of C9 slightly and, with certain loudspeakers or room acoustics, it might be advisable for this capacitor to be as low as 0.01μF. A useful refinement, if bass response is felt to be particularly critical, would be to make C9 a switched bank of three or four capacitors, retaining VR3 for fine adjustment.

The output transformer should be a good quality component offering an anode-to-anode impedance of 8kΩ and capable of working up to 10 watts. A number of transformers meeting this specification (such as the Gilson W0905 – Home Radio Cat. No. T026) are available. The transformer used by the author was the Radiospares 'Hygrade' component, which offers outputs at 3Ω to 15Ω by 4 taps. (This transformer must, like other Radiospares components, be ordered through a retailer). Older transformers, designed for use with 6L6 output pentodes, can also be used. For maximum convenience, all the output impedances offered by the transformer employed may be brought out to output terminals at the chassis rear; otherwise, wire up only for the impedance most likely to be required. The feedback components have values applicable to 3Ω output. If the speaker is fed at a different impedance, connect R18 to the 3Ω output tap.

Little need be said concerning the power supply. Any good quality heavy-duty mains transformer capable of supplying the correct currents and voltages can be pressed into service – this is one case where a component from the spares box can serve the purpose admirably, since transformers, unlike many other salvage items, do not normally deteriorate with age or use. Smoothing is assisted by the 180Ω resistor, R16, which is wired directly across the double smoothing capacitor terminals.



The wiring and layout under the chassis

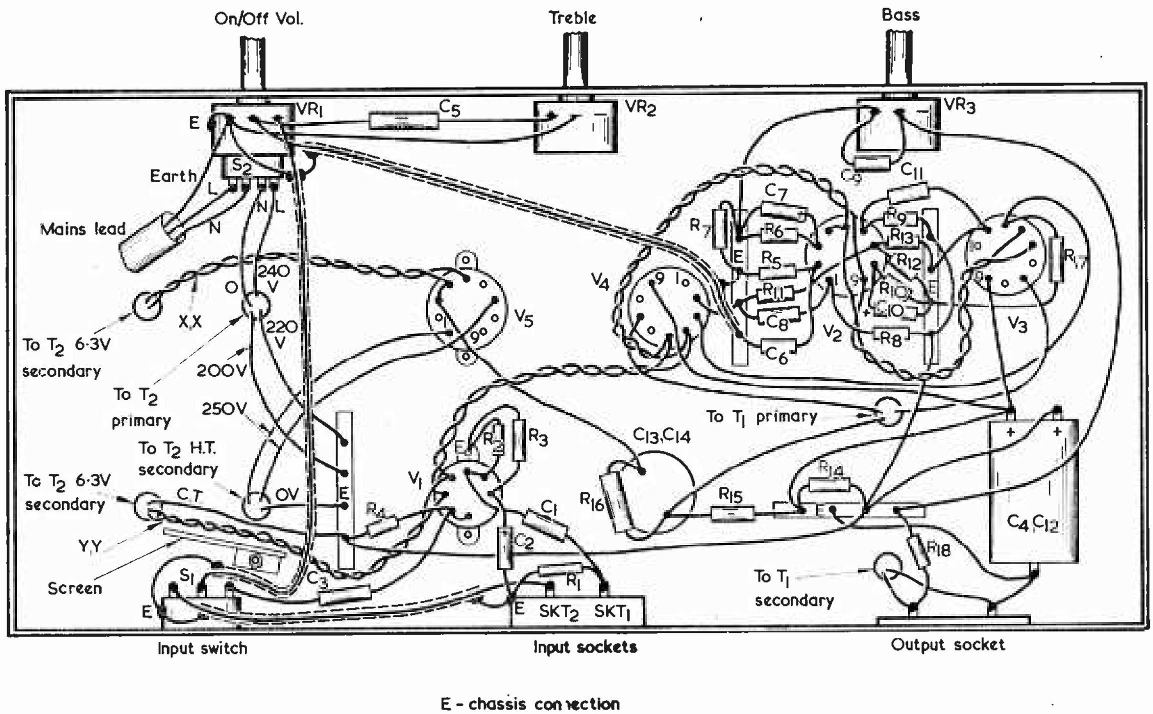


Fig. 3. Under-chassis wiring diagram

CONSTRUCTION

Fig. 2 gives dimensions and drilling details for the chassis, which can be either purchased or made up from standard aluminium sheet. It is important to note that the dimensions in Fig. 2 are applicable to the output transformer, T1, and the mains transformer, T2, that were used in the author's prototype. The constructor must check that the components he intends to use in these positions will fit in the space available. If not, the chassis needs to be longer and/or wider as necessary to accommodate the particular components to be employed for T1 and T2. Different transformers will also, of course, require altered hole positions. Similarly, it may be necessary to modify the hole positions and cut-outs for S1 and the sockets and terminals fitted to the rear chassis apron to take components other than those used by the author.

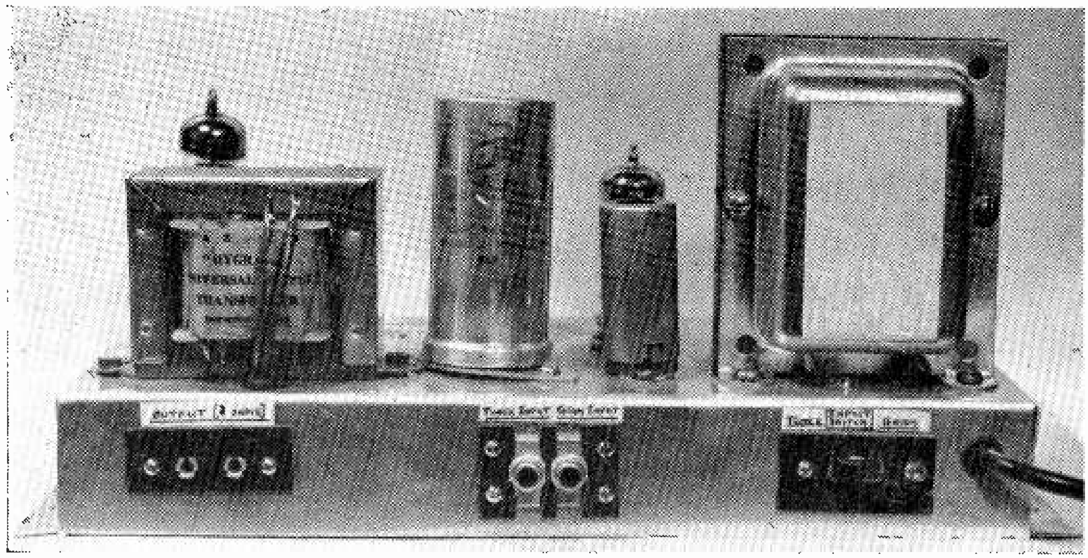
In Fig. 2 the holes marked 'A' are $\frac{3}{4}$in. diameter for B9A valveholders. Hole 'B' is $\frac{5}{8}$in. diameter for a B7G valveholder. Hole 'C' is $\frac{3}{4}$in., or larger if necessary, for dual electrolytic capacitor C13, C14. Holes 'D' are $\frac{3}{8}$in. for control bushes, holes 'E' are $\frac{1}{4}$in. for rubber or p.v.c. grommets, and holes 'F' are 4BA or 6BA clearance as applicable to the associated component. In the group of three 'F' holes at the T1 position, the two outside holes are for the transformer. The inside hole is countersunk and, with the prototype, is used to secure a tagstrip under the chassis. There is an additional 'F' hole near the T2 group of holes. This is for a small screen whose function is described later.

Initially, all fixed components except the power transformer and C13, C14 should be mounted in position. Valveholder orientation is given in the wiring diagram, Fig. 3. V1 valveholder has a skirt, to take a screening can. Note also from Fig. 3 the position of the chassis tag on each of the four 4-way tagstrips. The letter 'E' in the wiring diagram indicates a chassis connection, which may be given either by the chassis tag of a tagstrip, by a solder tag fitted under one of the valveholder securing nuts or by any other point at chassis potential.

WIRING

Commence wiring by running a pair of twisted leads for valve heaters from V1 to V4 by the route shown in Fig. 3, remembering that, if V1 is the ECC91 specified, the correct tags are 3 and 4. (If an EF86 has been chosen for V1, as discussed earlier, a B9A valveholder is required with tags 4 and 5 providing the heater conections). In the case of V2, tags 4 and 5 are joined together, and heater connections are taken from this junction and tag 9 respectively. Route all these heater leads as close to the chassis as possible.

Now proceed to the components around V2, taking care to follow Fig. 3 in detail with respect to the connections to the 4-way tagstrips sited on either side of this valveholder. This is the most exacting part of the design, since short, compact wiring is essential in order to obtain stability and freedom from spurious oscillation. Next mount the output transformer, and wire up V3 and V4, concluding with the leads which pass through the chassis to the primary of the output transformer. Rubber grom-



The chassis rear

mets are advisable here. The leads must be soldered to the correct tags for push-pull operation; these may be indicated on the card or leaflet usually provided with such transformers. Connect the secondary to the loudspeaker output socket via the appropriate chassis hole, but do not connect in the negative feedback line or R18 at this stage.

Next, mount the power transformer and main smoothing capacitors C13 and C14, and wire the power supply section into circuit. Once again, use rubber grommets for through-chassis wiring from the transformer. The heater leads to the rectifier valveholder must carry 6.3 volts so, if a tapped 0/5/6.3 volt secondary winding is available on the transformer, make sure the voltage is correct and then cut short and carefully insulate the unused lead to prevent it accidentally touching the chassis. Similarly, check the tapped primary for correspondence with the mains voltage. In this case, a couple of spare tags are available on an adjacent tagstrip (see Fig. 3), so the unused tapping leads can be soldered to these tags for convenience. Fig. 3 shows the 240 volt tap connected to the switch.

Continue the h.t. wiring with C4, C12, R14, R15 and R16, taking care to bend the connections to R16 slightly back from the smoothing capacitor base in order to prevent heat dissipated by this resistor from damaging the capacitors. Capacitor mounting clips can be made from aluminium strip where necessary. Finally, V1 valveholder and adjacent components should be wired up. This part of the wiring is best left until the end, so that the screened leads connecting the slide switch, S1, to the input sockets on the one hand and the volume and treble controls on the other can be suitably positioned clear of hum-inducing wires. A fairly long screened lead joins the volume control to the tagstrip connected to C6 at V2 valveholder. Make sure that this and all other outer screens are earthed efficiently at both ends (refer again to Fig. 3). Rather surprisingly, it was found, on initially testing the amplifier, that mains hum was slightly evident at full gain on the Gram input, although, as already mentioned, it was practically non-existent when S1 was put on to the higher-gain tuner section. The reason for this hum was not clear, but was reduced to negligible proportions by inserting a small piece of angled aluminium, as shown in Fig. 3, to partially shield the slide switch from the leads emanating from the mains transformer.

TESTING

When the wiring has been completed and carefully checked, test the h.t. positive line with an ohmmeter for short-circuits to chassis at all points from V5 cathode back to the low-voltage end of R14. If all is well, connect a loudspeaker and mains supply, and switch on. Keep the volume control at minimum, since, as no negative feedback is as yet being applied, some l.f. instability may be present. Slight hum will also be noticeable at all volume levels.

The following procedure should now be followed in order to ensure that feedback is of the correct phase before permanently completing this final stage of the wiring. The feedback line runs from T1 secondary, via R18 and C9 (which is across the bass control, VR3, to the junction of R6 and R7, and thence to chassis). Completion of the feedback loop is by way of the opposite transformer secondary lead, which also connects to chassis. Start off by making a temporary connection from this lead (or, what is the same thing, one side of the output socket) to chassis, and quickly touch a temporary wire from R18 to the other socket terminal. If the phasing is correct to provide negative feedback, the hum level will practically disappear with the volume control at minimum. If a loud squeal occurs, feedback is positive, and a reversal of the output transformer secondary connections to the output socket should be made. All that remains now is to solder these leads and R18 permanently into position. Any necessary alterations to the bass boost circuit comprising C9 and VR3 should be made at this stage, as already outlined. At the same time C5, which determines the extent of treble cut, can be varied if desired, to suit individual tastes, using a typical input signal. Values of up to 0.005μF are permissible. This value proved desirable for voice amplification during a recent successful hook-up of the amplifier to modulate the author's Top-Band transmitter rig when the normal modulator equipment had given up the ghost – rather an unconventional use for a hi-fi amplifier but, in this case, justified by the succession of glowing S9 reports which flowed in !

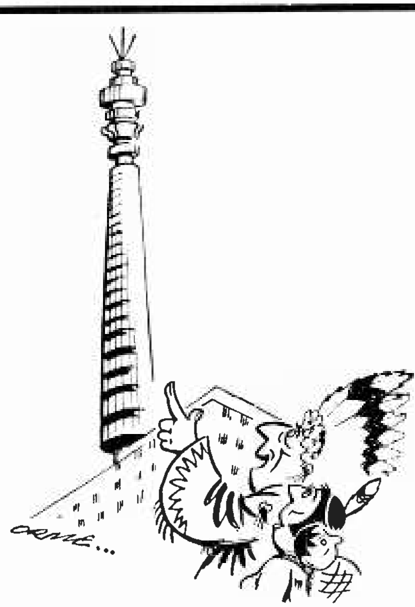
The final stage – housing of the unit – will depend on the ultimate applications which are envisaged; however, a cabinet of some sort is definitely advisable, since the EL84's are prone to mechanical damage due to their 'tall' shape and relatively unprotected position at the front of the amplifier. In spite of its power-handling capabilities, the unit is small enough to consider housing inside a fairly large record-player of the transportable type. In this case, adequate ventilation for the output and rectifier valves must be provided. ■

VACATION SCHOOL

A vacation school on basic concepts in modern control theory is to be held at the University of Birmingham from the 7th to the 11th September, 1970. The school, which is being organised by the Institution of Electrical Engineers, is for engineers and plant managers who wish to obtain a simple outline of modern control theory without a detailed study of specific techniques.

The main object of the school is to explain why classical single loop control theory is inadequate to deal with the control problems arising from the digital control of complex industrial plant. An introduction to the following techniques of modern theory will be given: state space theory, multiple loop theory, optimisation (including simple optimal control), and estimation (including the fitting of models to experimental data).

Further details and registration forms are available from the Secretary, LS(CA), IEE, Savoy Place, London, W.C.2.



"Ugh – heap big Totem Pole!"

CURRENT SCENE

SPRING—AND ALL THAT

It is popularly believed that in the spring, a young man's fancy turns to thoughts of love. During the same season, the housewife thinks of, and resorts to, spring cleaning. What if the young man happens to be an electronics enthusiast? Well, it is problematical but he could do no better than follow the example of the housewife.

During the winter, supposedly the height of the constructional period, the average workshop becomes untidy to say the least. Shelves around the workbench can easily become littered with all those components hastily put to one side. Some may require testing where they are suspected of being below standard and others, as in the case of doubtful value resistors, may require later evaluation. Add to this those components temporarily put to one side for one reason or another, and the various odds and ends that one always intends to store in the correct place but somehow never does, and we have a fine old shambles!

A prime dumping ground in many workshops is that invitingly empty space beneath the workbench. By the winter season's end, this part of the shack often exhibits a wonderful display of abandoned chassis festooned with components yet to be salvaged, cardboard boxes and other packing material received from the component houses, odd lengths of cable and wire and all the paraphernalia that one collects from one source or another which, to our magpie minds "will come in handy later".

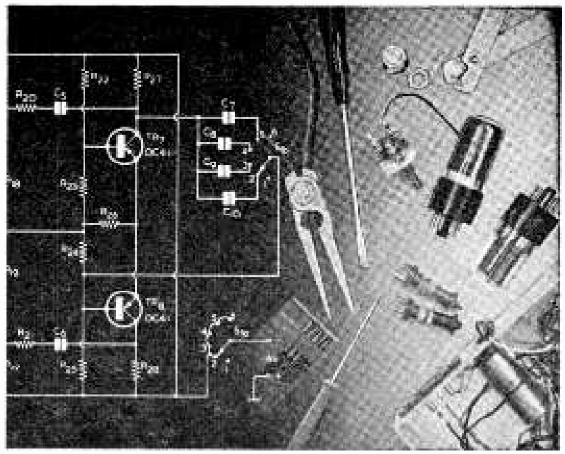
Then there are our workshop bookshelves – and what a mess these are in! In between our bound volumes, on top of them and even below, are those odd copies of magazines, consulted handbooks and catalogues – hastily thrust to one side once they have been perused for the immediately required information – and odd sheets of paper on which are scribbled various notes and circuits, etc.

The state of the workshop floor is often something best left to the imagination!

Before one's thoughts turn elsewhere, they perhaps had better be applied to those of spring-cleaning the workshop. All those small components such as resistors and capacitors should be sorted out and stored in the correct boxes. The old chassis dealt with by removing the wanted parts and dumping the remainder into the waste bin, tidying the bookshelves, testing the doubtful value components, sweeping the floor – a process during which one finds all those long lost nuts, bolts, shakeproof washers, earthtags, etc., that have the amazing property of mysteriously disappearing just when they are required.

Having played the role of housewife, with at least some success we hope, perhaps the final part to play is that of the clerk. Some of the acts here may be replying to unanswered letters from fellow enthusiasts, making the circuit record book up to date and finally collating all notes into a more permanent form. If you've done that lot young man, you just won't have enough time to think of anything else! C.W. ■

SIMPLE RELAY COUNTING CIRCUIT



by G. A. FRENCH

Circuits which are capable of counting a small quantity of operations have a number of applications, these appearing in such fields as production engineering, simple business machinery, educational aids and advertising displays. Counting circuits may rely completely on electronic principles, whereupon they can incorporate active components that are entirely 'solid-state'. However, semiconductor counting circuits tend to be a little complex and, for this reason, do not always present an attractive project for engineers whose main interests lie in electrical equipment or, so far as a proportion of readers of this journal are concerned, for home-constructors who have only recently taken up their hobby.

This month's article presents a counting circuit capable of counting up to any number although, in practice, it will normally be used for counting up to a dozen or less. The operating principles of the circuit are extremely simple to follow, and constructors should have no difficulty in bringing it into full operation. All the counting operations are carried out by relays, with the result that maximum counting speeds are by no means as fast as are those provided with purely electronic counting circuits. Two relays are required for each number counted, but this does not necessarily imply that a heavy initial cost is incurred when buying the components for the circuit. For the prototype circuit the author employed relays purchased retail at less than 5s. each, whereupon the cost of the counting circuit components required for each number counted came to less than 10s.

THE CIRCUIT

The counting circuit appears in Fig. 1, in which the relays are shown in the 'detached' manner. With 'detached' presentation each relay coil is represented by a rectangle, alongside which appears a letter over a figure. The letter indicates the relay concerned, whilst the figure shows the number of contact sets possessed by the relay. Contact sets may appear at any point of the diagram, and are designated by a letter followed by a serial number. Thus, in Fig. 1, the coil for relay A is shown as A/1. The legend tells us that the relay has one contact set; and this, appearing elsewhere in the circuit, is designated A1. If the relay had had, say, two contact sets, the coil would have been designated A/2, and the contact sets would have been shown as A1 and A2 respectively. All contact sets are illustrated in the position they take up when the associated relay is de-energised.

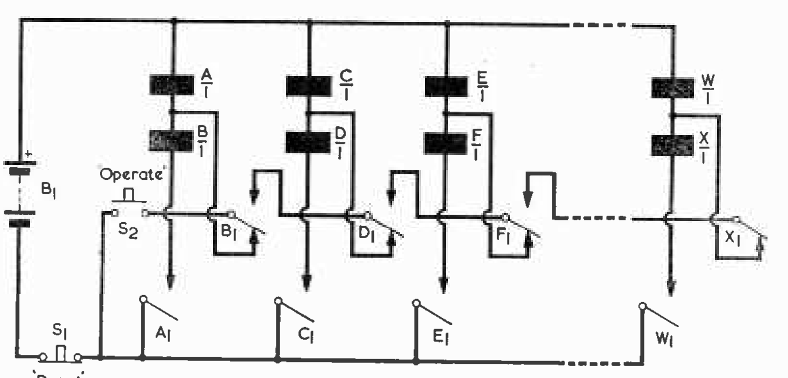


Fig. 1. The basic relay counting circuit

In Fig. 1 it is assumed that all relays have only the single set of contacts required for the counting circuit proper. In practice one or more of the relays will have further contact sets in order to actuate external circuits. Since these external circuits may vary considerably, the extra contact sets are not shown in the diagram. It is also assumed that each counting operation is carried out by pressing and releasing the push-to-make press-button, S2. The circuit is brought back to a count of zero (all relays de-energised) by pressing the push-to-break press-button, S1.

Let us commence an examination of circuit operation at a time when all relays are de-energised, as would occur after S1 had been pressed and released. S2 is pressed to start the first count, whereupon its contacts complete a circuit from the lower supply rail, through de-energised contacts B1 and relay coil A/1, to the upper supply rail. Relay A energises, and its contacts A1 close, coupling the lower supply rail to the lower terminal of relay coil B/1. However, the lower supply rail also connects to the upper terminal of coil B/1 via de-energised contacts B1 and the closed contacts of S2. There is, thus, a short-circuit across relay coil B/1, and relay B remains de-energised.

When press-button S2 is released its contacts open, taking the short-circuit off coil B/1. A circuit now exists from the lower supply rail, via the energised contacts A1, coil B/1 and coil A/1, to the upper supply rail. Current flows through coil B/1, and relay B energises, causing contacts B1 to take up their energised position. Relays A and B remain continually energised, the energising current flowing through energised contacts A1.

When S2 is next closed, it completes a circuit from the lower supply rail via energised contacts B1, de-energised contacts D1, and coil C/1, to the upper supply rail. Relay C energises and contacts C1 close. When S2 is released, a current flows from the lower supply rail via energised contacts C1 and coils D/1 and C/1 to the upper supply rail. As a result, relay D energises and contacts D1 change over. Also, relays C and D remain energised due to the circuit completed by contacts C1.

It will be seen that the operation of relays C and D is identical with that of relays A and B. When S2 is pressed and released once more, relays E and F are similarly actuated, and contacts F1 cause the operating circuit to be transferred to the next pair of relays along the counting chain. Any number of successive relay pairs may be employed in the chain, each pair appearing in the same circuitry as that around relays A and B, C and D, and E and F. In Fig. 1 the chain is shown as terminating in relays W and X. Relay X does not require a change-over contact set because there is no relay pair following it. In consequence, contacts X1 are of the break type (i.e. they break the circuit in which they appear when the associated relay energises).

Switch S1 is pressed to bring the circuit back to zero, and it causes all relays to be de-energised. This occurs because the contacts of S1 break the supply to all relays, and cause contacts A1, C1, E1, etc., to open. When the contacts of S1 close again, the relays can only be energised, in succession, by operating S2.

It is of value to note that a relay operation occurs both when S2 closes and when it opens. When S2 is first closed, relay A energises; and when S2 is next opened, relay B energises. Relays C and D, then E and F, *et seq*, similarly energise in turn on the closing and subsequent opening of S2. This fact can be of advantage in some of the applications in which the counting circuit is employed.

