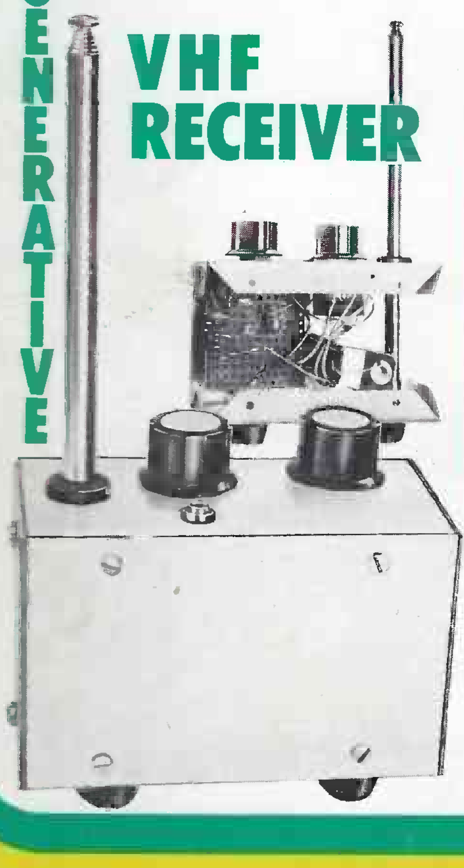
RADIO & ELECTRONICS CONSTRUCTOR

JANUARY 1974

20p

REGENERATIVE VHF RECEIVER



BURGLAR BEATER

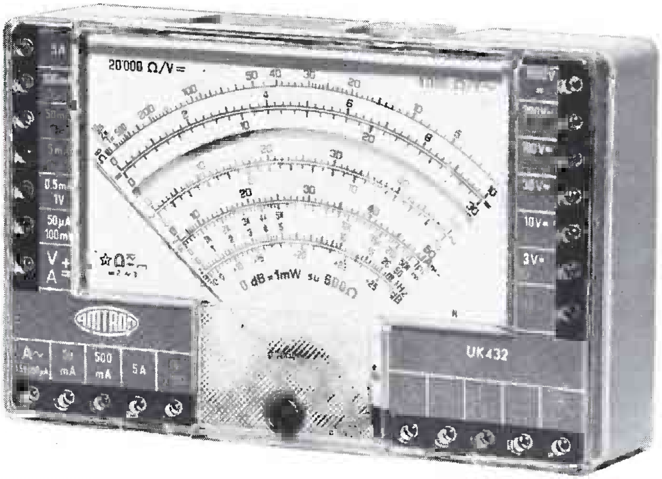
ALSO FEATURED UNIJUNCTION SIGNAL INJECTOR

AMTRON introduce their Utility Tester Kit

An all-in one Multi-Range AC/DC voltmeter, ammeter, ohmmeter. Indispensable in home repairs of electrical appliances, in laboratories, and for radio and TV trouble-shooting. The large, full visibility dial, its light weight and above all its accuracy make the UK 432 Utility Tester a top-quality Instrument. Instrument.

TYPICAL CHARACTERISTICS

Measuring ranges: 10
Ranges: 48
Sensitivity:
DC: 20,000 Ohms/V
AC: 4,000 Ohms/V
DC Volts: 8 ranges: 0.1, 1, 3, 10, 30, 100, 300, 1000 V
AC Volts: 6 ranges: 1.5, 15, 50, 150, 500, 1500 V
DC Amps: 6 ranges: 50 Micro-Amps, 0.5 mA, 5 mA, 50 mA, 500 mA, 5 A
AC Amps: 4 ranges: 250 Micro-Amps, 50 mA, 500 mA, 5 A
Ohms: 6 ranges: 0.1, 1, 10, 100, 1 k-Ohms, 10 k-Ohms
Reactance: 1 range: 0 to 10 M-Ohms
Frequency: 1 range: 0 to 50 Hz, 0 to 500 Hz (with external capacitor)
Output Volts: 6 ranges: 1.5 (with external capacitor), 15, 50, 150, 500, 1500 V
Decibels: 6 ranges: – 10 to + 70 dB
Capacitance: 4 ranges:



£21·27
INC V.A.T.

ILLUSTRATED LEFT THE COMPLETED UTILITY TESTER KIT

THE BIG NAME IN ELECTRONIC KITS

AMTRON UK

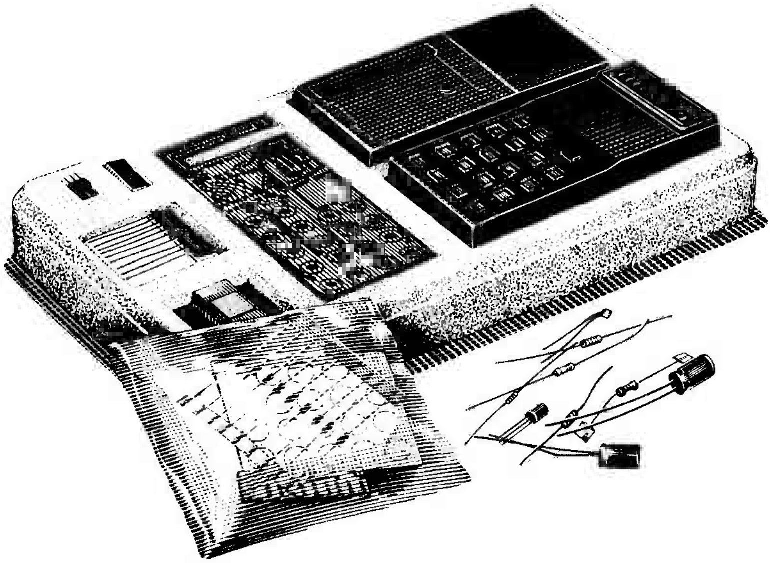
AMTRON U.K. 4 & 7 CASTLE STREET HASTINGS SUSSEX TELEPHONE HASTINGS 2875

A complete kit!

The kit comes to you packaged in a heavy-duty polystyrene container. It contains all you need to assemble your Sinclair Cambridge. Assembly time is about 3 hours.

Contents:

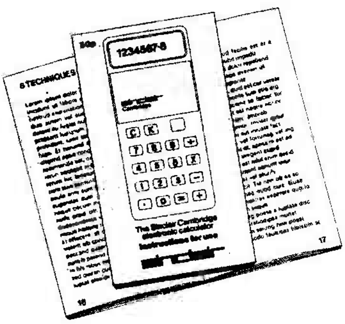
1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



This valuable book – free!

If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

But if you want to get even more out of it, you can go one step further and learn how to unlock the full potential of this piece of electronic technology.



How? It's all explained in this unique booklet, written by a leading calculator design consultant. In its fact-packed 32 pages it explains, step by step, how you can use the Sinclair Cambridge to carry out complex calculations like:

Logs	Sines	Cosines
Tangents	Reciprocals	nth roots
Currency conversion	Compound interest	

and many others...

sinclair

Sinclair Radionics Ltd, London Road,
St Ives, Huntingdonshire
Reg. no: 699483 England
VAT Reg. no: 213 8170 88

Why only Sinclair can make you this offer

The reason's simple: only Sinclair – Europe's largest electronic calculator manufacturer – have the necessary combination of skills and scale.

Sinclair Radionics are the makers of the Executive – the smallest electronic calculator in the world. In spite of being one of the more expensive of the small calculators, it was a runaway best-seller. The experience gained on the Executive has enabled us to design and produce the Cambridge at this remarkably low price.

But that in itself wouldn't be enough. Sinclair also have a very long experience of producing and marketing electronic kits. You may have used one, and you've almost certainly heard of them – the Sinclair Project 60 stereo modules.

It seemed only logical to combine the knowledge of do-it-yourself kits with the knowledge of small calculator technology.
And *you* benefit!

Take advantage of this money-back, no-risks offer today

The Sinclair Cambridge is fully guaranteed. Return your kit within 10 days, and we'll refund your money without question. All parts are tested and checked before despatch – and we guarantee a correctly-assembled calculator for one year.

Simply fill in the preferential order form below and slip it in the post today.

Price in kit form: £24·95 + £2·50 VAT. (Total: £27·45)
Price fully built: £29·95 + £3·00 VAT. (Total: £32·95)

REC/174

To: Sinclair Radionics Ltd, London Road,
St Ives, Huntingdonshire, PE17 4HJ

Please send me

☐ a Sinclair Cambridge calculator kit at £24·95 + £2·50 VAT (Total: £27·45)

☐ a Sinclair Cambridge calculator ready built at £29·95 + £3·00 VAT (Total: £32·95)

*I enclose cheque for £ ______, made out to Sinclair Radionics Ltd, and crossed.

*Please debit my *Barclaycard/Access account. Account number ______

Name ______

Address ______

*Delete as required.

PLEASE PRINT

THIS IS THE FIRST PAGE OF THE GREAT BI-PAK SECTION

BRAND NEW FULLY GUARANTEED DEVICES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	0.22	AD161 &		BC150	0.20	BD131	0.55	BF182	0.44	MAT121	0.22	2G304	0.27	2N2148	0.63	2N3055	0.55	2N4060	0.13
AC113	0.20	AD162(MP)	0.75	BC151	0.22	BD132	0.66	BF183	0.44	MJE2955	0.95	2G306	0.44	2N2160	0.66	2N3391	0.16	2N4061	0.13
AC115	0.22	ADT140	0.55	BC152	0.19	BD133	0.72	BF184	0.28	MJE3055	0.62	2G308	0.39	2N2192	0.39	2N3391A	0.18	2N4062	0.13
AC117K	0.32	AF114	0.27	BC153	0.31	BD135	0.44	BF185	0.33	MJE3440	0.55	2G309	0.39	2N2193	0.39	2N3392	0.16	2N4284	0.19
AC122	0.13	AF115	0.27	BC154	0.33	BD136	0.44	BF187	0.30	MPF102	0.46	2G339	0.22	2N2194	0.39	2N3393	0.16	2N4285	0.19
AC125	0.19	AF116	0.27	BC157	0.20	BD137	0.50	BF188	0.44	MPF104	0.41	2G339A	0.18	2N2217	0.24	2N3394	0.16	2N4286	0.19
AC126	0.19	AF117	0.27	BC158	0.13	BD138	0.55	BF194	0.13	MPF105	0.41	2G334	0.20	2N2218	0.22	2N3395	0.19	2N4287	0.19
AC127	0.20	AF118	0.39	BC159	0.13	BD139	0.61	BF195	0.13	OC19	0.39	2G345	0.18	2N2219	0.22	2N3402	0.23	2N4288	0.19
AC128	0.20	AF124	0.33	BC160	0.50	BD140	0.66	BF196	0.16	OC20	0.70	2G371	0.18	2N2220	0.24	2N3403	0.23	2N4289	0.19
AC132	0.16	AF125	0.33	BC161	0.55	BD155	0.88	BF197	0.16	OC22	0.52	2G371B	0.13	2N2221	0.22	2N3404	0.31	2N4290	0.19
AC134	0.16	AF126	0.31	BC167	0.13	BD175	0.66	BF200	0.50	OC23	0.54	2G373	0.19	2N2222	0.22	2N3405	0.46	2N4291	0.19
AC137	0.16	AF127	0.31	BC168	0.13	BD176	0.66	BF222	£1.05	OC24	0.62	2G374	0.19	2N2368	0.19	2N3414	0.17	2N4292	0.19
AC141	0.20	AF139	0.33	BC169	0.13	BD177	0.72	BF257	0.50	OC25	0.42	2G377	0.33	2N2369	0.16	2N3415	0.17	2N4293	0.19
AC141K	0.32	AF178	0.55	BC170	0.13	BD178	0.72	BF258	0.66	OC26	0.32	2G378	0.18	2N2369A	0.16	2N3416	0.31	2N5172	0.13
AC142	0.20	AF179	0.55	BC171	0.16	BD179	0.77	BF259	0.94	OC28	0.55	2G381	0.18	2N2411	0.27	2N3417	0.31	2N5294	0.60
AC142K	0.28	AF180	0.55	BC172	0.16	BD180	0.77	BF262	0.61	OC29	0.55	2G382	0.18	2N2412	0.27	2N3525	0.83	2N5457	0.35
AC151	0.17	AF181	0.55	BC173	0.16	BD185	0.72	BF263	0.61	OC35	0.46	2G401	0.33	2N2646	0.52	2N3614	0.74	2N5458	0.35
AC154	0.22	AF186	0.55	BC174	0.16	BD186	0.72	BF270	0.39	OC36	0.55	2G414	0.33	2N2711	0.23	2N3615	0.82	2N5459	0.44
AC155	0.22	AF239	0.41	BC175	0.24	BD187	0.77	BF271	0.33	OC41	0.22	2G417	0.28	2N2712	0.23	2N3616	0.82	2N6211	0.75
AC156	0.22	AL102	0.72	BC177	0.21	BD188	0.77	BF272	0.88	OC42	0.27	2N388	0.39	2N2714	0.23	2N3464	0.10	2S301	0.55
AC157	0.27	AL103	0.72	BC178	0.21	BD189	0.83	BF273	0.39	OC44	0.17	2N388A	0.61	2N2904	0.19	2N3702	0.13	2S302A	0.46
AC165	0.22	ASY26	0.28	BC179	0.21	BD190	0.83	BF274	0.39	OC45	0.14	2N404	0.22	2N2904A	0.23	2N3703	0.13	2S302	0.46
AC166	0.22	ASY27	0.33	BC180	0.27	BD195	0.94	BFW10	0.66	OC70	0.11	2N404A	0.31	2N2905	0.23	2N3704	0.14	2S303	0.61
AC167	0.22	ASY28	0.28	BC181	0.27	BD196	0.94	BFX20	0.30	OC71	0.11	2N524	0.46	2N2905A	0.23	2N3705	0.13	2S304	0.77
AC168	0.27	ASY29	0.28	BC182	0.11	BD197	0.99	BFX84	0.24	OC72	0.16	2N527	0.54	2N2906	0.17	2N3706	0.13	2S305	0.86
AC169	0.16	ASY50	0.28	BC182L	0.11	BD198	0.99	BFX85	0.33	OC74	0.16	2N598	0.46	2N2906A	0.20	2N3707	0.14	2S306	0.86
AC176	0.22	ASY51	0.28	BC183	0.11	BD199	£1.05	BFX86	0.24	OC75	0.17	2N599	0.50	2N2907	0.22	2N3708	0.09	2S307	0.86
AC177	0.27	ASY52	0.28	BC183L	0.11	BD200	£1.05	BFX87	0.27	OC76	0.17	2N696	0.14	2N2907A	0.24	2N3709	0.10	2S321	0.62
AC178	0.31	ASY54	0.28	BC184	0.13	BD205	0.88	BFX88	0.24	OC77	0.28	2N697	0.15	2N2923	0.16	2N3710	0.10	2S322	0.46
AC179	0.31	ASY55	0.28	BC184L	0.13	BD206	0.88	BFY50	0.22	OC81	0.17	2N698	0.27	2N2924	0.16	2N3711	0.10	2S322A	0.46
AC180	0.22	ASY56	0.28	BC186	0.31	BD207	£1.05	BFY51	0.22	OC81D	0.17	2N699	0.39	2N2925	0.16	2N3819	0.31	2S323	0.62
AC180K	0.32	ASY57	0.28	BC187	0.31	BD208	£1.05	BFY52	0.22	OC82	0.17	2N706	0.09	2N2926(G)	0.14	2N3820	0.55	2S324	0.77
AC181	0.22	ASY58	0.28	BC207	0.12	BDY20	£1.10	BFY53	0.19	OC82D	0.17	2N706A	0.10	2N2926(Y)	0.12	2N3821	0.39	2S325	0.77
AC181K	0.32	ASY73	0.28	BC208	0.12	BF115	0.27	BPX25	0.94	OC83	0.22	2N708	0.13	2N2926(O)	0.11	2N3823	0.31	2S326	0.77
AC187	0.24	ASZ21	0.44	BC209	0.13	BF117	0.50	BSX19	0.17	OC139	0.22	2N711	0.33	2N2926(R)	0.11	2N3903	0.31	2S327	0.77
AC187K	0.25	BC107	0.12	BC212L	0.12	BF118	0.77	BSX20	0.17	OC140	0.22	2N717	0.39	2N2926(B)	9.11	2N3904	0.33	2S701	0.46
AC188	0.24	BC108	0.12	BC213L	0.12	BF119	0.77	BSY25	0.17	OC169	0.28	2N718	0.27	2N3046	0.77	2N3905	0.31	40361	0.44
AC188K	0.25	BC109	0.12	BC214L	0.16	BF121	0.50	BSY26	0.17	OC170	0.28	2N718A	0.55	2N3011	0.16	2N3906	0.30	40362	0.50
ACY17	0.28	BC113	0.11	BC225	0.28	BF123	0.55	BSY27	0.17	OC171	0.28	2N726	0.31	2N3053	0.19	2N4058	0.13		
ACY18	0.22	BC114	0.17	BC226	0.39	BF125	0.55	BSY28	0.17	OC200	0.28	2N727	0.31	2N3054	0.51	2N4059	0.11		
ACY19	0.22	BC115	0.17	BC301	0.30	BF127	0.55	BSY29	0.17	OC201	0.31	2N743	0.22						
ACY20	0.22	BC116	0.17	BC302	0.27	BF152	0.61	BSY38	0.20	OC202	0.31	2N744	0.22						
ACY21	0.22	BC117	0.20	BC303	0.35	BF153	0.50	BSY39	0.20	OC203	0.28	2N914	0.16						
ACY22	0.18	BC118	0.11	BC304	0.40	BF154	0.50	BSY40	0.31	OC204	0.28	2N918	0.33						
ACY27	0.20	BC110	0.33	BC440	0.34	BF155	0.77	BSY41	0.31	OC205	0.39	2N929	0.23						
ACY28	0.21	BC120	0.88	BC460	0.40	BF156	0.53	BSY95	0.14	OC309	0.44	2N930	0.23						
ACY29	0.39	BC125	0.13	BCY30	0.27	BF157	0.61	BSY95A	0.14	OCP71	0.48	2N1131	0.22						
ACY30	0.31	BC126	0.20	BCY31	0.29	BF158	0.61	BU105	£2.20	ORP12	0.48	2N1132	0.24						
ACY31	0.31	BC132	0.13	BCY32	0.33	BF159	0.66	C111E	0.55			2N1302	0.16						
ACY34	0.23	BC134	0.20	BCY33	0.24	BF160	0.44	C400	0.33			2N1303	0.16						
ACY35	0.23	BC135	0.13	BCY34	0.28	BF162	0.44	C407	0.28	P20	0.55	2N1304	0.19						
ACY36	0.31	BC136	0.17	BCY70	0.16	BF163	0.44	C424	0.28	P21	0.50	2N1305	0.19						
ACY40	0.19	BC137	0.17	BCY71	0.22	BF164	0.44	C425	0.55	P346A	0.22	2N1306	0.23						
ACY41	0.20	BC139	0.44	BCY72	0.16	BF165	0.44	C426	0.39	P397	0.46	2N1307	0.23						
ACY44	0.39	BC140	0.33	BCZ10	0.22	BF167	0.24	C428	0.22	ST140	0.14	2N1308	0.26						
AD130	0.42	BC141	0.33	BCZ11	0.28	BF173	0.24	C441	0.33	ST141	0.19	2N1309	0.26						
AD140	0.53	BC142	0.33	BCZ12	0.28	BF176	0.39	C442	0.33	TIS43	0.33	2N1613	0.22						
AD142	0.53	BC143	0.33	BD115	0.68	BF177	0.39	C444	0.39	UT46	0.30	2N1711	0.22						
AD143	0.42	BC145	0.50	BD116	0.88	BF178	0.33	C450	0.24	ZN414	£1.20	2N1880	0.35						
AD149	0.55	BC147	0.11	BD121	0.66	BF179	0.33	MAT100	0.21	2G301	0.21	2N1889	0.50						
AD161	0.39	BC148	0.11	BD123	0.72	BF180	0.33	MAT101	0.22	2G302	0.21	2N1893	0.41						
AD162	0.39	BC149	0.13	BD124	0.76	BF181	0.33	MAT120	0.21	2G303	0.21	2N2147	0.79						

DIODES AND RECTIFIERS

AA119	0.09	BY128	0.17	OA70	0.08
AA120	0.09	BY130	0.18	OA79	0.08
AA129	0.09	BY133	0.23	OA81	0.08
AAY30	0.10	BY164	0.55	OA85	0.10
AAZ13	0.11	BYX38/30	0.46	OA90	0.07
BA100	0.11	BYZ10	0.39	OA91	0.07
BA116	0.23	BYZ11	0.33	OA95	0.08
BA126	0.24	BYX12	0.33	OA200	0.07
BA148	0.16	BYZ13	0.28	OA202	0.08
BA154	0.13	BYZ16	0.44	SD10	0.06
BA155	0.16	BYZ17	0.39	SD19	0.06
BA156	0.15	BYZ18	0.39	1N34	0.08
BA173	0.16	BYZ19	0.31	1N34A	0.08
BY100	0.17	CH62		1N914	0.06
BY101	0.13	(OA91Eq)	0.06	1N916	0.06
BY105	0.19	(G651 (OA70		1N4148	0.06
BY114	0.13	OA79)	0.07	IS021	0.11
BY124	0.13	OA5	0.39	IS951	0.07
BY126	0.16	OA10	0.15		
BY127	0.17	OA47	0.08		

LINEAR I.C's—FULL SPEC.

Type No.	Case		1	25	100+
72702	DIL	14	0.50	0.48	0.45
72709	DIL	14	6.35	0.33	0.30
72710	DIL	14	0.45	0.43	0.40
72741	DIL	14	0.40	0.38	0.35
72741C	TO-5	8	0.45	0.43	0.40
72741P	DIL	8	0.38	0.36	0.34
72748P	DIL	8	0.38	0.36	0.34
SL201C	TO-5	8	0.50	0.45	0.40
SL701C	TO-5	8	0.50	0.45	0.40
SL702C	TO-5	8	0.50	0.45	0.40
TAA263	TO-72	4	0.80	0.70	0.60
TAA293	TO-74	10	£1.00	0.95	0.90
TAA350A	TO-5	10	£1.85	£1.80	£1.70
µA703C	TO-5	6	0.28	0.26	0.24
µA709C	TO-5	8	0.35	0.33	0.30
µA711	TO-5	10	0.45	0.43	0.40

DTL 930 SERIES LOGIC I.C's

Type	1	25	100+
BP930	0.15	0.14	0.13
BP932	0.16	0.15	0.14
BP933	0.16	0.15	0.14
BP935	0.16	0.15	0.14
BP936	0.16	0.15	0.14
BP944	0.16	0.15	0.14
BP945	0.30	0.28	0.25
BP946	0.15	0.14	0.13
BP948	0.30	0.28	0.25
BP951	0.70	0.65	0.60
BP962	0.15	0.14	0.13
BP9093	0.45	0.43	0.40
BP9094	0.45	0.43	0.40
BP9097	0.45	0.43	0.40
BP9099	0.45	0.43	0.40

NUMERICAL INDICATOR TUBES

Type	Description	
3015F	Minitron 7 Segment Indicator	£1.50
MAN 3M	L.E.D. 7 Segment Display 0.127" High Characters	£1.90
CD 66	Side Viewing 'Nixie Type' Tube 16 m/m	£1.87
GR 116	Side Viewing 'Nixie Type' Tube 13 m/m	£1.70

ALL PRICES INCLUDE V.A.T.

3 TERMINAL POSITIVE VOLTAGE REGULATORS

To3 Plastic Encapsulation O/P 1.5 Amps.

µA7805	5V (Equiv. to MVR5V)	£1.76
µA7812	12V (Equiv. to MVR12V)	£1.76

RTL MICROLOGIC CIRCUITS

	Price each		
Epoxy TO–5 case	1-24	25-99	100 up
µL900 Buffer	39p	36p	30p
µL914 Dual 2I/p gate	39p	36p	30p
µL923 J-K flip-flop	55p	52p	50p

Date and Circuits Booklet for IC's. Price 7p.

DUAL IN LINE SOCKETS

14 & 16 Lead Sockets for use with DUAL-IN-LINE I.C's. TWO Ranges PROFESSIONAL and NEW LOW COST.

TSO14	14 pin type	0.33	0.30	0.27
TSO16	16 pin type	0.38	0.35	0.32
BPS14	14 pin type (low cost)	0.16	0.14	0.12
BPS16	16 pin type (low cost)	0.17	0.15	0.13

74 Series T.T.L. I.C's

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
7400	0.18	0.17	0.16	7453	0.18	0.17	0.16	74153	£1.30	£1.20	£1.10
7401	0.18	0.17	0.16	7454	0.18	0.17	0.16	74154	£1.98	£1.90	£1.75
7402	0.18	0.17	0.16	7460	0.18	0.17	0.16	74155	£1.50	£1.45	£1.35
7403	0.18	0.17	0.16	7470	0.32	0.29	0.27	74156	£1.50	£1.45	£1.35
7404	0.18	0.17	0.16	7472	0.32	0.29	0.27	74157	£2.00	£1.90	£1.80
7405	0.18	0.17	0.16	7473	0.41	0.39	0.35	74160	£2.10	£2.00	£1.90
7406	03.9	0.34	0.31	7474	0.41	0.39	03.5	74161	£2.10	£2.00	£1.90
7407	0.39	0.34	0.31	7475	0.50	0.48	0.46	74162	£4.40	£4.15	£3.85
7408	0.20	0.19	0.18	7476	0.44	0.43	0.42	74163	£4.40	£4.15	£3.85
7409	0.20	0.19	0.18	7480	0.74	0.71	0.64	74164	£2.20	£2.10	£2.00
7410	0.18	0.17	0.16	7481	£1.30	£1.25	£1.20	74165	£2.20	£2.10	£2.00
7411	0.28	0.27	0.26	7482	0.96	0.95	0.94	74166	£3.20	£3.10	£3.00
7412	0.39	0.34	0.31	7483	£1.20	£1.15	£1.05	74174	£2.50	£2.40	£2.30
7413	0.32	0.31	0.30	7484	£1.10	£1.05	£1.00	74175	£1.75	£1.65	£1.55
7416	0.48	0.44	0.42	7485	£3.50	£3.40	£3.30	74176	£1.85	£1.75	£1.65
7417	0.48	0.44	0.42	7486	0.35	0.34	0.33	74177	£1.85	£1.75	£1.65
7420	0.18	0.17	0.16	7489	£4.00	£3.75	£3.50	74180	£1.50	£1.40	£1.30
7422	0.55	0.53	0.50	7490	0.74	0.71	0.64	74181	£5.00	£4.50	£4.00
7423	0.55	0.53	0.50	7491	£1.10	£1.05	£1.00	74182	£2.00	£1.90	£1.75
7425	0.55	0.53	0.50	7492	0.74	0.71	0.64	74184	£3.20	£3.10	£3.00
7426	0.50	0.46	0.44	7493	0.74	0.71	0.64	74190	£2.15	£2.10	£2.00
7427	0.50	0.46	0.44	7494	0.85	0.82	0.75	74191	£2.15	£2.10	£2.00
7428	0.55	0.53	0.50	7495	0.85	0.82	0.75	74192	£2.15	£2.10	£2.00
7430	0.18	0.17	0.16	7496	0.96	0.93	0.86	74193	£2.15	£2.10	£2.00
7432	0.50	0.46	0.44	74100	£1.50	£1.45	£1.40	74194	£2.98	£2.88	£2.75
7433	0.75	0.73	0.70	74104	£1.07	£1.04	£1.00	74195	£2.00	£1.95	£1.90
7437	0.70	0.68	0.65	74105	£1.07	£1.04	£1.00	74196	£1.95	£1.90	£1.85
7438	0.70	0.68	0.65	74107	0.44	0.42	0.40	74197	£1.95	£1.90	£1.85
7440	0.18	0.17	0.16	74110	0.60	0.55	0.50	74198	£5.00	£4.75	£4.50
7441	0.74	0.71	0.64	74111	£1.38	£1.27	£1.21	74199	£5.00	£4.75	£4.50
7442	0.74	0.71	0.64	74118	£1.10	£1.05	£1.00				
7443	£1.20	£1.15	£1.10	74119	£1.50	£1.40	£1.30				
7444	£1.20	£1.15	£1.10	74121	0.50	0.48	0.45				
7445	£1.98	£1.95	£1.90	74122	£1.50	£1.45	£1.40				
7446	£1.20	£1.15	£1.10	74123	£3.00	£2.90	£2.80				
7447	£1.10	£1.07	£1.05	74141	0.85	0.82	0.79				
7448	£1.10	£1.07	£1.05	74145	£1.65	£1.55	£1.45				
7450	0.18	0.17	0.16	74150	£2.90	£2.80	£2.70				
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200	0.27	0.32	0.54	0.54	0.62	0.67	0.67	£1.76
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200	0.06	0.10	0.07	0.12	0.22	0.25	£1.00
400	0.08	0.15	0.08	0.15	0.30	0.38	£1.35
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1021	For model G240 ⅛" ..	23p
1022	For model G240 3/16" ..	23p
50	For model X25 3/32" ..	38p
51	For model X25 ⅛" ..	38p
52	For model X25 3/16" ..	38p

ELEMENTS
ECN 240 .. £1.16 ECCN 140 .. £1.16
EG 240 .. £1.16 EX 25 .. £1.16

LOOK FOR OUR AUDIC AND ELECTRONIC COMPONENT ADVERTISEMENTS IN 'PRACTICAL ELECTRONICS'

ALL PRICES SHOWN INCLUDE V.A.T.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx count by weight ..	0.55
C 2	200	Capacitors mixed values approx. count by weight ..	0.55
C 3	50	Precision Resistors .1%, .01% mixed values ..	0.55
C 4	75	⅛th W Resistors mixed preferred values ..	0.55
C 5	5	Pieces assorted Ferrite Rods	0,55
C 6	2	Tuning Gangs, MW LW VHF	0.55
C 7	1	Pack Wire 50 metres assorted colours ..	0.55
C 8	10	Reed Switches ..	0.55
C 9	3	Micro Switches ..	0.55
C10	15	Assorted Pots and Pre-Sets ..	0.55
C11	5	Jack Sockets 3 - 3.5m 2 - Standard Switch Types ..	0.55
C12	40	Paper Condensers preferred types mixed values	0.55
C13	20	Electrolytics Trans. types ..	0.55
C14	1	Pack assorted Hardware Nuts Bolts, Grommets etc.	0.55
C15	4	Mains Switches.	0.55
C16	20	Assorted Tag Strips & Panels	0.55
C17	10	Assorted Control Knobs ..	0.55
C18	4	Rotary Wave Change Switches	0.55
C19	3	Relays 6-24V Operating ..	0.55
C20	4	Sheets Copper Laminate approx. 10" × 7" ..	0.55

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19 and C20.

