THE

RADIO CONSTRUCTOR

Vol. 24 No. 3 OCTOBER 1970 3/6

ULTRA SIMPLE TREMOLO UNIT

FREE INSIDE **Detachable Plans of Printed Board Layout, Point-to-Point Wiring Diagram and Cabinet Details of this 2-transistor (ACY19, OC44) unit**

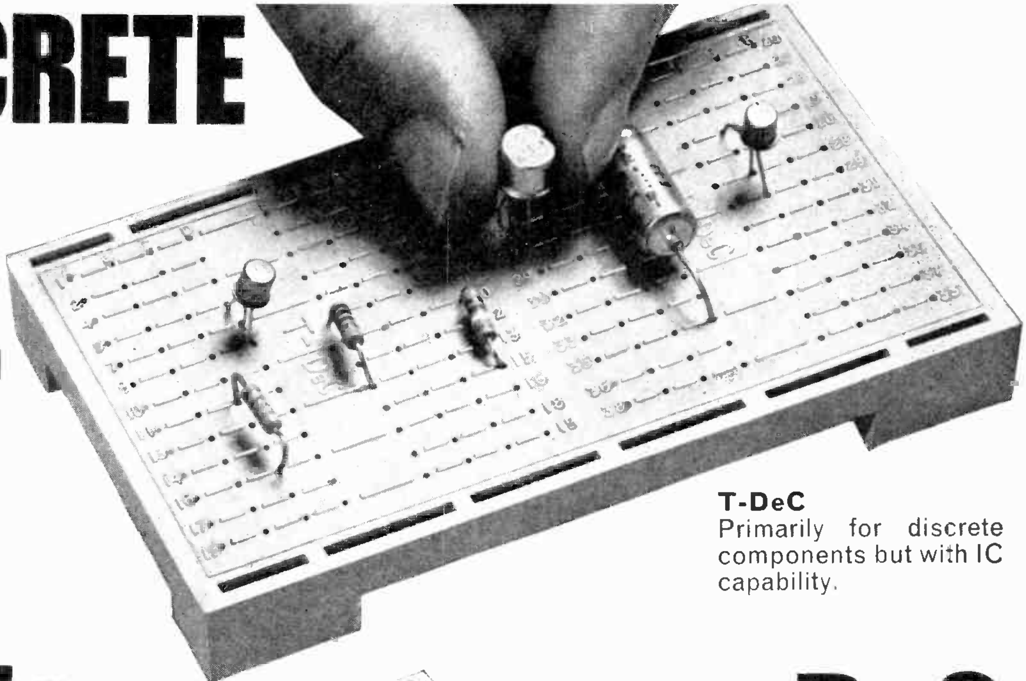
Special IN THIS ISSUE

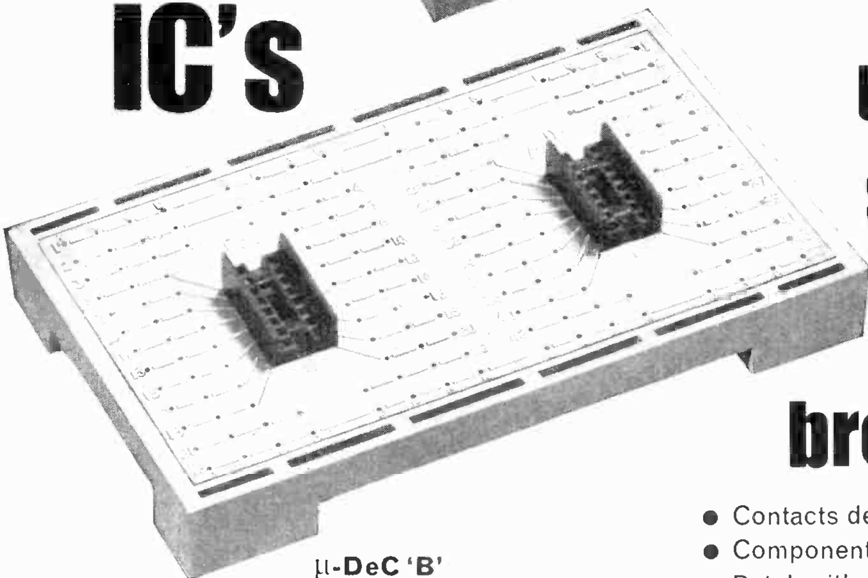
'TRIO' 9R-59DE MODIFICATIONS

I.C. GRAM AMPLIFIER

EXCLUSIVE

WORKSHOP EQUIPMENT OFFER





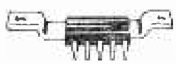
VALUE ALL THE WAY

LINEAR INTEGRATED CIRCUITS

BI-PAK MONOLITHIC AMPLIFIERS (TO-5 8 lead)

BP709C, Operational amplifier, 15/- each.
BP701C, Operational amplifier (with Zener output), 12/6 each.
BP702C, Operational amplifier (with direct output), 12/6 each.
BP501, Wide band amplifier, 18/- each.
BP521, Logarithmic wide band amp., 14/- each.
BP201/C, General purpose amplifier (TO-5 8 lead), (voltage or current amp.), 12/6 each.
I.C. Operational Amplifier with Zener output. **Type 701C.** Ideal for P.E. Projects. 8 Lead TO-5 case. Full data.
Our price 12/6 each
5 off 11/- each. Large Qty Prices quoted for.

IC AMPLIFIER



Identical encapsulation and pin configuration to the following: SL402-3, IC10 and IC403. Each circuit incorporates a pre-amp and class A.B. Power amp stage capable of delivering up to 3 watts RMS. Fully tested and guaranteed. Supplied complete with circuit details and data. CODED BP.1010. OUR LOWEST PRICE 30/- each. 10 up 25/- each.

MULLARD I.C. AMPLIFIERS

TAA243, Operational amplifier, 70/- each.
TAA263, Linear AF amplifier, 15/9 each.
TAA293, General purpose amplifier, 21/- each.

CA3020 RCA (U.S.A.) LINEAR INTEGRATED CIRCUITS

Audio Power Amplifier. 30/- each.

OTHER MONOLITHIC DEVICES

D13D1 Silicon Unilateral switch 10/- each.
A Silicon Planar, monolithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuits available on request.

Silicon Microwave Diodes Sylvania (U.S.A.)

IN218 and IN218R matched pair S. Band mixer. Max overall noise faction 13.7dB at 3,000 m/cs Brand new and boxed. Clearance Price 6/- pr.

EX-EQUIPMENT MULLARD

AF117 transistors. Large can 4 lead type. Leads cut short but still usable. real value at 15 for 10/-.

AD161 AD162

NPN PNP
MATCHED COMPLEMENTARY PAIRS OF GERM. POWER TRANSISTORS.
For mains driven output stages of Amplifiers and Radio receivers.
OUR LOWEST PRICE OF *12/6 PER PAIR.*

HIGH POWER SILICON PLANAR TRANSISTORS. TO-3.
Ferranti ZT1487 NPN VCB60 Ic 6A fT. 1M/c. VCE 40 Ptot. 75W VEB8 hFE 15-45
Price 15/- each

2N3055 115W. SIL POWER NPN
OUR PRICE 12/6 each

FULL RANGE OF ZENER DIODES VOLT. RANGE 2-16V

400mW (DO-7 Case) 2/6
1·5W (Top-Hat) 3/6
10W (SO-10 Stud) .. 5/-
All fully tested 5% tol. and marked. State voltage required.

BRAND NEW TEXAS GERM. TRANSISTORS

Coded and Guarant'd

Pak No.		EQVT.
T1	8 2G371A	OC71
T2	8 2G374	OC75
T3	8 2G3744A	OC81D
T4	8 2G381A	OC81
T5	8 2G382T	OC82
T6	8 2G344A	OC44
T7	8 2G345A	OC45
T8	8 2G378	OC78
T9	8 2G399A	2N1302
T10	8 2G417	AF117

All 10/- each pack

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS.
OUR PRICE 5/- each.

120 VCB NIXIE DRIVER TRANSISTOR Sim. BSX21 & C407. 2N1893 FULLY TESTED AND CODED ND120. 1-24 3/6 each. TO-5 NPN 25 up 3/- each

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 1/- each. Any Qty.

FREE

One 10/- Pack of your own choice free with orders valued £4 or over.

NPN DIFFUSED SILICON PHOTO-DUO-DIODE TYPE IS701 (2N2175) for Tape Readout, high switching and measurement indicators, 50V, 250mW. OUR PRICE 10/- EACH, 50 OR OVER 8/6. EACH. FULL DETAILS.

FET'S

2N 3819.... 10/-
2N 3820.... 25/-
MPF105 ..... 8/-

LOW COST F.E.T.s

Fully Tested, Guaranteed Perameters equit. to 2N3819, MPF102, 2N5459. 1-24 7/6 each; 25-99 6/3 each; 100 up 5/6 each. Coded FE19. Full data sent. TO-72 case.

CADMIUM CELLS

ORP12 8/6
ORP60, ORP61 8/- each

PHOTO TRANS.

OCP71 Type. 8/6

KING OF THE PAKS Unequalled Value and Quality

SUPER PAKS NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.		
U1	120 Glass Sub-min. General Purpose Germanium Diodes	10/-
U2	60 Mixed Germanium Transistors AF/RF	10/-
U3	75 Germanium Gold Bonded Diodes sim. OA5, OA47.	10/-
U4	40 Germanium Transistors like OC81, AC128........	10/-
U5	60 200mA Sub-min. Sil. Diodes.....................	10/-
U6	30 Silicon Planar Transistors NPN sim. BSY95A, 2N706	10/-
U7	16 Silicon Rectifiers Top-Hat 750mA up to 1,000V ...	10/-
U8	50 Sil. Planar Diodes 250mA OA/200/202	10/-
U9	20 Mixed Volts 1 watt Zener Diodes	10/-
U11	25 PNP Silicon Planar Transistors TO-5 sim. 2N1132..	10/-
U13	30 PNP-NPN Sil. Transistors OC200 & 2S104	10/-
U14	150 Mixed Silicon and Germanium Diodes	10/-
U15	25 NPN Silicon Planar Transistors TO-5 sim. 2N697 ..	10/-
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV.	10/-
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10/-
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	10/-
U19	25 Silicon NPN Transistors like BC108	10/-
U20	12 1·5-amp Silicon Rectifiers Top-Hat up to 1,000 PIV.	10/-
U21	30 A.F. Germanium alloy Transistors 2G300 Series & OC71	10/-
U23	30 Madt's like MAT Series PNP Transistors	10/-
U24	20 Germanium 1-amp Rectifiers GJM up to 300 PIV...	10/-
U25	25 300 Mc/s NPN Silicon Transistors 2N708, BSY27...	10/-
U26	30 Fast Switching Silicon Diodes like IN914 Micro-min	10/-
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc., 8 Assorted Pieces	20/-
U29	10 1 amp SCR's TO-5 can up to 600 PIV CRS1/25-600..	20/-
U31	20 Sil. Planar NPN trans. low noise Amp 2N3707	10/-
U32	25 Zener diodes 400mW D07 case mixed Volts, 3-18 ..	10/-
U33	15 Plastic case 1 amp Silicon Rectifiers IN4000 series ..	10/-
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 2S302/4	10/-
U35	25 Sil. Planar trans. PNP TO-18 2N2906	10/-
U36	25 Sil. Planar NPN trans. TO-5 BFY50/51/52	10/-
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322..........	10/-
U38	20 Fast Switching Sil. trans. NPN 400Mc/s 2N3011....	10/-
U39	30 RF Germ. PNP trans. 2N1303/5 TO-5	10/-
U40	10 Dual trans. 6 lead TO-5 2N2060	10/-
U41	25 RF Germ. trans. TO-1 OC45 NKT72	10/-
U42	10 VHF Germ. PNP trans. TO-1 NKT667 AF117......	10/-

Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

NEW LOW PRICE TESTED S.C.R.'S

PIV	1A (TO 5 case) each	3A (TO-66 case) each	7A (TO-48 case) each	16A (TO-48 case) each	PIV	30A each
50	4/6	5/-	9/6	10/6	25	20/-
100	5/-	6/6	10/6	12/6	50	23/-
200	7/-	7/6	11/6	15/-	100	28/-
400	8/6	9/6	13/6	18/6	200	32/-
600	10/6	11/6	15/6	25/-	400	35/-
800	12/6	14/-	18/-	30/-	600	80/-

SIL. RECTS. TESTED

PIV	750mA	3A	10A	30A
50	1/-	2/9	4/3	9/6
100	1/3	3/3	4/6	15/-
200	1/9	4/-	4/9	20/-
300	2/3	4/6	6/6	22/-
400	2/6	5/6	7/6	25/-
500	3/-	6/-	8/6	30/-
600	3/3	6/9	9/-	37/-
800	3/6	7/6	11/-	40/-
1000	5/-	9/3	12/6	50/-
1200	6/6	11/6	15/-	

2 Amp POTTED BRIDGE RECTIFIERS
200V. 10/-.

TRIACS

V_{BOM}	2A (TO-1)	6A (TO-66)	10A (TO-48)
100	14/-	15/-	22/6
200	17/6	20/-	28/6
400	20/-	24/-	35/-

V_{BOM} = Blocking voltage in either direction.

TRANSISTOR EQUIVALENT BOOK

A complete cross reference and equivalent book for European, American and Japanese Transistors. Exclusive to BI-PAK. 15/- each

LUCAS 35A SILICON RECTIFIERS

Branded. 400 PIV. Special Price stud type, flying lead, 22/6 each.

PRINTED CIRCUITS EX-COMPUTER

Packed with semiconductors and components, 10 boards give a guaranteed 30 trans. and 30 diodes. Our price 10 boards 10/-. Plus 2/- P. & P.