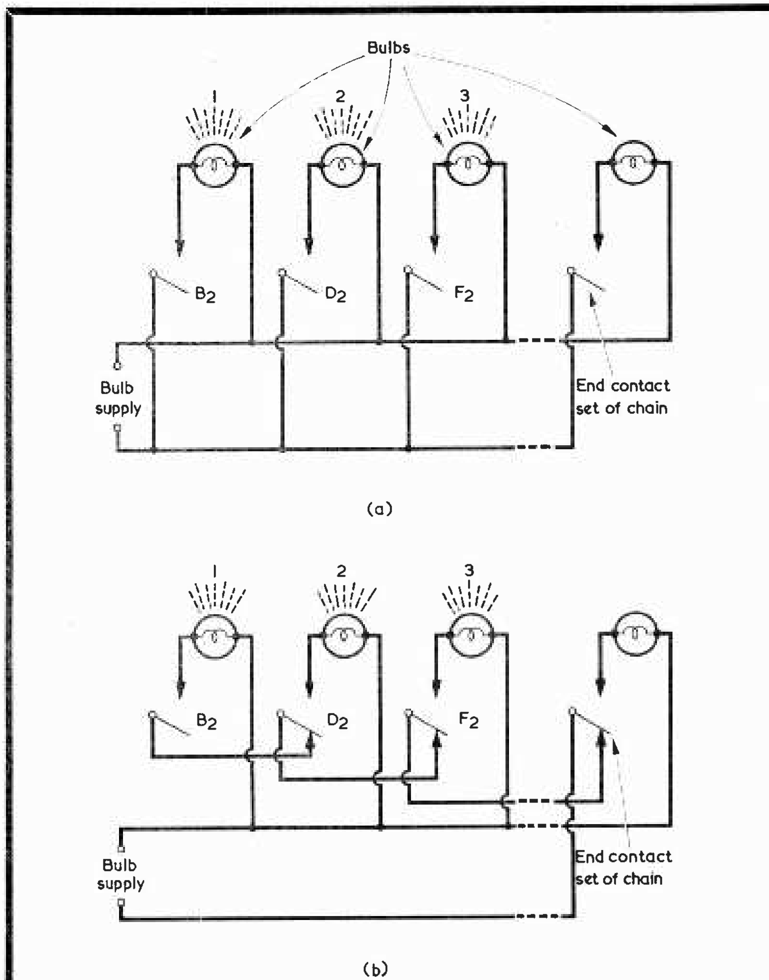


Fig. 2(a). Each successive count can cause a bulb to be illuminated (b), An alternative bulb circuit

APPLICATIONS

One of the simplest applications for the counting circuit consists of displaying the number of operations which have been carried out. Relays B, D and F, etc., may each be provided with a 'make' contact set (i.e. a contact set which closes when the associated relay energises), this causing a bulb to illuminate a number when the associated relay energises. A simple circuit for this application is shown in Fig. 2(a). A somewhat more attractive circuit is given in Fig. 2(b), in which relays D and F, etc., have added change-over contacts. These contacts ensure that the bulb illuminating the figure '1' is extinguished when that illuminating the figure '2' is lit, and so on.

If it is desired that the circuit automatically returns to zero after the last figure has been counted, an extra relay may be added at the end of the chain as in Fig. 3, where the relay is designated Y. This relay is energised by an extra 'make' contact set on the last relay (assumed to be relay X) and is made slow-to-operate by reason of the resistor in series with, and the capacitor connected across, its coil. The additional relay has a 'break' contact set which carries out the same function as does S1 of Fig. 1. When, after a delay, it energises, the counting circuit reverts to zero and the supply is removed from all relay coils, including that of the additional relay. The circuit cannot then recommence counting until the additional relay de-energises and its contacts close once more. The values of resistance and capacitance needed for the additional relay are found by experiment. A good approach here consists of employing a relay whose energising voltage is a little less than half the available supply voltage and of giving the

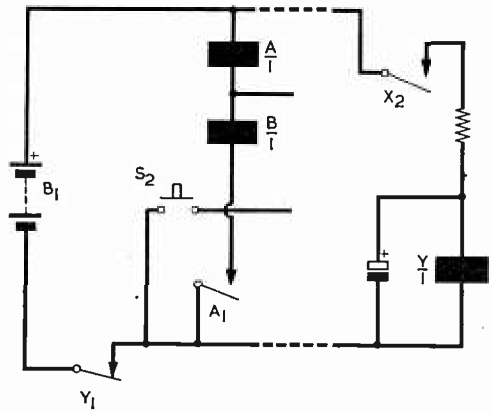


Fig. 3. An additional relay at the end of the counting chain can cause the circuit to automatically return to zero a short period after the last count

series resistor a value approximately equal to the resistance of the relay coil. Various values of capacitance are then connected across the coil until the desired operating delay is achieved. The appropriate capacitor will need to be an electrolytic component, and its value will be of the order of 100 to 1,000μF. The higher the resistance of the relay coil, the lower is the value required in the parallel capacitance to achieve a given operating delay.

If the counting circuit is to be used to illuminate successive sections of an advertising display, it may be operated by a periodic switch, such as that described in this series in last month's issue. A simpler periodic switch with quicker operation is illustrated in Fig. 4.

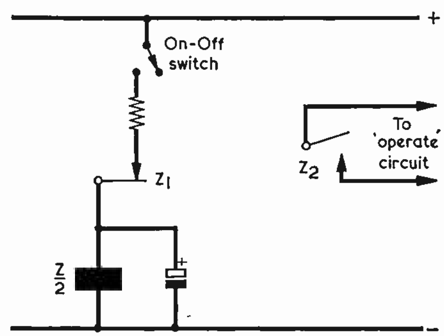


Fig. 4. A simple periodic on-off switching circuit. If contacts Z2 are employed in place of S2 in Fig. 1, the switch can cause the counting circuit to illuminate successive sections of an advertising display

When the supply is initially applied in Fig. 4 the relay, designated Z, is slow-to-operate because of the resistance in series with, and the capacitance in parallel with, its coil. When the relay does operate its own contacts Z1 break the supply, whereupon the parallel capacitance discharges into the relay coil. Since a relay armature releases at a lower coil energising voltage than that required to operate it, a period of times elapses before the relay de-energises and contacts Z1 complete the supply circuit again. The relay circuit of Fig. 4 is capable of continually switching an external circuit on and off. The values of series resistance and parallel capacitance are found by experiment, working to the same general principles as those just discussed for the additional relay at the end of the counting chain which gives automatic reset.

If the periodic switch employed offers open and closed periods which are approximately equal in time, the successive sections of an advertising display may be illuminated, as shown in Fig. 5, by relays A, B, C, D, etc., instead of by the alternate relays B, D and F, etc. This technique results in a halving of the relays required in the counting circuit proper.

The applications just discussed are, of course, only a few from quite a wide possible range. Many others may suggest themselves to the more ingenious constructor.

RELAY TYPES

Provided that the requisite con-

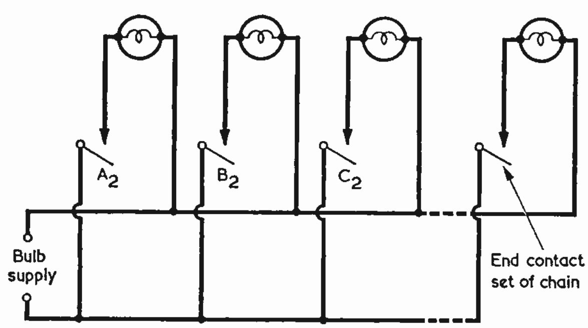


Fig. 5. A possible circuit for illuminating the advertising display

tact sets are available, virtually any relay type may be used in the counting circuit. It is preferable for all the relays employed to have the same energising voltage and coil resistance, and it is obvious that power supply requirements are eased if the relay coil resistances are reasonably high. The power supply voltage must be at least twice the energising voltage of each relay. Although the full supply voltage is applied to only one relay coil when the operating circuit is closed, both relay coils in a pair connect across the supply rails in series when the operating circuit is opened again.

Various types of low-cost relay are available on the home-constructor retail market. As an example of what is obtainable, the writer checked out the prototype circuit of Fig. 1 with ten relays of P.O. 3000 type purchased from Chiltmead Ltd., 22 Sun Street, Reading, Berks. These were ex-equipment, had 500Ω coils and two changeover and two make contact sets each, and were available, at the time of writing, at a little less than 5s. each. The unrequired contact sets of each relay were ignored and a counting circuit of ten relays was set up, this running from a 21 volt supply given by seven Ever Ready type 800 3-volt batteries in series. Each pair of relays thus drew 21mA from the supply when energised and with S2 open. For a permanent installation a mains power supply offering some 20 to 25 volts d.c. at a current rating of some 150 mA (or more if more relays were employed) would have been, of course, a more economic proposition. However, and as has already been mentioned, the choice of relay rests with the constructor, who will be able to calculate power supply requirements accordingly.

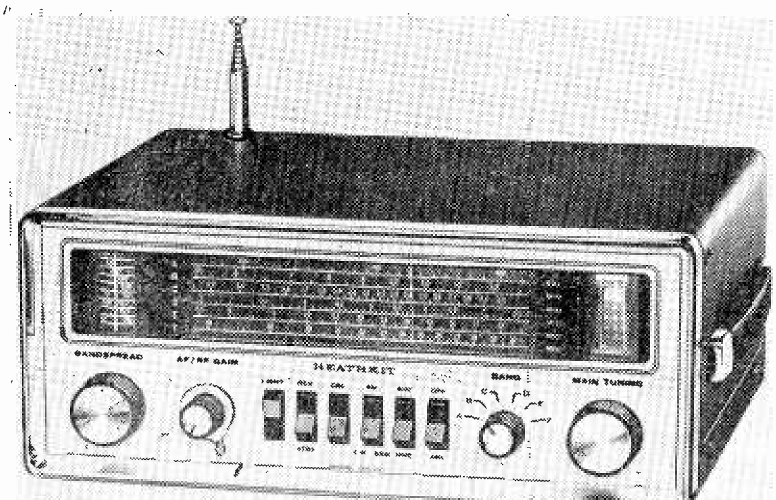
A final point is concerned with the polarity of the supply. In Figs. 1, 3 and 4, the upper relay supply rail is shown as being positive but, in practice, the polarity of the supply is unimportant. The electrolytic capacitors employed in Figs. 3 and 4 must be connected into circuit so that their polarity agrees with that of the supply. ■

CURRENT TRENDS

NEW SOLID-STATE GENERAL COVERAGE RECEIVER KIT

The GR-78 General Coverage Receiver recently announced by Heath Company provides AM, CW and SSB coverage from 190kHz to 30MHz in six switch-selected bands. The all solid-state circuit employs field effect transistors in the RF section and four ceramic IF filters for excellent sensitivity and selectivity. The ceramic IF filters eliminate the need for alignment. Built-in Bandspread tuning can be calibrated for either the Shortwave Broadcast or Amateur Radio bands, and a switchable 500kHz crystal calibrator ensures accurate dial calibration.

This receiver comes complete with a rechargeable nickel-cadmium battery pack with a built-in charging circuit. Wiring options permit operation from either 120 or 240V a.c. and 12V d.c. This receiver incorporates switched Automatic Volume Control and an Automatic Noise Limiter. Additional features include headphone jack, built-in speaker, external antenna terminals, receiver muting for use with a transmitter and a front panel relative signal strength meter.



Attractively styled in Heath charcoal wrinkle finish with grey, black and chrome accents, the unit measures only $4\frac{5}{8}$ H x $11\frac{3}{8}$ W x $8\frac{5}{8}$in D and weighs only 11lbs. Kit GR-78 £68 18s. 0d. For further information write to Daystrom Ltd., Heathkit Division, Gloucester. Telephone: OGL2 29451.

LASKY'S HI-FI SUCCESS STORY

Lasky's imposing Hi-Fi Centre in Tottenham Court Road, London, W.1.

From small beginnings, to what is claimed to be the biggest audio firm in Europe with a public flotation in the offing, is the success story of Lasky's Radio Ltd., owners of London's new hi-fi centre.

The present chairman, Harry Lasky, started in 1933 with a shop in Harrow Road, London, W.9., with his wife as his only assistant. They lived above the shop and the early days were not easy as electronics interest was generally minimal. Despite this, progress was made and important foundations for future growth were laid.

Shortly before the war, Harry Lasky was joined by his younger brother, Edward.

In 1951 new and larger premises were acquired in Harrow Road, and three years later the first of the company's West End branches opened, at Tottenham Court Road. It was in the Fifties that the first Lasky catalogue for mail order appeared and the range of merchandise vastly increased.

Thanks to Edward's foresight, London's first demonstration studio for high fidelity equipment was opened, followed in 1957/58 by a 140-page hi-fi catalogue, probably the first of its kind in the world. New branches followed rapidly.

1965 saw Lasky's bursting at the seams with £¼m. worth of stock and a massive mail order business. So a warehouse/distribution/H.Q. complex was custom-built at 3-15 Cavell Street, London, E.1., and for the first time vast stocks and administration were under the same roof.

Kenneth Lasky, son of the chairman, joined the company in 1961 after spending a period in the U.S.A. studying the electronics business.

Since 1960 a mail order department has expanded tenfold under the direction of Alfred Allenstein, who has been with the company for 25 years.

SOLDERING FLUX FROM FRY'S METALS

"R.8" Soldering Flux is a new contribution to the successful soldering of printed circuit boards.

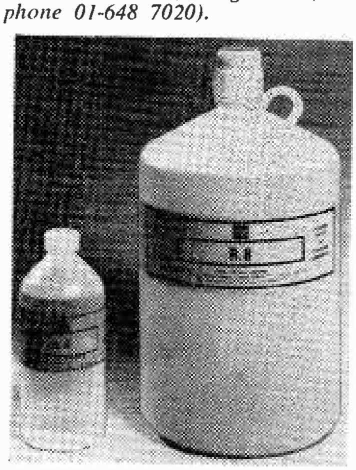
It is a clear solution of activated rosin, the activator and rosin-blend having been specially chosen to make the flux eminently suitable for use on plain copper, solder-plated, roller-tinned, nickel-plated, silver-plated and gold-plated surfaces.

It has been produced by the Research Department of Fry's Metals Ltd. and is especially suitable for application with the Fry "Flowfluxer" and by brushing or spraying.

"R.8." has also been formulated to allow fast drying between the fluxing and flowsoldering stations and thus permits a considerable increase in production speeds.

This new soldering flux, by suppressing the tendency of circuit boards to form "icicles" on the soldering surface or "bridges" between closely spaced conductors, makes the correct maintenance of soldering conditions much less critical, ensuring a consistent quality of soldering with less after work. The flux being non-persistent, leaves practically no flux residue on the underside of the soldering board, making it unnecessary to clean the boards, which are then left dry and not sticky after soldering.

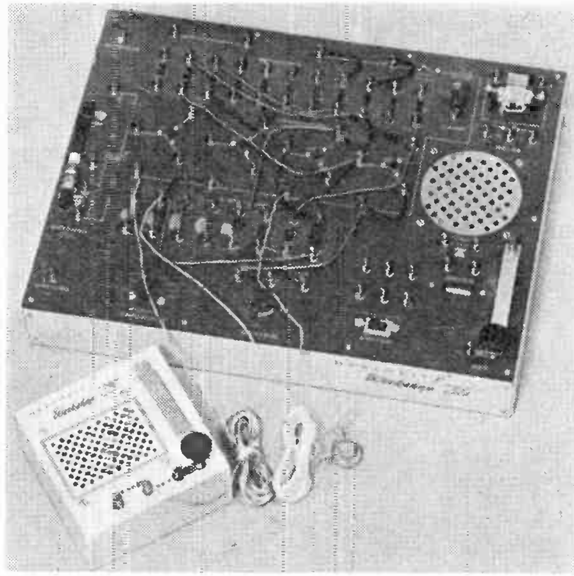
Particulars may be obtained from Fry's Metals Ltd., Solder Division, Tandem Works, Merton Abbey, London, S.W.19, England. (Telephone 01-648 7020).



"R.8" soldering flux, which is supplied in 16oz. and one gallon containers as shown above.

. . . COMMENT

HEATHKIT INTRODUCE ANOTHER JUNIOR KIT



A new experimentation course in basic electronics for young people has just been introduced by Heathkit. Designated the Heathkit JK-18, it features 35 exciting experiments using the 'learn-by-doing' technique.

All the parts are mounted on a 'breadboard' and then various circuits are constructed according to instructions by connecting them with ordinary wire, as provided in the kit. For speed and easy circuit assembly and disassembly, solderless spring-clip connectors are used throughout the kit.

The illustrated manual included has a fold-out diagram for easy experiment which also describes the operation of the circuit in easy-to-understand language. All parts used in any given experiment are identified by both a pictorial diagram and the standard schematic representation so that the experimenter learns how to read circuit diagrams.

For further information write: Daystrom Ltd., Heathkit Division, Gloucester. Tel: 29451. The kit costs £13 18s. 0d., carriage 5/- extra.

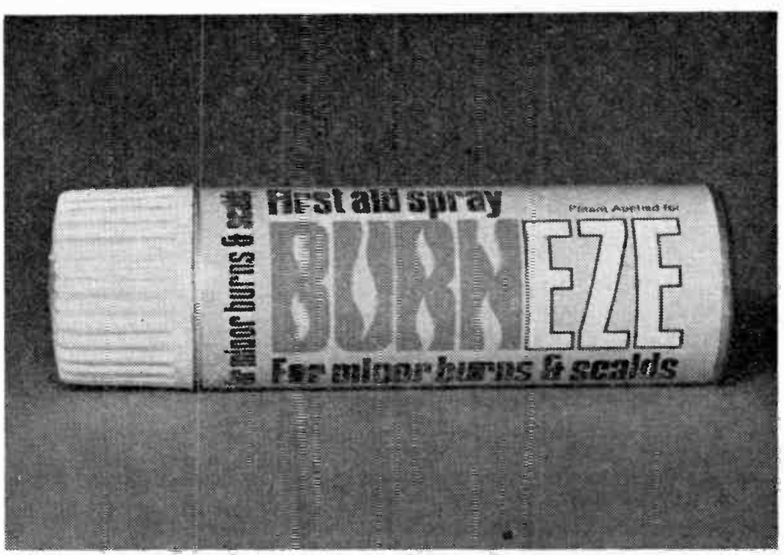
NEW OPTICAL AID IN ELECTRONICS

A very neat optical aid is helping the women workers who fit electronic components into printed circuit boards, a monotonous, tricky and important task. Miniaturised components look very much alike, the only identification being the colour code marking. Obviously after some hours of work it is all too easy to fit the wrong component.

Optics solved this problem very neatly, reports a recent edition of the B.B.C. World Service programme 'Science in Action'. Components are arranged in front of each women in small bins, a separate pigeon-hole for each type of component. When she is ready to fix the next component, two beams of light switch on. One beams on the pigeon-hole from which the part is to be taken. The other illuminates the relevant point on the circuit.

This device is called the Vision Circuit Master, and though a programme machine of this kind is expensive, mistakes are almost impossible and the speed of each worker is doubled.

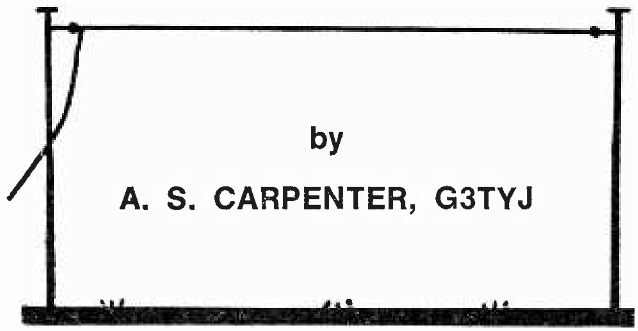
ALLEVIATE MINOR BURNS



Minor burns caused by solder, steam, hot metal, plastic or blow torches can be alleviated or cured by the immediate application of Burneze (7/3d). It not only chills the burn (which it should, according to the latest scientific opinion) but has a local anaesthetic included which immediately soothes that otherwise long-lingering pain. Supplied in a handy aerosol, spray for a few seconds and the pain is lessened or gone. Wear a dressing as Burneze is not glutinous.

Burneze is available through Boots and all chemists.

'GETTING OUT' WITH AN END-FED WIRE



by

A. S. CARPENTER, G3TYJ

Practical comments for those who like to work the amateur bands '80' through '10' as simply as possible, together with constructional details of an efficient all band aerial matching unit

LARGE TRANSMITTER POWER IS NOT AN ESSENTIAL requirement for reliable Dx-ing and W stations running a kilowatt or so have been known to express surprise at the signal strength received from some British stations running but one twentieth of this amount! In fact plenty of Dx can be worked running only 50 watts input, and in c.w. connections plenty of VK's, etc., can be QSO'd when conditions are suitable. Since a d.c. input of 50 watts can be obtained quite easily using just a single valve of the Brimar 6146 class as p.a., many such rigs are in use. Clearly a high power rig working into an indifferent aerial system can be less effective at the distant station than a comparatively low power transmitter working into a resonant system.

For general purpose all-band work the end-fed wire is certainly one of the most popular types of aerial, mainly because it is both easy to erect and operate. Feeders are not needed, since one end of the wire is brought straight into the station. The total length of wire used is limited often by the location but if 132ft. can be accommodated, even if it has to be partly wrapped around the garden, good results can be expected; if the length has to be reduced to 120ft. no great problems should arise.

Although an end-fed wire can often be connected to the output socket of the station transmitter direct this is not particularly desirable if TVI is to be avoided. Usually several items of equipment are introduced between the aerial and the transmitter, each with a special job of work to do. A typical set-up is illustrated in Fig. 1 in block form, the various items being interconnected, in practice, with coaxial cable. The purpose of the aerial changeover relay (which may be operated by the transmitter Send/Receiver switching system) is obvious, enabling the same aerial to be used both for transmitting and receiving.

THE LOW-PASS FILTER

The low-pass filter (l.p.f.) is normally designed to pass all radio frequencies up to, say, 30MHz with negligible attenuation but to heavily attenuate higher frequencies which, for example, lie in the television i.f. and r.f. ranges[1]. The filter is normally designed for either 50 or 75Ω impedances.

THE S.W.R. MONITOR

This item[2] will also be designed for either 50 or

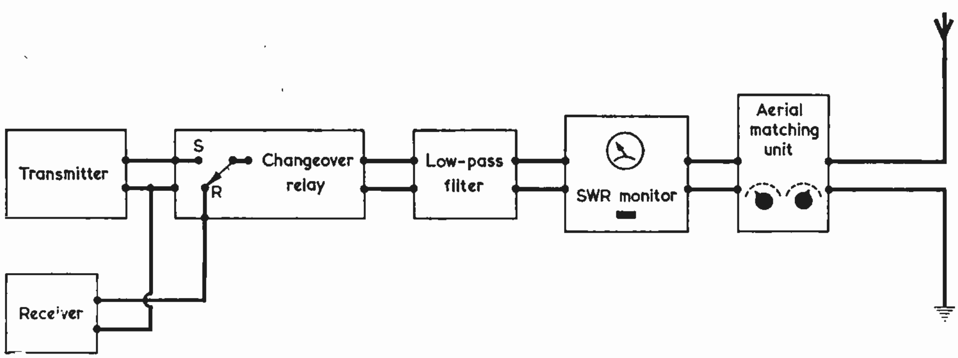


Fig. 1. Block diagram illustrating the equipment between the transmitter and receiver and the end-fed wire

75Ω working, and will be chosen to operate in conjunction with the low-pass filter. If the matching from transmitter to aerial is incorrect the ideal state of affairs, where *maximum* signal current is going towards the aerial and *minimum* back to the transmitter, cannot be realised, and valuable transmission-reception potential is lost. The s.w.r. monitor provides a visual means of checking that the required conditions are being fulfilled; it is an essential item of equipment.

THE AERIAL MATCHING UNIT

Many forms of aerial matching unit (a.m.u.) are known but one of the simplest to employ with an end-fed wire is a simple L-network type. A suitable practical design will be described later in this article.

Briefly, the purpose of the aerial matching unit is to enable the aerial to be correctly coupled, impedance-wise, to the transmitter which, as has already been noted, may be operating through a low-pass filter designed for, say, 75Ω working. The transmitter output is normally widely adjustable and can often be set up to give adequate loading with the a.m.u. alone. This is not sufficiently good when the l.p.f. is incorporated, however, because the l.p.f. is effective *at its design impedance only*. The impedance presented by one end of the aerial on its own is most unlikely to be anywhere near 75Ω, and even if it could be made so for a particular frequency such a condition would be immediately lost on making a band change!