PLUGS AND SOCKETS

SOCKETS

PS35	DIN 2 Pin (Speaker) ..	0.06
PS36	DIN 3 Pin ..	0.10
PS37	DIN 5 Pin 180 ..	0.10
PS38	DIN 5 Pin 240° ..	0.10
PS39	Jack 2.5mm Switched ..	0.09
PS40	Jack 3.5mm Switched ..	0.10
PS41	Jack ¼" Switched ..	0.17
PS42	Jack Stereo Switched ..	0.26
PS43	Phono Single ..	0.06
PS44	Phono Double ..	0.10
PS45	Car Aerial ..	0.09
PS46	Co-Axial Surface ..	0.09
PS47	Co-Axial Flush ..	0.14

INLINE SOCKETS

PS21	DIN 2 Pin (Speaker) ..	0.13
PS22	DIN 3 Pin ..	0.17
PS23	DIN 5 Pin 180° ..	0.17
PS24	DIN 5 Pin 240 ..	0.17
PS25	Jack 2.5mm Plastic ..	0.10
PS26	Jack 3.5mm Plastic ..	0.12
PS27	Jack ¼" Plastic ..	0.24
PS28	Jack ¼" Screened ..	0.28
PS29	Jack Stereo Plastic ..	0.22
PS30	Jack Stereo Screened ..	0.32
PS31	Phono Screened ..	0.14
PS32	Car Aerial ..	0.15
PS33	Co-Axial ..	0.17

PLUGS

PS 1	DIN 2 Pin (Speaker) ..	0.11
PS 2	DIN 3 Pin ..	0.12
PS 3	DIN 4 Pin ..	0.15
PS 4	DIN 5 Pin 180 ..	0.14
PS 5	DIN 5 Pin 240 ..	0.15
PS 6	DIN 6 Pin ..	0.15
PS 7	DIN 7 Pin ..	0.15
PS 8	Jack 2.5mm Screened ..	0.10
PS 9	Jack 3.5mm Plastic ..	0.09
PS10	Jack 3.5mm Screened ..	0.12
PS11	Jack ¼" Plastic ..	0.13
PS12	Jack ¼" Screened ..	0.18
PS13	Jack Stereo Screened ..	0.29
PS14	Phono ..	0.06
PS15	Car Aerial ..	0.15
PS16	Co-Axial ..	0.10

CABLES

CP 1	Single lapped screen ..	0.06
CP 2	Twin Common Screen ..	0.08
CP 3	Stereo Screened ..	0.08
CP 4	Four Core Common Screen ..	0.23
CP 5	Four Core individually Screened	0.30
CP 6	Microphone Fully Braided Cable	0.10
CP 7	Three core mains cable ..	0.07
CP 8	Twin oval mains cable ..	0.06
CP 9	Speaker Cable ..	0.04
CP10	Low Loss Co-Axial ..	0.10

CARBON POTENTIOMETERS

Log and Lin 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M.

VC1	Single less Switch ..	0.14
VC2	Single O.P. Switch ..	0.26
VC3	Tandem Less Switch ..	0.44
VC4	1K Lin Less Switch ..	0.14
VC5	100K Log anti-Log ..	0.44

HORIZONTAL CARBON PRESETS

0.1 watt 0.06
100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M.

BOOK BARGAIN BUNDLE

8 Books comprising:
2 Transistor Equivalent Books.
1 Radio & Electronic Colour Code & Data Chart.
1 Radio Valve Guide PLUS
3 other Constructional books on Receivers, FM Tuners etc.
Also 1 General Constructional book.

Value £3. Our price £2.

BP1	Handbook of Transistor Equivalents and Substitutes ..	40p
BP2	Handbook of Radio T.V. and Industrial Tube & Valve Equivs.	40p
BP3	Handbook of Tested Transistor Circuits ..	40p
BP4	International Handbook of the World's Short Wave, Medium and Long Wave Radio Stations and FM/TV Listings. ..	35p
BP5	Handbook of Simple Transistor Circuits ..	35p
BP7	Radio & Electronic Colour Codes & Data Chart ..	15p
BP8	Sound & Loudspeaker Manual ..	50p
BP9	38 Practical Tested Diode Circuits for the Home Constructor ..	35p
BP11	Practical Transistor Novelty Circuits ..	40p
129	Universal Gram-Motor Speed Indicator ..	8p
138	How to make FM & TV Aerials, Bands 1, 2 & 3 ..	18p
141	Radio Servicing for Amateurs ..	20p
146	High Fidelity Loudspeaker Enclosures ..	37p
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161	Radio, TV & Electronics Data Book	25p
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174	Transistor Subminiature Receivers	32p
175	Transistor Test Equipment and Servicing Manual ..	25p
176	Transistor Audio Amplifier Manual	40p
177	Modern Transistor Circuits for Beginners ..	40p
178	A Comprehensive Radio Valve Guide, Book 5 ..	30p
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185	Tested Shortwave Receiver Circuits using MAT's ..	30p
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198	Reactance-Frequency Chart for Audio & RF use ..	15p
	Resistor Colour Code Disc Calculator	10p

CARTRIDGES

ACOS	GP91 1SC	200mV at 1.2cms/sec	£1.16
	GP93 1	280mV at 1cm/sec ..	£1.65
	GP96 1	100mV at 1cm/sec ..	£2,65
TTC	J 2005	Crystal/Hi Output ..	95p
	J-20 10C	Crystal/Hi Output Compatible ..	£1.10
	J-200 CS	Stereo/Hi Output ..	£1,60
	J-2105	Ceramic/Med Output	£1,64

CARBON FILM RESISTORS

The E12 Range of Carbon Film Resistors, ⅓th watt available in PAKS of 50 pieces, assorted into the following groups:

R1	50 Mixed 100ohms - 820ohms ..	40p
R2	50 Mixed 1Kohms - 8.2Kohms ..	40p
R3	50 Mixed 10Kohms - 82Kohms ..	40p
R4	50 Mixed 100Kohms - 1Megohm ..	40p

THESE ARE UNBEATABLE PRICES - LESS THAN 1p EACH INC. V.A.T.!

BI-PAK SUPERIOR QUALITY LOW-NOISE CASSETTES

C60 32p C90 41p C120 52p

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OPEN: MON–THURS 9.15–6pm SAT 9.15–5.30 LATE NIGHT SHOPPING UNTIL 7pm FRIDAYS. Tel 61593

BI-PAK QUALITY COMES TO AUDIO!

AL10 AL20 AL30
AUDIO AMPLIFIER MODULES

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

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

PARAMETER	CONDITIONS	PERFORMANCE
HARMONIC DISTORTION	Po 3 WATTS f 1 KHz	0.25%
LOAD IMPEDANCE	–	8 – 16Ω
INPUT IMPEDANCE	f 1KHz	100 KΩ
FREQUENCY RESPONSE ±3 dB	Po 2 WATTS	50 Hz – 25 KHz
SENSITIVITY for RATED O/P	Vs 25V. RL 8Ω f 1KHz	75mV. RMS
DIMENSIONS		3" × 2½" × 1"

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

PARAMETER	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL 8Ω f 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL10 3 Watts £2.19
AL20 5 Watts £2.59
AL30 10 Watts £3.01

PRE-AMPLIFIERS

PA 12 (Use with AL10 & AL20) .. £4.35
PA100 (Use with AL30 & AL50) .. £13.15

POWER SUPPLIES

PS12 (Use with AL10 & AL20) 88p
SPM80 (Use with AL30 & AL50) £3.25

TRANSFORMERS

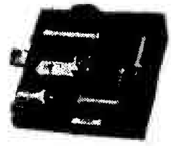
T461 (Use with AL10) p&p 15p .. £1.38
T538 (Use with AL20) p&p 15p .. £1.93
BMT80 (Use with AL30 & AL50) p&p 25p £2.15

FRONT PANELS PA 12 With knobs £1.00

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL10, AL20 and AL30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response 20Hz–50KHz (–3dB)
Bass control ±12dB at 60Hz
Treble control ±14dB at 14 KHz
*Input 1.
Impedance 1 Meg. ohm.
Sensitivity 300 mV
†Input 2.
Impedance 30 K ohms
Sensitivity 4 mV

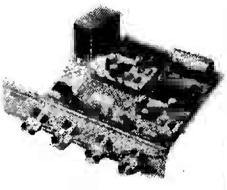


EA1000 AUDIO AMP MODULE

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

SPECIAL OFFER £2

The STEREO 20



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

Output power 20w peak
Freq. res. 25Hz–25kHz
Harmonic distortion typically 0.25% at 1 watt
Input 1 (cr.) 300mV into 1M
Input 2 (Aux.) 4 mV into 30K
Bass control ±12bB at 60 Hz
Treble con. ±14bB at 14 kHz

£14.45

BI-PAK DO IT AGAIN!

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

- ★ Frequency response 15Hz to 100,000 - 1dB.
- ★ Load - 3, 4, 8 or 16 ohms.
- ★ Distortion - better than .1% at 1KHz.
- ★ Signal to noise ratio 80dB.
- ★ Supply voltage 10 - 35 Volts.
- ★ Overall size 63mm x 105mm x 13mm.

ONLY £3.58 each

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs. FULLY BUILT - TESTED - GUARANTEED.

STABILISED POWER MODULE SPM80

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (rms) per channel, simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 62mm x 105mm x 30mm.

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

PRICE £3.25

TRANSFORMER BMT80 £2.15 p. & p. 25p.

STEREO PRE-AMPLIFIER, TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques.

Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

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

SPECIFICATION

Frequency Response 20Hz — 20KHz ± 1dB
Harmonic Distortion better than 0.1%
Inputs: 1. Tape Head 1.25 mV into 50KΩ
2. Radio, Tuner 35 mV into 50KΩ
3. Magnetic P.U. 1.5 mV into 50KΩ
All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB, from 20Hz to 20KHz.
Bass Control ± 15dB @ 20Hz Treble Control ± 15dB @ 20KHz
Filters: Rumble (High Pass) 100Hz
Scratch (Low Pass) 8KHz
Signal/Noise Ratio better than — 65dB
Input overload + 26dB Supply + 35 volts @ 20mA
Dimensions 292mm × 82mm × 35mm

Price £13.15

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 and 1 PA100 ONLY **£25.30** FREE p & p.

All prices quoted in new pence Giro No 388 7006
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BI-PAK

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Postage and packing add 10p Overseas add extra for airmail
Minimum order 50p Cash with order please

Guaranteed Satisfaction or Money Back

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JUST A FEW OF OUR BARGAINS ARE LISTED BELOW - PAY US A VISIT OR SEND STAMPED ADDRESSED ENVELOPE FOR A QUOTE ON YOUR REQUIREMENTS

MAINS POWER SUPPLY UNIT. 400m/A, 6-7.5-9-12 VOLT MADE TO SELL AT £5.25 OUR PRICE £3.50

VALVE BASES

Chassis or printed circuit B9A – B7G	3p
Chassis UX7 – UX5 – B9G	3p
Shrouded chassis B7G – B9A	4p
B11A chassis (relay)	8p
B8A chassis	5p

TAG STRIP
6 way **2p** Single **1p**

WRIST COMPASS
20p with Needle Lock

TO3 Mica Washer	2p
3″ Standard Tape - Boxed	15p
GP91-1 Cartridge, turnover stylii	65p
GC10/4B Cold Cathode	£5.00
Brand New Boxed 6K7G	25p

$1\frac{1}{4}$ glass fuses— 250 m/a or 3 amp (box of 12)	6p
3″ tape spools	4p
FX2236 Ferrox Cores	5p
PVC or metal clip on M.E.S. bulb holder	3p
All metal equipment Phono plug	2p
Bulgin, 5mm Jack plug and switched socket (pair)	20p
12 volt solenoid and plunger	25p
250 RPM 50 c/s locked frequency miniature mains motor	50p
200 OHM coil, $2\frac{1}{4}$″ long, hollow centre	10p
Relay, P.O. 3000 type, 1,000 OHM coil, 4 pole c/o	60p
R.S. 12 way standard plug and shell	50p

ELECTROLYTICS
Mullard C426, TCC, CRL, CCL, Cullins, Hunts, STC Subminiature, etc

MFD/VOLT 2p 100/6, 6/3, 8/6, 200/3, 25/3.
3p 25/6.4, 500/6, 250/6.
4p 20/12, 100/25, 100/12, 25/12, 100/15, 64/10, 125/10, 50/50, 50/10, 100/18, 6/25, 2/350.
9p 8/500, 100/200. 400/40, 100/250-275.
5p 8/50, 8/20, 8/40, 2.5/64, 12/50, 12/20, 10/20, 16/50, 16/40, 25/25, 50/25, 150/12, 150/25, 260/12, 4/60, 15/35.
6p 250/18, 400/16, 250/30, 550/12.
50p 8/800, 12,000/12, 2000/50.
20p 100-100/150, 100-100/275, 32-32/275.

INDICATORS

Arcolectric green, takes M.E.S. bulb	10p
Bulgin D676 red, takes M.E.S. bulb	15p
12 volt red, small pushfit	15p
Mains neon, amber, green or red, pushfit	15p

SWITCHES

Pole	Way	Type	
4	2	Sub. Min. Slide	10p
6	2	Slide	15p
4	2	Lever Slide	10p
6	4	Wafer Rotary	12p each
4	3	Wafer Rotary	12p each
3	7	Wafer Rotary	12p each
2	5	Wafer Rotary	12p each
1	3	+ off Sub. min. edge	10p
1	3	13 amp small rotary	12p
2	2	Locking with 2 to 3 keys	£1.50
2	1	2 Amp 250V A.C. rotary	20p
1	2	Toggle	10p

RESISTORS

$\frac{1}{8}$-$\frac{1}{4}$-$\frac{1}{2}$ watt	1p
1 watt	$1\frac{1}{2}$p
Up to 10 watt wire	8p
15 watt wire wound	10p

SKELETON PRESETS
5K or 500K **3p**

SAFETY PINS
Standard size, 10 for **4p**

WIREWOUND POTS
250, 300 OHM, 1K, 4 watt, 10K, 20K, 50K, all at **10p each**

5K switched volume control	15p
5K Log Pot	10p
1meg Tandem Pot	15p

THERMISTORS
VA1040, VA1055, VA1066, VA1100 **10p each**
VA1077 **13p**

STEEL BOX WITH LID
10 x $5\frac{1}{2}$ x 3″ grey hammer finish **£1**

RELAYS
6 volt, 2 pole c/o heavy duty contacts **50p**
Mains 3 pole c/o heavy duty contacts ex equipment **35p**

CAPACITORS
Mixed type PFDS, 2p. 3.3, 4.7, 10, 16, 18, 22, 24, 25, 27, 30, 37, 39, 47, 50, 56, 68, 88, 100, 110, 150, 200, 220, 250, 270, 300, 350, 470, 500, 600, 680, 800, 1000, 2200, 3000, 3300, 5000.
Poly, met., film, paper, etc. MFD/Volt, 3p. .001/1250, .03/350, .022/70, .03/12, .033/100, .0068/70, .056/350, .061/350, .069/350, .075/350, .08/350, .1/350, .1/500, .13/350, .25/150.
4p. 1500, 1800, 2200, 3000, 3300, 6800, 8200 PFD. .01/350, .013/350, .02/250, .05/125, .25/350.
5p. .033/100, .1/250, .25/500, .5/350.
6p. .1/600, .1/1500, .22/250.
10p. .01/1000, 1/350, 2/150, 2/200, 2/250.
40p. 5/150, 9/275AC, 10/150, 15/150, 40/150.

TRIMMERS, 10p each
100PF Ceramic, 30PF Beehive, 12PF PTFE, 2500PF 750 volt, 33PF MIN. AIR SPACED.

CONNECTOR STRIP
Belling Lee L1469, 12 way polythene. **5p each**

CAN CLIPS
1″ or $1\frac{3}{8}$″ or $\frac{3}{4}$″ **2p**

LABGEAR MAINS DROPPER
36 ohm 25 watt + 79 ohm 9 watt **15p**

TUNING CONDENSERS 33 or 50PF, **20p**

PAXOLINE

3 x $2\frac{1}{2}$ x $\frac{1}{16}$″	2p
$4\frac{3}{8}$ x $\frac{1}{2}$ x $\frac{1}{8}$″	2 for 1p
220K 3 watt resistors	2p
VALVE RETAINER CLIP, adjustable	2p

OUTPUT TRANSFORMERS

Sub-miniature Transistor Type	20p
Valve type, centre tapped or straight	40p

COMPUTER AND AUDIO BOARDS
HOST OF QUALITY, REASONABLE LEAD TRANSISTORS, SOME POWER. SILICON, GERMANIUM, ZENER DIODES, POT CORES HI-STAB RESISTORS, SOME WIREWOUND, CONDENSERS, CHOKES, TRIMPOTS, ELECTROLYTICS, ETC.
3lb. for **75p** + **25p** post and packing
7lb. for **£1.50** + **40p** post and packing

SUBMIN VERTICAL SKELETON PRESET 100, 220, 470, 680 OHM 1, 2.2, 4.7, 6.8, 10, 15, 22, 47, 68, 100, 220 K OHM.
ONLY **4p** EACH

KNOBS
SILVER METAL PUSH ON WITH POINTER, OR WHITE PLASTIC, GRUB SCREW, WITH POINTER AND SILVER CENTRE **5p** EACH.

ZM1162A INDICATOR TUBE
0-9 Inline End View. Rectangular Envelope 170V 2.5M/A **£1.70**

RESETTABLE COUNTER
English Numbering Machines LTD.
MODEL 4436-159-989
6–14 volt, 6 digit, illuminated, fully enclosed. **£2.50**

3 pin din to open end, $1\frac{1}{2}$yd twin screened lead **35p**

10 mtrs loudspeaker extension lead fitted 2 pin din plug and socket **40p** (retail 80p)

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SEMICONDUCTORS

Full spec marked by Mullard, etc. Many other types in stock

AC127	12p	BCY70	13p	BF183	28p
AC187/8	12p	BCY71	12p	BF184/5	17p
AD149	35p	BCY72	8p	BF194/5/6/7	12p
AD161/2	26p	BD115	62p	BF262/3	22p
AF116/7	12p	BD131	40p	BFX29/30	25p
AF139	31p	BD132	50p	BFX84	24p
AF178	32p	BD135	33p	BFX88	20p
AF180	40p	BD203	£1.00	BFY50/1/2	13p
AF239	37p	BD232	65p	BSV64	40p
BC107A or C	10p	BD234/5	48p	BSX21	20p
BC107/8/9	7p	BF115	20p	BU105/01	£1.30
BC147/8/9	8p	BF167	20p	OC35	34½p
BC148B/9B	10p	BF173	20p	TAA570	1-50p
BC157/8/9	11p	BF178	25p	2N706	10p
BC178	14p	BF179	30p	2N2219	20p
BC186/7	22p	BF180	20p	2N2401 (ASY26-27)	25p
BCY40	25p	BF181/2	32p	2N2904	18p
2N2905	22p	2N3053	15p		
2N2906	15p	2N3055	35p		
2N2907	20p				

THYRISTORS

Amp	Volt		
1	240	BTX18-200	30p
1	240	BTX30-200	30p
6.5	300	BT102-300R	42p
6.5	500	BT102-500R	60p
6.5	500	BT107	90p
6.5	500	BT108	90p
6.5	500	BT101-500R	68p
6.5	500	BT109-500R	90p
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£12

BRIDGE RECTIFIERS

Amp	Volt RMS		
½	1,600	BYX10	30p
1	140	OSH01-200	25p
1.4	42	BY164	35p
2	30	LT120	30p
0.6	6-110	EC433 Encapsulated with built-in heat sink	15p

Plastic types

OTHER DIODES

Centercel	5p
IN916	4p
BA145	15p
BA182	24p

5 pin and 6 pin 240° (Type B) Metal Chassis Din Sockets **6p**

TRIACS

Amp	Volt		
25	900	BTX94-900	£6.50
25	1200	BTX94-1200	£9

DIAC BRI00 **30p**

CQ11B Infra red transmitter £4

WESTINGHOUSE 28TIO 30 AMP 1000 VOLT THYRISTER WITHOUT NUT £5

PHOTO SILICON CONTROLLED SWITCH
BPX66 PNPN 10 amp £1

1 AMP RECTIFIERS

IN4002	100 volt	4p
IN4003	200 volt	5p
IN4004	400 volt	6p
IN4005	600 volt	7p
IN4006	800 volt	8p
IN4007	1,000 volt	8p

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BYX72-300R	10	300	35p
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½	CF	22-1M	1	0·8	0·65	0·62	0·55	0·5	0·45	5·5x16
¼	MF	10-2M7	1	0·9	0·8	0·7	0·65	0·65	0·6	3x7
½	MF	10-2M2	1	0·9	0·8	0·7	0·65	0·65	0·6	4·2x10·8
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10μF	63V	6p	220μF	63V	21p
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22μF	25V	6p	470μF	40V	20p
22μF	63V	6p	680μF	16V	15p
32μF	10V	6p	680μF	40V	25p
33μF	16V	6p	1000μF	16V	20p
33μF	40V	6p	1000μF	25V	25p
32μF	63V	6p	1500μF	6·4	15p
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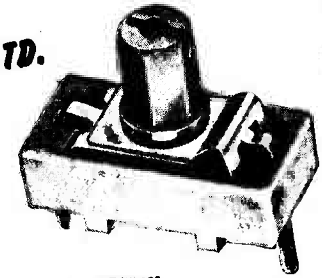

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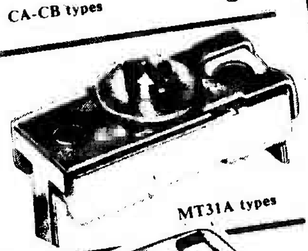

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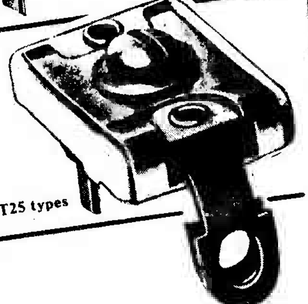

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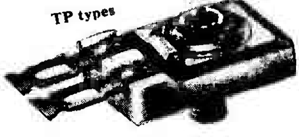

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CONTENTS

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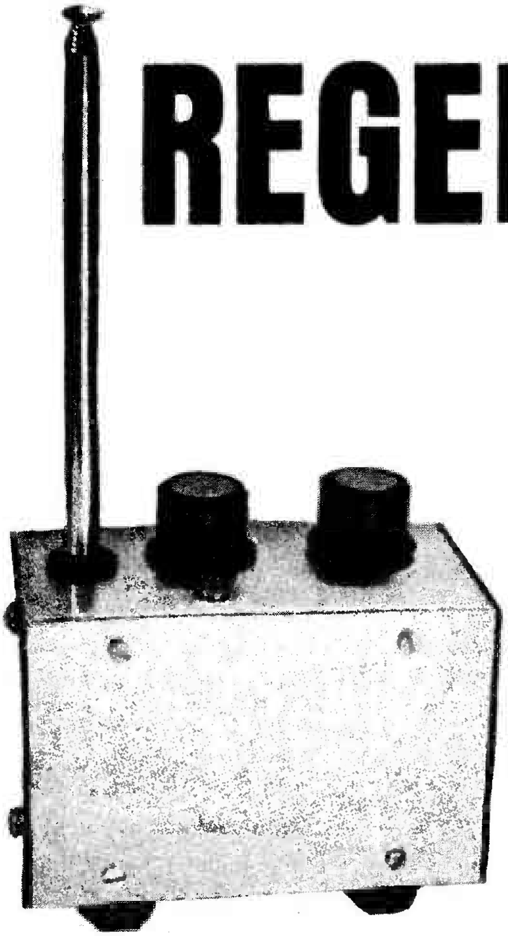
FEBRUARY ISSUE WILL BE PUBLISHED ON 1st FEBRUARY

REGENERATIVE



by R. A. Penfold

This unusual receiver, intended primarily for areas where f.m. reception is reasonably good, employs only two transistors. It draws an extremely low current from its internal 9 volt battery

THIS IS A SIMPLE 2-TRANSISTOR REGENERATIVE RECEIVER suitable for the reception of B.B.C. f.m. transmissions in the 88 to 108MHz band. Apart from the ordinary Radios 2, 3 and 4, this band also provides local radio stations in appropriate areas. The set is completely self-contained, having an internal 9 volt PP3 battery and a telescopic aerial. The output is suitable for driving a crystal earphone. The case measures approximately 4 by 2⅛ by 2½ in., excluding the knobs and telescopic aerial.

Although the set has some advantages over simple medium wave receivers, such as superior treble response and freedom of interference from foreign stations, it does have a few disadvantages. Firstly, as the receiver uses an extremely simple circuit it is only suitable for use in fairly strong reception areas. It should be borne in mind that there are still certain parts of the country which are not effectively covered by v.h.f. f.m. transmissions and there are local black-spots in otherwise good areas of reception. The set should not be built unless the reader resides in an area where v.h.f. reception is reasonably good. The prototype set is operated 25 miles from the Wrotham transmitter and gives satisfactory results. As is explained at the end of this article an improvement in sensitivity can be given by a different type of telescopic aerial, but this improvement cannot be guaranteed to overcome the limitations of the circuit in a poor reception area.

A second disadvantage is that the receiver is slightly more difficult to build and adjust than a simple medium wave set. Thirdly it cannot, of course, receive foreign stations. Nevertheless, it does make an interesting alternative to medium wave receivers and, when properly built and adjusted, is capable of a very high quality output.

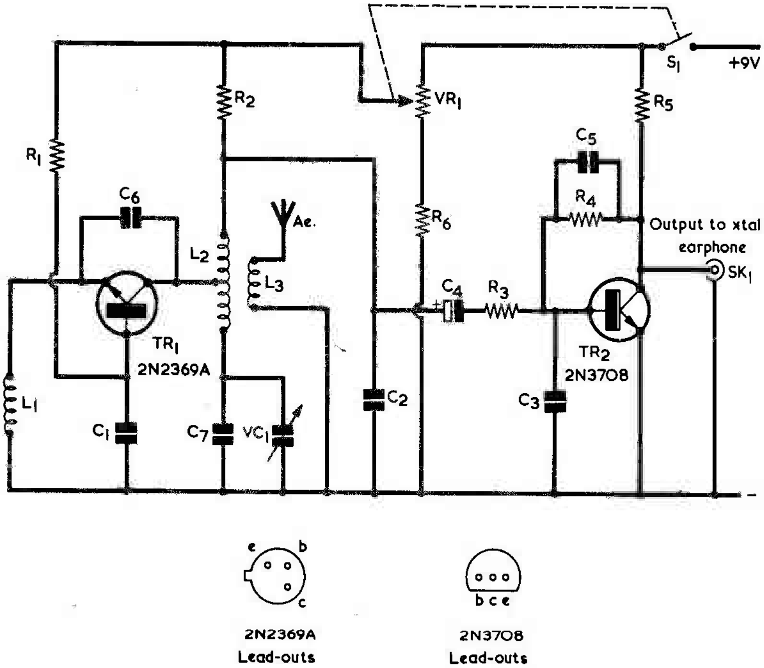
CIRCUIT OPERATION

The circuit of the receiver is shown in Fig. 1. TR1 is an inexpensive v.h.f. transistor type 2N2369A, and is used here as the regenerative detector. Basically this circuit consists of a grounded base oscillator with capacitive feedback, the regeneration being set to a point just below the level at which oscillation occurs.

R1 biases the transistor, whilst C1 bypasses the base for radio frequencies. L2 is the v.h.f. tuned winding and VC1 the tuning capacitor. L1 is a choke which provides a d.c. return to the negative supply rail for the emitter and offers a high impedance at the signal frequencies. In the grounded base configuration the emitter and collector are in phase, whereupon C6 introduces positive feedback. The supply for TR1 is obtained via the potentiometer VR1 which, in consequence, controls the gain of the stage. VR1 acts as the regeneration control.

The aerial currents are loosely coupled to the tuned

V.H.F. RECEIVER



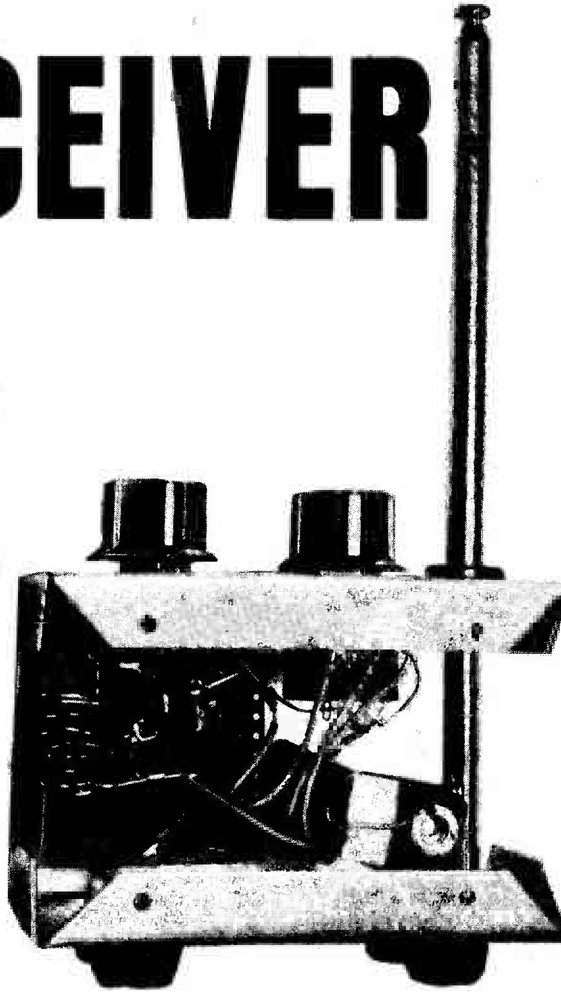


Fig. 1. The circuit of the v.h.f. receiver. TR1 is a regenerative detector and TR2 an a.f. amplifier

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	330kΩ
R2	3.9kΩ
R3	2.2kΩ
R4	560kΩ
R5	4.7kΩ
R6	1.8kΩ
VR1	10kΩ potentiometer, log, with switch S1

Capacitors

C1	1,000pF disc ceramic
C2	0.022μF polyester
C3	0.01μF disc ceramic
C4	4μF electrolytic, 10 V.Wkg.
C5	220pF ceramic plate
C6	1.8pF tubular ceramic
C7	6.8pF tubular ceramic
VC1	5 or 6pF variable, miniature (see text)

Inductors
L1, L2, L3 See text

Semiconductors

TR1	2N2369A
TR2	2N3708

Socket
SK1 3.5mm jack socket

Miscellaneous
Telescopic aerial type TA 10 (Eagle – see text)
9 volt battery type PP3 (Ever Ready)
Battery connectors
Crystal earphone with 3.5mm. jack plug
2 control knobs
Plain Veroboard, 0.15 in. matrix
Aluminium sheet
Formica
Grommet (see text)
4 rubber feet

circuit via L3. The detected audio signal is developed across R2, whilst C2, R3 and C3 form an r.f. filter. C4 provides a.f. coupling and d.c. blocking. TR2 operates as a straightforward common emitter a.f. amplifier, with R5 as the collector load and R4 as the base biasing resistor.

