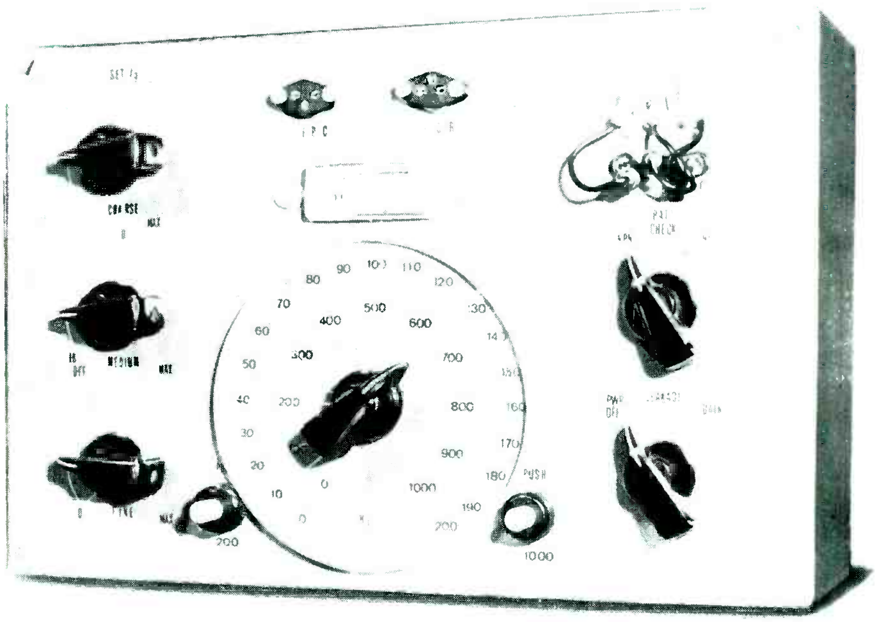
THE

RADIO CONSTRUCTOR

Vol. 25 No. 6 JANUARY 1972 20p



TRANSISTOR TESTER

Provides accurate measurements of transistor a.c. gain by means of a bridge technique, dispensing with the necessity for an expensive meter.
Also gives a measure of leakage current and checks semiconductor diodes.

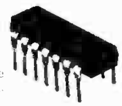
FEATURED IN THIS ISSUE

I.C. INTRUDER ALARM

-the lowest prices!

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

DOWN AGAIN IN PRICE



Check our 74 Series List before you buy any I.C's. Our prices are the lowest possible. All devices ex-stock. Full spec. guaranteed.

BI-PAK Order No.		Price and qty. prices 1-24 £p	25-99 £p	100 up £p
BP00	SN7400	0.15	0.14	0.12
BP01	SN7401	0.15	0.14	0.12
BP02	SN7402	0.15	0.14	0.12
BP03	SN7403	0.15	0.14	0.12
BP04	SN7404	0.15	0.14	0.12
BP05	SN7405	0.15	0.14	0.12
BP07	SN7407	0.18	0.17	0.16
BP08	SN7408	0.18	0.17	0.16
BP09	SN7409	0.18	0.17	0.16
BP10	SN7410	0.15	0.14	0.12
BP13	SN7413	0.29	0.26	0.24
BP16	SN7416	0.43	0.40	0.38
BP17	SN7417	0.43	0.40	0.38
BP20	SN7420	0.15	0.14	0.12
BP30	SN7430	0.15	0.14	0.12
BP40	SN7440	0.15	0.14	0.12
BP41	SN7441	0.67	0.64	0.58
BP42	SN7442	0.67	0.64	0.58
BP43	SN7443	1.95	1.85	1.75
BP44	SN7444	1.95	1.85	1.75
BP45	SN7445	1.95	1.85	1.75
BP46	SN7446	0.97	0.94	0.88
BP47	SN7447	0.97	0.94	0.88
BP48	SN7448	0.97	0.94	0.88
BP50	SN7450	0.15	0.14	0.12
BP51	SN7451	0.15	0.14	0.12
BP53	SN7453	0.15	0.14	0.12
BP54	SN7454	0.15	0.14	0.12
BP60	SN7460	0.15	0.14	0.12
BP70	SN7470	0.29	0.26	0.24
BP72	SN7472	0.29	0.26	0.24
BP73	SN7473	0.37	0.35	0.32
BP74	SN7474	0.37	0.35	0.32
BP75	SN7475	0.47	0.45	0.42
BP76	SN7476	0.43	0.40	0.38
BP80	SN7480	0.67	0.64	0.58
BP81	SN7481	0.97	0.94	0.88
BP82	SN7482	0.97	0.94	0.88
BP83	SN7483	1.10	1.05	0.95

BI-PAK Order No.		Price and qty. prices 1-24 £p	25-99 £p	100 up £p
BP86	SN7486	0.32	0.30	0.28
BP90	SN7490	0.67	0.64	0.58
BP91	SN7491AN	0.87	0.84	0.78
BP92	SN7492	0.67	0.64	0.58
BP93	SN7493	0.67	0.64	0.58
BP94	SN7494	0.77	0.74	0.68
BP95	SN7495	0.77	0.74	0.68
BP96	SN7496	0.77	0.74	0.68
BP100	SN74100	1.75	1.65	1.55
BP104	SN74104	0.97	0.94	0.88
BP105	SN74105	0.97	0.94	0.88
BP107	SN74107	0.40	0.38	0.36
BP110	SN74110	0.55	0.53	0.50
BP111	SN74111	1.25	1.15	1.00
BP118	SN74118	1.00	0.95	0.90
BP119	SN74119	1.35	1.25	1.10
BP121	SN74121	0.67	0.64	0.58
BP145	SN74145	1.50	1.40	1.30
BP150	SN74150	1.80	1.70	1.60
BP151	SN74151	1.00	0.95	0.90
BP153	SN74153	1.20	1.10	0.95
BP154	SN74154	1.80	1.70	1.60
BP155	SN74155	1.40	1.30	1.20
BP156	SN74156	1.40	1.30	1.20
BP160	SN74160	1.80	1.70	1.60
BP161	SN74161	1.80	1.70	1.60
BP164	SN74164	2.00	1.90	1.80
BP165	SN74165	2.00	1.90	1.80
BP181	SN74181	2.75	2.60	2.40
BP182	SN74182	0.97	0.94	0.88
BP190	SN74190	3.50	3.25	3.00
BP191	SN74191	3.50	3.25	3.00
BP192	SN74192	2.10	1.95	1.75
BP193	SN74193	2.10	1.95	1.75
BP195	SN74195	1.10	1.05	0.95
BP196	SN74196	1.80	1.70	1.60
BP197	SN74197	1.80	1.70	1.60
BP198	SN74198	5.50	5.00	4.00
BP199	SN74199	5.50	5.00	4.00

PRICE-MIX. Devices may be mixed to qualify for quantity prices.

PRICES for quantities in excess of 500 pieces mixed, on application.

Owing to the ever increasing range of TTL 74 Series, please check with us for supplies of any devices not listed above, as it is probably now in stock. WARE 3442.

DTL & TTL INTEGRATED CIRCUITS

Manufacturers' "Fall-outs"—out of spec. devices including functional units and part function but classed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C's and experimental work.

D T L

PAK No.			
UIC930	12	μA 930	50p
UIC932	12	μA 932	50p
UIC933	12	μA 933	50p
UIC935	12	μA 935	50p
UIC936	12	μA 936	50p
UIC944	12	μA 944	50p
UIC945	8	μA 945	50p
UIC946	12	μA 946	50p

PAK No.			
UIC948	8	μA 948	50p
UIC951	5	μA 951	50p
UIC961	12	μA 961	50p
UIC9093	5	μA 9093	50p
UIC9094	5	μA 9094	50p
UIC9097	5	μA 9097	50p
UIC9099	5	μA 9099	50p

UIC 925 Assorted 930 Series £1.50

Packs cannot be split but 25 Assorted Pieces (our mix) is available as Pack UIXC9. Every Pak carries our BI-PAK Satisfaction or money back guarantee.
Data booklet available the BP930 Series. PRICE 13p

PAK No.			
UIC00	12	7400N	50p
UIC01	12	7401N	50p
UIC02	12	7402N	50p
UIC03	12	7303N	50p
UIC04	12	7404N	50p
UIC05	12	7405N	50p
UIC10	12	7410N	50p
UIC13	8	7413N	50p
UIC20	12	7420N	50p
UIC40	12	7440N	50p
UIC41	5	7441AN	50p
UIC42	5	7442N	50p
UIC43	5	7443N	50p
UIC44	5	7444N	50p

PAK No.			
UIC45	5	7445N	50p
UIC46	5	7446N	50p
UIC47	5	7447N	50p
UIC48	5	7448N	50p
UIC50	12	7450N	50p
UIC51	2	7451N	50p
UIC53	12	7453N	50p
UIC54	12	7454N	50p
UIC60	12	7460N	50p
UIC70	8	7470N	50p
UIC72	8	7472N	50p
UIC73	8	7473N	50p
UIC74	8	7474N	50p
UIC75	8	7475N	50p

PAK No.			
UIC76	8	7476N	50p
UIC80	5	7480N	50p
UIC81	5	7481N	50p
UIC82	5	7482N	50p
UIC83	5	7483N	50p
UIC86	5	7486N	50p
UIC90	5	7490N	50p
UIC91	5	7491N	50p
UIC92	5	7492N	50p
UIC93	5	7493N	50p
UIC94	5	7494N	50p
UIC95	5	7495N	50p
UIC96	5	7496N	50p
UIC121	5	74121N	50p

UICX1 25 Ass't'd 74's £1.50

Data is available for the above Series of Integrated Circuits in booklet form, price 13p. Packs cannot be split but 20 assorted pieces (our mix) is available as PAK UICX1. Every PAK carries our BI-PAK Satisfaction or money back GUARANTEE.

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THE NEW SGS EA1000 AUDIO AMPLIFIER MODULE

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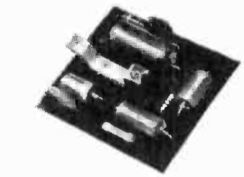

Especially designed by S.G.S. incorporating their proven Linear I.C. Audio Amp. TAA621 providing unlimited applications for the enthusiast in the construction of radios, record players, Audio and Stereo units. Also ideal for inter-com systems, monitoring applications and phone answering machines. Other uses: **portable applications where supply rails as low as 9V are of prime importance.**

* Sensitivity 40 mV for 1 watt Voltage gain 40 dB but can be varied up to 73 dB for some applications
* Signal to Noise Ratio 86 dB
* Frequency response better than 50 Hz to 25 KHz for 3 dB
* Normal supply Voltage 9–24V
* Suitable for 8–16 ohm loads.
* Overall size 2" × 3" × ¾".
* Typical Total Harmonic distortion at 1 Watt less than 1%.
* Supply Voltage (Vs) 24V 15 ohm load.

Module Tested and Guaranteed.

Qty	1-9	10-25
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LOGIC DTL 930 SERIES I.C's

Type No.	Function	Price 1-24	25-99	100 up
BP930	Expandable dual 4-input NAND	12p	11p	10p
BP932	Expandable dual 4-input NAND buffer	13p	12p	11p
BP933	Dual 4-input expander	13p	12p	11p
BP935	Expandable Hex Inverter	13p	12p	11p
BP936	Hex Inverter	13p	12p	11p
BP944	Dual 4-input NAND expandable buffer without pull-up	13p	12p	11p
BP945	Master-slave JK or RS	25p	24p	22p
BP946	Quad. 2-input NAND	12p	11p	10p
BP948	Master-slave JK or RS	25p	24p	22p
BP951	Monostable	65p	60p	55p
BP962	Triple 3-input NAND	12p	11p	10p
BP9093	Dual Master-slave JK with separate clock	40p	38p	35p
BP9094	Dual Master-slave JK with separate clock	40p	38p	35p
BP9097	Dual Master-slave JK with Common Clock	40p	38p	35p
BP9099	Dual Master-slave JK Common Clock	40p	38p	35p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application (DTL 930 Series only.)

BRAND NEW LINEAR I.C's—FULL SPEC.

Type No.	Case	Leads	Description	Price 1-24	25-99	100 up
BP 201C SL201C	TO-5	8	G.P. Amp	63p	53p	45p
BP 701C—SL701C	TO-5	8	OP Amp	63p	50p	45p
BP 702C—SL702C	TO-5	8	OP Amp Direct OP	63p	50p	45p
BP 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	53p	45p	40p
BP 709—72709	D.I.L.	14	High OP Amp	53p	45p	40p
BP 709P—μA709C	TO-5	8	High Gain OP Amp	53p	45p	40p
BP 710—72710	D.I.L.	14	Differential Comparator	53p	45p	40p
BP 711—μA711	TO-5	10	Dual comparator	58p	50p	45p
BP 741—72741	D.I.L.	14	High Gain OP Amp (Protected)	75p	60p	50p
μA 703C—μA703C	TO-5	6	R.F.-I.F. Amp	43p	35p	27p
TAA 263—	TO-72	4	A.F. Amp	70p	60p	55p
TAA 293—	TO-74	10	G.P. Amp	90p	75p	70p
TAA 350	TO-5	8	Wideband Limiting Amplifier	170p	158p	150p

RTL MICROLOGIC CIRCUITS

Epoxy TO-5 case	Price each 1-24	25-99	100 up
uL900 Buffer	35p	33p	27p
uL914 Dual 2i/p gate	35p	33p	27p
uL923 J-K flip flop	50p	47p	45p

Data and Circuits Booklets for I.C's. Price 7p.

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TSO 14 pin type	30p	27p	25p
TSO 16 pin type	35p	32p	30p

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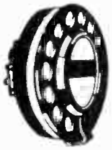

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B2	4	Photo Cells, Sun Batteries. 0·3 to 0·5V. 0·5 to 2mA.	50p
B79	4	IN4007 Sil. Rec. diodes. 1,000 PIV lamp plastic	50p
B81	10	Reed Switches, mixed types large and small	50p
B99	200	Mixed Capacitors. Approx. quantity, counted by weight	50p
H4	250	Mixed Resistors. Approx. quantity counted by weight	50p
H7	40	Wirewound Resistors. Mixed types and values.	50p
H8	4	BY127 Sil. Recs. 1000 PIV. 1 amp. plastic	50p
H9	2	OCP71 Light Sensitive Photo Transistor	50p
H12	50	NKT155/259 Germ. diodes, brand new stock clearance	50p
H18	10	OC71/75 uncoded black glass type PNP Germ.	50p
H19	10	OC81/81D uncoded white glass type PNP Germ.	50p
H28	20	OC200/1/2/3 PNP Silicon uncoded TO-5 can	50p
H29	20	OA47 gold bonded diodes coded MCS2	50p

NEW UNMARKED UNTESTED PACKS

B66	150	Germanium Diodes Min. glass type	50p
B83	200	Trans. manufacturers' rejects all types NPN, PNP, Sil. and Germ.	50p
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	50p
B86	50	Sil. Diodes sub. min. IN914 and IN916 types	50p
B88	50	Sil. Trans. NPN, PNP equiv. to OC200/1 2N706A, BSY95A, etc.	50p
B1	50	Germanium Transistors PNP, A.F. & R.F.	50p
H6	40	250mW. Zener Diodes DO-7 Min. Glass Type	50p
H10	25	Mixed volts, 1½ watt Zeners Top hat type	50p
H17	20	3 amp. Silicon Stud rectifiers, mixed bolts	50p
H15	30	Top Hat Silicon Rectifiers, 750mA. Mixed volts	50p
H16	8	Experimenters' Pak of Integrated Circuits. Data supplied	50p
H20	20	BY126/7 Type Silicon Rectifiers 1 amp plastic. Mixed volts.	50p

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TYPE "A" PNP Silicon alloy, TO-5 can.
TYPE "B" PNP Silicon, plastic encapsulation.
TYPE "E" PNP Germanium AF or RF.
TYPE "F" NPN Silicon plastic encapsulation.

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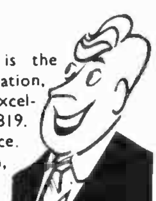
	£p		£p
AC107	0·15	OC170	0·23
AC126	0·13	OC171	0·23
AC127	0·17	OC200	0·25
AC128	0·13	OC201	0·25
AC176	0·25	2G301	0·13
ACY17	0·15	2G303	0·13
AF239	0·37	2N711	0·50
AF186	0·50	2N1302-3	0·20
AF139	0·37	2N1304-5	0·25
BC154	0·25	2N1306-7	0·30
BC107	0·13	2N1308-9	0·35
BC108	0·13	2N3819FET	0·45
BF194	0·15	**Power Transistors**	
BC109	0·14		
BF274	0·15	OC20	0·50
BFY50	0·20	OC23	0·30
BSY25	0·57	OC25	0·25
BSY26	0·13	OC26	0·25
BSY27	0·13	OC28	0·30
BSY28	0·13	OC35	0·25
BSY29	0·13	OC36	0·37
BSY95A	0·15	AD149	0·30
OC41	0·13	AUY10	1·25
OC44	0·13	25034	0·25
OC45	0·13	2N3055	0.50
OC71	0·13		
OC72	0·13	**Diodes**	
OC81	0·13	AAY42	0·10
OC81D	0·13	OA95	0·19
OC83	0·20	OA79	0·09
OC139	0·13	OA81	0·09
OC140	0·17	IN9114	0·07

F.E.T. PRICE BREAKTHROUGH!!

This field effect transistor is the 2N3823 in a plastic encapsulation, coded as 3823E. It is also an excellent replacement for the 2N3819. Data sheet supplied with device. 1-10 **30p** each, 10-50 **25p** each, 50+ **20p** each.



BULK BUYING CORNER

NPN/PNP Silicon Planar Transistors, mixed, untested, similar to 2N706/6A/8, BSY26-29,BSY95A, BCY70, etc. **£4·25** per 500; **£8** per 1,000

Silicon Planar NPN Plastic Transistors, untested, similar to 2N3707-11, etc., £4·25 per 500; £8 per 1,000.

Silicon Planar Diodes, DO-7 Glass, similar to OA200/202, BAY31-36, £4·50 per 1,000.

NPN/PNP Silicon Planar Transistors, Plastic TO-18, similar to BC113/4, BC153/4, BF153/160, etc., £4·25 per 500; £8 per 1,000.

OC44, OC55 Transistors fully marked and tested, 500+ at **8p** each; 1,000+ at **6p** each.

OC71 Transistors, fully marked and tested, 500+ at **6p** each; 1,000+ at **5p** each.

3823E Field effect Transistors. This is the 2N3823 in Plastic Case, 500+ **13p** each; 1,000+ **10p** each.

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IN4006, 500+ at **6p** each, 1,000+ at **5p** each
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OC71 or 72 Fully Tested Unmarked	5p	5p	4p
Matched Sets 1-OC44 and 2-OC45's. Per Set.	25p	20p	15p
Matched Sets of OC45's 1st and 2nd IF	15p	12p	10p
OA47 Gold-Bonded Diodes, Marked and Tested	3p	3p	2p
1-watt Zener Diodes 7·5, 24, 27, 30, 36, 43 Volts	5p	4p	3p
10-watt Zener Diodes 5·1, 8·2, 11, 13, 16, 24, 30, 100 Volts	20p	17p	15p
Micro Switches, S/P, C/O	25p	20p	15p
1-amp Bridge Rec's 25-volt	25p	22p	20p

INTEGRATED CIRCUITS

SL403D Audio Amp.,3-Watts	2·00	1·95	1·80
709C Linear Opp. Amp.	50p	40p	35p
Gates, Factory Marked and Tested by A.E.I.	25p	22p	20p
J. K. Flip-Flops Factory, Marked and Tested by A.E.I.	40p	35p	30p
PA234 1-watt Audio Amp.	1·00	90p	80p
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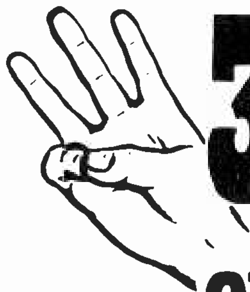

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THE Radio Constructor

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Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that such queries cannot be answered over the telephone; they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

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CONTENTS

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FEBRUARY ISSUE WILL BE PUBLISHED ON FEBRUARY 1st

NOVEL A.F. AMPLIFIER

by

J. A. BRETT

An unusual amplifier design which provides a Class A output and which can be made to operate with either a negative or a positive supply rail.

THIS NOVEL AMPLIFIER WAS DESIGNED TO PROVIDE, AT little cost, a simple audio amplifier for use with a record player. It is sufficiently sensitive to accept the output of most crystal pick-ups and if two amplifiers are built up a low-cost stereo system is easily made.

The amplifier may also be used to give a more powerful output from small transistor radios by taking an input from the personal earphone socket of the radio.

An unusual feature is that the amplifier may be built up in one of two versions, one version employing p.n.p. input and output transistors, and the other employing n.p.n. input and output transistors. Both versions offer approximately the same performance and both have the same circuit, with the exception that rectifiers and electrolytic capacitors are reversed in one as compared with the other. This factor can be of assistance to the constructor, who may already have one or more of the transistors required for one of the versions on hand.

THE CIRCUIT

Referring to either of the circuit diagrams given in Figs. 1 and 2, the amplifier functions in the manner to be described. Where a transistor is referred to by its

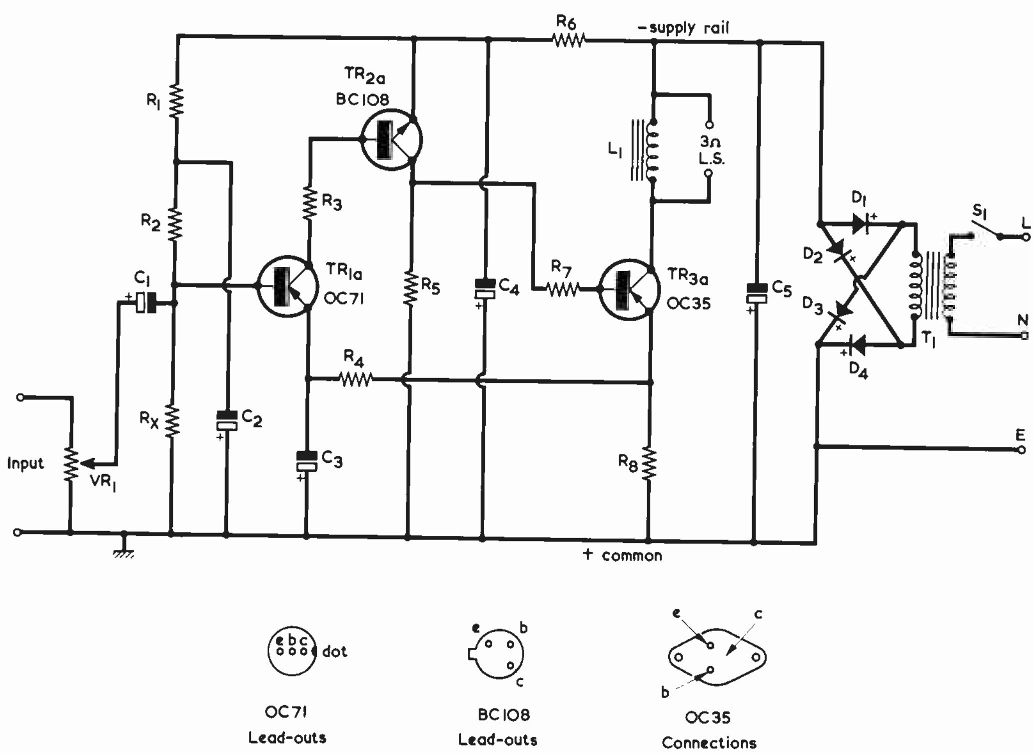

Fig. 1. The a.f. amplifier in the form in which it incorporates p.n.p. input and output transistors

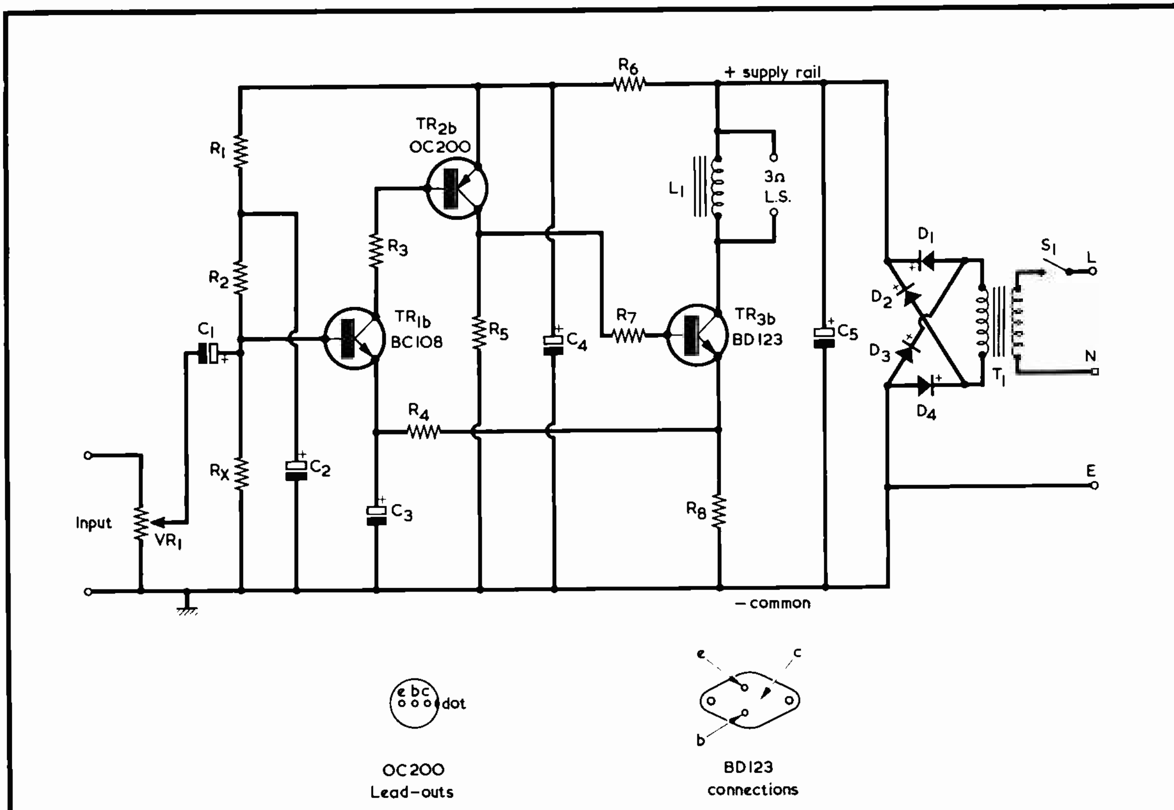

Fig. 2. The alternative version, which offers a similar performance. Here, all the polarities of Fig. 1 are reversed

COMPONENTS

Resistors
(All fixed values ¼ watt 20% unless otherwise stated)

R1	100kΩ
R2	100kΩ
R3	1kΩ
R4	1kΩ
R5	10kΩ
R6	100Ω
R7	1kΩ
R8	1Ω 1 watt, wire-wound
Rx	See text
VR1	250kΩ potentiometer, log, with switch S1.

Capacitors
(All capacitors electrolytic)

C1	5μF 6 V.Wkg.
C2	10μF 6 V.Wkg.
C3	100μF 6 V.Wkg.
C4	200μF 12 V.Wkg.
C5	1,000μF 12 V. Wkg.

Inductors

T1	Mains transformer, see text
L1	Output choke, see text

Transistors
For Fig. 1 circuit:
TR1(a) OC71
TR2(a) BC108
TR3(a) OC35*
For Fig. 2 circuit:
TR1(b) BC108
TR2(b) OC200
TR3(b) BD123*
*With mica washer and insulated mounting bushes

Diodes
D1–D4 silicon rectifiers, 1 amp 50 p.i.v.

Loudspeaker
3Ω moving-coil loudspeaker

Miscellaneous
Chassis (as required)
10-way groupboard
Knob
Screened cable
6-way terminal strip
Grommets, bolts, nuts, etc.

suffix number, this can apply to the appropriate transistor in either Fig. 1 or Fig. 2. Thus, a reference to 'TR2' may apply equally to TR2(a) in Fig. 1 or to TR2(b) in Fig. 2.

The bias for the three transistors is developed automatically, as they are connected in a closed loop

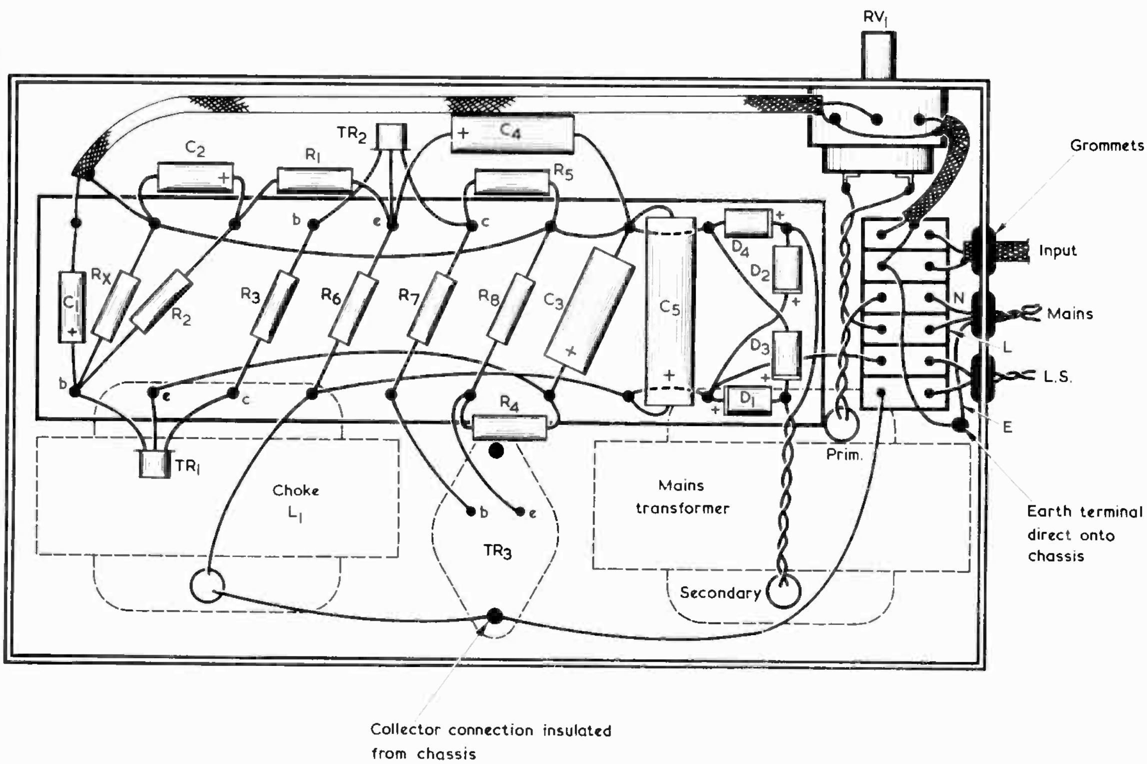

Fig. 3. Under-chassis view, showing a suitable wiring and component layout for the amplifier. This diagram corresponds to the circuit of Fig. 2. If the circuit of Fig. 1 is used, the polarities of the diodes and the electrolytic capacitors must all be reversed

arrangement. The current in the output power transistor develops a proportional voltage across the 1Ω resistor R8, and this is decoupled by R4 and C3 to remove the signal component. The first transistor standing current is set by this voltage, which appears at its emitter, and by the fixed reference voltage determined by the value of Rx. The current in TR1 is amplified by the second transistor and this amplified current drives the base of the output transistor, thereby setting the standing current in the output stage. In operation, an increase in output stage current caused, for example, by the start of thermal runaway, will cause a rise in the voltage across R8. This voltage, applied to the emitter of the first transistor, reduces its standing current and hence also the base drive to the second transistor. Reduction of current in the second transistor causes a lowering of the voltage across its collector load resistor, R5, and, by normal emitter follower action in TR3, a reduction in the voltage across R8, together with a drop in the current passed by TR3.