In Fig. 2 three random lengths of wire are indicated, together with their voltage (E) and current (I) curves in relationship to a given frequency. If the wire is one half wavelength at this frequency, as at (a), the station ('S') 'sees' a point of high impedance which may be several thousands of ohms. At (b), and at the same frequency, the station 'sees' a somewhat lower impedance for the wire is longer. And what about (c), where the wire is shorter than one half wavelength?

Quite clearly we are not, at a given station, likely to be continually making our aerial longer and shorter physically to suit the operating frequency. But at the same time we have to overcome the difficulty arising from the fact that the aerial impedance 'seen' by the transmitter becomes different at every frequency change.

Fortunately, it is not really necessary to know the impedance presented by the aerial at all, and what is needed is a means of matching whatever impedance it presents to the required impedance at the output of the transmitter. The aerial matching unit should do this job successfully.

CIRCUITRY

The circuit diagram of an aerial matching unit of the type just mentioned is given in Fig. 3. This, if analysed, can be seen to be merely an added section to the transmitter pi-tank network, as is indicated in Fig. 4. Networks of this nature have good harmonic rejection properties, thus offering a further precaution against dreaded TVI!

[1] Suitable low-pass filters can be either home constructed or purchased commercially.

[2] For details of an excellent S.W.R. monitor see 'ARRL Antenna Book', 9th ed., p.134. These items can also be obtained commercially.

In use, socket SK1 of Fig. 3 is connected to one side of the s.w.r. monitor as in Fig. 1. With the aerial and a good earth connected to SK2 and SK3 respectively, switch S1 is adjusted in conjunction with C1 to provide the best s.w.r. indication for any particular frequency. This procedure will be discussed in detail later on.

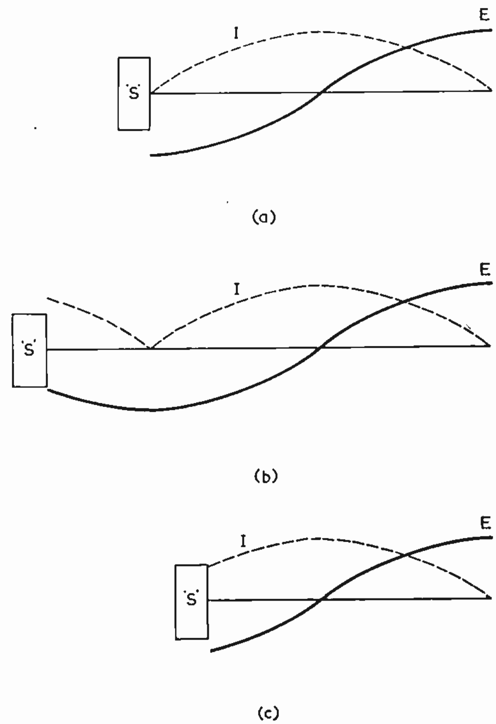


Fig. 2. The impedance 'seen' by the transmitter at a single frequency varies according to the length of the wire

CONSTRUCTING AN A.M.U.

It is easy to look at a circuit such as that of Fig. 3 but it is usually rather more difficult to convert it to a practical working item of equipment; this is partly the aim of this article.

The practical a.m.u. which will next be described

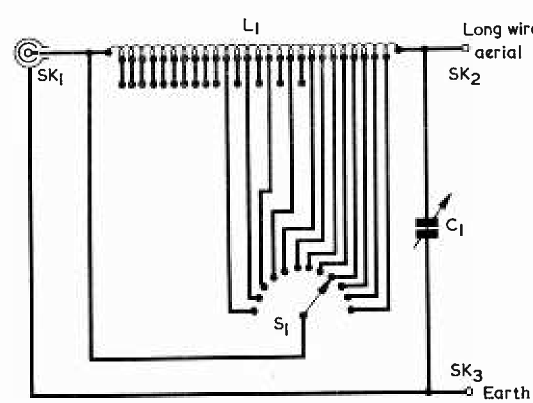


Fig. 3. Circuit of a practical aerial matching unit

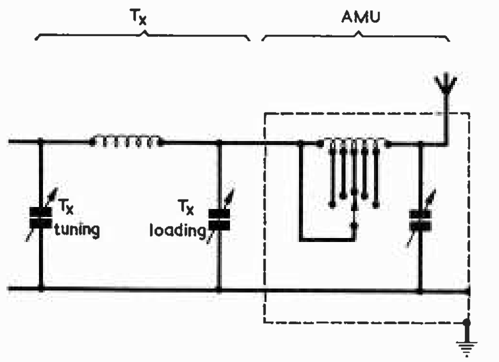


Fig. 4. The aerial matching unit is, in effect, an added section to the transmitter pi-tank network

COMPONENTS

Capacitor
C1 160pF variable, air-spaced (see text)
Switch
S1 Single-pole, 12-way, rotary (see text)
Sockets
SK1 Standard coaxial socket
SK2, 3 Aerial-Earth sockets, banana type
Miscellaneous
Paxolin panel
2 pointer knobs
18 s.w.g. tinned copper wire
Materials for coil former (see text)

can be used for all bands, 80 through 10 metres, in conjunction with end-fed wires of the lengths previously mentioned. It has been used very successfully with 75Ω operation.

The heart of the unit is coil L1 and some care is needed in the construction of this; any old coil most certainly will not do. The diameter of the coil should be approximately $2\frac{1}{2}$in. and it should be wound with 18 s.w.g. tinned copper wire with turns spaced wire thicknesses; 26 turns are needed.

For the coil 'former' a Horlicks or similar type of glass bottle could be used; a commercially produced 'former' may also be utilised although these tend to be costly to purchase. One difficulty found with a 'bottle former' is the problem of making reliable soldered tapping points after the turns have been put on tightly. The coil 'former' preferred by the author can be made up from seven smaller formers of $\frac{7}{8}$in diameter, each bonded to its fellows as is indicated in Fig. 5. A length of about 4in. is suitable for the complete 'former' and although various materials for use as sub-formers can be found, Paxolin tubing seems an excellent choice. This is easily obtainable with an outside diameter of $\frac{7}{8}$in. and in lengths of 6in. (e.g. under Cat No. ZA23A from Home Radio).

With the 'former' made up in this manner the finalised coil will be a six-sided affair which is virtually air-cored. Tappings – which are required at every turn at one end of the coil – can be easily made.

To construct such a coil the sub-formers are first bonded together with Bostik No. 1 adhesive. When firm, take wire from the spool together with a length of cord of similar thickness between finger and thumb. Anchor the ends of the wire and cord then wind on both together tightly so that wire and cord lie side by side. When the correct number of turns are in place cut off the wire and anchor it firmly. Next slowly unwind the cord and whilst the wire is still steady smear Bostik No. 1 adhesive along the side of each sub-former to hold the turns.

When dry a coil of professional standard should result, whereupon bend twelve hooks of copper wire and, referring to Fig. 6, solder them to the turns at the points marked 'X'. Additional hooks are soldered to the points indicated 'Y', these being trimmed off slightly shorter than the others to aid identification.

The twelve switch fixed contacts are wired in succession each to an 'X' coil tap in such a way

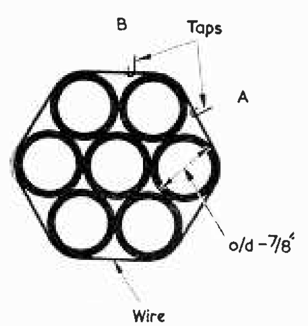


Fig. 5. A suggested method of making up a.m.u. coil former

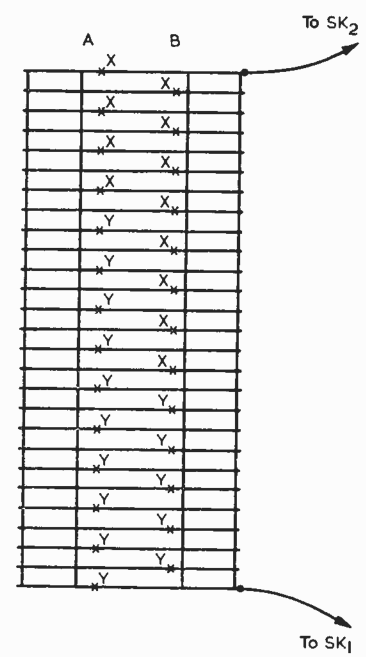


Fig. 6. Making the taps into the coil. The latter is shown elongated for reasons of clarity. The coil construction in Fig. 5 enables taps to neighbouring turns to be staggered, thereby easing soldering problems

that, as the switch is rotated, extra turns come into circuit. Practically the whole coil will be short-circuited due to the switch when the band in use is 10 metres; as lower frequency bands are selected it will be found necessary to bring additional turns into use. The taps marked 'Y' may never be needed but if it is later found difficult to obtain a good s.w.r. on either '40' or '80' they enable the appropriate switch wire to be moved a turn or two without difficulty. This facility may be found necessary if the aerial is shorter than 132ft.

The 12-way switch used in the prototype was of the miniature wave-change type, but a larger component could be employed instead if desired. C1 was a Wavemaster 160pF variable capacitor (Home Radio Cat. No. VC75). Despite the small size of these components, no flashover occurred.

The various components of the a.m.u. can easily be assembled on a Paxolin panel, the switch being so positioned that the leads to the coil taps are kept short.

ADJUSTMENTS

Initially, the aerial and a.m.u. are left disconnected and (assuming 75Ω operation) a 75Ω dummy load[3] is plugged into the s.w.r. monitor outlet (see Fig. 1).

After checking on the station receiver for a clear channel, the transmitter can then be fired up on one of the amateur bands – say 40 metres – tuned and loaded to maximum dummy load capability. The s.w.r. monitor should now indicate a zero reading in the 'Reverse' position of its switch and f.s.d. in the 'Forward' position. After temporarily removing the r.f. input the dummy load may be exchanged for the a.m.u., to which is connected the aerial and earth. When transmitter r.f. is reapplied the s.w.r. monitor meter should ideally indicate zero when the switch is at 'Reverse' but in practice this state of affairs is most unlikely. *Without touching the transmitter controls* the desired zero s.w.r. monitor reading should be obained by carefully manipulating the a.m.u. tuning capacitor in conjunction with switch S1. When this condition has been achieved it will be appreciated that the transmitter output is set correctly for 75Ω working into the low-pass filter, the higher impedance presented by the aerial having been matched down to the correct value by the aerial matching unit. This procedure can be followed equally successfully for all bands from '80' through to '10'. If simple card scales are glued to the panel behind the a.m.u. controls, settings for each band can be recorded, whereupon rapid band changing will later be found possible.

CONCLUSION

A simple a.m.u. of the type just described has proved itself satisfactory both for transmission and reception. The faint-hearted need not worry unduly about flash-over as the author's version, using the components already mentioned, has been working happily and without trouble for a considerable period at his QTH, which runs over 100 watts input of c.w. alternately with 180 watts p.e.p. of single-sideband! ■

3 Twenty 1.5Ω 2 watt carbon resistors wired in parallel can be used for transmitter inputs up to 50 watts.

CASSETTE RECORDER MAINS UNIT

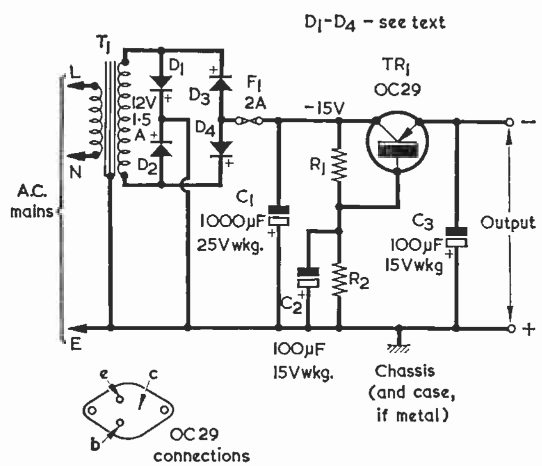
by

P. L. MATTHEWS

This power supply unit, intended for portable cassette recorders, takes advantage of a neat circuit technique to provide a wide range of output voltages

THE MARKET HAS RECENTLY SEEN A TREMENDOUS increase in the sales of portable cassette tape recorders, and a number of firms are now marketing pre-recorded music for use with them. The writer found, however, that their initial attraction of portability was rapidly outweighed by the practical cost of batteries, a typical recorder giving only six hours of operation from four 1.5 volt cells. The necessity for a mains power unit immediately becomes apparent; the recorder can still be operated as a portable unit when required but considerable cost can be saved by using the mains unit when it is running for long periods in the home.

Any such unit must be able to supply up to about 0.25 amp at voltages between 4.5 and 12 to suit the particular recorder, but although there must be freedom from hum there is no need for elaborate voltage stabilisation. Most recorders function satisfactorily at two-thirds of the nominal battery voltage as the speed of the motor is controlled by governing arrangements and the circuitry is designed to be reasonably tolerant of supply voltage changes.



The circuit of the cassette recorder mains supply. The values of R1 and R2 are given in the Table

CIRCUIT DESIGN

It was with these points in mind that the circuit, shown in the accompanying diagram, was developed. A 12 volt transformer, T1, feeds a bridge rectifier consisting of diodes D1 to D4, their output being passed via a fuse to the reservoir capacitor, C1. The resultant voltage is applied to a hum filter circuit consisting of R1, R2, C2 and TR1, and thence to the recorder. For reasons of safety it is essential to earth one side of the output, and a positive earth has been chosen here. If the recorder has its chassis common to the negative instead of the positive battery supply, its voltage above earth will still be negligibly low, but care must be taken to ensure that the supply unit case, if metal, cannot come into contact with any recorder metalwork or connections common to the recorder chassis. Also, that the latter do not come into direct contact with other earthed domestic appliances.

It can be seen that, whereas the voltage produced across C1 is about 15, suitable adjustment of R1 and R2 will reduce this to any desired value at the output because of emitter-follower action in TR1. Thus the output voltage is approximately equal to the voltage at the junction of R1 and R2 and, since the current flowing through these resistors is much greater than the base current for TR1, it is a simple matter of proportion to determine the required values of the two resistors for any output voltage. Recommended values for commonly encountered voltages are given in the accompanying Table, but these are not intended to be precise. For example, the prototype, which used 330Ω for R1 and 220Ω for R2, gave an output of 6.3 volts off-load, this falling to 5.2 volts when a current of 175mA was flowing.

COMPONENTS

The mains transformer employed in the prototype was an Osmabet heater transformer (available from Home Radio under Cat. No. TH11) offering 12 volts at 1.5 amp. Although the current rating is higher than is actually needed, the use of this transformer ensures the provision of a well regulated secondary voltage together with low heat dissipation. The diodes should be silicon types having a p.i.v. rating of 25 volts minimum and a current rating of 250mA minimum. A wide range of diodes meets these requirements including, for instance, the 1N482. For cool and reliable running, it is preferable that both R1 and R2 be wirewound types having a minimum rating of 2 watts, even though the actual power each dissipates is significantly lower than this figure. Their tolerance or value should should be 5% or better.

TABLE

	Output Voltage				
	12V	9V	7.5V	6V	4.5V
R1	100Ω	220Ω	270Ω	330Ω	330Ω
R2	390Ω	330Ω	270Ω	220Ω	150Ω

If the expense of a panel-mounted fuseholder is considered excessive, F1 can consist of about an inch of 2 amp fuse wire (43 s.w.g. copper wire) soldered between two tags of a tagstrip. Take care to ensure that the fuse wire cannot short-circuit to any other connection or to the case (if this is metal) either before or after blowing.

CONSTRUCTION

Construction may follow normal practice. The prototype was assembled in an Eddystone diecast box measuring 3½ by 4½ by 2 in. deep (Home Radio Cat. No. E650). TR1 was bolted to one side of the box, being insulated from it by the usual mica washer and insulating bushes. If the unit is made up in an insulated case, TR1 needs to be mounted on a heat sink of some 3 to 4 sq. ins.

The main points to cater for are those concerning safety. The 3-core mains lead should be secured inside the case by a suitable clamp. Ensure that all mains connections are completely covered and cannot be accidentally touched. Make certain also that the mains lead terminates in a 3-pin plug offering connection to the mains earth.

It will be noted that there is no on-off switch, as this was considered unnecessary for the prototype. However, a suitable switch may of course be added, if desired. A single pole switch should be inserted in series with the live mains connection, or a double pole switch in series with the live and neutral connections. ■

DAYSTROM AT I.E.A. INTERNATIONAL EXHIBITION, OLYMPIA, 11th—16th MAY, 1970

Instruments from the wide range of Heathkit electronic instrumentation will be on display at this exhibition. These include transistor and valve voltmeters, oscilloscopes, signal generators, power supplies, etc. A selection of Heath Scientific Instruments will be on view. New models on show for the first time are a solid state sine square wave generator IG-18, a regulated power supply, IP-28, an automobile tune-up meter, ID-29, and a solid state metal locator, GD-48.

A selection of the world famous Heathkit Hi-fi equipment on view will include such new models as the AD-17 and AD-27 stereo hi-fidelity "Compacts".

For further information telephone Glos. 29451.

HOW MANY EGGS?

How many eggs in your basket?

Many enthusiasts devote their available time to all aspects of the hobby of electronics but others tend to specialise in one particular field or another. The construction of radio and electronic devices is a pastime in which we all engage, the whole object being to bring to a successful outcome the equipment currently on the workbench. Often, once completed, the device is then dismantled and the components used again in a subsequent design, the end result being simply the acquisition of electronic knowledge and know-how for its own sake. Others construct designs, either following those published here or using their own ideas or even, in some cases, utilising a mixture of the two methods. Usually these equipments are not immediately dismantled but are intended for some years usage within the workshop or shack, being included in the transmitting, listening or testing line-up.

Some constructors have almost entirely gone over to the use of semi-conductor devices mounted on printed circuit boards of their own design or proprietary small copper laminated sheets. Others much prefer the inclusion of valves in their projects – as one colleague recently stated – the glow of a valve can be a comforting sight! Many of us, however, adopt both methods of construction, and often both transistors and valves are incorporated in a hybrid circuit.

Radio constructors are a diverse lot to say the least and it is impossible to separate them into single interest groups. The generic term radio constructor covers a whole variety of individual types, the prime requirement being a genuine interest in electronics. In this, none of can be included out – as a famous personality once remarked!

Whether you are currently engaged in construction for its own sake, operating a transmitter or receiver, or perhaps delving into all three pastimes, it is certain that you have more than one egg in your basket.

New ideas, new circuits and new methods of construction are all part of the ever changing scene encountered by the electronics and amateur radio enthusiast. To keep abreast of events and trends, is a challenge to all and requires continued interest and a constant application of the mind. Those of us who have been engaged in the hobby for a long period of time have come a long way from the old breadboard method of construction and have now entered into the period of integrated circuit applications. What a difference – and what a challenge! Where will it all end? Evolution being what it is, it never will end and we are faced with constantly changing devices and techniques – some of them being part of the spin-off from space technology.

The question was – how many eggs in your basket? If we are interested and currently engaged in some of the many facets of radio and electronics, then certainly the basket holds quite a lot of hen fruit! Consumed by an avid interest in the latest electronic devices, we look to future developments with unabated enthusiasm.

Tied by choice to the yoke of electronics, we have no alternative! C.W.

■

CURRENT SCHEDULES

★ MALAGASY REPUBLIC

According to a recent schedule, Tananarive on **17730** (100kW) radiates a programme in English called "QSL Service" on Tuesdays, Thursdays and Saturdays from 1700 to 1715. Closes at 1730.

★ SEYCHELLES

The latest schedule of the FEBA transmitter is as follows:– 0030 to 2000 on **11760;** 2005 to 0330 on **15185;** 0340 to 0500 also on **15185** and from 1300 to 1630 on **15265.**

★ EL SALVADOR

YSS Radio Nacional de El Salvador, San Salvador, on **5980** and **9555** (both 5kW) have a schedule from 1700 to 0500. Special programmes for French and English speaking listeners are radiated from Monday to Saturday inclusive from 0300 to 0330 and on Sunday from 0030 to 0100.

★ SWEDEN

Radio Sweden has a new schedule for Europe and this will be effective until 3rd of May. On **9625** from 0830 until 1130 and on **6065** from 1600 to 1730, from 1945 to 2115 and from 2130 to 2230 in various languages.

★ TANZANIA

Zanzibar can be heard on the regular channel of **3339** around 1800. The schedule is from 0330 to 0430 and from 1400 to 1930 on this channel and from 1100 to 1200 on **6005.** Both stations radiate the Home Service in Swahili.

★ JAPAN

The General Service of Radio Japan can be heard at 0800, 0900 and at 1000 on **17855.** The General Service from 0400 to 0430 and from 0500 to 0530, in English and Japanese, is now on **15105** instead of **9505.**

NHK Tokio can also be heard with identification in English at 1230 on **11705.** Programme in Russian follows. (All 100kW).

★ PAKISTAN

The English programme from Radio Pakistan for Europe and the U.K. is now radiated from 1945 to 2030 on **7095** and **9465.** (10/50kW – see **Now Hear These**).

★ SUDAN

Radio Omdurman schedule is from 0700 to 0900 and 1600 to 1900 on **4994** (50kW) and **11835** (50/100kW). English programme is from 1715 to 1800. Radio Omdurman can also be heard with the English transmission on **15270.**

★ GUINEA (REPUBLIC)

Conakry may be heard on **4900** (4kW), **7125** (50kW) and **15310** (50kW). Schedule is from 0600 to 0830, 1230 to 1330 and from 1700 to 2300. **9650** (50kW) is also used for this latter transmission. Programmes are mostly in French.

★ YUGOSLAVIA

Radio Belgrade has a service for Europe as follows – 1530 to 1600 on **9620, 11735** and **15240;** from 2000 to 2030 on **6100, 7200** and **9620;** from 2200 to 2215 on **6100, 7200** and on **9620.**

Acknowledgements to our own Listening Post, Swedish Dx'ers and World Radio Club.

TRADE REVIEW . . .

NO-COMPROMISE RECEIVER

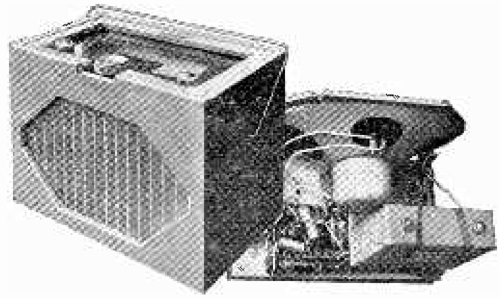
The accompanying photograph illustrates what must be the design engineer's dream project. It shows the new Marconi H2900 receiver which has been produced to offer, regardless of price, the utmost in reliability, performance, serviceability, ruggedness and compactness. Marconi's refer to it as the 'No-Compromise Receiver', since the design approach is aimed at improving existing receiver standards with no compromise at all so far as costs are concerned.

The receiver will have a wide application in fields where trouble-free reception of speech or data is vital, and it fulfils the growing requirements for extreme reliability with ship, ground-to air, military, missions, together with detection of speech with or without carrier. Individual automatic gain control systems, capable of handling severe fading conditions are available for these services. The design is basically a triple-conversion superhet using intermediate frequences analysed by computer to minimise spurious responses. The three frequency changes are controlled by a frequency synthesizer which relies on a high-stability crystal oscillator and produces a train of pulses controlling the frequency of an L/C oscillator. This technique gives stable locking onto frequencies selected, in steps of 1Hz only, by digital calibrated controls. Tuning is simplfied by a special memory

embassy and meteorological communication, in both fixed and mobile use. It can operate from a wide range of mains voltage or from batteries, and is intended for the 1.5 to 30MHz h.f. range, where it should give better performance than any other equipment in its class in the world. The receiver has a rugged cast alloy chassis with full component accessibility, and occupies 22 by 17½ by 17in. only. Extensive use of sealed microcircuit flatpacks, including field effect types, contributes to the high reliability.