PLEASE NOTE. To avoid any further Increased Postal Charges to our Customers and enable us to keep our "By Return Postal service" which is second to none, we have re-organized and streamlined our Despatch Order Department and we now request you to send all your orders together with your remittance, direct to our Warehouse and Despatch Department, postal address: **BI-PAK SEMICONDUCTORS, Despatch Dept., P.O. BOX 6, WARE, HERTS.** Postage and packing still 1/- per order. Minimum order 10/-.

UNIJUNCTION

UT46. Eqvt. 2N2646, Eqvt. TIS43. BEN3000
5/6 EACH
25-99 5/- 100 UP 4/-

NPN SILICON PLANAR

BC107/8/9, 2/- each; 50-99, 1/10; 100 up, 1/8 each; 1,000 off, 1/6 each. Fully tested and coded TO-18 case.

SILICON HIGH VOLTAGE RECTIFIERS

10-Amp 3-K.V. (3000 P.I.V.) Stud Type with Flying Leads.......... **16/- each**

QUALITY-TESTED PAKS

6 Matched Trans. OC44/45/81/81D .	10/-
20 Red Spot AF Trans. PNP	10/-
16 White Spot RF Trans. PNP	10/-
5 Silicon Rects. 3 A 100-400 PIV ...	10/-
2 10 A Silicon Rects. 100 PIV	10/-
2 OC1 140 Trans. NPN Switching..	10/-
1 12 A SCR 100 PIV	10/-
3 Sil. Trans. 2S303 PNP	10/-
3 200 Mc/s Sil. Trans. NPN BSY26/27	10/-
3 Zener Diodes 1W 33V 5% Tol....	10/-
4 High Current Trans. OC42 Eqvt..	10/-
2 Power Transistors 1 OC26 1 OC35	10/-
5 Silicon Rects., 400 PIV 250mA....	10/-
4 OC75 Transistors	10/-
1 Power Trans. OC20 100V	10/-
10 OA202 Sil. Diodes Sub-min.	10/-
2 Low Noise Trans. NPN 2N929/30	10/-
1 Sil. Trans. NPN VCB 100 ZT86 ..	10/-
8 OA81 Diodes	10/-
4 OC72 Transistors	10/-
4 OC77 Transistors	10/-
4 Sil. Rects. 400 PIV 500mA	10/-
5 GET884 Trans. Eqvt. OC44	10/-
5 GET883 Trans. Eqvt. OC45	10/-
2 2N708 Sil. Trans. 300Mc/s NPN ..	10/-
3 GT31 LF Low Noise Germ Trans.	10/-
6 IN914 Sil. Diodes 75 PIV 75mA...	10/-
8 OA95 Germ. Diodes Sub-min. IN69	10/-
3 NPN Germ. Trans. NKT773 Eqvt..	10/-
2 OC22 Power Trans. Germ.......	10/-
2 OC25 Power Trans. Germ.......	10/-
4 AC128 Trans. PNP High Gain.....	10/-
4 AC127/128 Comp. pair PNP/NPN	10/-
3 2N1307 NPN Switching Trans.....	10/-
7 CG62H Germ. Diodes Eqvt. OA71	10/-
3 AF116 Type Trans.	10/-
12 Assorted Germ. Diodes Marked ..	10/-
4 AC126 Germ. PNP Trans........	10/-
4 Silcon Rect. 100 PIV 750mA.......	10/-
3 AF117 Trans.	10/-
7 OC81 Type Trans................	10/-
3 OC171 Trans....................	10/-
5 2N2926 Sil. Epoxy Trans.........	10/-
7 OC71 Type Trans.	10/-
2 2S701 Sil. Trans. Texas..........	10/-
2 10 A 600 PIV Sil. Rects. IS45R ...	10/-
3 BC108 Sil. NPN High Gain Trans.	10/-
1 2N910 NPN Sil. Trans. VCB 100 .	10/-
2 1000 PIV Sil. Rect. 1·5 A R53310 AF	10/-
3 BSY95A Sil. Trans. NPN 200Mc/s.	10/-
3 OC200 Sil. Trans.	10/-
2 GET880 Low Noise Germ. Trans.	10/-
1 AF139 PNP High Freq. Trans.....	10/-
3 NPN Trans. 1 ST141 & 2 ST140 ..	10/-
4 Madt's 2 MAT100 & 2 MAT120...	10/-
3 Madt's 2 MAT101 & 1 MAT121...	10/-
4 OC44 Germ. Trans. AF	10/-
3 AC127 NPN Germ. Trans.	10/-
1 2N3906 Sil. PNP Trans. Motorola	10/-
2 Sil. Power Rects. BYZ13	15/-
1 Sil. Power Trans. NPN 100Mc/s. TK201A	15/-
2 2N1132 PNP Epitaxial Planar Sil...	10/-
3 2N697 Epitaxial Planar Trans. Sil..	15/-
4 Germ. Power Trans. Eqvt. OC16.	15/-
1 Unijunction Trans. 2N2646.......	15/-
2 Sil. Trans. 200Mc/s 60Vcb ZT83/84	15/-
20 NKT Trans. AF. RF. VHF. Coded + Eqvt. Lirs	10/-
2 2N2712 Sil. Epoxy Planar HFE225	15/-
8 BY100 Type Sil. Rects...........	20/-
25 Sil. and Germ. Trans. Mixed, all marked, New	30/-

SEMICONDUCTORS FOR "P.E." 50+50 AMP.

TYPE	EACH	TYPE	EACH
2N1613	4/6	IN914	1/-
2N3055	12/9	OA200	1/-
2N3703	3/-	BFY51	3/6
2N3704	3/6	BYZ13	4/6
2N3707	3/9	40632	14/-
2N3819	8/-	22V 1¼W Zener	3/6

GIRO No. 388-7006

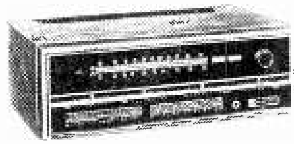
BI-PAK

63A High Street
WARE
Herts.

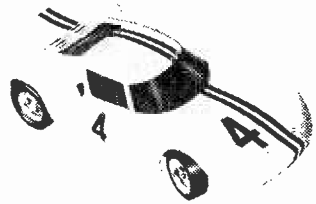
KING OF THE PAKS BI-PAK GUARANTEE SATISFACTION OR MONEY BACK

Many New Models!
in the FREE
HEATHKIT 1971 Catalogue...

CONSUMER



HI-FI & AUDIO

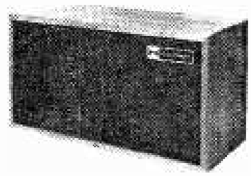


MODEL R/C CARS

Here's the bumper Heathkit catalogue for you. Read about the wonder and fascination of kit building . . see in full colour the world's best values in Hi-Fi . . Radio, and even model radio control. Get up to date with what's new in scientific instrumentation . . instruments for test and service . . in fact there is a Heathkit for almost every purpose, in every walk of life. A wealth of information is all yours for the price of a postage stamp, in the Free Heathkit Catalogue.

MARINE

★ No previous knowledge of electronics required.
★ The constructional manual supplied with every kit shows you how
★ Building Heathkit models is so economic.
★ Save up to 50% over factory built equipment.
★ Money saving direct from factory prices.
★ They make excellent Christmas gifts.



TRENT SPEAKER

HEATHKIT

A Schlumberger Company

HEATH (Gloucester) LTD. GLOUCESTER GL2 6EE

BLOCK CAPITALS PLEASE

Many other models in wide range

FILL IN THE COUPON FOR YOUR FREE CATALOGUE TODAY.

Name..

Address...

....

Post Code...

53/10A

BI-PRE-PAK LIMITED

FULLY TESTED AND MARKED

AC107	3/-	OC140	3/6
AC126	2/6	OC170	4/6
AC127	3/6	OC171	4/6
AC128	2/6	OC200	5/-
AC176	5/-	OC201	5/-
ACY17	3/-	2G301	2/6
AF139	7/6	2G303	2/6
AF186	10/-	2N711	10/-
AF239	7/6	2N1302-3	4/-
BC154	5/-	2N1304-5	5/-
BC171 = BC107	2/6	2N1306-7	6/-
BC172 = BC108	2/6	2N1308-9	7/-
BF194	3/-	2N3819FET	9/-
BF274	3/-	**Power Transistors**	
BFY50	4/-	OC20	10/-
BSY25	7/6	OC23	6/-
BSY26	2/6	OC25	5/-
BSY27	2/6	OC26	5/-
BSY28	2/6	OC28	6/-
BSY29	2/6	OC35	5/-
BSY95A	2/6	OC36	7/6
OC41	2/6	AD149	6/-
OC44	2/6	AUY10	25/-
OC45	2/6	2N3055	12/6
OC71	2/6	2S034	5/-
OC72	2/6	**Diodes**	
OC73	3/6	AAY42	2/-
OC81	2/6	OA95	2/-
OC81D	2/6	OA79	1/9
OC139	2/6	OA81	1/9
		IN914	1/6

FREE! Packs of your own choice up to the value of 10/- with orders over £4.

ANOTHER SCOOP FOR BI-PRE-PAK

JUST RELEASED FROM STOCK, A.E.I. INTEGRATED CIRCUITS

These are brand new genuine surplus stocks, marked and guaranteed to full makers specification and not remarked rejects.

NE808A	Single 8 I/P Nand Gate TTL	7/-
NE816A	Dual 4 I/P Nand Gate TTL	7/-
NE825A	D.C. Clocked J-K Flip-Flop TTL	17/6
NE840A	Dual 4 I/P Exclusive OR Gate TTL	7/-
NE855A	Dual 4 Power Gate TTL	7/-
NE870A	Triple 3 I/P Nand TTL	7/-
SP616A	Dual 4 Nand Gate DTL	7/-
SP631A	Quad 2 I/P Gate Expander DTL	7/-
SP670A	Triple 3 Nand Gate DTL	7/-
SP806A	Dual I/P Expander TTL	7/-
SP808A	Single 8 I/P Nand Gate TTL	7/-
SP816A	Dual 4 /IP Nand Gate TTL	7/-
SP825A	D.C. Clocked J-K Flip-Flop TTL	17/6
SP840A	Dual 4 I/P Exclusive OR Gate TTL	7/-
SP855A	Dual 4 Power Gate TTL	7/-
SP870A	Triple 3 I/P Nand TTL	7/-
SP880A	Quad 2 I/P Nand TTL	7/-
NE500K	Video Amplifier	40/-
NE501K	Video Amplifier 40 MHz	40/-
NE806J	Dual 4 I/P Expander TTL	7/-
NE808J	Single 8 I/P Nand Gate TTL	7/-
NE816J	Dual I/P Nand Gate TTL	7/-
NE825J	D.C. Clocked J-K Flip-Flop TTL	17/6
NE840J	Dual 4 I/P Exclusive OR Gate TTL	7/-
NE855J	Dual 4 Power Driver TTL	7/-
SN7430	8 Input Pos. Nand Gate TTL	7/-
ST620A	J-K Flip-Flop DTL	17/6
ST659A	Dual 4 Buffer/Driver DTL	7/-

Suffix: A=DIP 14 lead K=10 lead TO.5 J1=Flat Pack

NEW TESTED & GUARANTEED PAKS

B2	4	Photo Cells, Sun Batteries. .3 to .5V, .5 to 2mA.	10/-
B77	2	AD161–AD162 NPN/PNP Trans. Comp. output. Pair	10/-
B81	10	Reed Switches. Mixed types large and small.	10/-
B89	2	SSP5 Light Sensitive Cells. Light res. 400Ω. Dark 1MΩ.	10/-
B91	8	NKT163/164 PNP Germ. to —5. Equiv. to OC44, OC45.	10/-
B92	4	NPN Sil. Trans. A06=BSX20, 2N2369, 500 MHz, 360 mW.	10/-
B93	5	ACY17-21 PNP Germ. GET113 Trans. equivalent to	10/-
B96	5	2N3136 PNP Sil. Trans. TO-18. HFE100-300. IC.600mA. 200 MHz.	10/-
B98	10	XB112 & XB102 equiv. to AC126, AC156, OC81/2, OC71/2, NKT271, etc.	10/-
H4	250	Mixed Resistors. Post & packing 2/-.	10/-
H7	40	Wirewound resistors. Mixed values. Postage 1/6.	10/-
H8	4	BY127 Sil. Recs. 1000 PIV. 1 amp. Plastic.	10/-
H9	2	OCP71 Light sensitive photo-transistors.	10/-

Return of the unbeatable P.1 Pak. Now greater value than ever.

Full of short lead semiconductors and electronic components, approx. 170. We guarantee at least 30 really high quality factory marked Transistors PNP and NPN, and a host of diodes and rectifiers. Mounted on printed circuit panels. Identification chart supplied to give some information on the transistors.

P.1 PLEASE ASK FOR PAK P.1 ONLY **10/-**
2/- P & P on this Pak.

LOOK! TRANSISTORS ONLY 6d. EACH

TYPE A
PNP SILICON ALLOY TO-5 CAN
Spec:– hFE 15-100. ICER at VCE=20V 1mA Max. These are of the 2S300 range which is a direct equivalent to the OC200-205 range.

TYPE B
PNP SILICON PLASTIC ENCAPSULATION
Spec:– hFE 10-200 ICER at VCE=10v 1mA Max.
These are of the 2N3702-3 and 2N4059-62 range.

TYPE D
NPN SILICON PLANAR PLASTIC PACKAGE
Spec:– VCB 10v VCE 10v Ptot 500 mW hFE 50 min. Audio Preamplifier Transistor, similar to BC 113/4/5.