In terms of an applied signal the three transistors behave as conventional amplifiers. The 1Ω resistor in the output stage provides negative feedback to compensate for the non-linear characteristics of the power transistor. The output choke L1 is required to bypass the d.c. component of the output stage current from the loudspeaker. This is necessary as a high direct current in the loudspeaker coil would cause it to move hard over in one direction, distorting the sound.

COMPONENTS

The output choke, Lx, is the secondary of an old valve output transformer wound to suit a 3Ω loudspeaker. No connection is made to the primary, which is left open-circuit. The transformer is rated at 2 watts.

The choice between the negative supply rail circuit of Fig. 1 and the positive supply rail circuit of Fig. 2 will depend on the availability of suitable transistors. If all transistors have to be obtained new, or if all are already available, the positive rail circuit is marginally preferable as it uses a silicon output transistor which will not require so much care with heat sinking. Silicon transistors can be allowed to run at much higher temperatures than germanium transistors.

The mains transformer is not criticial in terms of secondary voltage as the circuit is adjusted on test to suit the gain of the transistors and the supply rail voltage. Any secondary voltage between 4 and 8 volts, rated at 1 amp, would be suitable. The prototype circuits were tried with an old bell transformer, having a secondary of 3–0–5 volts, on each of the voltage combinations; i.e. 3, 5, and 8 volts. It should be noted however that with the higher voltages the power transistor will develop more heat and need a larger heat sink. Since the bell transformer employed is not a regular type available from radio component suppliers, constructors may prefer to use a standard heater transformer with a secondary rated at 6.3 volts at 1 amp minimum.

The size of the heat sink will relate directly to the supply rail voltage. The minimum size where a 6.3 volt transformer is to be used will need to be 10 square inches for the germanium output transistor and 4 square inches for the silicon one. With these dimensions the thickness should be in the order of $\frac{1}{32}$ in. for brass or copper and $\frac{1}{16}$in. for steel or aluminium. The best plan consists of making up the amplifier on a metal chassis and using this chassis as the heat sink. The output transistor will need to be insulated from the chassis by a mica washer and insulated bushes at the mounting bolts. Care should be taken to ensure that the transistor is in good thermal contact with the metal of the chassis: the latter should be flat and have no burrs on the holes for the transistor.

The electrolytic capacitors can have working voltages equal to or greater than those quoted in the Components List. Apart from R8, the resistors need only be 20% $\frac{1}{4}$ watt types. R8 is, however, a wire-wound component rated at 1 watt or more.

CONSTRUCTION

The layout is not critical provided that the output choke is not mounted immediately adjacent to the mains transformer and that some care is taken with the wiring of the common rail. A convenient chassis would be the larger size of die-cast alloy box, although an old sub-chassis from a TV set would be suitable if the amplifier is to be fitted into a record player cabinet. All the components should be obtained first before deciding on the size required of the chassis.

A suitable layout is shown in Fig. 3, in which the smaller components are mounted on a 10-way double tagboard spaced away from the chassis underside by nuts or washers. A 6-way terminal strip takes the input mains and output connections. Although the mains connections are adjacent to the input connections, no difficulty with hum pick-up was experienced in a prototype amplifier using this arrangement. The risk of hum from this source would be completely eradicated, of course, if the input connection was taken to a jack socket mounted alongside the volume control.

The layout of Fig. 3 corresponds to the circuit of Fig. 2. If the circuit of Fig. 1 is to be employed, the polarities of the four diodes and the electrolytic capacitors have to be reversed.

SETTING UP

After construction is complete, make a careful check of the wiring then fit a 10k Ω resistor in the Rx position. Connect a d.c. voltmeter across the 1Ω resistor, R8, in the output transistor emitter circuit. Switch on and note the reading in the voltmeter. If the reading is not 0.75 volt switch off and change the value of Rx. Increasing the value of Rx will increase the current through the 1Ω resistor roughly in proportion to the change in value of Rx. Try different values in the Rx position until the 0.75 volt reading is obtained.

Note that it is important that the resistor Rx be properly soldered in before switching on, as an open-circuit at this point will cause the output transistor to turn on hard, with consequent risk of damage to it and to the rectifier diodes.

As a final point, the input resistance may be found a little low for use with some high impedance pick-ups. An improvement will be effected by connecting a resistor of between 240kΩ and 1MΩ in series with the input connection to VR1. ■

NEW PRODUCTS

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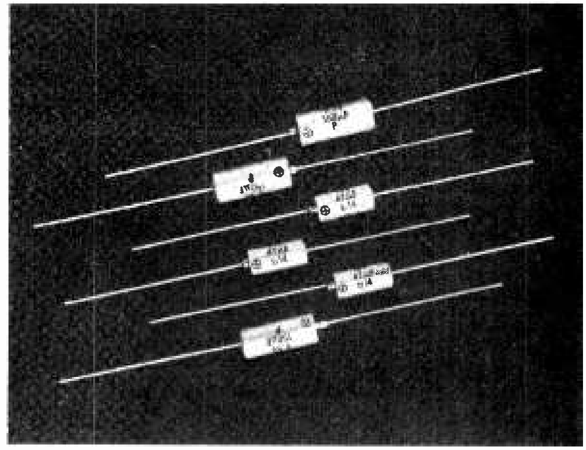
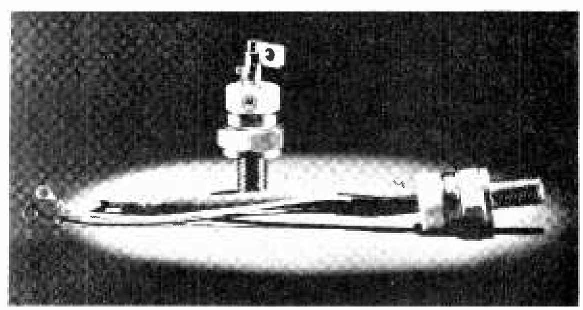


Seatronics (UK) Ltd. announce a new range of metal cased solid tantalum electrolytic capacitors. The Type CSH hermetically sealed capacitor is suitable for measuring instruments and communications equipment where reliability under extreme environmental conditions is essential. They offer a long service life over a wide operating temperature range (–55°C to +125°C). Capacitance tolerance is ± 20% in the range of 0.33uF to 330uF, E6 Series at voltages from 6.3 to 50Vd.c. Leakage current 0.02uA/uFV max., and tan delta = 0.06 max.

For comprehensive data and prices please contact Seatronics (UK) Ltd., 22-25 Finsbury Square, London.

POWER THYRISTORS



A range of 16 thyristors (SCRs) introduced by Motorola Semiconductors, types 2N4361 to 2N4368 and 2N4371 to 2N4378, are rated for a current carrying capacity of 110 A at voltages from 100 to 1400 V.

These thyristors are produced in two types of casing, one with flexible leads (TO-94) and the other with rigid terminals (TO-83). Both types have a $\frac{1}{2}$-inch threaded stud mounting capable of withstanding a torque of 130 inch-pounds without distortion. Pressure-contact encapsulation ensures a reliable electrical and thermal connection between the semiconductor and the outer casing even under conditions of rigorous thermal cycling. Added protection against thermal deterioration is afforded by matched coefficients of expansion of the semiconductor chip and its mounting base. A thermal resistance of only 0.28°C rise in temperature per watt of electrical power allows the device to be operated at high temperatures with small heat sinks.

The devices are available at prices of between £7.53 and £76.73 each for quantities of 100 and over.

NEWS . . . AND .

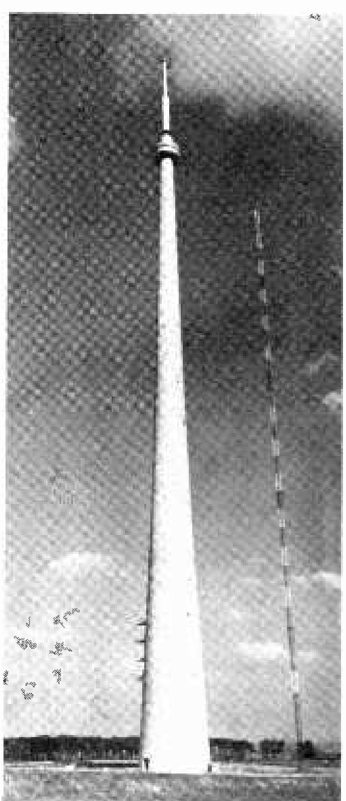
EMLEY MOOR – ITA AERIAL SUPPORT TOWER

The new ITA aerial-support tower at Emley Moor in Yorkshire is the first self-supporting concrete tower ever to be built for television broadcasting in the United Kingdom.

The concrete section is 900 ft. high, has a base diameter of 80 ft. tapering to 20 ft. at the top; above this are triangular lattice steel sections carrying the transmitting aerials, covered by glass-reinforced-plastics, bringing the total height to 1,080 ft.

The tower has cost about £650,000 for the civil engineering work, plus about £250,000 for the aerials, electrical work and the like. It has been built to replace the tubular steel mast which collapsed on March 19th, 1969.

A unique feature of the construction of the tower was the lifting, in a week-long operation, of the entire steel section, with the UHF aerials in position, a weight of about 60 tons, up through the centre of the tower.



SEARCH AND RESEARCH

The Mullard company, as a scientifically-based enterprise, has long enjoyed close and fruitful relationships with many universities and scientific institutions. This association takes the form of research fellowships, consultancies and joint projects which have helped to forge links of goodwill between education and industry in general.

As a mark of their 50th anniversary last year, the company decided to set down in book form detailed accounts of some of these successful collaborations.

This book, entitled *Search and Research* has now been completed. It consists of contributions from Prof. Sir Martin Ryle of the Mullard Radio Astronomy Observatory (University of Cambridge) Prof. N. Kurti of the Mullard Cryomagnetic Laboratory (University of Oxford) and Prof. R. L. F. Boyd of the Mullard Space Science Laboratory (University of London).

A limited number of copies of the book have been produced and these will be distributed to academic and scientific institutions, government establishments, libraries and selected industrial organisations.

AEROSOL FLUID TO FIGHT RUST AND CORROSION

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For further information contact: Chekmate, 73 Orchard Place, Harvington, Evesham, Worcs.

TALKING POINT

At the annual meeting of the American Academy of Paediatrics in Chicago, Dr. Gerald Looney of Arizona University, speaking about children and television, said that the average child in America by the age of 14 could expect to have seen 18,000 people "killed" on TV.

Other rather frightening comments by Dr. Looney were that by the time the child left high school he would have seen 350,000 commercials and by the time he died 10 years of his life would have been spent watching TV.

. . . COMMENT

DEVELOPMENT OF BBC STEREOPHONIC RADIO SERVICES

The BBC is planning to expand its stereo service considerably during the next few years. The extension beyond the present Radio 3 service will take place in three phases.

1. The installation of stereo origination facilities for Radio 2 (with Radio 1) and Radio 4.

2. The extension of Radio 2 and Radio 4 stereo to those transmitters already radiating Radio 3 in stereo.

3. The extension of the three network stereo service northwards to Central Scotland and westwards to the Bristol Channel area.

RADIO AMATEUR OPERATOR'S HANDBOOK

The Twelfth edition of this ever popular book, has just been published.

Now enlarged to 80 pages on improved paper, it contains all the usual features brought up to date plus extensions to the map section, and greatly improved lay-out of Amateur Prefixes, etc.

Price 45p plus 5p postage. Available from Data Publications or through your bookseller.

SHOENBERG MEMORIAL LECTURE

The Royal Television Society's second annual 'Shoenberg Memorial Lecture', sponsored by E.M.I., was given by Dr. Walter Bruch at the Royal Institution, Albemarle Street, London, W.1. on Thursday 2nd December.

The title of the lecture was 'The Next Decade in Home Entertainment'.

Dr. Bruch is Chief of the Basic Television Research Department of A.E.G. Telefunken, a post he has held since 1959. He invented the PAL system of colour television as well as systems for recording colour television on tape and discs. From 1964 to 1970 he was President of the German Television Society and in 1967 he was awarded the Royal Television Society's Geoffrey Parr Award.

Dr. Bruch, who joined Telefunken in 1935, was concerned with the design of the Iconoscope camera. In 1937 he installed the Iconoscope television studio in the German Pavilion at the World Fair in Paris and also the first German television studio in Berlin.

Mr. Patrick Dromgoole, the Society's Vice Chairman, and Programme Controller, West of England, of HTV, was in the chair.

WITHOUT COMMENT

In America research has been going on to perfect a dishwasher which uses high frequency sound waves as a cleaning agent. Results so far are that it gets the dirt off with great efficiency but also shatters the plates!

CLOSED CIRCUIT TV FOR NURSES' TRAINING

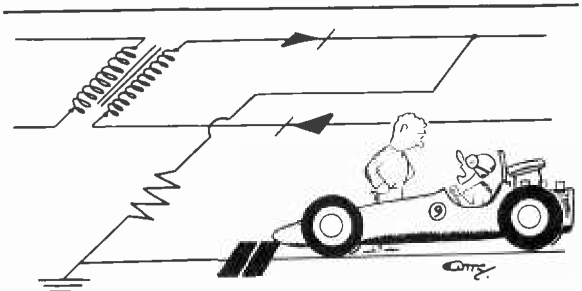
Closed-circuit television, in a compact and highly mobile form, is the new training aid for student nurses at the Middlesex Hospital. Here, with two of her students, Miss E. L. Blake (Principal Nursing Officer, Education Division), examines the Video Trundle, a trolley-based unit which combines all the equipment needed to record study-material on video tape for use in the hospital's training syllabus.

Explaining the controls is Robert Powell of the Bell & Howell Video Systems Division, which designed and equipped the Trundle.

Introduced last year, mainly to provide mobile closed-circuit facilities in education and training establishments, the Trundle is small enough to pass through a single door and, to suit individual requirements, can be supplied with any combination of equipment. The unit illustrated was presented to the Middlesex Hospital by the husband of a former patient.

QUOTE

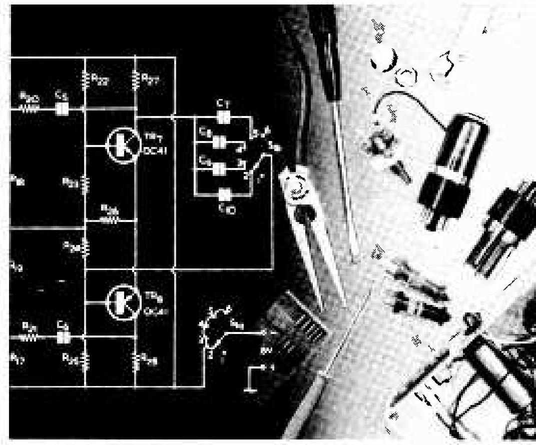
'Most ideas I usually get while I am shaving, I suppose people with beards do not have so many ideas. That's something for the young people to remember.' Dr. Gabor, the 1971 winner of the Nobel prize for physics.



"I don't know who thought this one up, but it's the strangest circuit I've raced over"

PILOT LAMP DIGITAL DISPLAY

by G. A. FRENCH



THIS MONTH'S ARTICLE IN THE 'Suggested Circuit' series describes a digital display incorporating 15 pilot lamps. These lamps can be illuminated by means of a group of 10 switches to display the numerals 0 to 9. If the circuit is duplicated and a second set of 15 lamps positioned alongside the first, it becomes possible to display the numbers 0 to 99; whilst a third set of lamps increases the range to 0 to 999. The ease of recognition for each number is of a slightly lower order than is that of the 'computer numerals' on a cheque form. However, since the patterns displayed by the lamps offer an unambiguous representation of each number, there is no possibility of making a mistake in identification.

The main application for the lamps is that of indicating numbers where it is desirable for a quantity of people to see them. They could, for instance, be used at Bingo sessions, showing each number as it is called out. More serious applications occur in factories or offices, where they may be employed to show the existing production figure, or to present similar information.

LAMP ARRANGEMENT

It is probable that 15 lamps is about the minimum quantity that is capable of indicating numerals from 0 to 9. In the design described here, they are set up in 5 horizontal rows of 3 lamps, as illustrated in Fig. 1. The letters from A to O which appear in the diagrams are intended to provide references for the purpose of explanation in this article, and they do not in practice appear alongside the lamps.

Numbers are indicated by illuminating some of the lamps only, as illustrated in Fig. 2. Thus, the number 1 is given by having the central vertical line of lamps lit up, as is shown. The patterns representing the succeeding numbers will also be recognised. In Fig. 2 the non-illuminated lamps are indicated by the black circles, and are included for the sake of completeness. In practice, the pattern presented by the illuminated lamps is more readily recognisable than would appear from Fig. 2. because the non-illuminated lamps simply become part of the background and do not distract the attention of the viewer. This effect can be checked by covering the black dots for any number in Fig. 2 with one or more pieces of paper.

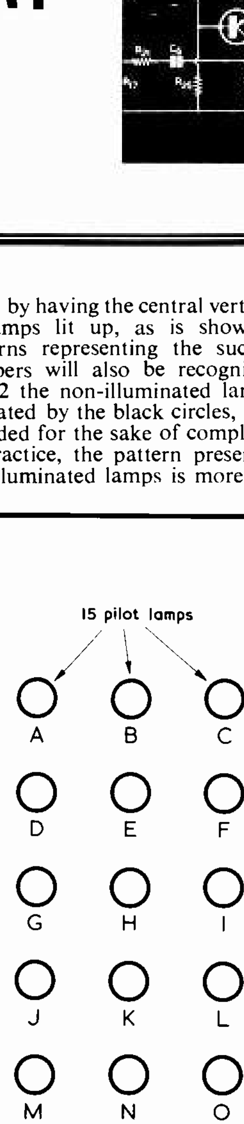


Fig. 1. The fifteen lamps which form the display are laid out in five horizontal rows

It is intended that each pattern in Fig. 2 be selected by closing one of ten s.p.s.t. on-off switches. It is obviously necessary for each switch to select its own pattern of lamps only, and that some form of electrical isolation between patterns must, in consequence, be provided. A simple method of obtaining this isolation consists of using diode OR-gates at each lamp in the manner shown in Fig. 3. Pilot lamp K in this diagram appears in both the number 1 pattern and in the number 4 pattern. When the upper switch, designated '1', is closed, current flows to the pilot lamp from the positive supply point via the upper diode. The lower diode prevents this current flowing to the switch designated '4' where it would cause the other lamps which make up the number 4 pattern to be illuminated. Similarly, if the switch labelled '4' is closed and that labelled '1' is open, lamp K is illuminated by the current which flows through the lower diode, whilst the upper diode prevents this current passing through to the number 1 lamp circuit. In practice the diodes would be silicon rectifiers.

It follows from Fig. 3 that each of the patterns of Fig. 2 could be reproduced by having a diode at each lamp for each switch circuit. The requisite lamp combinations for each number are shown in Fig. 4(a), the letters corresponding to those in Fig. 1. Thus, number 1 is given when lamps B, E, H, K and N are illuminated, and so on.

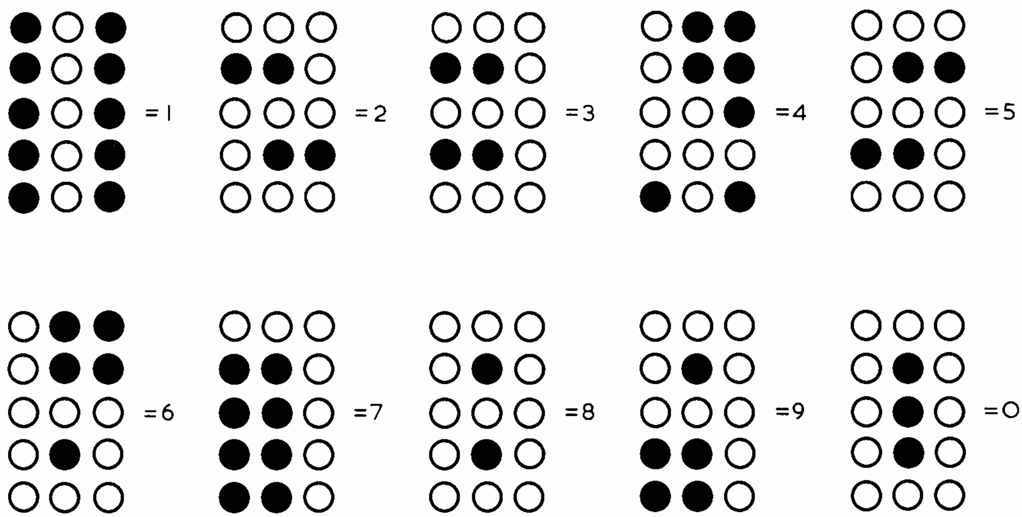


Fig. 2. The lamps are illuminated to represent numbers from 1 through to 0 in the manner shown here

If we are to use the simple diode concept shown in Fig. 3, we will require a diode for each letter in Fig. 4(a), this representing a total of 98 diodes.

However, several groups of letters appear in four or more number patterns, and it is possible to reduce the number of diodes required by grouping these lamps. Each group then requires only one diode for each switch position. The consequent simplification is shown in Fig. 4(b), in which it will be seen that lamps (ABC), (GHI), (MNO), (DJ) and (FL) are bracketted together. This simplification reduces the overall number of diodes required to 64 and is patently well worth-while carrying out. A further simplification could be given by using (ABCGHI) as a group, and this would save 2 further diodes. However, an (ABCGHI) group would require series isolation diodes with a forward current rating higher than the nominal 1 amp figure which is specified here, and it was felt that the consequent complications would not merit the saving of 2 diodes.

Some years ago a circuit of this nature incorporating 64 diodes would have been considered prohibitively expensive, Nowadays, though, silicon rectifiers are available at exceptionally low prices and the total cost of components for the circuit can be kept relatively low. A further economy could be effected by purchasing a batch of 'untested' diodes, as are sold from time to time at very low cost, or by buying surplus equipment from which diodes may be removed.

OPERATION

The overall operation of the circuit is illustrated in Fig. 5. Here, the secondary of mains transformer T1 offers 12.6 volts at a current rating of 3 amps to the bridge rectifier given by D1 to D4. The negative output from the bridge rectifier provides a common connection for all the pilot lamps, whilst the positive output is applied, via fuse F1, to switches S1 to S0, and thence to the main diode circuits. Outputs from the diode circuits couple to the ABC, GHI, MNO, DJ and FL gates, which connect to their appropriate groups of lamps. Further outputs are taken to the individual lamps. The actual diode and gate circuits will be introduced and described when the constructional details are given; to reproduce them in Fig. 5 would result in a complex diagram that would be difficult to follow.

So far as components are concerned, T1 is any mains transformer providing 12.6 volts at 3 amps or more, and may conveniently consist of a valve radio mains transformer having two 6.3 volt 3 amp heater windings which are connected in series. The h.t. winding on such a transformer is ignored. The actual voltage provided by the transformer is not particularly critical and

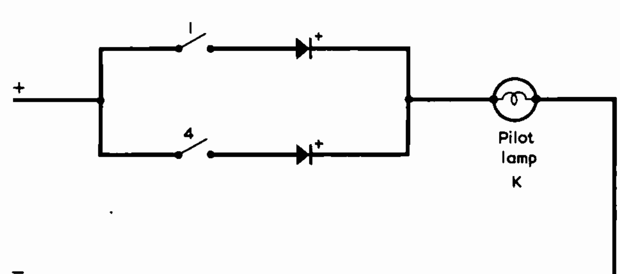


Fig. 3. Illustrating the basic OR-gate circuit which allows the number patterns to be isolated from each other

any secondary voltage between 11 and 13 would be satisfactory. Diodes D1 to D4 are standard silicon rectifiers with a forward current rating of 3 amps or more. The peak inverse voltage applied to them is less than 20 and the rectifiers employed can have any p.i.v. rating above this figure. They are specified as 50 p.i.v. because this is the lowest silicon rectifier rating usually encountered.

Fuse F1 consists of a length of 5 amp fuse wire positioned between two terminals or solder tags. One of its functions is to protect the wiring, D1 to D4 and transformer T1 in the event of accidental short-circuits during wiring-up. The fuse may not be capable of protecting the smaller diodes used in the D5 to D68 positions if any of these should happen to enter the short-circuit path. Because of this, the usual precautions against errors have to be taken when wiring-up is in progress.

Switches S1 to S0 are toggle switches and cause the corresponding numbers to be displayed when they are closed. A 10-way rotary switch would be preferable, but it may be difficult to find such a switch with contacts rated at 3 amps, as would be required here.

Pilot lamps PLA to PLO are 12 volt 0.18 amp m.e.s. types, and are available from Home Radio under Cat. No. PL13. The reason why a nominal 12 volt supply and 12 volt lamps are employed instead of using, say, a 6 volt system is that (as will be shown shortly) some lamps are illuminated by way of a single series diode whilst other lamps are illuminated by way of two diodes in series. In consequence, some lamps receive about 0.6 volts less (the forward voltage drop in the extra series diode) than do others. With a nominal supply voltage of 12 the 0.6 volt drop is proportionately small and all lamps then appear to have the same brilliance. Assuming a similar lamp wattage, the use of a 12 volt system also incurs the flow of less current than would be required in a lower voltage system. The lamps may be mounted in any form of bulbholder favoured by the constructor.

The 64 silicon rectifiers used in the D5 to D68 positions have already been mentioned. These are nominally 1 amp 50 p.i.v. types, and could have higher forward current or p.i.v. ratings if the higher rating types were to hand or could be obtained cheaply. The actual p.i.v. to which they are subjected is a little under 20 volts. Diodes connecting to single lamps and to the DJ and FL gates could, in practice, have a forward current rating of 500mA, but those connecting to the ABC, GHI and MNO gates require the 1 amp rating. The latter diodes (which appear in later diagrams) are D5 to D11 inclusive, D15 to D20 inclusive and D24 to D29 inclusive. It is probable that most constructors would prefer to use 1 amp types throughout since this reduces complications.

Final points are concerned with the power supply. It will be noted that there is no reservoir capacitor following diodes D1 to D4. This is intentional since, without such a capacitor, the bridge rectifier circuit offers very good voltage regulation, this being due to the low internal resistance of the mains transformer and the low slope resistance of the rectifiers D1 to D4. Good regulation is essential here as, otherwise, numbers which require a large quantity of lamps for their display would have a lower lamp brightness than numbers which require only a small quantity of lamps. With the prototype there was no noticeable difference in lamp brightness for all numbers.

The maximum current which can be drawn from the rectified supply is 2.7 amps. This is given if all lamps are illuminated, as could occur if two or more switches were accidentally closed at the same time.

1 = B,E,H,K,N
2 = A,B,C,F,G,H,I,J,M,N,O
3 = A,B,C,F,G,H,I,L,M,N,O
4 = A,D,G,J,H,K,N,L
5 = A,B,C,D,G,H,I,L,M,N,O
6 = A,D,G,H,I,J,L,M,N,O
7 = A,B,C,F,I,L,O
8 = A,B,C,D,F,G,H,I,J,L,M,N,O
9 = A,B,C,D,F,G,H,I,L,O
O = A,B,C,D,F,G,I,J,L,M,N,O

(a)

1 = B,E,H,K,N
2 = (ABC),F,(GHI),J,(MNO)
3 = (ABC),(GHI),(MNO),(FL)
4 = A,G,H,K,N,L,(DJ)
5 = (ABC),D,(GHI),L,(MNO)
6 = A,L,(GHI),(MNO),(DJ)
7 = (ABC),I,O,(FL)
8 = (ABC),(GHI),(MNO),(DJ),(FL)
9 = (ABC),(GHI),D,O,(FL)
O = (ABC),(MNO),G,I,(DJ),(FL)

(b)

Fig. 4 (a). The lamps which require to be lit for each number
(b). Simplification can be achieved by grouping lamps common to four or more numbers

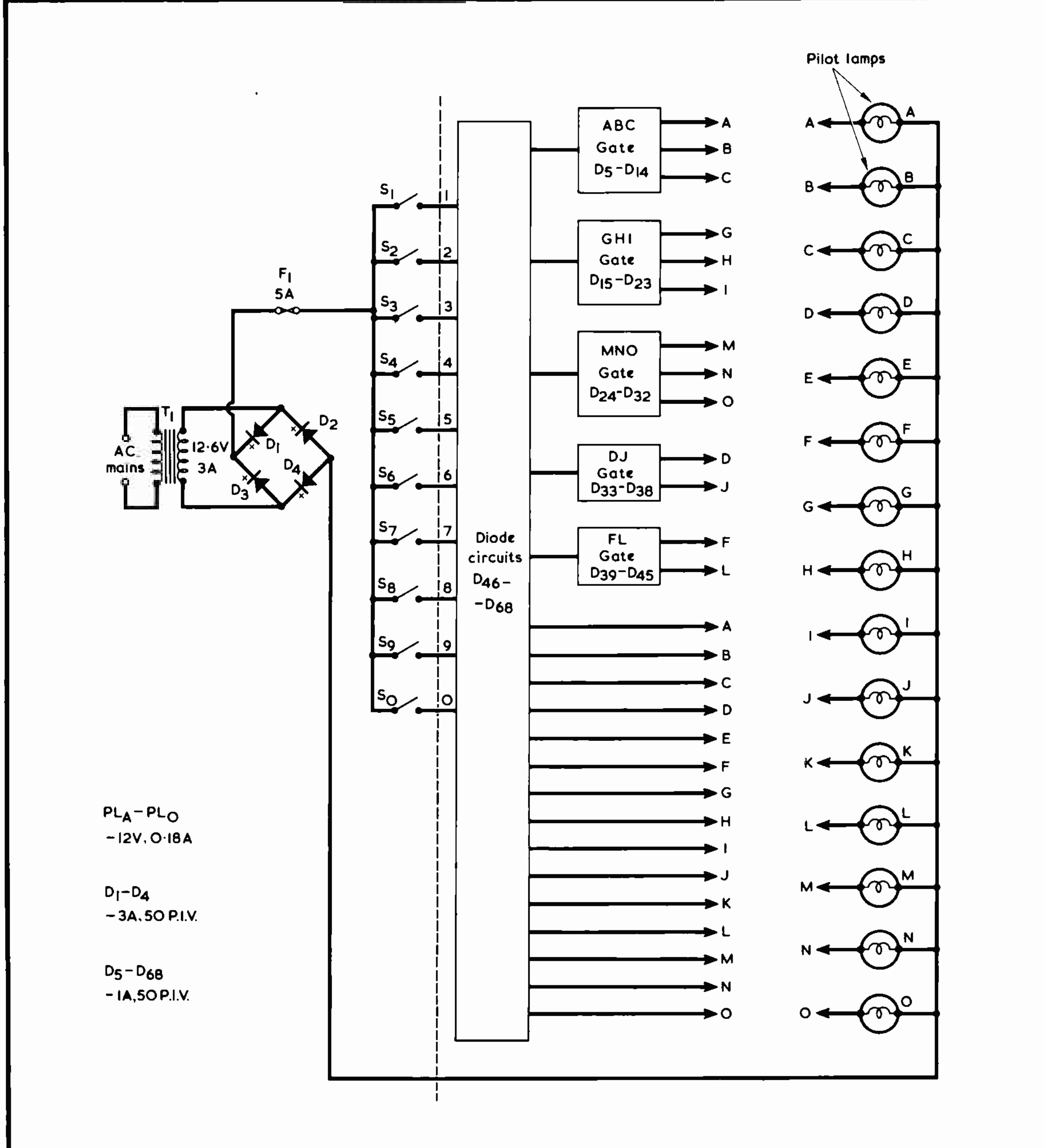


Fig. 5. Overall circuit of the display unit. This may conveniently be made up in two sections, these being separated here by the vertical dashed line

CONSTRUCTION

In dealing with the construction we shall also be able to describe the individual diode circuits. This approach is employed because it avoids the reiteration of circuit information. Also, it is important to understand what each wiring step achieves and this again involves a discussion of circuit operation.