The H2900 is available in versions which cater for reception of data, Lincompex and Piccolo transmissions circuit which enables a new setting to be brought into use by simply pressing a button. The overall frequency stability is better than 0.5Hz throughout the range.

As may be seen from the photograph, the front panel of the receiver is divided into two sections, these being for receiver control, including the frequency synthesizer dials, and for receiver monitoring. Controls are arranged for operator convenience and moving parts are reduced to a minimum. Also, the full control facilities can be extended to a similar panel in a remote position on a digital link by way of a telephone or radio. ■



THE "FETAFLEX 4" T

(Pa

SIR DOUGLAS HALL,

Incorporating an insulated gate f.e.t. design uses double reflexing in its fi capable of feeding low resistance head here, describes the circuit and its ope appear next month, deals with assem of a neat functional cabinet which sh the home

THE "FETAFLEX" IS AN ENTIRELY NEW DOUBLE reflex circuit suitable for reception over the whole of the medium wave band, and for Radio 2, alone, on the long wave band. It employs a field effect transistor in one of the double reflexed stages, this giving the circuit its name.

DOUBLE REFLEX STAGES

The basic arrangement of the two reflexed stages is shown in Fig. 1. The signal is picked up on the tuned circuit given by L1, a ferrite rod assembly, and VC1, and is then passed to the gate of TR1. TR1 is wired into circuit as a source follower and has, therefore, a very high input impedance of many megohms. There is, consequently, virtually no damping of the tuned circuit. TR1 acts as an impedance transformer with the output at the source directly coupled to the base of TR2 which, at radio frequencies, functions as a common emitter amplifier. The voltage at the base is therefore approximately the same as the voltage across the high impedance tuned circuit, despite the fact that the input impedance of TR2 is low. Without the impedance transformation given by TR1, it would have been necessary to use a coupling winding on L1 which would have cut down the input voltage by ten or more times. In other words, although TR1 offers no voltage amplification, it enables a far greater voltage to be applied to the base of TR2 than would have been possible without it.

It will be seen that TR2 is a p.n.p. device and that there is negative feedback of d.c. throughout the circuit comprising TR1 and TR2.

The signal, after amplification by TR2 appears at the collector of that device across the load formed by L3 and VR1. It is then applied to diode D1, which is a selenium rectifier with a very high impedance – about 100kΩ in this circuit. The rectified output appears across diode load R1 and is then fed back to TR1, which again acts as a source follower, this time at audio frequencies. The a.f. signal at TR1 source is passed to the base of TR2 which, at audio frequencies, functions as a common collector current amplifier. The output at the emitter of TR2 is at a low impedance of about 50Ω. If (in the practical

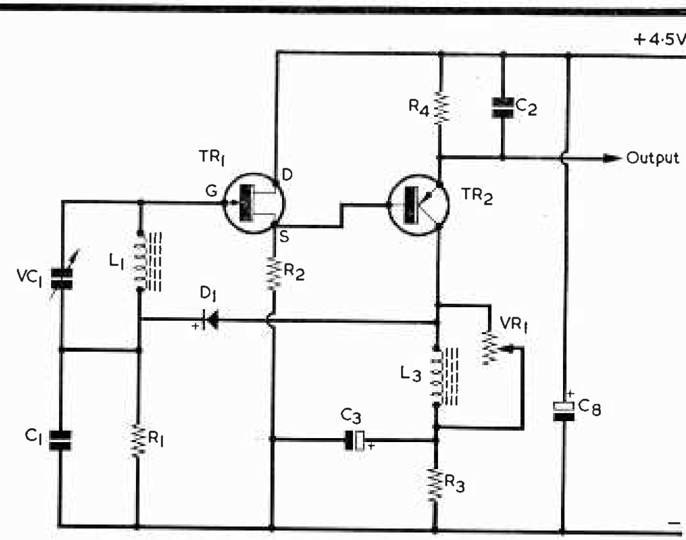


Fig. 1. The basic double reflexed circuit

ANSISTOR PORTABLE

|)

Cover Feature

.C.M.G., M.A.(Oxon)

his sensitive and selective receiver two stages which, on their own, are ones. Part 1 of the article, published tion, whilst the concluding Part 2, to , setting up and the construction ld be well within the capabilities of arpenter

version of Fig. 1) a pair of sensitive low resistance phones is connected, via a 100μF electrolytic capacitor, between the emitter of TR2 and either the positive or the negative supply line, good signals will be received.

The value of C1 is such that it provides a suitable capacitive tap into the tuned circuit to allow regeneration to take place in the Colpitts mode. Its value is fairly critical for best results, and in the practical version of the circuit a trimmer is used in parallel with a fixed capacitor. VR1 causes variable damping across choke L3 and acts as reaction and volume control combined. The volume facility is provided since, if VR1 is set to insert zero resistance into circuit, there is no r.f. output load for TR2, and no signals can pass through the circuit. It will be found that, owing to the large amount of r.f. amplification which takes place, oscillation will occur very readily, and L3 is orientated with respect to L1 in such a way that it introduces negative feedback, thereby holding the circuit in the non-oscillating condition until VR1 has most of its resistance in circuit.

C8 is the normal large-capacitance electrolytic component which prevents spurious oscillation taking place as the battery runs down. It functions as a decoupling capacitor when additional stages are added to operate a speaker.

PRACTICAL CIRCUIT

Fig. 2 shows a complete practical circuit for a portable receiver employing a speaker. The two additional transistors, TR3 and TR4, are audio frequency amplifiers.

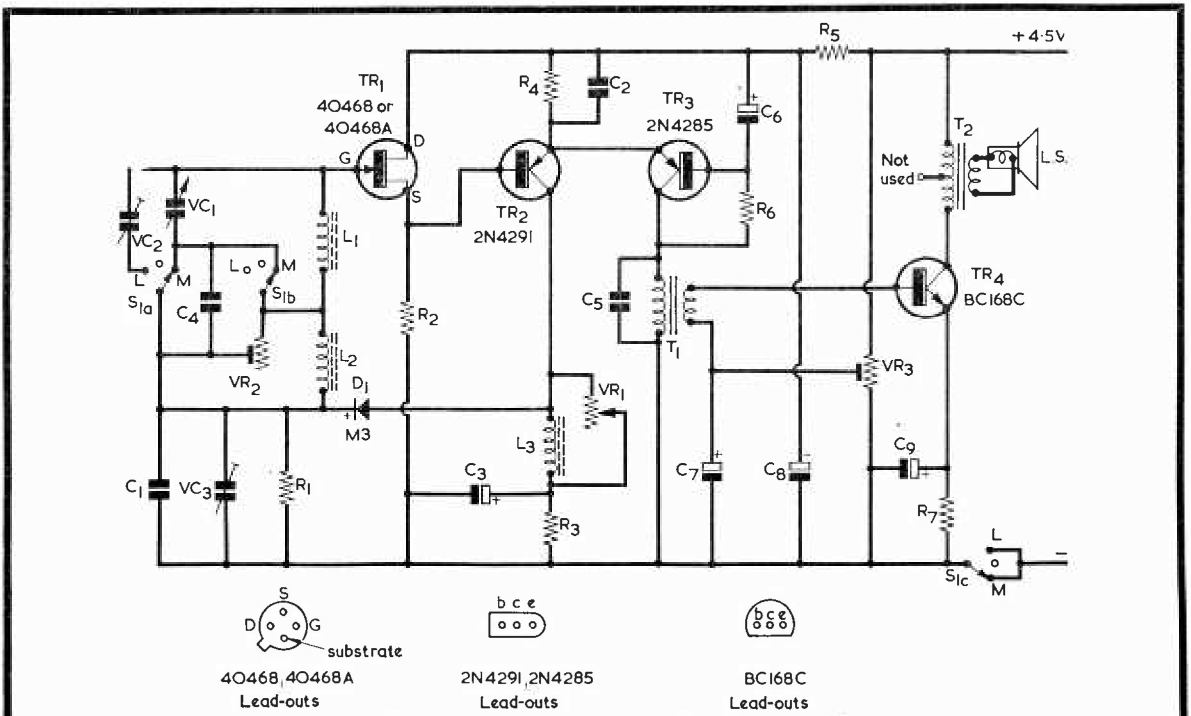


Fig. 2. The complete circuit of the "Fetaflex 4" receiver

COMPONENTS

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

R1	100kΩ
R2	1kΩ
R3	820Ω
R4	680Ω
R5	47Ω
R6	1MΩ
R7	10Ω
VR1	500Ω potentiometer, linear
VR2	250kΩ potentiometer, preset, miniature or skeleton
VR3	5kΩ potentiometer, preset, miniature or skeleton

Capacitors

C1	500pF silver-mica
C2	0.1μF paper or plastic foil
C3	100μF electrolytic, 2.5V wkg.
C4	50pF silver-mica
C5	1,000pF silver-mica
C6	2μF electrolytic, 4V wkg.
C7	100μF electrolytic, 2.5V wkg.
C8	500μF electrolytic, 6V wkg.
C9	1,000μF electrolytic, 2.5V wkg.
VC1	300 or 365pF variable, air-spaced
VC2	250pF trimmer
VC3	750pF trimmer

Inductors

L1	See text
L2	See text
L3	2.5mH r.f. choke, type CH1 (Repanco)
T1	Microphone transformer, type TT53 (Repanco)
T2	Output transformer, type TT56 (Repanco)

Transistors

TR1	40468 or 40468A
TR2	2N4291
TR3	2N4285
TR4	BC168C

Diode

D1	M3 (S.T.C.)

Switch

S1	3-pole 3-way, or 4-pole 3-way, miniature rotary

Speaker
3Ω speaker, 8in. by 5in.

Miscellaneous
18-way groupboard, Radiospares "Standard" (Home Radio Cat. No. BTS10)
Transistor holder (for TR1)
Ferrite rod, 6in. by $\frac{3}{8}$in. dia. (for L1)
Ferrite rod, 5in. by $\frac{3}{8}$in. dia. (for L2)
4.5 volt battery, No. 126 (Ever Ready)
3 knobs
1$\frac{3}{4}$in. drive drum (see text)
Drive spindle and bush
Plywood, Perspex, Fablon, etc.

In Fig. 2, S1 is illustrated in the medium wave position. The circuit, so far as TR1, TR2 and their associated components are concerned, then becomes nearly identical to that shown in Fig. 1, apart from the fact that C1 now has a trimmer, VC3, across it. The correct total capacitance in this position is about 1,000pF, so that a 500pF component is used for C1 and a 750pF trimmer for VC3.

Experiments showed that it was difficult, if not impossible, to obtain satisfactory operation over a continuously variable long wave band with this circuit, though it could be set up without difficulty to receive a single station, such as Radio 2 on 1500 metres. If S1(a) and S1(b) are considered to be in the long wave position it will be seen that the long wave ferrite rod inductor L2 is brought into series with L1; trimmer VC2 is brought into parallel with this series combination; and a fixed capacitor of 50pF, C4, comes into series with the tuning capacitor VC1. Radio 2 is tuned by VC2; whilst VC1, with C4 in series, acts as a fine tuning device to allow for variations in internal capacitances which may come about as the result of a failing battery or marked changes in ambient temperature.

The audio frequency signal at the emitter of TR2 is applied directly to the emitter of TR3. This transistor is connected in common base configuration in order to allow its input impedance to match the low output impedance of TR2. The very large transformer winding (normally intended for connection to a crystal microphone or pick-up and offering an impedance of the order of 200H) in the collector circuit of TR3 means that TR3 gives very high amplification, but it is necessary for the current it passes to be kept down to a maximum of about 150μA to avoid saturation of the core of the transformer. The transistor specified for TR3 is a type which maintains good amplification with a very small collector current, and the value of R6 is chosen to provide a base bias suitable for a collector current of about 120μA. C5 is needed to prevent unwanted radio frequency signals appearing in the TR3 and TR4 stages. It also helps to equalise the load offered by the large winding of T1 at different audio frequencies.

It might be mentioned at this point that the effect of the large inductance offered by the T1 winding in TR3 collector circuit, in combination with R6 and C6, means that TR3 does not pass current for about 3 or 4 seconds after switching on. This slight delay in operation must therefore be expected. It may also be found that when the receiver is critically tuned to a weak station near the high frequency end of the medium wave band there will be a tendency for reaction to "spill over" for a few seconds, this requiring small adjustments to the reaction control, VR1. The effect stops soon after switching on and does not take place at the middle or low frequency end of the medium wave band. Nor does it occur at high frequency settings if the incoming signal is strong.

T1 has a step-down ratio of 25:1 so that its secondary offers a good match to the input of TR4, which is wired as a common emitter power amplifier. A transistor giving very high amplification is used in this position. It will be noted that TR3 must be a p.n.p. device to allow direct coupling from TR2. Since transformer coupling is used, TR4 could, in theory, be p.n.p. or n.p.n., provided that the neces-

RADIO CONSTRUCTOR MAY ISSUE

★ **NEON-L.D.R. A.F. OSCILLATOR**

The a.f. oscillator 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. Extremely economical of components, the circuit is original and has not – so far as we are aware – been previously described.

★ **INCREASING TRANSISTOR RADIO COVERAGE**

Extend the range of your portable receiver to cover 1,570 to 3,800 kHz – covering the 160 and 80 metre bands as well as the 'Trawler Band' – by mixing on the second harmonic of the oscillator. This article tells you how it can be done.

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★ **EXCLUSIVE MOTORING OFFER**

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★ **DATA SHEET 38**

ON SALE 1st MAY

SIMPLIFIED SOLID-STATE DISTORTION METER

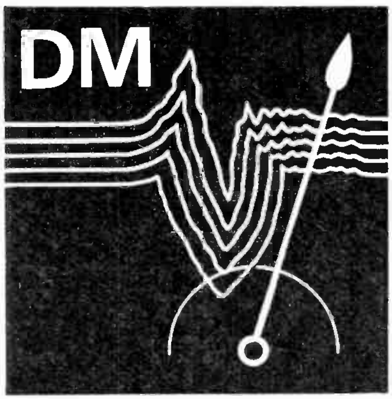
The insignia below is that of the Solid-State Distortion Meter constructional project featured in our next issue.

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.

The semi-conductor line-up is 2N697, 2N2926 Yellow, 2N2926 Yellow, MPF105, 2N2926 Yellow, 2N2926 Yellow, OA90 (4 off) and an OA85. Construction is centred mainly on two printed circuit boards – full details of which are given in the free four-page art paper cut-out colour supplement.

FREE

A four-page art paper cut-out colour supplement featuring Workshop Plans, Circuit, and Printed Circuit Boards Layout for this constructional project.



sary alterations to wiring were made, but the n.p.n. type specified is recommended for best results. It might be mentioned that all the five semiconductors specified can be obtained for well under £1 at the time of writing. The four transistors may be obtained from Amatronix Ltd., and the diode is available, sometimes listed as a "meter rectifier", from Henry's Radio Ltd. and other suppliers.

COMPONENTS

All the parts required for the receiver are listed in the accompanying Components List. The concluding article, to be published next month, gives details of coils L1 and L2, and of the drive spindle and bush, the drive drum, and the plywood, Perspex and Fablon required for the cabinet. Readers wishing to obtain the ferrite rods for L1 and L2 in advance may note that L1 employs a 6in. by $\frac{3}{8}$in. ferrite rod, and that L2 employs a 5in. by $\frac{3}{8}$in.. ferrite rod. (The 5in rod is available from G. W. Smith and Co. (Radio) Ltd., 3 Lisle St., London W.C.2.)

(To be concluded)

TOP BAND TRANS-ATLANTIC TESTS, 1969-70

The Top Band Trans-Atlantic Tests for 1969–1970, organised by W1BB, were held on 30th November, 14th December and 28th December 1969, and on 11th January, 1st February and 15th February 1970 respectively, commencing at 0500GMT and lasting until 0800GMT.

During every one of these Tests our Listening Post was eavesdropping on the c.w. activity to ascertain the amount of European interest apparent and to gain some information on the volume of activity from the other side of the Atlantic.

When conditions were such that contacts were at all possible, a listening watch was maintained for most of the Test period. When conditions were very poor, only a limited time was spent on the Band.

For those interested, we present the results obtained.

30th NOVEMBER

It was apparent from switch-on that the Atlantic signal-path was only *just* open, with signals barely over-riding the noise level. During the period 0445 to 0530GMT the only Trans-Atlantic signal heard was K3DC? and that only partly deciphered, with no guarantee that the call-sign is correct.

The European stations, mostly British, patiently called CQ within their allotted frequency allocation of 1823 to 1830kHz from the outset of the Test, but as time passed and the realisation dawned that conditions were anything but hopeful, Eu activity rapidly declined.

With the W signals tantalizingly just slightly above the noise level, one G3-plus-3 losing patience with the bad conditions brazenly set himself up on 1804kHz and proceeded to put out a long CQ call. Another G3-plus-3, to his great credit, promptly came up on the frequency and, in no uncertain terms, told the miscreant to QSY out of it! A few moments later, however, a certain G2 station plonked himself on 1802kHz and repeated the long CQ performance! As the frequency allocation for W/VE stations is from 1800 to 1820kHz the barging-in episodes represented sheer bad operating.

Although conditions made this first Test a non-success, the previous weekend had shown great promise with the logging of K1BPW, W1EXI, W1BB/1, and VP9GW – although we have some doubt about the authenticity of this latter call.

14th DECEMBER

This Test unfortunately followed the pattern of the previous one, a very high noise level being apparent from switch-on at 0445GMT. The Test finally fizzled out at around 0545GMT, the only Trans-Atlantic signal heard being that of W1BB/1 – and that only being deciphered by replaying the tape several times! W1BB/1 was taped at 0504 GMT.

The only European stations heard were British and included G3ADH, G3IGW, G3WPO, G3XDV, G3XNS, G3YGF, G3YIY/A, G3YMH and G3YRA.

28th DECEMBER

From the moment of switch-on at 0430GMT Trans-Atlantic activity was at full-swing. Across-the-pond contacts were going on prior to the official commencement (0500GMT) and everyone was getting into the act! After the previous disappointments this Test turned out to be a welcome change.

The strongest Trans-Atlantic signals were undoubtedly those of KV4FZ and W1HGT, both peaking to S7 at times. Other signals from across the Atlantic coming in at various strengths were – K1BPW, K2ANR, K8DH, K8RNE, W2IU, W4BRB, W8AH, W8ANO, W8GDQ, W9BKA/8 and WA4SGF.

Activity from the European Continent, as distinct from G calls, were – DL9KRA, OK1AIN, OK1ATP and OK1MIO.

Activity rose to a peak between 0530 to 0600 GMT, after which period the skip distance commenced to alter and Trans-Atlantic signals started to gradually fade out, although K2ANR peaked to S7 at 0615.

This Test was marred at times by static 'crashes' caused by an electrical storm but, despite these, the results achieved were well worth-while.

11th JANUARY

This Test turned out to be much like the first two; a high noise level predominated, making W signals barely audible above the 'mush'. W1BB/1 was heard at 0445GMT at S6 and was the only Trans-Atlantic signal logged around that time. By 0525GMT the Test had petered out.

British stations manfully struggling on were – G3JAG, G3RFS, G3VXM, G3XEI, G3YGF and G3YMK, all heard around 0510GMT.

In between times, from 0445 till 0535GMT, the OK's were having a wonderful time busily working each other. Those logged were – OK1ALI, OK1ALM, OK1BLU, OK1FAB, OK1JBF, OK1MAA, OK1KYS, OK2KKD, OK2KNZ, OK2RGA, OK2KYI, OK3TOA, OL2AIO, OL2ANK and OL5ALY. Although not representing Trans-Atlantic Dx, the foregoing does provide some indication of the state of the Band at that period of time.

Returning to Top Band at 0750GMT, W1HGT was heard at S5 working G3RLS and W1BB/1 at S5 working G3SVC, the latter call being misread by W1BB/1 in the first instance as G3HVC, which was

Mt. Carmel, Conn.
200 Todd Street

K1PBW

James (Ernie) Hemingway

A QSL card received from K1PBW for a report on his 1969 Top Band c.w. signals.

not surprising considering the conditions at the time. Not a very successful Test by any standard.

1st FEBRUARY

Propagation conditions during this Test turned out to be better than those of the previous one – although only very slightly.

At 0500GMT the only Trans-Atlantic signal heard was that of the indefatigable W1BB/1 at S4 to 5. At 0545 KV4FZ and W2GGL were just audible. By 0550GMT W1BB/1 was calling CQ at S6. This subsequently proved to be the best time for Trans-Atlantic contacts, although there were more CQ calls being put out than actual contacts made.

At 0602GMT the signals of W8ANO, calling CQ, were heard just above the noise level, peaking at times to S4, whilst W1BB/1 was calling G3PL at 0604GMT at about the same signal strength. The only other additional W signal deciphered, with some difficulty, was W8GDQ at 0610. W2GLL was again heard at 0615GMT vainly trying to establish another contact, putting out a CQ call that could only just be made out amid the surrounding 'mush'.

European stations active during the period of this Test were – at around 0500GMT, G3KPU, G3OQT, G3RKJ, G3RFS, G3YCC, OK2HZ and OL6AKP – all calling W1BB/1. By 0545GMT the following were still active – G3LIQ, G3RGA, G3RKJ, G3XEI, OK1AWQ, OK1DIM and OK2HZ. Later on, at 0610GMT, G3OQT was heard calling W8GDQ.

This particular Test was anything but a roaring success!

FEBRUARY 15th

Conditions for the last Test were anything but favourable, the noise level was high, activity was sparse and for those with outside 'shacks' the temperature was below freezing point!

A watch on the band from 0445 until 0515 GMT produced only W1BB/1 at the low end of the band with a signal strength of S3–4. No other W signals were heard during this period.

Local activity emanated from G3XNS calling CQ at 0450; G3RKJ at 0500; G3ADH calling W1BB/1 at 0505 with G3RCE/A doing a similar stint lower down the band.

Returning to the band at 0625 GMT, the only locals heard were G3PU calling CQ at 0625; G3JMJ at 0627 and G3NSS at 0629.

W1BB/1 had faded out but W1HGT could be heard above the noise level at S3 peaking to S4 and was worked by G3PU at 0634 GMT.

With that cold comfort, the 1969/70 Top Band Tests fizzled out with the freeze-up! ■

NOW HEAR THESE

All times GMT. Information correct at time of preparation.

● **CEYLON**

The Commercial Service of Radio Ceylon, in English, now begins at 0100 on **9720** (100kW) and **15120** (35kW).

● **CONGO REPUBLIC**

Radio Brazzaville on **4800** (4kW) with news in English from 1930 to 1945.

● **ECUADOR**

HCJB "The Voice of the Andes" is back on **21460** (100kW) with a service to Europe from 1830 to 2130.

● **JAPAN**

Radio Japan on **9530** (100kW) at 1300 with a programme called "Japanese by Radio". Radio Japan can also be heard on **17855** (100kW) at 0758 with identification in English preceded by the unmistakable 'tinkling' sound of their musical box interval signal, according to our Listening Post.

● **KUWAIT**

Radio Kuwait signs on in English at 1600 for Europe on **4967** (10kW) and on **15405** (10/250kW). Transmission to Europe ends at 1900 but continues, in English, to the Gulf, on **4967.** News in English at 1830. Closes at 2100.

● **VATICAN**

Heard with English programme at 1630 on a new channel of **17795.**

● **BELGIUM**

Brussels has been reported on the new channel of **11790** in parallel with the usual **6125** (100kW) frequency.

● **PIRATE RADIO**

Radio Nordsee International, a pirate radio ship anchored in International waters off the Hook of Holland, has been reported on **6120** from 0505 to 0900 in German and in English and German from 0900 till midnight.

● **FRANCE**

Paris has commenced radiating an English news programme from 2015 to 2100 on **15295, 15315, 17720** and **21580** (all 100kW), according to a report,

● **U.S.A.**

A station not often reported is WINB Red Lion, Pennsylvania, heard by our Listening Post at 2130 on **11795** with identification.