NEW UNMARKED UNTESTED PAKS

B80	8	Dual Trans. Matched O/P pairs NPN. Sil. in TO-5 can.	10/-
B83	200	Trans. Makers rejects. NPN/PNP. Sil. & Germ.	10/
B84	100	Silicon Diodes DO-7 glass equiv. to OA200. OA202.	10/-
B86	50	Sil. Diodes sub. min. IN914 & IN916 types.	10/-
B88	50	Sil. Trans. NPN. PNP. equivalent to OC200/1, 2N706A, BSY95A, etc.	10/-
B60	10	7 Watt Zener Diodes. Mixed voltages.	10/-
H6	40	250mW. Zener Diodes DO-7 min. Glass Type.	10/-
H10	25	Mixed volts 1½ watt Zeners. Top Hat type.	10/-
H11	30	Mat series "Alloy" PNP Transistors.	10/-
H15	30	Top Hat Silicon Rectifiers. 750mA. Mixed volts.	10/-
H16	8	Experimenters' Pak of Integrated Circuits. Data suppd.	10/-
H20	20	BY126/7 type Silicon Rectifiers. 1A. plastic to 1,000v.	10/-

MAKE A REV. COUNTER for your Car. The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a perfectly linear and accurate rev. counter for any car. **20/- each**

FREE CATALOGUE AND LISTS for:–

ZENER DIODES
TRANSISTORS, RECTIFIERS
FULL PRE-PAK LISTS
& SUBSTITUTION CHART

MINIMUM ORDER 10/-. CASH WITH ORDER PLEASE. Add 1/- post and packing per order. OVERSEAS ADD EXTRA FOR POSTAGE.

P.O. RELAYS

Various Contacts and Coil Resistances. No individual selection. Post & Packing 5/- **8 FOR 20/-**

FREE! A WRITTEN GUARANTEE WITH ALL OUR TESTED SEMICONDUCTORS

BI-PRE-PAK LTD DEPT. C, 222-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX
TELEPHONE: SOUTHEND (0702) 46344

THE **Radio Constructor**

Incorporating THE RADIO AMATEUR

OCTOBER 1970

Vol. 24 No. 3

Published Monthly (1st of Month)
First Published 1947

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9

Telephone 01-286 6141

Telegrams Databux, London

Annual Subscription 48s. (U.S.A. and Canada $6) including postage. Remittances should be made payable to "Data Publications Ltd.". Overseas readers please pay by cheque or International Money Order.

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

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

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Production.—Letterpress.

CONTENTS

TRANSISTOR SUB-STANDARD FREQUENCY MARKER 138
ULTRA-SIMPLE TREMOLO UNIT 144
SIMPLE TRANSISTOR CHECKER (Suggested Circuit No. 239) 148
NEWS AND COMMENT 150
MODIFICATIONS TO THE 'TRIO' 9R-59DE COMMUNICATIONS RECEIVER 152
SPECIAL REPEAT WORKSHOP EQUIPMENT OFFER 155
REFLEX TAPE TUNER 156
NOW HEAR THESE 160
BARE BONES 160
FACSIMILE RECEPTION FOR THE RADIO AMATEUR 161
THE 'TRI-add' PRE-AMPLIFIER 162
CURRENT SCHEDULES 166
INTEGRATED CIRCUIT GRAM AMPLIFIER 167
AMSAT POLICY OUTLINED 170
UNDERSTANDING TAPE RECORDING 171
IN YOUR WORKSHOP 176
NEW PRODUCT 178
RECENT PUBLICATIONS 180
RADIO TOPICS 187
LATE NEWS 189
ASIAN BROADCAST DX 189
LAST LOOK ROUND 189
RADIO CONSTRUCTOR'S DATA SHEET No. 43 (Two-Terminal L.C. Oscillators) iii

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

NOVEMBER ISSUE WILL BE PUBLISHED ON NOVEMBER 1st

Transistor Sub-Standard Frequency Marker

by

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

Using four readily obtainable and inexpensive transistors, together with a dual crystal unit, this frequency marker offers sine and square wave outputs both at 100kHz and 1MHz. Calibration markers are available at frequencies in excess of 100MHz

THIS ARTICLE DESCRIBES A SIMPLE BUT EXTREMELY useful transistor crystal sub-standard frequency marker. The unit gives both sine and square wave outputs simultaneously at either 100kHz or 1MHz. The circuit uses only four transistors and is powered by an internal 9-volt battery, this making the instrument equally useful both on the test bench and in the field. The battery drain is low enough to allow continuous use for long periods without battery replacements being necessary.

The construction of the unit is quite straightforward and not at all critical, while setting-up should offer no problems since only one trimming capacitor is involved. Cost-wise the frequency marker can be made for well under five pounds. This represents very good value when the long life and number of functions such an instrument can perform are considered.

The principal function of sub-standard frequency markers is in the calibration of test instruments, e.g.

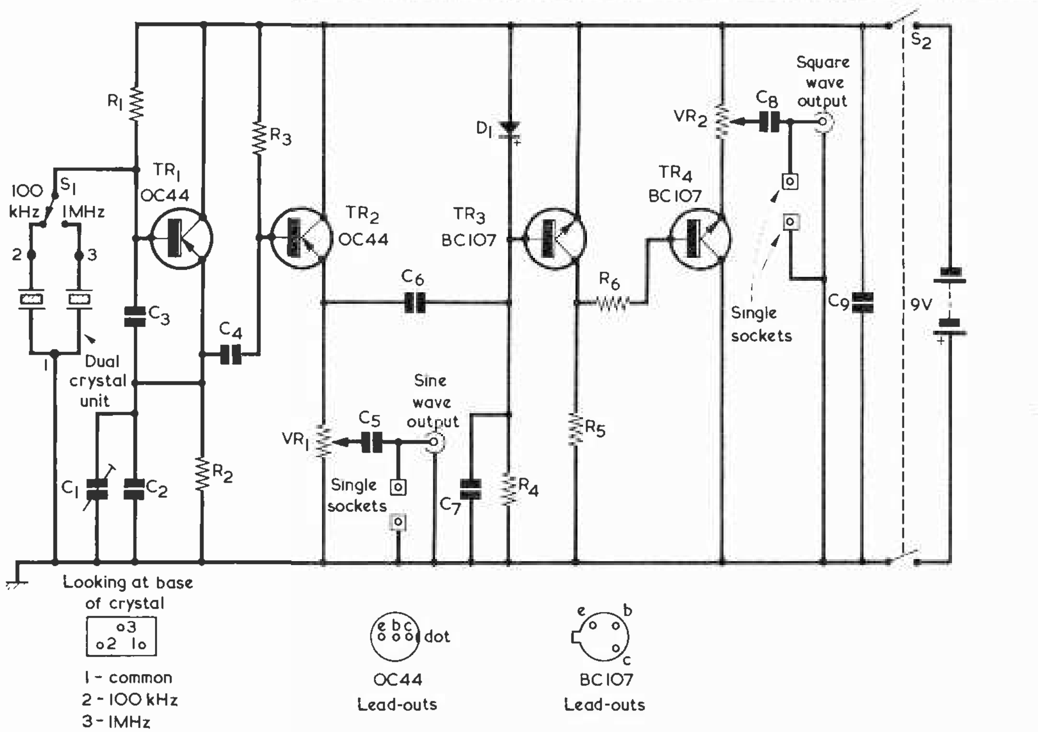


Fig. 1. The full circuit of the sub-standard frequency marker. The crystal is a dual component having 100kHz and 1MHz units in a single case

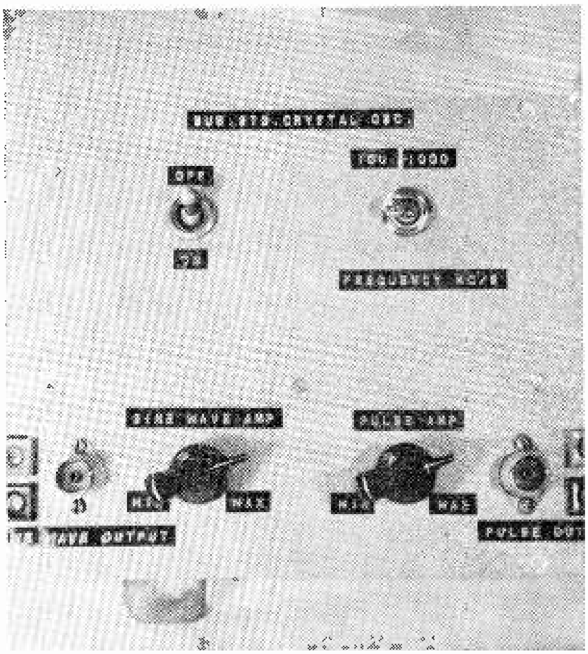
checking the accuracy of signal generators and pulse generators, c.r.o. time bases and pulse markers etc. Their other main function is for frequency marking and dial calibration checks on communications receivers and transmitters, v.f.o.'s, etc. The writer normally has the marker permanently connected in with the Rx/Tx so as to maintain a constant check on the dial calibrations of these pieces of equipment. This is besides its intermittent use for instrument calibration.

SQUARE WAVE OUTPUT

The unit described, besides having the normal sine wave output, also has a simultaneous square wave output having a fast rise time. This ensures a signal output very rich in harmonics, so allowing checks on communications equipment up to very high frequencies. Using the square wave output the marker has been used to check calibration points in excess of 100MHz. Using the 1MHz marker, dial calibration can be carried out through the h.f. and v.h.f. ranges. By switching to the 100kHz marker, the ten sub-division points between any two 1MHz points can be checked. For example, having fixed the 14MHz point on the receiver dial using the 1MHz marker, the 14.1, 14.2, 14.3, etc. points can be notched when the 100kHz marker is switched in.

Both sine and square wave outputs being available simultaneously means that injection into two instruments can be carried out at the same time. Both outputs, besides giving adequate output levels for the majority of test purposes, are also independently variable between zero and full output. It can therefore be seen that, besides being very useful in a number of fields, the instrument is also extremely versatile.

The actual frequency accuracy obtained will of course be dependent upon the accuracy of the crystals



The front panel of the 100kHz, 1MHz marker

COMPONENTS

Resistors
(All fixed values ½ watt 5%)

R1	100kΩ
R2	3.3kΩ
R3	100kΩ
R4	270kΩ
R5	3.3kΩ
R6	6.8kΩ
VR1	1kΩ potentiometer, linear, wirewound
VR2	1kΩ potentiometer, linear, wirewound

Capacitors

C1	100pF, trimmer
C2	250pF, silver-mica
C3	5,000pF, silver-mica
C4	1,000pF, silver-mica
C5	0.01μF, polyester
C6	100pF, silver-mica
C7	100pF, silver-mica
C8	1μF, plastic foil
C9	0.01μF, polyester

Semiconductors

TR1	OC44 (Mullard)
TR2	OC44 (Mullard)
TR3	BC107 (Mullard)
TR4	BC107 (Mullard)
D1	Silicon diode (e.g. OA200)

Switches

S1	s.p.d.t. toggle
S2	d.p.s.t. toggle

Crystals
Twin crystal 3-pin type (Henry's Radio Ltd.) or two separate crystals, 100kHz and 1MHz

Sockets
2 coaxial sockets
4 single sockets (for Belling-Lee 'OZ' plugs or similar)
1 UX5 valve base (for 3-pin crystal unit)

Battery
1 PP9 battery (Ever Ready)

Miscellaneous
2 pointer knobs
18-way tagboard, Cat. No. BTS12 (Home Radio)
Cabinet, 8 x 6 x 6in., type 'W' (H. L. Smith & Co. Co. Ltd.)
3 grommets
Aluminium for chassis, panel and battery clip
Wire, nuts, bolts, etc.

used. While the twin crystal used by the writer is advised, being simpler from the point of view of construction, two separate crystals may be employed if they are already to hand or more easily obtainable. A number of twin crystals were tried and their frequencies measured on a digital frequency counter. The highest order of error was in the region of 0.05% while the best approached 0.01%. The crystal used in the prototype described had errors of about −0.03% at both frequencies. The complete specification of the frequency marker is given in Table I.

TABLE 1

Specification

Sine wave output:	0-5 volts peak-to-peak at 100kHz and 1MHz.
Square wave output:	0-8 volts peak-to-peak at 100kHz and 1MHz; rise times 1μS and 0.1μS respectively.
Output impedance:	500Ω both outputs.
Supply:	Internal 9-volt battery; drain approx. 9mA.
Size:	8in. wide, 6in. wide, 6in. high.

CIRCUIT DESIGN

The function of the circuit, which is shown in Fig. 1, is quite simple. TR1 is connected as a Colpitts oscillator with emitter follower output, the crystals being selected by S1, and the d.c. bias on the base being provided by R1. R2 is the emitter load resistor, the output providing a low impedance output source. Feedback between emitter and base is achieved via the capacitor divider network C2 and C3, these being fed at their junction from the emitter output. The correct amount of positive feedback is obtained by adjustment of the trimmer C1 which is in parallel with C2. This is increased to allow just sufficient feedback so as to maintain oscillation. With the type of oscillator shown the crystal, which can be represented by a very high Q tuned circuit, is used in the parallel mode of resonance. The bias resistor is of sufficiently high value to prevent damping of the base circuit. Good quality capacitors of the silver-mica type should be used for C2 and C3 to help ensure good oscillator stability.

The output from the oscillator is taken via the blocking capacitor C4 to the emitter follower output stage TR2. This stage, which provides isolation between the oscillator and output, has a high input impedance which does not load oscillator TR1, and a low output impedance which is essential since the instrument may be used to drive a wide range of apparatus having an equally wide range of input impedances. R3 provides the necessary d.c. bias while VR1 is the emitter load. The potentiometer allows the output voltage to be varied between maximum and zero, C5 providing d.c. isolation to the output socket.