A certain amount of treble cut is applied in order to compensate for the treble boost given to the signal at the transmitter. The r.f. filter components give a small amount of treble cut and the rest is provided by C6. No output coupling capacitor is required as the receiver is designed for use with a crystal earpiece, which does not allow the passage of direct current. A series coupling capacitor of suitable value would be required if the receiver were coupled to an a.f. amplifier, and this should be positioned at the amplifier end of the screened lead coupling the two units together. There is a very slight possibility that a small amount of v.h.f. signal may still be present in the receiver output. Should this cause any problems in the amplifier a series 2.2kΩ resistor in the non-earthy output lead followed by a 1,000pF ceramic capacitor to earth should be added, these components again being fitted at the amplifier end of the screened cable. But it must be emphasised that the receiver is essentially intended for use with a crystal earphone only, and that it should be initially put into working order with an earphone of this type.

The receiver demodulates by reason of the fact that the received f.m. signal is converted to a.m. on the sloping skirts of the sharp selectivity curve given when regeneration is just below the oscillation point. Because of this method of detection there is a central tuning point for each station received where the signal is applied to the peak of the selectivity curve and is effectively nulled. The signal distorts when the set is tuned next to the central point. The central range over which these effects occur is extremely narrow, and it is not at all difficult to receive the signal properly on either side of it.

The current consumption of the receiver is a mere 2mA, with the result that even a small battery such as the PP3 will have an extremely long life.

The component employed in the VC1 position in the author's receiver is a surplus type which is not generally available. A Jackson Brothers variable capacitor type C804 will fit quite well into the layout, and this capacitor is available with a value of 5pF. Potentiometer VR1 should be a reasonably small component, with a body diameter of 1⅛ in. or less. The 'ceramic plate' capacitor specified for C5 is a miniature low voltage component having a square outline and side wires. A suitable component would be Cat. No. C87N from Home Radio.

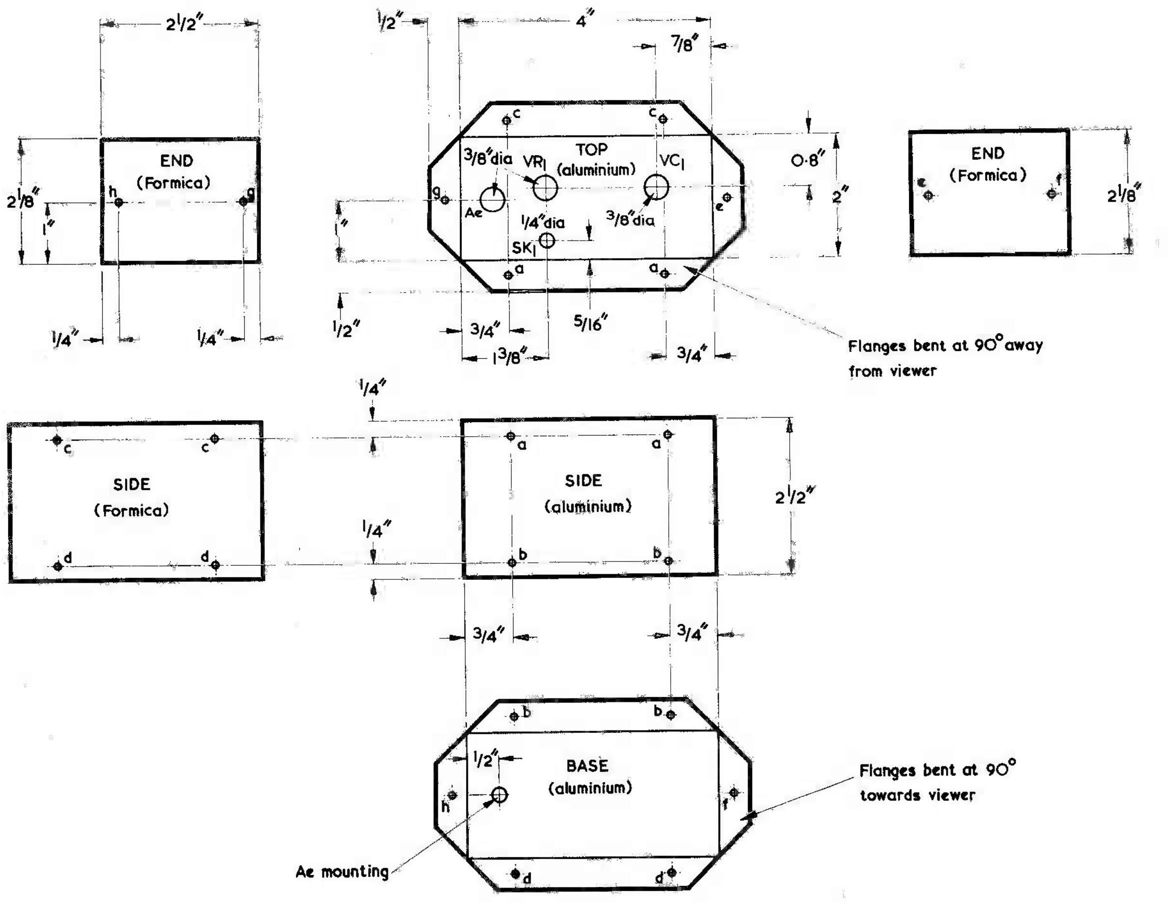


Fig. 2. Details of the parts which make up the case. The panels are aluminium sheet or Formica, as indicated

MAKING THE CASE

The case used to house the receiver is made from aluminium sheet of around 18 s.w.g., and Formica. Fig. 2 shows the individual parts and indicates the manner in which they are assembled together. The case is bolted or screwed together by fastenings which pass through the holes which have the same lettered markings. For example, the two holes marked 'a' on the flange of the top panel correspond with the two holes marked 'a' on the aluminium side.

The top and base panels are each bolted to the aluminium side plate by two $\frac{1}{4}$ in. 6BA bolts and nuts. Thus, all the holes 'a' and 'b' should be drilled out 6BA clearance. The Formica side is secured to the top and base flanges with self-tapping screws. In consequence, holes 'c' and 'd' on the aluminium flanges should be drilled out tapping size for the self-tapping screws and holes 'c' and 'd' in the Formica side should be drilled out clearance size. The two Formica ends are also secured with self-tapping screws, whereupon holes 'e', 'f', 'g' and 'h' are drilled out tapping size in the aluminium flanges and clearance size in the Formica ends. The finished case is quite attractive and is inexpensive to make. With the Formica side and ends removable, there is easy access to the inside. The Formica employed should not, incidentally, be the heat-resistant type. This type of Formica may have a metal shim laminated inside it, and this might conceivably alter receiver performance.

Two points need to be noted concerning the holes in the top panel. It is assumed that the hole for the telescopic aerial requires a diameter of $\frac{3}{8}$ in. It is possible that some aerials may require a hole of different diameter, and this should be checked before drilling the hole. As can be seen from the photographs, the hole accepts a p.v.c. grommet through which the aerial passes. In the prototype the grommet had an inside hole diameter of $\frac{5}{16}$ in. The second point concerning the top panel is that one of the dimensions relating to the holes for VR1 and VC1 bushes is the decimal 0.8 in.; all the remaining dimensions which are not in whole numbers of inches are fractional.

Returning to the telescopic aerial, this has a threaded portion at its bottom which fits into a hole drilled in the aluminium base. The hole is drilled slightly too large and insulating washers are placed over the threaded section of the aerial on each side of the panel. Also, a solder tag is fitted over the threaded section above the upper insulating washer to enable connection to be made to the aerial later. The aerial is positioned so that the threaded section is central in the hole and its mounting nut is then tightened. An ohmmeter or continuity tester is then used to ensure that the aerial is insulated from the aluminium chassis.

Socket SK1 and potentiometer VR1 can be mounted at this stage. VC1 forms part of the main component assembly and is fitted later. Four small rubber feet are mounted on the aluminium base. The holes for the screws which secure these feet in position are not shown in Fig. 2.

COMPONENT ASSEMBLY

All the small components including the coils are mounted on a plain 0.15 in. matrix Veroboard panel. This has 12 by 14 holes. Fig. 3 shows the component side of the panel, together with the connections to VR1,

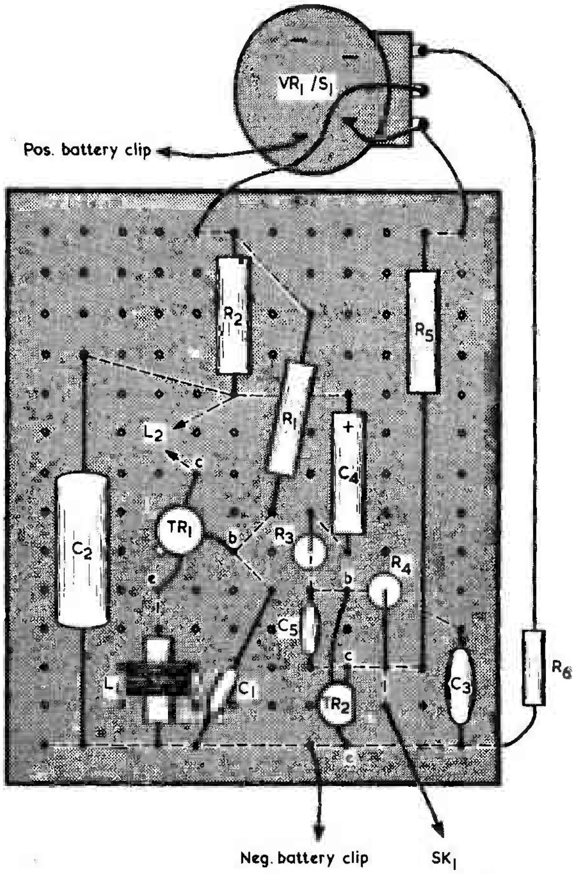
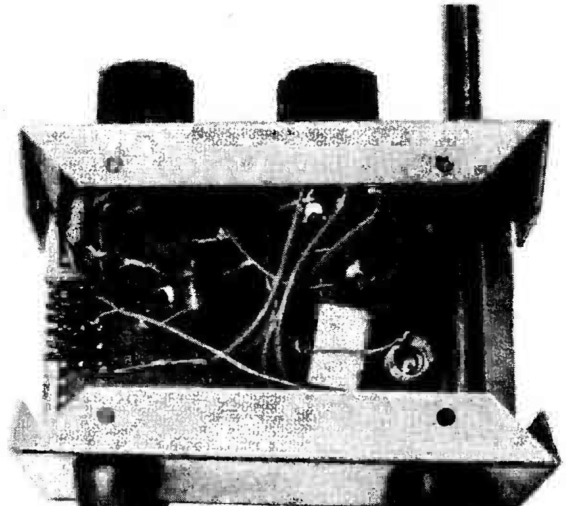


Fig. 3. One side of the component panel, with parts fitted and wired in place



A closer view. Note that the side of the component board on which L2 and L3 are fitted is towards the viewer

S1, SK1 and the battery. The chassis connection to SK1 is given automatically via its mounting bush and nut. The potentiometer switch will very probably be a 2 pole type, and only one pole is needed here. If necessary the appropriate tags can be identified with the aid of a continuity tester or ohmmeter.

The component board is very easy to assemble, the components being mounted in the positions shown with their leads bent over at right angles on the reverse side of the board and then cut to length. The leads are soldered together as indicated by the broken lines in the diagram.

Fig. 4 shows the underside of the board and the additional wiring needed to complete the assembly. A piece of thick tinned copper wire, of around 16 s.w.g., passes along the bottom of the board, and ensures that all the components which run to earth make a good connection. The moving vane tag of VC1 is soldered to this wire, and it is through VC1 that the board is earthed to the aluminium section of the case. This soldered connection also provides the physical mounting for the board.

L2 consists of 6 turns of 16 s.w.g. enamelled copper wire wound on a $\frac{5}{16}$ in. diameter former. It is important that the coil is exactly 6 turns, as if it is even a quarter of a turn out the set will have an incorrect frequency coverage. Initially, the coil is given a length of 0.6 in. It has a centre tap for the collector of TR1. Any round object of the required diameter can be used for the former, and this is removed after the coil has been wound and the centre tap point has been scraped clean of enamel and tinned, ready for connection. The ends of the coil are also, of course, scraped clean and tinned before connection. These ends are positioned and soldered in the manner shown in Fig. 4. The lead from the junction of L2 and C7 to the fixed vanes tag of VC1 should be kept reasonably short.

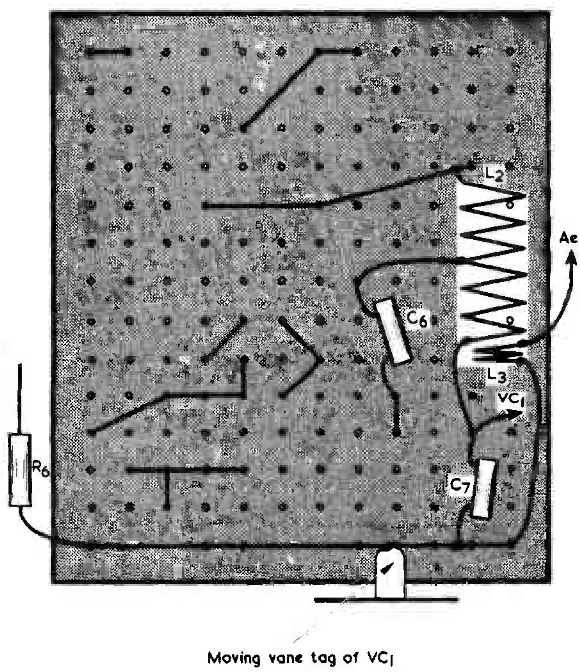
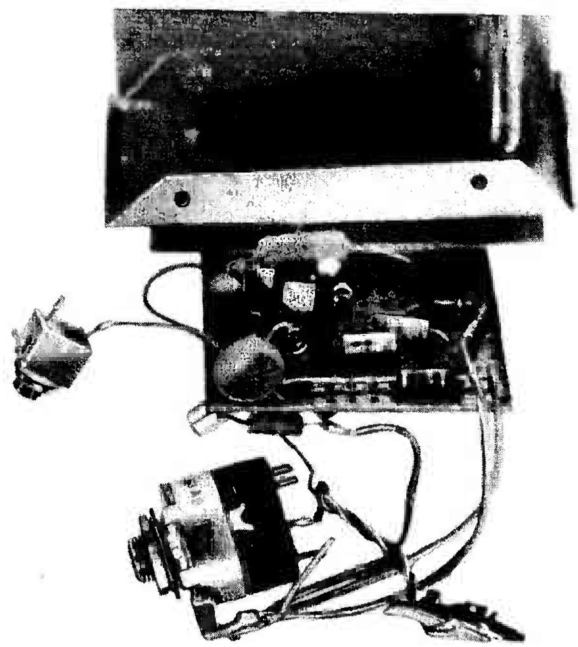


Fig. 4. The other side of the panel, on which are fitted C6, C7, L2 and L3



The component board removed from the case. The tuning capacitor is below the board and was a little out of position when this photograph was taken

L3 is merely two turns of wire, again with an inside diameter of $\frac{5}{16}$ in., which are wound in the lead which travels from aerial to earth. When the component board is mounted, this lead runs across the surface of the board. The wire is ordinary p.v.c. covered connecting wire with a single core for stiffness. The turns are closely wound and the coil is pushed close up to the end of L2, as illustrated.

L1 is wound on a 100kΩ $\frac{1}{4}$ watt 10% or 20% resistor, and consists of 40 turns of enamelled or rayon covered wire of around 34 s.w.g. The coil is scramble-wound and its ends are anchored by being soldered to the lead-outs of the resistor. The resistor lead-outs also provide a convenient means of connection to the coil. (Do not use a 5% resistor here. Close tolerance carbon composition resistors are occasionally subjected to a 'copper spray' at the factory, and this constitutes a short-circuited turn. – Editor.)

VC1 may now be fitted, whereupon the component board takes up the position shown in the photographs of the interior of the receiver. The battery fits in the space between the component board and the aerial. It is secured in position when the Formica side panel is screwed on. If necessary, a piece of plastic foam may be fitted between the panel and the battery to hold it securely.

RECEIVER OPERATION

With the prototype it was found necessary to have the telescopic aerial fully extended for best results. It is therefore not recommended that an aerial be used which is shorter than that specified. This has an extended length of 120 cm.

With the set turned on and VR1 advanced slightly, background noise should be heard in the earphone. If VR1 is advanced further a point will be reached where the noise suddenly becomes greatly diminished. Any further advancement of VR1 will probably cause an extremely loud hissing noise to be heard. The set is at its most sensitive when VR1 is adjusted to the point where background noise is just beginning to be diminished. *When the set is in use, VR1 should not be advanced beyond this point as this will cause the set to oscillate and radiate interference.* When the receiver is actually tuned to a station it is easy to accidentally turn VR1 too far, and this may not be noticed because the first stage of the set will then be operating as a super-regenerative detector. *Great care should therefore be exercised when tuning the receiver.*

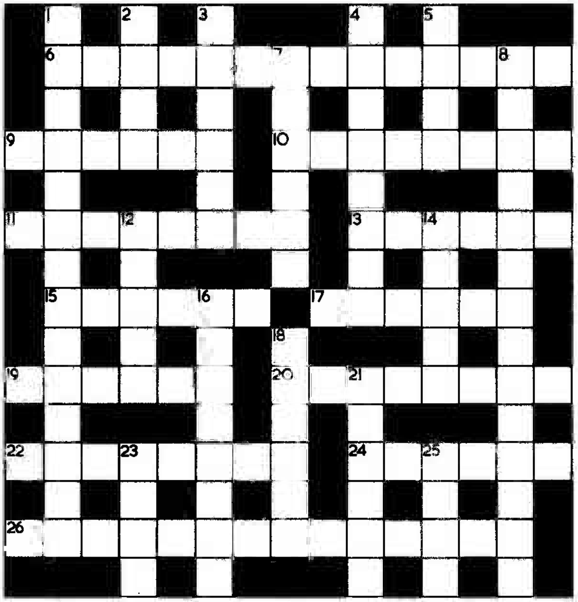
It may be found that the receiver does not quite cover the desired range, making it impossible to tune in all three main B.B.C. stations. In such a case a little experimental alteration of the inductance of L2 by either stretching or compressing the winding should put matters right. However, if L2 is made accurately in the first place subsequent adjustment of its inductance should not normally be necessary.

With the prototype, Radios 2, 3 and 4 can all be received with good volume and quality, and with a reasonably low noise level. In the author's area there is no local radio station, but signals from the Radio Medway transmitter were just perceptible above the noise level of the receiver.

ALTERNATIVE AERIAL

Since the B.B.C. uses horizontally polarised signals and the receiver has a vertical aerial, the author tried the effect of a swivel base telescopic aerial, since this could be oriented to a 45° position or to the horizontal position. This gave quite a large increase in sensitivity, and tuning and regeneration adjustments became less critical. Since the author lives in a fairly good reception area the modification has relatively little advantage to him, as the volume level and signal-to-noise ratio were not much different. However, the point is mentioned because, in a poorer reception area, the use of a swivel base telescopic aerial would probably give an improvement that is more worth-while. The aerial is fitted to an insulated mounting at the top of the case and should have an extended length of around 40 in. or more. A 40¼ in. swivel jointed aerial appears in the Henry's Radio catalogue under Type No. TA12A.

CONSTRUCTOR'S CROSSWORD



Across

6. Evident in the mains transformer secondary. (7,7)
9. Jacket appendage for disc or wire. (6)
10. Describes the 0-V-1 receiver. (3,5)
11. Two Morse transmissions could produce these. (1,1,1,5)
13. Electromagnetic C.G.S. unit of e.m.f. (6)
15. Bring to light. (6)
17. The Greeks had a word for wavelength. (6)
19. Units of the light type of flux. (6)
20. Is solved, break up! (8)
22. He who instigates transistor amplification mode? (8)
24. Figures with four equal sides. (6)
26. Less Roy's thesis, this simply adds up to transformer waste. (10,4)

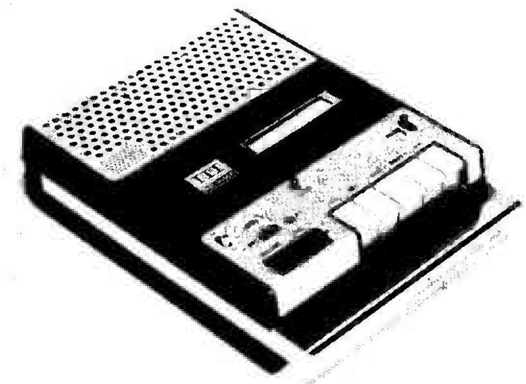
Down

1. In British TV this is 50Hz. (5,9)
2. Non-active home of Wharfedale. (4)
3. You can expect the series tuned circuit to do this. (6)
4. Robots. (8)
5. With a triangle, half the base times the height. (4)
7. Hate and remove meter check? (6)
8. B9A bottom. (5,5,4)
12. One is shattered to give unwanted sound. (5)
14. Can precede 'tron' or 'massage'. (5)
16. Doubtful sinecure, not very safe. (8)
18. Decks. (6)
21. Accent in a distressing circumstance. (6)
23. Surprising that a quartz crystal should be this resonant! (4)
25. Musical radar system. (4)

(Solution on page 361.)

NEWS . . . AND .

INTEGRAL MICROPHONE TAPE RECORDER



ITT's new Studio 60M tape recorder, with its highly sensitive integral microphone allied to the important back-up of Automatic Recording Level Control, is a superb addition to the cassette recorder field and will certainly rate among the most popular of battery-or-mains portable recorders so far marketed.

Handsome in its black-and-silver styling, the Studio 60M is nevertheless far from being just a pretty face, since the quality of its sound reproduction is impressively high, whether heard through its own wide-range speaker, through headphones, or extension speakers. Yet although ideal for the expert user, with its separate circuits for ferroxide tapes and the new 'chrome' variety, and choice of auto or manual recording level control by flicking a switch, it is also great for the novice. Simple in operation, it even switches off automatically as the tape ends, with an indicator light switching on to show it has done so!

Automatic recording level control in the Studio 60M is uncannily accurate, so manual control is seldom needed. With the silent-running recorder switched on, the highs and lows of sound volume it captures on tape are automatically balanced, making the new model exceptionally useful.

ELECTRONIC AID TO ENABLE DUMB TO COMMUNICATE

About five years ago, at the age of 21, Toby Churchill a qualified mechanical engineer working for Lucas – contracted an unidentified virus disease which left him with a number of disabilities. These included a complete loss of the power of speech and a paralysed right arm.

He conceived the idea of a portable electronic device which would enable him to communicate with others easily and set about the task of putting his idea into practice. After reviewing the electronic components available, he knew that his ideas were not just a pipe dream but a practical possibility. The Engineering Department at Cambridge University heard of Toby's ideas and agreed that they would form the basis of a worthwhile project.

Very quickly the ideas became reality. A typewriter-like keyboard was coupled to a Burroughs 'self-scan' display system. Circuits were designed to allow the unit to be powered from rechargeable batteries.

Toby now talks to people using the keyboard: the letters, words and numerals appear in a very easily-read form on the self-scan display panel.

A number of people assisted with the development of the unit – which has been called the Lightwriter – in many different ways. Burroughs, keyboard manufacturers, Cambridge University and Burroughs' UK agents, Walmore Electronics Ltd., all played their parts.

As a result of pressure from friends and aquaintances with similar disabilities, a company – Toby Churchill Ltd. – has been set up to manufacture the Lightwriter. The company has financial backing and production facilities, and it is expected that the first unit will become available in the first half of 1974.

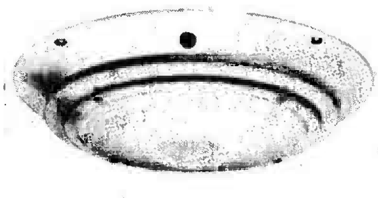
The heart of the Lightwriter is the self-scan display panel which is manufactured by Burroughs Corporation in America and available through the UK agents, Walmore Electronics Ltd.

SLIMLINE CEILING SPEAKER

The new FF.22 Ceiling Speaker from Eagle International achieves a remarkably low profile of only 70mm using an inverted magnet speaker. This slim surface mounting unit requires no cutting or recessing, minimising installation problems and harmonising equally well with new or existing architecture.

The 165mm diameter speaker provides a high standard of clarity and definition. Its power handling of 8 watts continuous rating affords adequate capacity for use in hotels, supermarkets, hospitals, garages and similar locations.

An important safety feature of the FF.22 is its finish, in stove enamelled metal, which eliminates fire risk. The unit has a frequency range of 60 – 14000Hz with 8 ohms impedance. Dimensions: 235 × 50mm.



EAGLE INTERNATIONAL FF22. Ceiling speaker. Surface-mounting for really low profile (only 70mm) and very easy installation. Excellent clarity and definition. Power handling: 8 ohms. Continuous rating. R.R.P. £5.25 + VAT.

. . . COMMENT

NORWICH OBSERVATORY

In this electronic age, it is difficult to draw a line between where one science ends and another begins, each discipline runs into another. We feel justified therefore in giving some details of the observatory being built by members of the Norwich Astronomical Society, particularly as regular observations are already being carried out by one of its members on sunspot activity, and it is planned to put into operation a Solar Noise Recording installation operating on 136MHz, to correlate visual sunspot observation with radio observations.

The new observatory is located on a fine site overlooking and leased from the University of East Anglia.

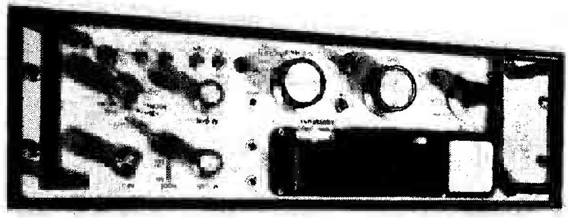
There will be two telescopes, the 10 inch telescope, from the Society's old site which is now unusable because of electrical interference, and a completely new telescope of 30 inch aperture to be housed in a dome of quite original design.

The electronic equipment includes frequency controlled synchronous drive for the 10 inch telescope, which will be a pilot scheme for the drive on the 30 inch telescope and for which it will be uprated, and electronic safety interlocks between domes and telescope drives so that neither will over-run.

The 200 or so members are working very hard on the project, labouring, bricklaying etc., and on fund raising schemes.

Readers are reminded that under the terms of the Wireless Telegraphy Act 1949, it is an offence within the U.K., to operate any transmitting apparatus except in accordance with the conditions of a Licence issued by the Minister of Posts and Telecommunications.

HIGH STABILITY DIGITAL DISPLAY RECEIVER



A new full-facility digital display communications receiver, providing frequency read-out to an accuracy of one Hertz in the high frequency bands at a lower price, it is claimed, than any comparable British receiver, is announced by Eddystone Radio, a GEC-Marconi Electronics company.

The new receiver, the EC958/7, is the latest version of the highly successful EC958 series of solid-state general purpose communications receivers, orders for nearly 1500 of which have been received from a wide variety of users throughout the world.

The EC958/7 incorporates all the facilities of the standard EC958, although many of the operating parameters have been improved. It provides frequency coverage from 10kHz to 30MHz in a continuous sweep which, coupled with its frequency stability and rugged construction, makes it well suited for a wide range of applications in fixed, mobile and maritime services.

The key to its high performance is the easy-to-operate tuning system. Using only the main tuning control and range switch the EC958/7 can be continuously tuned over the entire frequency range.

IN BRIEF

■ Coastal Radio Ltd., a Marconi Marine company, is featuring a wide range of communications equipment, echosounders, television and intercom. equipment at the International Boat Show, Earls Court.

■ Described by Howard Kornstein of Data Applications International Ltd., as a 'hands on' event, 23 of this country's leading design specialists attended an exclusive three-day microcomputer workshop session at London's Central Polytechnic recently.

■ Mr. G. R. Jessop, C.Eng., M.I.E.R.E., G6JP has been elected President of The Radio Society of Great Britain for 1974.

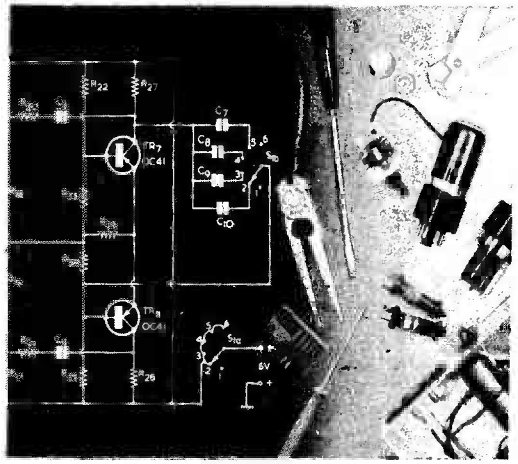
■ The Fourth European Microwave Conference is to be held in conjunction with the Microwave 74 exhibition in Montreux in September.

■ The BBC's regional TV centre at Plymouth is being up-dated for colour broadcasting, and will be the Corporation's first studio to operate EMI's latest colour TV camera, type '2005'.

■ Chinaglia (pronounced key-na-glia) (U.K.) Ltd., of 19 Mulberry Walk, London, S.W.3. have announced a low cost quality range of test equipment now available in this country. One of the range is the 'Cortina' multimeter priced at £15.90.

"Congratulations, you have a fine stereophonic set!"

FURTHER COUNTING CIRCUITS



by G. A. FRENCH

LAST MONTH'S ARTICLE IN THE 'Suggested Circuit' series was devoted to two circuits incorporating a Post Office electromagnetic counter. The type of counter employed presents numbers running from 0000 to 9999 and does not have a zero re-set. In consequence, the number displayed at the start of a counting operation has to be noted and then subtracted from the number which appears at the end of the operation. The counter mechanism is such that on applying a voltage to its coil an armature is energised, causing an operating pawl to move over one tooth of a ratchet wheel coupled to the 'units' digit wheel. When this voltage is removed the armature releases, moving the 'units' digit wheel on to the next figure. The 'units' digit wheel is coupled to 'tens', 'hundreds' and 'thousands' digit wheels by gearing similar to that encountered in a car mileometer. A more detailed description of counter operation was given in the previous article.