● **PAKISTAN**

Radio Pakistan has been logged by our Listening Post on the new channel of **9485** with news in English at 1500. Radio Pakistan may also be heard on the regular frequency **9465** (10/50kW) with Asian type music, identification in English and closing down at 2030.

● **VENEZUALA**

YVKR Radio Caracas (7.5kW) has been heard with a programme of Latin American music and station identification on **4920** as late as 0625.

YVQA Radio Sucre, Cumana (1kW) has been logged at 0345 with 4 chimes and station identification on **4960.**

Acknowledgements to our own Listening Post, Swedish Dx'ers and World Radio Club. ■

TRANSISTORISED LIE DETECTOR

by

G. C. DOBBS, G3RJV

Although intended primarily for amusement purposes, this simple instrument could also be employed for experimental work by students of psychology

LIE DETECTORS ARE USUALLY ASSOCIATED WITH American detective stories and spy thrillers. Their usefulness from the legal point of view is very limited, since they rely on the subject's emotional instability during questioning. Although such evidence would not be regarded as reliable in a law court, there are psychological advantages in using such an instrument. The simple instrument described here is intended for amusement and perhaps experiment by students of psychology.

When a person tells a lie, especially under emotional stress, certain physical changes occur in the body. There is likely to be an increase in perspiration, body temperature, and flow of blood, as well as other possible changes. As everyone who owns a high-reading ohmmeter knows, the human body has an electrical resistance which can easily be measured. This resistance will change in sympathy with physical changes in the body, so the physical changes which occur when a person tells a lie can be measured in terms of electrical resistance.

The actual amount of change in bodily resistance is very small when compared with the total resistance of the body. A method is required to measure small changes in a high total resistance. A normal ohmmeter would be useless because, in relation to the total reading on the scale, the change would be too small to notice. The circuit arrangement which springs to mind for such an application is the Wheatstone bridge.

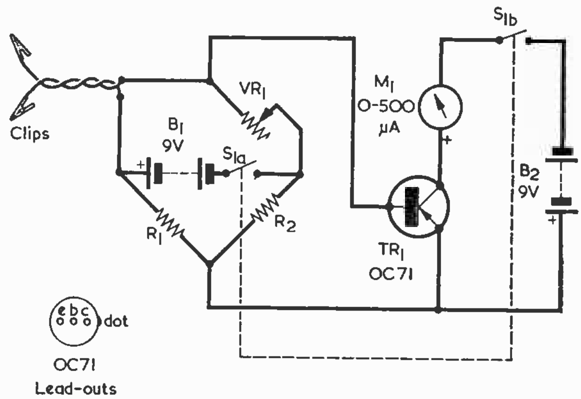


Fig. 2. The bridge as adapted for use in the Lie Detector

THE WHEATSTONE BRIDGE

The basic circuit of the Wheatstone bridge is shown in Fig. 1, and is well known to every school boy physicist. It has countless applications in electrical measurement. Because of the accuracy of the null point method of measurement, this circuit may be used to measure very small changes in resistance.

In the circuit given in Fig. 1 a null condition, in which no current flows in the meter, is given when $\frac{R1}{R2} = \frac{R3}{R4}$.

If the value of one of the resistors is altered, the balance is disturbed and the meter will deflect. The zero reading on the meter may be restored by adjusting a resistor in the other arm of the bridge, thus maintaining the ratio. So if R3 is likely to change in value, R4 could be a variable resistance to keep the meter reading at zero. Any change in R3, shown on

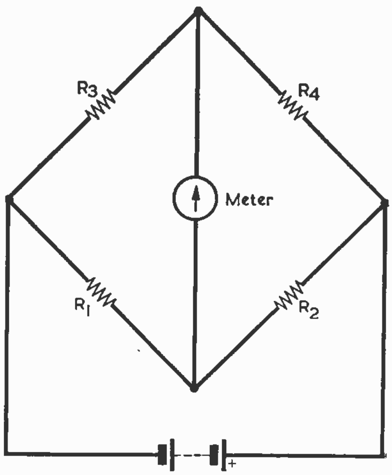


Fig. 1. The basic Wheatstone bridge

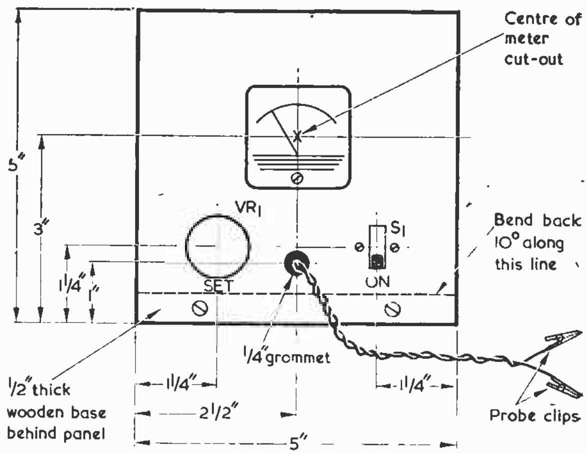


Fig. 3. The front panel dimensions and layout

the meter, could then be counteracted by altering the value of R4.

This method is used in the Lie Detector, whose circuit is given in Fig. 2, to measure changes in the subject's body resistance. The body becomes one arm of the Wheatstone bridge, via the contact clips, and VR1, which replaces R4, is used to achieve a balance reading in the meter. The usual disadvantage of the Wheatstone bridge is that it requires a very sensitive meter, which can be expensive and very delicate if small changes are to be detected. This difficulty is overcome in the present instrument by use of the transistor amplifier TR1. This increases the sensitivity of the instrument and allows the use of a cheaper and more robust meter.

Fig. 2 shows an OC71 transistor in the simple common emitter mode, with a meter to measure the collector current. Under these circuit conditions a small amount of collector current still flows at zero base input current. Normally, this would require some form of zeroing arrangement for the meter circuit, with the provision of a backing-off current. However, if the meter is only used at about mid-scale, as is intended here, no such provision is required.

Although the circuit of Fig. 1 is simple, it functions quite well in practice. Two 9-volt batteries are used, one to provide a voltage for the Wheatstone bridge, and one to provide the power for the transistor amplifier. The current drain on both batteries is very low, so that small batteries may be used, and will give many months of useful life.

The switch S1 is a double pole – double throw slide switch, which is used to switch on both the batteries B1 and B2. The meter has a 0-500μA movement. A Japanese meter with a Perspex front was employed in the prototype, although any similar meter would function in this circuit. As already mentioned, an OC71 transistor was used for the amplifier. Most small signal medium gain audio type germanium transistors would function in the circuit, and a 'red spot' surplus transistor has also given good results.

COMPONENTS

Resistors
- R1 330kΩ $\frac{1}{4}$ watt 10%
- R2 330kΩ $\frac{1}{4}$ watt 10%
- VR1 1MΩ potentiometer, linear
- *VR2 2kΩ or 2.5kΩ preset potentiometer, skeleton

Semiconductors
- TR1 OC71
- *D1 DD000

Meter
- M1 0-500μA, moving-coil

Switch
- S1 D.P.D.T. slide switch

Batteries
- B1, B2 9-volt batteries type PP3 (Ever Ready)

Miscellaneous
- Probe clips (see text)
- Battery connectors
- 4-way group board
- Material for panel, base, etc.

*Used for optional meter overload protection circuit.

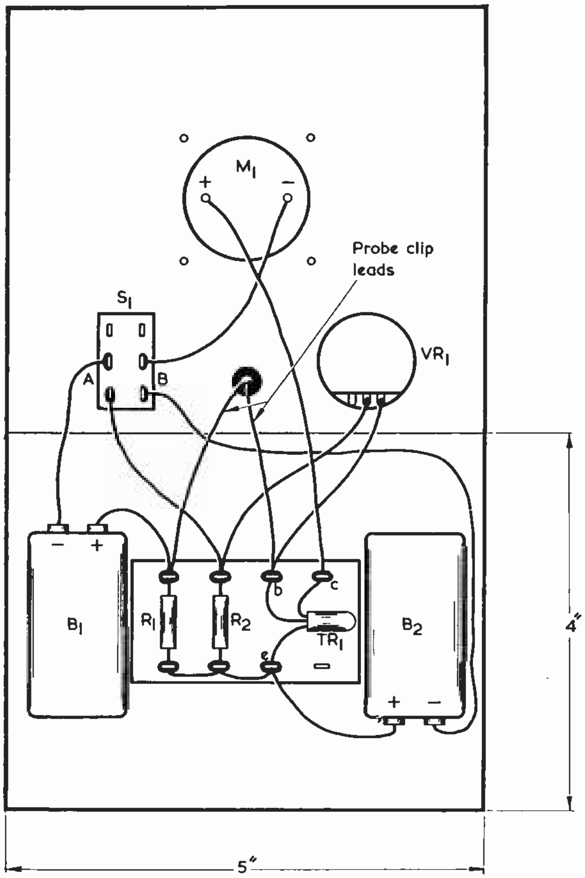


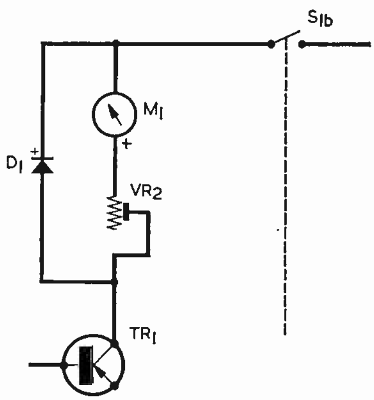
Fig. 4. Wiring diagram for the circuit of Fig. 2

PHYSICAL LAYOUT

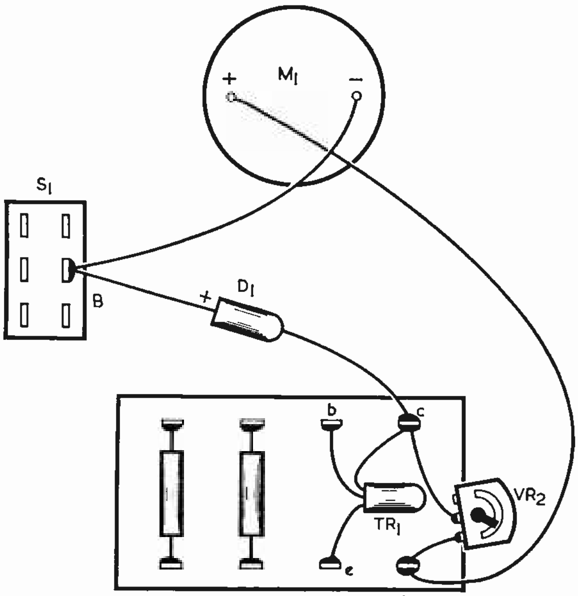
The appearance of the completed prototype is shown in Fig. 3. The prototype panel consisted of a piece of sheet aluminium screwed to a $\frac{1}{2}$in. thick wooden base, then bent back through about 10° to provide a sloping panel. The base measures 4 by 5in. The instrument could be mounted in a small case of suitable size, if desired. Terminals could be mounted on the front to connect the probe leads, but in the prototype a simple twisted lead passing through a $\frac{1}{4}$in. grommet was used. The probe leads are terminated with small aluminium clips. These are small, spring-loaded clips as used in hairdressing for keeping small pin curls in place whilst setting the hair. They can be bought from most chain stores. The batteries are held down on the board with two simple brackets made of tinplate.

THE WIRING

Most of the wiring is centred around a small 4-way group board (which can, if necessary, be a board having a larger number of tags cut down). When M1, S1 and VR1 have been mounted on the front panel, the group board and the batteries may be secured to the base. R1, R2 and TR1 may now be soldered into place on the group board, as shown in Fig. 4. The rest of the wiring can next be carried out, and it may be helpful to employ p.v.c. covered wire in red and black for the battery leads to avoid confusion over polarity. A large knot in the twisted probe clip lead will prevent it being pulled too tightly and straining the soldered connections to the group board.



(a)



(b)

Fig. 5(a). A meter overload protection circuit may be fitted by adding a preset potentiometer and a silicon diode, as shown here

(b). The altered collector and meter wiring when the protection circuit is included

USING THE INSTRUMENT

Before using the instrument it is wise to check all the wiring, especially the polarity of the batteries. The instrument should not be switched on with an open circuit between the probes, as this puts a needless strain upon the meter. The probes are connected to the small finger on each hand of the subject. The clips should be firm, to allow good electrical contact, but not so tight as to cause discomfort. The pin curl clips are usually sold in half-dozens, so two suitable clips can easily be found. The instrument may be tested under static conditions by connecting the clips to a fixed resistor, a value just below 1MΩ being suitable. The instrument is switched on, and it should be possible by adjusting the 'Set' control to move the needle on to the scale. If this can be achieved with a fixed resistor, the instrument is now ready for use.

The probes are connected to the fingers and the instrument is switched on. Once again it should be possible to adjust the 'Set' control to bring the needle to about the mid-scale position. It is probably best to attempt to keep the needle at about three-quarters of the total scale reading, because of the collector current flowing at zero input, as mentioned earlier. The needle may tend to drift slowly, this being due to slow natural changes in the subject's resistance.

Now the questioning can begin. The user of the instrument is looking for swift changes in meter reading which are noticeably different to the normal slow drift. The actual use and testing of the instrument on a subject is outside the scope of electronic discussion and is concerned with psychology. The instrument does work well in the context of a game in which the subject is given scope to cheat without the other observers seeing. The wilful attempt to cheat whilst being tested in this way produces a situation suitable for the instrument's detection.

EDITOR'S NOTE

The author's prototype instrument had no meter overload protection circuit and, under the working conditions given, this did not prove to be necessary. We would, however, recommend that any reader wishing to make certain that excess current cannot flow through the meter (due to incorrect operating or the use of a transistor having an abnormally high gain) should fit a protection circuit such as that illustrated in Fig. 5(a). The appropriate wiring for the collector circuit of TR1 is given in Fig. 5(b). D1 is a silicon diode, and may be a Lucas DD000 or similar.

Initially set the preset potentiometer, VR2, to insert maximum resistance into circuit. Switch on the instrument and set up an operating condition (such as probe clips open-circuit) which causes a high transistor collector current. Then reduce the resistance inserted by VR2 until the meter reads slightly in excess of full-scale deflection.

■

PRICE INCREASE

We regret to announce that, commencing with our next issue, the cover price of *The Radio Constructor* will be increased to 3/6d.

Annual subscription will be 48/- as from 1st May, existing subscriptions will be unaffected until expiry.

The increase will enable us to meet rising costs of production without in any way impairing the high standards we have set.

FOR THE SWL . . .

SELECTIVITY

It is probably true that many short-wave listeners graduate from home-constructed t.r.f. receivers to a comparatively inexpensive communications receiver. This being so, it will be found by the operator that most receivers in this latter category exhibit selectivity characteristics which leave much to be desired. Designed and produced to a low cost factor, the circuit does not include those additional components which would bring the specification more into line with the necessary selectivity requirements of present-day operation over the crowded short wave frequencies.

Fortunately however, there are several methods by which the short wave listener with average workshop facilities and technical know-how can cause an inexpensive communications receiver to exhibit greatly increased selectivity. Three simple methods in order of complexity are described here – all inexpensive to undertake and simple to put into operation. In the final result, although the receiver may not be equipped with the more expensive mechanical or crystal i.f. filter, a very near approach to the selectivity performance offered by these two devices can be obtained.

I.F. FEEDBACK

Although frowned upon by the purist, there is one simple method of increasing selectivity which may be easily and quickly installed by the listener. Fig. 1 shows the first method and this is carried out by deliberately introducing positive feedback, by means of a capacative coupling, between the anode and grid of the first i.f. stage of the receiver. A requirement of this circuit is that the valve must have variable-mμ characteristics and that its gain can be controlled by the operator.

The capacitive coupling between anode and grid is easily arranged by soldering two short lengths of comparatively rigid wire – say 18 s.w.g. – one to the grid pin and a similar short length to the anode pin of the valveholder. These two wires are then experimentally positioned close together without, of course, touching, such that when the i.f. gain control is at the position of maximum gain, the circuit is just below the oscillation threshold – similar to the effect obtained in a "straight" or t.r.f. receiver with reaction.

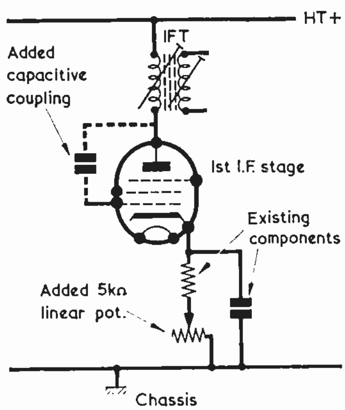


Fig. 1. The first method of increasing selectivity. The capacitance shown in dotted line between anode and grid of the i.f. stage is deliberately introduced to obtain positive feedback when the gain control in the cathode circuit is at the maximum gain position.

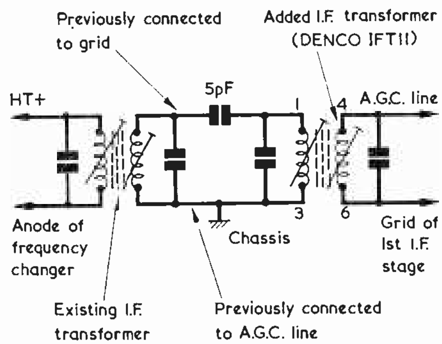


Fig. 2. The second method adopted to gain better selectivity characteristics consists of adding an i.f. transformer after the first i.f. transformer in the receiver

Where the i.f. stage concerned is not controlled by a panel mounted potentiometer, an i.f. gain control may easily be installed by disconnecting the existing cathode resistor from chassis and reconnecting to the centre tag of an added potentiometer, as in Fig. 1. One end of the track is connected to chassis so that the resistance inserted by the potentiometer decreases as its knob is turned clockwise.

In some cases it will be found that the existing fixed cathode resistor will require lowering in value, and the resistance required may be determined by trial and error. This method of improving selectivity is an old amateur dodge and was frequently used in earlier receivers having octal based valves, many of these sets still being currently in use. The setting up of this circuit for correct performance requires a little patience and time.

ADDED I.F. TRANSFORMER

Another comparatively simple method of improving receiver selectivity consists of introducing an additional i.f. transformer in the receiver circuit between the frequency changer and the first i.f. stage. This is shown in Fig. 2.

The first essential here, apart from obtaining an i.f. transformer conforming to the existing intermediate frequency, is that of chassis space considerations. Subject to the room being available, the i.f. transformer should be positioned and secured to the

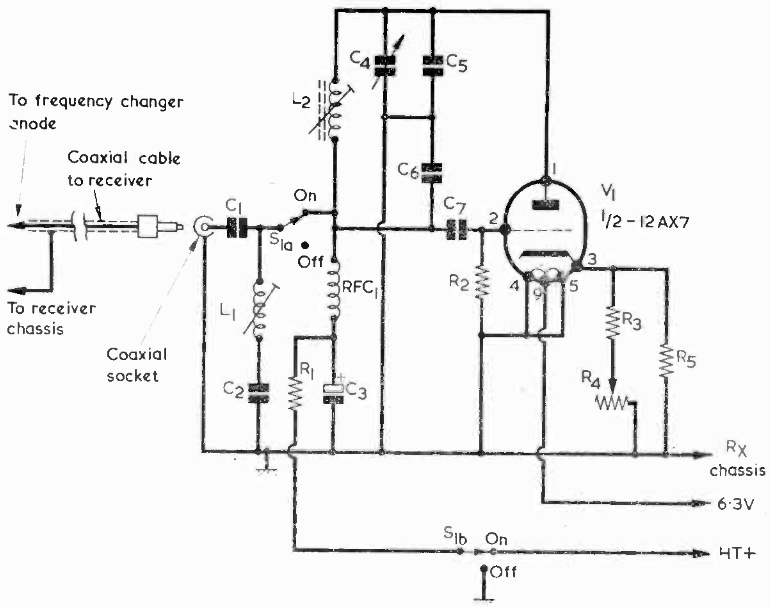


Fig. 3. By far the most satisfactory method of the three outlined here in obtaining near single-signal reception is to employ a Q-Multiplier circuit – either outboard or inboard of the receiver cabinet. In the circuit shown, C4 tunes across the receiver i.f. passband whilst R4 provides control of the degree of selectivity

COMPONENTS

(Fig. 3)

Resistors
(All fixed values ½ watt 10%)
R1 33kΩ
R2 2MΩ
R3 10kΩ
R4 5kΩ pot. linear track
R5 27kΩ

Valve
12AX7

Valveholder
B9A with skirt and screening can

Switch
S1(a), (b) 2-pole, 2-way

Capacitors
C1 1,000pF silver mica, 2%
C2 1,000pF silver mica, 2%
C3 8μF electrolytic, 350V wkg.
C4 100pF variable, Jackson Bros, type C804
*C5 1,000pF silver mica, 2%
*C6 3,000pF silver mica, 2%
C7 500pF silver mica

Inductors
*L1 Coil type QL10 (Electroniques)
*L2 Coil type QL4 (Electroniques)
RFC1 2.5 choke, type CH1 (H. L. Smith & Co. Ltd.)

*For 450-470kHz i.f.'s.
With 1.6MHz i.f.'s, C5 250pF; C6 750pF; L1 type QL3 and L2 type QL2.

chassis as near to the existing first i.f. transformer as possible. If chassis space is restricted, it is sometimes possible to mount the added i.f. transformer on a small metal bracket, this being secured to the chassis such that the transformer is placed horizontally and fits between existing above-chassis components. If this method is adopted, consideration must be given to ease of core adjustment at a later stage of the proceedings.

The correct i.f. transformer connections should be ascertained, from the receiver circuit for the existing transformer and from the manufacturer's literature for the added transformer; they do not necessarily have to be of a similar make or type provided the prime requirement – that of the same frequency – is met.

The circuit given in Fig. 2 shows an added Denco i.f. transformer type IFT11, this working at the usual intermediate frequency of 465kHz. (Type IFT11 transformers may also be obtained for an i.f. of 1.6MHz where required.) The 5pF top coupling capacitor should be of the silver mica type with the lead-out wires as short as possible. The addition of this second i.f. transformer entails a modification to the existing circuit in that the a.g.c. voltage carrying connection must be removed from the secondary winding of the first i.f. transformer and a connection made from this now blank tag to chassis as shown in the diagram. The a.g.c. connection is then taken to the secondary of the added i.f. transformer.

Once correctly wired into circuit, both of these i.f. transformers will require adjustment of the four cores to bring the receiver into correct i.f. alignment. The selectivity of the receiver will now be considerably enhanced by virtue of the extra two tuned circuits in the added i.f. transformer. It is not advisable to add a further i.f. transformer to the following i.f. stage.

Q-MULTIPLIER

The addition of a Q-Multiplier circuit, either within the existing receiver cabinet or as an external unit, is undoubtedly the best and most efficient method of considerably improving communication receiver selectivity characteristics. No other simple circuit of such low cost offers to the operator such a desirable attainment of functions – these being a continuously variable selectivity; single signal c.w. (continuous wave) selectivity and bandpass tuning.

The circuit of a Q-Multiplier, in its simplest form, is reproduced here in Fig. 3. As shown, this simply consists of one half of a 12AX7 double-triode valve, the unit tuning across the i.f. passband of the receiver when the i.f. stages are *accepting* the signal tuned by the operator. Tuning is carried out by the panel-mounted variable capacitor C4, whilst the degree of positive feedback is controlled by the panel-mounted potentiometer R4. R5 is connected in parallel across R3 and R4 in order to obtain "bandspread" characteristics from this latter component. With R5 in circuit the point of maximum selectivity – just below oscillation point – may be approached more slowly and smoothly and be capable of finer adjustment than is possible with R3 and R4 on their own.

When constructed as a separate unit, the power supplies may easily be obtained from the receiver, the total current requirements being minimal. The Q-Multiplier is connected, via a short length of coaxial cable, to the receiver frequency changer anode and the chassis. *This unit must not be used with receivers having their chassis connected to one side of the mains supply.* It is important that all fixed value capacitors, except C3, are silver mica types. The circuit shown in Fig. 3 will be found to perform with an exceptionally high efficiency.