The sine wave output from TR2 emitter is also coupled via the isolating capacitor C6 to the input of the squaring circuit. D1 and the emitter-base diode of TR3 provide clipping, TR3 being connected as a high gain amplifier. The semi-clipped square wave at the base of TR3 is amplified, and the output developed across the collector load R5 is a good square wave. As the drive is quite large and TR3 has a high gain, this transistor is driven between its fully bottomed and cut-off conditions. This ensures a good square wave with a fast rise time. R4 provides bias and C7 gives h.f. compensation and helps prevent "droop".

The output from TR3 is d.c. coupled via limiting resistor R6 to the emitter follower output stage TR4. The use of d.c. coupling ensures a good square waveform being maintained. TR4 provides a low impedance output, this being developed across emitter load VR2 which allows full variation of the output signal. The desirability of a low impedance output source has already been discussed. D.C. isolation to the output socket is obtained with C8, this being of a sufficiently large value to maintain a good square wave even when driving into a low impedance input. The double beam oscillograms in the photographs

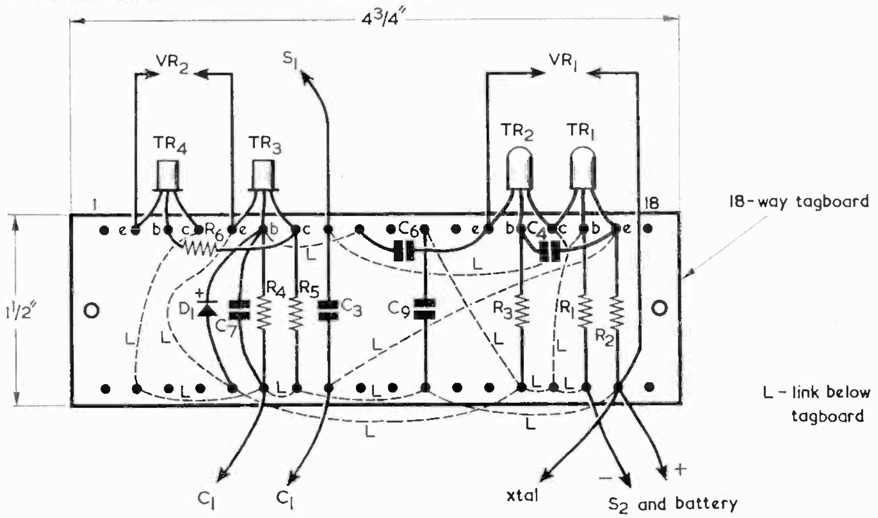


Fig. 2. Layout of components on the tagboard

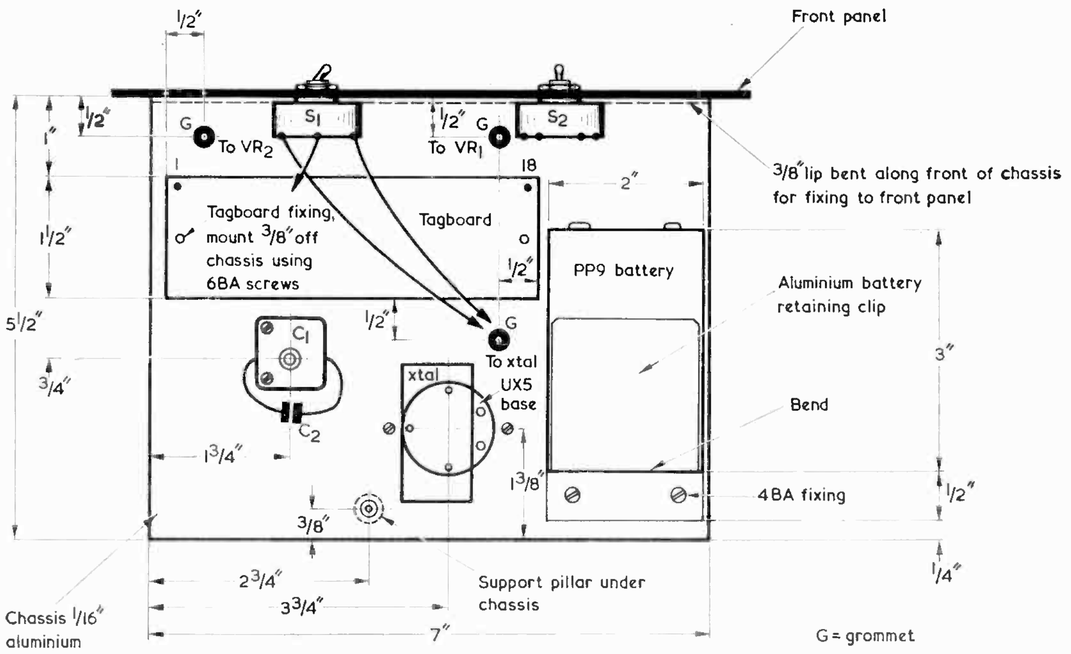


Fig. 3. Plan view of the chassis layout. Wiring from the tagboard is completed by following the circuit diagram. The retaining clip for the battery is home-constructed

show the simultaneous sine and square wave outputs at 100kHz and 1MHz respectively.

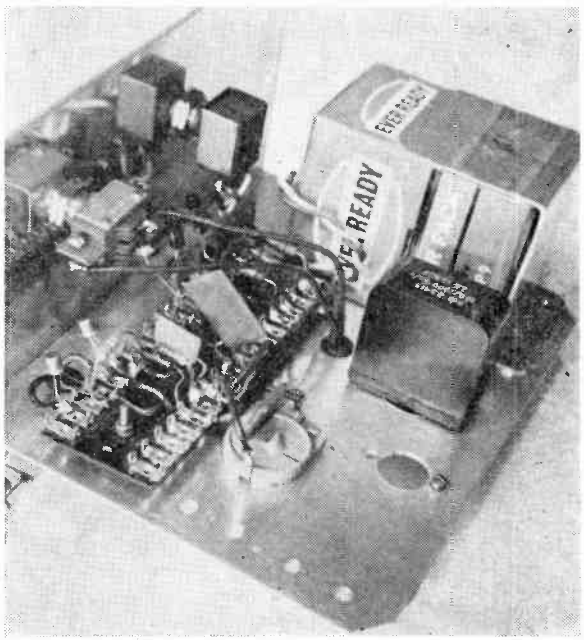
The instrument is fed from an internal 9-volt battery, this being decoupled through C9. The battery specified is of the large capacity type, this ensuring long life, particularly, as in the case of the writer, the instrument is in almost daily use. If only intermittent use is envisaged, a smaller battery of the PP3 type would be adequate as the drain is only in the region of 8.5mA.

It will be noticed that the transistors used in the oscillator section are germanium p.n.p. types while those in the squaring section are silicon n.p.n. It was found that to achieve suitable squaring with only one stage, such a high gain and wide bandwidth was required that only n.p.n. silicon types were suitable. These transistors were not ideal for use in the oscillator however, being very prone to self-oscillation at high frequencies. The p.n.p. type specified proved much more stable, having sufficient gain and adequate bandwidth for the function required. As, in the interests of economy and simplicity, the fewer stages required the better, the two types of transistor chosen provide the best compromise between the various parameters to be met. Both types are also cheap and easily obtainable.

Temperature changes, over the normal range which would be encountered in practice, provide no problem. The p.n.p. types which would normally be most susceptible to temperature change are working in a mode of operation which minimises such effects. The n.p.n. silicon types are virtually unaffected by normal changes in temperature, and, as they are not working under small signal conditions, any such changes can be ignored.

CONSTRUCTION

The construction of the unit is relatively simple and should offer no problems. The complete circuit,



Side view of the completed instrument, showing the neat and uncluttered chassis layout

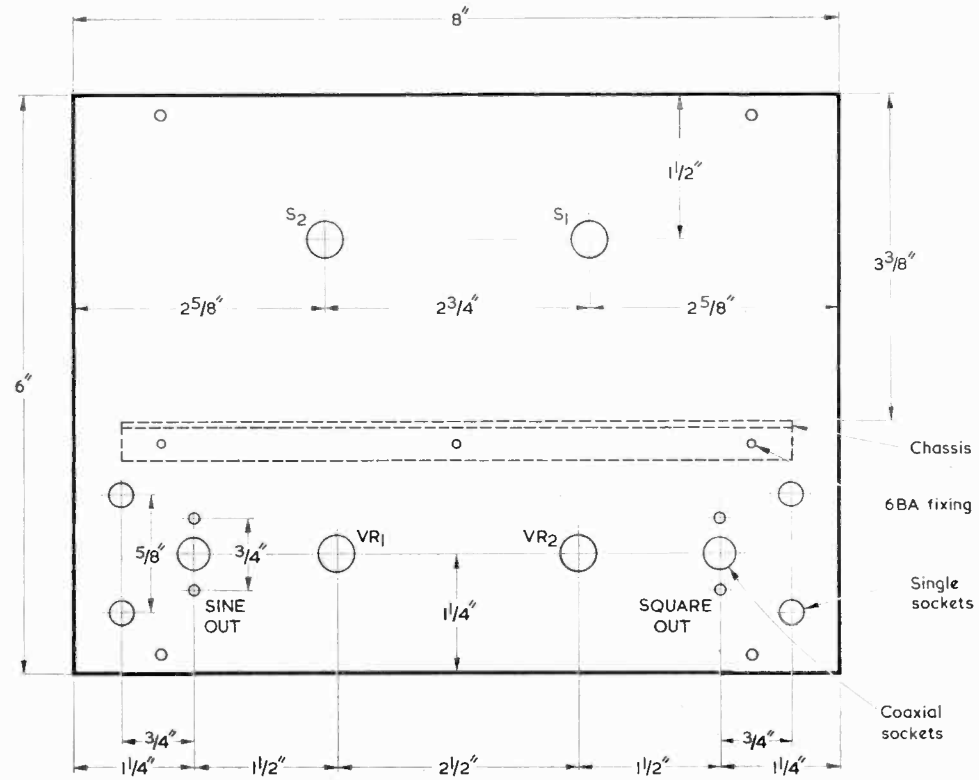
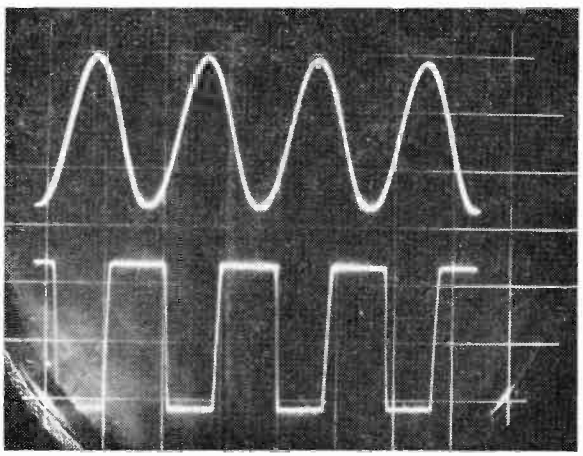


Fig. 4. Front panel dimensions and control layout

excluding output potentiometers and capacitors, crystal, trimming capacitor and C2 are wired on to an 18-way tagboard. This is wired up and then mounted on to the chassis after completion. Such a method makes for economy and simplicity of construction. The layout of the components on the tagboard is shown in Fig. 2 while the layout of the chassis and remaining components is shown in Fig. 3, together with relevant dimensions.



Simultaneous displays of sine and square wave outputs at 100kHz

The chassis is simply a small plate of aluminium with a $\frac{3}{8}$in. lip bent along the front edge. This is drilled for 6BA fixing to the front panel. A small pillar or leg, $2\frac{1}{4}$in. long, is screwed into the lower rear of the chassis so as to rest on the bottom of the case. While the cabinet used by the writer is specified, any cabinet or case of similar size may be used.

The front panel layout, again with necessary dimensions, is shown in Fig. 4. The front panel should be drilled and the components mounted before the chassis is screwed into place. The outputs in the prototype were brought out to both co-axial and single sockets. The chassis and front panel arrangements are also shown in the accompanying photographs.

If a 3-pin double crystal is used it will be found that this fits a U.S. 5-pin valve base (UX5). A ceramic type is to be preferred. The pin connections of the crystal are shown in Fig. 1. If two separate crystals are used (normally 2-pin with $\frac{1}{2}$in. or $\frac{3}{4}$in. spacing) they should be mounted in the appropriate holders.

SETTING UP

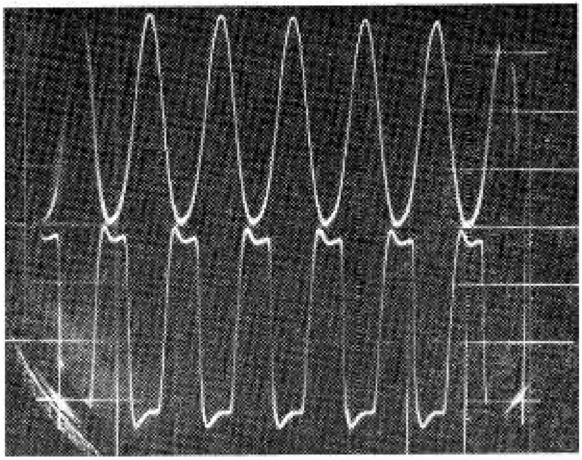
With the construction complete carefully check all wiring and components before connecting the battery and inserting the crystal. The simplest way to set up the unit is to connect an oscilloscope to the sine wave output and adjust C1 until the circuit goes into oscillation. This must be done with the 100kHz. crystal switched in. It will be found that if the

TABLE II

Voltage, Current and Frequency Measurements

All voltages measured on 20Ω per volt instrument on 10 volt range with respect to common positive.