The method of mechanical construction is left to the reader. For most applications, it will be required that the lamps be fitted on a flat board behind which is mounted the circuitry incorporating diodes D5 to D68. An 11-way lead can then connect this board to the power supply negative output and to switches S1 to S0. These, together with the mains transformer, F1, and D1 to D4, are then positioned at a convenient control point. The two separate sections appear on either side of the vertical dashed line in Fig. 5.

It will be necessary to fit an 11-way tagstrip on the board, ten tags of which are numbered through from 1 to 0. The 11-way lead from the switch section will connect to this, the switch numbers corresponding to the tag numbers. The eleventh tag will be for the common negative supply line.

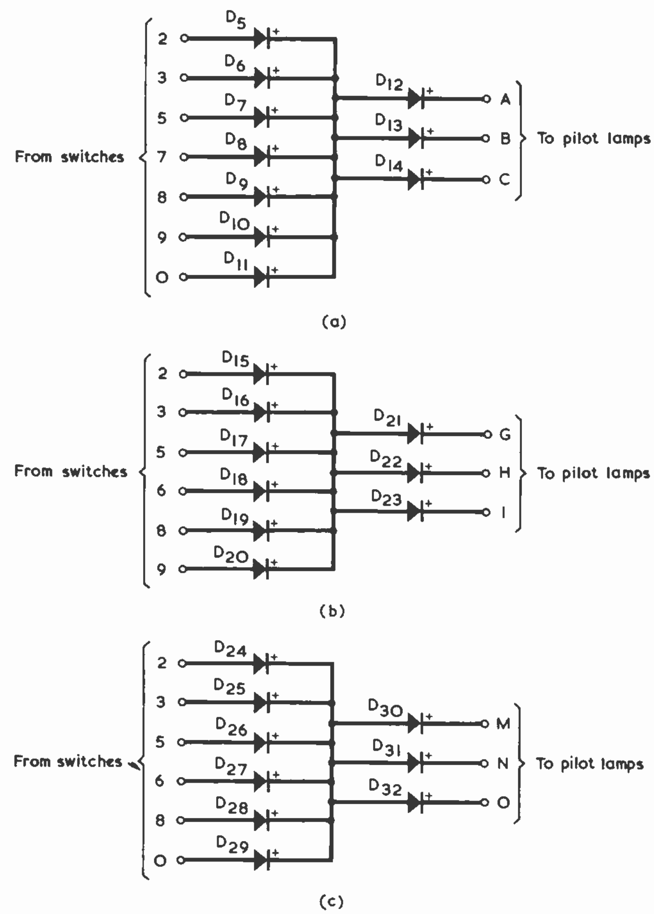


Fig. 6. Gate circuits for (a) the ABC group, (b) the GHI group, and (c) the MNO group

More than one connection will be made to the positive lamp terminals and it should be adequate to provide each positive tag with a 3-way tagstrip having all tags commoned to take the connections. This does not, however, apply to the positive terminal of pilot lamp K, to which only two connections are needed. Tagstrips will also be required for diode junctions for the five gates and to augment the tags of the 11-way tagstrip just mentioned. Physical layout of components is unimportant and, as the parts used are all small in size, the rearward projection from the back of the lamp board should be small.

The first part of the construction consists of assembling and wiring T1, D1 to D4, F1, and S1 to S0. The switches and the negative supply rail should next be connected to the 11-way tagstrip on the lamp board. Add, also, a temporary fly-lead connecting to the junction of F1 and the switches. The other end of this fly-lead is used to provide a positive test voltage for circuit checking during construction.

Next, fit all the bulbholders and insert the bulbs. Wire up the common negative terminals of all bulbholders. Apply the mains to T1 and check the supply by connecting the positive fly-lead to the positive terminal of any bulb. This should light up brightly without any flickering. Take care to ensure that the positive fly-lead does not accidentally touch any negative point.

The next process consists of wiring

up the gates. Each gate is checked after wiring because mistakes here can be rather difficult to trace later. Take great care to connect each diode with correct polarity and, if the diodes are of the 'untested' variety, check them also for short-circuit junctions before connecting them into the circuit. A short-circuited or reversed diode can cause confusing results. It should be noted that the diode cathodes are always towards the lamps, i.e. the '+' side of each diode is on the lamp side and the 'arrow-head' of the diode circuit symbol 'points' towards the lamps.

Fig. 6(a) shows the ABC gate, and its mode of operation will be evident from consideration of the OR-gate shown in Fig. 3. The positive terminals of the ABC group of lamps are coupled to D12, D13 and D14, and thence to the further isolating diodes D5 to D11. Lamps A, B and C appear in the numbers 2, 3, 5, 7, 8, 9 and 0, and in consequence the group is wired to the correspondingly numbered switches. Thus, closing any of these switches switches is closed.

The GHI gate, shown in Fig. 6(b), comes next. This functions in a similar manner to the ABC gate, and the GHI lamps become illuminated when any of the numbers 2, 3, 5, 6, 8 and 9 is selected. After wiring, first apply the positive test fly-lead to the junction of the two sets of diodes, whereupon the lamps G, H and I should light up. They should also light up when either S2, S3, S5, S6, S8 or S9 is closed.

The third gate, that for lamps M, N and O, is illustrated in Fig. 6(c). After wiring, check with the positive test fly-lead at the junction of the two sets of diodes and then confirm that lamps M, N and O light up when either S2, S3, S5 S6, S8 or S0 is closed.

Figs. 7(a) and (b) give the circuits for the DJ and FL gates respectively. These operate in the same manner as the previous gates. First wire up the DJ gate, checking with the positive test fly-lead at the junction of the two sets of diodes, and then confirm that lamps D and J light up when either S4, S6, S8 or S0 are closed. Next, wire up

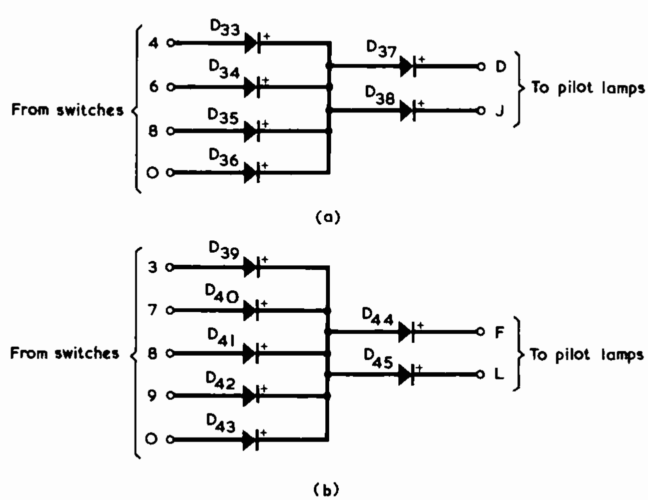


Fig. 7. Circuits for (a) the DJ group and (b) the FL group

causes lamps A, B and C to be illuminated, the diodes in the gate preventing any other circuits from being affected. Wire up the diodes as illustrated, then check the circuit by first applying the positive test fly-lead to the junction of the two sets of diodes, i.e. to the common negative ends of D12, D13 and D14. All the three lamps, A, B and C, should then light. Next ensure that all three lamps are illuminated when any of the associated the FL gate, similarly test with the positive fly-lead and then with switches S3, S7, S8, S9 and S0. The positive test fly-lead is now no longer required and may be removed.

If, during any of the gate tests, *more* than the selected lamps become illuminated, the fault probably lies in a short-circuited diode fitted in an earlier step. It is for this reason that it is advised that diodes of doubtful performance be checked before they

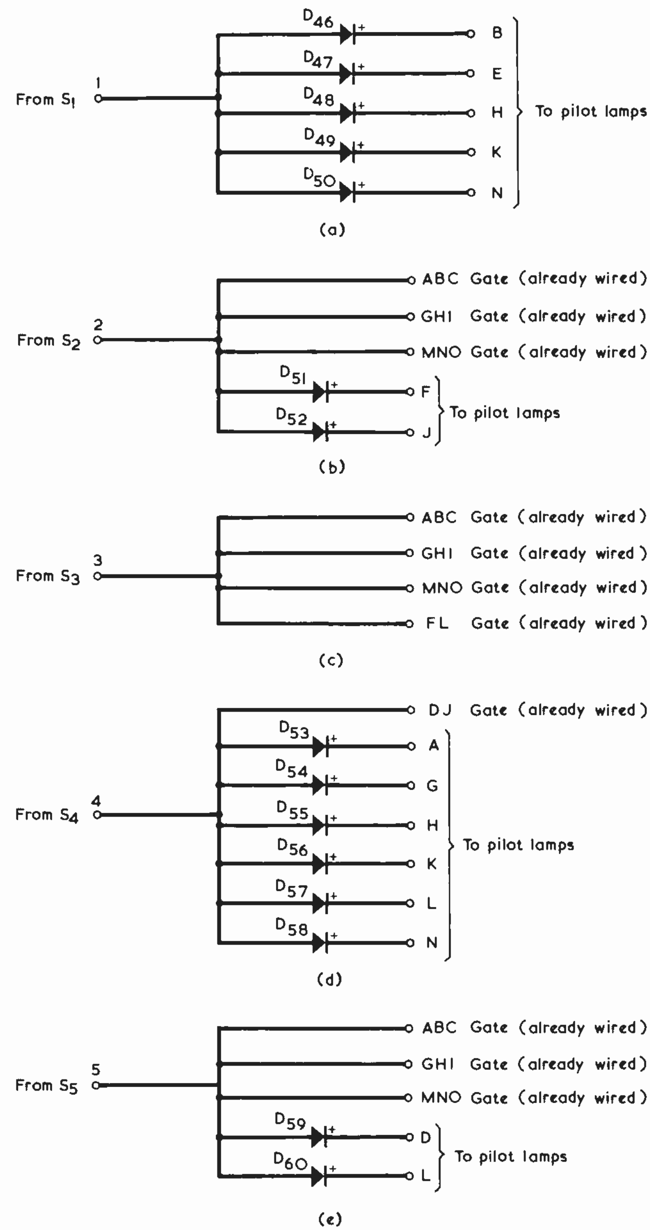


Fig. 8. Wiring for (a) the number 1 display, (b) the number 2 display, (c) the number 3 display, (d) the number 4 display and (e) the number 5 display

are fitted. If a diode is wired in with reverse polarity, the corresponding lamp or switch circuit will not function; and this is one reason why each wiring step should be checked before proceeding further. A reverse-connected diode can cause lamps other than those selected to be illuminated, and would be difficult to trace if the circuit were wired up in its entirety without testing after each step.

The number 1 display pattern comes next. This does not use any of the groups which have just been wired up but simply causes lamps B, E, H, K and N to light up. The circuit is as

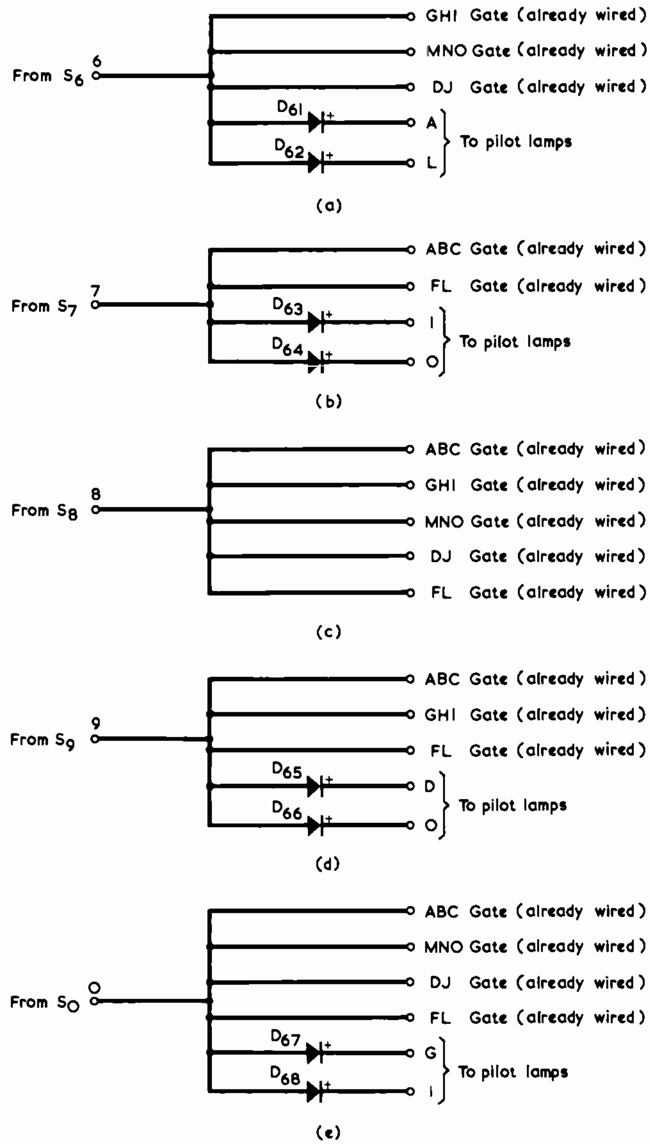


Fig. 9. Further number pattern circuits. That in (a) is for number 6, (b) number 7, (c) number 8, (d) number 9, and (e) number 0.

shown in Fig. 8(a), in which S1 connects directly to diodes D46 to D50. These, in turn, connect directly to the positive terminals of the lamps concerned. The lamps should become illuminated when S1 is closed.

Number 2 follows. This uses the gates ABC, GHI and MNO, which have already been wired up. See Fig. 8(b). It only remains to make connection to lamps F and J via D51 and D52, as shown. When S2 is closed the lamps should display the number 2.

Number 3 is next. This has already been wired up since it uses group gate circuits throughout, as illustrated in Fig. 8(c). The number 3 should be displayed when S3 is closed.

The next number is 4, and this is wired up as in Fig. 8(d). Diodes D53 to D58 are wired into circuit as shown, the group DJ being already connected up. Check that the number 4 is displayed when S4 is closed.

Proceed in the same manner with number 5, as in Fig. 8(e), then carry on to numbers 6 and 7, as in Figs. 9(a) and (b) respectively. Number 8, shown in Fig. 9(c), is already fully wired, and only requires checking. The final two numbers are 9 and 0, and these are connected up as in Figs. 9(d) and (e) respectively.

After these last two numbers have been wired and tested, the digital display unit is complete and ready for use. The amount of wiring required may appear rather extensive, but this is largely because the constructional steps have been described in terms of circuit function. The prototype unit, assembled by the author to test the circuit, was wired up in the course of an afternoon.

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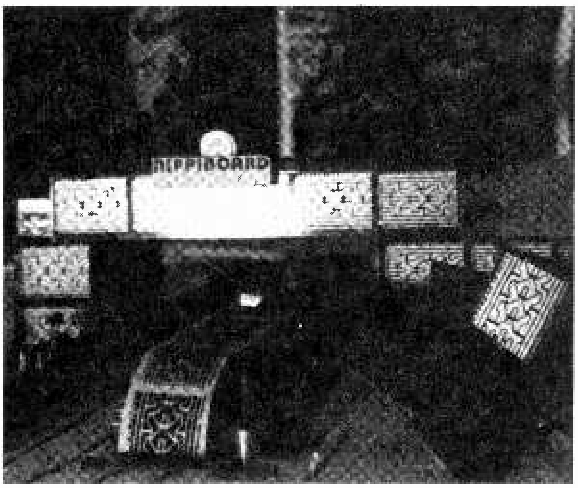
Trade News . . .

'NIPPIBOARD' PRINTED CIRCUITS



A new departure in the field of printed wiring boards is announced by NIP Electronics, whose product 'Nippiboard' is now available to readers. 'Nippiboard' consists of ready-printed circuit board having a copper pattern which has been specifically designed to provide a 'bread-board' for semi-conductor circuits.

The essential feature of 'Nippiboard' is that the copper pattern is particularly intended for transistor amplifiers, oscillators, timers, switching circuits and similar configurations. Each 'Nippiboard' pattern module, which is approximately 2 in. long and 1½in. wide, has a copper layout which is symmetrical about the centre line along the 2in. length. There are two unbroken copper strips at top and bottom for supplies, whilst the intervening copper pads are designed to take the number of components they will normally be expected to provide connection for in transistor circuits. A small pattern module can take up to four or five transistors. The copper sections are provided with a matrix of small marker holes, these being identified by the numbers 1 to 16 along the 2in. length, and by the letters A to M along the 1½ in. width. The numbers and letters are part of the copper print and the overall pattern is copyright by NIP Electronics.

After the user of 'Nippiboard' has decided on the circuit design to be employed, this is marked up with the 'Nippiboard' number-letter references, after which the corresponding holes are drilled in the 'Nippiboard' base to take component lead-outs. The components can then be soldered to the board in the usual manner.

'Nippiboard' is available with an s.r.b.p. ('Paxolin') or a fibreglass base, and is flux varnished on the copper side to prevent oxidation and to ease soldering. The board is available in a wide variety of sizes, these ranging from a base carrying a single pattern module to a base carrying ten of the patterns in two rows of five. Further details may be obtained from NIP Electronics, P.O. Box 11, St. Albans, Herts.

U.H.F. AND V.H.F. DIODES

Motorola Semiconductors have introduced new ranges of voltage-variable-capacitance tuning diodes, p.i.n. switching diodes, mixer diodes and detecting diodes for use in v.h.f. and u.h.f. applications, primarily television. All of these diodes are housed in an axial-lead 'MINI-L' plastic casing which has been specially designed to have a very low lead inductance of typically 3.0 nanoHenries. The L-shaped case clearly identifies the cathode for ease of testing and insertion into printed-circuit boards.

Continuously-variable tuning in the v.h.f. band is the function of the MV 3140-42 series voltage-variable-capacitance diodes. These have a nominal capacitance of 2.1 pF at 25 V and capacitance can be varied over a 4.5:1 ratio. The minimum Q value, measured at 100 MHz, is 150.

Continuous tuning over the v.h.f. band is catered for by the MV 3102-03 series 'Epicap' tuning diodes. These exhibit typical capacitance ratios of 4.8:1, a minimum Q value, at 300 MHz, of 300 and a nominal capacitance of 22 pF at 3 V d.c.

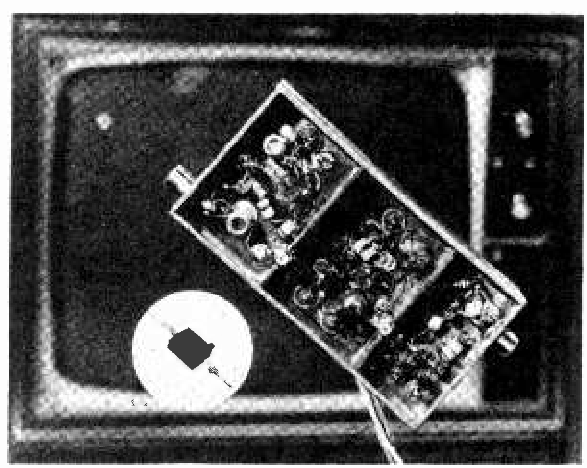
These two series of tuning diodes can be obtained in computer-matched groups in which capacitance values can be matched to $\pm 1.5\%$ or 0.1 pF (whichever is the greater) over the specified tuning range. Devices in these matched groups are rated at 30 V maximum reverse voltage.

Band-selection at v.h.f. is greatly simplified by the MPN 3401-02 p.i.n. switching diodes. These enable components to be switched into or out of circuit merely by application of d.c. bias voltages, eliminating the need in television and similar applications for bulky turret tuners.

Two Schottky 'hot carrier' diodes, types MBD-502 and MBD-702, are for use in high-efficiency u.h.f. and v.h.f. detectors. They are rated at 50 and 70 V, respectively.

A third Schottky diode, type MBD-102, is primarily for u.h.f. mixer applications. It has a noise figure of 5.5 dB at 1 GHz.

In quantities of 100 and more, prices per 100 are: £20.00 to £40.00 for the MV 3140-42 u.h.f. tuning diodes, £35.00 and £27.50 for the MV 3102-03 v.h.f. tuning diodes, £18.90 for the MPN 3401-02 p.i.n. diodes, and £110.00 to £38.50 for the MBD Schottky diodes.



TRANSISTOR STABILIZED POWER UNIT

By

P. CAIRNS, M.I.P.R.E., G3ISP

PART 2

In this concluding article constructional details are given for the power supply whose circuit was described last month. It offers an output that is continuously variable from 6 to 36 volts.

CONSTRUCTION

THE UNIT IS MADE AS COMPACT AS POSSIBLE AND, while the case and dimensions used by the writer are specified, a larger cabinet and different layout may be adopted to meet individual choice. There is nothing critical about component configuration.

The electronic components are wired on a 12-way tagboard. The tagboard employed by the author had dimensions of 1½ by 3½in., as shown in Fig. 4. If an exactly similar board cannot be obtained, a suitable alternative is a 12-way miniature tagboard measuring 1½ by 3⅜in. available from Henry's Radio, Ltd. The author's version of the tagboard assembly incorporated a Mullard silicon bridge rectifier for D1 which, at the time of writing, is not readily available through the usual retail channels. Other miniature silicon bridge rectifiers, such as the type 2002 available from Henry's Radio, can be used instead provided, of course, the ratings are adequate. Alternative rectifiers may have different lead-out layout to that shown in Fig. 4, which illustrates the tagboard wiring. The components are connected up as shown, after which the tagboard is mounted vertically on the chassis by means of a narrow angle bracket. All outgoing flyleads can be connected to the board before it is mounted in position. The

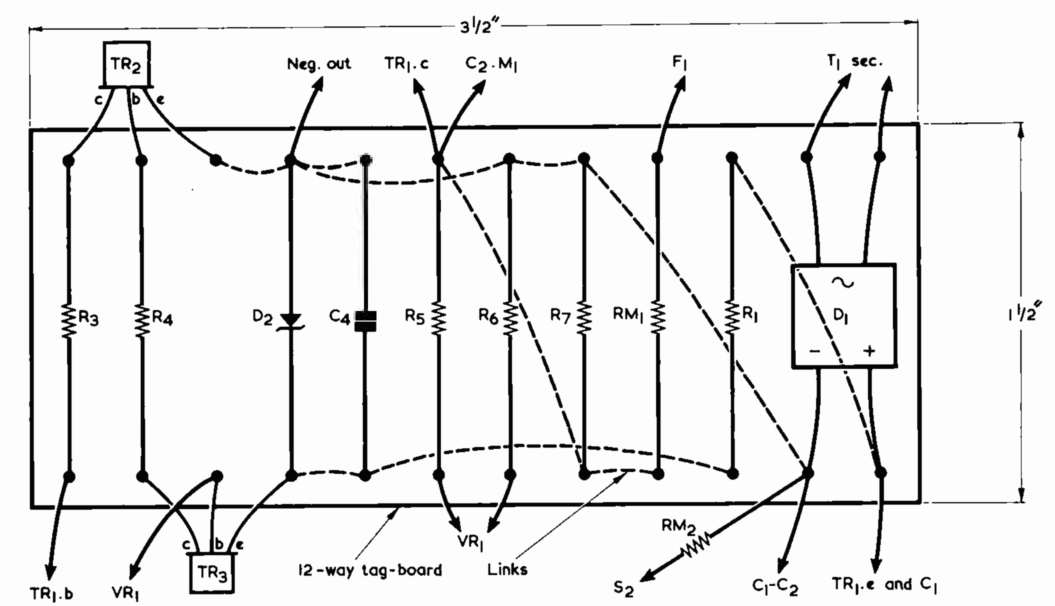


Fig. 4. Component assembly on the 12-way tagboard. The links, shown in broken line, are behind the board

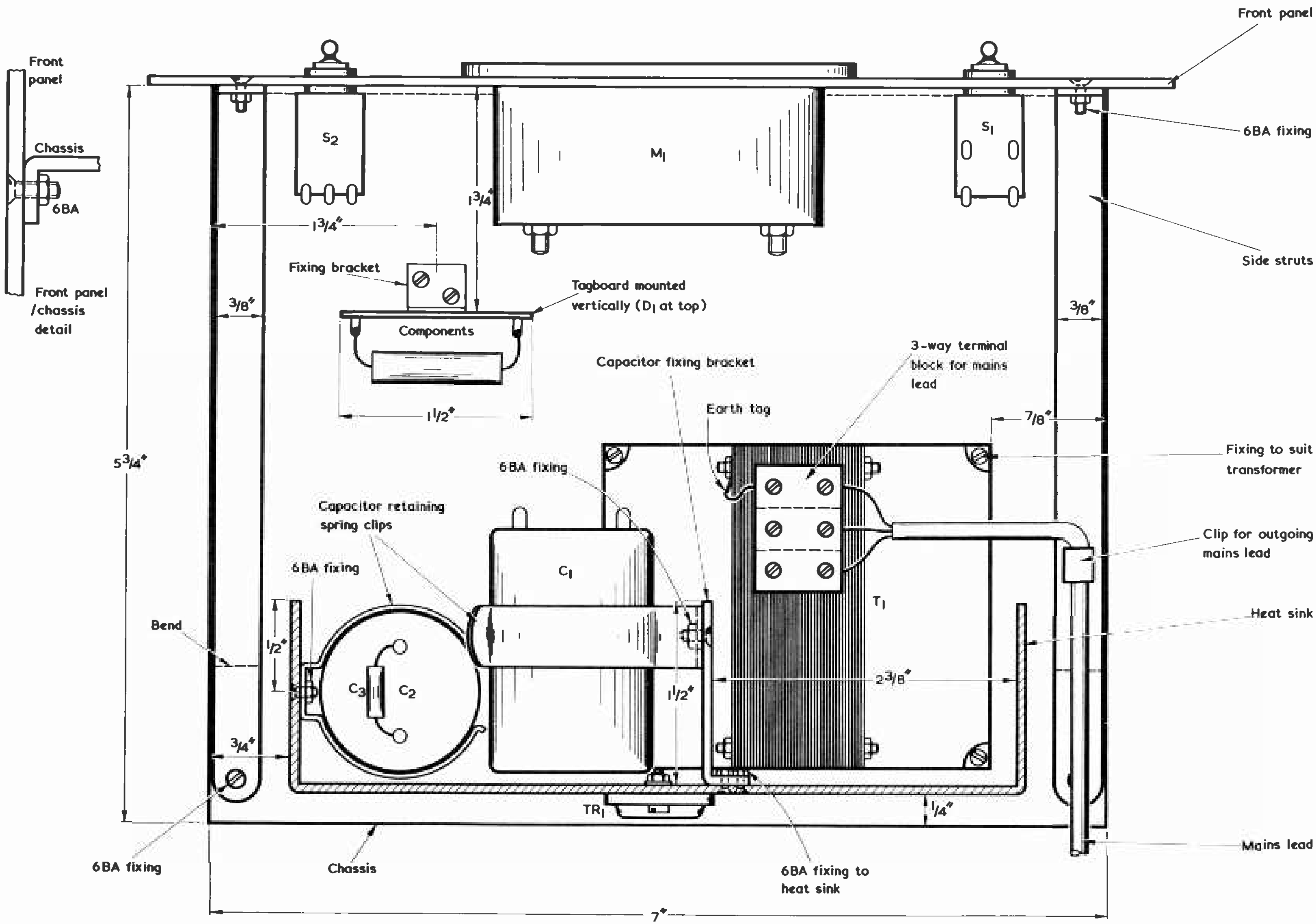


Fig. 5. The chassis layout. Component dimensions are omitted as they vary slightly between different manufacturers. The heat sink also carries a bracket and clip for C1 and a clip for C2

chassis can be simply made from an aluminium plate with a lip bent along the front edge for fixing to the front panel. Side angle struts should be mounted between the chassis and front panel for extra strength. The transformer and heat sink with smoothing capacitors are all mounted on the chassis, the complete layout with all relevant dimensions being shown in Fig. 5. The front panel is drilled and components mounted before being screwed into place. Fig. 6 shows the front panel with dimensions.

The heat sink is made from $\frac{1}{16}$in. aluminium, drilled to allow the mounting of the OC35 and capacitor clips and then bent as shown in the heat sink details given in Fig. 7. The heat sink is also used as the anchoring point for the smoothing capacitor retaining clips. These capacitors can be mounted either by means of conventional clamps or, more simply, by means of insulated spring clips. If the capacitors used are of the type having the can common to negative, ensure that the can is insulated from chassis. When the capacitor is mounted in place a strip of insulating tape or heavy polythene between can and clamp is suitable.

As the heat sink is mounted directly on the chassis the OC35 must be insulated electrically from the metalwork by means of a mica washer and insulating bushes for the two fixing screws. These are standard items and can be bought with the transistor. Since it is extremely important that the transistor should have a good thermal junction with the heatsink, any burrs and rags on the holes drilled should be removed and the mounting surface rubbed over with fine emery cloth so as to present a completely clean, smooth surface. A smear of silicon grease should be placed between the transistor face and mica washer and between the mica washer and heat sink surface. The transistor is then clamped down firmly by means of the two fixing screws. Before mounting on the chassis the complete surface of the heat sink, apart from that immediately beneath the OC35, should be given a coat of matt black paint, the surface being rubbed over first with emery cloth to give the paint a hold. The heat sink details have been stressed since the correct preparation and mounting of the transistor is extremely important if good thermal contact and good heat dissipation are to be achieved.

METERING CIRCUIT

The metering circuit will be rather dependent upon the type of meter used. With the 10mA movement specified the series resistor, RM2, will have a value of 5kΩ for a 50 volt full-scale reading, such a movement having a sensitivity of 100Ω per volt. The accuracy will of course depend upon the accuracy of the resistance used and the quality of the meter. At least a 5% high stability type is advised while a 1% or 2% type is preferable.