The Q-Multiplier tuned circuit which allows the high selectivity to be achieved is given by L2, C4, C5 and C6, the resonant frequency being adjustable over a narrow band of frequencies by means of C4. This tuned circuit is capable of achieving a very high Q because of the regeneration provided by V1. The circuit is basically a Colpitts oscillator which can be kept just short of the oscillation point by suitable adjustment of R4. Signals within the i.f. passband of the associated receiver suffer attenuation if they are not at, or very close to, the resonant frequency of the high Q tuned circuit, whilst signals at the resonant frequency pass through unattenuated. It is this mode of operation which enables the Q-Multiplier to provide enhanced selectivity.

Coil L1 and capacitor C2 are not intended to offer increased selectivity. Their function is merely to "tune out" the capacitive reactance in the coaxial cable coupling the Q-Multiplier to the receiver.

A typical outboard Q-Multiplier

The Q-Multiplier is switched on and off by means of S1(a)(b). When it is switched on, S1(a) couples the receiver i.f. circuit to the Q-Multiplier high Q tuned circuit, whilst S1(b) completes the h.t. supply circuit. Bypass capacitor C3 prevents interaction between the Q-Multiplier and any other circuits sharing the same h.t. supply. R1, as specified, is suitable for h.t. input voltages of around 160 volts; it may be increased for higher voltages, the prime requirement being that the voltage at the triode anode is around 150 when potentiometer R4 is at maximum resistance setting. The value shown for R3 may also require some variation according to the receiver i.f. characteristics into which the unit is coupled. If oscillation does not occur at any setting of R4, the value of R3 should be progressively reduced until the required oscillation is obtained within the rotation of R4. Normally however, it should not be necessary to reduce the value of R3 below 4.7kΩ.

The unused section of the 12AX7 should have all three electrodes connected to chassis. These are pins 6, 7 and 8.

SETTING UP

Prior to making the connection to the receiver frequency changer anode, ensure that the receiver is correctly aligned. With the Q-Multiplier switched off, adjust inductor L1 to obtain maximum receiver signal strength. It is important here *not* to readjust the receiver first i.f. transformer cores, or the Q-Multiplier characteristics will be degraded.

Set the tuning capacitor C4 to its mid-position and adjust inductor L2 to obtain the maximum possible signal at the centre of the i.f. passband. Switch the Q-Multiplier off, readjust L1, switch on and readjust L2. Repeat these steps several further times to obtain optimum performance, as there is a degree of interaction between the two adjustments .

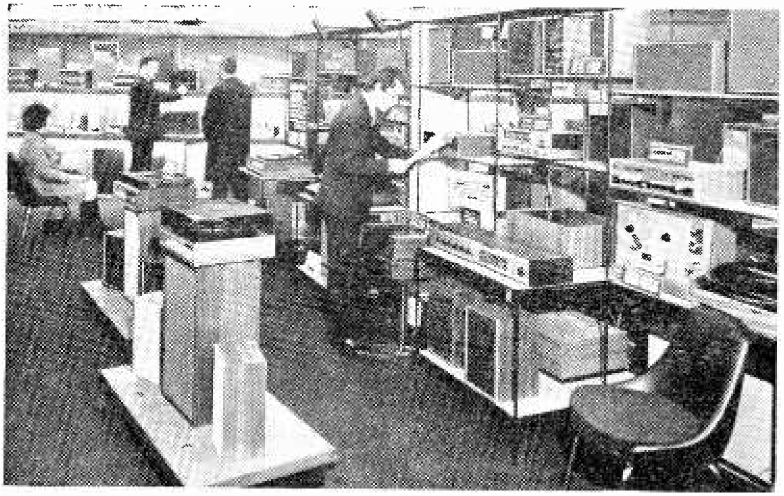
OPERATION

The peak selectivity position can be shifted, or tuned, across the receiver i.f. passband, thereby tuning out a jumble of signals to select the one required by the operator. When receiving c.w., C4 should be rotated either side of the centre position to a point where the wanted signal not only peaks but stands out from the unwanted transmissions with almost crystal clarity and single signal reception.

In the crowded s.s.b. portion of the amateur frequencies it is perfectly possible to use the unit to differentiate between signals. According to the adjustment of R4, the audio response will be found somewhat restricted but nevertheless quite readable. When operating over the broadcast bands, the Q-Multiplier will be found to be a virtual necessity. Strong local transmissions with their consequent sidesplash can be eliminated with respect to their "spread", allowing the operator to successfully log the weaker and more desirable Dx transmissions formerly hidden under the splatter.

Any of the foregoing three methods of improving receiver selectivity characteristics may be adopted by the short wave listener according to individual requirements, that producing by far the best results being the Q-Multiplier. ■

THE HI-FI BOOM



Increased awareness in the 'good sound' which started when the Beatles and stereo popular records came in is responsible for the opening of the Lasky London hi-fi centre. Throughout the sixties, interest in better audio and high fidelity grew apace with technical innovations that made it easier—and cheaper—for the general public to enjoy better listening reproduction.

Keeping pace with changes in the domestic electronics market has been the London-based company, Lasky's Radio Ltd., founded 40 years ago, but increasing their size four times over from 1965 to 1969.

The most staggering increase has been in the range of high fidelity equipment stocked, catering for beginners, mid-fi, and true hi-fi enthusiasts. Now, Lasky's are the biggest hi-fi/audio retailers in the country stocking more than 10,000 separate lines. To offer out-of-London—and overseas—customers the same purchasing facilities, a 28-page colour tabloid catalogue Audio-tronics 70, is mailed to 250,000 customers.

Their new 'UK Home of High Fidelity' is the latest result of Britain's hi-fi boom and under one roof, for the first time, is the widest range of audio equipment ever assembled in Europe.

More than 5,000 square feet of diplayed equipment for those with £40 to spend on a hi-fi set-up or those with a sky-is-the-limit budget. An impression of space is maintained in the new store even with the great variety and sheer volume of equipment on show. The centre is staffed by experts.

An airy and light open-plan display system, incorporating island units, enables customers to view hundreds of amplifiers, tuners, tuner/amplifiers, record decks, tape and cassette recorders, speakers and accessories. For those wishing to hear a balanced comparison of every combination of sounds, reproduced exactly as home listening conditions, there is a comfortable demonstration studio.

The studio is equipped with the latest top-grade hi-fi equipment permanently wired to a customer-built comparator for immediate listening choice.

The new Lasky Hi-Fi centre is at 42-45 Tottenham Court Road, London W.1. Another hi-fi audio centre is at 118 Edgeware Road, London W.2., and the seven-branch group headquarters is 3-15 Cavell Street, London E.1. ■

CONFERENCE

A conference on optimisation techniques in circuit and control applications is to be held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. from 29th to 30th June, 1970.

In the last five years the use of optimisation techniques for the solution of problems in circuit and control-systems design has grown considerably. These two fields of application are generally discussed in isolation, and the aim of the conference is to bring together specialists and users in both fields.

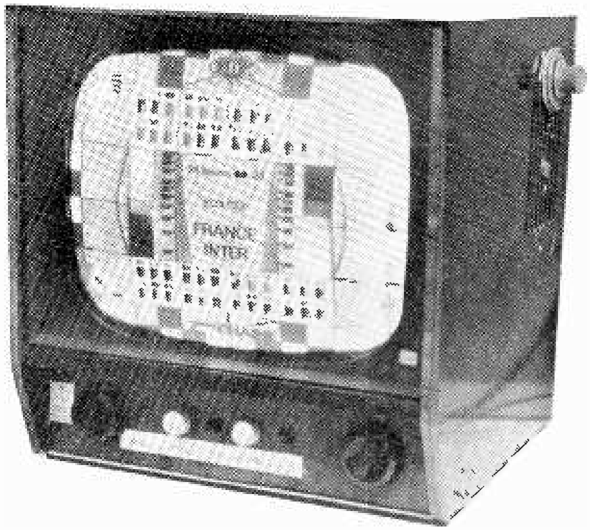
The conference will consist of a survey of optimisation techniques used in circuit and control-systems design; nonlinear programming and computational techniques; applications (e.g. device modelling, network response optimisation, dynamic optimisation of processes, and parameter estimation).

Organised by the IEE, the conference is being held in association with the Institution of Physics and the Physical Society. Further details may be obtained from the Manager, Conference Department, IEE, Savoy Place, London, W.C.2.

European Systems TV Conversion

by

M. N. CORBETT, A.M.R.T.S.



Intended for the constructor who is familiar with TV operation, this article describes the very successful conversion of an early U.K. television receiver for Continental Dx reception, pointing out also the snags to be avoided in a venture of this nature and offering valuable advice to those who contemplate undertaking a similar project

With the ever-increasing number of TV transmitters operating on the Continent and the spread of stations to the u.h.f. bands, it is hardly surprising that interest in Dx TV reception has grown in recent years. Whereas the family 625 line set can be used for exploring the bands, sound will not be obtainable and some transmissions will appear in negative form, requiring modifications which the family is certain to frown upon. This article describes how to set about converting old 405-line-only TV receivers for European reception.

Conversion of these receivers is not an easy task but, providing the constructor is prepared to spend some time on the described alterations, it can be done at a modest cost and will yield a set capable of receiving all the European 625 line transmissions and the sound channels of most. BBC 2 will also be received as well as the 625 line BBC 1 and I.T.A. alternatives. The ability of the receiver to accept 405 line signals will be permanently removed. The conversion does not cater for reception of France 1, as this is due to be replaced with a 625 line service. Also, the total channel width of 14MHz causes difficulties to arise with the sound. (However, the author's converted received has resolved the 819 line picture on Channel 7 with reduced width).

SELECTING THE RECEIVER

A block diagram for a typical 405 line TV is shown in Fig. 1(a), whilst Fig. 1(b) gives the stage layout after conversion, illustrating the stage switching that is required. Not shown in Fig. 1(b), incidentally, is the fact that the h.t. supply to the tuner unit not in use is switched off, as well as its output. It is not possible to give step-by-step conversion details for one model only, as there are many models on the used TV market. The writer's conversion was carried out on a Pam 501F.

The main requirements are that the set should be in good condition, being preferably a 'fringe' model with all the v.h.f. channels available in the tuner. Its line timebase must be capable of the frequency shift to provide the 625 line scan and this point should be checked before any other conversion work is attempted. The service sheet will be most valuable here, and if the set is bought from a local dealer he may be willing to lend the manual as well. Tell him what the set is wanted for and he may have a number to choose from, possibly supplying a u.h.f. tuner later on.

Run the receiver on the normal 405 line transmissions for a number of hours and make sure it provides good clean pictures with no intermittent faults. The sensitivity should be such that an inferior aerial can be used with acceptable performance. Check the circuit to find out how the line oscillator frequency is controlled. Some sets have a trimmer as a coarse control, and this should be unscrewed to bring the frequency towards the 15,625Hz required for 625 lines. It may be necessary to reduce the value of any fixed capacitor connected across the trimmer as well. The line whistle will go just beyond audibility and a 405 line transmission should lock on a multiple, this serving as a rough check that the line timebase can run at the higher frequency required for 625 line reception.

The line oscillator may be a multivibrator with a resistive network around the line hold control. Note which end of the control is approached by the slider to increase frequency and reduce the value of any series resistor accordingly. Experimenting with the grid components in a blocking oscillator will usually enable the frequency to be increased in this type of circuit.

After having increased the line frequency, examine the width and adjust for maximum. Also, re-adjust focus and the ion trap magnet. If the width and brightness are low, then conversion should not be attempted on the particular set selected unless the constructor is experienced enough to carry out modifications to the line output stage itself.

Some sets have flywheel sync circuits using tuned inductors; these will be difficult to set to 625 lines and should be avoided. If a little more is paid for the set then it may be possible to obtain one of the early 'Convertible' receivers with a 625 line switch already fitted. This will remove any uncertainty regarding the line output stage, but the i.f.

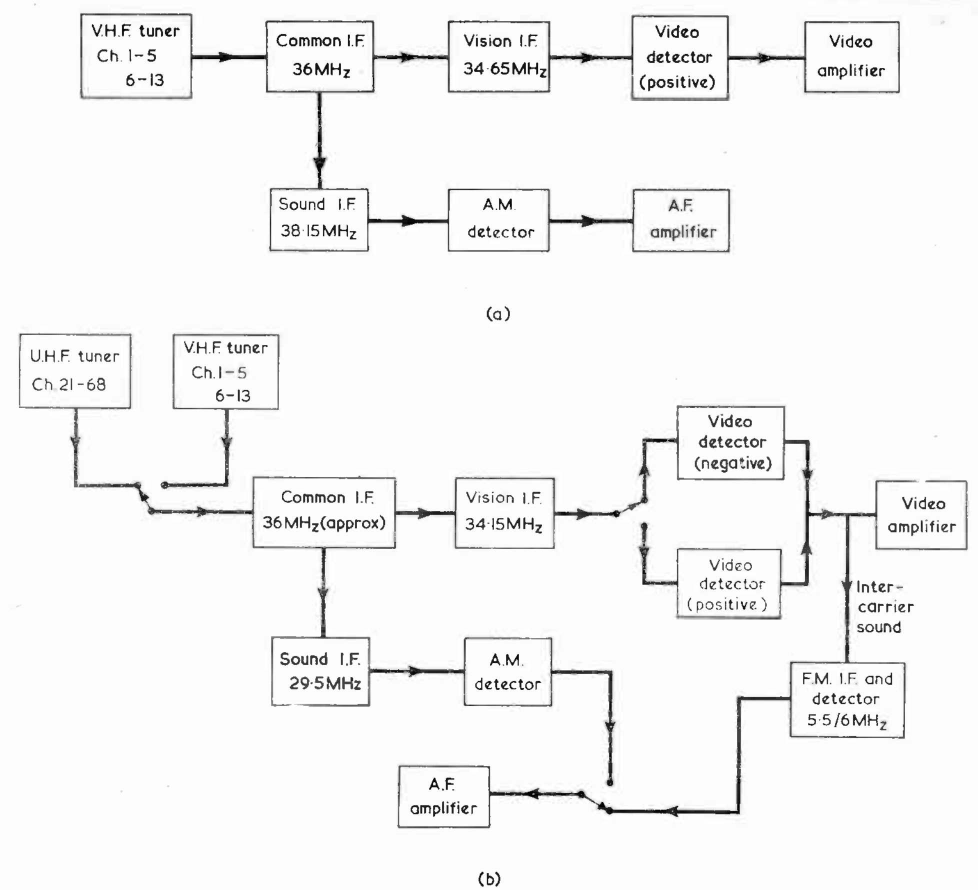


Fig. 1. The signal stages of a typical 405 line receiver (a) before conversion for Dx reception and (b) after conversion. The frequencies quoted for the common i.f. and vision i.f. amplifiers will vary somewhat between receivers of different design

gain of these receivers is often low, and it may be advisable to include a transistor stage after the u.h.f. tuner.

Such a stage was tried successfully with the author's receiver, and the circuit shown in Fig. 2. The coil used here consisted of a primary with 20 turns of enamelled wire around 22 s.w.g. close-wound on a ¼in. diameter former fitted with an adjustable dust core, the secondary comprising 7 turns of the same wire wound over the earthy end of the primary. Some experimenting with primary turns, or the value of the capacitor across the primary, may be needed to bring the coil exactly to the frequency required. It may be necessary to screen the pre-amplifier, or the coil on its own, to prevent i.f. breakthrough or instability. The 50kΩ potentiometer can be a skeleton preset component, and it is set up for best results from the transistor. An advantage conferred by the pre-amplifier is that it enables the vision i.f. bandwidth of the receiver to be extended.

THE U.H.F. TUNER

Once a satisfactory 625 line raster has been obtained, the next step is to get a 625 line signal into the set. The u.h.f. tuner will enable full strength signals from U.K. transmitters to be received, and these can be used for initial setting up. A 6MHz sound facility has been included in the author's f.m. strip (described later) for this reason. The acceptance of weak signals will depend on the tuner, and the constructor is advised to obtain a new transistorised unit complete with fitting kit. Many tuners have a resistive divider to provide 12 volts for the transistors from the h.t. rail, but make certain of this before connecting. If in doubt, a low voltage line can be supplied from a battery until the f.m. section has been completed, whereupon the tuner supply may be taken from that section.

With the supply voltage sorted out, connect the i.f. lead via a ceramic capacitor, after temporarily disconnecting the v.h.f. tuner. Tune in the local U.K. signal. This will be negative and will not lock properly. If conditions are right in the South East, turn a Group 'A' u.h.f. aerial (i.e. an aerial intended for Channels 21 to 34) to France 2 on Channel 21, and this should provide a positive fully locked picture to check performance at this stage. Although no trouble was experienced with the sync separator in the writer's conversion, the possibility of snags here cannot be ruled out.

VIDEO REVERSAL

Now that a 625 line signal is available, attention may be turned to the fitting of the vision diode reversal switch. In most receivers the vision detector is placed inside the last i.f. coil can, and some have a removable top section to expose the diode. Long leads cannot be tolerated here, so the changeover switch must be positioned right up against the coil can. To simplify switching it is best to employ two diodes with a single pole changeover switch of the slider type, as used in some transistor radios.

If the coil has no top section, remove the can and cut this in half to permit access to the diode. Wire the switch with leads as short as possible. Switch mounting can be carried out with the aid of stout wires soldered from the frame of the switch to convenient chassis points. External control may be obtained by way of a wire looped round the switch actuator, this being brought out at a suitable place in front of the set to provide a push-pull control.

Most video amplifier stages employ direct coupling from the diode to the grid, and diode reversal may cut off the amplifier valve. Fit a coupling capacitor as shown in Fig. 3. By now it will be possible to receive U.K. and European 625 line pictures, both positive and negative, but sound will still be absent.

FRENCH A.M. SOUND

To bring in the French sound the frequency of the existing sound i.f. strip must be altered. This applies only to the French 2nd programme on 625 lines with a separation of 5.5MHz. Refer to the receiver circuit and fit small 3–30pF trimmers across the tuned sound i.f. coils. It may be necessary to remove the sound detector can in order to get a connection to the secondary winding leading to the diode. Using a signal generator, align the circuit to 29.5MHz. If the generator is not available, tune in the Channel 21 transmission when conditions permit, and align on the signal by increasing trimmer capacitance a little at a time and searching for the sound with the tuner. The sound can gradually be brought closer to the vision signal and once in the right place all circuits can be trimmed for maximum. This operation, in the writer's receiver, assisted by a signal generator, took roughly 30 minutes.

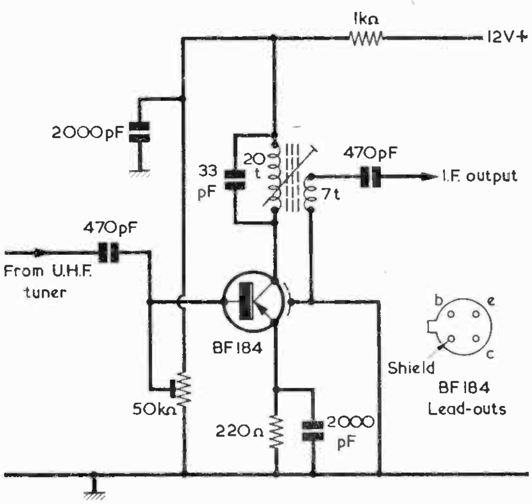
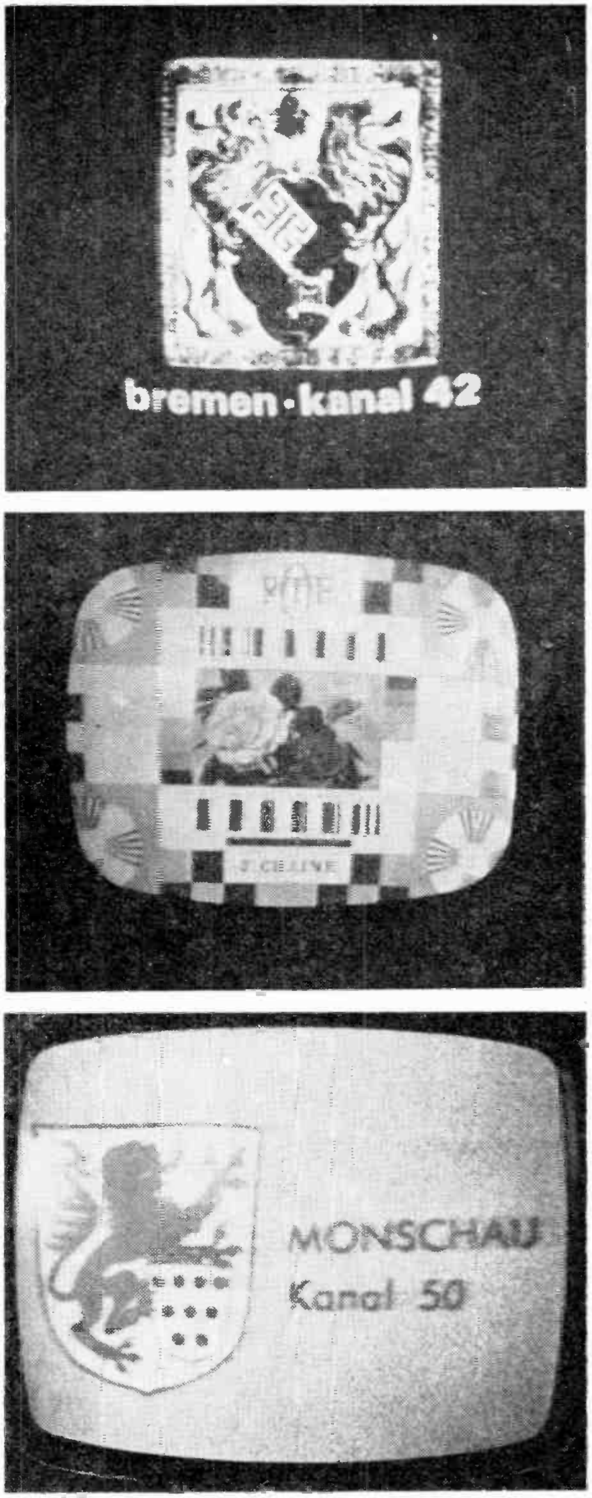


Fig. 2. A simple i.f. pre-amplifier suitable for boosting the output of the added u.h.f. tuner



Just a few of the many pictures from the Continent received on the converted TV receiver

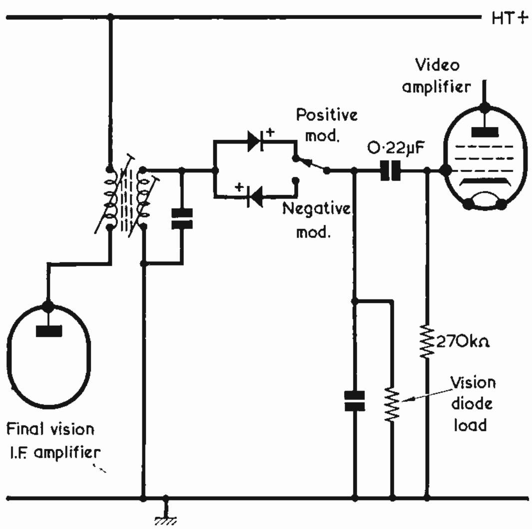


Fig. 3. To prevent the video amplifier being cut off when receiving negative modulation signals, a capacitor should be inserted in series with the grid, and a grid leak added

F.M. INTERCARRIER SOUND

Most of Europe is using the intercarrier technique for reception of the sound signal. The sound is amplified along with the vision until the vision detector, which acts as a mixer. The difference in frequency between the two carriers gives the intercarrier sound i.f. and, because the sound modulation is f.m., detection is possible without interference from the vision information.