Electromagnetic counters of this type are available with various coil resistances. The type employed in the author's circuits has a coil resistance of 2,300Ω, and is obtainable from Henry's Radio Ltd., by whom it is listed as Type 14B. Operating voltage is of the order of 80 to 100 volts.

Two further counting circuits will be described in the present article.

1-SECOND COUNTER

The first application to be discussed is one in which the electromagnetic counter is employed in a 1-second counting circuit. In this circuit the counter passes through one energise and release cycle every second, with the result that it counts the number of seconds elapsing from the moment of turning on the counting circuit. The counter may, as a result, be employed as an 'electronic stopwatch', as a timer for photographic and production processes, or as a timer for sporting events and similar applications. Its timing precision will not be as high as that of an escapement operated mechanism, but a surprisingly high degree of accuracy will nevertheless be given provided care is taken in the selection of the timing components.

The circuit of the 1-second counter is given in Fig. 1. In this diagram the electromagnetic counter is operated by way of TR3, a high voltage power transistor type MJE340, in the same manner as occurred in one of last month's circuits. The 125–0–125 volt secondary of transformer T1 couples to the full-wave rectifier circuit given by D4 and D5, and the unsmoothed rectified half-cycles are fed via voltage dropping resistor R7 to the coil of the electromagnetic counter. The armature of this counter energises when TR3 turns on, and releases when TR3 cuts off, and there is no necessity for any smoothing capacitors in this part of the circuit. Diode D3 prevents the appearance of high back e.m.f's in the counter coil when TR3 cuts off. The mains transformer is an R.S. Components product described as a 'Midget Mains 250 volt' transformer.

The 1-second timing circuit proper consists of the multivibrator incorporating TR1 and TR2, and this runs at a frequency of 1 cycle per second. TR1 and TR2 are germanium rather than silicon transistors because the more commonly encountered silicon devices have reverse base-emitter voltage ratings which are too low to enable them to be employed in simple multivibrators. The supply for the multivibrator is obtained from the rectifiers D4 and D5 and is passed, via R6 and zener diode D1, to the second zener diode, D2. The stabilized voltage across D2 is smoothed by C3 and is then applied to the multivibrator. The multivibrator period is controlled by C1, C2, R2, VR1 and R3, and the transistors are turned on, within the multivibrator cycle, for roughly equal lengths of time. When TR2 turns on, its collector current flows by way of R4 into the base of TR3, thereby turning this transistor on also and energising the counter armature. When TR2 turns off, so also does TR3, and the counter armature releases.

The counting operation is controlled by S1(a)(b). The circuit is initially switched on by means of S2 with S1(a)(b) being in the 'Stop' position, as shown in Fig. 1. Section S1(b) of the switch short-circuits the base of TR3 to chassis. If this is not done, the process of switching on at S2 can cause a momentary base current to flow in TR3 as the capacitors in the multivibrator settle down to their charged conditions. As a result, the counter may energise and produce a false increase of

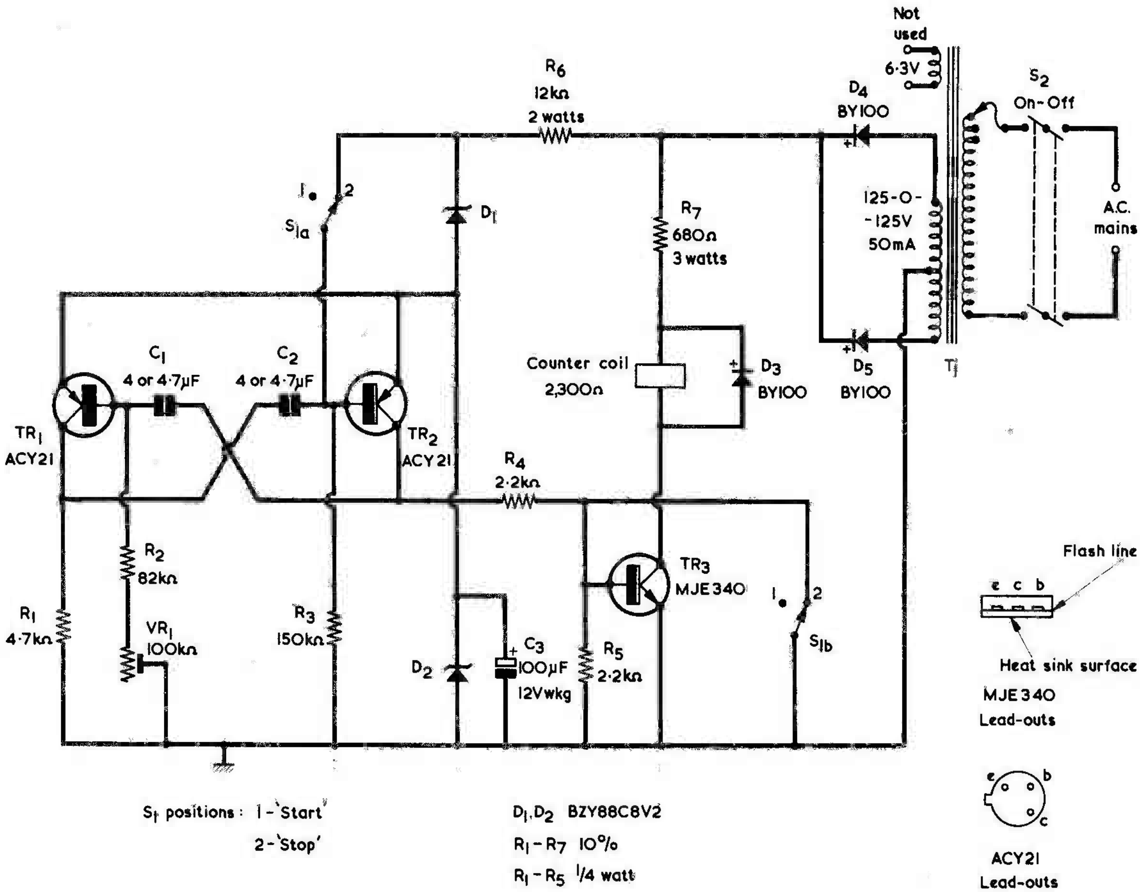


Fig. 1. A 1-second counting circuit. The counter indicates the number of seconds elapsing from the instant of setting switch S1 to 'Start'

1 in the number displayed. Section S1(a) connects the base of TR1 to the upper terminal of zener diode D1. The zener diodes are both rated at 8.2 volts, with the consequence that the base of TR2 is taken positive of its emitter by this voltage.

Immediately after switching on at S2, therefore, there is a very short period during which C1 and C2 take up their charges, after which TR1 is turned on, with TR2 cut off. The supply voltage fed to the upper terminal of D1 consists of unsmoothed rectified half-cycles but C2, which connects to this terminal via S1(a), is still capable of charging to their peak value. This peak value is the zener voltage of the diode.

When S1(a)(b) is set to 'Start', section S1(b) removes the short-circuit between the base of TR3 and chassis, whilst section S1(a) disconnects the base of TR2 from the upper terminal of D1. At this instant C1 is charged to the full voltage across zener diode D2, less the very small forward base-emitter voltage drop in TR1, whilst C2 is charged to the full voltage across zener diode D1 plus the very small saturation voltage across TR1. Since D1 and D2 are rated at the same voltage, the voltage across the capacitors are very nearly equal. C2 now commences to discharge via R3 until a moment is reached when base current starts to flow in TR2. Multivibrator action takes place, TR2 comes hard on, thereby turning on TR3 and energising the counter, and TR1 cuts off. The base of TR1 is now held positive of its emitter, due to the charged capacitor C1, by a voltage approximately equal to D2 zener voltage. C1 discharges by way of R2 and VR1 until current flows into TR1 base. Again multivibrator action occurs, with TR1 coming on and TR2 turning off. TR3 also turns off, the counter armature releases, and the counter number displayed increases by 1. At this instant the base of TR2 is taken positive of its emitter by a voltage approximately equal to the zener voltage of D2 due to the charged capacitor C2. C2 now starts to discharge into R3 and a second multivibrator cycle commences.

This detailed description of multivibrator operation has been given in order that the function of S1(a)(b) can be more readily explained. It will now be seen that, when section S1(a) of this switch is set to 'Start', the multivibrator is in exactly the same state as it will be in the later multivibrator cycles immediately after turn-on in TR2. Because of this, the first cycle of the multivibrator has the same length as all succeeding cycles. If the multivibrator were started by simply applying power to it there would be one or more cycles of incorrect length before it settled down to its proper speed.

If desired, S1(a) could be replaced by a break contact set on a relay coupled such that it was automatically energised during a process being timed. Section S1(b) would be retained as a single-pole switch in the unit, whereupon the latter would be brought into action by first switching on at S2 and then putting S1(b) to the 'Start' position. The counter would then subsequently indicate the number of seconds during which the process-controlled relay was energised.

For optimum timing accuracy, R2 and R3 should be high stability (or wire-wound) components, and VR1 should be a wire-wound potentiometer. C1 and C2 may be 4 or 4.7µF non-electrolytic capacitors. There is no point in employing close-tolerance components here as these would still necessitate a variable control for final fine setting up. In consequence, it is recommended that normal wide-tolerance parts be used, with the setting up control having a wide range. There is a possibility that this approach may result in the required multivibrator frequency of 1 cycle per second being outside the range of VR1. Should this occur it is merely necessary to increase the value of R2 if it is desired to lengthen the multivibrator cycle, or to reduce the value of R2 in order to shorten the cycle. Increasing or decreasing the value of R3 will have a similar effect.

The adjustment of VR1 is not particularly tedious, although a little patience is required. Setting up is carried out with the aid of a watch having a second hand. Initially, VR1 is roughly set up for a count of 15 in 15 seconds, after which increasingly fine adjustments can be made for a count of 30 in 30 seconds and then for 60 in 60 seconds. Final setting up should always be against 60 seconds, or a multiple of 60 seconds, as this ensures that any slight inaccuracies in watch scale calibration which may be present cannot affect the results. The setting up should be undertaken quite some time after the unit has been assembled, to allow the components which directly control the multivibrator frequency to settle down to normal after the thermal stress given by soldering.

Dissipation in TR3 is very small, because this transistor is either fully cut off or is hard on with a very low voltage across it and because there is a rapid transition from one condition to the other. In the prototype circuit, the author mounted TR3 on a small flat heat sink measuring ½ in. by 1½ in., and it ran quite cool. The heat sink is insulated from chassis and must not be touched when the unit is switched on because it is common with the collector of the transistor and has a relatively high voltage on it over half the multivibrator cycle. The transistor is secured to the heat sink with a 6BA bolt and nut.

Rectifiers D3, D4 and D5 are shown in Fig. 1 as type BY100. However, any other silicon rectifiers may be employed here provided that they are rated at 0.5 amp or more and have a p.i.v. of at least 350 volts. Care must be taken to connect D3 into circuit with correct polarity, as there might otherwise be damage to transformer T1.

LIGHT OPERATED COUNTER

Another counting circuit is illustrated in Fig. 2. In this circuit the number displayed by the electromagnetic counter increases by 1 each time a light beam is broken. It may be used to count objects passing along a production line and for similar applications. Speed of operation is limited only by the speed of the electromagnetic counter.

The power supply circuitry and that

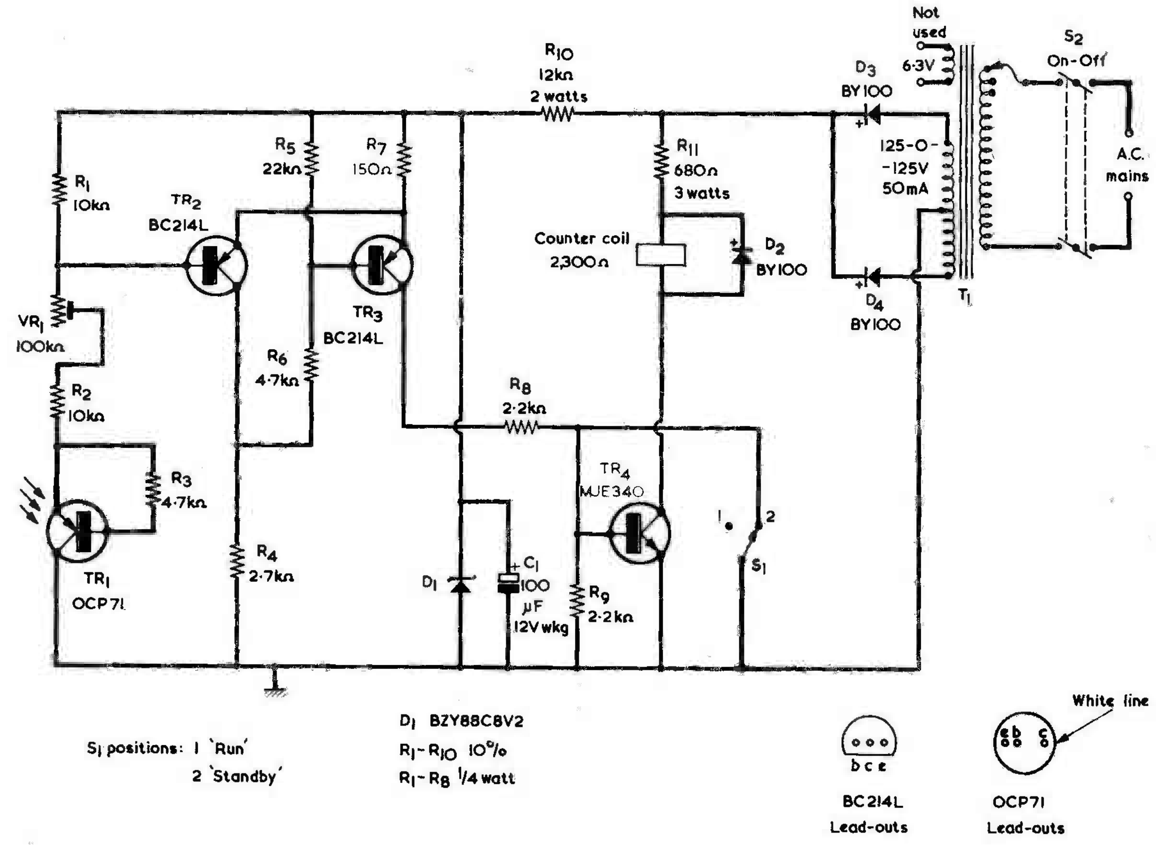


Fig. 2. A light operated counter. This indicates the number of times a light beam, incident upon the OCP71, is interrupted

immediately associated with the MJE-340, which now appears as TR4, are the same and use the same components as occurred with Fig. 1. Switch S1 now carries out the function which was previously undertaken by S1(b); it short-circuits the base of the MJE340 to chassis to eliminate possible spurious counts immediately after switching on at S2. The MJE340 is again fitted on a ½ by 1½ in. heat sink and, as before, the counter armature energises when current flows into the MJE340 base. The armature releases when the MJE340 base current ceases.

The photo-sensitive device which detects the breaking of the light beam is the phototransistor TR1, this being an OCP71. When connected in the manner illustrated, it exhibits a collector current which becomes larger as the intensity of the light incident upon it increases. It is convenient to look upon the behaviour of the OCP71 as being reminiscent of that of a cadmium sulphide photoconductive cell, the resistance of which decreases as light intensity increases. The OCP71 requires a higher level of light intensity for operation in a circuit of the present type, but this may be readily provided by means of a cheap convex lens. The lens offers the incidental advantage of making the operation of the OCP71 highly directional, and thereby less likely to be affected by changes in ambient light level. The speed of effective 'resistance' change in the OCP71 resulting from variations in illumination intensity is very much greater than is given by a cadmium sulphide cell.

It is necessary for a trigger circuit to appear between the phototransistor and the MJE340 in order to ensure that the latter changes rapidly from the cut off to the hard on state, and vice versa, following changes in phototransistor illumination. This will ensure conditions of minimum power dissipation in the MJE340. The trigger circuit employed here is the Schmitt trigger incorporating TR2 and TR3. This is powered by the stabilized voltage across zener diode D1.

We may now examine the chain of events which follows the illumination and non-illumination of the OCP71, and we shall assume that VR1 has previously been set up to a position which is correct for the particular level of OCP71 illumination to be employed. (The process of setting up VR1 is described later.) The OCP71 is illuminated by a beam of light and, in consequence, exhibits a low effective 'resistance'. Because of this, a sufficiently high base current flows in TR2 to turn this transistor on, whereupon the complementary transistor in the Schmitt trigger, TR3, is turned off. As a result, no collector current flows in R8, and TR4 is also turned off. Under these conditions the armature of the electromagnetic counter is in the released position.

An opaque object passes through the light beam, whereupon TR1 immediately exhibits a high effective 'resistance'. The voltage at the base of TR2 now goes sufficiently positive for this transistor to become cut off, allowing the complementary transistor, TR3, to turn on. The collector current of TR3 flows via R8 into the base of TR4, thereby turning this transistor on also, and causing the armature of the electromagnetic counter to move to the energised position.

As soon as the opaque object has passed through the beam of light TR1 becomes illuminated once more. TR1 at once presents a low effective 'resistance', turning TR2 back on and thereby cutting off TR3. The base current in TR4 ceases and this transistor similarly cuts off, releasing the armature of the electromagnetic counter. The latter returns to its released position and, in so doing, causes the number displayed to increase by 1.

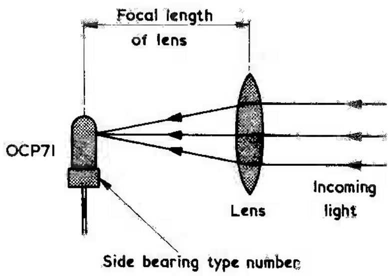


Fig. 3. A simple lens system is required with the OCP71 to provide a sufficiently high illumination level

As was just mentioned, the OCP71 needs to be illuminated by way of a lens, and Fig. 3 illustrates the simple arrangement that is required here. The most sensitive area of the OCP71 is about a third of the way down from the top of the translucent section, with the side bearing the type number towards the source of illumination. The plane through the three OCP71 lead-outs is at right angles to the surface of the paper. The lens can be taken from any small cheap 'magnifying glass' and it is positioned away from the OCP71 by a distance equal to its focal length. This focal length can be determined previously by holding the lens between an electric light bulb and a sheet of paper. When a clear image of the bulb is visible on the paper, the distance between the paper and the lens is the focal length.

The OCP71 should be fitted in a light-proof box with the lens mounted at one end. It is desirable to have a removable side to the box so that it can be aligned correctly on to the source of light. Correct alignment is given when the area of focussed light is clearly seen on the phototransistor body. The phototransistor, with R3, may be positioned some distance away from the other components, being coupled to them by way of a 2-core lead. Care should be taken to see that it is connected into circuit with correct polarity.

The source of light depends upon the particular application. The author checked the prototype circuit with the aid of a 100 watt electric light bulb positioned about 6 ft. away from the lens and the phototransistor. There was no lens or reflector at the bulb, and this method of illumination may be employed by the constructor when initially trying out the circuit. Passing a hand, or any other object, between the bulb and the phototransistor lens will then cause the counter to operate. If desired, more specialised sources of light beam incorporating a lens and/or reflector may be employed later. The wattage required for a bulb having a lens or reflector will be much smaller than 100 watts. Also, reduced wattage in the bulb will be required if the distance between the bulb and the lens is significantly less than 6 ft.

When the circuit has been assembled and a suitable light source and lens for the OCP71 has been provided, the unit may be switched on at S2, and S1 set to the 'Run' position. VR1 is next set up. The phototransistor is suitably illuminated and VR1 adjusted to insert minimum resistance into circuit. Under these conditions, and if the OCP71 illumination is sufficient, the electromagnetic counter armature should be in the released position. It is helpful, here, to have the cover of the counter removed so that the position of the armature can be checked visually. VR1 is adjusted to insert increasing resistance until the armature of the counter suddenly energises. VR1 is then adjusted in the reverse position, i.e. to decrease the resistance it inserts into circuit, until the armature releases. VR1 is adjusted a little further in the reverse direction so as to take circuit operation reliably outside the hysteresis range of the Schmitt trigger, and setting up is then complete. Reliable operation of the counter should be given each time the light beam is interrupted. The final setting required in VR1 is not critical.

In use, the unit is switched on at S2, with S1 in the 'Stand By' position. A useful plan, with respect to S2, is to have it control the illuminating bulb as well, whereupon this can be fed from the two a.c. mains points following the switch. Switch S1 is next set to 'Run' and the instrument is ready to start counting.

A final few words are required in order to explain the presence of R2 in series with the phototransistor. This is a current limiting resistor, and it ensures that there is not excessive dissipation in the phototransistor when VR1 is set to insert minimum resistance into circuit. If R2 were omitted, a high current could flow through the base-emitter junction of TR2 and R7, and the phototransistor could be damaged as a result. ■

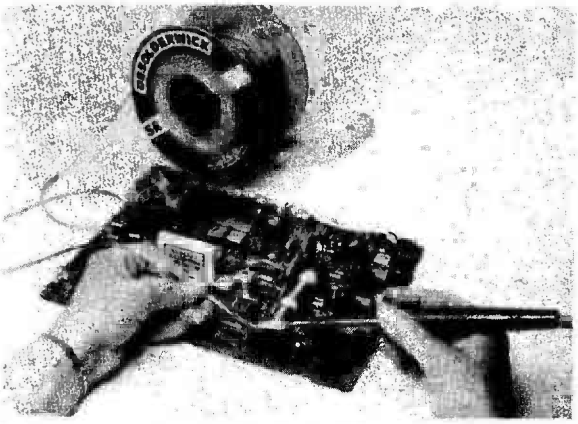
New Products for the Workshop

SOLDER-ABSORBING WICK

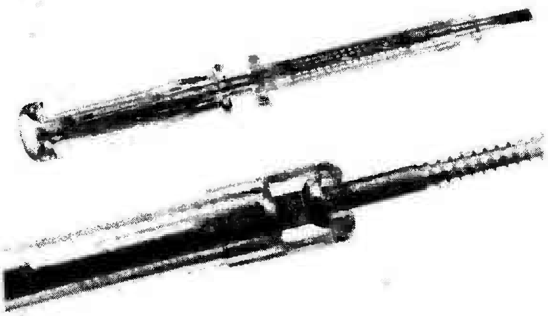
New DESOLDERWICK is the low cost solution to rapid desoldering of all types of joints for quality repair. Hot solder is mopped up by capillary attraction to leave a joint completely clear of solder – ready for immediate corrective resoldering. It is non-corrosive, dry fluxing.

DESOLDERWICK is useful to every solderer. With just a standard soldering iron, an operator can desolder safely without special training. Every production assembly sector can deal with its own rework – simply, economically and without disturbing routine soldering operations. Desoldering requires no preparation, jigs or post cleaning and, of course, is completely maintenance-free.

DESOLDERWICK is available in 4 widths; on convenient standard reels for production lines, servicing departments and laboratories, and in zip Pocket Packs for the field engineer, hobbyist and D.I.Y. enthusiast. Further details from:- Orientation Ltd., Coverack, Cornwall.



SCREW HOLDING SCREWDRIVERS



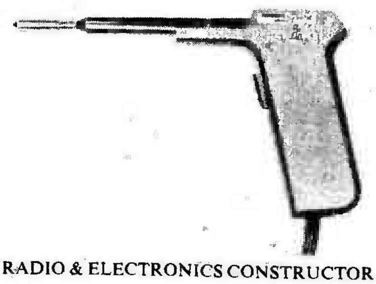
Thunder Screw Anchors Ltd. of Victoria Way, Burgess Hill, Sussex, announce an addition to their range of screwdrivers by the introduction of four screwholding screwdrivers. Two are suitable for slotted head screws and two for recessed head screws, their dimensions being 8½″ and 9¼″ overall length, 3/16″ and ¼″ blade diameter respectively. The screw is firmly held at the tip of the screwdriver by sliding the spring loaded shank over the head of the screw, leaving one hand free to hold the article to be fixed. It is possible to fix screws in the most difficult of places, where to hold a screw in the hand might normally be impossible. The screwdrivers are individually carded and the recommended retail prices excluding V.A.T. are 20372 and 20376 69p each, 20374 and 20378 79p each.

SOLDERING GUN FROM THE CONTINENT

Greenwood Electronics have signed a reciprocal distribution agreement with ERSA – Europe's number one manufacturer of soldering irons, under the agreement Greenwood will have exclusive selling rights for the UK.

One of the ERSA products is the SPRINT soldering gun. At only 6 ounces the Sprint is the lightest gun available on the UK market. The compact construction and light weight will enable the service engineer to manoeuvre the gun in the most awkward areas. It is 80W–150W and has two heating elements in series which heat-up to maximum temperature in less than 10 seconds. The Sprint will sell at £5.75.

Details of the ERSA range are available from Greenwood Electronics, 21 Germain Street, Chesham, Bucks HP5 1LL.



UNIJUNCTION SIGNAL INJECTOR

by P. T. Jenkins

A low-cost unit which aids transistor servicing

THIS LITTLE DEVICE CAN BE ASSEMBLED IN LESS THAN an hour and it requires only one capacitor, three resistors, a unijunction transistor and a coil made up with thin connecting wire. When this coil is held in line with the ferrite rod aerial of any medium and long wave superhet radio a loud tone at about 700Hz is heard over all of both bands. The coil is positioned outside the receiver case and no direct connection to the receiver is required.

CIRCUIT OPERATION

The circuit of the signal injector is given in Fig. 1. TR1 is a unijunction transistor type 2N2646 and it runs as a relaxation oscillator. At the instant of applying the 9 volt supply capacitor C1 is discharged, and the semiconductor material between base 1 and base 2 inside TR1 acts as a resistor. C1 commences to charge by way of R1, whereupon the voltage on the unijunction emitter starts to go positive. When this voltage reaches triggering level the unijunction transistor exhibits a negative resistance effect between its emitter and base 1, causing C1 to discharge rapidly into R3 and the injector coil. The unijunction transistor then reverts to its previous state, C1 commences to charge once more via R1, and another cycle commences.

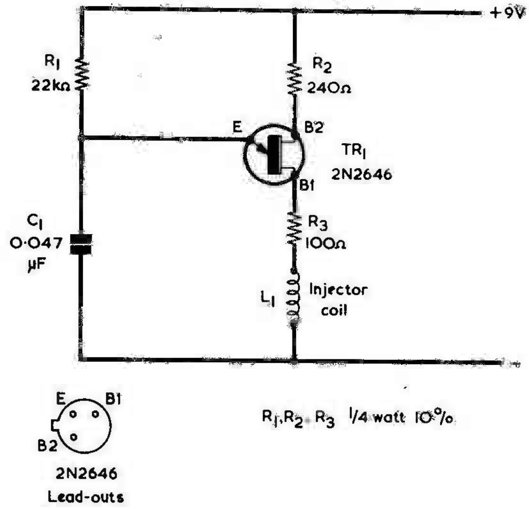


Fig. 1. Very few components are required for this servicing aid

With the values shown for R1 and C1, the oscillator repetition frequency is around 700Hz. The pulses in R3 and the injector coil are extremely short and have a peak amplitude of around 25 to 30mA. Since they are present for only a very short period inside each cycle the average current drawn from the 9 volt battery is low, being a mere 1.5mA. There is no need to wire a bypass capacitor across the supply rails because the pulse currents flow in the loop given by C1, the emitter and base 1 of TR1, R3 and the injector coil. Operation was unaltered with the writer's unit when a 33Ω resistor was experimentally inserted in series with the positive battery input.

Because of their steep fronts, the pulses produce an exceptionally wide band of harmonics, these extending well above the medium wave band. The harmonics are, of course, all modulated at the fundamental frequency. When the pulses are inductively coupled into the ferrite rod aerial of a receiver the fundamental frequency is then heard from the speaker at all points in the medium and long wave bands.

INJECTOR COIL

The injector coil consists of 20 to 25 turns of p.v.c. covered connecting wire in an open coil of about 3½ in. diameter, as in Fig. 2. The number of turns and the dimensions are not critical. The coil can be made self-supporting by wrapping tape around it, and it couples to the remainder of the circuit by about 18 in. of twin

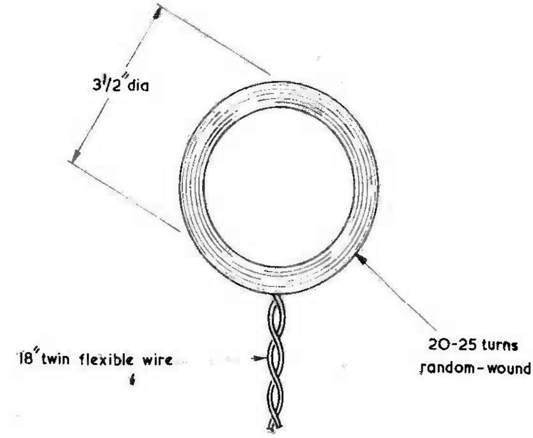


Fig. 2. The injector coil is wound with ordinary connecting wire

flexible wire. To inject a signal into a radio, the injector coil is held, outside the case of the radio, in line with the ferrite rod aerial, as shown in Fig. 3. A little experimenting with several receivers will soon give an idea of performance.

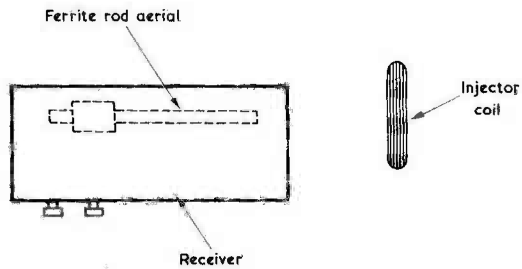


Fig. 3. Maximum signal injection is given when the injector coil is in line with the ferrite rod aerial inside the receiver case

The signal injector is useful in servicing as it enables a quick check of overall sensitivity to be given. If a receiver reproduces the tone at good level at the low frequency end of a band but at much lower level at the high frequency end then there is lack of sensitivity at the high frequency end. The signal injector will also show if the receiver oscillator is cutting out over any section of a band. But its most helpful function is in oscillator padding at the low frequency end of a band. The receiver oscillator coil core (or other padding adjustment) is merely set up for maximum volume of the injected tone and there is no need to 'rock' the receiver or signal generator tuning as occurs when padding with a single frequency signal. For this adjustment the injector coil should be positioned some distance from the receiver so that signal injection is at a low level only. ■

ZENER DIODE POLARITY

Which way round do you connect a zener diode?