The shunt resistor RM1 will have to be made by hand, the actual value being dependent upon the internal resistance of the meter, the value of which will vary with different makes and types. The shunt value can be calculated from $Rs = \frac{Rm}{n-1}$, Rm being the meter resistance and n the range multiplying factor. As an example, the resistance of the meter used by the writer was 3Ω, therefore the value of Rs to give a full-scale reading of 1 amp (100 times factor) was $\frac{3}{100-1}$ or 0.0303Ω. Say 0.03Ω. As the shunt value will always be very small it can be simply made from a few inches of Eureka or Nichrome resistance wire wound on a $\frac{1}{4}$ or $\frac{3}{8}$in. diameter former. A gauge of wire is chosen which will carry 1 amp without overheating. Using the example just given, 18 s.w.g. Eureka has a resistance of 0.384Ω per yard and Nichrome a resistance of 0.854Ω per yard; therefore a length of 2.81 in. of the Eureka or 1.26 in. of the Nichrome would give the required shunt value. An extra $\frac{1}{4}$in. at each end should be allowed for soldering and connection. (18 s.w.g. wire, both in Eureka and in Nichrome, is available from Post Radio Supplies, 33 Bourne Gardens, London, E4 9DX). Conversely, any piece of heavy resistance wire out of the junk box can be cut down to size experimentally by connecting the meter in series with another ammeter and an external supply and load. The length of wire is reduced until the readings on both meters are the same. Take care to ensure that, due to a poor connection, an excessively high current cannot be passed through the meter on its own. The test current should be established in the resistance wire first, the meter to be shunted then being temporarily connected to the wire. When the shunt is completed it is advisable to make a final check on both current and voltage calibration before the meter and components are put into circuit. The voltage and current ranges on the average multimeter will be sufficiently accurate for calibration checks.

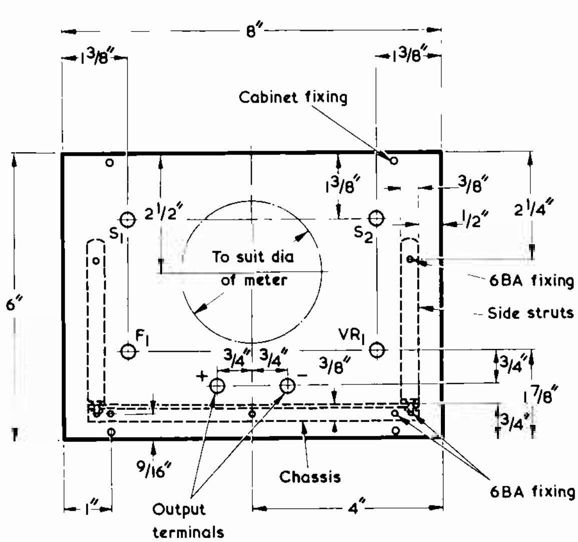


Fig. 6. Layout and dimensions of the front panel

FINAL DETAILS

For those who, like the writer, prefer to wind their own transformers and can obtain the laminations required, the following details are included. Core, Stalloy 1in. square interleaved stack, window space $1\frac{1}{2}$ by $\frac{3}{4}$in. Primary, 2,000 turns 32 s.w.g.; secondary 285 turns 20 s.w.g. Allow suitable insulation on primary and between windings.

With the heat sink and other components all in position, the front panel can be screwed into place and the various interconnections made off. Ensure that the output terminals are insulated from the panel. The mains input is brought in from the rear of the chassis and taken to a 3-way terminal block secured with

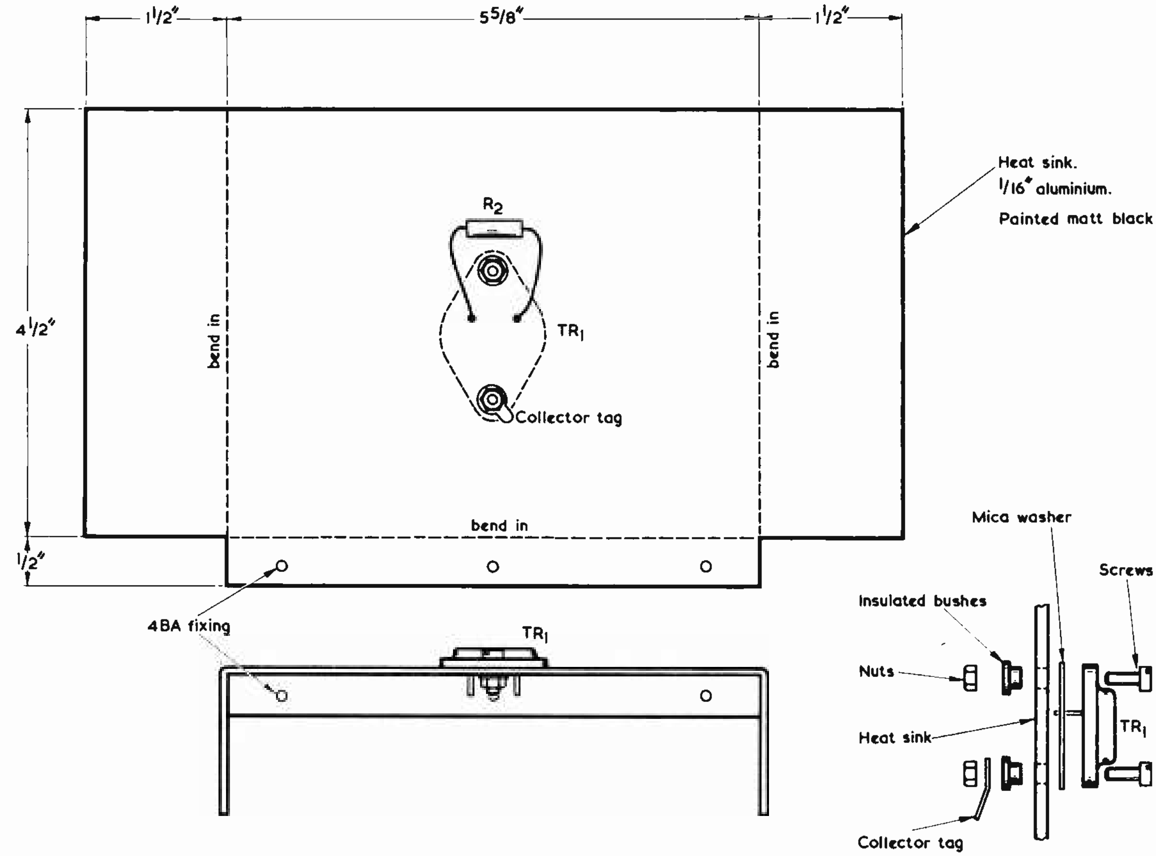


Fig. 7. Details of the heat sink and method of mounting TR1

Araldite to the top of the transformer. Alternatively a suitable tag-strip can be mounted under one of the core securing bolts or at any other convenient point. A 3-core mains lead is employed, the earth being taken only to the transformer core and chassis. This means that the chassis, front panel and all metalwork inside the unit are safely earthed, while the d.c. supply is floating. The layout and appearance of the completed power unit is clearly shown in the photographs.

Final testing should offer no problems. With VR1 set to about mid-point and the meter switched to read voltage, connect the mains supply. The meter should immediately indicate some reading about the middle of the voltage range. If internal metering is not used connect a d.c. voltmeter across the output terminals and switch on S1. VR1 can be varied over its entire travel, whereupon the voltage reading should vary appropriately over the quoted range. Some slight tolerance can be expected on upper and lower limits, principally due to transformer, zener and divider differences. These voltage differences should be quite small, however.

If desired the regulation can be checked, a suitable load being connected across the output terminals and any difference between load and no-load voltage readings noted. The load can be quickly switched in and out by means of S1. The load current can also be checked by switching S2 to the current position. As an example, with the output set to 20 volts a resistor of 40Ω would be required across the output terminals to check the 0–0.5 amp regulation. Any load resistors used for test purposes should be capable of handling the necessary power. In the example just mentioned a 10 watt resistor would be necessary. To check ripple values an oscilloscope having a Y sensitivity of at least 20mV/cm is required. Should the voltage fail to stabilize at either of the extreme ends of VR1 traverse, a slight change in the value of either R5 or R6 as applicable can be made to pull TR3 base voltage within the stabilizing characteristic of the circuit. For future servicing, a list of voltage readings is given in Table II.

In practice the power unit should prove extremely useful and reliable. Its compact construction makes for portability while the wide range of voltage and current offered should meet the everyday needs of most amateur constructors and experimenters. ■

(concluded)

TABLE II

Voltage Readings

All readings measured with 20kΩ per volt instrument with respect to negative line. Vout = 20, Iout = 0.25A. Transformer secondary 34.6V a.c.

TR1	Emitter	42.9V
	Base	42.7V
	Collector	20V
TR2	Base	0.55V
	Collector	41V
TR3	Emitter	5.61V
	Base	5.2V
	Collector	0.6V

QSX

By FRANK A. BALDWIN
(All Times GMT)

From time to time, the writer receives letters from readers of the short wave features in this journal and, in fact, is very pleased to receive the views and comments. One such regular correspondent is B. Walsh of Romford, Essex, who by now has become a collaborator in the monitoring of channels on which unidentified stations are known to operate. Additionally, he supplies a steady stream of information on the loggings he has made to date.

One of the stations he heard was Radio Euzkadi, the Basque underground transmitter which operates on a measured **13220** with identification and sign-on at 2027 in English, Spanish, French, Italian and Basque. Programming is in Spanish and Basque from 2030 until 2055, then into English to explain the objects of the Basque movement. The transmission ends at 2103, the address given for reports being R. Euzkadi, B.P.59, Paris 16, France.

Radio Liberation, Hanoi, on **10010** in French and Vietnamese at 2015 is another of his loggings, as is CKZN, St. Johns, Newfoundland on **6160** from 2200 onwards. Considering that the power of CKZN is only some 300 watts, this represents quite a Dx feat.

● PROGRAMMES IN ENGLISH

Another reader of the short wave features, whom the writer regularly meets, has frequently suggested that Dx loggings be put aside for one month and a feature made of programmes in English that the average listener could, with reasonable luck, receive. So for Mr. L. E. Collop, here it is!

The times listed are those at which such programmes were actually received and those new to short wave listening should note that programme schedules are subject to change from time to time. However, many of the English transmissions will be logged by those who tune to the channels shown.

1500 9645 (31.10m) 100kW Vatican, identification and news. Parallel channels are **11740** (25.55m) and **15120** (19.84m).

1545 3905 (76.83m) 20kW AIR Delhi, news and identification. This one may be difficult for the 'average' listener but is included for those who may care to try and receive Delhi the 'hard way'.

1600 6035 (49.71m) 100kW Warsaw, identification, news events in Poland.

1830 9530 (31.48m) 100kW AIR Delhi, 'Press Review', Indian music. Programme beamed to Africa.

2000 9440 (31.78m) 250kW Pekin, identification after 'East is Red' tune, news from the Chinese point of view.

2000 9912 (30.27m) 100kW AIR Delhi, identification then newscast, Indian views on current dispute with Pakistan.

2030 9575 (31.33m) 60/100kW, Rome, programme about events in Italy.

2100 9525 (31.50m) 250kW Johannesburg, identification and African news, beamed to West Africa.

2100 9625 (31.17m) 100kW Tel Aviv, identification and news.

2100 11900 (25.21m) 250kW Johannesburg, tuning signal at 2059, identification, 6 'pips' at 2100, then news to West Africa.

2115 9545 (31.43m) 100kW Tema, Ghana, identification, recorded music programme.

2115 9460 (31.76m) 50kW Karachi, Pakistan, news in English at dictation speed.

2130 11720 (25.60m) 250kW R. Canada, identification and events in Canada.

2200 9515 (31.53m) 250kW Ankara, Turkey, identification, newscast.

2200 11970 (25.06m) 250kW Johannesburg, newscast directed to Europe.

There are, of course, many other English language transmissions on the short waves not listed above, notable amongst which are those from Radio Moscow and the Voice of America.

● LATIN AMERICA

If conditions are right, Latin America can be fairly easily received on bands other than the L.F. 60 or 90 metre portions of the spectrum. The following lists some of the LA stations operating 'higher up' the dial, the frequency being listed first, as is more usual.

9610 2115 (31.22m) 10kW ZYC9 Radio Tamoio, Brazil, talk in Portuguese after identification.

9665 2200 (31.04m) 10kW PRL Radio Nacional Brasilia, Brazil, station identification, Latin American music.

9695 2158 (30.94m) 7.5kW ZYB22 Radio Rio Mar, Brazil, sports commentary in Portuguese – all very excitable!

11720 2130 (25.60m) 10kW PRL Radio Nacional Brasilia, sports commentary. Interference from R. Canada on same channel.

11805 2118 (25.41m) 10kW ZYZ36 Radio Globo, Brazil, talk in Portuguese and music.

11865 2115 (25.28m) 7.5kW PRA8 Radio Clube Pernambuco, Brazil, Latin American music, identification.

11925 2050 (25.16m) 10kW Radio Bandeirantes, Brazil, discussion in Portuguese (station in Sao Paulo).

11935 2200 (25.14m) 25kW ZYS35 Radio Clube Paranaense, identification and news in Portuguese.

11965 2342 (25.07m) 7.5kW PRB24 Radio Record, Sao Paulo, Brazil, discussion in Portuguese, music.

15145 2035 (19.81m) 10kW ZYK33 Radio Journal de Commercia, Recife, Brazil, identification and LA music.

15225 2053 (19.71m) 10kW ZYN 30 Radio Cultural da Bahia, Brazil, sports commentary.

Quite a tour of Brazil!

● ODDS AND ENDS

To conclude, here are a few stations recently logged which may interest some readers.

3905 2345 (76.83m) 20kW AIR Delhi, Indian-style music, identification in English at 2359, sign-off at midnight. (See earlier listing).

3930 2350 (76.34m) 1kW CR4AC Radio Barlavento, Cape Verde Islands, single gong note, identification in Portuguese followed by music and song programme.

3945 1554 (76.05m) 10/50kW Peshewar, Pakistan, native musical programme.

4990 0505 (60.12m) 10kW Lagos, Nigeria, newscast in English.

5038 2110 (59.55m) 100kW Bangui, Central African Republic, news in English, identification at 2118. ■

NOTES ON SEMICONDUCTORS

Further Notes — 2

CURRENT AFFAIRS

by

PETER WILLIAMS

This note illustrates a constant current circuit and explains how it functions.

IT IS EASY TO THINK IN TERMS OF CONSTANT VOLTAGE supplies because all the commonly available power sources are in this form – mains supplies, primary and storage batteries. To get the most out of our electronics we should not allow ourselves to be dictated to by these supplies, but consider how we could make use of constant current supplies and then proceed to design them (or vice-versa if we are in a particularly obstinate mood).

CONSTANT CURRENT CIRCUIT

The clue to such uses lies in considering what properties of semiconductor devices and circuits depend primarily on operating current. For example a zener diode (or its transistor cousin as in 'Notes on Semiconductors' in the June 1971 issue) provides a stable d.c. reference only if temperature and current are controlled. If such a diode is supplied via a resistor from a voltage supply it is at the mercy of any variations in that supply. By interposing a constant current circuit the stability of the reference can be greatly improved.

Fig. 1. shows one way of producing such a constant current. To simplify the circuit behaviour assume that the transistor has a very high gain and that Vbe is negligible compared with the voltages across R1 and R2. Then I1 R1 = I2 R2, i.e. the current in R2 and hence in the transistor collector is independent of the load placed in that collector. In practice the collector current does vary at both extremes of collector voltage, but a variation of less than 1% is possible for many applications.

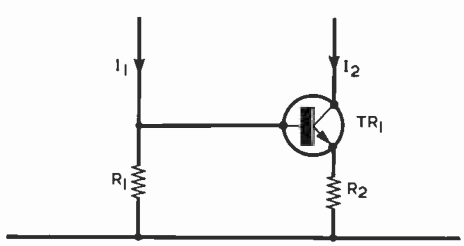


Fig. 1. When TR1 here has a high gain, its collector current is virtually constant despite varying collector loads

The higher the current gain of the transistor, the more stable the ratio of I2 to I1. If I2 is required to be stable against changes in supply voltage as well as load then either I1 has to be stabilized or R1 be replaced by an element providing a constant bias voltage. This leads to the circuit of Fig. 2 shown in complementary form as a reminder that we always have this facility of circuits that 'fall upwards' as well as downwards.

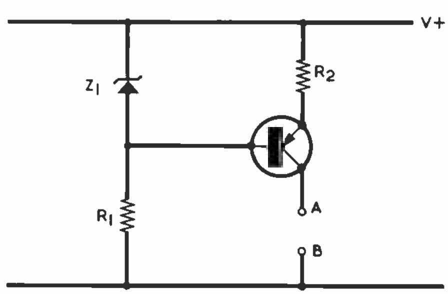


Fig. 2. The inclusion of the zener diode Z1 guards against changes in supply voltage

A zener diode between A and B would now show a high stability against changes in supply voltage and would be useful for a highly-regulated supply. A second application could be in a waveform generator using a unijunction transistor. Normally the capacitor associated with such a circuit is fed from the supply voltage via a resistor and the charging waveform is non-linear. With this modification, the constant current in the capacitor would ensure a voltage that changed linearly with time. ■

RECENT PUBLICATIONS

GUIDE TO PRINTED CIRCUITS. By Gordon J. King, R. Tech. Eng., M.I.P.R.E., M.I.T.A.I., F.S.R.E.
148 pages, 5½ x 8½in. Published by Fountain Press Ltd. Price £2.50.

This latest title from Gordon J. King deals with a subject which has not, perhaps, received as much attention as it should have had over the last two decades. Printed circuits started to make a significant appearance in domestic electronic equipment some fifteen to sixteen years ago. During the relatively short space of time which has elapsed since their introduction they have revolutionised manufacturing processes, and they probably provide the major reason for the relative stability of electronic entertainment product prices over a period when most other retail costs have been severely increased by inflation.

In this book, Gordon J. King does not set out to give a scientific account of printed circuits; instead he deals with them for the benefit of the amateur, the experimenter and the service engineer. After an introductory chapter, the book proceeds to describe the design and manufacture of printed circuits and then discusses how printed circuits can be made in the amateur workshop. The next chapter deals with printed circuit substitutes, including Veroboard, Cir-Kit and S-DeC systems, after which the servicing of printed circuit equipment is covered with particular reference to soldering problems and to de-soldering guns and tools. The last chapter looks into the future of printed circuits and is mainly taken up with integrated circuit applications.

'Guide To Printed Circuits' is written in the down-to-earth manner for which its author is well known, and it offers good, practical, common-sense advice to those who read it. The book is liberally illustrated with line drawings and clear photographs, and it has a useful index.

PUBLIC ADDRESS HANDBOOK. By Vivian Capel.
214 pages, 5½ x 8½in. Published by Fountain Press Ltd. Price £3.00.

The author of this book has had much practical experience of the installation of public address systems, and he also acts as public address engineer for a large educational organisation. This wide background is clearly reflected in the book, which deals in a practical manner with all p.a. work from simple sound reinforcement systems, as would be encountered in small clubs, to multi-watt installations in football stadia.

The book commences by dealing, in turn, with the basic principles of p.a. work, with the choice of microphones, with microphone mixers, and with amplifiers and loudspeakers. Next to be covered are the assembly of the units which make up p.a. systems and the avoidance of that bugbear of all p.a. engineers, feedback; these subjects are then followed by discussions on the best methods of obtaining both short and long term reliability and on taking advantage of auxiliary services such as Post Office lines. A further topic is the amplification of live music, including that from the electronic guitar, and the possible use of ambiophony with artistes playing in the open air or in acoustically dead surroundings. Ambiophony refers to the technique of adding, near the players, speakers which are fed with low level delayed versions of the signals produced by the players themselves. The consequent effect is of normal hall reverberation. Without such 'feedback' performers tend to subconsciously force their tone under the assumption that they cannot be heard.

Yet further chapters in this comprehensive book deal with outdoor installations, practical systems and fault finding. The section on practical systems is particularly useful as it gives examples of nine actual installations. The book concludes with the procedure involved in setting up in business as a p.a. contractor.

'Public Address Handbook' can be recommended to anyone who anticipates carrying out p.a. or sound reinforcement work in the future or who has embarked on this particular segment of electronics already. The book also affords very interesting reading to those who have only a general interest in the subject of public address.

SIGNALS AND INFORMATION. By C. C. Goodyear, B.Sc., D. Phil., A. Inst.P.
318 pages, 5½ x 8½in. Published by The Butterworth Group. Price £4.20 cased, £2.80 limp.

This book is intended to offer, at final-year undergraduate level, an introduction to the theory of signals, signal processing, noise and information. Its main purpose is to offer a background of communication theory for students specializing in telecommunications. The emphasis is on fundamental theory, and details of circuits and practical applications are touched on only lightly.

The author states in his preface that most students encountering the material for the first time will find that a few of the more mathematical sections take a little time to digest, and he suggests a 'first reading' sequence which enables the student to skip the more difficult sections, returning to these at a later stage.

The first chapter in the book provides an introduction to the subjects covered, whilst the second chapter covers the overall field of signals. Succeeding chapters deal with signal processing, modulation theory, probability and statistics, noise, signals with noise, informating and coding, and communication channels

Cover Feature

Transist

A. G.

This test instrument provides ac a.c. gain by means of a bridge the necessity for an expensive n a measure of leakage current a di

HAVING PURCHASED A LARGE QUANTITY OF ex-computer transistors, both silicon and germanium, the author had a requirement to classify them; clearly some sort of tester was required, preferably direct-reading, to evaluate their performance. The same tester would also be required to check known transistors against their specifications, and to test diodes as well.

Cost was of prime importance, so initial outlay would have to be kept small, precluding the use of expensive meter movements. It was not intended to attempt to measure absolute maximum ratings or frequency limitations, thus leaving the leakage and current gain to be measured as is common with most simple transistor testers.

The most often specified leakage current in transistor data sheets is Icbo, or the current that flows between collector and base when this junction is reverse-biased at a specified voltage, the emitter terminal being unconnected. The tester was therefore designed to measure this parameter.

Two expressions for current gain exist, and an explanation of the differences will help the reader understand why the tester has been designed to measure one and not the other.

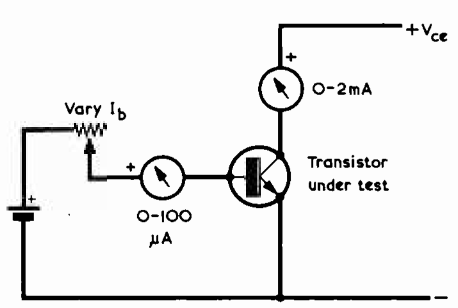


Fig. 1. A circuit capable of measuring d.c. gain, hFE

A.C. AND D.C. GAIN

If a known quantity of current is fed to the base of a transistor, the resulting collector current can be measured, and the two compared to give a gain figure. See Fig. 1.

The measurement is taken at a specified collector-emitter voltage, and the relation Ic/Ib is called the d.c. current gain, or hFE for short. This is the quantity which is most often measured in simple transistor testers. In practice, the meter in the base circuit can be eliminated by feeding the base from the collector supply via a resistance much greater than the emitter/base resistance, in which case the effect of the latter can be ignored, and Ib calculated from Ib = Vce/Rb. See Fig. 2. Alternatively Rb can be calibrated directly

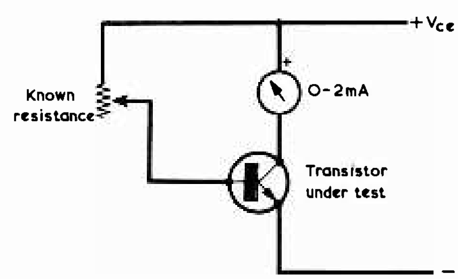


Fig. 2. If the base bias resistance is known, the base current meter can be dispensed with

in terms of Ib. (See Suggested Circuit No. 243, 'Transistor Gain Checker', by G. A. French, published in the February 1971 issue.)

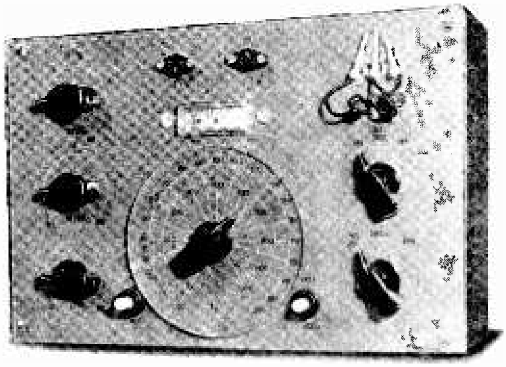
Although hFE gives a good idea of how a transistor will perform in-circuit, it is not an accurate measure of how much it can amplify; a better indication is given by the second expression of current gain.

This is called the 'small signal current gain', or hfe for short. By definition, this is the *change* in collector

r Tester

r

EWETT



rate measurements of transistor chnique which dispenses with er. In addition, the unit can give can also check semiconductor s.

current resulting from a small *change* in the base current with Vce constant at a specified value of standing collector current and with zero load (in other words, with the collector short-circuited to a.c.). The smaller the change, the more accurate becomes the measurement. In practice, providing the change in Ic is small compared with the standing value of Ic at which the gain is to be measured, change in Ic divided by change in Ib can be taken as hfe.

This parameter could be measured using the circuit of Fig 3, in which pressing the push-button increases base current by 1µA. The meter in the base circuit has been eliminated as in Fig. 2, and a variable resistor provided to set the standing current to, say, 1mA. In order to satisfy the previous statement that the change in Ic must be small compared with the standing Ic, the former will have to be kept below say 100µA, which with the 0–2mA meter suggested in the diagram is going to make accurate readings difficult, to say the least.

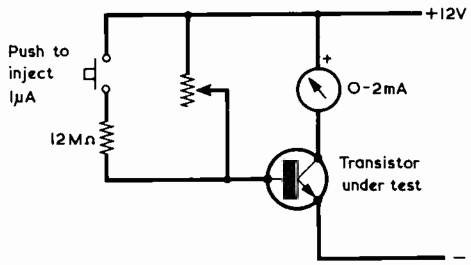


Fig. 3. The circuit of Fig. 2 modified to enable a.c. gain, hfe, to be measured

What is required is to make the meter read only *changes*, and not standing values, and this can be achieved using a Wheatstone bridge, as in Fig. 4.

If, in Fig. 4, R1/R2=R3/R4, then no current will flow in the meter. If R1 is replaced by the transistor under test, and it is arranged that its effective resistance is set by altering its base current so that it presents the same resistance as did R1, the bridge will again be balanced. In the basic circuit shown in Fig. 5 the supply voltage and the resistances have been chosen such that the meter zeros only when 12 volts appears between emitter and collector, and the emitter current is 1mA. This is the standing voltage at which measurement of hfe will be made.

If a known amount of base current is now injected in addition to the standing base current, the effective resistance offered by the transistor will drop, and the bridge will be unbalanced. The reading on the meter is proportional to the amount of bridge unbalance and hence transistor gain, which can be read from a suitably calibrated meter dial.

A better (and cheaper) approach would be to replace R3 with a variable component which is calibrated in terms of gain, thereby allowing the meter to be replaced by an inexpensive but sensitive miniature stereo balance type. The variable resistance is then adjusted to achieve bridge balance, and the gain reading taken directly from it. This is the basis of the practical circuit, which is shown in Fig. 6.

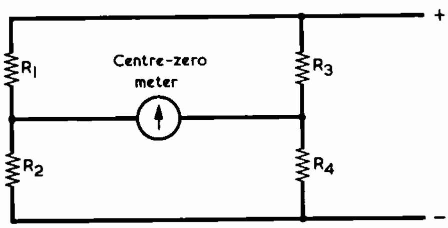


Fig. 4. The Wheatstone bridge

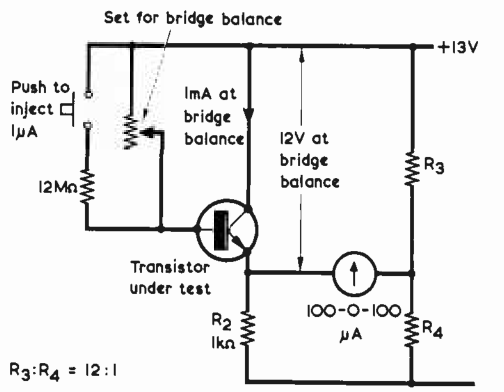


Fig. 5. Combining the circuit of Fig. 3 with that of Fig. 4 offers a practical means of measuring hfe

PRACTICAL CIRCUIT

In the practical circuit the four arms of the bridge are: first, the transistor emitter and collector test terminals; second, R14; third, VR4, R18 and VR5 in series; and fourth, R19 and VR6 in series.

VR2, VR1 and the resistors selected by S6 give fine, medium and coarse adjustment, respectively, of base current to bring the bridge initially into balance. The base current is limited to 1mA maximum by R1. When the bridge is balanced with these controls, the transistor under test will have an effective resistance of V/I= 12V/1mA=12kΩ

Under these conditions, VR4, the 'Gain', control is set to insert maximum resistance, thereby indicating a gain of zero. Pressing S2 causes an extra base current of 1µA to be injected. If the transistor had a gain of 200 the resulting collector current (assuming an unaltered voltage drop across R14) would be 1mA plus 200µA, or 1.2mA, and the effective transistor resistance would now be 12V/1.2mA=10kΩ. VR4 now needs to be in the minimum resistance position, corresponding to a gain reading of 200, for the bridge to be balanced again. So that VR4 can be made to cover the exact range of 0 to 200, VR5 and VR6 are provided as calibration controls. Only two extra resistors are required for the calibration, as will be explained later. In practice, the voltage dropped across R14 does not remain unaltered when S2 is pressed but rises to 1.2V, whereupon the effective transistor resistance becomes 11.8V/1.2mA=9.8kΩ. The resultant error is only 2%, but its existence should be mentioned. The 2% error is given only at the maximum gain position of VR4 and becomes proportionately less at lower settings. It could, if desired, be taken up in the calibration process.

Pressing S3 instead of S2 causes 0.2µA to be injected into the base, so multiplying the range by 5 and allowing gain readings from 0 to 1,000 to be given.

Another factor which affects accuracy lies in the values of R15 and R16. It is difficult to obtain close

COMPONENTS

Resistors
(All fixed values ¼ or ½ watt 10% unless otherwise stated)
R1 12kΩ
R2 10MΩ
R3 9.1MΩ
R4 8.2MΩ
R5 7.5MΩ
R6 6.5MΩ (4.3MΩ and 2.2MΩ in series)
R7 5.6MΩ
R8 4.7MΩ
R9 3.9MΩ
R10 3MΩ
R11 2MΩ
R12 1MΩ
R13 12kΩ 5%
R14 1kΩ 2%
R15 12MΩ (10MΩ 5% and 2MΩ 5% in series)
R16 60MΩ (6 x 10MΩ 5% in series)
R17 30kΩ
R18 20kΩ 5%
R19 2kΩ 5%
R20 1kΩ 2%
VR1 1MΩ potentiometer, carbon linear, with switch S1
VR2 100kΩ potentiometer, carbon linear
VR3 25kΩ skeleton preset potentiometer (see text)
VR4 5kΩ potentiometer, 3 watt wirewound
VR5 10kΩ skeleton preset potentiometer
VR6 1kΩ skeleton preset potentiometer

Capacitors
C1 4,700pF, plastic foil
C2 4,700pF, plastic foil

Diodes
D1 AA129 (Mullard)
D2 AA129 (Mullard)
D3 Zener diode, 13V 5%, 250 to 400mW

Meter
M1 100–0–100µA, moving-coil, edge mounting

Switches
S1 s.p.s.t., part of VR1
S2 s.p.s.t., push-button
S3 s.p.s.t. push-button
S4 4-pole 3-way, miniature rotary
S5 4-pole 3-way, miniature rotary
S6 1-pole 12-way, miniature rotary

Battery
B1 18-volt battery (2 x PP6 in series)

Miscellaneous
6 pointer knobs
3 crocodile clips
3 miniature wander plugs and sockets
2 transistor holders
Battery connectors
Material for case and front panel
Copper laminate printed circuit board

tolerance resistors in the 10MΩ value incorporated in these two components. However, 5% 10MΩ resistors are available in ½ watt carbon from Electrovalue, 28 St. Judes Road, Englefield Green, Egham, Surrey, and this tolerance should be adequate for general usage of the tester. Constructors requiring higher accuracy in R15 and R16 could make up these components with a larger number of close tolerance resistors of lower value. The author obtained all the fixed resistors for the prototype, together with VR1, from Electrovalue.