A simple transistor i.f. strip was made for f.m. sound and the circuit is shown in Fig. 4. Two BF184 silicon transistors are employed for the i.f. section with a BC108 as an audio amplifier. Other surplus silicon types have been tried and work well, their varying characteristics being catered for by the inclusion of adjustable base bias. The skeleton preset potentiometers used for this purpose were found to be almost as cheap as the conventional 2-resistor divider, and are very much more convenient when aligning and setting up the circuit.

The unit was made on a printed board made for experimental transistor circuits by Radiospares, this being available from Home Radio under Cat. No. BTS37. With a small drill, holes were made to mount the coils and preset potentiometers, whilst the transistor mountings were already provided on the board with the emitter, base and collector positions marked. The coils were wound on $\frac{3}{16}$in. diameter formers taken from a scrap transistor radio, the coil turns being indicated in the diagram. 26 s.w.g. enamelled wire is suitable. The input coil was screened to prevent broadcast station breakthrough, but the other coils were unscreened. The ratio detector secondary is shown as having a centre-tap but the winding consists, in practice, of 2 x 16 turns bifilar wound. Wind two wires together and connect the start of one winding to the finish of the other, this forming the centre-tap. This method ensures complete balance of the inductance regardless of the position of the iron dust core. The 8-turn coil of the ratio detector transformer is wound over the collector end of the 32 turn coil.

The 5.5–6MHz switch, S1(a)(b)(c), can be an old f.m. slider switch or part of a system switch, and it is mounted close to the edge of the board. This cuts in small trimmers to give the 5.5MHz facility. The strip is initially aligned to 6MHz before these trimmers are adjusted. The initial 6MHz alignment really needs a signal generator, as the circuit could well be several MHz off frequency when first tried out. Using the generator, gradually align nearer to 6MHz and, when centred on that frequency, connect the input to the video detector output and listen for U.K. 625 line sound. Trim for best quality on signal, adjusting the base bias controls if instability results. If the frequency is too high it may be necessary to alter the capacitance in the base coupling dividers, and a compromise between gain and stability may be found by altering either the series or the shunt capacitor.

When the 6MHz sound is satisfactory, seal the cores with a little wax and align for 5.5MHz with the trimmers switched in by S1(a)(b)(c), centring this with the generator, and obtaining a final trim on a Dutch or German station when conditions permit. The sound should be received with good quality when the vision is showing only a grainy picture. The ratio detector may be a little critical to align, and final trimming must be done on a weak signal to ensure a low noise level. One problem with this type of conversion is the narrow bandwidth of the 405 line vision strip, this giving a poor response at the sound frequency. To get sufficient sound it may be advisable to adjust the vision i.f. coils to improve the response around 6MHz.

The balance control may be found helpful in eliminating buzz from the vision information which occurs with some transmitted scenes. The Dutch put out a lot of subtitles with English sound and these cause persistent buzzing if the balance is incorrect.

RESULTS

Constructors who live well away from the South East will no doubt scan this article and say: 'Not for me', in the belief that Dx reception is impossible at their location. There is little doubt that the South East has the lion's share of the u.h.f. programmes but those further inland need not feel hopelessly out of things. There are two main causes of long distance propagation, one being the tropospheric type affecting mostly Band III and u.h.f., and 'Sporadic E' affecting Band I only.

'Sporadic E' conditions occur mainly in summer and are caused by drifting clouds of ionised gas reflecting the Band I signals. Hops of well in excess of 1,000 miles can occur and this type of reception is possible anywhere in Great Britain. The bursts of this type of Dx are often short-lived, and can produce several different test cards on the same channel in quick succession. Those who live in low lying parts are not at a disadvantage as the signals are descending, and those who feel they live well beyond the u.h.f. range can concentrate on Band I only and need not fit the u.h.f. tuner.

Under certain weather conditions signals can be bent round the Earth's curvature and u.h.f. can

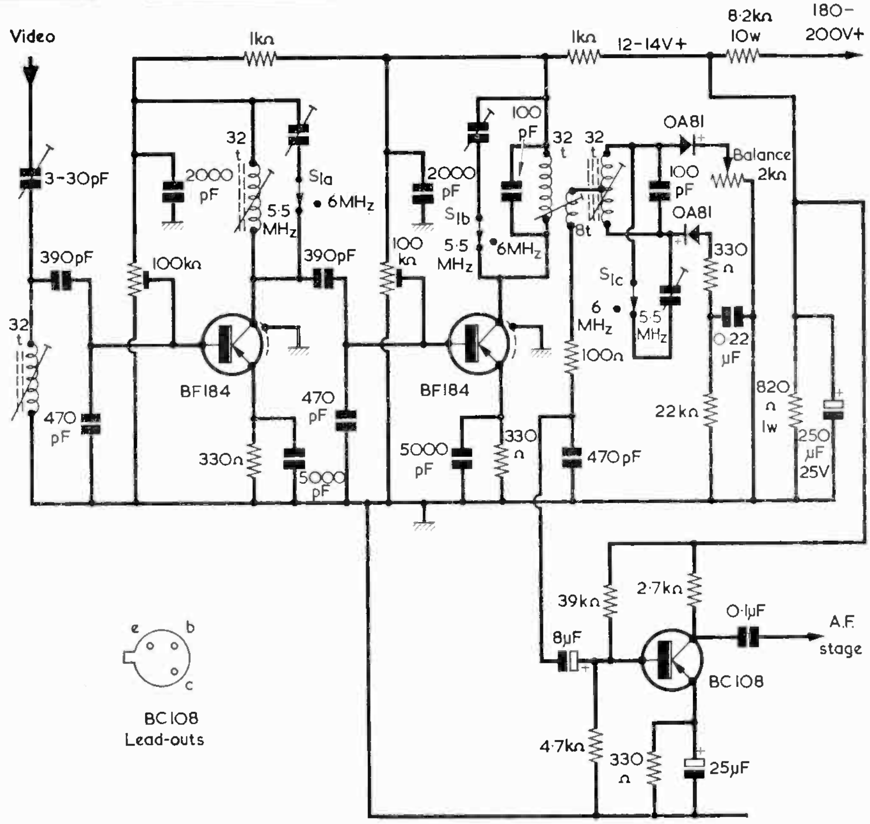


Fig. 4. The intercarrier f.m. i.f. strip used for the conversion. This can operate at either 5.5 or 6MHz

travel several hundred miles with an amazingly high input at the distant receiver. Periods of high pressure over the transmission area and extending to the receiving point bring the best conditions. Naturally a high position is a distinct advantage, but signals can still be arriving at the receiving aerial at a slight angle, thus overriding local terrain. With an anti-cyclone in the North Sea of 1034 millibars, Swedish u.h.f. has been received in Ipswich together with many stations well inside Germany. At such times French and Dutch signals can even overload the receiver! Thus, those who live nearer to the West coast than the East still have an excellent chance of good Dx reception.

Finally, a word on aerials. A rotating mast is essential for all Dx work and the mechanics of this will depend on where the constructor has his receiver.

For Band I an 'H' aerial will be adequate in most cases and will be easier to make than the 3-element type. Band III can use 8 or 11 element arrays or stacks, depending on available space. The channels used will mainly be those not already blocked by local transmitters. For u.h.f., three main aerial groups have been planned so that one array will cover a number of channels. These are:

Group A – Channels 21 to 34,
Group B – Channels 39 to 51,
Group C – Channels 50 to 68.

Double arrays are most desirable here with mast-head boosters, and the u.h.f. aerials should be mounted at the top of the mast. When starting on u.h.f. Dx it is best to employ a Group A stack at first, as this part of the band is most active. All aerials should be horizontally polarised, and an additional booster at the set end of the feeder will give a valuable increase in sensitivity on all bands.

TABLE

The different TV systems in use

Country	*Line*	*Vision Mod*	*Sound Mod*	*Separation between sound & Vision–MHz*	*Sound placing*
France 1	819	Pos	AM	11.15	Low*
France 2	625	Pos	AM	5.5	High
Holland	625	Neg	FM	5.5	High
Germany	625	Neg	FM	5.5	High
G.B.(625)	625	Neg	FM	6.0	High
G.B.(405)	405	Pos	AM	3.5	Low

*On Band I the 819 line sound carrier is lower than the vision carrier. On Band III the sound channel is higher or lower in frequency than the vision carrier on alternate channels.

One booster will be required for each u.h.f. group, whilst the whole of Band III can be covered with a single unit. Band I requirements can be met with one booster, but it may have to be tuned to the channel which is going to be used most.

In your work-shop

In this month's episode Smithy introduces to Dick a new type of stabilised power supply that is currently being used in domestic colour television receivers. Stabilisation is provided by means of a chopper transistor, and the Serviceman devotes his lunch-break to explaining the operation of a practical circuit employing the technique

"THERE SEEMS," SAID DICK chattily, "to be quite a lot of interest in stabilised power supplies and their applications these days."

Smithy drained his tin mug and placed it on his bench.

"Stabilised power supplies are an interesting subject in themselves," he remarked. "Indeed, if you can cast your mind back a few years you may recall that we once evolved a stabilised power supply design of our very own."

"Ah yes," replied Dick. "I remember that now you mention it. I suppose, incidentally, that all stabilised power supplies work on more or less the same principles, don't they?"

"If," said Smithy in reply, "you mean that they all work by comparing the output voltage they give with a reference voltage, then you're right. But the method of controlling the output voltage *after* the comparison has been made can vary considerably."

CHOPPER POWER SUPPLY

Smithy settled himself more comfortably on his stool and clasped his hands contentedly over his stomach. The latter was agreeably distended after its lunch-time intake of four corned beef sandwiches, one Lyon's Individual Fruit Pie, a banana, two Yeast-Vite tablets and three mugs of tea. Smithy liked a little variety in his mid-day meals.

"As a matter of interest," he offered, "an extremely interesting and rather unusual type of stabilised power supply is being used currently in colour television receivers. It's employed to stabilise the d.c. supply voltage to the line, field and sound output stages, and it holds this voltage steady in the range of 58 to 65 volts at currents between 1.5 and 2 amps. The circuit is being used in the new 3,000 series of colour receivers manufactured by British Radio Corporation."

"1.5 to 2 amps, eh?" returned Dick musingly. "That's a fair old current, isn't it?"

"It's pretty high," agreed Smithy. "The main advantage of the circuit used to provide the stabilisation is that it doesn't dissipate a great deal of power or heat despite the high output current. The circuit works on the chopper principle."

"Come again?"

"It works on the chopper principle."

"I thought," said Dick uneasily, "you'd said that. What do you mean by the chopper principle?"

"Don't you know what a chopper is?"

"The only chopper I can think of is the one you use for chopping firewood."

"The word 'chopper'," explained Smithy, "has rather a different meaning in electronics. A chopper is a device which periodically opens and closes an electric circuit. You'll sometimes find choppers in the input circuits of instruments which are intended to amplify low direct currents or voltages. After passing through the chopper the d.c. input is then amplified by normal a.c. techniques, whereupon there is no necessity to guard against d.c. drift, as occurs with d.c.-only amplifiers."

"Oh, I see," remarked Dick brightly. "Could the chopper consist of a pair of contacts mechanically driven so as to continually open and close?"

"It could," replied Smithy. "Or it could be a transistor which is continually turned on and off by the output of an oscillator. A transistor is used in the stabilised TV power supply I was just talking about. Chopper stabilised power supplies are not all that new, incidentally. They have been used fairly extensively over recent years, appearing in test equipment and things like that. It's rather intriguing, though, to think that they are now also being used in domestic TV sets."

"I'm trying," said Dick pensively, "to work out how on earth you can use one of these chopper gubbinses for power supply stabilisation. I can't say I'm being very successful!"

"The principle," remarked Smithy, "is quite simple, although I must admit that some of the circuits in which it is used in practice tend to get a bit complicated."

"I'd be more than satisfied," grinned Dick, "with just some glim-

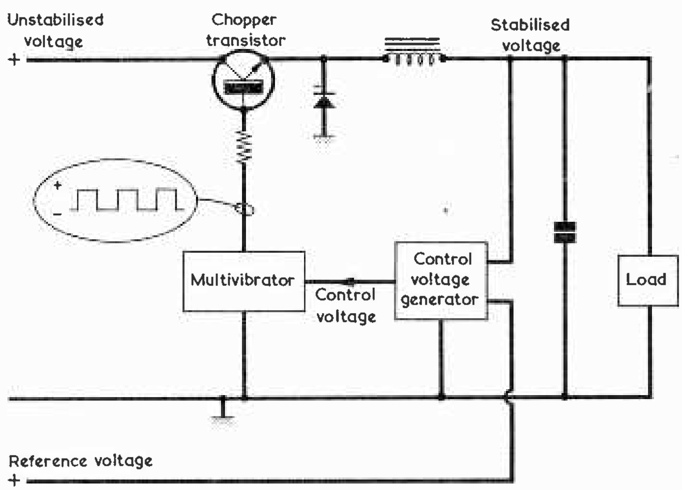


Fig. 1. The basics of a simple chopper stabilised power supply

*See 'In Your Workshop', *The Radio Constructor*, December 1967.

merings of knowledge on the *principle*!"

"Fair enough," chuckled Smithy. "Well, bring your stool over here and I'll see if I can impart a spot of basic gen to you."

Dick walked over to Smithy's bench and settled himself comfortably alongside the Serviceman. The latter took out his pen, pulled his note-pad towards him and sketched out a diagram on its top sheet. (Fig. 1.)

"Now here," he remarked, "is a simplified diagram for a chopper stabilised power unit. On the left there is an unstabilised input which offers a positive voltage with respect to chassis of about two times the stabilised output voltage that is required. This positive voltage is applied to the collector of the chopper transistor which, in this instance, is an n.p.n. type. The emitter of the chopper transistor connects to a choke, which is followed in its turn by a capacitor and the laod. The stabilised voltage then appears across the capacitor and load."

"Hang on a minute," protested Dick. "What about that diode you've drawn in between the emitter of the chopper transistor and chassis?"

"You can forget about that for the time being," replied Smithy. "I'll tell you what it does later."

"As you wish," said Dick reluctantly, scowling suspiciously at the diode of obscure function.

"For the sake of explanation," resumed Smithy, "we'll assume that the oscillator driving the chopper transistor is a multivibrator; and I've shown its output as a 50:50 square wave. This output is applied to the base of the chopper transistor via a limiter resistor. During positive half-cycles from the multivibrator the chopper transistor is driven hard on, and acts as though it were a short-circuit. During negative half-cycles the chopper transistor is cut off and acts like an open-circuit."

"I think I'm beginning to see what happens now," said Dick excitedly.

the choke carries out a rather more complex function than that of mere smoothing. However, you needn't worry your head about that for the time being. One important thing is that we've already learned enough to appreciate one of the major advantages given by the chopper technique."

"Blimey, have we?"

"Oh, definitely. What we've found is that the chopper transistor we are considering has succeeded in dropping the input voltage to about

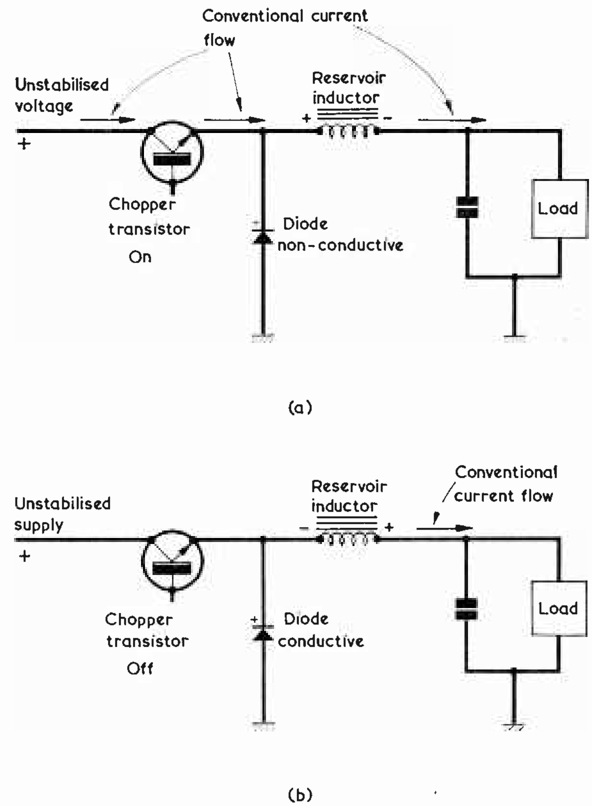


Fig. 3(a). Circuit conditions around the reservoir inductor when the chopper transistor is turned on
(b). Current still flows to the capacitor and load after the chopper transistor is turned off

"Since the chopper transistor is passing full unstabilised voltage half the time and zero voltage for the remaining half of the time, the average voltage at its emitter will be equal to about half the unstabilised voltage. This average voltage then appears after the choke which, together with the capacitor that follows it, acts as a smoothing component."

LOW POWER DISSIPATION

"That's pretty well what happens," confirmed Smithy. "The only thing you haven't got quite right is that, as I'll show you in a few minutes, half its value by the simple process of being in either the cut-off state or in the hard-on state."

"Well?"

"In the cut-off state," continued Smithy, "the chopper transistor passes no current and, therefore, dissipates no power. In the hard-on state, on the other hand, the chopper transistor is passing full current but the voltage that's dropped across it is still very low. So, even in this condition, the transistor dissipates only a small amount of power. Thus, although the chopper arrangement has caused a significant voltage to be effectively dropped at what could be quite a high current, it has done

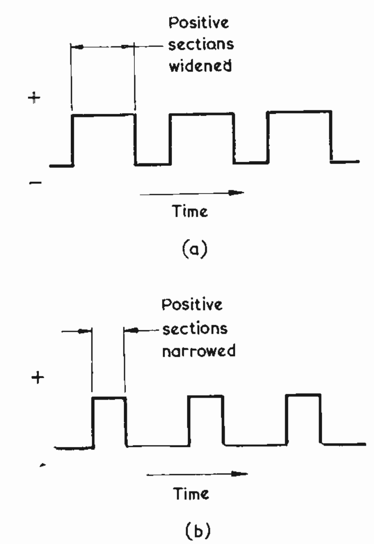


Fig. 2(a). To increase output voltage across the load in Fig. 1, the width of the positive sections of the multivibrator waveform is increased
(b). Output voltage is decreased by reducing the width of the positive sections

this with almost negligible power dissipation in the series transistor. In consequence, the series chopper transistor runs cool and the overall efficiency of the system is very high."

"Blow me, so it is," remarked Dick, raising his eyebrows. "This chopper business certainly represents a useful way of getting rid of odd volts without wasting too much power in the process!"

"Exactly," confirmed Smithy. "And it's just the job, in this respect, for a TV set because it means that everything runs nice and cool."

"How," asked Dick, "is the voltage stabilising bit done?"

"One of the processes in the chain of stabilisation control," replied Smithy, taking up his pen once more, "is carried out by varying the relative widths of the positive and negative sections of the waveform fed to the base of the chopper transistor. These widths are varied in their turn, by applying a control voltage to the multivibrator which is derived by comparing the stabilised output with a reference voltage. In my diagram I used circuit blocks to represent the multivibrator and the control voltage generator, and all you need to know at the present is that if, for any reason, the stabilised ouput voltage drops, the control circuit causes the width of the positive sections of the multivibrator waveform to become wider. (Fig. 2 (a)). The result is that the chopper transistor is kept turned on for a longer period of time during the multivibrator cycle, and the stabilised output rises to counteract the initial drop. Similarly, if the stabilised output voltage should happen to rise too high, the control circuit causes the positive sections of the multivibrator waveform to become narrower (Fig.2(b)), whereupon the chopper transistor is turned on for a shorter period of time during the cycle and the stabilised output voltage falls. In consequence, therefore, the circuit possesses a complete control loop and ensures that the stabilised output voltage is always maintained at the desired output level."

"Gosh," said Dick, impressed. "That's certainly a neat method of supply voltage stabilisation."

"Isn't it?" agreed Smithy. "The main disadvantage with the arrangement is that, in practice, rather a large number of components are required to carry out the relatively simple task of voltage stabilisation. But, in circumstances where it is necessary to keep heat and power losses to a minimum, this disadvanage is very considerably outweighed by the exceptionally high efficiency of the circuit."

Smithy replaced his pen on the bench top with a decisive gesture.

"Right now, Dick!" he said briskly. "Have you followed everything we've discussed up to now?"

"Oh, definitely," replied Dick. "I've been with you all the way."

"Good," returned Smithy. "Then the next job consists of doing a bit of tidying up."

"Tidying up?" said Dick, outraged. "During lunch-break?"

"I don't mean tidying up the Workshop, you twit," replied Smithy irritably. "I mean tidying up a few loose ends in what we've just discussed."

"Oh well," conceded Dick, relieved, "that's all right, then. For a moment I thought I'd have to flash my Union card and stand up for my rights."

"The only Union that would accept you," returned Smithy dispassionately, "is the Mother's Union, mate. Now, where the dickens was I?"

"You were going," replied Dick helpfully, "to tidy up the explanation a bit."

"Oh yes, so I was," said Smithy. "Do you know, Dick, I've never known anyone like you for breaking up a train of thought. Anyway, let us resume! To start off with, I may have given the impression that the desired stabilised voltage is given when the multivibrator gives a 50:50 square wave. Actually, the correct stabilised voltage can correspond to any reasonable time ratio between the positive and negative sections of the multivibrator waveform. All that's required of the waveform to enable control to be achieved is the ability to widen the positive sections when the stabilised output voltage goes down, and the ability to narrow them when the stabilised output voltage goes up. Okay?"

"Sure."

"Fine," returned Smithy. "The next bit of tidying-up is concerned with the action of that choke which follows the chopper transistor. This means that I'll have to introduce the function of that diode which troubled you so much earlier on."

RESERVOIR INDUCTOR

"Ah," said Dick, pleased. "I was wondering when you'd get to that."

"Now, that choke," continued Smithy, "is more than a smoothing component. Its full function is to act as a reservoir inductor."

"As a reservoir *what*?"

"As a reservoir inductor."

"Come off it, Smithy," snorted Dick indignantly. "There ain't no such animal!"

"Yes there is," retorted Smithy, "and if you would kindly refrain from those demonstrations of incredulity of yours for just a few fleeting moments, I might possibly have a chance to explain how it works. The best way of doing this is to start at an instant in the multivibrator cycle when the chopper transistor has just come on, whereupon the situation is like this."

Smithy once more scribbled out a diagram on his pad. (Fig. 3 (a)).

"Here's what's happening," he went on. "Conventional current, from positive to negative, flows from the source of unstabilised voltage, through the chopper transistor, and then through the choke to the capacitor and the load. The choke presents an impedance to the current which has suddenly just become available, with the result that its left hand end is positive and its right hand end is negative. The choke will have already acquired a magnetic field due to previous cycles, and the current flowing which is opposite in polarity to that which previously existed. Like this."

Smithy scribbled out a further diagram. (Fig. 3 (b)).

"The left hand of the choke goes negative," he resumed, "and it becomes clamped at chassis potential by the diode. At the same time, the right hand end of the choke goes positive, causing conventional current to continue to flow into the capacitor and the load. So that is why the choke acts as a reservoir component. When the chopper transistor is turned on the choke acquires excess energy, and when the chopper transistor is turned off it allows this excess energy to flow into the capacitor and load circuits."