ZENER DIODES CAN SOMETIMES RAISE A FEW QUERIES. Ordinary rectifying diodes have the cathode lead-out identified by a coloured dot or band, and a dot or band similarly appears at the cathode lead-out of zener diodes. Since a zener diode is used 'wrong way round', does the marked lead-out go to the positive or to the negative side of the circuit in which it is used?

BASIC THEORY

To find the answer to this, we have to look into a little basic theory.

Fig. 1 shows an ordinary rectifier diode. 'Conventional current' (from positive to negative) flows in the direction of the arrow. The diode symbol itself is, in fact, an arrow-head plus a straight line. Since conventional current flows in the direction indicated we know that we must get a positive voltage from the cathode, or 'plus end', of the diode. We can, as a result, connect an electrolytic smoothing capacitor after the diode with the polarity illustrated. In other words, the cathode lead-out of the diode corresponds with the positive rectified voltage.

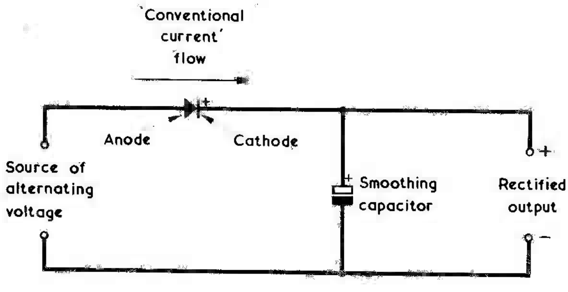


Fig. 1. The direct voltage polarities which appear in a rectifier diode circuit

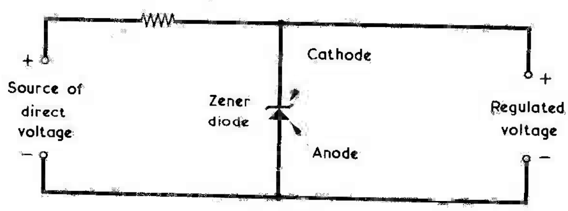


Fig. 2. In a zener diode circuit the diode cathode is still associated with the positive potential

In Fig. 2 we have a zener diode. A zener diode is a silicon diode which gives the zener regulating effect when it is *reverse* biased. So we connect it into circuit in the manner shown in Fig. 2, where it is connected the opposite way round to that in which it would pass conventional current as a rectifier.

And what do we find? We find that the cathode couples to the positive side of the source of voltage. So, once again, the lead-out of the diode which is marked with a colour dot or band is the one which is associated with positive polarity.

A diode which is used as a zener diode is doing quite a different job from one which is functioning as a rectifier. But it is fortunate, nevertheless, that the identified cathode lead-out is, in both cases, the lead-out which corresponds with the positive side of the associated circuit. This simple fact can save a lot of head-scratching when dealing with these devices.

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

From Riyadh, Saudi Arabia, experimental broadcasts which include Arabic music, readings from the Quran (westernised as Koran) together with announcements in both Arabic and English have been made at various times throughout the day for some weeks now.

Riyadh has been logged from 2100 onwards on **6080** (49.34 metres), **7110** (42.19m) and on **7195** (41.70m). At this time the latter channel provides the best reception, the former channels suffering from USSR QRM. A request for reports is made during the announcements.

Other channels in use for these programmes are **5965** (50.29m), **5990** (50.08m), **6190** (48.47m), **9585** (31.30m), **9605** (31.23m), **9625** (31.17m), **11750** (25.53m), **11870** (25.27m), **15205** (19.73m), **15240** (19.69m), **21510** (13.94m) and on **21635** (13.87m).

● CURRENT SCHEDULES

● NETHERLAND

From Hilversum, programmes in English to Europe are radiated on Weekdays from 0930 to 1050 on **6045** (49.63m) and **7210** (41.61m); from 1400 to 1520 on **6020** (49.83m), **6045**, **11740** (25.55m), **15425** (19.45m), **21480** (13.97m) and on **21570** (13.91m); from 1830 to 1950 on **6020**, **6085** (49.30m) and on **11730** (25.58m). Sundays from 0930 to 1050 on **6020**, **6045** and **7210**; from 1400 to 1520 on **6020**, **6045**, **11740**, **15425**, **21480** and **21570**; from 1830 to 1950 on **6020**, **6085** and on **11730**.

● SWITZERLAND

The Overseas Service of S.B.C. from Berne radiates in English to Europe as follows – from 1100 to 1130 on **3985** (75.28m), **6165** (48.66m), **9535** (31.46m), **15430** (19.44m), **17795** (16.86m), **21520** (13.94m) and on **21585** (13.90m); from 1315 to 1345 on **3985**, **6165**, **9535**, **9590** (31.28m), **15305** (19.60m), **17830** (16.83m) and on **21520**; from 1530 to 1600 on **3985**, **6165**, **9535**, **9590**, **11870** (25.17m), **15305** and on **21520**; from 2100 to 2130 on **3985**, **6165**, **9535**, **9590**, **9635** (31.14m), **11720** (25.60m) and on **11870**.

● PHILIPPINES

From Manila, Radio Philippines broadcasts to Europe mainly in English from 1900 to 2200 on **9575** (31.33m). They also radiate in English to Japan, Korea and Taiwan from 0700 to 0810, from 0815 to 0900, from 0910 to 0945, all on the same channel.

● CZECHOSLAVAKIA

Radio Prague now radiates in English to Asia from 0730 to 0800 on **11855** (25.31m), **15310** (19.60m) and on **21700** (13.83m); from 1430 to 1500 on **5930** (50.59m), **7345** (40.85m), **11990** (25.02m), **17840** (16.82m) and on **21670** (13.84m).

● BANGLADESH

Radio Bangladesh has an External Service in English from 0230 to 0300 on **9580** (31.32m) and on **11650** (25.75m); from 1230 to 1300 on **15455** (19.41m) and on **17690** (16.96m); from 1845 to 1900 and from 2100 to 2200 on **7250** (41.38m) and on **9580**.

● ALGERIA

Radio Algiers has a daily broadcast in English from 1900 to 1930 on **15160** (19.79m), **17745** (16.91m) and on **17825** (16.83m).

● PAKISTAN – 1

Radio Pakistan has a news service directed to the Middle East in English at dictation speed from 1530 to 1545 on **9690** (30.96m) and on **11672** (25.70m). The former channel is useless for listeners here in the U.K. but the latter has been logged here at good signal strength and in the clear.

● AUSTRALIA

Radio Australia currently beams a programme in English to the U.K. during the evenings from 1900 to 2000 on **7290** (41.15m) although this second choice of channel (the first was on **9660**) also suffers from QRM and may have been changed by the time this information is published. The first channel is occupied by a jamming transmitter throughout the period stated whilst the second is also occupied by other, more local to the U.K., stations.

● ETHIOPIA

Radio Ethiopia, Addis Ababa, has a Home Service in English on weekdays from 1000 to 1100 and from 1600 to 1700, on Sundays from 0900 to 1100 and from 1600 to 1700 on **9610** (31.22m) throughout and additionally on **6185** (48.50m) for the first sessions.

● PAKISTAN – 2

Radio Pakistan directs a programme in Urdu to the U.K. from 0830 to 1100 on **17910** (16.75m) and on **21510** (13.94). In English, Urdu and Sylheti to the U.K. from 1915 to 2115 on **9463** (31.71m) and on **11672** (25.70m).

● QSX

Intended for the Dxer, wavelengths are not quoted in this section.

One of the most interesting events recently on the 60m band has been the loggings of XZK42 Rangoon, Burma, on a measured **5044** (slightly variable at times) from around 1430 onward. On the last occasion, they were radiating a newscast of local affairs (YL announcer) at 1455; world news (OM announcer) from 1500 to 1515, then dance music and song ("Moon River" etc.) till 1558, at which time we heard "This is the Burma Broadcasting Service wishing you a very goodnight", National Anthem and sign-off at 1559.

Another Far Eastern station that may interest Dxers this month is that pro-communist clandestine station R. Pathet Lao. Whilst claiming to be located in Laos, it is thought to be actually operating from North Vietnam. Try from 1500 when the programme in French commences (1515 in Cambodian, 1530 in Laotian) until sign-off at 1600. The channels used at these times are **4660, 6200, 7310** and **7480.** Prior to 1500, two networks are in operation, one being on **4538, 6200, 7480, 7958** and **8660** whilst the other network is on **4660** and **7310.** The identification is "Thi ni witayu kachai siang fai Pathet Lao" and from 1500 during this month most of the short route signal path will be in darkness. For the insomniacs amongst us, sign-on is at 2227 in Laotian on **4660** and **7310** until 0230 sign-off, the format being as follows – 2300 to 2400 Laotian, 0001 to 0100 various dialects, 0100 to 0115 in French, 0115 to 0130 Vietnamese, 0130 to 0230 Laotian.

● CHINA

In the last 'QSX' (November issue) mention was made of the Chinese regional stations on **4865** (listed Lanchow and heard regularly) and **4975** (listed Foochow and heard irregularly). Two others of interest to the Dxer would be Wuhan on **3940** (listen around 2200) and Nanning on **5010** (listen from 2300) the locations being as listed.

● 5010 AND ALL THAT

Amongst many others, a channel that has interested the writer of late is that of **5010.** It is often an interesting exercise, whilst doing other jobs around the shack, to stay on this channel from around 2145 onwards, a technique known to the writer as "sitting on the fence," and simply sorting out what one hears which, of course, will vary according to conditions at the time.

At 2145 or so, Garoua will be heard until sign-off at 2200. After this time, with any luck, one may log Singapore with the Chinese service, the signal tending to peak around 2230 to 2300. Quite recently, conditions were such that we heard Singapore at good signal strength programming music and songs with Nanning underneath, YL in Chinese, usual format. As time progresses, these signals will fade out as HIMI Radio Cristal, Dominican Republic becomes audible, usually after midnight. It all sounds simple and orderly, probably your sum total result will be a channel covered by commercial QRM or R. Cristal coming in exceptionally early (it has been known) or R. Singapore and nothing else or . . .

● EAST AND FAR EAST

Whilst discussing stations in these areas, we draw the attention of enthusiasts to Lhasa on **9395.** From 1600 the station relays the Hindi service of R. Peking, the modulation is poor and the identification at 1630 is, in fact, R. Peking, but don't be fooled! Slow drum beats around 1615 are a feature of the broadcast.

Prior to 1600, whilst around the above area of the dial, try **9422.5,** at which dial setting you may hear the clandestine "Voice of the Thai People". The best time is probably from 1530 onwards, although the writer had logged them from 1500 onwards, the language used is of course Thai, interspersed with martial music and slogans. Sign-off is at 1615 (varies) after more slogans and a stirring march.

Very often, from 1830 onwards, Dacca, Bangladesh, can be heard on **4890.** They have been logged here from 1845 with the news in English at dictation speed until station identification at 1900, also at 2115 in English (YL and OM announcers) when featuring "Listeners Letters Answered". Prior to this is often featured a talk on local affairs ". . . in the Asian service of Radio Bangladesh".

Further up the dial, on **4985,** Penang operates an English service from 2200, the signal tending to peak around 2300. Dance music recordings are a favourite format with this one.

On **4840** around 2015 can sometimes be heard PLA Fukien, although according to currently available information (probably now outdated) sign-on should be at 2300 with a relay of Peking Taiwan service in Standard Chinese.

Kajang, Malaysia, signs on at 2200 on **4845** in Tamil and may often be heard with Indian-type music and songs soon after this time. In practice however, the channel is often covered by teletype transmissions.

Radio Pakistan can sometimes be logged from 1800 until sign-off at 1810 after a newscast in dialect on a measured **6257.** Difficulty will be encountered with QRM from the adjacent Schulungsender, Austria, on **6255.**

● LATIN AMERICA

For LA-addicts, who must also perforce become, like the writer, an occasional insomniac, there is YVQE R. Bolivar on **4770** at 0144 with songs in Spanish followed by identification or the nearby YVOA R. Tachira on **4830** at 0214 with LA music and identification at 0216. When the 90m band is active, try **3325** around 0200 when the identification of YVRA R. Monogas will be heard.

A good signal can often be heard from HJCO R. Nacional on **4955,** we logged them at 0257 when OM & YL announcers were reading the local news, time-check, three chimes and identification at 0300.

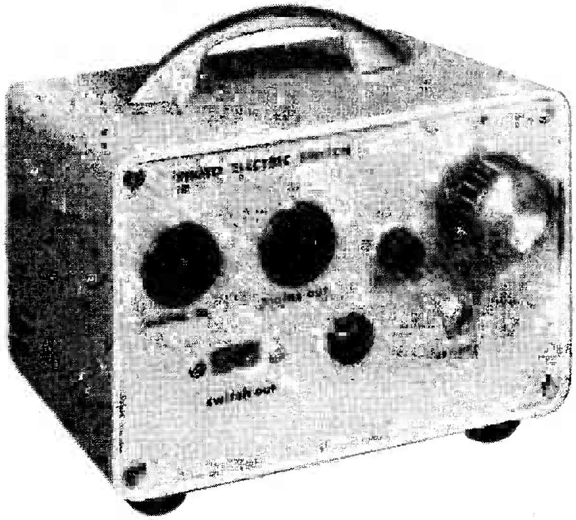
TIHB R. Capital, Costa Rica, is on **4832** and can be heard throughout late nights and early mornings, being recently logged here at 0555 with musical programme and identification at 0600.

HIAS Onda Musical, Santa Domingo, on **4775** at 0300 with identification followed by the usual LA music etc.

LAST BUT NOT LEAST

We end QSX as we began, with a 60m band report on Eastern stations. R. Pakistan on a measured **4877** (listed **4875** but varies from time to time) at 1756 with sign-on signature tune, six pips and identification at 1800 followed by a newscast in dialect.

Bangkok, Thailand, at 2327 on **4830** with Asian-type music, drums, YL with songs, all complete with intermittent teletype QRM!



BUR BEA

by Jame

Keep would-be thi the aid of this ph

IT HAS BEEN SAID THAT A LIGHT IN A BACK ROOM IS A deterrent to burglars, especially if it goes off and on daily. This apparatus is basically a photo-electric switch, turning a light on at dusk and off at dawn. The sensor is a small photoconductive cell of the type used extensively a few years ago for automatic contrast control in television receivers, and the nature and extent of the switching functions is determined by the relay used in the output stage.

Besides the primary function for which it was built, other applications have been found. It may, for instance, be used at slide shows to turn room lights or a light near the projector on when the projection light is switched off.

CIRCUIT

The circuit of the switch is given in Fig. 1.

A Schmitt trigger incorporating TR1 and TR2 provides the toggle action necessary, the zener diode D1 defining the emitter voltage and thus reducing hysteresis and making threshold setting easier. There is a filter, R4 C1, at the input to eliminate stray a.c. signals, and the 20kΩ 'Threshold' control, R3, adjusts the point at which the circuit operates.

The 4.7kΩ resistor, R8, across the base-emitter junction of TR3 ensures that this transistor is cut off when no base current is flowing to it from TR2. The two resistors R1 and R2 are limiters to prevent an excessive current flowing when the photoconductive cell is in bright light and R3 is set towards minimum resistance.

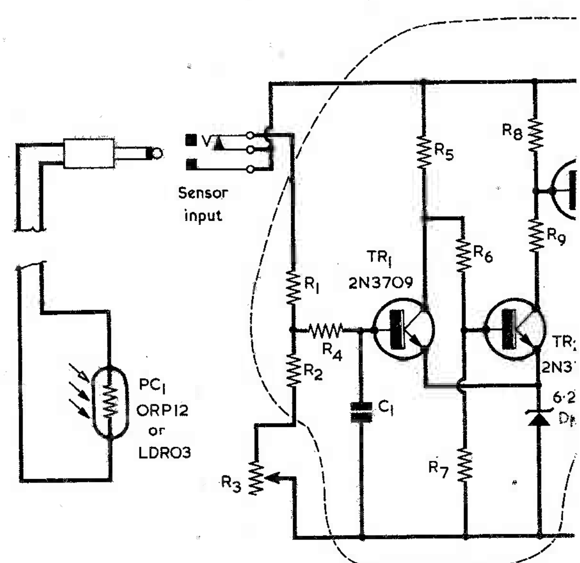


Fig. 1. The circuit of the 'Burglar Beater' photo-electri mounted on a p

BURGLAR BEATER

by James Kerrick

Keep would-be thieves guessing with the aid of this photo-electric switch.

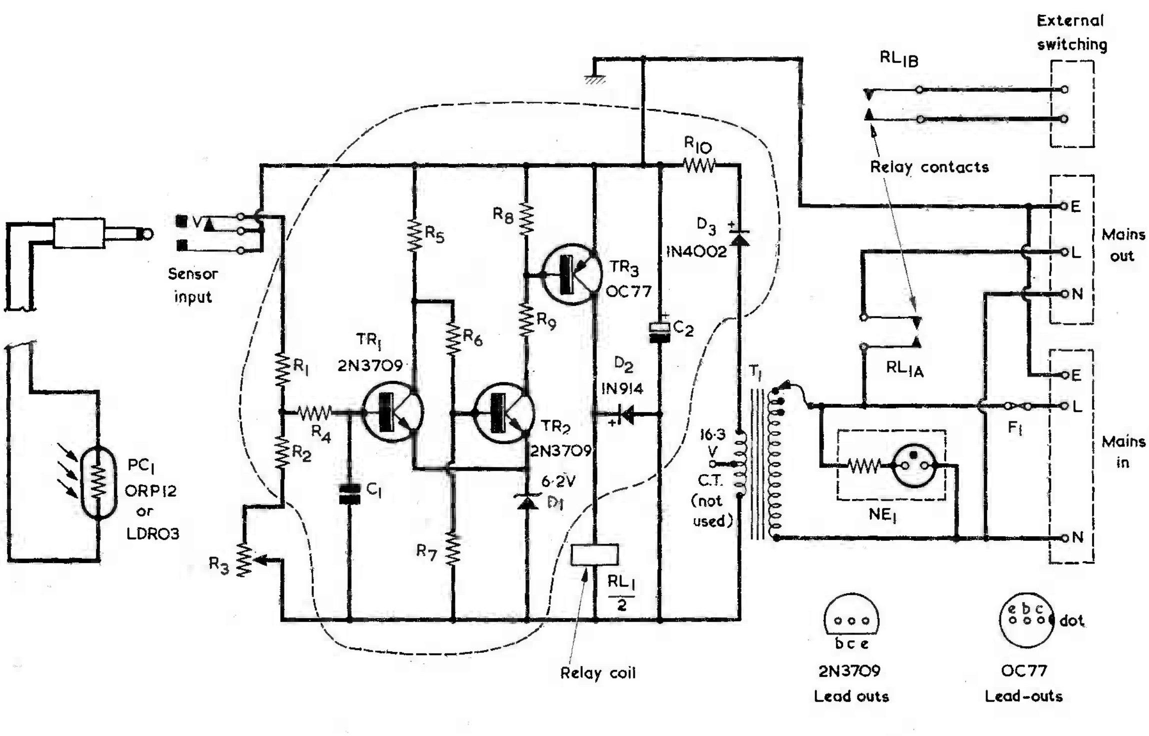


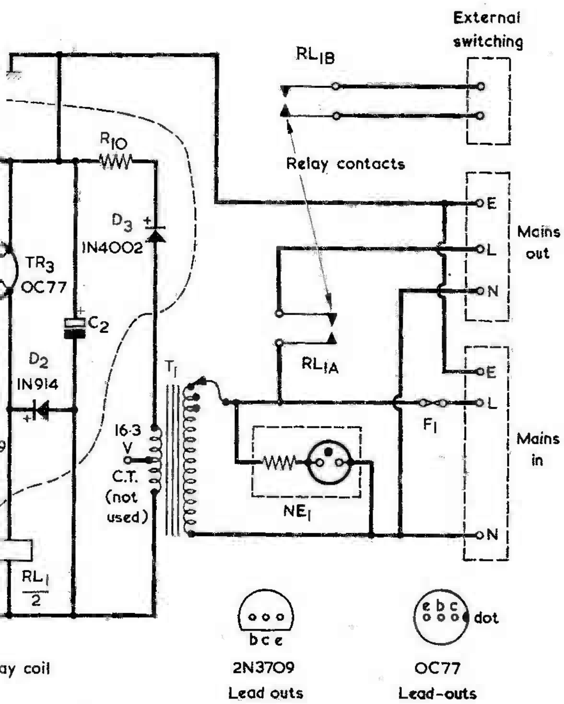
Fig. 1. The circuit of the 'Burglar Beater' photo-electric switch. The components within the broken line may be mounted on a printed circuit board

GLAR

TER

Kerrick

eves guessing with
to-electric switch.



witch. The components within the broken line may be ted circuit board

Resistors

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

R1	4.7kΩ
R2	1.5kΩ
R3	20kΩ potentiometer, linear
R4	10kΩ
R5	10kΩ
R6	2.2kΩ
R7	4.7kΩ
R8	4.7kΩ
R9	10kΩ
R10	10Ω 1 watt

Capacitors

C1	0.1μF plastic foil
C2	100μF electrolytic, 40 V.Wkg.

Transformer

T1	Mains transformer, secondary 16.3V at 0.3A (see text)

Semiconductors

TR1	2N3709
TR2	2N3709
TR3	OC77
D1	zener diode, 6.2V 400mW
D2	1N914
D3	1N4002

Relay

RL1	P.O. 3000 relay (see text)

Photocell

PC1	ORP12 or LDR03

Neon

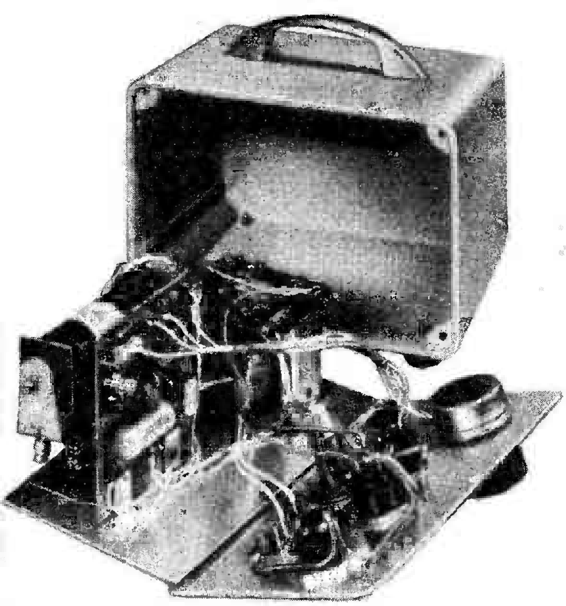
NE1	Neon assembly with integral resistor

Fuse

F1	1 amp cartridge fuse

Plugs, Sockets
Bulgin plug and socket assembly type P360
Bulgin plug and socket assembly type P438
3.5 mm. jack socket with short-circuited contacts (see text)
3.5 mm. jack plug
2-way plug and socket for external switching, as required

Miscellaneous
Knob
Panel mounting fuse holder (for F1)
Mounting clip (for TR3)
Case



A view inside the prototype model. Layout is not important and the components may be positioned in any convenient manner

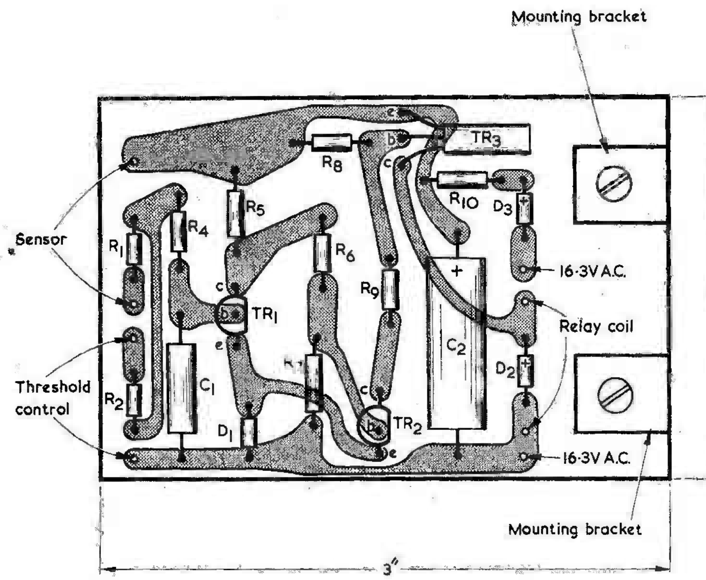


Fig. 2. Layout of the printed board. This view is of the component side of the board

A miniature 3.5 mm. jack socket having contacts which close when the plug is removed is provided for the photoconductive cell input. Since the relay operates when the sensor is in the high resistance state, the socket is wired such that the input is short-circuited when the plug is removed.

No apology is offered for the use of a relay rather than a triac, as it was felt that this was the optimum device in the present case, where operating speed is of no consequence and isolation from the mains is essential.

The basic circuit constants are largely determined by the characteristics of the relay employed, and that used by the author was a P.O. 3000 type with a coil resistance of 3kΩ which energised at about 20 volts. (P.O. 3000 relays with high voltage contacts made to customer's specification are available from L. Wilkinson (Croydon) Ltd., Longley House, Longley Road, West Croydon, Surrey.) The author's relay had two sets of make contacts, and one is used for the light switching operation. The other set is connected to a 2-way socket on the front panel for external purposes as required.

The rail voltage required for relay operation was obtained from an R.S. Components 16.3 volt filament transformer and a half-wave rectifier circuit. This transformer has a secondary rating of 0.3 amp and any other small transformer of around the same secondary voltage and current rating could be employed instead. The low value resistor, R10, is purely a surge limiter. The usual protective diode, D2, is connected across the relay coil to prevent the appearance of a high back e.m.f., which could damage TR3, when the relay de-energises.

It should be noted that the chassis and mains earth are connected to the positive side of the circuit and not, as might normally be expected, to the negative side. This is done to avoid the possibility of damage caused by the sensor short-circuiting to the chassis or other earthed parts.

The incoming mains supply is applied to a Bulgin plug and socket assembly type P360, and the switched output supply is carried by a Bulgin plug and socket assembly type P438. The appropriate part of each assembly is mounted on the front panel.

CONSTRUCTION AND USE

Layout is not important and any small box capable of holding the components may be used. The author assembled all the parts which appear inside the broken line in Fig. 1 on a small printed circuit board measuring 2 by 3 ins. in size. This board, shown from the components side, is reproduced full size in Fig. 2, which may be traced. As will be seen, the printed circuit pattern is quite simple. TR3 is fitted with a small metal mounting clip which secures it to the board: This clip is not shown in Fig. 2. D1 should be connected into circuit with the polarity indicated in the circuit diagram of Fig. 1. The board, together with the transformer and relay, is mounted on a chassis plate, and the remainder of the components are fixed to the front panel.

In use, the threshold control of the unit is set up to switch at any predetermined light level. Light from the controlled lamp must not, of course, be allowed to fall on the photoconductive cell or a form of relaxation oscillation may result. The photoconductive cell may be built into a small light-proof box with an aperture at one side or, as in the author's case, it can be strapped to a window in an inconspicuous position with black adhesive tape. ■

RADIO RECEIVERS USING TWO INTEGRATED CIRCUITS

Part 2 by M. J. Darby

In last month's issue the integrated circuit type ZN414 was described in detail. This concluding article shows how a ZN414 receiver may be coupled to an integrated circuit a.f. amplifier to form a complete receiver operating a speaker.

HAVING NOW DEALT WITH THE CIRCUIT INCORPORATING the ZN414 we shall next see how it performs with an integrated circuit a.f. amplifier. The amplifiers we will use are the Sinclair 'Super IC-12' and the Plessey SL402D and SL403D.

THE SUPER IC-12

The Sinclair Super IC-12 is a dual-in-line integrated circuit audio amplifier with cooling fins fitted onto the upper part of the encapsulation. The device can provide a power output of 6 watts into an 8Ω load when fed with the maximum permissible power supply voltage of 28 volts. Any value of speaker impedance between 3Ω and 15Ω is satisfactory, but 8Ω is the optimum value. More current is taken from the power supply when a low impedance speaker is employed.

The Super IC-12 will operate at power supply voltages in the range of 8 to 28 volts, but the maximum power output and the distortion depend on the power supply voltage. For example, the device can provide up to about 1 watt when fed from a 12 volt supply or about 0.5 watt from a 9 volt supply. The maximum power output is also somewhat dependent on the load impedance. The Super IC-12 requires a current of about 10mA from a 28 volt supply when no signal is applied at the input.

The total harmonic distortion is typically 0.1% and the frequency response is 15Hz to 500kHz. The output voltage required to produce 6 watts in an 8Ω speaker is about 30mV. It therefore appeared that the output from the ZN414 circuit of Fig. 2 (published last month) would be suitable for driving a Super IC-12.

The Super IC-12 is supplied together with a printed circuit board. The manufacturers recommend very strongly that the device be mounted on this board, since the board has been designed to reduce the possibility of instability. All of the component numbers are clearly marked on the board.

The Sinclair circuit board can be fixed to a board on which the ZN414 receiver is mounted, but the radio frequency circuits (and especially the ferrite rod aerial) should be kept well away from the audio amplifier, or there may be some instability. The type of circuit recommended for the Super IC-12 is shown in Fig. 7. A short screened lead should be used to connect the output of Fig. 2 to the input of Fig. 7.

Initially, the writer used the maker's recommended value of 100Ω for R4, but the gain of the whole system was then too high. A value of 390Ω seems to be suitable for R4 in the present application. It can be increased to 1kΩ if a still lower gain is required.

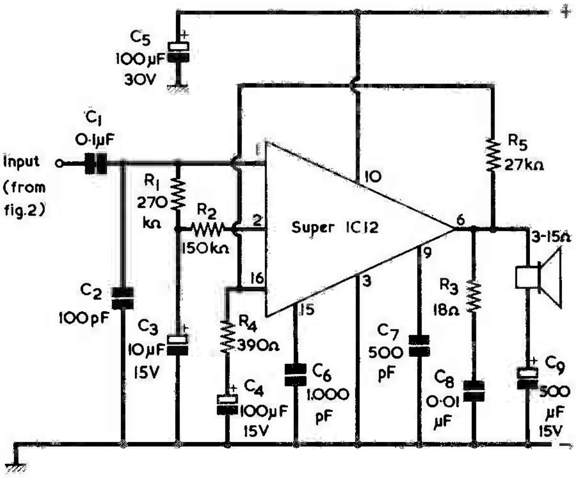


Fig. 7. A.F. Amplifier section incorporating the Sinclair 'Super IC-12' amplifier

It has been found that the circuits of Fig. 2 and Fig. 7 combine well together to form a radio receiver which operates from a 9 or 12 volt supply. If a battery supply is to be used, the value of C5 should be increased to about 1,000μF.