C1 and C2 prevent any rectified a.c. pick-up interfering with readings, and different transistor attachments are provided to suit various transistor lead-out configurations. These are described in the constructional notes.

When the function switch S4 is placed to 'Leakage', the emitter circuit is broken by S4(c). The base current is set to zero by opening S1, which is integral with VR1. The transistor collector-base junction is now placed across the supply voltage with the meter in series with it, hence measuring Icbo at the supply voltage. R13 limits the meter current in the case of a faulty transistor. S5(c) and (d) ensure that the correct supply polarity is fed to the transistor for this test.

Power for the tester comes from two 9V batteries in series giving 18 volts, which is stabilized down to approximately 13V due to R20 and D3. Power is applied via S4(d) in the 'Leakage' and 'Gain' positions. The meter is short-circuited at 'Off', with S5 at either 'N.P.N.' or 'P.N.P.' by S4(a) and S4(b).

In the 'Gain' position of function switch S4, S5(c) and (d) ensure correct polarity as before. As it was considered desirable to retain the same sense of meter pointer movement relative to the rotation of VR4 for bridge balance with both polarities, sections (a) and (b) of S5 ensure that VR4 is always turned in the desired direction of meter pointer movement to achieve bridge balance.

In the 'Battery Check' position of S5, sections (a) and (b) connect the meter across R20 via VR3 and R17, the former being preset to make the meter read 5V f.s.d. Hence, provided there is deflection on the meter on this check, the batteries are still usable. Their actual voltage can be assessed, if required, with the knowledge that f.s.d. in the meter corresponds to 5V, whereupon battery voltage is equal to 13V plus meter reading. R17 is inserted in series between the positive end of R20 and S5(b) rather than in series with VR3 at the negative end of R20. If there were a direct connection between the positive end of R20 and S5(b) the battery would be momentarily short-circuited when changing

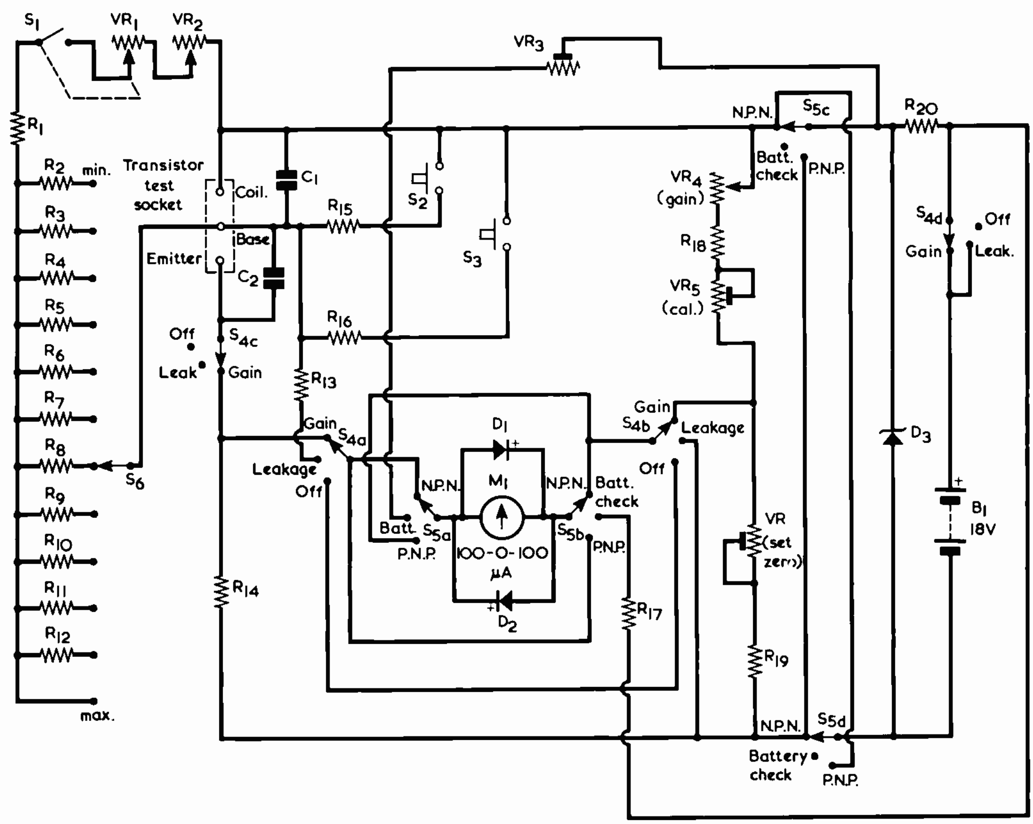


Fig. 6. The full circuit of the transistor gain tester

S5(b) from 'N.P.N.' to 'Battery Check' if S4(b) were at 'Leakage'. The circuit location chosen for R17 ensures that the momentary current which flows is negligibly low.

Diodes D1 and D2 are transistor bias stabilizing types, chosen in this application for their low forward conducting voltage (typically 200mV). These conduct if the meter is subjected to an overload, and protect it. Substituting ordinary germanium types here is not advisable, as some of these have higher forward current voltages, in which case damage could be caused to the meter.

The meter used in the prototype was a 100–0–100μA edge type panel meter and had an internal resistance of around 1,000Ω, whereupon f.s.d. in either direction requires 100mV, and AA129's are suitable for protection. Any centre-zero 100–0–100μA meter with a resistance of 1,000Ω or less can be employed. Since only the central null indication is of main importance there is no necessity to obtain a scaled meter and a less expensive stereo balance movement is all that is required. If the meter resistance is lower than 1,000Ω a series resistor may be added, as in Fig. 7, to bring the total

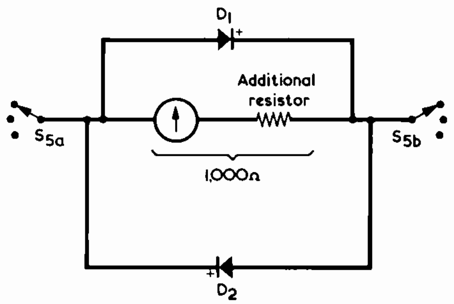


Fig. 7. If the meter employed has an internal resistance less than 1,000Ω, additional series resistance may be added to bring the total resistance presented to D1 and D2 up to that value

resistance up to 1,000Ω. The two AA129's will then continue to provide the desired protection. The meter used by the author originally had two arrow-heads on the scale, their tips meeting at the central null point, and it was decided to modify this by removing the scale, turning it over and marking up the reverse side in terms of 100–0–100. This is not an easy process and is not recommended to those without experience of fine work. In any event, the calibration is not necessary as the previous null-only indication was quite adequate, being sufficient also to enable leakage and battery voltage readings to be reasonably well adjudged.

Diodes can be tested for 'goodness' by connecting them between the base and collector terminals of any test socket, and setting S4 to the 'Leakage' position. Switching S5 from 'N.P.N.' to 'P.N.P.' should then make the meter read f.s.d. one way when the diode is conducting, and produce a slight deflection or none the other way, indicating the leakage level when reverse biased. Where diode polarity is to be established, the mnemonic 'Polarity check, switch to P.n.p., Cathode Connected to Collector when diode Conducting' (no apologies for corniness!) can be used.

CONSTRUCTION

The following describes the author's tester, but any convenient layout and method construction may be used as desired, to accommodate the particular components employed.

The case was made from ½in. plywood, pinned and glued together to form a 5-sided box with the top open, measuring 9 by 6 by 2¾in. deep. The exterior of this was then covered with Formica plastic laminate to give a neat and durable finish. See Fig. 8.

The top was made from a 9 by 6in. sheet of Formica, on which the lettering for scales and component functions was made using dry print transfers, and scale calibrations engraved with a sharp pair of dividers. The resulting engravings were then filled with a contrasting colour paint, and the surface wiped immediately with a clean rag to leave the paint only in the scratches. This gives sharp and legible scales. Incidentally, do not use the heat-resistant grade of Formica for the panel as this may be found to incorporate a thin metal lamina which could cause short-circuits between the wander sockets mounted on the panel.

A 9 by 6in. piece of clear plastic sheeting, ⅛in. thick, was then cut to fit over the Formica panel. This protects the markings and gives the whole top assembly strength, since it is required to carry all the components. The two parts are held together by the bushes of the controls, etc.

Figs. 8 and 9 give an idea of the general assembly and of the appearance of the front panel. It is recommended that the cutting of all holes in the panel is carried out before applying the transfers and paint in

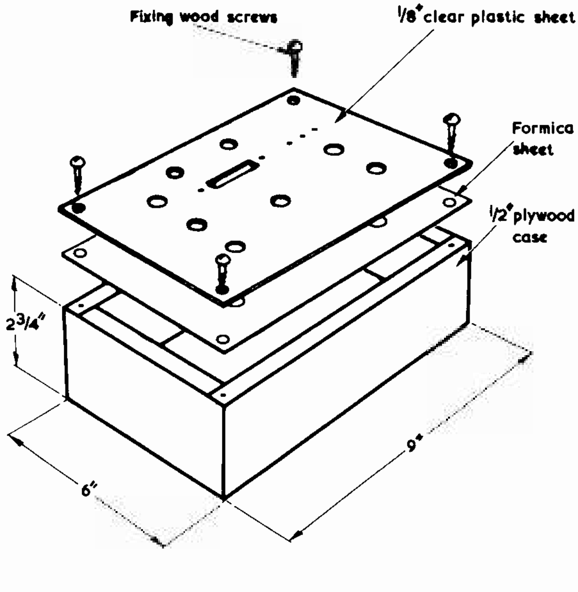


Fig. 8. Details of the case employed for the prototype

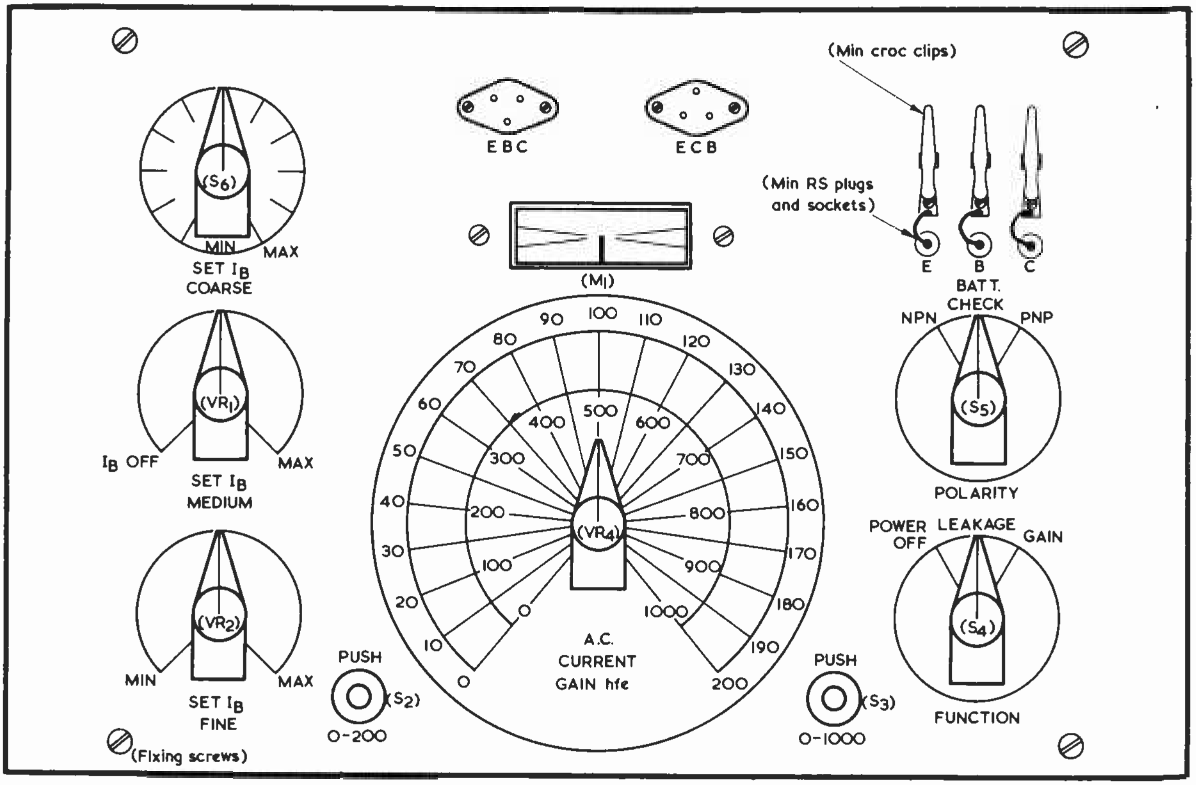


Fig. 9. Layout and legends printed on the front panel. Items in brackets indicate component functions and do not appear on the panel

order to avoid damaging them.

The cursor for the gain control knob was made from a circular piece of clear plastic sheet, about $3\frac{1}{4}$in. in diameter, this being cemented to the knob underside with Araldite. A radial engraved line indicates the gain reading. The total potentiometer travel of VR4 can be measured using a protractor, and the result divided by 20 to obtain the scale calibrations, as shown in Fig. 9. It should be borne in mind that the first few degrees at the beginning and end of travel of some potentiometers produce no change in resistance due to the construction of the wirewound track. This can be allowed for if the end points are established using an ohmmeter and the scale adjusted accordingly.

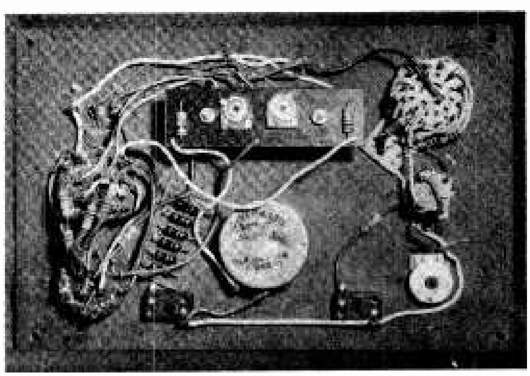
The contacts of the two moulded transistor holders are paralleled, but in a different order, to suit different lead-out layouts, and they are screwed to the front panel with 8BA bolts and nuts. Three crocodile clips are drilled 8BA clear, and mounted on the panel as shown in Fig. 9. Short lengths of flexible insulated wire attached to these are terminated in miniature wander plugs; this allows the clips to be plugged into the sockets in any desired order, again accommodating different transistor lead-out layouts.

The meter was fixed to the front panel with two countersunk 4BA bolts, these being 2in. long as they also secure a small printed circuit panel at the rear.

The rest of the controls are self-explanatory from a mounting point of view, and their positions can be seen in Fig. 9.

In view of the small battery drain of the unit (approximately 5mA) it was decided not to provide a special access to the batteries, so the front panel is fixed to the case with four countersunk brass woodscrews. The batteries are held in place with rubber bands attached to the plywood case with small eyes of the type used for curtain rods. The leads are made sufficiently long to allow removal of the top panel without disturbing the batteries for purposes of calibration, etc.

Three small panels were used to mount some of the resistors and the preset potentiometers, the layout of these being shown in Fig. 10. The board in Fig. 10(a) consists of a plain plastic sheet which carries the six 10MΩ resistors which make up R16. That in Fig. 10(b) is a printed circuit board, and it has a $\frac{3}{8}$in. hole



All the components, apart from the batteries, are fitted to the rear of the front panel

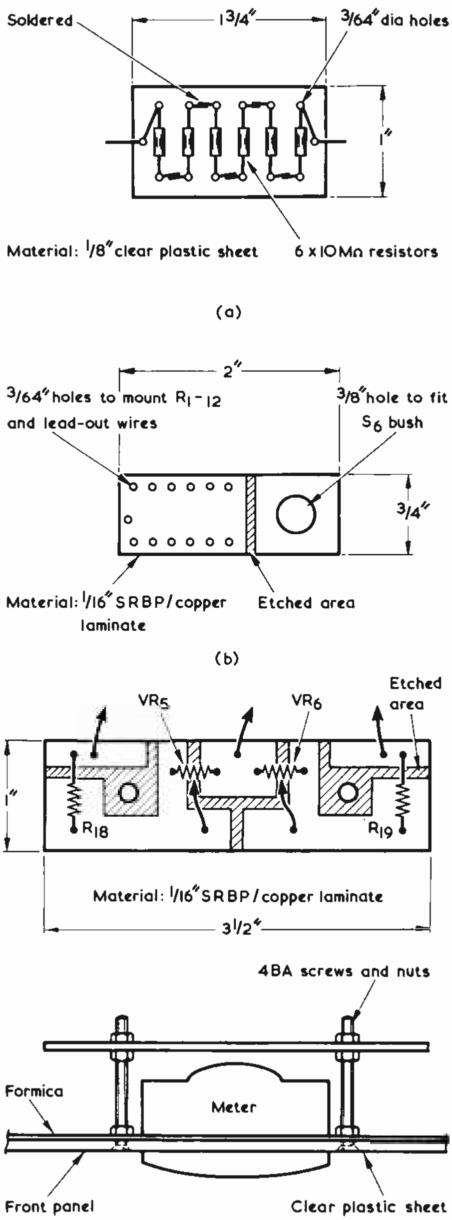


Fig. 10 (a). The board on which are mounted the six resistors which constitute R16
(b). This printed circuit board provides a common connection for R1 to R12
(c). The printed circuit board which carries R18, R19, VR5 and VR6, together with details of its mounting

at one end enabling it to be mounted, suitably spaced from the rear of the front panel, on the bush of S6. The board is etched at the place indicated, whereupon a large area of copper is available to take the common ends of R1 to R12. The board in Fig. 10(c) is another printed circuit board, etched as shown. It accommodates preset potentiometers VR5 and VR6 and R18 and R19, and is mounted on the 2in. bolts securing the meter. Dimensions will have to be modified slightly to suit meters different to that used by the writer.

A partial wiring diagram is given in Fig. 11. This is intended as a guide and shows the positions of the principal components.

CALIBRATION

To check the completed unit, initially switch S4 to 'Leakage', S5 to 'N.P.N.', VR1 and VR2 to minimum, and S6 to maximum. Rotate VR1 to switch on the base current feed, and check that the deflection in the meter increases as VR1 is rotated. Repeat with S5 at 'P.N.P.'.

Next set VR3 to insert maximum resistance, and switch S4 to 'Battery Check'. Connect a voltmeter across R20 and check that it reads around 5V. The reading may be removed somewhat from this figure because of tolerance in D3. Adjust VR3 so that the meter in the unit reads f.s.d. If greater accuracy of calibration voltage is required, an accurate external source of 5V must be used as a reference in place of R20. VR3 may be replaced with a fixed resistor of the same value when the final setting has been found.

Adjust VR5 and VR6 to mid-resistance positions. Switch S4 to 'Gain', whereupon the meter should read f.s.d. to the left (assuming that the meter has the same terminal polarity as that employed by the author). Connect a 12kΩ 2% resistor between the collector and emitter terminals of any convenient socket, rotate VR4 to maximum resistance (gain = 0) and adjust VR6 for zero meter reading. Replace the 12kΩ resistor with one of 10kΩ and 2% tolerance, rotate VR4 to the minimum resistance position (gain = 200) and adjust VR5 once more for meter zero.

Repeat the adjustment steps of VR5 and VR6 until with the 12kΩ resistor in circuit the meter zeroes with VR4 at 0, and with the 10kΩ resistor in circuit the meter zeroes with VR4 at 200. Bearing in mind the remarks concerning accuracy mentioned earlier, the calibration will take up the possible 2% error referred to if the two calibrating resistors have values, within the stated tolerance, in the ratio of 12 to 9.8.

Calibration is now complete, and the intermediate readings on VR4 scale will automatically be correct.

USE OF TESTER

To test transistors the following simple procedure is used:

1. Connect transistor to most convenient attachment socket.
2. Select 'N.P.N.' or 'P.N.P.' as required.
3. Switch to 'Leakage', open S1, and assess Icbo from the meter reading.
4. Switch to 'Gain', adjust VR1, VR2 and S6 for meter zero with VR4 at 0.
5. Depress S2 or S3 and rotate VR4 until meter zeros.
6. Read the gain directly from VR4 (0–200 with S2 pressed, 0–1,000 with S3 pressed).

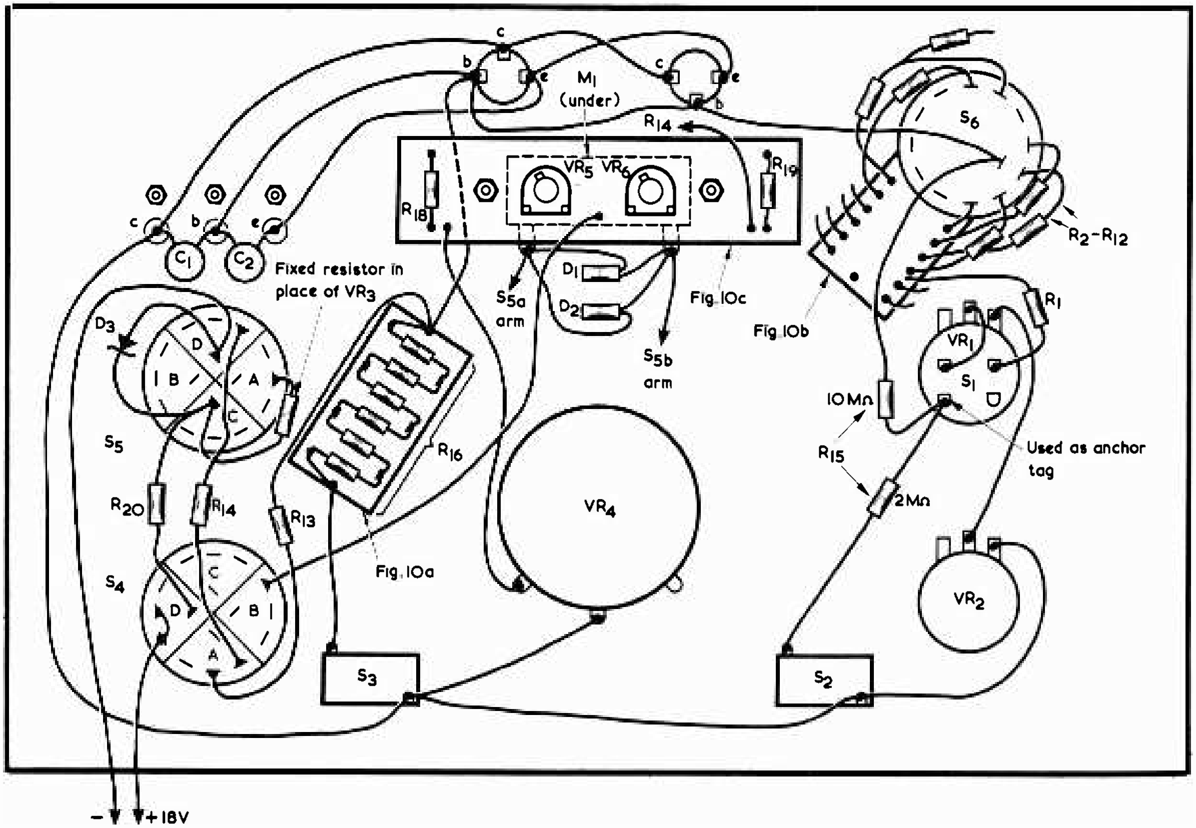


Fig. 11. Layout of the principal components in the transistor tester. R16 is suspended in the wiring, being connected into circuit with relatively heavy gauge leads

To test diodes:

1. Connect diode between base and collector terminals of any convenient socket.
2. Switch to 'Leakage'. Check forward and reverse current by switching from 'N.P.N.' to 'P.N.P.'.
3. Polarity is established if required as described earlier.

An open-circuit transistor will produce constant left deflection of the meter regardless of the positions of the base current and gain controls, and a short-circuit transistor will cause continual deflection to the right. (Again, this assumes the same meter terminal polarity as in the author's unit. If the polarity is opposite, reverse the connections to the meter.)

Finally, as this tester makes measurements at Vce = 12V, it should be remembered that a few transistors, notably earlier ones, have a Vce rating lower than this, so they should not be checked on the unit.

Owing to the standing current level of 1mA the tester is also not suitable for measuring power transistors as these are invariably designed to operate at far greater values of Ic, though there is no reason why an attempt should not be made to check their gain at the collector current used here. ■

CATALOGUE

Currently available is the 10th Edition Catalogue of Henry's Radio Ltd. The catalogue has 352 pages and lists some 10,000 stock lines, these including items in which Henry's radio have specialised over a long period. Typical examples are low-cost quartz crystals in a wide range of frequencies and types, valves, and a very wide selection of semiconductor devices. The last include transistors, thyristors, integrated circuits, rectifier diodes, zener diodes, f.e.t.'s, unijunction transistors and triacs. Semiconductor accessories such as i.c. and transistor holders, heat sinks and power transistor insulators are also shown.

A large selection of the catalogue is devoted to audio equipment and everything required for high fidelity recording and reproduction is listed, individual items ranging from stereo headphones to complete hi-fi installations. There is a very comprehensive range of loudspeakers, together with microphones and pick-ups. Another section of the catalogue is devoted to electronic organs and to components for these and other electronic musical instruments.

The 10th Edition Catalogue may be obtained from Henry's Radio Ltd., (Dept. R.C.), 3 Albemarle Way, London, E.C.1. for 55p post paid. The price is 40p for callers at Henry's Radio retail shops at 303, 309, 354 and 356 Edgware Road, London W.2. The catalogue contains five 10p vouchers which may be used for retail and mail order purchases.

I.C. INTRUDER ALARM

By
VINCENT S. EVANS, G8EDM

This comprehensive intruder alarm functions when an invisible infra-red beam is broken. A unique feature is that the light beam is modulated at 50Hz. with the result that the complementary photosensitive device is not affected by steady ambient light and offers an output which can be treated as an a.c. signal.

THIS INTRUDER ALARM IS INTENDED to be both practical and instructive, and it offers an interesting and educational approach to the various functions that inexpensive integrated circuits can be made to perform.

BASIC OPERATION

Three Fairchild μL914 integrated circuits and one Mel 11 phototransistor with Darlington pair incorporated are employed. The Mel 11 is available from JEF Electronics, York House, 12 York Drive, Grappenhall, Warrington, Lancs.

Overall circuit operation occurs in the following manner. An infra-red beam projector modulated at 50Hz illuminates a beam sensor. The output from the sensor is applied to an a.c. amplifier which feeds into a voltage doubler rectifier. This couples to a Schmitt trigger, a monostable multivibrator and a d.c. amplifier. The d.c. amplifier actuates the warning device when the beam is interrupted and it offers an output at 6 volts with a current capability of up to 0.5 amp. The system is specifically designed to be insensitive to spurious signals and other sources of false alarm. It only operates when a solid body interrupts the beam.

Almost any warning device operating at 6 volts and within the load current limit can be switched into action by taking its power supply direct from the output connections of the alarm. Electric bells should be checked for load factor as some of the cheaper types take an excessive current. Various circuits are published from time to time for electronic 'noise makers' such as warblers or sirens. These can usually be adapted as the alarm signal and provide room for novelty and experiment. Higher voltage or heavy load apparatus can be used by connecting a suitable relay in the output. Thus, a high powered bell, tape recorder or solenoid operated camera can be brought into operation.

The internal circuit of the μL914 is shown in Fig. 1. Should this look formidable to the constructor it will be found easier to interpret if it is treated as four separate transistors in one case, the emitters and collectors being connected internally. In fact, not all the transistors available are used. Note that the lead layout, shown inset in Fig. 1, represents a top view of the i.c., with the lead-outs pointing *away* from the reader. Lead-out number 8 is

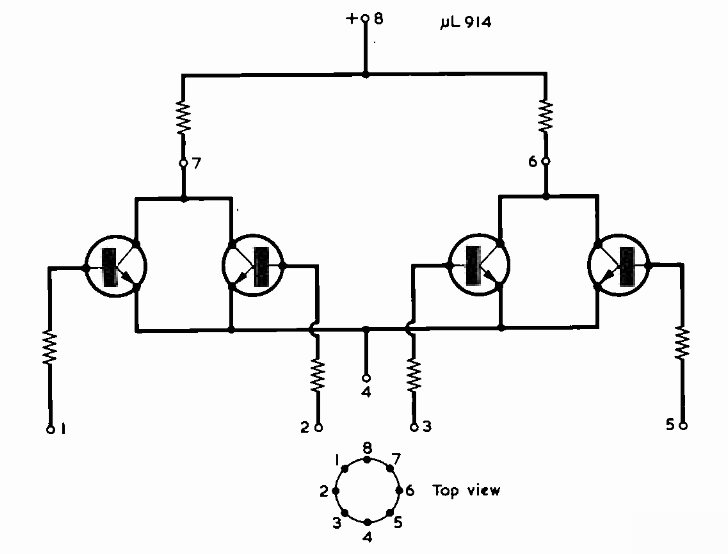
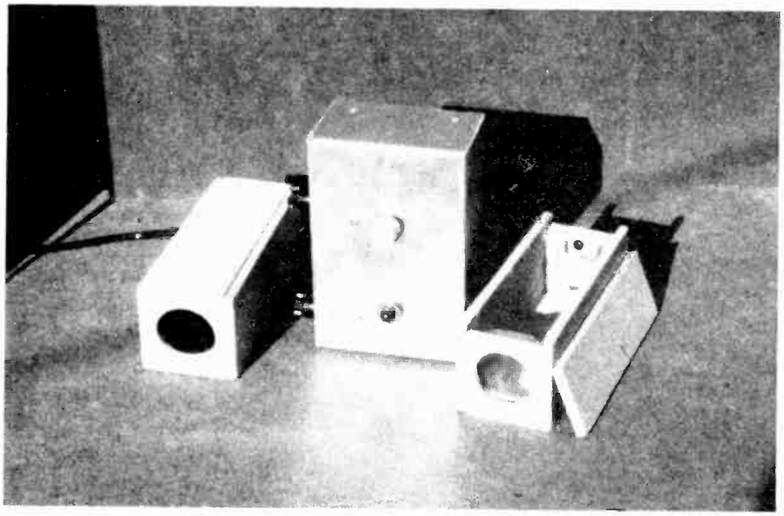


Fig. 1. Internal circuitry and lead layout of the μL914



The base unit, flanked by the projector and receiver cases. The neon bulb and signal warning light appear on the front surface of the base unit

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)

R1	56kΩ
R2	10kΩ
R3	56kΩ
R4	33kΩ
R5	68Ω
R6	1kΩ
R7	1.2kΩ
R8	6.8kΩ
R9	1kΩ
R10	22kΩ
R11	1kΩ
R12	1.2kΩ
R13	10kΩ
R14	120Ω
R15	1kΩ
R16	1kΩ
VR1	25kΩ potentiometer, skeleton pre-set.

Capacitors

C1	32µF electrolytic, 10 V. Wkg.
C2	0.01µF plastic foil
C3	32µF electrolytic, 10 V. Wkg.
C4	4µF electrolytic, 10 V. Wkg.
C5	32µF electrolytic, 10 V. Wkg.
C6	0.1µF plastic foil
C7	1,000µF electrolytic, 10 V. Wkg.
C8	2,000µF electrolytic, 16 V. Wkg.