"Blimey," gasped Dick. "This *is* something new. Now that you've explained it, I *can* visualise how that choke acts as a reservoir of energy. Even so, though, the idea of

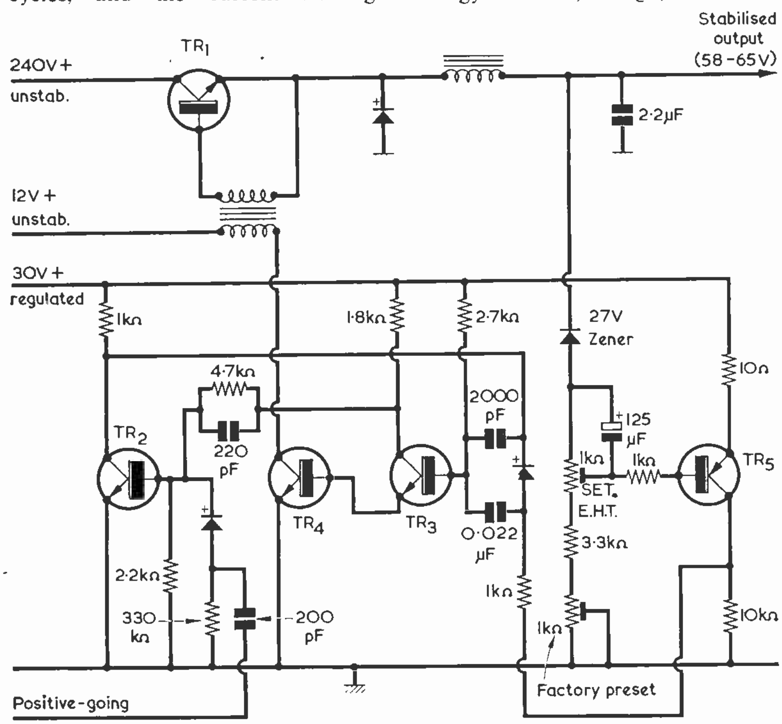


Fig. 4. Simplified circuit illustrating chopper stabiliser action in the B.R.C.3,000 series of colour television receivers. It must be emphasised that a number of protective components and circuit devices which are fitted in the practical circuit are omitted here

through it from the chopper transistor will cause this field to expand. This condition exists until the period during which the chopper transistor is turned on comes to an end, and it suddenly cuts off. There is now no current flowing through the choke from the transistor, and its field starts to collapse. Since the lines of force in the field are now cutting the turns of the choke winding in the opposite direction, they induce a voltage across the choke a choke acting as a reservoir takes a bit of getting used to, especially for someone who's been brought up on the idea of reservoir capacitors only!"

"Actually," commented Smithy, "the operation of the reservoir inductor is dead opposite to that of a reservoir capacitor. With a reservoir capacitor the voltage never changes polarity and always tends towards a constant value. On the other hand the direction of current *does* change since the reservoir capacitor is charging during part of the rectified cycle and is discharging during the other part. With the reservoir inductor the direction of current doesn't change, and it is the current that tends towards a constant value. But the voltage does change direction or, to be more precise, change polarity."

"I've just thought of something."

"What's that?"

"If," said Dick, "that diode wasn't in circuit the choke wouldn't act as a reservoir inductor at all. It would simply be a smoothing choke."

"True," agreed Smithy. "You need a diode to clamp the reversed choke voltage if you want it to function as a reservor component. Anyhow, that's enough about the choke so let's see what else there is to say about the simple chopper circuit. One thing I haven't mentioned is the frequency of the waveform which drives the chopper transistor. This frequency isn't critical but it's helpful to make it fairly high because the values of any subsequent smoothing components, as well as that of the reservoir inductor itself, may than be kept quite small. They can certainly be made very much smaller than would occur in similar circuits following a 50Hz rectifier. A final point is that, provided the correction provided in the control circuits operates swiftly enough, the chopper circuit removes any 50Hz ripple that may be present on the unstabilised input voltage. The only requirement here is that the ripple should not be so high that any part of the unstabilised waveform falls below the lowest voltage which the stabiliser circuit can cope with.",

"Stap me," remarked Dick elegantly. "There certainly seem to be a lot of hidden advantages in this chopper scheme."

"There are rather," agreed Smithy. "And, as I said before, the only big disadvantage is that the circuit tends to be rather complex in practice. However, let me next give you an idea of how the circuit works out in practice with the B.R.C.3,000 series television receivers."

Smithy tore the top sheet off his pad and sketched out a further diagram on the sheet underneath. After a minute or two he leaned back and examined the circuit he had drawn. (Fig.4).

"Here we are," he announced. "This is only a simplified version of the circuit that's actually used, but it will enable you to get a basic idea of how it operates. The waveform that's fed to the chopper transistor base is not, in this particular instance, derived from a free-running multivibrator. Instead, it's provided by a monostable multivibrator which is triggered by positive-going pulses from the line oscillator elsewhere in the receiver. The actual output of the multivibrator, as applied to the chopper transistor base, is then of the order of about 35% positive, after triggering, and 65% negative, after the monostable has returned to its stable condition. The multivibrator operating conditions are such that, in the absence of pulses from the line oscillator, TR3 and TR4 are on, with TR2 off. You'll notice that TR4 is really just an amplifier, its collector current being an amplified version of the emitter current in TR3."

"TR4," remarked Dick, who had been studying Smithy's circuit closely, "is coupled to TR1, the chopper transistor, by way of a transformer."

"That's right," confirmed Smithy. "The transformer windings are phased in such a manner that TR1 base goes positive of its emitter when TR3 and TR4 switch off. The effective base-emitter diode in TR1 is then fully conductive, which means that the positive pulse from the transformer secondary can only rise to a fairly small voltage. This ensures that the positive bias to TR1 base is maintained throughout the period, during the switching cycle, when TR3 and TR4 are off."

"Could we," asked Dick, "go through a switching cycle?"

"We'll do that little thing right now," replied Smithy obligingly. "As I've just said, TR3 and TR4 are on in the absence of line pulses. Let's now commence our examination at the instant when a line pulse arrives. This is positive-going, and is applied to TR2 via the 200pF capacitor and the diode in its base circuit. TR2 is turned on and its collector goes negative, taking the base of TR3 negative as well, via the 2,000pF and 0.022μF capacitors in series with that base. TR3 collector current reduces, whereupon its collector voltage goes positive and carries the base of TR2 further positive by way of the cross-coupling 4.7kΩ resistor and 220pF capacitor. You get the usual cumulative multivibrator changeover action, and it ends with TR2 being hard on, with TR3, and in consequence TR4, fully off. A positive pulse is applied to the chopper transistor base and this switches on and passes current. Okay up to now?"

"Yes," confirmed Dick. "Everything's nice and straightforward so far."

"Good," approved Smithy. "Well, the multivibrator has now changed over to its unstable state with TR4 and TR3 off. It will stay in this condition until the 2,000pF and 0.022μF capacitors in TR3 base circuit discharge sufficiently for TR3 to start passing current and initiate the return changeover to the original state. Of these two capacitors the 0.022μF is the more important, the 2,000pF component being little more than a 'speed-up' capacitor which ensured that the last changeover was good and quick. Now, let's say for the moment that the 0.022μF capacitor is returned to the slider of a potentiometer connected between chassis and a positive supply point. Like this."

Smithy scribbled out the appropriate circuit. (Fig. 5).

"What we must next consider," he said, "is the charge acquired by the 0.022μF capacitor during the time that TR3 is on. Since the effective base-emitter diodes of TR4 and TR3 are both conducting at this time, the charge acquired by the capacitor will be proportional to the positive potential tapped off from the pot. If the slider of the pot is moved towards the positive end of the track, this charge will increase. The result is that, when

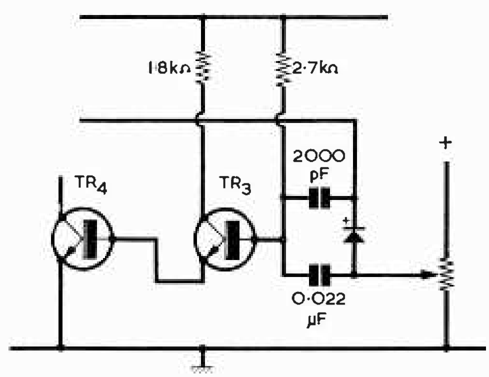


Fig. 5. Stabilising action can be explained more readily if, as an intermediate step, it is assumed that the 0.022µF capacitor in the base circuit of TR3 is returned to the slider of a potentiometer, as shown here

the changeover to TR3 being off takes place, the base of TR3 will be driven more negative and it will remain in the off condition for a longer period of time."

FEEDBACK CONTROL

"Whoa-up," called out Dick. "I want to recap for a moment! If I've got it right what you've just said is that, if the slider of the pot goes towards the positive end of its track TR3 is cut off for a longer period in the cycle. The reverse must then also be true. If the slider of the pot is moved towards the negative end of the track, then TR3 is cut off for a shorter period in the cycle."

"That's correct."

"Let's take this a stage further," said Dick, a ferocious scowl furrowing his brow as he gazed intently at Smithy's sketches. "Now, the chopper transistor is turned *on* when TR3 is turned *off*, which means that if the slider of your pot goes towards the positive end of its track the chopper transistor is turned on for a longer period in the cycle. Also that, when the slider of the pot goes towards the negative end of its track, the chopper transistor is turned on for a shorter period."

Smithy said nothing.

"The output voltage of the supply," stated Dick, his scowl of concentration deepening even further, "goes up when the period during which the chopper transistor is on increases. So the overall effect of turning the slider of that pot towards positive must be that the output voltage of the supply increases."

"That's it!"

"And," concluded Dick triumphantly, "the overall result of moving the slider towards the negative end of the track must be that the output voltage of the supply decreases."

"I couldn't," commented Smithy, "have put it more succinctly myself."

Dick's face broke into an immense smile.

"I'm a genius," he remarked happily. "A genuine Bedouin genius!"

"You have," stated Smithy approvingly, "put up a highly commendable performance. There are quite a few intermediate steps in the process you've just described, and you worked your way through them all without a fault. Well now, let us proceed to even greater revelations. Let's next say that any voltage similar to that tapped off by the slider of the pot I introduced is a control voltage whose function is that of controlling the output of the chopper transistor. After which, we can return to the full circuit of the supply. If you look at this you'll see that the 0.022μF capacitor is returned, not to an imaginary potentiometer as I introduced for explanation, but, via a low-value 1kΩ resistor, to the collector of TR5. This transistor is the feedback amplifier for the supply and its collector voltage controls the output voltage which is applied to the load. Thus, when the collector of TR5 goes positive, the chopper output voltage increases, and vice versa. Now, as you can see from the circuit, a voltage proportional to the output voltage of the power supply is applied to the base of TR5, this voltage being fed by way of the 27 volt zener diode and a network comprising a 1kΩ preset pot, a 3.3kΩ resistor and another 1kΩ preset pot which finally goes down to deck."

"From here on it's all dead simple," broke in Dick. "We've now got the set-up where, when the output voltage of the chopper supply decreases, the base of TR5 goes negative and its collector goes positive, causing the chopper supply output to increase again to its previous level. The reverse effect will also take place if, for any reason, the chopper supply output should increase."

"Exactly," confirmed Smithy. "The final result is that the 1kΩ pot whose slider couples to the base of TR5 is the output voltage control for the whole circuit. But, before we go any further, we've got to be careful not to forget one very important point."

"What's that?"

"The emitter of TR5 is returned to a positive line carrying 30 volts regulated. The regulation is provided, by the way, by a 30 volt zener diode followed by an emitter follower which I haven't included in my diagram. This 30 volt line is the reference voltage for the whole supply, and what TR5 is effectively doing is to compare the voltage applied to its base from the slider of the 1kΩ pot with the 30 volt *reference* voltage applied to its emitter. Without the 30 volt regulated line for reference, the circuit couldn't stabilise. Having cleared up that matter, let's return to the 1kΩ preset. This is designated 'Set E.H.T.' in the TV receivers in which the circuit is used. The stabilised supply feeds the line output stage, and the pot is adjusted for the correct e.h.t. voltage for the tube. The chopper supply circuit then ensures that the supply voltage to the line output stage remains at the level which produces this e.h.t. value."

BACK TO WORK

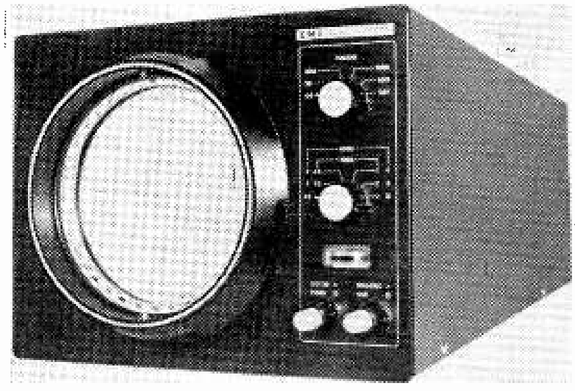
"Well," remarked Dick. "I've certainly learned a few things today that I'd never even heard of before. This chopper supply business doesn't seem to be too difficult after all!"

"It isn't when you get down to its basic method of operation," agreed Smithy. "But I must hasten to point out that the circuit I've shown you is a considerably simplified version of the actual thing. Also, I've left out several safety devices and circuits which are incorporated to guard against damage in the event of fault conditions, as well as a number of diodes and other components whose function is to prevent excessive reverse base-emitter voltages on individual transistors and things like that. None of these are involved in the fundamental chopper section itself so far as chopper operation is concerned, but they are necessary in the practical high voltage, high current, circuit."

"I've really enjoyed our session today," remarked Dick. "Come to think of it, it's quite some time since we last had a natter on anything which was connected with colour TV."

"It is, isn't it," said Smithy. "I can see that that's an omission I'll have to make good at some time in the future!" ■

ELECTRA-SCAN NAVIGATIONAL AID

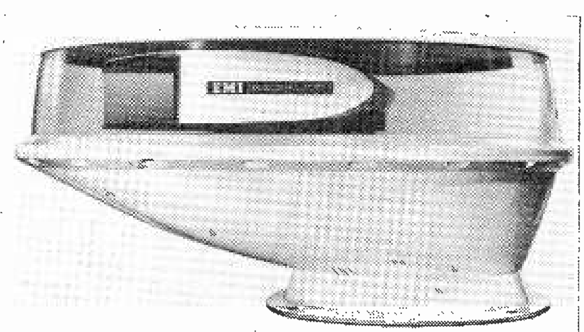

The Electrascan display and unit controls

The advantages of radar navigation for the small boat are here to stay with this new compact radar. Fog, rocks, uncharted waters are no longer the hazard they were. The 'lone sailor' will find it indispensable; the reason – its special 'auto alert' early warning device. Set the radar, leave it and an audible signal will call the skipper back to his post. The signal is activated by echoes appearing within the selected range of the scanner display.

The scanner unit is light enough to be fitted to any wheel-house top, and weighs no more than 48 lbs. (20 kilograms). Its dimensions are a mere 32in. across by 16in. deep. A radome of glass fibre and perspex contains the scanner itself, attractively designed, and neat; it does not get fouled in ropes and sails. By use of the latest solid-state techniques the system has been reduced to two units, the scanner and display. The display unit, like the scanner, is compact and attractive. 9½in. high, 12½in. wide and 19in. deep, it weighs 33 lbs. (14 kilograms). The power consumption of Electrascan is remarkably low, less than 125 watts, and it can be run off the boat's own d.c. power supply, 12 or 24 or 32 volts. The flexibility of scan is variably between 30 yards and 16 nautical miles via a six-position range selector. Easy to install (four bolts and a single cable), simple to operate, Electrascan is well worth serious consideration by yachtsmen.

Other aids in the Electra range include the Electralog and Electradepth and Electratune. These instruments are each complete units in themselves. 6in. square and 3in. deep, they can be mounted individually, or in a four-face display console. Stirrup mounting enables the units to be fitted in any convenient part of the bulkhead. They can also be flush-fitted for use in an open cockpit. Both airtight and watertight, and made of non-corrosive materials, they are virtually indestructible.

Electradepth 1 is a fully transistorised echo sounder with a meter display in two ranges of 0 to 60 feet and 0 to 60 fathoms. It has controls to correct the transducer depth either to the chart datum, or the bottom of the keel. Electradepth 2 is also fully transistorised. It has, however, a rotating high-intensity flash tube which emits signals that can be read, even in direct sunlight, due to a unique optical system. This type of neon display covers a far greater range of information; details of the nature of the sea bed and the size of shoals of fish can be determined.


The Electrascan waveguide aerial enclosed in glass fibre and perspex radome

Electralog, a fully transistorised electronic instrument, has three speed ranges 0 to 6, 0 to 12 and 0 to 24 knots, together with a distance recorder which indicates to within 0.01 of a nautical mile. The instrument has a calibration control peculiar to Electra instruments, with adjustments from minus 5% to plus 20%.

The depth sounder and log have a submerged component that houses the transducer. EMI Marine call it their "Yellow Submarine Dry Cleaning Machine". This neat sea valve means the transducer can be removed and cleaned easily at sea without the tiniest drop of water escaping into the bilges. The yellow handle is pulled up to partly retract the transducer and the black knobbed handle is then turned to shut a watertight seal; without fuss or mess the depth sounder and log will be fully operational within minutes.

Electratune is the combined term for Electravane (apparent wind direction) and Electrawind (apparent wind speed). Electravane has a two-scale facia; the first gives a continuous 0° to 360° reading of apparent wind direction, relative to the ship's head; the second gives a greatly magnified 60° to 0 to 60° reading of the wind direction on any chosen point of sailing. Electrawind has three speed ranges: 0 to 12, 0 to 24, 0 to 48 knots. Sold together as Electratune, they are calibrated electronically before they leave the factory. They both operate from a mast-head fitting with a dynamically balanced vane (a mast-head light is part of the unit).

Each instrument is available in an identical module complete with the required fittings. The instruments all have internal lighting to assist night navigation and can be energised from the boat's d.c. power supply, varying between 12 to 30 volts.

LATE NEWS

★ AMATEUR BANDS

● THAILAND

HS4ABV has been heard on 14MHz ssb giving his QTH as N.E. Thailand and his QSL manager as W5PJR.

● PERU

OA4KY is active on 14MHz ssb and was heard to give his QTH as P.O.B. 538, Lima.

● GABON REPUBLIC

TR8MC heard on **14211kHz** ssb at 2005 GMT.

● 3.5MHz

Dx activity at the h.f. end of the band continues apace. Some of the ssb stations heard of late were – HK3WO, HP1JC, K2DPA, K3UZE, KG4AS, TG9EP, VE1AMJ, VE2OB, W2AC, W2JBU, W3BLS, W3GM, W4FIB, W4JNJ, W4NQM, W4RDV/P/VP9, W4ZFH, WA8OBG, WA8TPV, WA8VMQ, WB2LWH/VP9, YV5BWG, and 4X4BL.

● ST. HELENA

ZD7SD has been heard using ssb around 2000 GMT on **14207kHz.**

● NIGER REPUBLIC

5U7AR uses cw on **14035kHz, 21059** and **21150** and is often QRV on Sundays between 1100 and 1800 GMT on **21150kHz.**

● WEST PAKISTAN

AP2MR has been heard using ssb on **14146kHz** around 1430 GMT.

● 7MHz

Active cw stations recently logged include - CO3DB, CO7VJ, CR6CA, CX2AN and PJ2HT.

★ BROADCAST BANDS

● SOUTH AFRICA

RSA is at present using a new frequency of **9695kHz** with a service to N. America from 2330 to 0330 GMT in parallel with **9705, 11875** and **15220kHz.** RSA is also testing for the best channels to use for a service to the U.K. and Eire from 1800 to 1850 GMT on **15250, 17795** and **21480 kHz.** Sometimes also uses **11875kHz.** Reports are requested.

● AFGHANISTAN

Kabul (50kW) now has an English programme at 1800 GMT on **11790kHz** and a new outlet on **9530kHz.**

● IRAN

Radio Teheran now operates a Foreign Service on two new channels – **7020** and **9020kHz.** English programme is from 2000 to 2030 GMT.

● NIGERIA

The Voice of Nigeria, Lagos, radiates an English programme entitled Morning Melodies from 0600 to 0730 GMT on **7275kHz** (100kW). The evening transmission in English is now from 1830 to 1930 GMT. on **15430kHz.**

● PHILIPPINES

Radio Veritas, Manila, has been heard testing from 1100 to 1130 GMT on **11830** and **15170kHz.** Reports are requested and should be sent to P.O. Box 431, Manila.

● COLOMBIA

HJLW Ecos Combeima, Ibague (1kW) has moved from 4785 to **6175kHz.**

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

MUNICH OLYMPIC DIPLOMA

REQUIREMENTS:

All contacts with stations in Munich, from January 1st, 1970, 0000 GMT to 2400 GMT the day of official closing of the Olympic Games 1972, will count for the award.

Contacts with Munich stations are credited the following points: German participants, phone 2 points, c.w. 4 points; other Europeans, according to WAE-list, phone 4 points, c.w. 8 points; participants outside Europe, phone 6 points, c.w. 12 points.

The MOD will be issued separately or c.w., phone and mixed. Operation of the award is possible on any single-band, and this will be endorsed accordingly. At least the following minimum points are required for each class: Class I (Gold) 250 points; Class II (Silver) 200 points; Class III (Bronze) 100 points.

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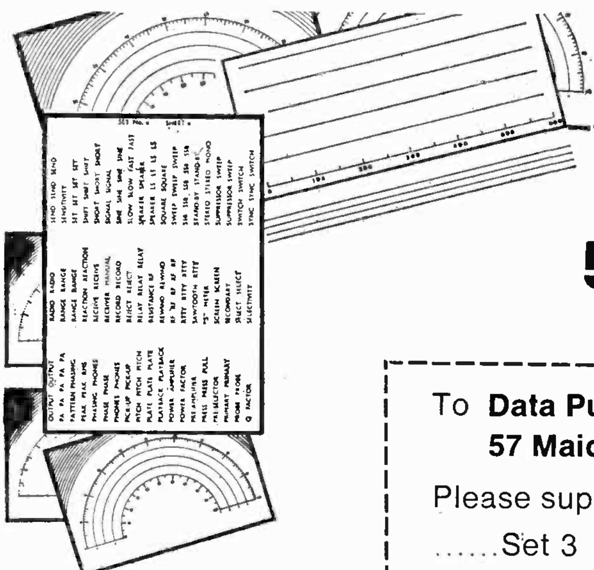

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(Continued on page 577)

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Continued from page 575

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(Continued on page 579)

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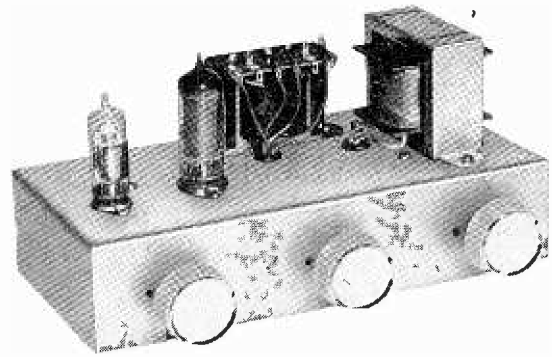

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Continued from page 577

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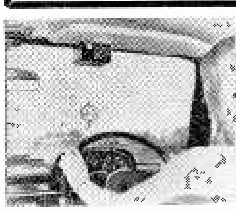

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RADIO CONSTRUCTORS DATA SHEET 37

CAPACITANCE UNITS

Due to the continually increasing range of capacitance values encountered in electronic work it appears feasible that the term 'millifarad' (mF) may become common for capacitances of 1,000μF or more. The unit 'milli-picofarad' (mpF) is already in use, whilst 'nanofarad' (nF) has been extensively employed for many years. These different methods of expressing capacitance can be confusing, particularly for newcomers to electronics.

The relationship between the units is as follows:

1,000mpF	=	1pF
1,000pF	=	1nF
1,000nF	=	1μF
1,000μF	=	1mF

The Table lists equal quantities of the units over the ranges where they are normally employed or are likely to be employed, and is intended to assist in the quick determination of significant figure position relative to the decimal point. It may also be employed for quick conversions of other units, a particular example being given by the milliseconds, microseconds and nanoseconds encountered in computer work.

mF	μF	nF	pF	mpF
100	100,000			
10	10,000			
1	1,000			
	100	100,000		
	10	10,000		
	1	1,000		
	0.1	100	100,000	
	0.01	10	10,000	
	0.001	1	1,000	
	0.0001	0.1	100	
	0.00001	0.01	10	
		0.001	1	
		0.0001	0.1	100
		0.00001	0.01	10
			0.001	1