Supply Volts	9.3		
TR1 emitter	4.7		
TR2 emitter	5.4		
TR3 base	8.9		
TR3 collector	4.4		
TR4 base	4.5		
TR4 emitter	4.9		
Current drain (total)	8.5mA		
Frequencies measured	100kHz	99970Hz	Error – 0.036%
	1MHz	999641Hz	Error – 0.03%



The sine and square wave outputs given at 1MHz

capacitance of C1 is increased too much the waveform will begin to clip. The correct adjustment is to have just sufficient capacitance in circuit to maintain oscillation while at the same time obtaining a good sine wave output. Check that VR1 adjusts the waveform amplitude from zero to maximum.

Now connect the oscilloscope to the square wave output and check that the correct waveform is obtained. VR2 should allow this to be adjusted from zero to maximum. If a double beam oscilloscope is available both waveforms can be checked simultaneously. The square wave should have a mark-space ratio of approximately 1:1, this being slightly dependent upon the gain of TR3. If a very accurate 1:1 ratio is required, or if a mark-space ratio of other than 1:1 is wanted, e.g. 3:1, 5:1, etc., these can be obtained by a slight adjustment of R5. The 1MHz crystal is now switched in and the waveforms checked at both outputs. No adjustment is required in the 1MHz position.

The true crystal frequency can only be accurately checked on a digital frequency counter as even an error of 0.05% (the worst error measured by the writer) is still much better than the accuracy of any c.r.o. time base, signal generator, receiver or grid dip meter. Some comparison may be made if a communications receiver having an internal crystal marker of known accuracy is available.

Should oscillation fail to occur at one or both frequencies, the crystal may be suspected (assuming the circuit and components are correct). A number of crystals were tried during tests, and on the two occasions when the circuit failed to oscillate a faulty crystal was found in each case. As the crystals used are "gov. surplus" (new ones being extremely expensive) and as they are somewhat fragile, the occasional failure is not surprising.

If an oscilloscope is not available the marker unit can be set up using a receiver with b.f.o. which covers 1MHz (300 metres). Switch to the 1MHz crystal, turn C1 to maximum capacitance and loosely couple the sine wave output to the receiver aerial, VR1 being turned to give maximum output. The receiver is switched on and allowed to warm up and the b.f.o. switched in, the r.f. gain being turned near maximum. The receiver is tuned about the 1MHz mark on the dial until the marker whistle is heard, the output is then reduced until it is just audible; this prevents overloading the receiver. The receiver is then carefully tuned until the zero beat is obtained. Having found the 1MHz point and shown the marker unit to be functioning, the 100kHz crystal is switched in and the receiver tuned to 1.1MHz (273 metres). The output may have to be increased to obtain the beat note, as the receiver is now working on a tenth harmonic and not a fundamental. When the beat note is obtained the trimmer C1 should be reduced until the marker stops oscillating (no beat) and then slowly increased again until the marker begins to oscillate (beat note returns). This completes the setting up procedure.

Once the setting up is complete, no further adjustment should be necessary. In the event of some problem occuring or for any future maintenance a table of voltages throughout the circuit is given in Table 2. Long trouble-free service can be expected and the instrument, being self-contained and portable, should prove invaluable as a good frequency reference in all aspects of amateur, servicing and experimental work. ■

MARTIN AUDIOKITS

It is announced that after a period of re-organisation, these very popular constructional units for building a high fidelity amplifier and FM tuner systems are again in production.

Martin Audiokits were probably the very first to exploit the advantages of using transistorised modular units for the constructor to assemble and they quickly gained a reputation for reliability, good performance and value.

The range is now to be extended and updated, but owners of existing equipment will still be able to add any new items to what they already have. Full servicing facilities are available and enquiries should be addressed to Martin Audiokits, 154 High Street, Brentford, Middlesex (Telephone 01-560 1161), which is now a division of Louis and Lewis (Electronics) Ltd., The Boat House, 15 Thames Street, Hampton, Middx.

ULTRA-SIMPLE TREMOLO UNIT

by

D. W. NELSON

Using very simple circuit techniques, this economic design is capable of providing tremolo modulation of an electric musical instrument which is controllable both in depth and speed

THE SORT OF CIRCUITS NORMALLY ENCOUNTERED for home built tremolo or vibrato units usually employ from four to six transistors and a host of other components and hardware. Although these designs are satisfactory, by the time the experimenter purchases all the parts and assembles the device he has probably spent more than a shop-bought unit! The ultra simple tremolo unit described here employs only two readily available transistors and the actual circuit may be constructed in one evening quite easily. The unit may be used with a guitar or other musical instruments and produces a very pleasant sound modulation effect of variable speed and depth, greatly enhancing listening pleasure. Size and cost of the complete device has been kept to a minimum and in fact many of the components will probably be at hand in the experimenter's workshop. The whole unit has been housed in a 6 by 4 by 1½in aluminium box and powered by two 15 volt Ever Ready batteries in parallel. Although printed circuit construction has been employed, it is quite satisfactory to use ordinary tagboard or Veroboard with equal results, and of course the actual mode of construction is left to the hobbyist's discretion.

THE CIRCUIT

The circuit, shown in Fig. 1, consists basically of a low frequency resistance – capacitance oscillator, TR1, followed by a signal modulating transistor, TR2. It may seem at first sight that a transistor RC oscillator would require a high gain transistor to overcome the usual feedback losses at the oscillating frequency and indeed this would normally be true if the resistor-capacitor feedback network was constructed in the usual way. If, however, a tapered feedback network is employed, as in the oscillator circuit shown, one can obtain a better impedance match between collector and base of TR1 and in this way reduce attenuation losses. By tapering the resistor feedback network, one then has simply to increase the capacitor values to restore the originally intended operating frequency. The frequency of operation is determined by VR1 and may be adjusted from about 3 to 20Hz. Resistor R2 simply prevents oscillator cut-off when VR1 is turned through its maximum rotation.

Cover Feature

Transistor TR2 and resistors R7 and R1 act as a voltage divider with TR2 acting as a variable impedance. This is possible due to transistors being non-linear devices. With no oscillator signal applied to the base of TR2 the pick-up signal from the guitar or other electric instrument (typically 0.5 volt peak-to-peak) is divided between resistors R7 and R1. Application of the oscillator signal to the base of TR2 via C4 and VR2 when footswitch S1 is closed turns TR2 off or on depending on whether the oscillator signal is positive or negative. By controlling the magnitude of the base signal to TR2 with the depth potentiometer, VR2, the amount by which TR2 is turned on may be adjusted and hence its impedance. In this way the percentage modulation of the applied signal may be altered.

As the circuit is drawn, transistor TR2 and resistors R7 and R1 form a shunt across input and output signals; for example 50% modulation results in about 50% loss of the input signal. However, since most guitar amplifiers are easily able to accommodate such a loss, this mode of operation is normally satisfactory. The oscillator only is switched in or out of circuit by means of the s.p.s.t. microswitch foot pedal. If this loss of signal cannot be tolerated, however, the oscillator circuit and TR2 may be switched in and out of circuit with a d.p.s.t. footswitch, as shown in Fig. 2. The d.p.s.t. footswitch used would be a microswitch type, and would break both the oscillator and modulator circuits. If a shop-bought unit cannot be found a suitable switch may be home-made from two 'ganged microswitches'. It is impor-

Cut along this line

ULTRA-SIMPLE TREMOLO UNIT

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

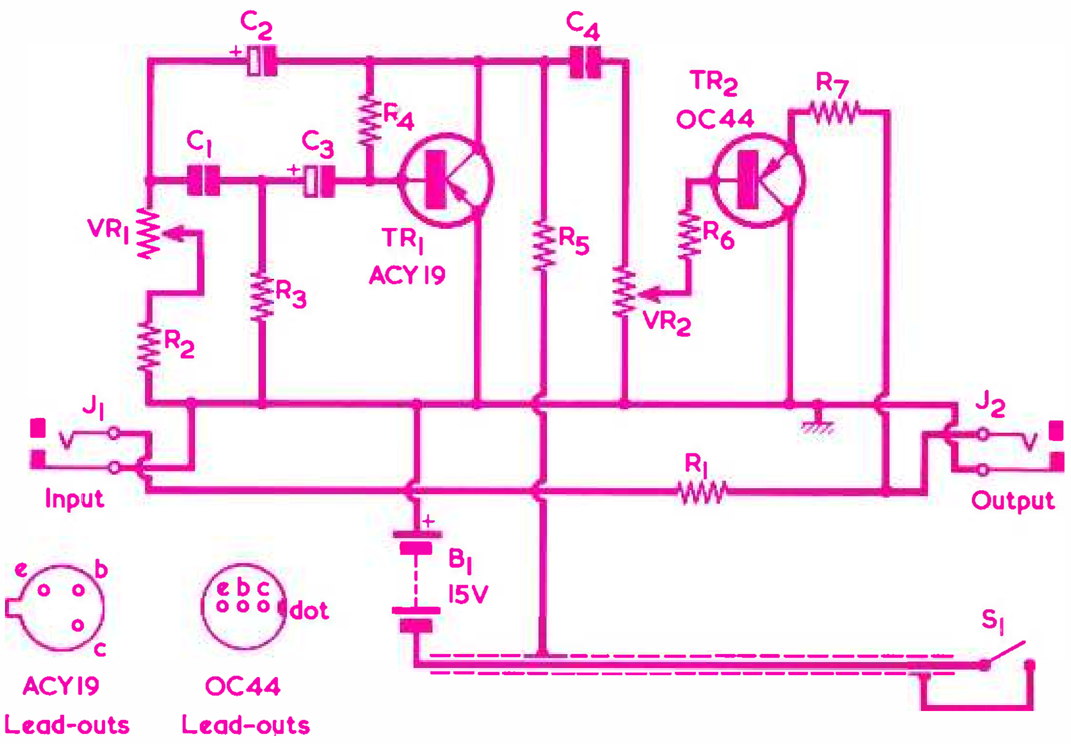


Fig.1 The circuit of the tremolo unit. S_1 is a footswitch.

COMPONENTS

RESISTORS

(All fixed values 1/4 watt 10%)

R_1 - 100kΩ
R_2 - 180Ω
R_3 - 3·3kΩ
R_4 - 680kΩ
R_5 - 33kΩ
R_6 - 470kΩ
R_7 - 39kΩ
VR_1 - 5kΩ potentiometer, wirewound
VR_2 - 500kΩ potentiometer, wirewound

CAPACITORS

C_1 - 1μF (see text)
C_2 - 0·64μF electrolytic, 64V wkg. miniature (Mullard)
C_3 - 5μF electrolytic, 15V wkg.
C_4 - 0·047μF, 250V wkg. miniature foil (Mullard)

TRANSISTORS

TR_1 - ACY19
TR_2 - OC44

SOCKETS

J_1, J_2 - jack sockets (Igranic)

BATTERY

B_1 - Two batteries type B121 (Ever Ready) in parallel (see text)

SWITCH

S_1 - s.p.s.t. footswitch

MISCELLANEOUS

2 knobs
Printed circuit board
4 - 1/2in. 6BA insulated spacers
Flexible screened wire
1 - 3/8in. grommet
Material for case and base (as required)

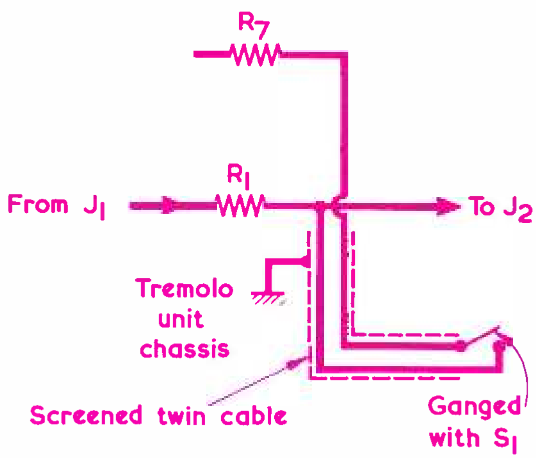


Fig. 2 A possible modification to reduce attenuation when the tremolo effect is not wanted

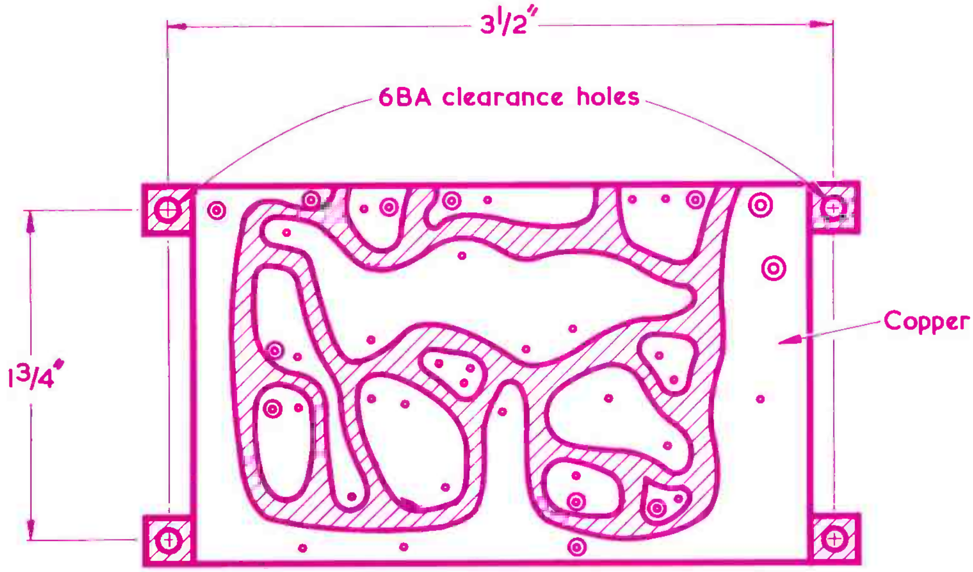


Fig. 3. The copper side of the printed circuit board.
This is reproduced full size and may be traced.