Transformer

T1	Charger transformer; secondary 0–9–17 V at 1A.

Integrated Circuits

IC1	Mel 11
IC2	µL914
IC3	µL914
IC4	µL914

Transistors

TR1	AC128
TR2	AC128
TR3	OC29
TR4	AC127
TR5	AD161 (with mica washer and insulating bushes)

Diodes

D1	OA81
D2	OA81
D3	DD000 or similar
ZD1	6.2 volt zener diode 250mW 5%, OAZ203 or similar.

Rectifier

MR1	Bridge rectifier, 35 V r.m.s., type GI W005

Lamps

PL1	6.3 V 0.1A, m.e.s. or l.e.s, with holder.
PL2	6.3 V 0.3A, m.e.s., with holder.
NE1	Panel mounting mains indicator neon, with integral series resistor.

Fuses

F1	1A cartridge fuse, with holder
F2	2A cartidge fuse, with holder

Miscellaneous
(see text for details)
Case for base unit.
Materials for projector and receiver assemblies.
Infra-red filter.
2 lenses
Insulated component board
Interconnecting flex

identified by a coloured mark and/or a 'flat' on the edge of the case.

The Mel 11 is shown in Fig. 2 and will be seen to consist of two transistors arranged as a Darlington pair. The first of these is a photo-transistor and is the actual beam sensor. The lead layout inset gives the usual bottom view.

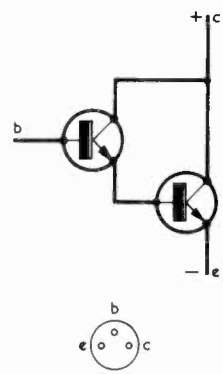


Fig. 2. The Mel 11 incorporates two transistors in a Darlington pair

POWER SUPPLY

Considerable latitude can be exercised on the method of construction and layout. If the purpose is to be experimental, no better method can be used than to take advantage of one of the commercial breadboard systems such as 'T-Dec'. However, the writer found it convenient to use a standard aluminium chassis measuring some 6 by 4 by 2½ in. as a case to house the power supply and main circuit board. Since constructors may not be able to obtain the same model of transformer as was used by the author, it will be advisable to have all the components on hand first before deciding on the size required of the case.

The power supply has to provide a stabilized d.c. output at 6 volts nominal, together with an a.c. output (actually a half-wave rectified output) to supply the 6.3 volt projector bulb.

The circuit of the power supply is shown in Fig. 3. Here, the a.c. mains is applied via fuse F1 to a mains transformer offering secondary voltages of 9 and 17 volts at 1 amp. The component employed is a charger transformer and is available from G. W. Smith & Co. (Radio) Ltd., 3 Lisle Street, London, W.C.2. The 9 volt section feeds a bridge rectifier which is followed by the voltage stabilizing circuit given by ZD1, the AC127 and the AD161. If an alternative transformer is employed the secondary feeding

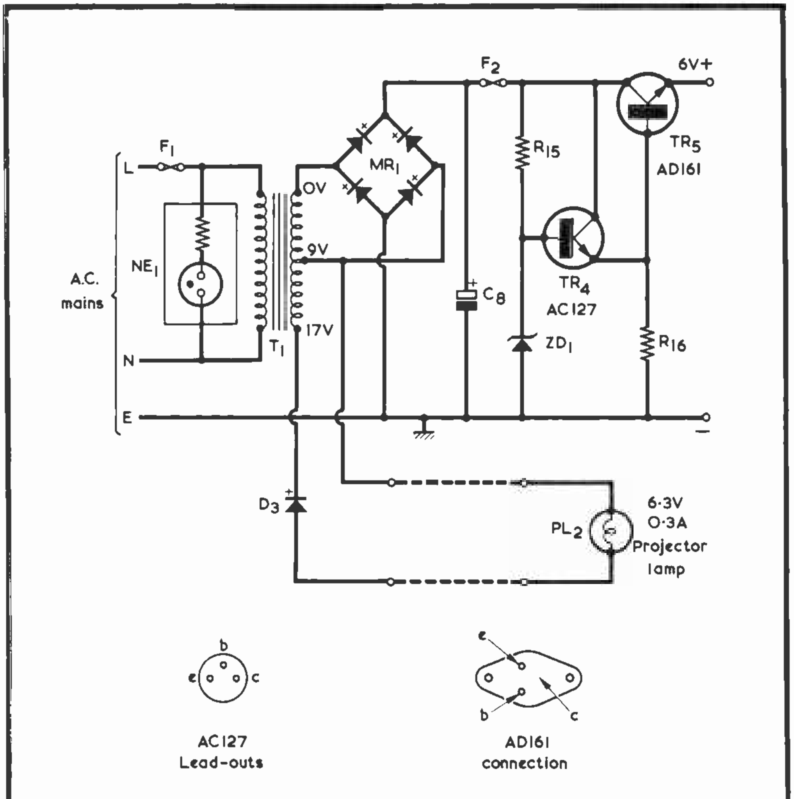


Fig. 3. The power supply circuit. Also shown is the remote wiring to the projector bulb

the bridge rectifier should not offer a voltage lower than 9 volts, or output stability may be poor on full load. The transformer secondary rating must be 1 amp or better. The bridge rectifier specified may also be obtained from JEF Electronics.

The d.c. output voltage from the supply should be between 6 and 6.4 volts for best results and it might be necessary to select a suitable zener diode. Surplus types with wide voltage spreads should not be used.

The 9 and 17 volt taps provide 8 volts for the 6.3 volt 0.3 amp projector lamp. This is fed via a 500 mA silicon rectifier with the result that its light output is modulated at 50Hz.

A neon bulb assembly with integral series resistor is connected across the primary of the mains transformer to indicate when the unit is on with the mains applied.

In the prototype, the transformer was bolted directly to the case for optimum heat dispersal. The fuse-holders were panel-mounting types. The AD161 power transistor is mounted on a heat sink, as shown in Fig. 4, the sink being bolted to the case. It is necessary to insulate the AD161 from the heat sink, this being done in the usual manner with the aid of a mica washer and insulating bushes for the mounting bolts.

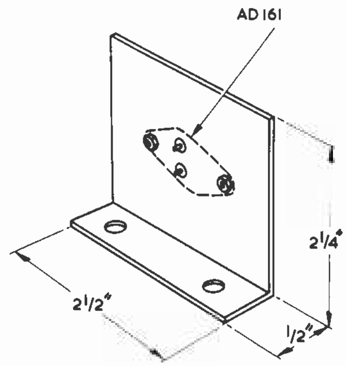
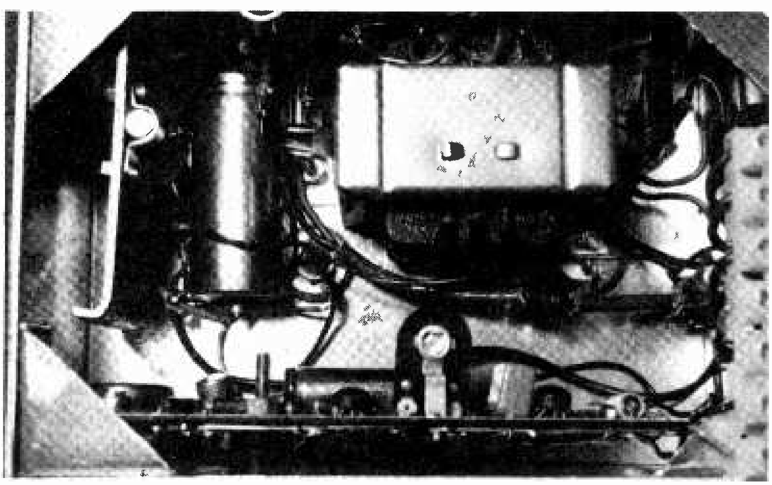


Fig. 4. Dimensions of the heat sink on which the AD161 of Fig. 3 is mounted. The material is aluminium sheet



A view inside the prototype base unit. The mains transformer is clearly visible, as also is the main panel on which is mounted the skeleton pre-set potentiometer VR1

When the power supply is complete it is instructive to demonstrate the degree of stabilization as compared with an unstabilized mains unit. With a voltmeter across the nominal 6 volt output, various values of resistor (of adequate wattage) may be connected, in series with a suitable current-reading meter, as the load. The degrees of voltage drop at various levels of current flow can be seen and compared.

PROJECTOR AND RECEIVER CASES

Before commencing on the assembly of the projector and receiver cases the constructor should first obtain the two lenses required, one being employed at each case. These lenses are not available through radio component retailers but are sold instead by stationers or at the stationery departments of the larger departmental stores, being usually presented on a 'help yourself' display. They are sold as 'Ivypak Magnifiers' and their cost, at the time of writing, is 15p each.

They are made up of a single piece of clear plastic having a square outline measuring just under 2in. by 2in. The handles have to be sawn off flush, whereupon they will be found to fit snugly into the cases to be described. The author obtained his lenses at a Debenham store in the North of England. These lenses should be readily available throughout the country, but, if the constructor should be unable to obtain them, any other type of small 'magnifying glass' may be used, the case dimensions being adapted to suit.

The projector and receiver cases are the same size and should be made of ¼in. hardboard or dense plywood. These are assembled as illustrated in Figs. 5(a), (b) and (c). The inside measurements, with the lid in place, are 2 by 2 by 6¼in. The end pieces are 2 by 2in. square. The two end pieces through which the beam passes have a central hole of 1½in. diameter. The other end pieces are drilled as is described shortly.

Matchstick guides 2in. long are glued to the inside of each case, as in Fig. 5(b), and they enable the lenses, infra-red filter and the beam sensor board to be slid in position. The lenses are the 'Ivypak' types just described and have a focal length of about 5¼in.

An infra-red filter is employed at the projector. It is cut from infra-red film, which can be obtained at the larger photographic suppliers. It plays no part other than blocking off visible light and is not required for setting-up and trial operation. It is inserted immediately in front of the projector lens and hard up against it, and it may cause a small deflection of the beam, whereupon a slight correction is required. There should be no appreciable loss of output from the receiver circuits after the filter has been added if adjustments have been accurate. It may be added that black polystyrene sheet, sometimes used for the manufacture of small plastic boxes and decorative tiles, has been found satisfactory as an infra-red filter. It can be identified by looking through it at an electric light bulb. The light will be discernable as a dull ruby red.

The rear end piece for the projector case has a suitable hole or holes drilled to take a panel-mounting m.e.s. bulb holder. The filament of the projector bulb when fitted should be approximately 5¼in. (the focal length) behind the projector lens. The final position should be adjusted so that the beam throws a well-defined image on a flat surface at a distance of 15 to 20ft.

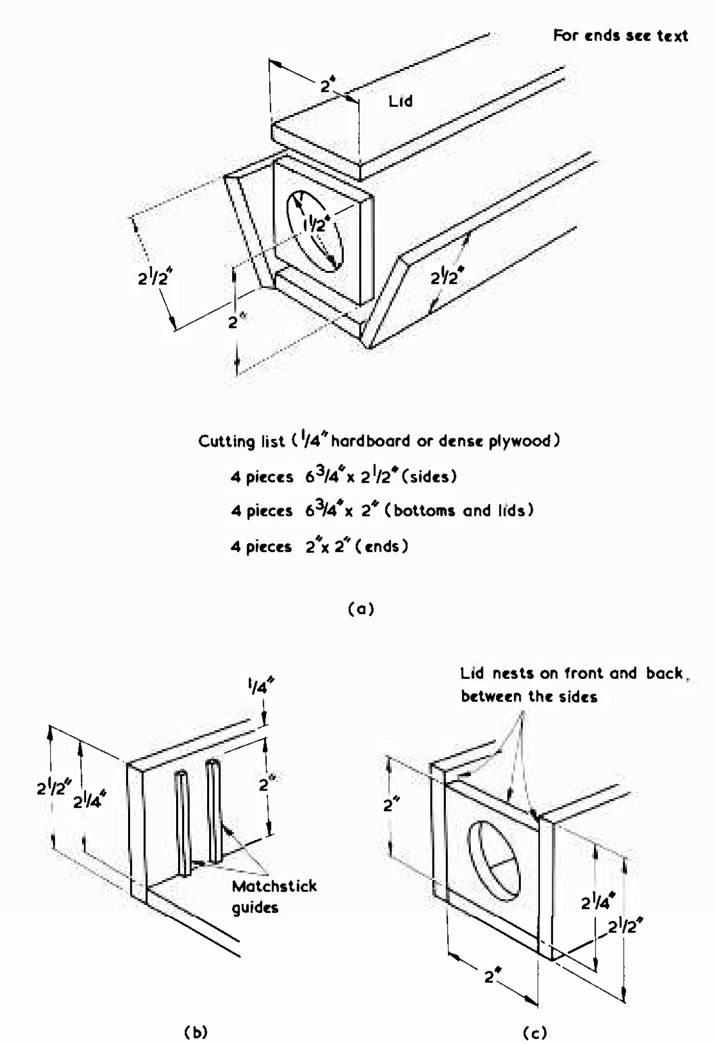


Fig. 5 (a). Illustrating the general construction of the projector and receiver cases

(b) How the matchstick guides are glued to the inside of the case. They are positioned along the length of the case according to the focal length of the lenses, as is described in the text

(c) Detail illustrating how the case lids rest on the front and back end pieces

A.C. BEAM SENSOR

For economy the writer uses Formica offcuts for all circuit panels. (Avoid, however, the heat-resistant grade, as this may have an integral metal shim lamina). Alternative brands of plastic laminate, if used, should be of adequate thickness. When it can be found, medium grey matt texture 'Resopal' is best, as this takes readily to a ballpoint pen for circuit drawing, which can later be erased. The holes required can easily be drilled with a cheap Archimedon drill. Alternative methods can, of course, be used by the constructor.

The beam sensor and a.c. amplifier employ the Mel 11 and one of the μL914 integrated circuits. These are mounted, with their associated components, on a 2in. by 2in. Formica (or similar) board mounted at the rear of the receiver case. The circuit employed

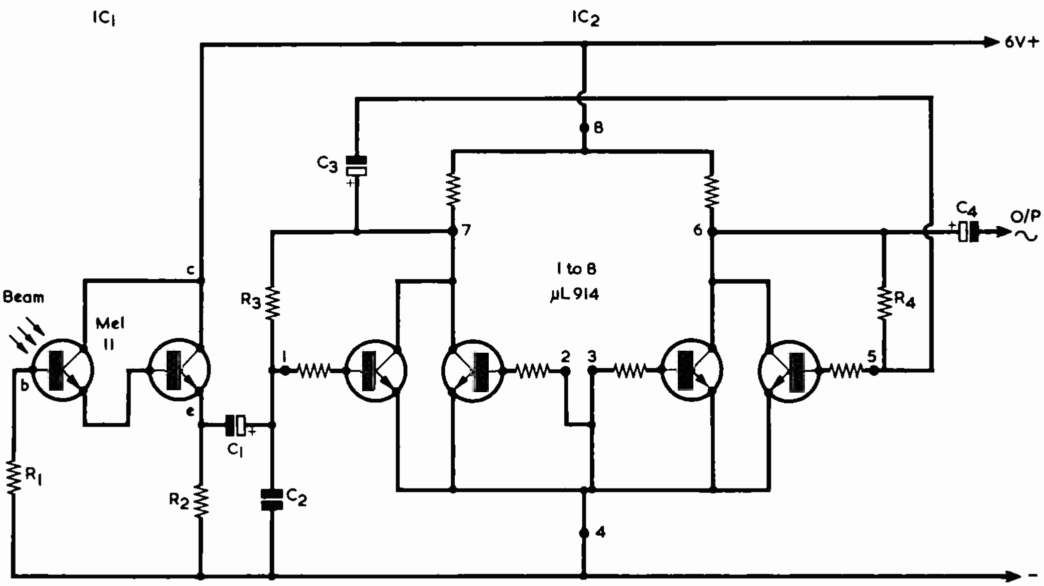


Fig. 6. The circuit of the beam sensor and a.c. amplifier. All the components shown here are mounted in the receiver case

is illustrated in Fig. 6. Here, the Mel 11 picks up the a.c. from the projector beam, this being amplified and passed through the d.c. blocking capacitor C1 to the base of the left-hand transistor in the μL914. The output from this transistor couples via C3 to the base of the right-hand transistor in the μL914, the further amplified signal from this being fed to the output isolating capacitor, C4. Both of the transistors employed operate in the common emitter mode. The two centre transistors in the μL914 are not used, and their bases are coupled to the negative supply line.

Start construction by cutting a Formica panel 2 by 2in. This is best done by scouring with a sharp point against a metal straight-edge on the working face, until the cut is half-way through. The material should then snap cleanly across a sharp corner. Mark a ⅛in. strip along two opposite sides, to be left clear for sliding between the guides in the case. When finished, the board should fit snugly without play. The Mel 11 is mounted dead centre by drawing two diagonals and three small holes are drilled to take its leads. It should be flat against the board with no movement tolerance. The μL914 is mounted similarly.

The distance between the face of the Mel 11 and the receiver lens should be the focal length precisely. This length can be found accurately by directing the lens at an electric light bulb and, with the aid of a piece of paper, finding the distance behind the lens where the image of the bulb is smallest. It will be necessary to determine the exact position in the receiver case required for the Mel 11 before fitting the guide matchsticks for its panel.

The components on the panel of Formica are next wired up as shown in the top view given in Fig. 7. The hardboard or plywood end piece for the receiver case can then have suitable

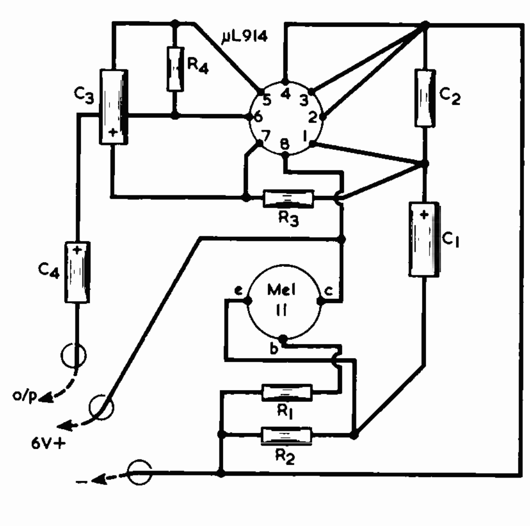


Fig. 7. Wiring diagram for the beam sensor and a.c. amplifier. This is a top view

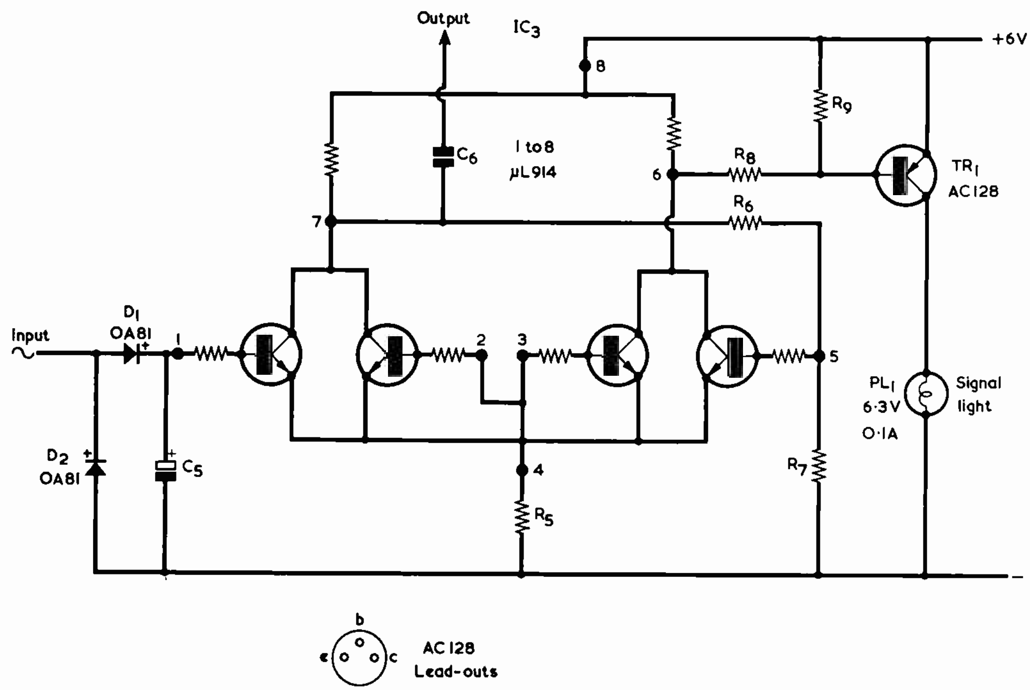


Fig. 8. The circuit of the voltage doubler rectifier, Schmitt trigger and bulb driver

holes drilled for the output and power supply leads, after which it may be fitted to the case also.

The power supply, projector and receiver circuits can now be initially checked out. The projector and receiver should be lined up and the power switched on. An a.c. voltmeter across the output and negative supply lines at the a.c. amplifier should indicate some 1.5 to 2 volts, this dropping to zero when the beam is interrupted. The current drawn from the 6 volt supply should be approximately 10mA.

MAIN CIRCUIT BOARD

The first section of the stages mounted on the main circuit board consists of the rectifier, Schmitt trigger and bulb driver. The circuit of this section is given in Fig. 8. The output of the a.c. amplifier of Fig. 6 is applied to the voltage doubling rectifier given by D1 and D2. These cause a rectified voltage to appear across reservoir capacitor C5. This capacitor serves the secondary function of smoothing out sharp transients, which would cause false alarms. The two outside transistors of the μL914 form the Schmitt trigger, in which the left-hand transistor is 'on' and the right-hand transistor is 'off' when an a.c. signal is fed to D1 and D2 from the a.c. amplifier. The two

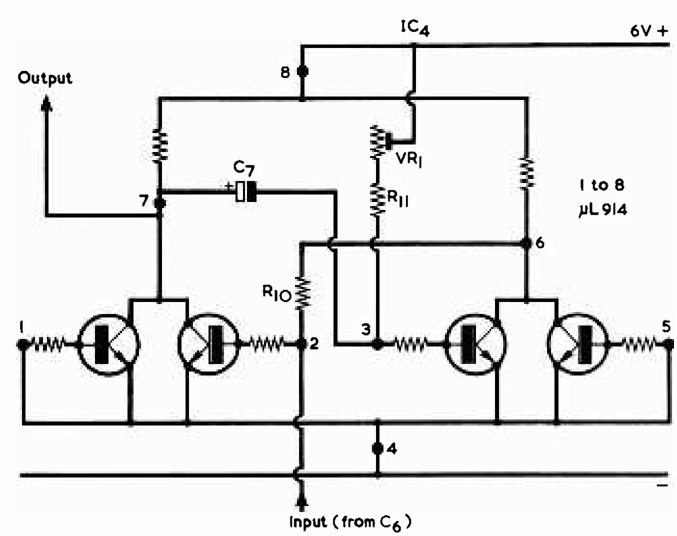


Fig. 9. The monostable. This receives a positive pulse via C6 of Fig. 8

centre transistors of the μL914 are not used, and their bases couple to the common emitter line. On the cessation of input from the a.c. amplifier, the left-hand transistor cuts off sharply, and the right-hand transistor comes on. This causes base current to flow through R8 to the AC128 bulb driver, whereupon the 6.3 volt 0.1 amp signal lamp becomes illuminated. At the same time, when the left-hand triode cuts off its collector goes positive, causing a positive-going pulse to be fed to the following stage, which is the monostable.

The circuit of the monostable is given in Fig. 9. In this stage the left-hand centre transistor of the μL914 is normally off, and the right-hand centre transistor is normally on. The two outside transistors in this integrated circuit are not used. When the positive pulse arrives from the Schmitt trigger, the left-hand centre transistor is turned on and the right-hand centre transistor is cut off. This condition continues until C7 discharges, whereupon the circuit reverts to its original state. The length of this period can be varied from some 2 to 3 seconds to about 30 seconds by adjustment of

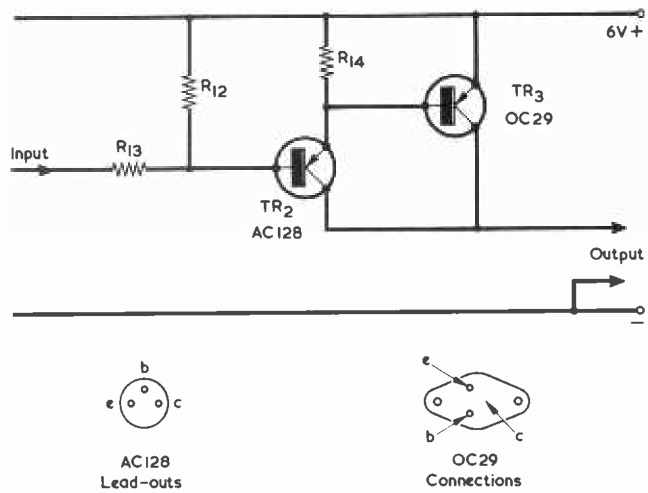
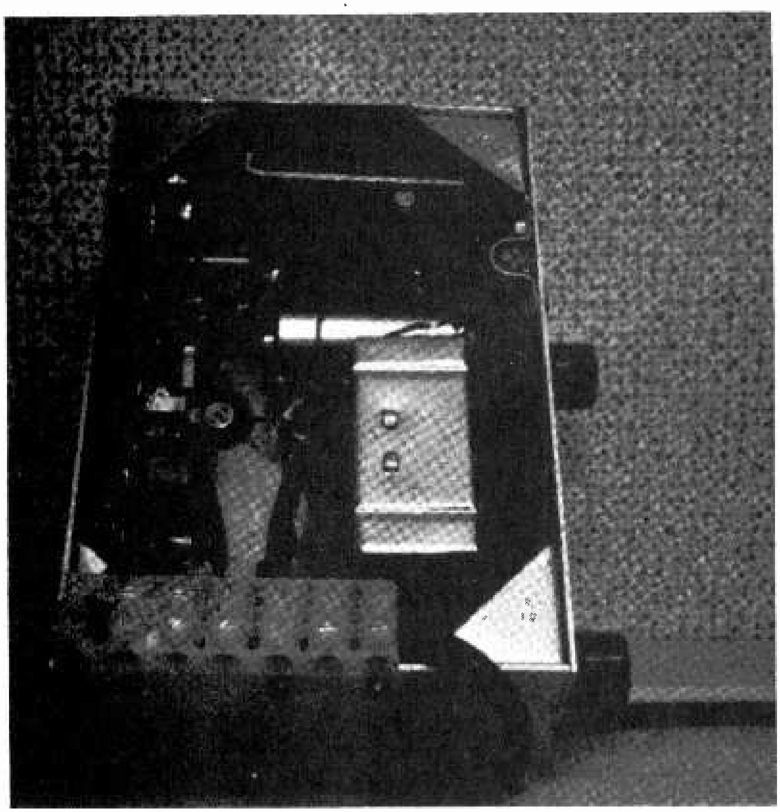


Fig. 10. The power d.c. amplifier. The warning device may be connected to the output terminals. The input is taken from the output of Fig. 9



Another view of the base unit. Connections to the projector and receiver units are made via a terminal strip

VR1. It is important that C7 be of first-class quality, as leakage in this component can be the cause of troublesome false alarms.

When the left-hand centre transistor of Fig. 9 is turned on, its collector goes negative. This collector is connected to the d.c. power amplifier of Fig. 10. The amplifier in this diagram employs an AC128 and an OC29 in a Darlington pair configuration, and the two transistors are caused to pass current when the input from the monostable goes negative. Since the OC29 then becomes conductive, the supply voltage appears across the output terminals of Fig. 10 and activates the warning device.

The main circuit board for the prototype measured 5¾ by 2in. and incorporated the components used in the circuits of Figs. 8, 9 and 10. It is advisable to proceed in stages, checking each stage as wiring progresses. The power supply, projector, receiver and a.c. amplifier circuits have already been checked, and these are now employed for testing the stages which follow. The overall component and wiring layout is shown in Fig. 11. It should be noted that the use of integrated circuits has resulted in quite simple wiring, despite the relative complexity of the circuits.

First, complete the wiring of Fig. 8 and test this part of the system. With power on and no input from the a.c. amplifier, the 6.3 volt 0.1 amp bulb PL1 should light up, When the projector beam is lined up with the receiver, the bulb should extinguish. Interrupting the beam will cause the bulb to light up again.

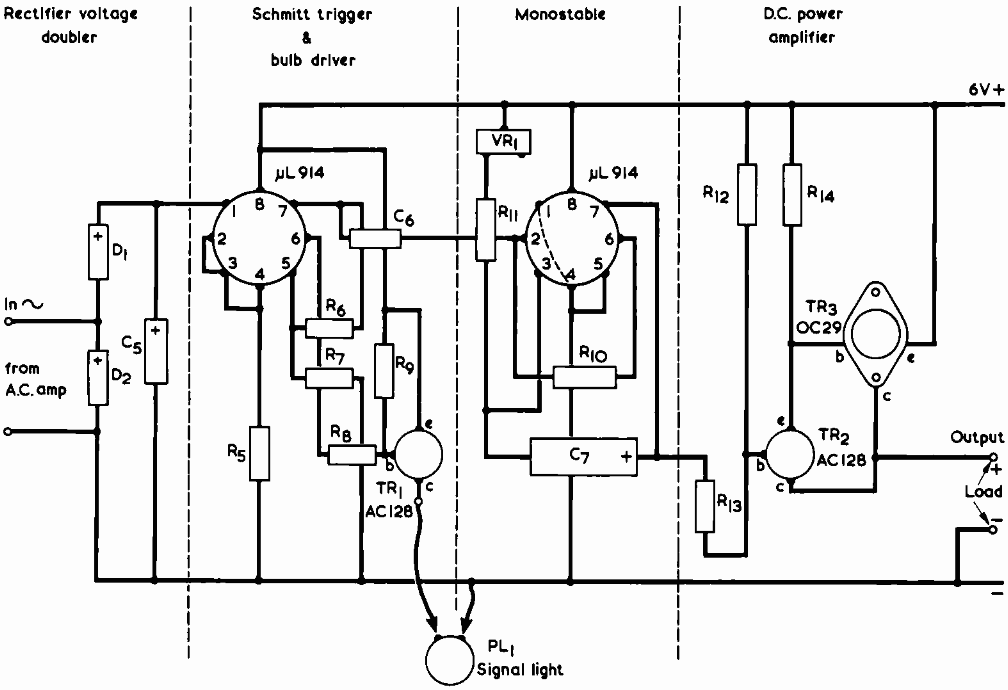


Fig. 11. Top view, illustrating the wiring on the main panel

Next wire up the circuitry shown in Fig. 9. This can be checked by connecting a voltmeter between lead-out number 7 of the μL914 and the negative supply line. With power on and the beam aligned, the voltage at this lead-out will be near the potential of the positive supply line and the meter will register. An obstacle passing through the beam will be indicated by the meter needle dropping to near zero for a period of time and then returning to its previous reading. The length of this period may be varied by adjustment of VR1.

All being well, the d.c. output stage of Fig. 10 can now be wired up. It will be noted that no heat sink is used for the OC29, its own metal bulk being sufficient for the purpose for which it is being used, i.e. for short periods of current flow at 0.5 amp or less. A convenient load for testing purposes is a 6.3 volt 0.3 amp bulb, and this should become illuminated during the period when, in the last test, the voltmeter indicated nearly zero volts. It is most important that the output in Fig. 10 is not at any time short-circuited.