MAINS POWER SUPPLY

Should it be desired to use these circuits in a mains radio receiver, lower distortion and more output power will be obtained when a higher supply voltage is used for the audio amplifier. The power supply may consist of a transformer with a 12 to 20 volt secondary winding rated at 0.5 amp or more feeding a diode bridge rectifier which supplies a 5,000μF reservoir capacitor. If this type of power supply is used the value of R3 in Fig. 2 must be increased so that a suitable voltage is fed to the ZN414.

Care must be taken not to short-circuit the output leads of the Super IC-12 when it is operating, since excessive currents can flow in the output stage which can damage the device.

Full details of the Super IC-12 and its associated circuits including suitable tone controls, are given in reference 4. This is available at 15p post free (at the time of writing) from Sinclair Radionics Ltd., London Road, St. Ives, Huntingdonshire, PE17 4HJ.

SL402D AND SL403D AMPLIFIERS

The circuit of Fig. 2 may be employed with the Plessey SL402D or SL403D integrated circuit audio amplifiers instead of the Sinclair Super IC-12. The SL402D and the SL403D can be operated from maximum power supply voltages of 14V and 18V respectively. Maximum peak load current is 1.4 amps. The SL402D can provide at least 1.5 watts (typically 2 watts) into a 7.5Ω load when fed from a 14 volt supply, whereas the SL403D can provide a minimum of 2.5 watts (typically 3 watts) into the same load when fed from an 18 volt supply. The two devices are similar in construction, but the cheaper SL402D is quite suitable for use in 12 volt car radio receivers or in any application where its output power is adequate. Both types are fully described in the appropriate data and application notes (reference 5).

Unlike the Super IC-12, the Plessey devices do not incorporate their own heat sink. A piece of metal about 2.5 in. square must be bolted to the metal lugs fitted to the amplifiers.

INTERNAL PROTECTION

The SL402D and the SL403D incorporate circuits to protect the devices from damage due to short-circuiting of the output terminals or due to the application of a moderately excessive power supply voltage. If the output is short-circuited, an internal silicon controlled rectifier (or thyristor) fires and switches off the output transistors until the power supply is momentarily interrupted. Similarly, if the power supply voltage rises to a value which is too high, the amplifier is switched into a non-operating state where it can withstand considerably higher voltages than its normal operating supply. (These protection circuits are not incorporated in the earlier types SL402A and SL403A.)

The Pleseey amplifiers employ a preamplifier which consists of two cascaded emitter followers feeding a common emitter stage. This preamplifier *must* be used to provide the bias to the main amplifier, no matter whether the audio signal is fed to the preamplifier or directly to the main amplifier. This ensures that temperature dependent bias variations in the main amplifier are cancelled by those in the preamplifier.

The quiescent current is considerably greater than that of the Super IC-12, being about 60mA typical when the SL402D is operated from a 14 volt supply and 80mA typical when the SL403D is operated from an 18 volt supply.

In a preliminary experiment, the output from the ZN414 circuit was fed directly into the main amplifier of a Plessey SL403D. No audio signal was fed to the preamplifier stage. Reasonable results were obtained, but the gain was rather limited. This was to be expected since the main amplifier of the Plessey devices requires an input of about 250mV r.m.s. to produce maximum output power.

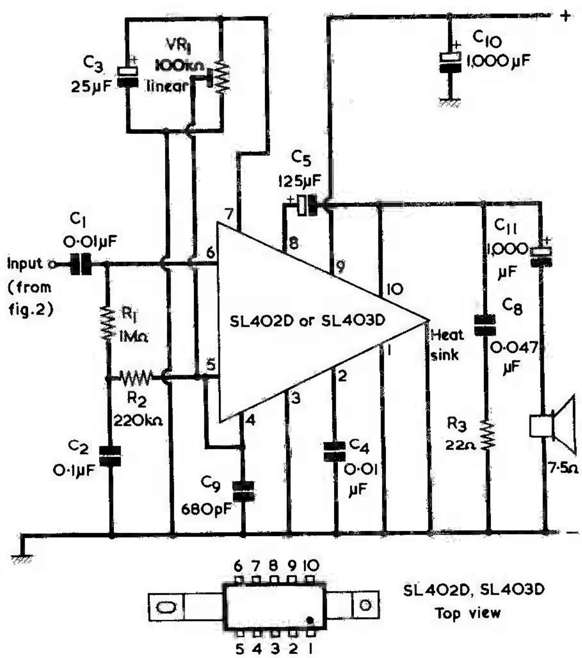


Fig. 8. An alternative amplifier employing the Plessey SL402D or SL403D

The circuit of Fig. 8 was therefore tried. In this circuit the input voltage is fed first to the preamplifier input (pin 6) and the output from this stage (pin 5) is fed into the main amplifier input (pin 4). The data sheet states that an audio input signal of about 25mV r.m.s. is required at the preamplifier input to produce full output power. The writer found that the gain was rather greater than was really required.

The gain could be reduced by adjustment of VR1 and VR2 of Fig. 2, but it was found desirable to fit a resistor of a few kilohms between the output of Fig. 2 and chassis to reduce the audio voltage applied to the SL403D circuit. Alternatively, the voltage applied to the ZN414 could be reduced still further.

The performance of the whole radio receiver was found to be very similar to the performance when a Sinclair Super IC-12 is used. However, the Super IC-12 could be used to provide more power than the Plessey amplifiers if a suitable power supply voltage is employed.

In the circuit of Fig. 8, the preset potentiometer marked VR1 is used to set the voltage at pin 10 to half the power supply voltage. This ensures that maximum output power for any voltage supply can be obtained.

The heat sink employed with the Plessey amplifiers must be connected to chassis at a point near pin 1 of the amplifier.

REFERENCES

4. R. J. Torrens, 'Sinclair Super IC-12 Instructions', Sinclair publication No. RA-02.
5. SL402D, SL403D data sheet, Plessey publication P.S.1309, Issue 3, December 1971.

(Concluded)

CAN ANYONE HELP?

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

Jason valved and switched 3 programme FM tuner—C. Ross, 101A, High Street, Ruislip, Middlesex – Circuit, Service Data purchase or borrow.

Radio Constructor, September 1968—M. J. Stepney, 35F Kelbourne Street, Glasgow, G20 8PF – To purchase or borrow.

Taylor, Valve Tester Model 45A and All Wave Generator Model 65B—W. Lee, 82A Warwick Avenue, Maida Vale, London, W9 – Manual required.

"Emmerson Radio and Television" 3 waveband receiver—P. G. Moyse, 25 Townsend Road, Harpenden, Herts – Circuit, instruction manual or any technical information.

Ultra Valiant Transceiver Type IMR IBO AB4T—M. H. Hurst, 53 Belmont Drive, Tuebrook, Liverpool, L6 7UP – Information and circuit.

"Appealing Door Chimes", Radio Constructor February 1965—B. B. Rafter, 10 Danfords Close, South Road, Oundle, Peterborough – Borrow or purchase issue or photo-copy of article.

Ripmax, Worm and Wheel Set 36:1 for 'Cyclops'—R. Weatherhead, 1 Viewforth, Dunbar, East Lothian, EH42 1AX – Supplier sought to enable completion of project.

Tape Recorder Marconiphone Model 4246—J. Regan, 163 Cotton Lane, Halton Lodge, Runcorn, Cheshire – Information as to suppliers of Drive Belt.

Radio Constructor, November 1970—C. J. Sanders, 2 Leinster Square, London, W2 – To purchase or borrow.

Electronic Projects—V. H. Vaidya, 19A Manekwadi Station Road, Krishnanagar, Bhainagar, Gujurat – Constructional help required.

CROSSWORD SOLUTION—

Across
6. Induced Current
9. Sleeve
10. Two Valve
11. B.F.O. Notes
13. Abvolt
15. Elicit
17. Lambda
19. Lumens
20. Dissolve
22. Enhancer
24. Rhombs
26. Hysteresis Loss

Down
1. Field Frequency
2. Idle
3. Accept
4. Automata
5. Area
7. Detest
8. Noval Valve Base
12. Noise
14. Vibro
16. Insecure
18. Adorns
21. Stress
23. Anti
25. Oboe

The 'WYVERN' 30 watt Stereo Amplifier

Part 2 by John R. Green, B.Sc., G3WVR

In the second article in this 3-part series our contributor describes the regulated supply unit and the power amplifier, dealing in detail with the theoretical design of the latter.

IN PART I, PUBLISHED LAST MONTH, THE OVERALL BLOCK diagram for the amplifier was given, together with theoretical and practical descriptions of the input equaliser circuits and the active tone controls.

The next section of the amplifier to be dealt with is the regulated supply unit for the pre-amplifiers.

18 VOLT REGULATOR UNIT

A regulated supply voltage of 18 to 20 volts is specified for the pre-amplifier units and this is provided by the simple zener diode and emitter follower regulator whose circuit is shown in Fig. 10. Either a single zener diode rated at 18 to 20 volts 200 to 250mW may be employed, or two or three diodes in series whose zener voltages total up to 18 to 20 volts. This approach eases difficulties in obtaining the zener diode or diodes required.

The simple perforated board layout, as seen from the component side, is shown in Fig. 11, and this assumes three zener diodes in series. As with the equaliser and tone control boards the material employed may have either a 0.1 or 0.15 in. hole matrix, and the other comments concerning the previous boards are applicable here. The voltage regulator transistor, TR4, should be fitted with a TO5 heat clip, such as the type H2 available from Henry's Radio. This is not really essential, but it might save the transistor in the event of excessive current being passed.

The regulator board is mounted on the pre-amplifier plate in the manner described in Part 1.

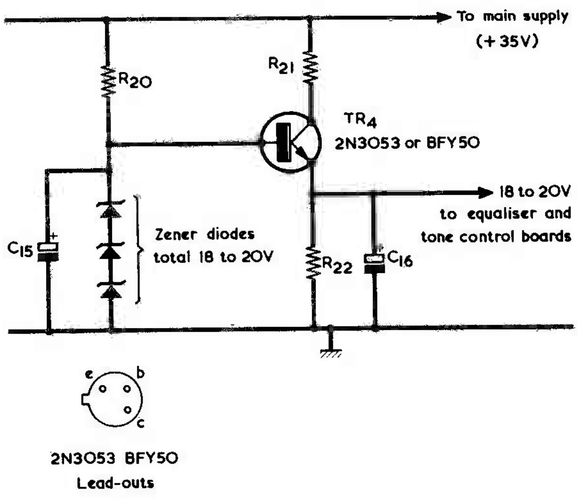
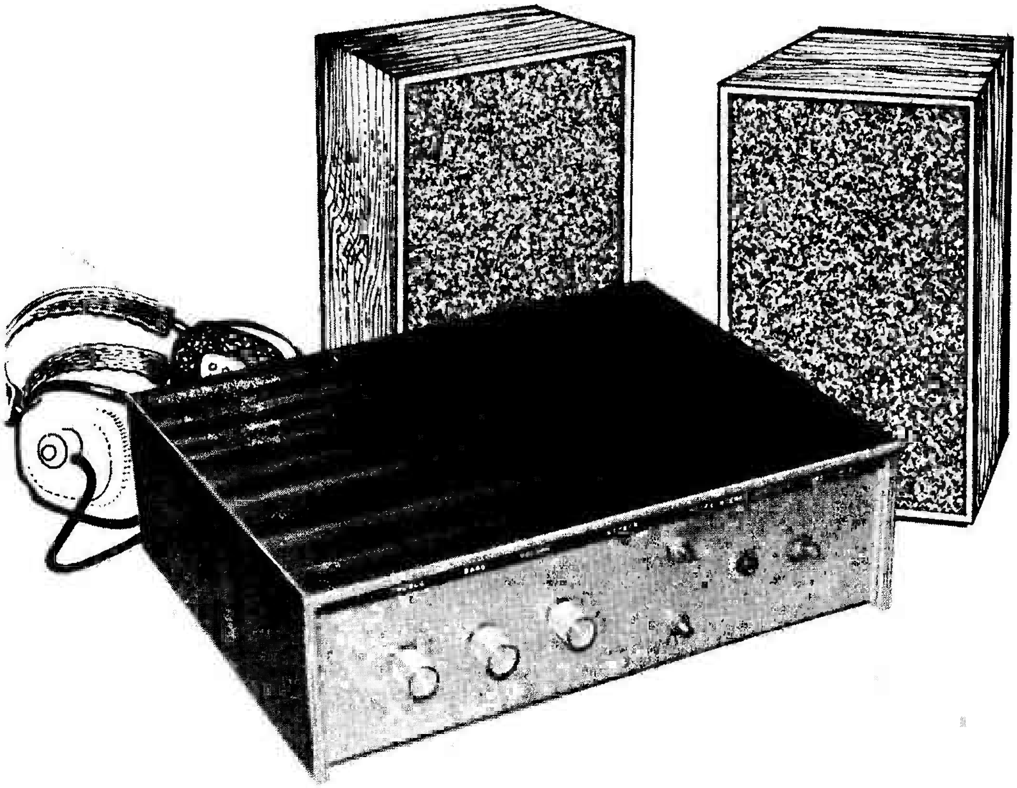


Fig. 10. The pre-amplifier voltage regulator. This supplies both channels, and only one is required



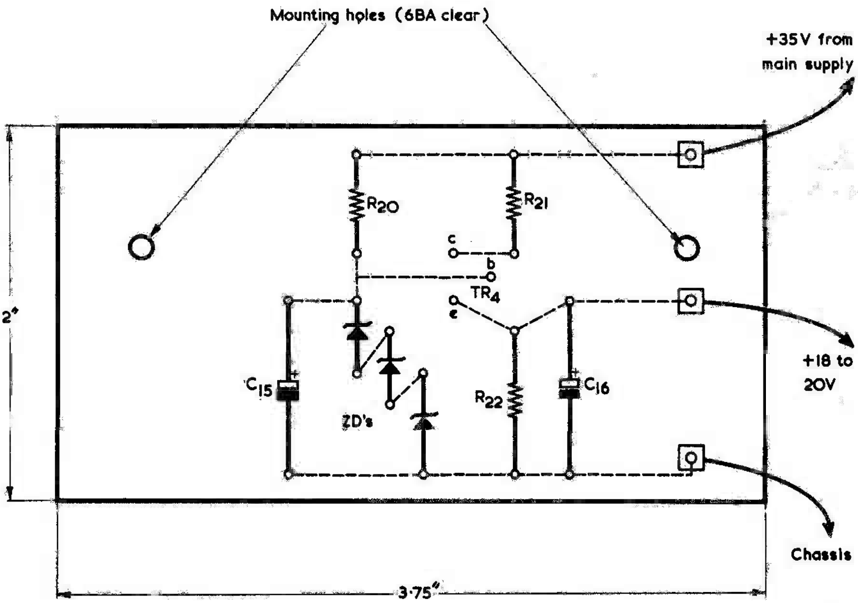


Fig. 11. The voltage regulator board, reproduced full size. This is viewed from the component side

POWER AMPLIFIER STAGE

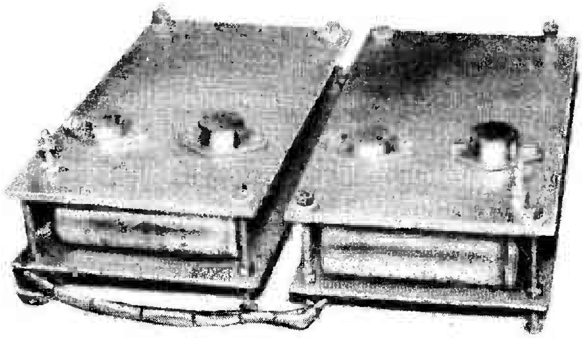
The circuit of the power amplifier is shown in Fig. 12. This diagram includes the 10kΩ balance control, RV4, discussed last month.

The author does not claim any particular originality for the design as it is similar to many others. It was, in fact, the result of discussions between the author and friends some four years ago and was intended to incorporate the best features of standard circuits in order to produce a simple, reliable and repeatable design.

The amplifier employs d.c. feedback to maintain the 'half rail' voltage, and a.c. negative feedback via C22 and R36, as is conventional with such designs.

Transistors TR5 and TR6 act as voltage amplifiers. TR7 functions as a 'variable zener diode' to set the quiescent bias current in the output stage. Transistors TR8 and TR9 operate as emitter followers and they provide current gain to drive the output transistors, TR10 and TR11.

The printed circuit layout for the amplifier, viewed from the component side, is given in Fig. 13. This diagram is reproduced full-size and may be traced if desired.



The power amplifiers with the pre-amplifier plate removed

Each power amplifier board is mounted on the main chassis by means of four 2 in. lengths of 4BA studding and nuts. Pre-set potentiometer RV5 is a panel-mounting type, and a hole is provided below it in the main chassis to allow its spindle to be adjusted.

The two output transistors for each amplifier are fitted to a flat aluminium heat sink, of 14 to 16 s.w.g., measuring 7 by 4 in. These are fitted on the 2 in. lengths

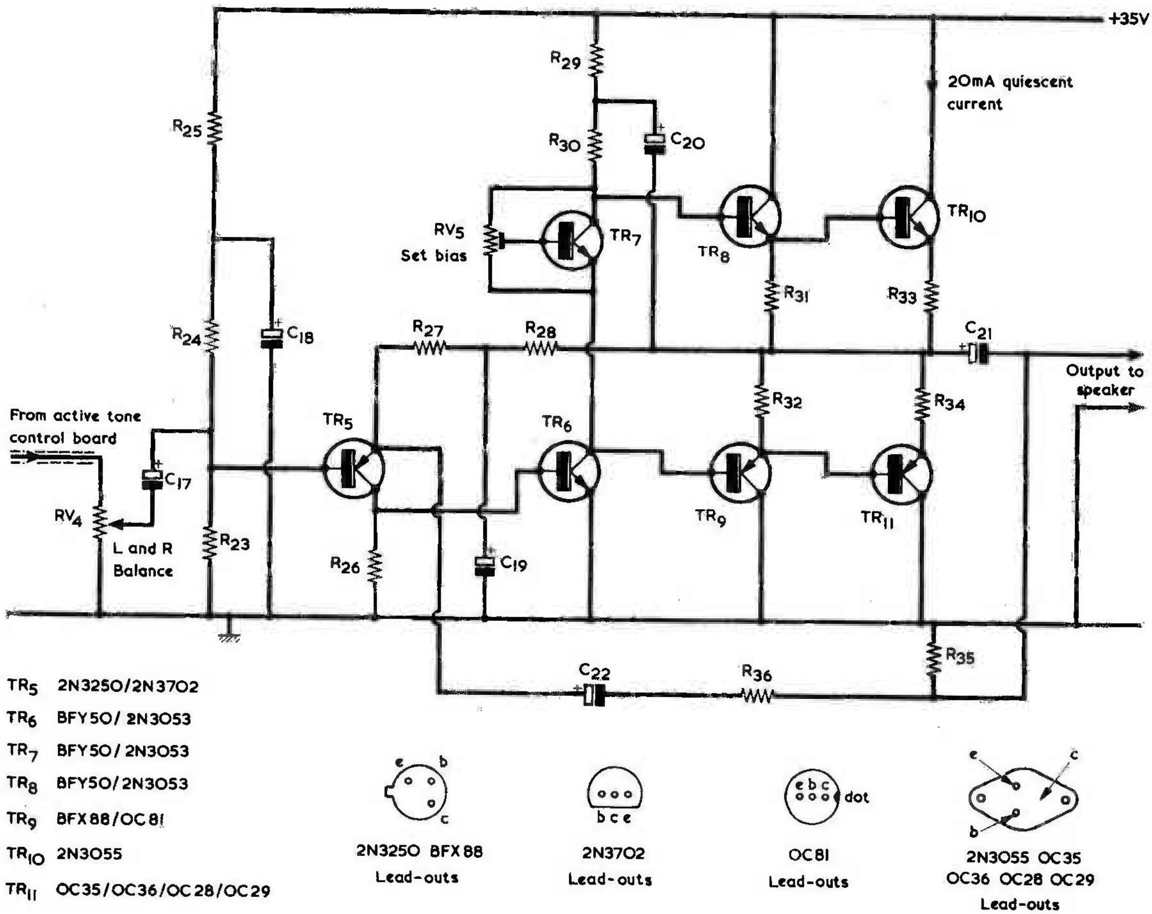


Fig. 12. Circuit diagram for the power amplifier. Two of these are required

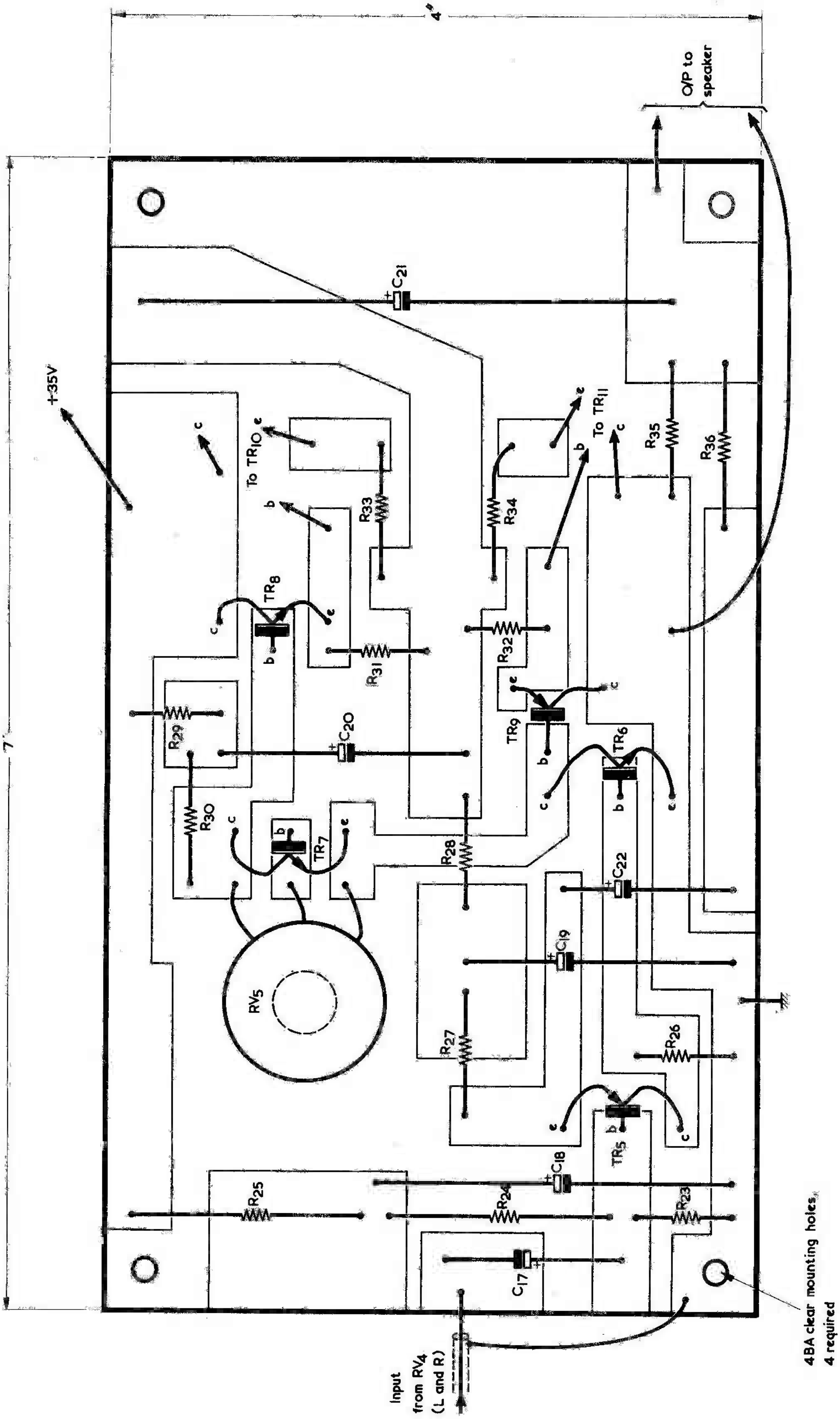
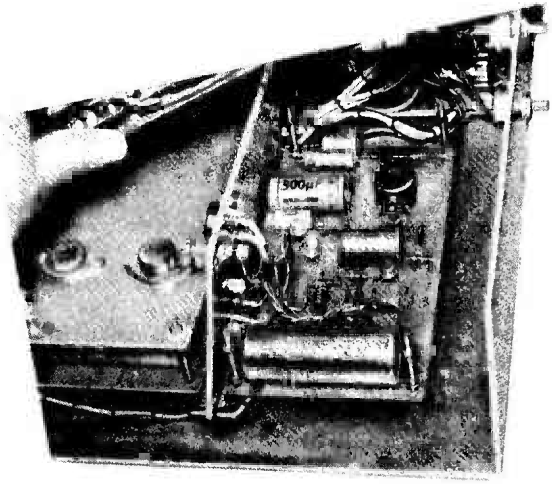


Fig. 13. Printed circuit layout of the power amplifier, viewed from the component side. This is reproduced full size, and may be traced

of studding, above the amplifier boards. The heat sinks also form a platform on which the pre-amplifier plate, again spaced off, may be fitted. The method of assembly is clearly illustrated by photographs appearing in this and last month's issues. Further details on the pre-amplifier plate will be given in Part 3, when the chassis assembly is dealt with.

It should be noted that only one output transistor, TR10, requires an insulating mica washer. Since the collector of TR11 connects to chassis, it may be bolted direct to the earthed heat sink.

Fig. 14 shows an alternative power amplifier using two n.p.n. silicon output transistors. This is included for the benefit of the more experienced constructor who requires circuit information only. The printed layout of Fig. 13 applies only to the circuit given in Fig. 12.



The power amplifier printed board assembly. Flexible wires couple this to the output transistors on the heat sink

DESIGN CONSIDERATIONS

It will no doubt be of interest to constructors to know the constraints existing in the design of the power amplifier circuit and the theory involved.

We will assume initially that the power amplifier will be designed to drive 15 watts r.m.s. into a 3Ω speaker. The voltage swing required is given by the formula.

$$\frac{V^2}{8R} = 15 \text{ watts}$$

where V is the peak-to-peak voltage and R is 3Ω. The formula gives 19 volts peak-to-peak.

In practice a supply voltage of greater than 19 volts is required, however, due to losses in the V_{BE} of the output transistors and their drivers. (V_{BE} is the base-to-emitter forward voltage.) These losses total nearly 2 volts and, in any instance, a considerably higher supply voltage is required in case it is required to drive an 8Ω

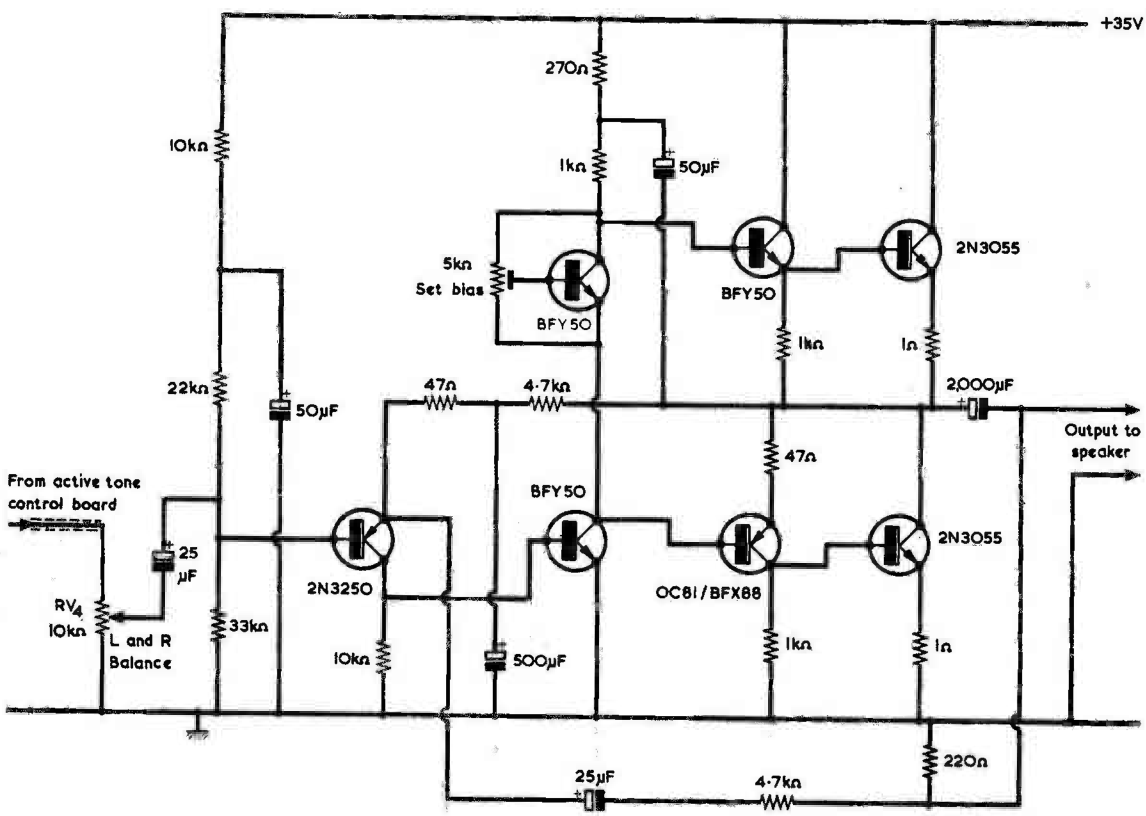


Fig. 14. An alternative power amplifier circuit incorporating two n.p.n. transistors in the output stage ➡

speaker. Such a speaker needs a higher voltage swing, of 31 volts peak-to-peak for 15 watts r.m.s.

The highest output current swing is, however, required for the 3Ω speaker design and here we base our current considerations on the 3Ω load.

The calculations which follow are intended to be as simple as possible and to this end a number of assumptions and approximations have been made. The circuit analysis should not be taken as rigorous.

The total current swing for the 3Ω load is given by the formula

$$\frac{I^2}{8} \times R = 15 \text{ watts}$$

where I is the peak-to-peak current and R is 3Ω. This gives 6.4 amps peak-to-peak current swing or ±3.2 amps from each output transistor; hence each output transistor must be able to provide 3.2 amps peak.

If we assume a current gain hfe of 20 for each output transistor, TR10 or TR11, then peak base current required is 3.2 amps divided by 20, or 160mA peak. This must be supplied by the emitter followers TR8 and TR9, and for these we will assume a higher current gain of 50 times as typical, which means that (neglecting the current in the emitter resistors) a base current of 3.2mA peak is required in each base of TR8 and TR9.