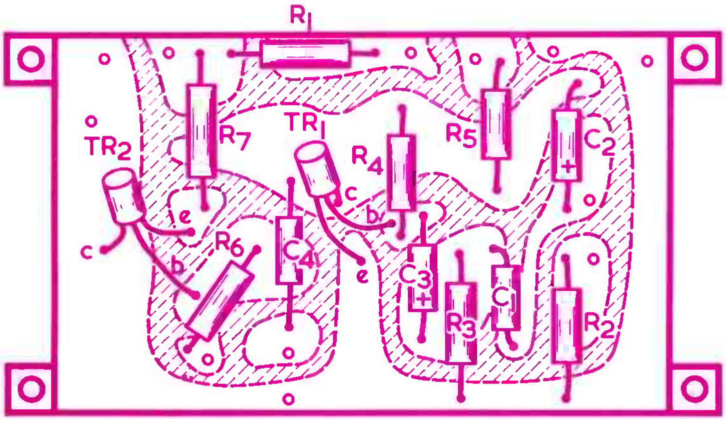


Fig. 4. The component side of the printed circuit board.

tant, with the circuit of Fig. 2, to employ screened cable for the switch connections to eliminate any chance of pick-up or transient 'clicks' through the amplifier when turning the unit on and off.

Returning to Fig. 1. it will be seen that C1 is non-electrolytic and has the high value of 1μF. The writer employed a miniature 'surplus' capacitor here but this is not available through normal mail-order channels. A Mullard miniature foil 250 volt flat capacitor, which measures 30 by 16.5mm. thick, can be employed if nothing else can be obtained, its leads being bent inwards to fit the printed circuit board holes.

The author's unit employs two Ever Ready 15 volt batteries type B121 connected in parallel. However, it is quite in order to use one battery as the current drawn by the unit is only about 0.2mA, and the battery would still have a very long life. If two batteries are used they should be purchased new and connected into circuit at the same time. Do not connect a new battery in parallel with a partly discharged battery.

Fig. 3 shows the printed circuit board design actual size, the shaded sections representing the bare plastic. Any one of the various techniques for preparing the board may be used after tracing the pattern from the sketch. After the copper has been etched away, the holes are drilled using a 1mm. drill. The holes which are circled in the pattern are drilled slightly oversize to take copper tagboard pins for external connections. The component layout is seen in Fig. 4.

Care should be taken when soldering in components and a heat shunt is advisable for transistors to avoid excessive heat dissipation which could easily destroy them.

FINAL ASSEMBLY

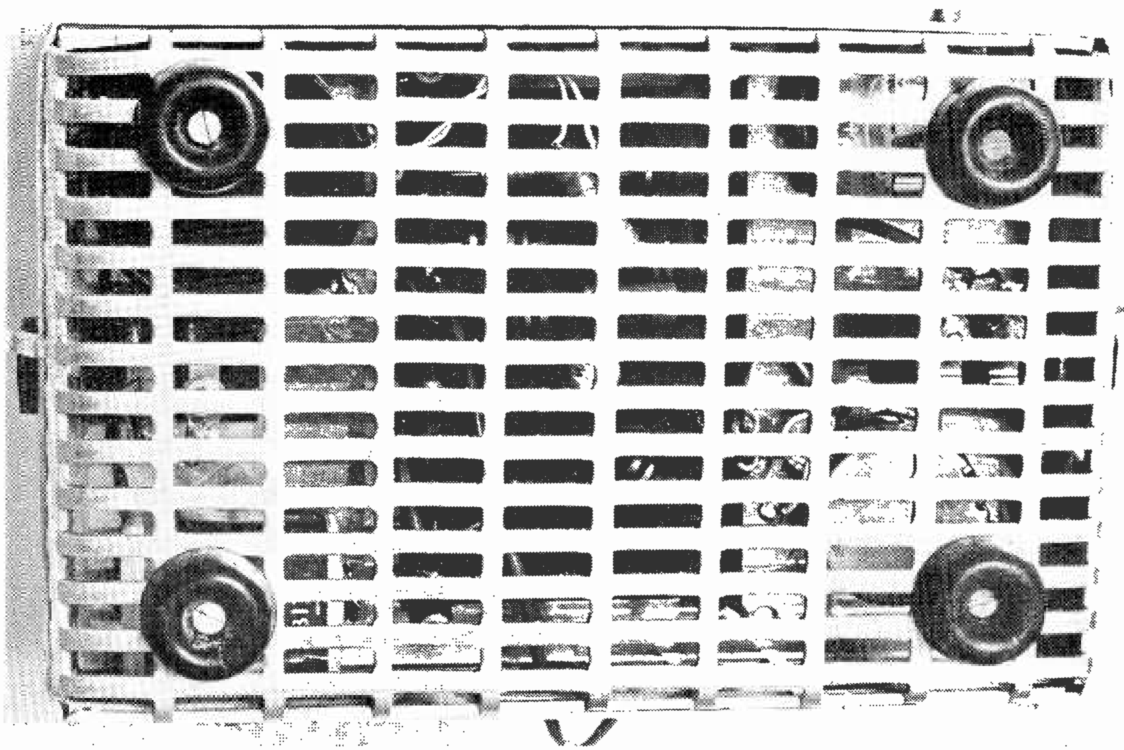
The box used to house the circuit was an aluminium tray having the same form as a conventional chassis and measuring 6 by 4 by $1\frac{1}{4}$in. Details for the drilling of this box are seen in Fig. 5.

Having drilled the container the jack sockets may be fitted and the two 15 volt batteries located in place, using two clamps made out of tinplate and bolted to the chassis side with 6BA bolts. If the batteries are metal-clad types, insulate them from the clamps and chassis by a length of thin polythene or PVC sheet. To locate the circuit board it is necessary to use four $\frac{1}{2}$in 6BA insulated spacers to lift the copper laminate off the aluminium tray surface.

The final underside layout is shown in Fig. 6. Thin screened wire is used for the footswitch and jack socket connections to the printed circuit, and twisted flexible PVC covered wire for the other connections. Note the solder tag under one of the securing nuts for the printed circuit board. This provides a connection to the metal case of the unit.

In the author's unit the case was finished off by fitting a 6 by 4in 16 s.w.g. anodised aluminium plate to the top side of the container. If desired, two potentiometer vernier scales can be added to aid in setting the speed and depth of tremolo action. A

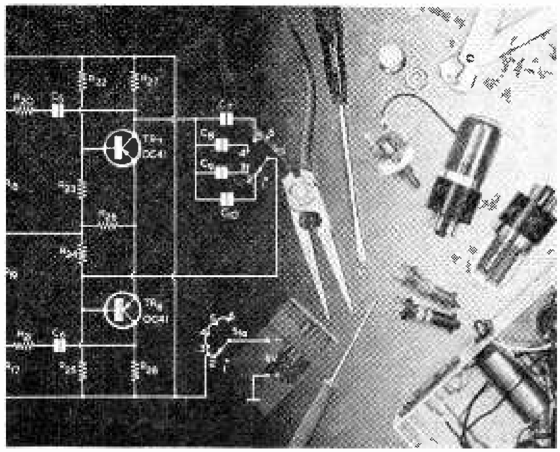
(Continued on page 178)



The writer's unit is fitted with a base piece made of perforated aluminium, to which are affixed four rubber feet

simple transistor checker

by G. A. FRENCH

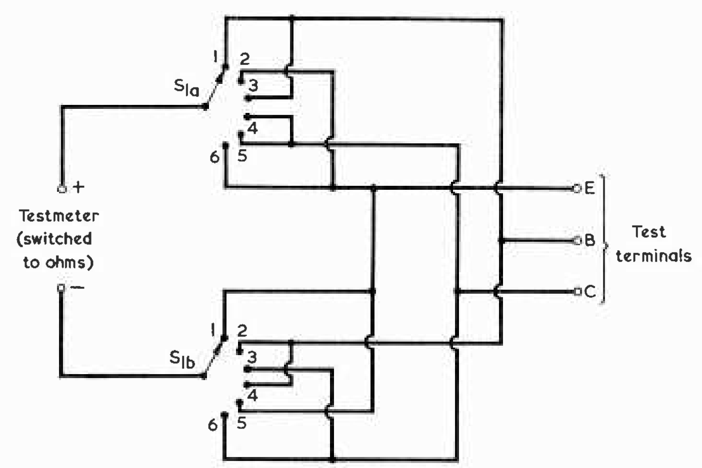


FROM TIME TO TIME IT IS necessary to carry out quick checks on the serviceability or otherwise of one or more transistors. When checks of this nature are not required frequently, they do not really merit the construction of a special transistor tester capable of measuring the main transistor characteristics. A more elementary method of testing is, then, usually employed instead.

A simple type of transistor test consists of measuring, with the aid of a testmeter switched to an ohms range, the forward and reverse resistance in the two junctions of the transistor under examination. Such a test is usually adequate for most requirements, particularly in the servicing field, and it enables transistors with short-circuit or open-circuit junctions to be reliably identified. Despite its simplicity, this type of check can still, unfortunately, be rather fiddling to carry out. The test clips of the testmeter have to be fitted to the transistor lead-outs to provide the successive modes of connection required, and it can be difficult to maintain an eye on the meter needle whilst simultaneously keeping the clips in position without their short-circuiting together.

SWITCHING CIRCUIT

The test device which forms the subject of this month's "Suggested Circuit" enables forward and reverse resistance tests to be carried out very quickly, and with the minimum of trouble. It also allows the leakage resistance between emitter and collector of the transistor being checked to be measured for both directions of current flow. All that are required for the device are a 2-pole 6-way rotary switch, three terminals for the transistor under test, two terminals to which the testmeter leads connect, and a suitable small insulated case.



Circuit of the transistor checker. In conjunction with a standard testmeter this allows quick measurements to be made of forward and reverse resistance in the transistor junctions, and of leakage resistance between emitter and collector

The circuit appears in the accompanying diagram. Here, S1(a) and (b) are ganged and form the 2-pole 6-way rotary switch. The testmeter, switched to a suitable ohms range, connects to the two terminals at the left with the polarity indicated, whilst the transistor under test connects to the three terminals at the right. The test procedure then consists of turning the switch from position 1 through the intermediate positions to position 6, noting the meter reading which is given at each position. As will be gathered, such a test can be carried out very quickly, and it allows the operator to give his full attention to the readings given by the meter. A further advantage is that this mode of checking is useful for batch testing of large quantities of "surplus" transistors.

On position 1 of the switch the positive testmeter terminal connects to the base of the transistor under test, whilst the negative testmeter terminal connects to the emitter. Assuming that the transistor is a serviceable p.n.p. type, the meter should then give a low resistance reading. On position 2 the testmeter positive terminal connects to emitter and the testmeter negative terminal to base, whereupon (again assuming a p.n.p. transistor) the testmeter should indicate a high resistance. Position 3 connects testmeter positive to base, and testmeter negative to collector, these connections being transposed on position 4. With a good p.n.p. transistor the consequent resistance readings should, once more, be low and high respectively. On position 5 the testmeter positive connects to collector and the testmeter negative to emitter, whilst on position 6 these connections are reversed. The testmeter should give a high resistance reading for both positions, since it is then reading leakage resistance.

Thus, when the transistor under test is a p.n.p. component, turning the switch from position 1 to position 6 should, for a good transistor, give meter readings that follow the sequence: low, high, low, high, high, high. If the transistor under test is n.p.n., the sequence for a good transistor is: high, low, high, low, high, high. A faulty transistor will be indicated if the appropriate sequence is not obtained.

THE TESTMETER

If the testmeter is of conventional design its internal switching circuits will be such that, on ohms ranges, its nominally positive test lead actually carries a negative voltage whilst its nominally negative test lead actually carries a positive voltage. This point is taken up in the description of operation just given and explains, for instance, why a low forward resistance is given on position 1 of the switch, where the nominally positive testmeter lead is applied to the base of a p.n.p. transistor. In normal circuit use, of course, the base of a p.n.p. transistor would be biased negative of its emitter to allow forward current to flow. Should the testmeter incorporate less usual internal circuitry, with the result that its nominally positive test lead does carry the positive voltage, then the indications offered by p.n.p. and n.p.n. transistors on switch positions 1 to 4 inclusive will be reversed. This point can easily be checked out in practice.

To keep reverse voltages applied to the transistor junctions to a low level, the energising battery in the testmeter should not offer a voltage higher than 1.5 volts. Also, maximum short-circuit current between the testmeter leads should be less than 1mA. This last point can be checked by applying the leads to another current-reading meter. Nearly all standard testmeters having sensitivities of 10,000 ohms per volt or better should be able to meet these two requirements.

The forward, reverse and leakage resistance readings given by different transistors will vary according to type. Lowest reverse and leakage resistance readings will occur with germanium power transistors, and it may be necessary to gain experience with a few serviceable transistors of this type to determine typical performance here. The resistance range switched in on the testmeter itself will also have an effect on the readings obtained. The writer checked results with a typical meter, this being a Taylor Model 127A switched to an ohms range which gives 2kΩ centre-scale, and found that the testmeter provided more than adequate disparity between indications for forward and reverse or leakage resistances with all normally encountered transistors.

THE SWITCH

Switch S1(a)(b) may be any 2-pole 6-way rotary type. It would, perhaps be slightly preferable to use a switch with break-before-make contacts rather than one with make-before-break contacts, since the latter type can cause the meter needle to be momentarily deflected towards the zero ohms end of the scale when switching from one position to the next. This point is only of minor importance, and the effect does not otherwise detract from the functioning of the circuit. It would be absent in a switch having break-before-make contacts.