In the prototype, the main circuit board was fitted into the chassis which houses the power supply components. The 6.3 volt 0.1 amp lamp is fitted to the top surface of this chassis, balancing off the mains neon indicator bulb of Fig. 3.

LINKING THE UNITS

Cheap plastic-covered flex was used for connection lines between the units. The signal and common negative lines between the receiver and the base unit were a twisted pair, with a third wire to carry the positive supply. The wires for the projector unit were a twisted pair. In the writer's case the receiver and projector are 12ft. apart, and cover the garage. The base unit, in the house, is coupled to these by 50ft. lines. No fall-off in performance is apparent at these distances. If there should be a reduction in voltage at the projector bulb due to the resistance of long lines, a lower voltage bulb can be substituted. The layout of the complete system is shown in Fig. 12.

In this type of project mains 'pick up' in the form of 50 Hz hum or spot surges must be avoided. Such interference can come through the supply unit or be picked up inductively. The result is erratic operation. The problem was taken into consideration at each stage of the present design and the final product shows no sign of this sort of instability with the lines twisted together their entire length. The suppression of mains interference was dealt with at three major points – design of supply unit, input to the Schmitt trigger and the point of entry into the monostable.

Nevertheless, it is conceivable that

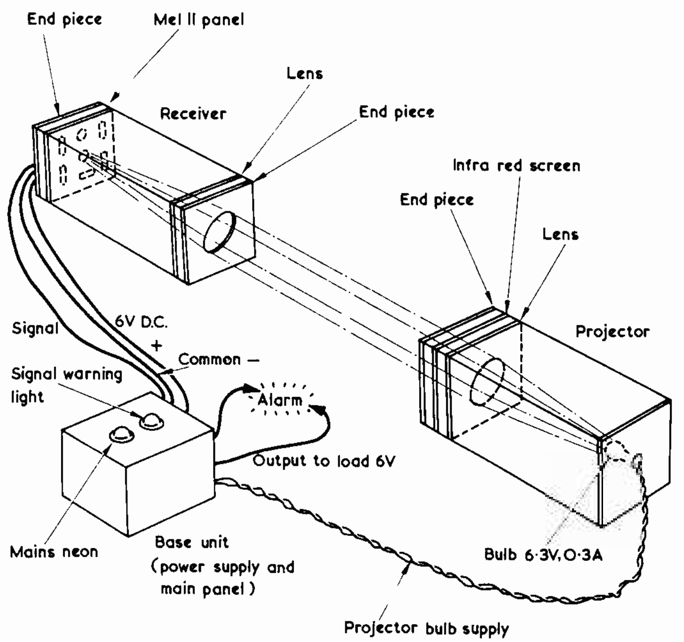


Fig. 12. The complete layout of the intruder alarm system

in a poor situation the signal line from the receiver to the base unit could be the cause of 'pick up' at 50 Hz. This would show on an a.c. voltmeter across the input to the base unit, the needle of which would fail to drop to nearly zero when the beam was interrupted. The answer would be to re-route the signal line away from the offending source or, in an extreme case, to use a screened cable.

CONCLUSION

To avoid unnecessary operation of the main alarm it has been arranged that this does not operate when there is a mains cut, nor will the classical 'floating leaf in the beam' cause a false alarm. Nevertheless a solid body cannot pass through without indicating its presence, even if 'jet propelled'. A mains failure is indicated by the neon bulb going out.

With careful lining up the apparatus can be used over quite a considerable distance, ambient light (daylight or roomlight) having very little influence. When testing, however, the lid should be on the receiver case, With care and rigid mounting of the two units it can be arranged that they are side by side, the beam being reflected by a mirror. There is little loss of signal strength by this method over distances of 20 or 30 ft. or so. There is also opportunity for experiment with larger lenses and possibly a reflector behind the projector bulb. ■

SHORT WAVE NEWS
FOR DX LISTENERS

Times = GMT *Frequencies = kHz*

● **SOUTH AFRICA**

South Africa may be heard on many channels at various times throughout the day but readers may care to log the Internal Service (Springbok Radio) on **4875** (61.54m – 20kW). This is the Afrikaans Service and it has been heard at 1930 with songs in that language. One channel of the All Night Service is **4945** (60.67m – 20 kW) where it has been logged at 2235 with a programme of musical records.

The External Service, Radio RSA, can be heard on **9525** (31.50m – 250kW) where it has been logged at 2100 with identification in English and a newscast directed to West Africa. An easier channel to hear perhaps is that of **11900** (25.21m – 250kW). Identification in English, 6 'pips' at 2100 followed by the same programme as above. A further channel is that of **15155** (19.80m – 250 kW) where RSA can be heard at 2000 with identification in English and time signal. This latter channel however suffers at times with interference from Havana, Cuba.

● **ISRAEL**

This country can be heard with a programme in English on **9009** (33.30m – 50kW) at 2100. Tel Aviv can also be heard, in parallel, on **9625** (31.17m – 100kW). A further interference-free outlet is being sought, Tel Aviv being heard on other channels in the 6 and 7MHz bands.

● **CAPE VERDE ISLANDS**

Radio Barlavento can be heard on **3930** (76.34m – 1 kW) around 2330 if the channel is clear of utility transmissions. Programmes from CR4AC are in Portuguese, the station being heard up to 2350 when a single gong note followed by station identification was logged.

● **INDIA**

Late night listeners (or insomniacs!) may care to tune to **3905** (76.83m – 20kW) for All India Radio (AIR) Delhi from around 2245 onwards to sign-off at 2400 after identification. The programme is in English and features typical Indian-style music.

● **GHANA**

Programmes from Accra can be heard on **9545** (31.43m – 100kW) from the transmitter at Tema. The English programme, directed to Europe, is from 2045 to 2215.

● **PORTUGAL**

Radio Portugal may be heard, in English with a programme for Europe, on **6025** (49.79m – 100kW) from 2045 to 2130.

● **CENTRAL AFRICAN REPUBLIC**

Bangui can be heard with a newscast in English at 2100 on **5038** (59.55m – 100kW). Listed on **5035**, the English news has been reported being heard at various other times. Both the frequency and time therefore would appear to be at variance from the schedule.

● **CAPE VERDE ISLANDS**

Radio Barlavento on **3930** broadcasts programmes in Portuguese Monday to Friday from 1500 to 1600, 2200 to 0100. On Saturdays from 1600 to 1900 and from 2200 to 0100. On Sundays from 1100 to 1300, from 1600 to 1900 and from 2200 to 0100. The 2200 to 0100 schedule is that best suited to U.K. listeners. The address of CR4AC is – C.P.29, S. Vincente.

● **PORTUGAL**

The International Service ('Voice of the West') can be heard in English, to Africa, from 1815 to 1915 on **11935** (25.14m – 100kW) and on **21495** (13.96m – 100kW). To Europe on **6025** (49.79m – 100kW) from 2045 to 2130; to North America from 0200 to 0245 on **6025**, **11935** and **15125** (19.83m – 100kW). The last three channels are also used from 0345 to 0430 for the English Service to the USA and Canada. The news in English during the above transmissions is at 1815, 2045 and 0200.

● **INDIA**

The General Overseas Service of All India Radio, in English, are radiated as follows – (UK and Western Europe only) – from 1745 to 2230 on **7215** (41.58m – 100kW), from 1745 to 2030 on **11620** (25.82m – 100kW) and from 1945 to 2230 on **9912** (30.27m – 100kW). Newscasts are at 1800, 1900, 2000, 2100 and at 2200.

● **MALAYSIA**

The Voice of Malaysia may be heard, in English, from 0625 to 0855 on **6175** (48.58m – 100kW), **11900** (25.21m – 100kW) and on **15280** (19.63m – 50kW) from the transmitter at Kuala Lumpur. Newscasts are at 0630 and 0830.

● **PAKISTAN**

The External Service of Radio Pakistan can be heard, in English to the U.K., from 1945 to 2030 on **9460** (31.76m – 10/50kW) and on **11672** (25.70m – 10/50kW).

● **TURKEY**

Programmes in English from Ankara can be heard from 1400 to 1430 on **17720** (16.93m – 250kW) and on **17820** (16.84m – 100kW). From 2200 to 2230 on **15160** (19.79m – 100kW) and on **15195** (19.74m – 250kW). Ankara can also be heard, in English, on **9515** (31.53m – 250kW) from 2200 – see QSX.

● **VATICAN STATE**

The Vatican radiates programmes in English as follows – at 1500 on **9645** (31.10m – 100kW), **11740** (25.55m – 100kW) and on **15120** (19.84m – 100kW). At 2045 on **6190** (48.47m – 100kW), on **7250** (41.38m – 100kW) and on **9645**.

● **UNITED ARAB REPUBLIC**

Cairo radiates an English programme, directed to Europe, from 2145 – 2300 on **9740** (30.80m – 100kW). Radio El-Fatah can be heard from 1730 to 1830 on **9755** (30.75m – 100kW).

SHORT WAVE NEWS
FOR DX LISTENERS

LATE NEWS

● **MAURITIUS**
Forest Side may be heard, if conditions allow, on **4870** (61.60m) with the news in English at 1800. Forest Side (10kW) is listed on **4850**.

● **PAPUA**
The ABC stations at Port Moresby, VLT4, has been logged at 2002 when an ABC (Australian Broadcasting Commission) newscast was heard. The frequency is **4890** (61.35m) and the power is 10kW.

● **INDONESIA**
RRI (Radio Republik Indonesia) Djakarta on **6045** (49.63m) 100kW can be logged around 1320. It has been heard at this time with a programme in English although reception may be marred by interference from a jamming station on **6043.**

● **PAKISTAN**
News in English at dictation speed can be heard from Karachi on **9460** (31.76m) 10/50kW at 2115, a daily service.

● **ECUADOR**
HCJB Quito on **11910** (25.19m) 50/100kW is worth listening for at 1930 when the news in English is radiated, followed by the remainder of the English programme.

● **TURKEY**
Ankara is to be heard on **9515** (31.53m) 250kW at 2200 with station identification and the news in English. A programme describing Turkish events and life follows the newscast.

● **INDIA**
The External Service of AIR (All India Radio) can be heard on **9912** (30.27m) 100kW at 2000 with station identification (Delhi) and the news in English. A programme in English may be heard every night at this time and on this channel.

The Internal Service can be heard, for instance, on **3925** (76.43m) 20kW around 1600. Late night listeners may care to try **3905** (76.83m) 20kW around 2330 when a programme of typical Indian music, much liked by the author, is often radiated. Sign-off is at midnight with station identification in English (Delhi). Delhi can also be heard on this channel, with the news in English, at 1545.

Another channel of the External Service is that of **9530** (38.48m) 100kW, where Delhi can be heard with an English programme directed to Africa. Station identification and the news in English can be heard at 1900.

● **AFRICA**
Life and events in one relatively small part of this huge continent are described on **9545** (31.43m) 100kW, where Tema in Ghana provides a nightly service in English at 2100.

Acknowledgements: Our Listening Post, BADX, and SCDX.

TURKS AND CAICOS ISLANDS

At the time of writing there are strong indications that Turks Island Radio is now on the air regularly with tests. The Station, owned and operated by Cable & Wireless Ltd., was used by the local authorities as part of the hurricane early warning system to residents. The 1.5kW transmitter operated on **4788** for approximately half an hour from 1800GMT with a programme of local news, the reading of telegrams and recorded music.

However, a new and more powerful transmitter is by now probably in operation, it being known that such equipment was ready 'on site' – complete with a new aerial system. Evidence of the new transmitter being in operation is the fact that several USA listeners, and Alan B. Thompson of Neath, have heard the transmitter from 2300 (BBC news relay) till sign-off at 2348.

A recent meeting between one of the station staff (on leave in the UK) and the author, provided the information that several letters had been received from USA listeners but that the QSL policy was unknown to the engineer in question.

LAST LOOK ROUND

LISTEN, ENJOY – BUT BEWARE

The hobby of short wave listening on the Broadcast bands is growing apace and any reader of our features devoted to this pastime will soon note that a great deal of information, and programme time, is directed to the U.K. from various parts of the world. Additionally, programmes in English are aired for consumption in other parts of the English-speaking world at various times throughout the day and night.

To be well informed on the views of other nations with reference to world events can often be an education in itself. Programmes of internal events, together with the native music are, more often than not, the most enjoyable.

Some countries simply 'project' themselves on the short waves whilst others engage in 'anti' propaganda on a large scale. Indeed, a recent programme on life in the U.K. (from an external source) sounded remarkably like a reading from an early Dickens novel!

In your workshop

This month we find Smithy the Serviceman and his able assistant, Dick, starting the New Year with only one receiver in the Workshop to repair. However, this receiver has an unusual f.m. detector circuit, and Smithy takes advantage of the welcome lull in the pressure of work to explain its operation to Dick.

DICK LOOKED AT HIS WATCH ONCE more.

"Blimey," he muttered to himself, "if old Smithy doesn't come in to work soon I reckon I won't see him at all today. And I thought *I* was late!"

He looked around the Workshop yet again. Both the 'Repaired' and 'For Repair' racks were completely empty and the only receiver that required servicing, a 23 inch dual-standard monochrome television set, stood on Smithy's bench. It was the very first day of the New Year and, as usual, the pace of work had eased off considerably following the rush which always occurred just before Christmas. Indeed, so quiet had things become that Dick and Smithy had spent the latter part of the previous day in giving the Workshop a long overdue tidying-up. Both their benches were now unaccustomedly tidy and uncluttered, with the test equipment on each lined up in an orderly manner that would have brought a gleam of approval to the eye of the most exacting of regimental sergeant-majors.

DUAL-STANDARD TV

Yet again, Dick consulted his watch. It was now no less than an hour and a half after the time when work should have started. Suddenly, there was an uncertain and faltering rattle at the knob of the door. Eventually this opened, and Smithy slowly entered.

"Happy New Year, Smithy," called out Dick cheerfully. "I thought you'd never make it!"

Smithy blinked as he gazed hesitantly into the brightly lit Workshop.

"What did you say?"

"I said Happy New Year."

"Did you? Oh yes, so you did. Well, a Happy New Year to you, too."

With a trembling hand, Smithy hung up his raincoat on the hook behind the door, then shambled over to his stool. He flopped down on this and stared listlessly at the television receiver on his bench.

Intrigued by this behaviour on the part of the normally brisk and alert Serviceman, Dick took his stool over to Smithy's side, sat down, and then examined that worthy critically.

"Gosh," he remarked, impressed, "you're *shattered!*"

"I must confess," admitted Smithy gloomily, as he did his best to avoid Dick's searching gaze, "that I don't feel quite up to my usual form this morning. Last night turned out to be the most horrible New Year's Eve I've ever had."

"What happened?"

"I'd really prefer not to discuss it for the time being," replied Smithy shortly. He cast a bleary eye around the Workshop. "Is this TV set on my bench the only job we've got to do today?"

"It is."

Smithy brightened visibly.

"Thank goodness for that," he remarked. "I don't think I could face very much in the way of work today. We'll do this set together, if you like."

"That would be fine," said Dick keenly. "I'll plug it in and put it through its paces right now."

Rising from his stool, Dick leaned over and plugged the television receiver into one of the selection of mains sockets mounted at the rear of Smithy's bench. He then connected up both v.h.f. and u.h.f. aerials, and switched the set on. After a while the screen came to life, and reproduced a bright test card exhibiting excellent contrast and resolution.

"You're on 405 lines now," commented Smithy. "Try it on 625."

Obediently, Dick adjusted the channel selector and tuning controls for the local u.h.f. channel. Once again, the pair were rewarded with a completely acceptable picture.

"Try the sound," said Smithy.

Dick turned up the volume control. A weak and very distorted signal became audible from the speaker. Dick returned the receiver to v.h.f., to find that the 405 line sound signal was equally weak and distorted. He switched off, took the back off the cabinet of the set, then looked expectantly at Smithy.

"It's pretty obvious," said Smithy, "that the distortion is occurring in the section following the 405 line sound i.f. and 625 line intercarrier stages, since the snag is occurring on both v.h.f. and u.h.f. signals. It would be silly to proceed further without swapping the valves concerned. I know this particular model quite well, and the valves in question are an EH90 and the pentode section of a PCL84, so I'd suggest you next try replacing these."

Smithy indicated to Dick the positions inside the receiver of the valves concerned, whereupon Dick made his way to the spares cupboard to obtain new valves. He first plugged in a new EH90, to find that this offered no improvement. A new PCL84 similarly effected no cure. Dick fitted the original valves into the set.

"It looks," he remarked, "as though we'll have to dig a bit deeper."

"It does, indeed," agreed Smithy. "Have a quick look round for obvious faults, such as wires which have come adrift and things like that. Whilst you're doing that, I'll get the service sheet for this set."

As Dick busied himself with a visual examination of the TV chassis, Smithy walked over to the filing cabinet and selected the service manual for the receiver. He returned to his bench with it, and opened it out at the circuit diagram.

"Any obvious faults?" he queried.

"None that I can see."

"In that case," said Smithy, "we'd better make a few electrical checks. Switch on the set and, for a start, check the voltages on the various pins of the sound output valve. Here's the circuit."

Smithy indicated the sound output stage in the service manual circuit. (Fig. 1).

"Righty-ho, Smithy," said Dick obligingly, "no sooner said than done!"

He switched the receiver on again, clipped the negative lead of Smithy's testmeter to the receiver chassis and waited for the valves to warm up.

"I'll check the anode voltage first," he called out. "Ah, here we are; it's about 220 volts. Now the screen-grid which is also 220 volts. Which leaves the cathode to be checked next."

Dick set the testmeter to a lower voltage range, and applied its positive prod to the cathode pin of the output valve.

"The cathode," he stated, "is reading about $7\frac{1}{2}$ volts positive of chassis.

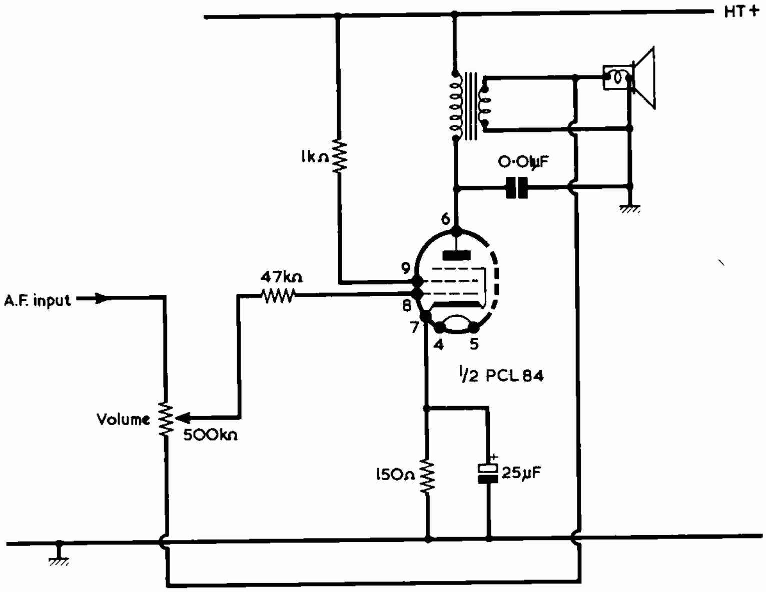


Fig. 1. The circuit of the TV sound output stage examined by Dick and Smithy. An interesting incidental point is the negative feedback loop from the speaker to the lower end of the volume control track. The triode section of the PCL84 is used elsewhere in the receiver circuit

So it looks as though there's nothing very much wrong in this output stage so far as voltages are concerned."

"Isn't there?" returned Smithy. "With most sound output valves I'd agree with you, but I seem to recall something about the pentode section of the PCL84 which makes that cathode voltage reading rather suspect. If I remember correctly, the PCL84 pentode has an unusually short grid base for an output valve, and it cuts off with about 6 to 8 volts negative on the control grid. Switch off the set and check the resistance of the cathode bias resistor. Its nominal value is 150Ω."

Dick did as he was bid. He looked at the testmeter, now switched to an ohms range and whistled.

"Blow me, Smithy," he remarked, "you haven't half got a nose for sniffing out faults! This meter's giving a reading of about 200kΩ instead of 150Ω."

"Good show," said Smithy, obviously pleased. "That 150Ω resistor is almost certain to be completely open-circuit, whereupon the 200kΩ reading is due to leakage resistance in the electrolytic bypass capacitor which is connected across it."

NEW CATHODE RESISTOR

Quickly, Dick unsoldered the open-circuit 150Ω resistor and fitted a replacement. He switched on and waited expectantly. After a short while the receiver sound channel came abruptly to life and the Workshop was flooded with loud and now undistorted music. Smithy winced and clapped his hands over his ears.

"For pity's sake," he pleaded, "turn it down. I'm not in a fit state to be subjected to a lot of noise this morning."

Dick turned the volume down to a low level, whereupon Smithy cautiously withdrew his hands from his ears.

"Stap me," remarked Dick, "you *must* have been on a bender last night."

"All that happened," replied Smithy, making a half-hearted attempt to maintain his dignity, "was that I set out to celebrate the New Year's Eve festivities in convivial company, as I have done for as long as I can remember. I'll agree that I feel a bit rough this morning but that's not the main thing that's getting me down. What's troubling me is that, so far as I can see, last night I disgraced myself with just about everybody I know in the community!"

"Go on," said Dick, his attention suddenly engaged by this confidence on the part of Smithy. "What did you do, then?"

Smithy grimaced as his mind passed over the events of the previous night, then his face hardened with resolve.

"Let us," he said, firmly changing the subject, "get back to this TV we're fixing. The fact that it nearly deafened me just now would seem to indicate that we've cleared the snag in its a.f. stages. Try it out on both standards to make certain that it really is all right but please, *please*, do not turn it up too loud."

Unwillingly tearing his thoughts away from the absorbing subject of Smithy's New Year's Eve activities, Dick checked the television receiver both on u.h.f. and on v.h.f. Its very good picture was now accompanied by equally good sound. Satisfied, Dick switched the set off again and proceeded to tidy it up preparatory to fitting the back.

"Wait a minute," he remarked, "there's something about this set that's just occurred to me."

"What's that?"

"We've just found that the cathode bias resistor was open-circuit," Dick went on. "Why, then, didn't the electrolytic capacitor which is connected across it break down?"

"Why should it?"

"Because," replied Dick, "if the resistor went open-circuit the voltage across it would rise to a very high value."

Smithy sighed.

"You've just *measured* the voltage across it," he remarked, "and it was only 7½ volts, which the electrolytic was obviously capable of withstanding. In other words 7½ volts is the cut-off voltage for the pentode section in the particular PCL84 which is fitted in that set."

"Come again?"

"Just visualise any valve with an open-circuit cathode," said Smithy. "Think, for instance, of a triode having an ordinary anode load resistor and a grid resistor maintaining its control grid at chassis potential." (Fig. 2).

"Well?"

"If the cathode of that triode is not connected to anything, it will go positive of chassis," explained Smithy, "but it cannot go further positive of chassis than the grid cut-off voltage for the valve. At this potential, the cathode is positive of the control grid by the cut-off voltage, which is another way of saying that the grid is negative

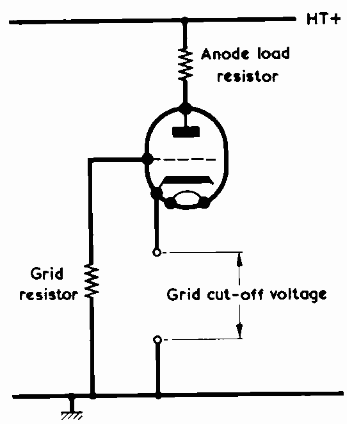


Fig. 2. If the cathode of any valve connected in a circuit of this order becomes open-circuit it rises above chassis to a positive potential equal to grid cut-off voltage

of the cathode by the same voltage. Under this condition the valve ceases to pass current and so it is impossible for the cathode to go any further positive. Got it?"

"Yes, I can see it now," said Dick, frowning. "That's an idea that never occurred to me before."

He picked up the back of the television receiver, then reverted to a subject which was, patently of even greater interest.

"Come along, Smithy," he remarked persuasively, "just tell me what it was that you did last night."

"I suppose I might as well," grunted Smithy reluctantly. "What annoys me, though, is that all the trouble arose from my old war-time experiences."

"Don't tell me you went around showing people that old war-wound of yours."

"What war-wound?"

"The one you acquired when you tripped and fell at Lime Street station in Liverpool. When the M.P'.s were chasing you."

Smithy shot an irritable glance at his assistant.

"I wish," he snorted, "I'd never told you that story. Anyway, the war-time experiences I'm referring to now were the times when, after a group of us had been celebrating a bit, we took it in turns to sing a song. That's what I did last night. I sang the *Eton Boating Song*."

"Where?"

"In our local Working Man's Club."

"What happened?"

"They threw me out. They said they didn't want toffee-nosed so-and-sos like me in there."

"Oh well," said Dick, suppressing a grin, "I suppose it will all be forgotten in a week or two."

"I hope so," replied Smithy glumly. "I was having quite a good time up till then."

Dick fitted the back of the television set to its cabinet, then glanced at the service manual for the receiver. This still lay open, displaying its circuit diagram.

"Hallo," he remarked, "that's funny."

"What's funny?"

"The sound section of this receiver," said Dick. "There doesn't seem to be an f.m. detector for the intercarrier sound."

"There's bound to be one."

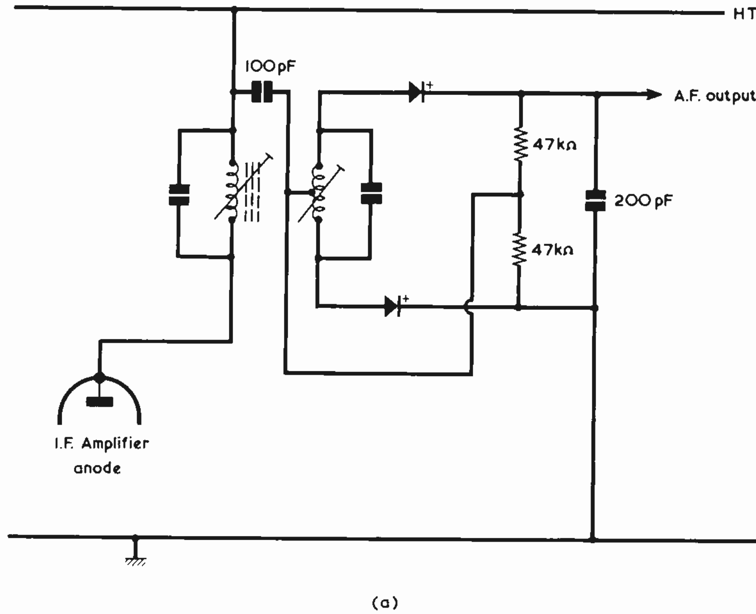
"Perhaps there is," replied Dick, "but *I* can't see it. Practically all these TV sets have a ratio discriminator to act as f.m. detector, and you can spot a ratio discriminator a mile off because of the two diodes connected in opposite directions. In fact, you told me once that the quickest method of telling whether an f.m. detector was of the ratio or phase discriminator type was by looking first at the way the two diodes were connected." (Figs. 3(a) and (b)).

"So?"

"So," continued Dick, "you can almost always find a ratio discriminator, or a phase discriminator for that matter, in a complicated receiver circuit by looking for the associated pair of diodes. But there isn't a pair of diodes in this TV circuit anywhere!"

Smithy glanced over at the circuit diagram.

"This set," he remarked, "doesn't have the usual type of f.m. discriminator. Instead, it has what is called a quadrature detector. There it is, and it's given by the EH90 stage."



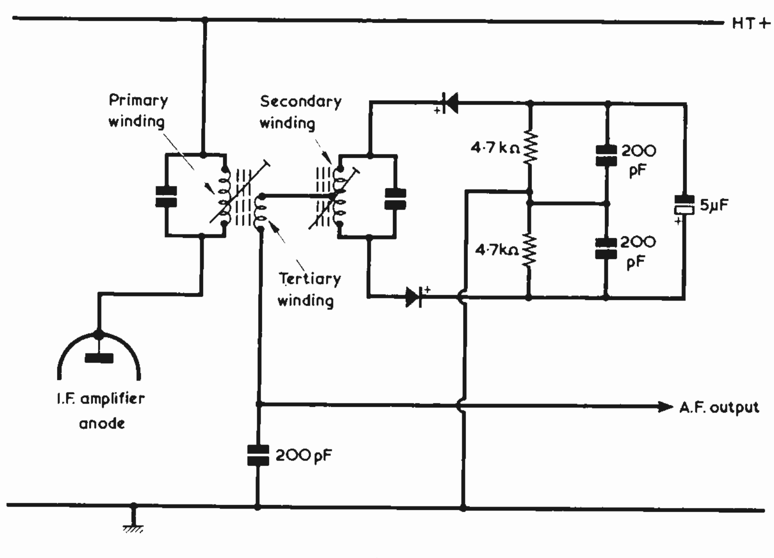


Fig. 3 (a). A typical phase discriminator circuit with representative values. Note that both diodes appear in the same direction
(b). A ratio discriminator circuit. This type of discriminator is easily distinguished from the phase discriminator by the fact that the two diodes are in opposite directions

Smithy pointed at the section of the receiver incorporating the EH90. (Fig. 4).

QUADRATURE F.M. DETECTOR

"*That's* an f.m. detector?"

"It is."

"Stap me, it's a new one on me. Since when have they been using f.m. detectors like that?"

"Quadrature f.m. detectors," said

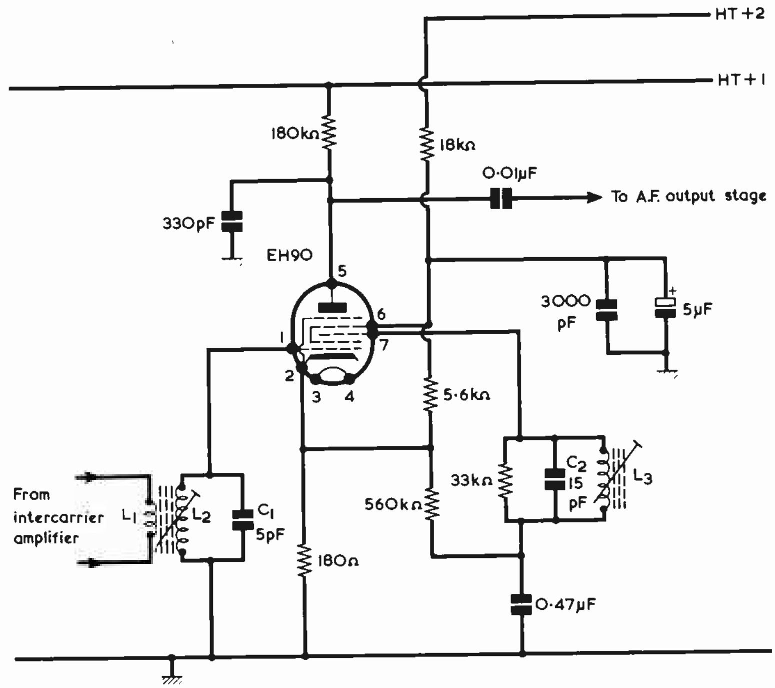


Fig. 4. A practical quadrature f.m. detector. This circuit, together with that of Fig. 1, appears in the G.E.C. 2022/2038 series of television receivers and is given when the receiver is switched to 625 lines. System switching circuits (omitted here for simplicity) cause the EH90 to function as an a.f. voltage amplifier on 405 lines

Smithy in reply. "have been in use, off and on, since round about 1946. They offer excellent linearity and are particularly suited to valve circuits. For some reason, though, they have never caught on with set designers to the same extent as have phase and ratio discriminators, particularly the latter. A quadrature detector is particularly useful for a TV set because the frequency modulated signal which is presented to it is always at good amplitude and is at a constant frequency, which is of course the intercarrier frequency. The constant frequency enables the quadrature detector to be set up very accurately."