Conventionally, we would now arrange to run the amplifier transistor, TR6, and its collector resistor chain at 10 times this current (i.e. 32mA standing direct current) so that the peak current required by the driver emitter followers would not significantly upset the operation of TR6 by imposing a significant load. In the present circuit, however, the supply to the amplifier transistor is 'bootstrapped' via C20, and this provides a high impedance current source for TR6. The standing collector current may therefore be reduced, since the collector of TR6 will not be so affected by load current. A current of 12mA was in consequence chosen and, assuming a supply voltage of 30 volts and TR6 collector sitting at 15 volts, this gives a collector load resistance of 1.25kΩ. In the circuit this is split into 1kΩ (R30) and 270Ω (R29) for the purpose of bootstrapping. The collector of the amplifier transistor, TR6, will therefore sit at half the rail voltage when the d.c. conditions are satisfied.

The first transistor in the amplifier chain, TR5, also provides voltage amplification. Assuming a current gain hfe of 100 times in TR6, with its collector current of 12mA, a base current of 120μA is required, and this is easily provided by TR5 collector current.

Transistor TR7 may be regarded as a 'variable zener diode'. Here the collector-to-emitter voltage is proportional to the 0.7 volt base-to-emitter voltage according to the setting of RV5. The collector-to-emitter voltage increases as the potentiometer slider is wound towards the emitter end of the track. The voltage required across TR7 should be approximately equal to the combined base-emitter voltages of TR8, TR9, TR10 and TR11, and RV5 is set to provide 20mA quiescent current in TR10 and TR11 to prevent crossover distortion.

VOLTAGE CONDITIONS

Having ensured that the current conditions are satisfied, we now turn our attention to the voltage constraints.

The no-signal d.c. voltage conditions are controlled by the input potential divider given by R23, R24 and R25. The values of these resistors are chosen such that the emitter of TR5 sits at the half rail voltage. They pass at least 10 times the base current required by TR5, and the design of the amplifier is such that the centre rail biases itself to the half rail voltage.

This process can be visualised by assuming first that the centre rail voltage is higher than half the supply voltage. This causes the current in TR5 to increase and drive more base current into TR6. The collector voltage of TR6 falls, taking the centre rail voltage down with it by way of TR8, TR9, TR10 and TR11. If we assume, on the other hand that the centre rail voltage is lower than half the supply voltage, then TR5 and TR6 are starved of current so that TR6 collector voltage rises,

COMPONENTS

Resistors

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

R20	1-off 2.7kΩ
R21	1-off 33Ω
R22	1-off 18kΩ
R23	2-off 33kΩ
R24	2-off 22kΩ
R25	2-off 10kΩ
R26	2-off 10kΩ
R27	2-off 47Ω
R28	2-off 4.7kΩ
R29	2-off 270Ω
R30	2-off 1kΩ
R31	2-off 1kΩ
R32	2-off 1kΩ
R33	2-off 1Ω 1 watt
R34	2-off 1Ω 1 watt
R35	2-off 220Ω
R36	2-off 4.7kΩ
RV5	2-off 5kΩ potentiometer, linear, panel-mounting pre-set

Capacitors

C15	1-off 25μF electrolytic, 25V.Wkg.
C16	1-off 25μF electrolytic, 25V.Wkg.
C17	2-off 25μF electrolytic, 25V.Wkg.
C18	2-off 50μF electrolytic, 25V.Wkg.
C19	2-off 500μF electrolytic, 25 V.Wkg.
C20	2-off 50μF electrolytic, 25 V.Wkg.
C21	2-off 2,000μF electrolytic, 25 V.Wkg.
C22	2-off 25μF electrolytic, 25 V.Wkg.

Semiconductors

TR4	1-off BFY50 or 2N3053
TR5	2-off 2N3250 or 2N3702
TR6	2-off BFY50 or 2N3053
TR7	2-off BFY50 or 2N3053
TR8	2-off BFY50 or 2N3053
TR9	2-off BFX88 or OC81
TR10	2-off 2N3055
TR11	2-off OC35, OC36, OC28 or OC29

Zener diode set, 1-off, total 18 to 20V (see text)

Miscellaneous

1-off TO5 heat clip (for TR4)
2-off mica washer and insulating bushes (for TR10)
Printed circuit board
Perforated board
Perforated board pins.

taking the centre rail with it. In either instance the circuit design maintains the centre line at half supply voltage.

A.C. feedback is provided via R36 and C22, and the closed loop gain of the amplifier, neglecting the emitter impedance of TR5 (210Ω at 120μA collector current) is given by R36 divided by R27. This is 4.7kΩ divided by 47Ω, or 100 times, and therefore for an output swing of 19 volts peak-to-peak an input swing of 190mV peak-to-peak (67mV r.m.s.) is required. An input at this level is easily provided by the pre-amplifier sections.

The open loop voltage gain of the amplifier is calculated in the following manner. To commence with, since the emitter of TR5 is not decoupled, its gain is given, to good approximation, by collector load divided by emitter load. The collector load is the input impedance of TR6 (in parallel with the 10kΩ R26) and the emitter load is the 47Ω resistor, R27.

If the emitter of TR6 connected to chassis via a resistor RE, the input impedance could be calculated as being hfe times RE. But in the present circuit the emitter of TR6 connects direct to chassis and the input impedance is hfe times the internal emitter resistance of the transistor. This resistance is usually very much lower than any external physical emitter resistor and under such circumstances is normally ignored. In the present instance, however, it is very important.

Semiconductor theory gives the value of the internal emitter resistance as 25 divided by Ic, where Ic is in mA. Hence the input impedance of TR6 (at 12mA collector current and assuming a current gain of 100) becomes equal to

$$\frac{hfe \times 25}{Ic} = \frac{100 \times 25}{12} = 208\Omega.$$

In consequence the gain of TR5 is equal to 208Ω divided by 47Ω, or 4.4 times. The 10kΩ resistor, R26, may be neglected as it will not significantly affect the 208Ω in parallel with it.

The gain of TR6, whose emitter is connected to chassis, would normally be given by the formula

$$\text{Voltage gain} = \frac{hfe\ RL}{hie},$$

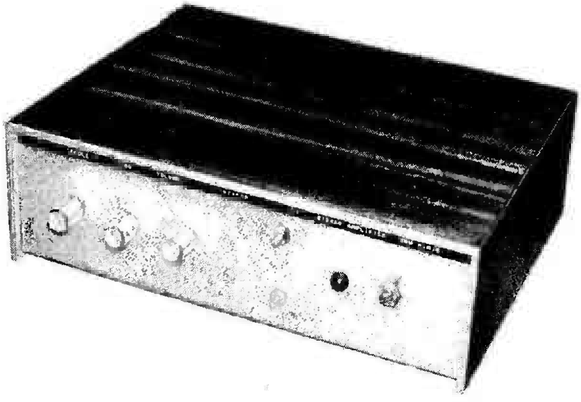
that is, the product of current gain and collector load divided by input impedance. The effective collector load is not, however, the 1kΩ collector load, R30, as the bootstrapping effectively raises this by many times, and so the effective load is taken as the input impedance to the output transistor drivers, TR8 or TR9.

The input impedance of TR8 and TR9, with respect to the centre rail, is given by the 1Ω emitter resistor (R33 or R34) multiplied by the current gain of TR10 and TR8 or of TR11 and TR9. Hence, the input impedance of TR8 or TR9, neglecting the emitter resistors, R31 and R32, is given by

$$1\Omega \times \text{hfe TR10 or TR11} \times \text{hfe TR8 or TR9}$$
$$= 1\Omega \times 20 \times 50$$
$$= 1k\Omega.$$

This figure applies for either path.

Since, for signal conditions, only one side conducts at a time (except at the crossover point) we may consider the load as 1kΩ and not as 2 loads of 1kΩ in parallel, or 500Ω.



Another view of the front of the completed amplifier

Hence, the voltage gain of TR6 is given by

$$\frac{hfe \times \text{RL effective}}{hie} = \frac{100 \times 1k\Omega}{208\Omega} = 480.$$

The voltage gain of the emitter followers TR8 and TR9 is unity ,and the voltage gain of TR10 and TR11 with respect to the 3Ω load is 0.75 times due to the 'potting down' effect of the 1Ω emitter resistor. The overall open loop voltage gain of the power amplifier is the product of the gains of TR5, TR6, TR8/9 and TR10/11 (TR8/9 and TR10/11 work alternately) and this is equal to

$$4.4 \times 480 \times 1 \times 0.75 = 1{,}580.$$

Now, we have already seen that the closed loop gain of the power amplifier is, to good approximation, 100 times. The quantity of negative feedback applied around the amplifier (i.e. the gain lost due to the feedback) is equal to open loop gain divided by closed loop gain. In the present amplifier this is

$$\frac{1{,}580}{100} = 15.8 \text{ (or 24dB)}.$$

Negative feedback is applied primarily to ensure a flat frequency response and to reduce non-linear distortion, but it also has the advantage of reducing the amplifier output impedance and increasing the input inpedance.

Since some of the output swing is lost in the 1Ω resistor, a supply voltage of 25 to 30 volts is used to enable the amplifier to deliver at least 15 watts r.m.s. into a 3Ω speaker. A supply voltage of 35 volts should be used for driving an 8Ω speaker if full output is required.

NEW DEVELOPMENTS

For the benefit of the more experienced constructor it should be mentioned in passing that it is possible to simplify the power amplifier and improve its performance by making use of 'Darlington' power transistors such as those manufactured by Motorola. These devices include a power transistor and its emitter follower driver in one package, giving a current gain of

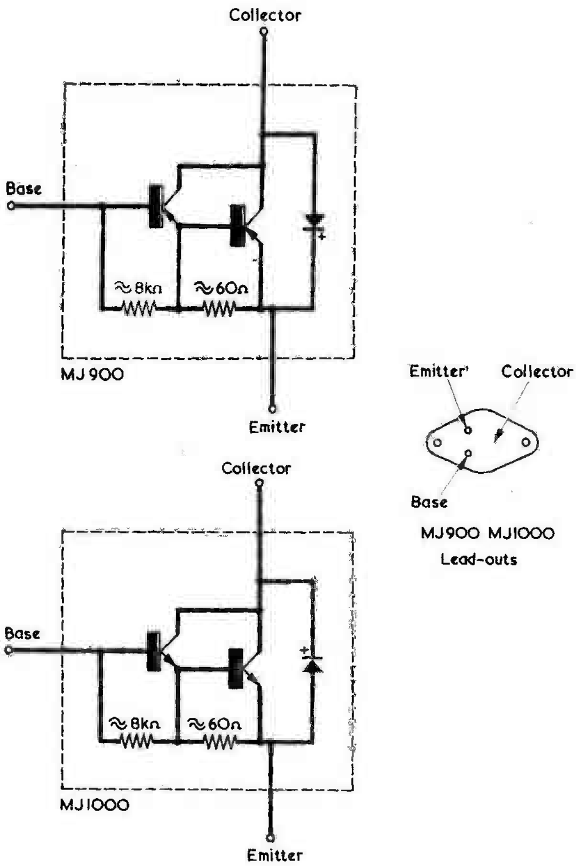


Fig. 15. Lead-out connections and internal circuit of 'Darlington' output transistors

greater than 1,000 times. They are available in complementary pairs (e.g. MJ900 p.n.p. and MJ1000 n.p.n.) and may be used to replace TR8 *and* TR10 (n.p.n. Darlington) and TR9 *and* TR11 (p.n.p. Darlington). The lead-out connections and internal circuits of these devices are shown in Fig. 15 and they may be obtained from Jermyn Industries, 90 Vestry Estate, Sevenoaks, Kent.

Alternatively, the output transistors only may be replaced by the MJ481 n.p.n. and MJ491 p.n.p. types. These will improve the amplifier output power response at the higher audio frequencies (as will the 'Darlingtons'), and they have the same lead-out layout as the types specified.

However, it should be noted that the design, as given and using inexpensive devices, gives results that are quite adequate for normal purposes, and is that which is recommended for the reader who prefers to work from practical constructional information.

NEXT MONTH

In the concluding article, to be published next month, the power supply and main chassis assembly will be described, as also will the process of testing and setting up.

(*To be concluded*)

LETTERS...

The Editor,
Readers' Letters,
Radio & Electronics Constructor,
57 Maida Vale,
London, W9 1SN.

Dear Sir,

I was greatly interested in your contributors experience with the 'Whoppodyne', described in your October issue, since I too encountered one, also in Scotland, about the year 1934. It was a multi valve monster with four H.F. stages separately tuned, and had a complex of hand wound plug-in coils which bore, as I remember, a strong resemblance to a row of black puddings encased in biscuit tins. The monster had been assembled on a table top approximately 5′ by 2′–6″ by the Aeronautics Department of a Scottish University for the purpose of receiving certain world-wide time signals on ear phones. As a 16-year-old 'Lab boy' its limited ambitions disgusted me. Fortunately the professor whose room was built around it used to leave early each evening to catch a train at 4 p.m. My hours were less flexible, and after he had left I had an hour to study its construction. As a wireless expert, ignored by those who had designed it, in a very short space of time I was able to make certain circuit alterations with 'jumper' leads which enabled me to obtain B.B.C. reception loud and clear. These alterations were of such a temporary nature that the professor never knew that anyone had realised its fuller potential!

John B. Francey – Erskine, Renfrewshire.

Dear Sir,

I recently read in a back copy of 'R. & E.C.', about Mr. S. Benson who owns a crystal receiver. I too have a crystal receiver and wondered where I could obtain 'crystals' and 'cat's whisker'. What are these two items made of and would a synthetic material give the same reception?

The set to which I refer has a 'BBC Approved' transfer on the front of it, with the words 'G.P.O. Reg. No. 861 – Type approved by Post Master General'.

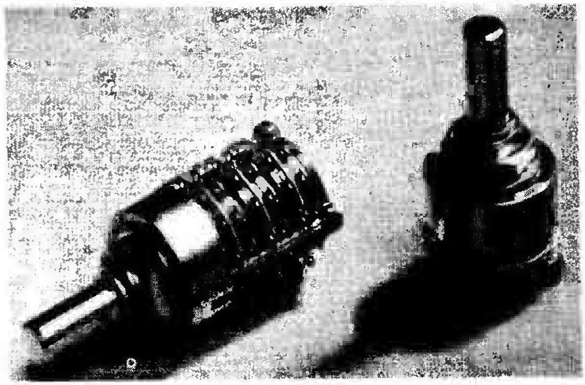
It was made by The British Thompson-Houston Co. Ltd., Rugby. Type G Form B. No. 25292. Made in September 1922 – 2nd edition.

I would be interested to receive any information on the query above.

K. W. Warn – Bristol.

Trade News . . .

ROTARY SWITCHES



The Feme series 5922, miniature panel mounted rotary switch is available up to 6 poles 12 way.

The switch is available with gold contacts in professional version, either hermetically sealed or with adjustable stop, and as an economic version with silver contacts, not sealed, with or without adjustable stop. The units are moulded in diallylphtalate, rated at 0.3 amps at 220 VAC or 1 amp at 30 VDC.

Units are 19 mm. diameter and maximum length for a 6 section unit is 46 mm. behind the panel.

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

LOW COST ELECTRONIC MULTIMETER

Avo claim to have produced one of the cheapest electronic multimeters ever for the professional market. This latest addition to the new "AVOMETER" generation, the EM 272, combines new techniques and components at a price to suit your pocket. The EM 272 has wide coverage of both a.c. and d.c. ranges and an input impedance compatible with modern circuits and components.

A high input impedance of 316kΩ/V, a wide range of measurement and a good frequency response to 20kHz are combined with simplicity of operation, rugged construction and "AVOMETER" reliability.

A.C. and d.c. voltages can be measured between 30mV and 1000V f.s.d., a.c. and d.c. current from 3μA to 3A f.s.d. and resistance between 1Ω and 40MΩ, the high impedance of the instrument ensuring accuracy of measurement in high impedance circuits.

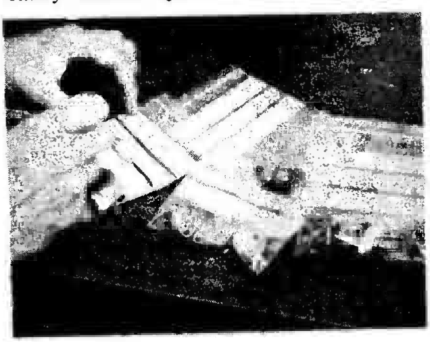
Printed circuits shunts and thick film resistor modules provide high reliability comparable to that of the small centre-pole movements. The moulded shatterproof case can be held in one hand.

The AVO EM 272 is a low cost electronic multimeter using proven techniques in a new combination to provide laboratory, production and servicing engineers with a truly professional specification.

Available from Wholesale Distributors at a U.K. Trade Price of £24.85 plus VAT £2.49.

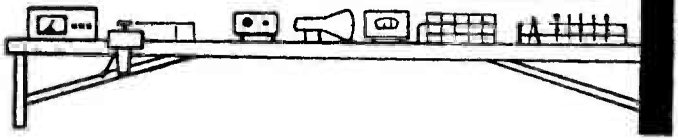
PROTECTION OF DELICATE AUDIO PARTS

Dixons Photographic Limited are now using a resealable polythene bag, called the MiniGRIP bag, to store and transfer approximately 3,000 different types of photographic and audio parts. The bag was adopted for the following reasons: it can be opened and sealed again repeatedly by hand; the closure excludes atmospheric pollutants from delicate components such as exposure meter movements, which are easily ruined by dust; optical parts such as focussing screens are protected against scratching, and the heavy gauge polythene is resistant to tearing.



In the shops, a single delicate part is often handed over in one of these bags, thus demonstrating to the customer that care has been taken. The bag is sealed by running thumb and forefinger along a sealing strip near the top and it is opened by pulling apart the two lips above this strip (see photo). MiniGRIP bags are marketed in U.K. and Eire by Supreme Plastics Limited, Vale Road, Harringay, London N4 1QB.

In your workshop



This month Dick and Smithy usher in the New Year by taking a look at the line output stages of U.K.-manufactured portable mains-battery television receivers. As Smithy is able to demonstrate to Dick, most of these single-standard sets have a common basic line output design.

"HAPPY NEW YEAR, ALREADY!" Smithy beamed at his assistant benevolently.

"Happy New Year, yet!" he replied.

Dick grinned back and hung his raincoat on the hook behind the door. He rubbed his hands together enthusiastically.

"I must say," he remarked keenly, "that this scheme of starting work on January the Second instead of January the First isn't half a good idea."

"You're dead right there," agreed Smithy. "It allows you to enjoy New Year's Eve without any worries at all about getting up early the next morning."

"Yes, it's just the job," said Dick, continuing the theme. "In fact, I was wallowing in the old pit yesterday right up to 3 o'clock in the afternoon!"

PORTABLE TV

He glanced around the workshop then looked at the 'For Repair' rack. All that stood on this was a portable mains-battery 12 inch monochrome television receiver.

"Blimey," he said, "Is that all there is to do today?"

"Up to now it is," replied Smithy. "We had a good clear-out of sets before New Year's Eve and nobody's got round to bringing in any more faulty ones since."

"These portable transistor TV's always strike me as being really neat jobs," said Dick warmly. "Is this one of the types which can operate from the mains or from a 12 volt accumulator?"

"It is," confirmed Smithy. "The consumption from the mains with these receivers is usually around 30 watts or so. When they're connected to a 12 volt battery they normally draw something like 1.2 to 2 amps."

"Well, that's pretty light, isn't it?" commented Dick. "Does it matter if the battery voltage isn't exactly 12 volts? For instance, a 12 volt accumulator can go up well over 13 volts when it's fully charged."

"Within reason, changes in battery voltage don't matter with these sets," stated Smithy. "They all have a voltage stabilizing supply circuit which is operative both on mains and battery. This sets the internal supply for the receiver circuits at a level of around 10.5 to 11.5 volts. The actual voltage depends upon the make and model of the set."

"Hmm," said Dick musingly. "That voltage should be enough for transistors to work from. And it can, of course, supply the heater of the cathode-ray tube quite happily as well. I suppose the tube is a standard sort of job."

"Oh yes," replied Smithy. "Although the small tubes used in these sets are designed specifically for transistor portable TV's, they're still the same as the larger tubes you have in standard monochrome sets. The usual screen sizes range from 9 to 14 inches. They have magnetic deflection, of course, and run at an e.h.t. for the final anode of around 10 to 12kV." (Fig. 1.)

"That e.h.t.," broke in Dick, "can easily be provided from the line output stage, can't it?"

"Oh yes," confirmed Smithy. "These small picture tubes have the usual heater and cathode, after which you get the first anode. In a typical tube, the second and fourth anodes are common with the final anode, and there is a third anode between them. This third anode is really a focusing electrode, and the focus is set up by varying the direct voltage which is applied to it. The voltage range for focusing is normally of the order of zero to 300 volts."

"Three hundred volts?" queried Dick. "How do you get 300 volts when the main stabilized supply rail inside the receiver is less than 12 volts?"

"You get it from the line output stage."

"Oh."

Dick thought for a moment.

"If my memory of cathode ray tubes serves me correctly," he went on slowly, "that first anode needs a fairly high voltage as well."

"It does," said Smithy. "About 300 to 400 volts, in fact."

"And where does that come from?"

"From the line output stage."

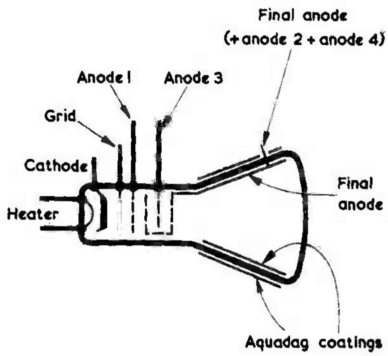


Fig. 1. The electrodes in a cathode-ray tube of the type employed in many mains-battery television receivers. The Aquadag coatings are conductive coatings of graphite which are painted on, in solvent form, during tube manufacture

"Blimey," remarked Dick. "Apart from its normal job of deflecting the spot across the tube face and providing e.h.t., the line output stage seems to be doing quite a bit of auxiliary work as well."

"So far as supplying the first and third anodes of the tube is concerned," said Smithy, "the extra work isn't particularly arduous. The current requirement of these two anodes is quite small. The first anode current will almost certainly be less than 10µA and the third anode current should usually be lower than 20µA."

"What about the video input to the tube? Is this fed in at the cathode?"

"Normally it is," said Smithy. "And with these smallish tubes the video input, excluding sync pulses, usually has a swing of about 30 to 40 volts."

"Blow me," protested Dick. "That's *another* voltage that's higher than the supply voltage which is available in the set!"

"I know it is," agreed Smithy. "It means that the video output transistor needs a supply potential of nearly three times that figure if it is to give a linear output complete with sync pulses. In practice, the supply for the video output transistor is fixed at around 100 volts. Also, the current requirement here is relatively high, being of the order of 6mA." (Fig. 2.)

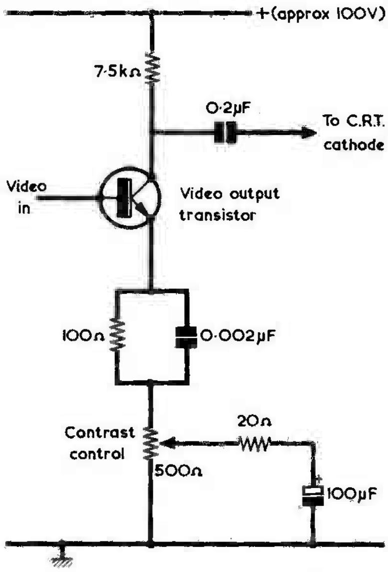


Fig. 2. Simplified circuit for a video output transistor stage. Note that contrast control is achieved by varying the amount of negative feedback introduced in the emitter load. Component values are representative of commercial practice in mains-battery single-standard portables

"One hundred volts at 6mA," repeated Dick incredulously. "Don't tell me that *that* comes from the line output stage as well."

"It does," chuckled Smithy. "In some sets also, the line output stage gives an enhanced supply voltage, of about 25 volts, for the i.f. amplifier, the sync separator and a few of the other stages."

LINE OUTPUT STAGE

"This seems crazy to me," commented Dick weakly. "How on earth can you get all these supply voltages from a single line output stage?"

"It's not too difficult," replied Smithy. "The main approach consists of connecting diode rectifier circuits to appropriate windings and taps on the line output transformer. Of the various higher supply voltages we've been mentioning, those for the c.r.t. and the video output transistor are essential in all mains-battery portables, with the result that the line output stages in these sets tend to be a little unique. An interesting factor is that there's a tendency towards the same basic line output design, irrespective of make and model. Another point is that these portable TV line output stages almost always employ a booster diode circuit that is virtually a Chinese copy of the booster diode circuits used in the old valve line output stages."

Dick frowned.

"I'm a bit lost now," he confessed. "I think you'll have to fill in a few details for me."

"Fair enough," said the Serviceman equably. "Come over here and I'll show you what I'm talking about."

Eagerly, Dick carried his stool to Smithy's bench and perched himself on it alongside Smithy. The latter pulled his note-pad towards him and sketched out a circuit. (Fig. 3(a).)

"Now this," he remarked, "is a basic version of the old line output valve and booster diode circuit. For the time being, I'm only showing the part of the line output transformer windings which appears in the booster diode circuit proper, and I haven't added the e.h.t. winding or the coupling arrangements to the line deflection coils. Which are, of course, fitted over the tube neck. And, next, here's a typical example, with the same section of the line output transformer windings, of the transistor version as encountered in mains-battery portable sets. The thermionic diode in the valve circuit is replaced by a semiconductor diode, and the line output valve is replaced by a power transistor connected in the common emitter mode."

Smithy indicated the diode and transistor in his second circuit. (Fig. 3(b).)

Dick looked at Smithy's sketch suspiciously.

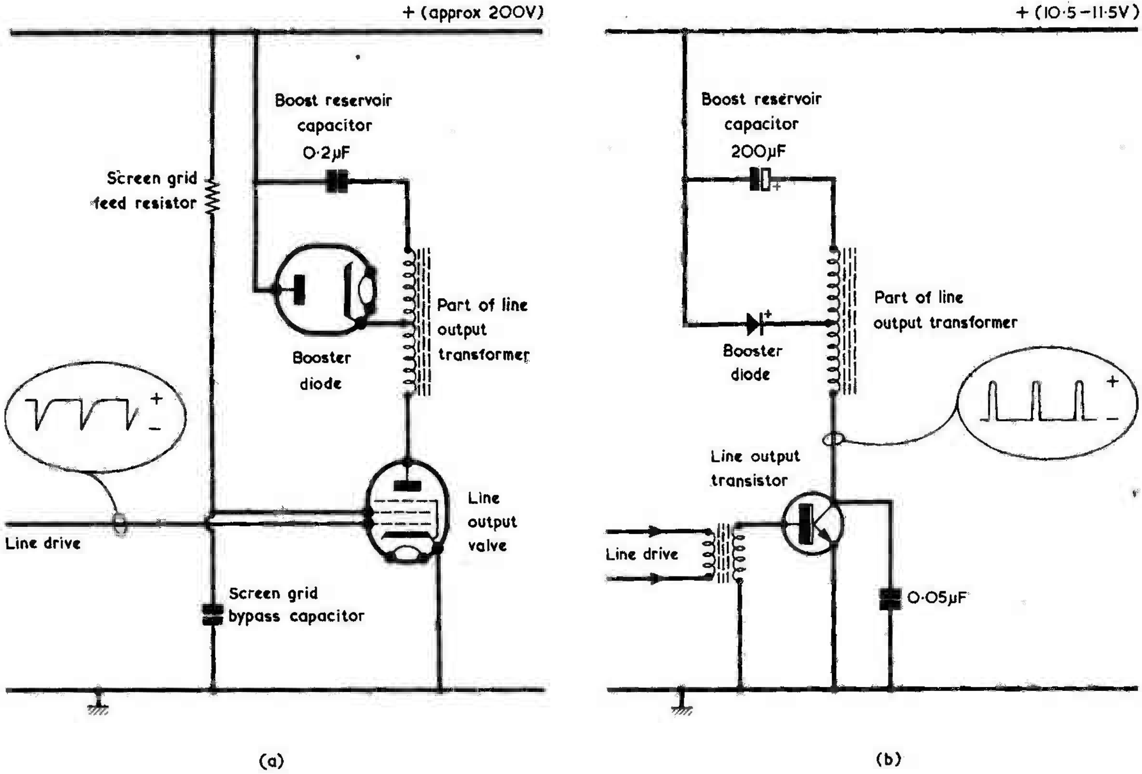


Fig. 3 (a). A circuit familiar to those raised on valve television servicing! This is the basic form of the booster diode line output circuit
(b). A very similar circuit is encountered in the line output stage of many mains-battery portable receivers. Capacitor values here and in (a) are representative

"There's an added capacitor between the bottom end of the transformer winding and chassis," he pointed out.

"True," agreed Smithy. "It's for transformer tuning. The transformer windings in the transistor version of the line output circuit have much lower inductance than those in the valve circuit because of the low supply voltage, which necessitates having much higher currents to achieve the same power output. Most valve line output transformers were tuned by their own winding self-capacitances, but the self-capacitances aren't high enough in transistor line output transformers. As a result, the transistor line output stages have an external transformer tuning capacitor lurking around somewhere in the circuit, usually from some part of the winding to chassis. A typical circuit position is between the bottom of the winding and chassis, as I've shown here. Another difference you will spot immediately is that, whereas the input coupling to the line output valve is by way of a capacitor and grid leak, that to the line output transistor is via a transformer. One of the advantages conferred by having an input transformer is that, if the line oscillator fails, there is no oscillatory voltage across the input transformer secondary and the line output transistor base has a d.c. connection to its emitter. This means that the output transistor is automatically turned off in the absence of line drive and there is no risk of damage."

"That's one good thing, at any rate," commented Dick. "In the old valve line output stages, the output valve anode used to go red-hot when the drive failed, because there was nothing to hold its control grid negative."

"True enough," agreed Smithy. "Anyway, I've now shown you the similarity in the boost section between these transistor portable TV line output stages and the earlier valve line output stages."

BOOST DIODE OPERATION

Smithy gazed cheerfully at his assistant. The latter looked back at him uncomprehendingly.

"Stap me," snorted Dick, suddenly breaking the silence. "You aren't just going to leave it there, are you?"

"What more do you want to know?" queried Smithy. "Both circuits work in the same basic manner. In the first circuit the line output valve acts like a switch and in the second circuit the line output transistor also acts like a switch."