To avoid errors in wiring, the switch contacts could be wired up before mounting this component in the case for the unit. Thus, S1(a) could have tags 1 and 3 joined together, with a fly-lead from tag 1 for the base terminal; tags 2 and 6 joined together, with a fly-lead from tag 6 for the emitter terminal; and tags 4 and 5 joined together, with a fly-lead from tag 5 for the collector terminal. Section S1(b) could, following the circuit diagram, be similarly wired up. After mounting the switch, the two sets of three fly-leads could then be connected together at the three transistor terminals. ■

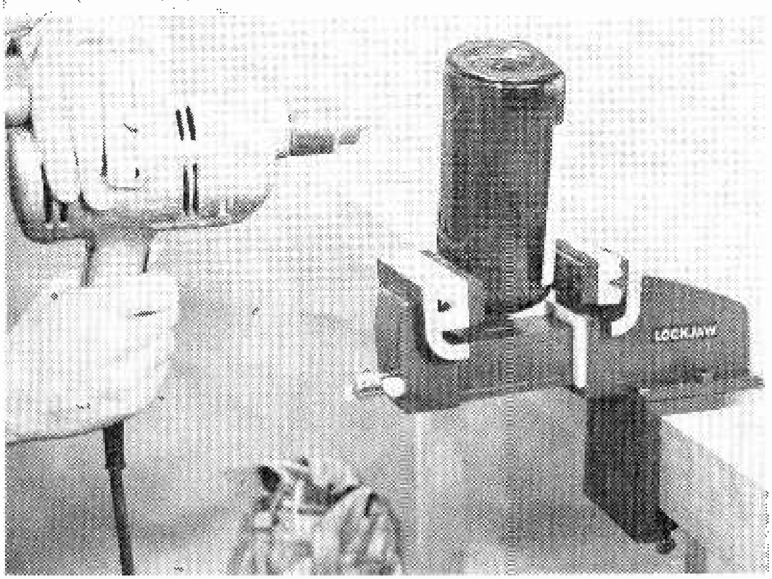
LIGHTWEIGHT X-BAND TRAVELLING WAVE TUBE

The M-O Valve Company Limited recently introduced a low-cost lightweight rugged X-band travelling wave amplifier, type TWX34, giving a minimum gain of 35dB and a saturated power output of 1 watt over the frequency range 7.5 to 11.0 GHz.

A typical application is in the ground station of a transportable satellite communications system where continuous operation in ambient temperatures of up to 60°C and ability to withstand shock, vibration and high humidity conditions are required.

NEWS . . . AND .

"WELL HELD"



Well you *can* hold a bottle in a vice, using the "Lockjaw", which has grooved jawgrips and a 'rocker' mechanism for self-adjustment of angle. One of the jawgrips is faced in rubber, the other is silicon metal. They are easily interchanged.

The bottle is being drilled with a masonry drill, first step in making a bottle table-lamp. Another method is to hold it horizontally and drill in a small pool of water or oil, to keep the drill cool.

Makers of the Lockjaw vice are the Vice & Workholding Co. Ltd., 149a Crayford Road, Crayford, Kent.

GOLDEN JUBILEE EXHIBITION

As part of their Golden Jubilee celebrations. Mullard Ltd. are to stage a three-week public exhibition in the Electronics Centre of their London headquarters. Mullard House, Torrington Place. London, WC1E 7HD. It is believed to be the first exhibition of its kind ever mounted.

With the title *Electronic Jubilee – An Exhibition of Electronic Ideas and Development*, the exhibition will trace the history of electronics – linked with the company's own history as pioneers in the field – over the past 50 years.

The exhibition opens on October 5th, and will run until October 24th, opening every day (except Sundays) between 1000 and 1800 (2100 on Thursdays). Admission will be free.

The main window of the Electronics Centre will contain examples of vintage electronic equipment, contrasted with their modern counterparts and supported by displays of Mullard components used in their manufacture.

Within the Centre one of the principal attractions will be a radio transmitter built and operated by Mullard radio amateurs. Some of the Company's earliest valves will be used in its construction.

In the Mullard House Theatre there will be continuous showings of the latest Mullard films.

DATES FOR NEXT IEA

The 1971 International Instruments, Electronics and Automation Exhibition will be at Olympia, London, from Monday, May 8th to Friday, May 12th. There will be no Saturday opening, the IEA Committee has decided.

Late nights, when the exhibition will remain open until 2000 hours, will be Wednesday and Thursday.

Chairman of the exhibition is Mr. P. J. P. Middleton, representing the Radio and Electronic Component Manufacturers' Federation, one of the IEA sponsoring bodies.

Mr. Middleton is sales director of Painton & Company Ltd., with whom he has been associated for 20 years. He is chairman of the RECMF Connector Group.

Mr. Middleton is also chairman of the International London Electronic Component Show, sponsored by the RECMF, to be held at Olympia from May 18th to 21st, 1971.

AUDIO CHAIR

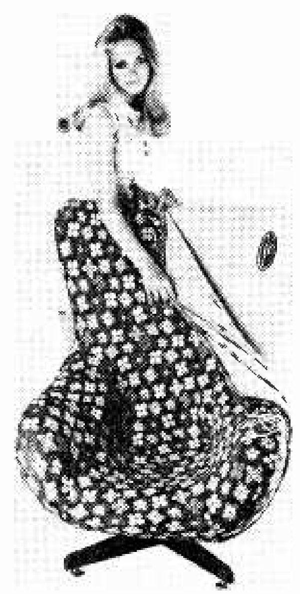
Lee Products (Great Britain) Ltd. of Clifton Street, E.C.2, have just introduced a new product to their wide range of audio equipment – the Elizabethan Audio Chair.

This is apparently an ordinary, extremely comfortable winged armchair (made by Englander), but there is a difference. Inserted into the wings are two concealed speakers, enabling the occupant to listen in comfort and privacy to stereo music or language courses, etc.

The nylon covers, which zip off for easy washing, are available in a choice of four plain colours – turquoise, tan, gold or avocado green, as well as two floral patterns in blues or browns.

Two or even three chairs can be connected to any stereo unit.

Recommended retail price of Audio Chair: £52.



. . . COMMENT

BATTERY TO LAST 30 YEARS ?

An American industrial research organisation has developed a lead-acid battery designed to last at least 30 years – which also improves in performance during most of its life span. This double-life battery has been produced by Bell Telephone Laboratories for use by the Bell System telephone companies in stand-by power applications.

Key elements of the unit are a cylindrical design, providing a more rigid structure than the familiar rectangular shape; and circular grids made of pure lead which are less subject to the corrosion that degrades batteries made with lead alloys of calcium or antimony.

In most batteries, the grids are rectangular lattice-like frames standing side-by-side. The grids are smeared with a paste of lead dioxide and floated in a sulphuric acid bath, through which an electric current flows from the positive to the negative poles. The batteries deteriorate gradually as corrosion widens the grid lattice work, separating it from the lead dioxide paste and thus breaking the contact.

The new grids consist of a series of concentric rings connected by radial spokes. Even when these corrode, the distance between the rings remains constant and they do not separate from the energy-producing paste.

Since corrosion has the effect of increasing the amount of lead dioxide paste, the battery's capacity becomes somewhat greater with age—until it eventually wears out.

B.A.T.C. – 21 YEARS OF AGE

We congratulate the British Amateur Television Club on having attained 21 years of age.

We set out one or two interesting snippets taken from the abbreviated history circulated in connection with the conference celebrating their 21st Birthday.

In 1949 Michael Barlow, G3CVO, wrote letters to various magazines and thereby contacted people interested in amateur TV. A circular "Newsletter" was followed by *CQ–TV*, a duplicated magazine with an initial circulation of 25 copies. The Club now has more than 1,000 members.

1950 saw the start of public demonstrations of amateur TV, these proving very popular as TV cameras were rarely seen by the general public.

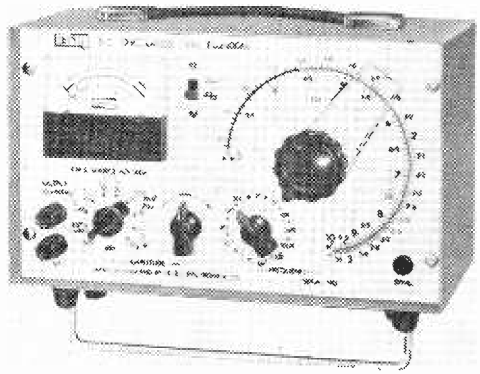
During this period the Cambridge Group built "Matilda", a completely mobile TV station, housed in a London taxi: it must be remembered that valves had to be used, as transistors were not then available.

Good luck to the B.A.T.C. as it looks forward to its Silver Jubilee in 1974.

WORKSHOP EQUIPMENT OFFER

We are very pleased to be able to repeat our great exclusive workshop equipment offer first made in our March and April issues. Details and order form appear on page 155.

LEVELL TG200 SERIES OF R.C. OSCILLATORS



These oscillators cover 1Hz to 1MHz in 12 ranges with versions available that generate sine and square waves or only sine waves. Output is variable from $200\mu V$ to 7V r.m.s. by a variable control and switched attenuator with 10dB steps up to 70dB. An output meter is fitted on some versions. The circuit uses a new technique with a single track linear potentiometer giving frequency control with absence of amplitude bounce which is characteristic of Wien bridge circuits with dual track controls. A sync. socket gives a constant output to lock an oscilloscope and the oscillator can be locked to signals fed into this socket.

Manufactured by Levell Electronics Ltd., Park Road, High Barnet, Hertfordshire.

"Bert! Got a bloke out here interested in micro-electronics!"

Modifications to the 'Trio' 9R-59DE Communications Receiver

by

C. M. LINDARS

A deservedly popular communications receiver amongst amateur operators is the imported 'Trio' model 9R-59DE, which provides continual coverage from 550kHz to 30MHz. The manufacturers of this receiver make provision for possible changes and additions by the owner, and this article describes a series of modifications which can improve an already acceptable receiver performance

Being in need of a general coverage receiver the writer purchased a 'Trio' Model 9R-59DE. The specification appeared to be what was desired and the price was right. Experience during operation confirmed that this choice was a good one, the receiver being both sensitive and selective. The workmanship is of a very high standard. For about twelve months the temptation to carry out modifications was resisted, but there was some distortion when the receiver was used for broadcast stations and also a fairly high level of hum. It was decided to tackle the distortion and hum problems in the first instance; and then, having done this, to see what other modifications could be carried out with a view to improving an already good performance.

POWER SUPPLY SECTION

On examination of the circuit it was noted that resistance-capacitance smoothing was used in the main h.t. line. (See Fig. 1.) In addition to being a cause of hum, the 2.2kΩ smoothing resistor also gave rise to a fairly large change in h.t. rail voltage on operation of the r.f. gain control. It was therefore proposed to substitute an l.f. smoothing choke in place of the 2.2kΩ resistor. The choke chosen was 10H 90mA. There was room for this to be mounted on the side of the chassis, underneath and close to the existing smoothing components. This necessitated drilling two small holes in the chassis to receive the 4BA fixing bolts. The choke was then wired into circuit in place of the main 2.2kΩ smoothing resistor and the anode of the output valve taken to the further side of the choke.

The output valve, a 6AQ5, seemed rather large for the amount of power necessary in a set of this type and after examination of valve tables it was decided to use an EL95 as a substitute; there being no need to alter the wiring to the valveholder. This valve takes a smaller heater current and the bias resistor installed in the receiver is of the correct value. The output transformer matching (7kΩ) is a little on the low side for the EL95 which requires 10kΩ. However, this was not considered to be serious and in practice the new valve proved to be satisfactory. When measurements of gain were taken on the audio side, it was found that with the EL95 fitted there was a

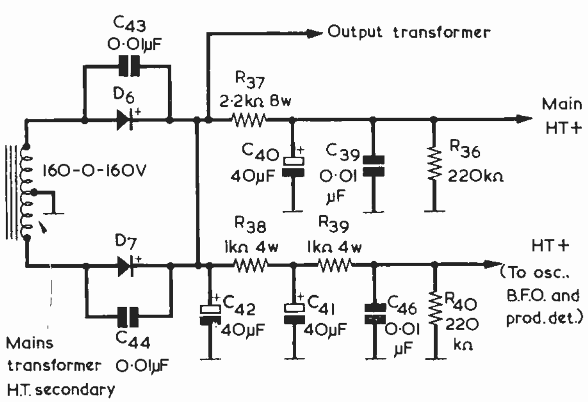


Fig. 1. The existing power supply circuit

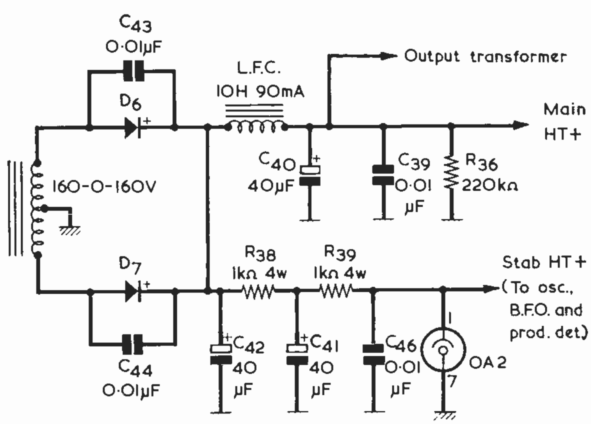


Fig. 2. The power supply circuit after modification

voltage gain of 5.5dB over the original 6AQ5. The distortion had now been removed and the hum reduced to a satisfactory level. The reason for the distortion was that with the r.f. gain control at maximum, the screen-grid of the output valve had only 150 volts. When the r.f. gain control was turned towards minimum, the level of distortion decreased as the voltage on the screen-grid of the output valve increased to 200 volts. The regulation of the power supply now being considerably improved, it was felt that it would be worthwhile to add a stabiliser valve to the supply for the oscillator, b.f.o. and product detector. The addition of such a valve is described in the manual for the receiver and a valveholder is provided, already wired up, for its use. All that is necessary, then, is to insert the valve, this being an OA2. Fig. 1 shows the original smoothing circuit and Fig. 2 the circuit after the foregoing modifications have been carried out. (Fig. 2 also shows R40 deleted, this point being dealt with later in this article.)