"Is a quadrature detector essentially a valve type?"

"At present it is," replied Smithy. "Or, rather, it is so far as simple practical versions of the detector are concerned. The basic principle consists of adding the frequency modulated signal to a fixed frequency which is equal to and in quadrature with the f.m. carrier. The 'quadrature' bit means that the fixed frequency is 90 degrees out of phase with the f.m. carrier frequency. Actually, the fixed frequency can be derived from the carrier frequency by means of a coupling which involves a 90 degree phase shift, and that is the method employed in the circuit we have here. There is little doubt that a semiconductor version would be feasible if the 90 degree phase shift could be arranged."

"How is it provided here?"

"It's given inside the EH90," replied Smithy. "If you look at the circuit you'll see that this valve is a heptode containing two control grids. The first of these is g1, and it connects to pin 1. The second control grid is g3 and it connects to pin 7. There are two screen-grids, g2 and g4, these both connecting to pin 6. The final grid, g5, is merely a suppressor grid, and it's internally connected to the cathode. The input signal, which is a frequency modulated carrier of 6MHz, is applied to the first control grid by way of L1 and the tuned circuit given by L2 and C1. L3 and C2 form another tuned circuit. This is resonant at 6MHz and it couples to the second control grid. Now, the internal construction of the EH90 is such that a space-charge coupling exists between the first and second control grids, this being sufficient to excite L3 and C2 into resonance at the f.m. carrier frequency. The final result is that L3 and C2 remain locked to the carrier frequency and exhibit a phase difference of 90 degrees with that carrier."

"Does that mean, then," asked Dick, "that the anode current of the valve is controlled by two different frequencies, one being the frequency modulated signal and the other being the fixed quadrature frequency?"

"It does," confirmed Smithy. "A further point I must tell you about is that either of the control grids in the EH90 causes anode current cut-off when it is about 3 volts negative of cathode. If it is assumed that the peak voltage of the signal at either grid is considerably greater than this figure, the valve can, as a first approximation, be looked upon as being switched off during negative half-cycles of either frequency. Let me get a bit of paper and show you what happens next."

Smithy, engrossed with his explanation of the quadrature mode of f.m. discrimination, had completely forgotten his tribulations of the night before. He reached over eagerly for his note-pad, and proceeded to sketch out on this a set of waveforms. (Fig. 5(a).)

"Let's start off," he resumed, "with the situation where the f.m. signal frequency and the fixed frequency have exactly 90 degrees phase difference between them, with the fixed frequency leading. This 90 degree phase difference will be maintained when the f.m. signal is suffering zero modulation. Now, working to our assumption that anode current is cut off for negative half-cycles of either frequency, we find that anode current cannot flow until the f.m. signal frequency passes the zero line and starts to go positive. Anode current then continues to flow until it is stopped by the fixed frequency as the latter passes the zero line and starts to go negative. Thus, anode current flows only for the duration of a quarter of a cycle of the carrier or the fixed frequency. The shape of the anode current waveform will be a summation of the shapes of the two half-cycles during the conduction period and will tend to be rather on the square side. In practice, the squareness will be accentuated because the grids normally go sufficiently positive to take the anode current up to saturation level."

"What happens when the frequency of the f.m. signal varies?"

"That," said Smithy, "is what we'll examine next."

He drew a further set of waveforms on his note-pad. (Fig. 5(b).)

"Here," he announced, "is what occurs when the frequency of the f.m. signal is increased. When this occurs, its half-cycles appear earlier in time and the fixed frequency leads by a value that is now less than 90 degrees. As before, anode current commences to flow when the f.m. signal frequency passes the zero line and starts to go positive. Also as before, the anode current ceases when the fixed frequency waveform passes the zero line and goes negative. In this case, however, the start of anode current flow occurs at an earlier time than in the first example, with the result that anode current is present for a longer period."

"I think," said Dick, his interest greatly aroused, "I'm getting the hang of all this. Show me what happens when the frequency of the f.m. signal decreases."

"Right you are," said Smithy, busy

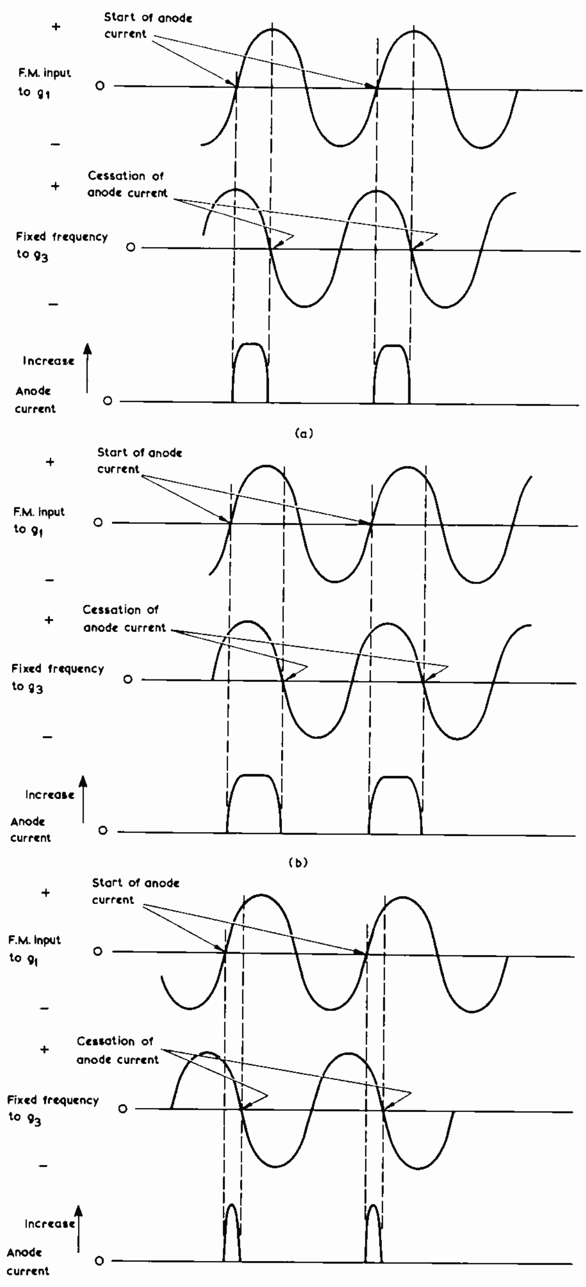


Fig. 5(a). The situation which exists in the EH90 circuit when the f.m. input signal and the fixed frequency have a phase difference of exactly 90°. The two upper curves represent voltage. Anode current flows when both of the grid waveforms are positive
(b). If the frequency of the f.m. signal increases, its cycles arrive earlier in relation to the fixed frequency. The pulses of anode current then increases in width
(c). When the frequency of the f.m. signal decreases, its cycles arrive later and the width of the anode current pulse decreases

with his note-pad again. "Ah, that's got it done!"

Proudly, he indicated a further set of waveforms. (Fig. 5(c).)

"Since, in this instance," he went on, "the frequency of the f.m. signal is decreased, its half-cycles arrive later than occurred in the first, quadrature, case. The resultant anode current now exists for a shorter period than in the quadrature example, because it commences at a later moment in time."

A. F. OUTPUT

"I can see it all now," stated Dick, beaming with the expression of one who has achieved complete comprehension. "What happens is that when the frequency of the f.m. signal increases the pulses of anode current increase in duration, and when the frequency of the f.m. signal decreases the pulses of anode current decrease in duration. If you could have some sort of smoothing circuit at the anode of the valve, you'd then have the situation where average anode current increases when the f.m. signal increases in frequency and where the average anode current decreases when the f.m. signal decreases in frequency. The increases and decreases in average anode current correspond to the changes in frequency of the f.m. signal and therefore correspond to the audio frequency which originally modulated it."

"Exactly," confirmed Smithy, "and the necessary smoothing circuit at the anode you refer to consists in practice quite simply of the single 330pF capacitor which is connected between the anode of the EH90 and chassis. The pulses of anode current appear at a frequency of 6MHz, and the single 330pF capacitor is quite sufficient to smooth these out and allow an average anode current at a.f. to appear. This causes an a.f. voltage to be developed across the 180kΩ anode load resistor, and that voltage can then be passed via an a.f. coupling capacitor to the following stage in normal manner."

"The waveforms you drew out," said Dick, "have the fixed frequency leading on the f.m. signal frequency. What would happen if you still had the quadrature relationship but with the fixed frequency lagging?"

"You'd still get the a.f. output at the anode," replied Smithy. "Only in this case average anode current will decrease as the frequency of the f.m. signal increases, and average anode current will increase as the frequency of the f.m. signal decreases. Okay?"

"Definitely," said Dick. "Well, you've certainly opened my eyes this New Year morning. This quadrature detection business is something I'd never even heard of before."

But mention of the New Year had reminded Smithy of his escapades of the previous night.

"Don't talk about New Year morning to me," he pleaded. "I'm still trying to forget New Year's Eve."

"Come off it, Smithy," said Dick scornfully, "you didn't put up too much of a black last night, so far as I can see. The Working Man's Club will soon forgive you for that little song of yours."

"That's not all that happened," stated Smithy unhappily. "After I'd been chucked out of the Working Man's Club I called in at the Liberal Club. I was enjoying myself there, too, until I had this sudden uncontrollable urge to sing once more."

"What did you sing this time?"

"I sang *Lloyd George Knew My Mother*. They didn't like it one little bit."

"What did they do?"

"They threw me out."

"Blimey," commented Dick. "Well, you certainly saw the old year out with a vengeance last night. But, just for the moment, let's get back to this quadrature f.m. detector. Does it give a.m. limiting?"

With difficulty, Smithy directed his mind away from the vicissitudes of the night before.

"A.M. limiting?" he repeated a little vaguely. "Why, yes it does, provided that the signal amplitudes at the two control grids are good and high. If they are sufficiently high in the negative direction to take the valve well beyond cut-off and are sufficiently high in the positive direction to take the valve well into anode current saturation, the pulses of anode current will more closely approach a square shape, and will change this shape by only a small amount for fairly high levels of amplitude modulation. In consequence, the amplitude modulation will not have any significant effect on the a.f. output appearing at the anode and so a useful measure of a.f. limiting takes place. Incidentally, it is a common practice, with valves used for quadrature detection, to design them such that the anode current reaches saturation level at a relatively low value."

"I see," said Dick thoughtfully. "There's one more thing that puzzles me. I can just about visualise a space-charge coupling which causes the tuned circuit connected to the second control grid to oscillate, but why should it choose to oscillate in *quadrature* with the frequency applied to the first control grid?"

"That bit is a little difficult to explain," confessed Smithy, "and, to be quite frank, it cannot really be fully described in simple terms. This business of space charge coupling between two control grids first came to light in the early days of multi-grid frequency changers, in which it was found to be the cause of a mysterious and previously unexplained coupling which existed between an oscillator grid positioned next to the cathode and a signal grid separated from the oscillator grid by a screen-grid. This is, incidentally, what we have in the EH90 we have been discussing, with the exception that the signal on the first control grid is not due to oscillatory operation but is the large amplitude f.m. signal applied to it by the receiver circuits. Returning to those old frequency changers, it was at first considered that the space-charge coupling between the two grids could be looked upon simply as a negative capacitance, but later work, particularly at higher frequencies, showed that it was of a far more complex character and that it was equivalent to a coupling which also contained resistive and even inductive elements. Such a coupling is bound to introduce a phase shift between the signal voltages on the two grids and the phase shift could be made approximately equal to 90 degrees for the particular type of detector we have been considering."

"Does the phase shift," enquired Dick, "have to be *exactly* 90 degrees?"

"Oh no," said Smithy. "The f.m. detection process we examined just now did assume that the phase difference between the received f.m. signal and the fixed frequency was exactly 90 degrees but, if you think about it, you could theoretically get an f.m. detection action with *any* amount of phase difference between the two signals, provided that this phase difference was not so small that frequency deviation in the f.m. signal passed the point where it caused a continually increasing or continually decreasing average anode current. Actually, of course, best results are given by the true quadrature condition, but the circuit would still give a good account of itself for phase differences which are merely close to 90 degrees. It is very probable that an exact 90 degree shift is not given in practice. In fact it is common practice to cook the results a bit by, say, slightly detuning the coil connected to the first control grid of the valve. In the EH90 arrangement we have been looking at, for instance, best results could well be given by setting L2 and C1 slightly off-tune, say to 6.1MHz. The slight readjustment of phase relationships which results would then bring the circuit sufficiently close to the quadrature condition for it to operate at its best."

PARALLEL RESISTOR

"Well, that all seems fair enough," commented Dick. "The only remaining question I have concerning the circuit has to do with the 33kΩ resistor connected across the tuned circuit given by C2 and L3. What's that resistor for?"

"It's to damp the tuned circuit down a bit," replied Smithy. "Without that resistor the tuned circuit could be too selective to follow deviations in the f.m. signal and may cease oscillating if the frequency of the f.m. signal varies widely on modulation peaks. As a final point, I should tell you that this tuned circuit can be adjusted by injecting an amplitude modulated signal into the intercarrier stage preceding L1, the core of L3 being then adjusted for minimum a.m. output from the EH90. As the core is turned there will be a sudden dip in a.m. output as the tuned circuit starts oscillating and thereby allows the EH90 to act as a true f.m. detector, and the final setting of the core will be mid-way between the two edges of the a.m. rejection dip."

"I see," said Dick warmly, "well, this morning has certainly proved to be a good start to the New Year so far as I'm concerned."

Once again, Smithy's thoughts returned to his activities of the night before.

"I wish," he pronounced gloomily, "I could say that the old year had ended as well for me."

"I shouldn't worry too much about what happened last night," remarked Dick soothingly. "All that it means is that you'll have to stay away from both the Working Man's Club *and* the Liberal Club for a bit until it all dies down."

"I've not even told you the worst of it yet," moaned Smithy. "After I'd got thrown out of the Liberal Club, I called in next at another of the local clubs."

"Oh no," groaned Dick, "don't say you did it once more."

"I did," wailed Smithy. "And I'd only been there half an hour when I started singing all over again."

"You didn't . . . ," started Dick horror-struck. "You couldn't have . . ."

He found it impossible to complete the sentence.

"But I did," bewailed Smithy. "I did. My very last act of the old year was to sing *The Red Flag* in our local Conservative Club!" ■

MULLARD ROSE PICTURE COMPETITION WINNERS

In the late Autumn of last year thousands of Mullard 'Jubilee' rose bushes were planted in gardens – ranging from modest patches at the rear of suburban houses to large municipal parks – all over the country.

In the competition, announced earlier this year, entrants were invited to submit a colour photograph or a painting in oils or water colours of a single 'Jubilee' rose or a group of not more than 12, grown by the competitor.

Winners in the Public Section were:– Photography – 1st prize: (75.00) Mr. C. A. Hull, Darwen, Lancs – 2nd prize: (£50.00) Mr. Colin Sproxton, Herne Bay, Kent – 3rd prize: (£25.00) Miss B. Farrington-House, Sittingbourne, Kent. Paintings – 1st prize: (£75.00) Mrs. I. Diplock, Dartford, Kent – 2nd prize: (£50.00) Miss D. M. Alderson, Darlington, Co. Durham – 3rd prize: (£25.00) Mrs. Rita Summers, Crowborough, Sussex.

Radio Topics

By Recorder

HAPPY NEW YEAR!

Yes, it's 1972, and we now press on to yet another year of constructional offerings which will, we hope, be of interest, instruction and amusement.

Turning to my own little patch, you may remember that I devoted all of the last Radio Topics to the subject of a.m. superhet alignment, and covered the field of medium wave setting up with and without benefit of signal generator. Let's next turn our attention to short wave alignment.

SHORT WAVE ADJUSTMENTS

The alignment of short wave ranges is similar to that of the medium wave range. At these higher frequencies, trimmer adjustments are much more critical. If the high frequency end of any short wave range is in the region of 30 to 10 metres (10 to 30MHz) beware of trimming to the second channel (given with the oscillator *below* signal frequency) instead of the correct signal frequency (given with the oscillator *above* signal frequency). The two frequencies are – assuming an i.f. of around 450kHz – nearly 1MHz apart. If you pick up the same signal at two settings of the receiver tuning, the correct reception condition is given when the receiver tuning capacitor has less capacitance in circuit. Another way of saying the same thing is that, if you are working with a signal generator and this offers an audible output at two of its settings spaced nearly 1MHz apart, the correct generator output is the lower frequency one.

Trimming of the aerial tuned circuit at the higher short wave frequencies may cause oscillator frequency to be 'pulled'. This can be guarded against by slightly rocking the receiver tuning back and forth through the signal whilst the aerial circuit is being trimmed.

The alignment of short wave bands is difficult if a signal generator is not available to enable the oscillator to be set up to the correct frequency at the low and high frequency ends of the range. If another short wave receiver is to hand this can be used to pick up and identify the frequency of the oscillator stage being aligned. A lead from the aerial terminal of the monitoring receiver is held near the oscilllator wiring. The oscillator may then be set up in terms of frequency, remembering that the signal picked up by the monitoring receiver is higher than the desired reception frequency by an amount equal to the intermediate frequency. Keep coupling as loose as possible to ensure that the monitoring receiver is not responding to harmonics, etc. Once the oscillator has been made to cover the desired frequency range, the aerial tuned circuit can be set up on received signals.

The only other alternative, in the absence of a signal generator or another short wave receiver, is to simply align a short wave band so that the set has reasonable sensitivity, then listen out for operation on the amateur bands. Once amateur bands at the high and low frequency ends of the range have been identified in terms of frequency, it becomes possible to adjust the oscillator circuit for correct coverage. The aerial circuit is then adjusted for optimum results with received signals.

In these notes I have assumed a fairly simple a.m. superhet having a single i.f. of the order of 450kHz. Naturally, you wouldn't be using such simple techniques with a more complex receiver, such as a double superhet. Should the receiver have an r.f. stage before the mixer, the r.f. tuned circuit is set up in the same manner as the aerial tuned circuit.

LONG WAVE ALIGNMENT

All that is now left to discuss is the alignment of the long wave band. I have purposely left this until last because long wave coverage with modern transistor receivers having ferrite rod aerials varies considerably from receiver to receiver. In many instances, long waves are selected by such circuit devices as switching an additional capacitor (usually with a parallel trimmer) across the oscillator tuned circuit and by switching in an additional long wave coil, with its own trimmer, on the ferrite rod. In circuits of this nature it is necessary first to get the medium wave circuits lined up before attempting to tackle the long wave alignment. The only adjustments then possible are trimming of both the oscillator and aerial tuned circuit and an inductance adjustment of the aerial circuit only (by moving the long wave coil along its ferrite rod). Variation of the oscillator inductance by adjustment of the oscillator coil core cannot be carried out because this core has already been set up for medium waves. A useful approach, if a signal generator is available, consists of trimming both aerial and oscillator coils at about 1200 metres (250kHz) and then adjusting the aerial coil inductance at around 1800 metres (167kHz) for maximum signal. If a signal generator is not to hand, trim the oscillator for correct scale indication of Radio 2 on 1500 metres (200kHz), then leave the oscillator circuit alone. Tune to around 1200 metres and trim the aerial coil on received signals, then down to around 1800 metres and similarly adjust aerial coil inductance. Provided that the Radio 2 signal, which is the most important signal in this band, is received at optimum signal strength, reasonable alignment can be assumed.

Older receivers and, perhaps, the better class modern receiver, will have a separate oscillator coil and padding capacitor for long waves. In this case, alignment is as for medium waves and a good tracking performance over a wide range is possible. In general, here, it is best to work to any alignment instructions that are given for the receiver. Should it be a commercially manufactured set, try and obtain its service sheet, if possible, and work to that when aligning the long wave band.

LUCKY YOUNG LADY

G8FDE – that is the amateur radio call sign of the very lucky young lady shown in our photograph, Miss Barbara Clements of Ilseham. Barbara, aged 22, was recently presented with a Pye SSB125T by Dr. J. M. Westhead, Managing Director of Pye Telecommunications Limited, of Cambridge.

Barbara is very active on the local 2 metre net, which comprises about 80 stations, and is now geared up to take full advantage when her G3 call sign is issued. She is the 100th licenced member of the Pye Telecom. Amateur Radio Group and in fact is their very first licenced young lady member. ■

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(Continued on page 381)

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6AQ5	.22	30P12	.69	ECF80	.27	PC86	.47	10	1.20	AF119	.23
6AT6	.18	30PL1	.59	ECF82	.26	PC88	.47	R19	.30	AF121	.30
6AV6	.28	30PL13	.75	ECF86	.64	PC97	.36	U19	1.73	AF126	.18
6BA6	.20	30PL14	.65	ECH42	.60	PC900	.32	U25	.64	BC107	.13
6BC8	.50	30PL15	.87	ECH81	.27	PCC84	.29	U26	.56	BC108	.13
6BE6	.21	35A3	.48	ECH83	.39	PCC88	.41	U191	.58	BC113	.25
6BH6	.43	35W4	.23	ECH84	.34	PCC89	.45	U251	.65	BC118	.23
6BJ6	.39	90C1	.59	ECL80	.30	PCC189	.48	U301	.40	BCZ11	.38
6BR7	.79	150B2	.58	ECL82	.30	PCF80	.28	U801	.93	BF159	.25
6BW6	.72	DAF91	.20	ECL83	.52	PCF82	.30	UABC80		BF163	.20
6BW7	.54	DAF96	.33	ECL84	.54	PCF84	.40		.30	BF180	.30
6BZ6	.31	DF91	.14	ECL86	.35	PCF86	.44	UBC81	.40	BY100	.18
6C4	.28	DL96	.34	EF22	.63	PCF801	.29	UBF80	.30	BY126	.15
6CU5	.30	DK91	.26	EF41	.58	PCF802	.40	UBF89	.30	BY127	.18
6F1	.59	DK92	.35	EF80	.22	PCF806	.57	UC92	.35	OA81	.09
6F23	.68	DK96	.35	EF85	.26	PCL82	.32	UCC84	.33	OA91	.09
6F28	.60	DL92	.25	EF86	.29	PCL83	.58	UCC85	.34	OA95	.09
6K7G	.10	DL94	.32	EF89	.23	PCL84	.34	UCF80	.33	OC23	.38
6K8G	.16	DL96	.35	EF91	.17	PCL805		UCH42	.60	OC24	.38
6X4	.20	DY87/6	.24	EF92	.35		.40	UCH81	.30	OC25	.38
9D7	.78	DY802	.35	EF183	.26	PCL86	.38	UCL82	.33	OC26	.24
10F18	.35	E88CC	.60	EF184	.29	PD500	1.44	UCL83	.48	OC35	.32
12A6	.63	E180F	.90	EH90	.36	PEN45	.40	UF41	.50	OC44	.10
12AT6	.23	EABC80		EL34	.44	PFL200	.52	UF80	.35	OC45	.11
12AU6	.21		.30	EL35	1.00	PL36	.47	UF85	.34	OC46	.15
12AV6	.28	EAF42	.48	EL37	.74	PL38	.90	UF86	.63	OC70	.13
12BA6	.30	EB34	.20	EL41	.53	PL81	.44	UF89	.27	OC71	.11
12BE6	.30	EB91	.10	EL84	.22	PL82	.30	UL41	.54	OC72	.11
12BH7	.27	EBC41	.48	EL91	.23	PL83	.32	UL84	.31	OC74	.23
12K5	.50	EBC81	.29	EL95	.32	PL84	.30	UY41	.38	OC75	.11
19AQ5	.24	EBF80	.30	EM80	.38	PL504	.62	UY85	.25	OC78	.15
20P4	.89	EBF83	.38	EM81	.39	PL508	.90	X41	.50	OC78D	.15
30A5	.44	EBF89	.27	EM83	.75	PL509	1.30	AC113	.25	OC81	.11
30C15	.60	EC92	.34	EM84	.31	PL802	.75	AC127	.17	OC81D	.11
30C17	.77	ECC33		EM87	.35	PX4	1.16	AC128	.20	OC82	.11
30C18	.60		1.50	EY51	.33	PX25	.98	AC154	.25	OC83	.20
30F5	.65	ECC81	.16	EY81	.35	PY32/2	.50	AC156	.20	OC84	.24

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1 set of vehicle mounting brackets, control boxes and loud-speakers for use with the above mobile radios.

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**Purchasing Officer,
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5, Wharf Lane,
Solihull,
Warwickshire.**

The Board does not bind itself to accept the highest or any tender

SMALL ADVERTISEMENTS

(Continued from page 379)

FOR SALE: Creed Teletax transceiver type TR 105, £15. Ex-R.A.F. tuning fork drive unit type 114, £12. Box No. G167.

"GOVERNMENT SURPLUS WIRELESS EQUIPMENT HANDBOOK". Contains circuits, data, illustrations, components lists for British/U.S.A. receivers, transmitters, trans/receivers; includes modifications to sets and test equipment. Surplus/commercial cross-referenced transistor and valve guide. A gold mine of valuable information. Price £2.84. P. & P. 16p. Myers, (R), 112 Stainburn Crescent, Leeds 17, Yorks.

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FREE CIRCUITS. Micro-transmitters, telephone transmitters, infinite range transmitters, squawk generators (MW/VHF/TV), parcel and car trackers. The lot free (but please send 5p P.O. for P. & P.). Mr. Bobker, 29 Chadderton Drive, Bury, BL9 8NL.

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FOR SALE: Electronic Devices (Cheltenham) Ltd. electric "bug" morse key. £10. Box No. G170.

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THE BRITISH AMATEUR ELECTRONICS CLUB. A club for all who are interested in electronics as a hobby. Quarterly Newsletter sent free to members. Subscription 50p per year. Details from Hon. Secretary, J. G. Margetts, 17 St. Francis Close, Abergavenny, Mon.

FOR SALE: Small stamp collection £5. Box No. G.171.

FOR SALE: 50 OC71 transistors, 50p. 200 silicon diodes, 60p. P. & P. 8p, over £1 free. ECB, 45 Brockhurst Street, Walsall, Staffs., WS1 4ED.

FOR SALE: Raven radio control Tx & Rx. Multichannel reed. £25. S.A.E. for details. Box No. G172.

(Continued on page 383)

SMALL ADVERTISEMENTS

(Continued from page 381)

ARE YOU A MOTORING ENTHUSIAST? The Seven-Fifty Motor Club caters for all types of motor sport-racing, rallies, hill climbs, etc. Monthly Bulletin free to members. For full details write to: The General Secretary, Colin Peck, "Dancers' End", St. Winifred's Road, Biggin Hill, Kent.

WANTED: Complete volumes of back issues of *Practical Wireless, Practical Electronics,* (*Practical*) *Television, Radio Constructor,* and *Wireless World* from 1960 onwards. Must be in good condition. E. G. Paul & Co. Ltd., 43 Thistle Street, Edinburgh 2. Telephone: 031-226-3407.

FOR SALE: Cossor double beam oscilloscope, model 339A. Just completely overhauled. Complete with spare new tube and instruction manual. £23. Further details on request. Box No. G173.

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WORLD DX CLUB covers all aspects of SWLing on Amateur and Broadcast Bands through its monthly bulletin "*Contact*". Membership costs £1.38 a year. Enquiries to Secretary, WDXC, 11 Wesley Grove, Portsmouth, Hants., PO3 5ER.

IF YOU HAVE ENJOYED A HOLIDAY on the Norfolk Broads, why not help to preserve these beautiful waterways. Join the Broads Society and play your part in determining Broadlands future. Further details from:– The Hon. Membership Secretary, The Broads Society, "Icknield", Hilly Plantation, Thorpe St. Andrew, Norwich, NOR 85S.

MAGAZINES FOR SALE: *Practical Wireless* – all issues for 1963, 1966, 1967, 1968, 1969. July/December 1962. 1964, all except March, April, July and August. 1965, all except May. 1970, all except March. *Radio Constructor* – 1966, all except March and April. £1 per year or £5 the lot. Smith, 27 Toller Road, Quorn, Leics. Telephone: Quorn 2665.

FOR SALE: Griffin A.F. signal generator/amplifier. Also Griffin vibration generator. As new. Offers? Telephone: Rugby 3107.

RADIO CONSTRUCTORS Components for sale. Several books, amateur antennas. S. W. Hughes, 11 Henley Road, Ludlow, Salop.

RADIO AMATEUR EXAMINATION COURSE Wednesday 6.30 to 9.00 p.m. To secure a place, enrol as soon as possible at ACTON TECHNICAL COLLEGE (opposite Town Hall). Telephone 992 3248. Lecturer: W. G. Dyer, M.I.E.E., G3GEH. Syllabus embraces Theory, Licence Conditions and Morse instruction; no prior knowledge is assumed or required.

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Inch-Millimetre Table I

Metrication in electronics is advancing rapidly, particularly in the dimensional field. The Table lists millimetre equivalents to 'round number' inch values from 0.005 to 0.5 in. Millimetres are given to four significant figures.

in.	*mm.*	*in.*	*mm.*	*in.*	*mm.*	*in.*	*mm.*
0.005	0.1270	0.08	2.032	0.21	5.334	0.36	9.144
0.01	0.2540	0.085	2.159	0.22	5.588	0.37	9.398
0.015	0.3810	0.09	2.286	0.23	5.842	0.38	9.652
0.02	0.5080	0.095	2.413	0.24	6.096	0.39	9.906
0.025	0.6350	0.1	2.540	0.25	6.350	0.40	10.16
0.03	0.7620	0.11	2.794	0.26	6.604	0.41	10.41
0.035	0.8890	0.12	3.048	0.27	6.858	0.42	10.67
0.04	1.016	0.13	3.302	0.28	7.112	0.43	10.92
0.045	1.143	0.14	3.556	0.29	7.366	0.44	11.18
0.05	1.270	0.15	3.810	0.30	7.620	0.45	11.43
0.055	1.397	0.16	4.064	0.31	7.874	0.46	11.68
0.06	1.524	0.17	4.318	0.32	8.128	0.47	11.94
0.065	1.651	0.18	4.572	0.33	8.382	0.48	12.19
0.07	1.778	0.19	4.826	0.34	8.636	0.49	12.45
0.075	1.905	0.20	5.080	0.35	8.890	0.50	12.70

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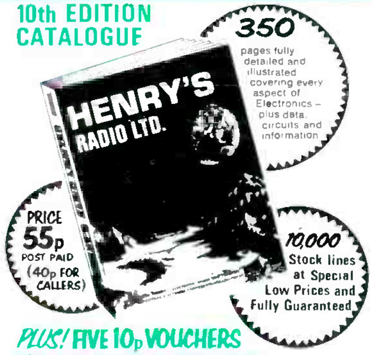

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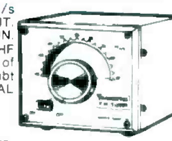

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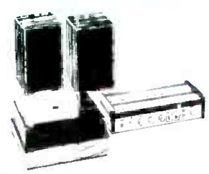

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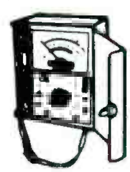

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