"Yes," protested Dick, "but that's not *explaining!* You aren't even telling me what happens during the line scan cycle."

"Dear, oh dear," sighed Smithy. "With you I always have to go into detail. O.K. then, we'll start an explanation at a moment in the line scan cycle when the spot on the c.r.t. face has been deflected horizontally nearly all the way to the right. At this part of the line scan cycle the output valve or transistor is fully conductive and an increasing field is being built up in the output transformer winding. The build-up of this field is relatively slow because an inductance always opposes a change in the current which flows through it. The current in the winding flows from the top supply rail, through the booster diode, and then into the anode of the valve or into the collector of the transistor. It is obvious that the bottom of the winding will be negative of the booster diode cathode tap, and it follows from this that transformer action will cause the top of the winding to be *positive* of the booster diode cathode tap. This positive voltage is applied to the right hand plate of the boost reservoir capacitor. Following the initial few cycles after switching on, this capacitor has acquired a charge across its plates, and this charge is such that the voltage across the capacitor is virtually the same as that now appearing between the top of the winding and the booster diode cathode tap. All right up to now?"

"Yep," said Dick shortly. "Keep at it, Smithy!"

"Right," replied Smithy. "We next reach the end of the scan and go into the flyback period. This period is initiated by a change in the drive input which suddenly turns off the line output valve or the line output transistor. The flow of current in the transformer winding ceases completely, and its field suddenly collapses. You get the usual ringing effect that is given in any coil when the current in it is suddenly switched off and the voltage across the winding reverses, causing the anode or collector to go violently positive. The cathode of the booster diode also goes positive with respect to the top end of the winding, whereupon this diode ceases to conduct, and the only stable d.c. voltage point in the circuit is given at the right hand plate of the boost reservoir capacitor."

Smithy paused for a moment as Dick absorbed these facts.

"The winding," resumed Smithy, "will continue to ring. After reaching a maximum positive excursion at the valve anode or transistor collector, and at the booster diode cathode, the voltage will start to fall just as rapidly and will pass through zero, taking the booster diode cathode negative. As soon as this negative voltage exceeds the voltage across the boost reservoir capacitor, the booster diode conducts, causing the very low impedance of the reservoir capacitor to be placed across the upper section of the winding. The effect is almost the same as applying a short-circuit across the winding, and the ringing at once stops. There is, however, a large magnetic field in the winding and this now commences to fall in strength, the fall being slow due to the short-circuiting effect of the boost reservoir capacitor. This fall in the field constitutes the first part of the horizontal scan after flyback and the current flowing in the winding is in the opposite direction to that which flows at the end of the scan. A little before half-way along the scan the current approaches zero, and the line output valve or transistor, which is now fully conductive again, takes over. An increasing current is drawn through the winding until the flyback period arrives, whereupon the process takes place all over again."

"Hell's teeth," remarked Dick, "there are quite a lot of things going on in that simple circuit."

"There are," concurred Smithy. "Now, I've shown voltage waveforms in my circuits, but it's helpful to look at a waveform which shows the current in the winding as well. The current is like this."

Smithy sketched out the current waveform. (Fig. 4.)

"Just before the flyback," he went on, "the current in the line output transformer winding is at a maximum in one direction. During flyback the current falls to zero at the same time as the voltage goes to its peak, after which the current goes to a maximum in the other direction until the ringing in the winding is brought abruptly to a stop by the booster diode and the boost reservoir capacitor. The current then falls relatively slowly towards zero, whereupon the line output valve or transistor resumes control and causes an increasing current to be built up in the opposite direction."

"I suppose," put in Dick tentatively, "that the ringing during flyback takes place at a frequency which is controlled by the tuning capacitor you mentioned earlier?"

"It is," confirmed Smithy. "So far as the transistor version of the circuit is concerned, a common approach consists of tuning the winding such that one half-cycle of its ringing frequency fits neatly into the flyback period."

E.H.T. GENERATION

"Well," said Dick in a relieved tone, "at least, that's got the booster diode business sorted out. Let's add on the e.h.t. winding. I know that in the valve circuit this consists of an overwind added on at the anode end of the winding we've just been talking about. The overwind has quite a lot more turns, with the result that its outside end goes positive, during flyback, to a much higher voltage than that at the line output anode. This higher voltage is applied to an e.h.t. rectifier which passes current on voltage tips and keeps the e.h.t. reservoir capacitor charged. And the rectifier is a thermionic diode whose heater is fed by

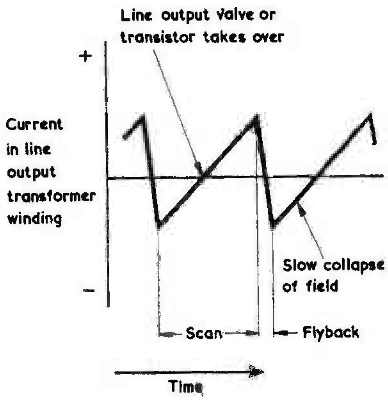


Fig. 4. Idealised waveform illustrating current conditions in the line output transformer winding

another winding on the line output transformer."

Dick added the new winding and components to Smithy's previous circuit. (Fig. 5.)

"Fair enough," commented Smithy. "In the valve circuit the line deflection coils could, typically, connect into suitable taps in the winding between the line output anode and the boost reservoir capacitor, but I don't think we want to keep on with the valve circuit any more. Let's concentrate instead on the transistor version as used in mains-battery portables. In this, the normal approach is to have a separate e.h.t. winding which has one end connected to chassis. The other end then couples to a single semi-conductor rectifier, and thence to the e.h.t. reservoir capacitor." (Fig. 6.)

"How about the line deflection coils?" asked Dick. "Do those also connect into taps in the main winding of the output transformer?"

"Not normally," replied Smithy. "The usual form is to couple the coils between chassis and the collector of the line output transistor via a capacitor and a line linearity control. The linearity control offers different and controllable impedances to currents in opposite directions, but I don't think I'll have enough time today to go into any greater detail about it than that. The line deflection coils may be in series or in parallel according to the make and design of the set."

Smithy drew in the two types of deflection coil circuits. (Figs. 7(a) and (b).)

"Up to now," he resumed, "I've shown you circuits in which the line output transistor is connected as a common emitter device. This is quite a common circuit but you may find that the line output transistor is more frequently employed as a common collector device. Here's the arrangement."

Smithy sketched out a further diagram. (Fig. 8.)

"In this instance," he said, "the transistor comes hard on during the scan period and acts as a switch in just the same manner as does the common emitter transistor. The only major difference occurs during the flyback period. With the common emitter circuit, the collector goes positive of chassis, and of the base and emitter, by a high voltage during the flyback cycle. When the common collector circuit is used, both the base and emitter, *and* the secondary of the drive transformer, go positive of chassis and the collector by a high voltage during flyback. Apart from this point the output transformer circuit into which the transistor connects is the same for both cases."

"Is that positive voltage during flyback very high?"

"It's pretty high for a transistor," replied Smithy. "Typically, the peak value is about 200 volts. Specially designed power transistors are employed for the job."

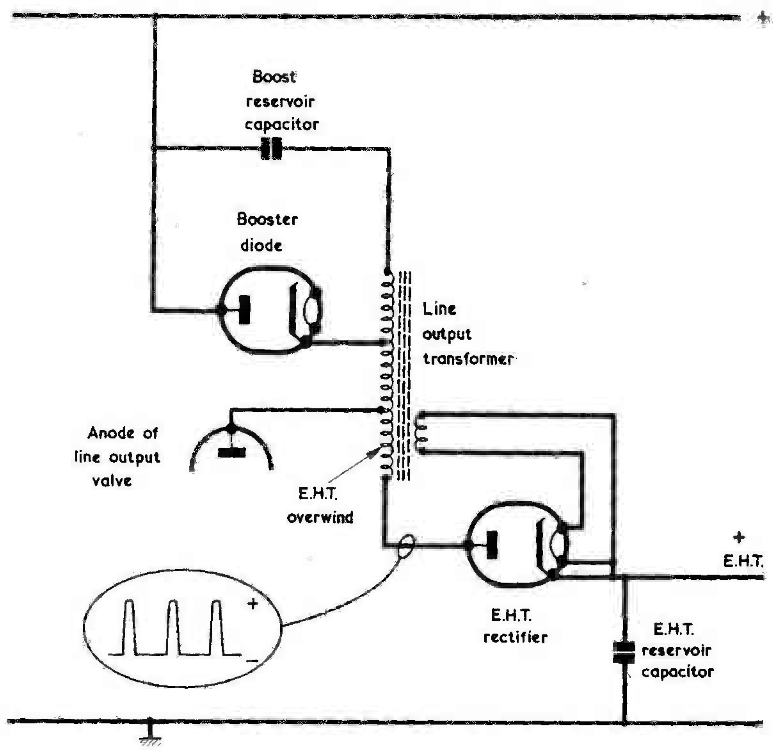


Fig. 5. Adding the e.h.t. overwind to the valve line output stage. The rectified e.h.t. supply connects to the final anode of the cathode-ray tube, whereupon the e.h.t. reservoir capacitor is formed in practice by the inside and outside graphite coatings of the tube, the outside coating being connected to the receiver chassis

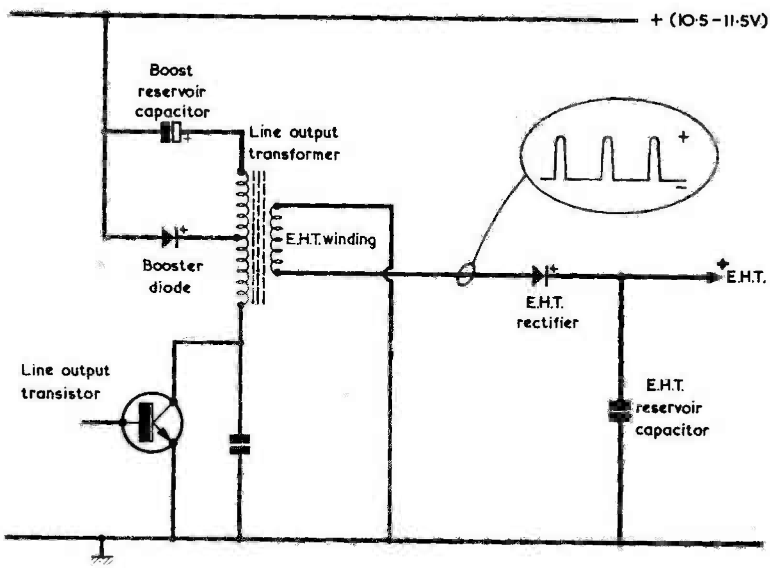
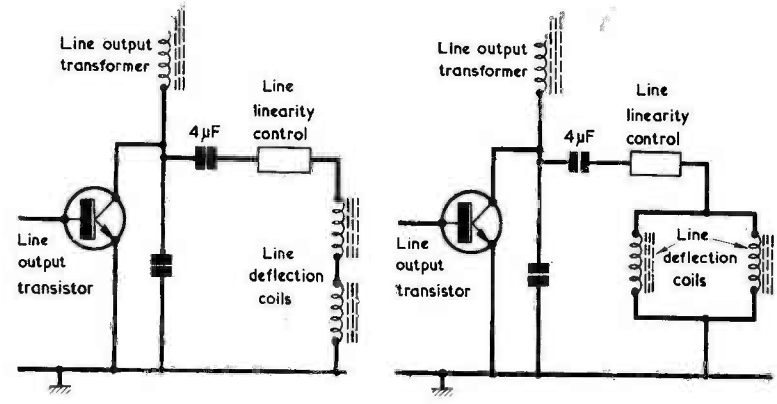


Fig. 6. In the transistor line output stage it is customary for the e.h.t. winding to be connected to chassis



(a) (b)

Fig. 7 (a). It is common practice to couple the line deflection coils to the line output transistor via a capacitor and the line linearity control. The components may appear in a different order in the series circuit, e.g. the capacitor could be between the deflection coils and chassis
(b). The same type of deflection coil feed circuit may also be used when the deflection coils are in parallel

HIGH VOLTAGES

"We seem," remarked Dick, "to have covered quite a lot of ground today. I hadn't realised that transistor TV line output stages could be as easy to follow as this!"

"It's quite easy to understand the ones used in mains-battery sets," qualified Smithy cautiously, "but this is only because the low supply voltage provided in these sets causes different set-makers to employ very nearly the same simple basic design. The fact that the e.h.t. voltages required in mains-battery sets are not very high also helps to make things easier. I should imagine, incidentally, that some of the old valve buffs are quite a bit relieved to find that there are some transistor line output stages which are very similar to the valve circuits they cut their TV teeth on!"

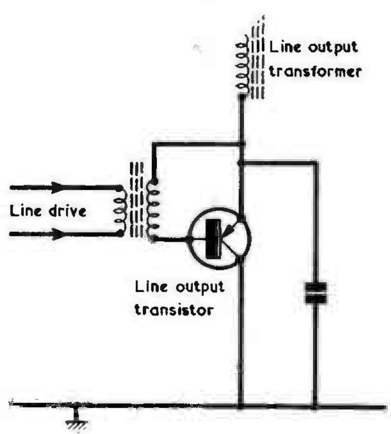


Fig. 8. It is frequent practice to have the line output transistor connected in common collector instead of in common emitter

"You're probably right there," grinned Dick. "Anyhow, let's dig next into those extra voltages you get from these transistor line output stages."

"As you like," responded Smithy obligingly. "Well now, we've already bumped into one of them."

"Have we? When?"

"When we mentioned the voltage which is built up across the boost reservoir capacitor. This voltage, added in series with the existing stabilized rail voltage of 10.5 to 11.5, gives a voltage above chassis which is, typically, of the order of 25 volts. Because of the high value of the reservoir capacitor this voltage is reasonably smooth and, if desired, can be used to supply the i.f. amplifier, sync separator and other stages. It is taken directly from the positive plate of the capacitor and requires only a little further smoothing."

"Fair enough," said Dick. "Now, what about the first and third anodes of the tube?"

"The voltages for these," explained Smithy, "are usually obtained from another winding on the transformer. Here's the basic idea."

Smithy picked up his pen, tore the top sheet from his note-pad, and drew another circuit on the fresh surface revealed. (Fig. 9.)

"The additional winding is connected," he went on, "so that its non-earthy end goes positive during the flyback period, whereupon positive pulses are passed via the rectifier to a

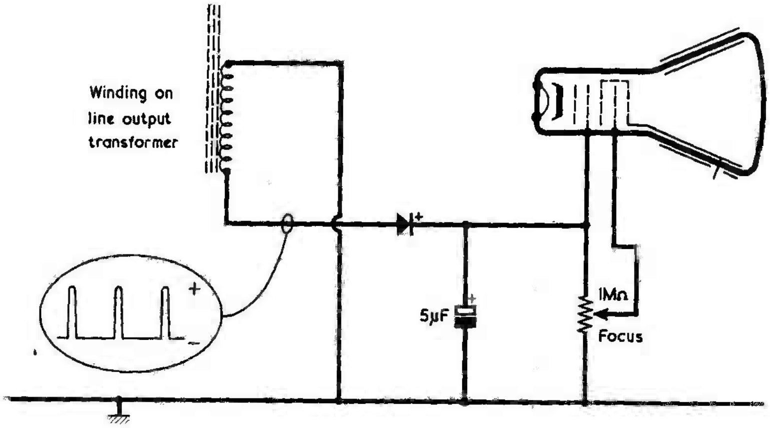


Fig. 9. A basic method, employed in some mains-battery portables, of obtaining a supply for the first and third anodes of the c.r.t.

reservoir capacitor and then to the first anode of the tube. The number of turns on the winding will be such as to cause the positive peaks to be around 300 volts or so. There is a pot between the first anode and chassis, and the third anode is connected to its slider. The pot is then adjusted for optimum focus."

"Stap me, that's neat!"

"It is rather, isn't it?" agreed Smithy. "Sometimes that extra winding is given by a tap in the e.h.t. winding, and sometimes there are more decoupling components than I have shown."

"All that's left now," said Dick, "is the supply of around 100 volts for the video output transistor."

"Ah yes," said Smithy. "Well, a further winding is often used for this supply, and it feeds another rectifier and reservoir circuit. However, the winding is so connected that the end which connects to the diode goes positive during the *scan* part of the line cycle. The voltage per turn is much lower than is needed when you're rectifying flyback pulses, but the positive voltage is present for a much longer period during the cycle. As a result, the rectified voltage has better regulation, as is required for a circuit like the video output stage, which needs much more juice than do the first and third anodes of the tube."

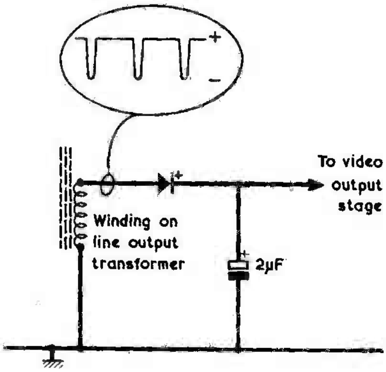


Fig. 10. A further winding on the line output transformer may be used to provide a rectified positive voltage of around 100 volts for the video output stage. In this case the non-earthy end of the winding goes positive during the scan period. The reservoir capacitor values shown here and in Fig. 9 are representative

Smithy drew his final circuit for the day. (Fig. 10.)

"I must add," he continued, "that, in some sets, the arrangements used to supply the video output stage may vary quite a bit from this last circuit I've drawn, and this is perhaps the least representative of all the schemes I've shown you. In some cases, for instance, the video output stage power may be picked up by a diode and series resistor from the line output transistor collector or emitter, as applicable, whereupon the supply consists of rectified flyback pulses. But the general basic ideas I've shown you today are typical of most of the U.K.-manufactured mains-battery TV portables you're likely to encounter."

NEW YEAR RESOLUTION

With these words, Smithy pushed his note-pad to the back of his bench and purposefully strode over to the portable television set which had been the initial cause of his discussion on line output stages. He examined the ticket tied to the back of the receiver.

"Humph," he grunted. "This set shouldn't be too difficult to fix. According to the ticket all that's wrong with it is lack of video h.f. response."

"That's funny," remarked Dick.

"Funny? In what way?"

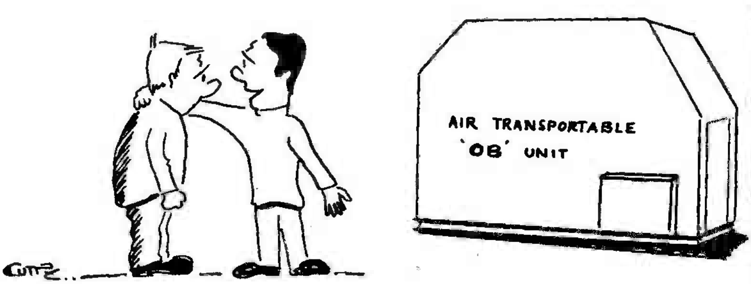
"Well," said Dick. "I said to myself on New Year's Day that this year I was going to stop the habit of pestering you for technical gen. But no sooner do I get into the workshop than I'm doing it all over again. So I'm guilty of the same thing that's wrong with that set."

Smithy looked mildly baffled.

"I'm a bit lost here," he said. "What is it you're guilty of?"

Dick grinned.

"I'm guilty," he chuckled, "of poor resolution!" ■



"I can assure you it's nothing to do with your B.O. problem!"

'The "Dualine" M.W.—V.H.F. Portable'

In Fig. 1 of this article, appearing on page 211 of the November 1973 issue, the upper end of VR1 should connect directly to the right hand end of L2, with neither of these components connecting to the collector of TR2.

Radio Topics

By Recorder

★ ★ ★ ★ ★ ★ ★

LIKE THE RED QUEEN, YOU HAVE TO keep running these days just to stay in the same place.

I am referring, of course, to the enormous spate of technical development and discovery which has continued unabated over the last two decades, and which necessitates continuous study on the part of the serious engineer if he is to keep up to date with current techniques and designs. The device which has done more than anything else to spark off all the present new ideas is the transistor. It was the transistor which demonstrated that it was possible to obtain amplification with solid-state devices, and as soon as the transistor became commercially viable the whole semiconductor revolution was launched. With the result that the transistor was followed by the other semiconductor devices which are now so plentiful and taken for granted: thyristors, f.e.t.'s, triacs, integrated circuits and all the rest of the solid-state family.

NON-SEMICONDUCTOR WORLD

What would life be like today if germanium and silicon had not proved to be so obliging as to lend themselves to the amplification of electrical signals?

For a start, there would be no semiconductor devices, and all signal amplifying processes would continue to be carried out by thermionic valves. But such valves would have undergone the further development which has been denied them since the advent of the transistor, and we would probably be employing much smaller and less power-consuming types than were evident when the transistor took over. So equipment would still have got smaller and lighter, although not by such a large amount as has actually happened with the transistor.

We would have computers, of course, but they would be quite enormous, costly and slow, as compared with actual present designs. There would be no such things as pocket electronic calculators, though doubtless some ingenious mechanical designs might have broken through here. Space travel would have been virtually unthinkable as also, and here's a thought, would be the more sophisticated types of guided missile.

For control purposes in factory production processes we would still be relying on relays and, in some instances, thyratrons. And much of our current electronic medical equipment would probably just not be in existence or would, at any rate, be available in much larger and clumsier form.

We would not have the really tiny sound radios which are retailed so cheaply these days but, nevertheless, I think there would have been quite a large quantity of fairly small battery radios knocking around. Apart from its small size a transistor scores by its low power consumption, and the use of Class B output stages enables the current requirement of a receiver at low volume level to be of the order of 10mA or less. But when the transistor ousted the valve in the portable radio field, we were already employing valves in which the filament consumption was only 25mA. Had a further twenty years of research on the valve been carried out, smaller types requiring lower powers could well have made their appearance.

At any event, semiconductor devices *have* taken over and they have probably changed our way of life to a greater extent than we realise. Perhaps their greatest effect, so far as our future destiny is concerned, is that they have enabled us to at least consider the hitherto unattainable: the possibility of physical contact with the other worlds around us.

LIFE AT SEA

Entertainment equipment plays an important role in alleviating the problem of boredom amongst the crews of ocean-going tankers. Marconi Marine, one of the GEC-Marconi Electronics companies, is well-known for shipboard radio installations and these include the provision of entertainment radio and television facilities. The company announces that it has just received orders from the BP Tanker Company for the supply of 2 radio and stereo cassette tape player units for each of 9 new vessels now nearing completion in Japanese, Swedish and French yards.

This is the second major order from BP for equipment of this type, 19 vessels having been similarly equipped last year. At that time Marconi Marine also supplied 2 triple-standard television receivers, complete with aerials, to each of 73 BP tankers.

The entertainment units ordered comprise a Marconi Marine broadcast receiver and a 4-track stereo cassette recorder, the amplifier of which feeds two matched speakers. Coverage of the commercial broadcast bands between 150kHz and 22MHz is provided by the receiver, which can also be connected to the tape recorder for direct recording of off-air programmes.

The 9 ships will each carry a library of cassette tapes and will have one unit installed in the officers smoke room and one in the crew's recreation room.

So far as the general installation of entertainment equipment in ships is concerned, television has proved a popular addition to sound systems, and Marconi Marine has now supplied some 3,000 receivers to vessels trading in all parts of the world. A further addition to the company's range of units is the Telmar EVR cassette television player, and more than 100 BP vessels have been fitted with these units.

ELECTRONIC ORGAN I.C.

Electronic organ enthusiasts will be more than interested to learn of a new integrated circuit manufactured by Mullard Limited, of Mullard House, Torrington Place, London, WC1E 7HD.

This is the type SAJ110 and it is a frequency divider which can produce seven different notes. Hence, twelve i.c.'s, with oscillators to generate the fundamental frequencies, can provide all the notes needed in an organ.

The SAJ110 contains seven frequency dividers with separate inputs for three, the other four are arranged in two pairs with one input for each pair. Each divider is a flip-flop which can accept any waveform and produce a square wave. Output impedance is low and the separation between adjacent dividers is of a very high order.

Combining outputs by means of resistor networks produces an increased range of harmonics and facilitates the synthesis of a wide number of tones. The outputs are short-circuit proof.

The use of the SAJ110 can greatly reduce the number of components that would otherwise be needed, as well as considerably simplifying the printed board layout. It has a 14 pin dual-in-line encapsulation.

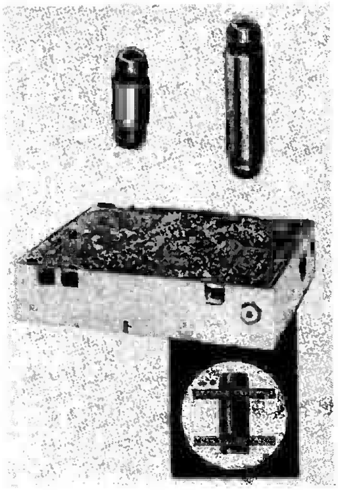
Another new i.c. from Mullard has been developed for use in high quality f.m. radio receivers with or without a stereo output. The type number is TCA420A, and it contains a four stage i.f. amplifier-limiter and a symmetrical quadrature detector which provides a high degree of a.m. rejection. The rejection is maintained even with small signals.

The TCA420A can also supply several other facilities required in a modern high quality f.m. receiver. For example, it has an output for driving a tuning meter, the zero and full-scale readings of which can be easily adjusted by means of a simple resistive circuit. Another output can operate an automatic stereo inhibit switch when the received signal exceeds a predetermined level. Muting between stations is provided and, to assist tuning, the TCA420A also gives 'side-response' damping.

This particular i.c. is in a 16 pin dual-in-line encapsulation.

SPACER BUSHINGS

Readers who undertake servicing jobs may have already encountered some of the polyamide spacer bushings which appear in the photograph. These are in the E. F. Johnson range of components and are offered by Vero Electronics Limited, Industrial Estate, Chandlers Ford, Eastleigh, Hampshire.



Snap-on printed circuit mounting is provided by the polyamide spacer bushings pictured here. These are available from Vero Electronics Limited

The spacers are available for stand-off heights ranging from 0.125 to 0.75in., and are designed so that a printed board can be snapped on to them and just as readily removed later. The board is provided with a hole which causes the widest part of the upper section of the spacer to contract as the board passes over it. Once fitted, the board is held securely in position.

The lower end of the spacer can snap permanently into a hole of suitable diameter in any $\frac{1}{16}$in. thick chassis or panel. In the assembly shown in the photograph there are two of the spacers on the side nearer the camera.

BENCH METER

Talking about servicing, there is a simple servicing aid which, I understand, is used quite a lot on the Continent although it is hardly ever encountered in the U.K. It consists quite simply of a current reading meter which is permanently installed on the bench and connected in series with the mains feed to the socket or sockets to which receivers and amplifiers being serviced are connected. When such a meter is present it becomes second nature, after a while, to automatically note the mains current drawn by equipment under test and see whether this differs from the norm. Service engineers who use such a meter claim that quite a few fault symptoms can be shown up by it.

This seems to be quite a good idea and is, at any rate, certainly worth while passing on. A 0–5 amp moving-iron meter would seem to be the best choice. The only snag I can think of is that the meter could suffer damage if a short-circuit were accidentally placed on the test mains socket.

Another simple servicing dodge is one which appeared in these notes some years ago but which merits repetition for the benefit of newcomers. If you think that the inductance of a ferrite rod aerial coil in a superhet needs varying, but it is difficult to move the coil along the rod, the following processes can be carried out. Tune in a weak station at the low frequency end of the band concerned, then bring another ferrite rod close to the rod on which the coil is fitted. If signal strength increases as the second rod approaches the first, the aerial coil needs more inductance. Alternatively, twist a length of solder to form a 'shorted turn' of about 1in. diameter and bring it up to and then over the end of the rod on which the coil is fitted. If this causes signal strength to increase then the aerial coil needs less inductance. ■

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(Continued on page 385)

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(Continued from page 383)

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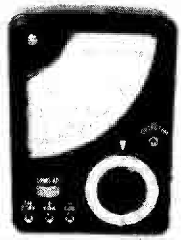
(Continued on page 387)



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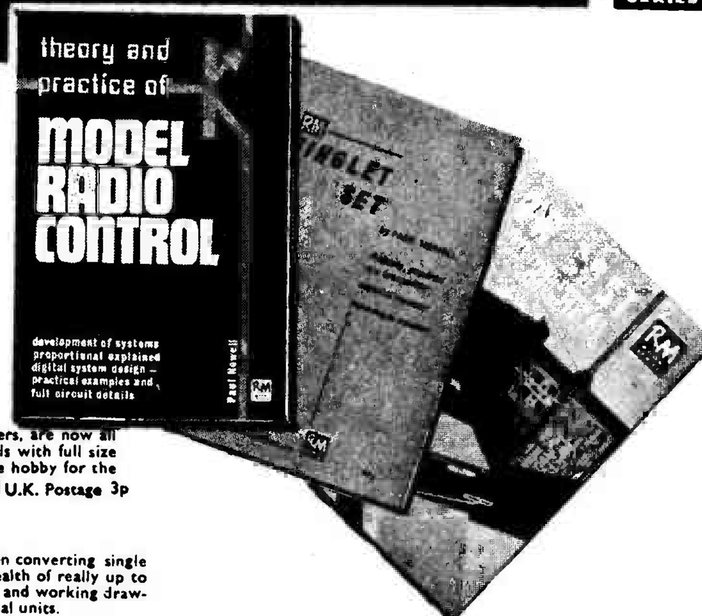

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(Continued from page 385)

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WAVELENGTH-FREQUENCY TABLE 1

The first five entries list radio frequencies of wavelengths from 0.3 to 3,000 metres, after which frequencies are given for wavelengths from 30 to 72 metres. Use the appropriate factor for wavelengths in other decades; thus, 5.2 metres corresponds with 57.7MHz. The list will be completed in the next Data Sheet.

Wavelength (metres)	Frequency (MHz)	Wavelength (metres)	Frequency (MHz)	Wavelength (metres)	Frequency (MHz)	Wavelength (metres)	Frequency (MHz)
0.3	1,000.0	37	8.10	49	6.12	61	4.91
3	100.0	38	7.89	50	6.00	62	4.84
30	10.0	39	7.67	51	5.86	63	4.76
300	1.0	40	7.50	52	5.77	64	4.69
3,000	0.1	41	7.31	53	5.66	65	4.61
30	10.0	42	7.14	54	5.56	66	4.55
31	9.67	43	6.97	55	5.45	67	4.47
32	9.37	44	6.82	56	5.35	68	4.40
33	9.06	45	6.67	57	5.26	69	4.35
34	8.80	46	6.52	58	5.17	70	4.29
35	8.57	47	6.38	59	5.08	71	4.22
36	8.33	48	6.25	60	5.00	72	4.17