SCREEN-GRID RESISTORS

It was next decided to use screen-grid resistors for the r.f. and both i.f. valves; these being the more necessary in view of the higher voltage available. Accordingly 33kΩ resistors of $\frac{1}{2}$ watt rating were installed on the printed circuit board for the i.f. valves and between the coil unit and the r.f. valve. In the case of the i.f. valves this required the cutting of the printed circuit and the provision of additional 0.01μF capacitors. The r.f. valve already has this capacitor wired to the valveholder. Fig. 3 should be referred to in order to see how the printed circuit

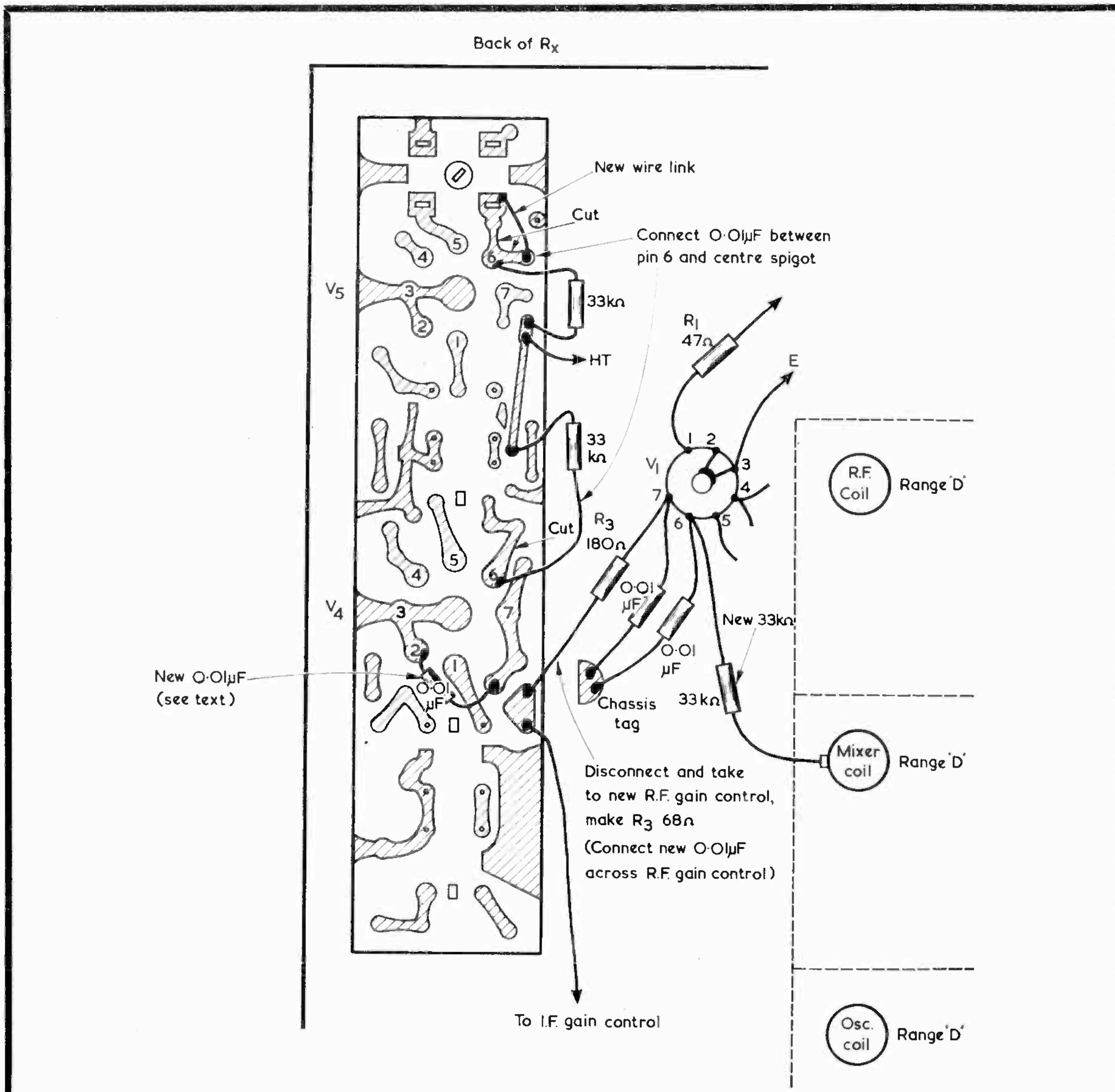


Fig. 3. Adding screen-grid dropper resistors and an r.f. gain control

pattern was cut and amended.

Having made this alteration it was noted that there was a trace of instability at the first i.f. valve. This was cleared by wiring an additional 0.01μF capacitor across the bias resistor. No attempt was made to alter the bias resistors of the i.f. valves as it was thought that this would alter the working of the "S" meter. Further, it was feared that trouble with instability might result if more gain were attempted with these valves.

R.F. GAIN CONTROL

It was next decided to separate the r.f. and i.f. gain controls which in the original are common. On examination it seemed that the best way to effect this would be to transfer the phone socket to the small plate at the back of the chassis and in its place to substitute the a.f. gain control. The r.f. gain control was moved to the place previously occupied by the a.f. gain control and was labelled 'I.F. GAIN'. A new 10kΩ control was then fitted in the upper position to form the r.f. gain control. It should be noted that the hole has to be enlarged slightly by means of a round file as the original controls are not of standard $\frac{3}{8}$in. fixing. This operation is best carried out with the set turned on its side in order that filings do not fall into the receiver. On studying the printed circuit panel and Fig. 3 it will be apparent how the connection to the new r.f. gain control should be made. The lead from R3 connects to the end of the potentiometer track which has zero resistance to the slider when the spindle is turned fully clockwise, and the slider connects to any convenient chassis point. A new 0.01μF capacitor connects across the new r.f. gain control. The opportunity should also be taken to reduce the bias resistor, R3, for the r.f. valve from 180Ω to 68Ω.

A small square piece of aluminium is shaped and drilled to take the phone socket already referred to and reference should now be made to Fig. 4 for the new connections to this socket.

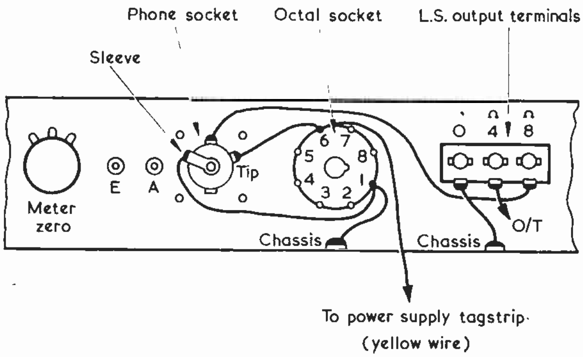


Fig. 4. Connections to the phone socket when this is mounted at the rear

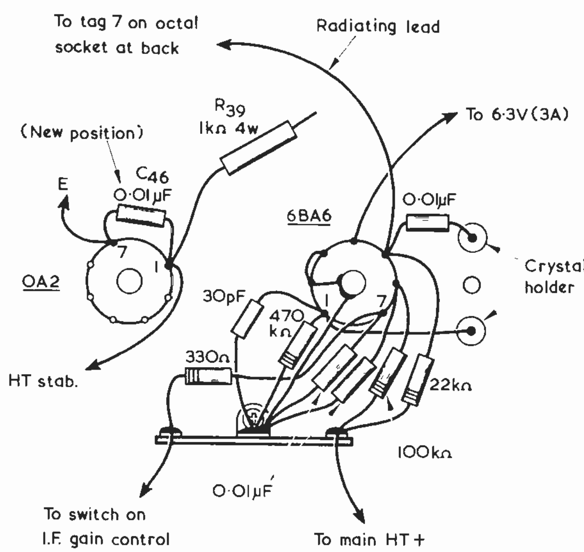


Fig. 5. Layout of components around the added OA2 stabiliser and 6BA6 crystal calibrator stage

COMPONENTS

Resistors
(All fixed values $\frac{1}{4}$ watt 10%)
68Ω 1 off
330Ω 1 off
22kΩ 1 off
33kΩ 3 off
100kΩ 1 off
470kΩ 1 off
10kΩ potentiometer, linear, 1 off

Capacitors
30pF silver-mica 1 off
0.01μF 400V wkg. 6 off (possibly 7, see text)

Choke
10H 90mA 285Ω. Radiospares 'Hygrade', Cat. No. CLF25 (Home Radio)

Valves
OA2
6BA6

Sockets
B7G valveholder
Crystal holder

Crystal
2-pin crystal (frequency as required)

Miscellaneous
Knob (to match 'Ant. Trim') (Eagle Products)
Connecting wire, etc.

OSCILLATOR STABILITY

It was found that only a slight jar was needed to alter the pitch of the b.f.o. and this proved to be an annoyance when receiving s.s.b. signals. Accordingly, an examination was made of the oscillator section of the receiver. It was noticed that the wiring to the switch wafer associated with the oscillator was such that it could take up differing positions from time to time. A few minutes spent with a pair of tweezers in rearranging the wiring enabled this disadvantage to be overcome. The red lead carrying the stabilised h.t. across the receiver should also be anchored to the chassis flange by means of adhesive at the same time.

CRYSTAL CALIBRATOR

Lastly, it was decided to install a crystal calibrator, for which provision is made in the receiver in the form of a cut-out for the crystal and valveholder. On mounting these two components it was noticed that the 220kΩ bleed resistor R40 and 0.01μF capacitor C46 were standing foul. There being another bleed path via R36, it was decided to remove the resistor and to rewire the capacitor clear of the valveholder. The circuit adopted for the crystal calibrator was that recommended in the handbook for the receiver and reference should now be made to Fig. 5 for the wiring to the tagstrip which is already installed in readiness by the manufacturer. The writer used a 1MHz crystal, and it was found necessary to extend the radiating lead across to a spare tag (No. 7) on the socket at the rear of the receiver in order to obtain a satisfactory marker at 30MHz.

These modifications by no means exhaust the possibilities with this receiver, but if they are carried out it is hoped that owners will find that they have improved performance and given more convenient control. The Components List gives details of the new parts required when *all* the modifications are carried out. Obviously, not all the components listed will be needed if only some of the modifications are undertaken. ■

REFLEX TAPE TUNER

by

G. C. DOBBS, G3RJV

Our contributor describes a simple single-transistor reflex tuner intended for medium wave reception. The incorporation of reaction enables a high degree of selectivity and sensitivity to be achieved

THERE ARE MANY USES FOR A SIMPLE MEDIUM wave radio tuner, even in the present age of high quality f.m. tuners. F.M. tuners are accepted as the best means of receiving and feeding the three main B.B.C. stations into a tape recorder, but one may wish to listen to and perhaps record other stations that are only found on the medium wave band. Pop music fans are likely to want to

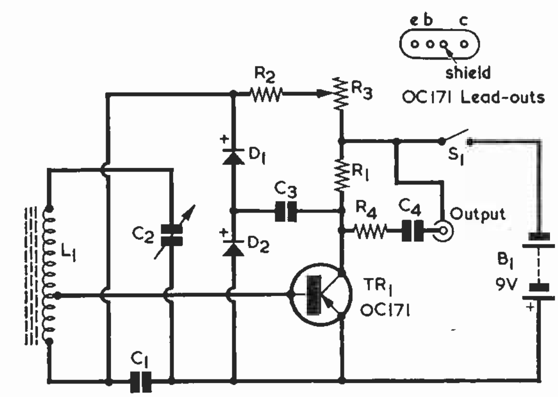


Fig. 1. The circuit of the reflex tuner. Reaction is controlled by R3

receive Radio Luxembourg and the B.B.C.'s Radio One. Some owners of f.m. tuners have no facilities for medium wave reception or, as is more often the case, the domestic medium wave receiver has no output at the correct level and impedance for the tape recorder.

This calls for a medium wave tuner whose output can be fed either into a tape recorder or an amplifier. Naturally, one could buy an a.m. superhet tuner, or build one, but there are simpler and less expensive ways of solving the problem. Some people use a simple crystal set type of circuit as a tape tuner. The writer has tried this type of circuit from time to time as a temporary measure, but success has only been limited. The circuit is not very sensitive and, unless a good aerial and earth are used, the number of stations that can be received is very low. Another and probably more serious shortcoming is the lack of selectivity. The medium wave band is packed tight with broadcast stations, and a simple crystal set circuit is completely out of its depth at the high frequency end of the band, where Radio Luxembourg and Radio One are to be found.

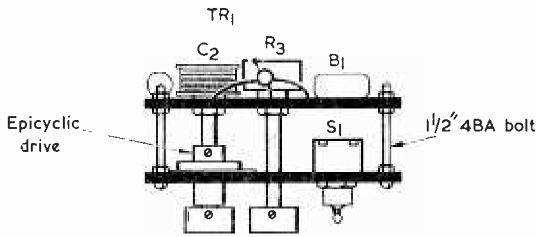


Fig. 2. How the two Paxolin panels are assembled together

However, it is possible to take the simple crystal set one stage further by including an amplifying stage, either valve or transistor, and then feeding back r.f. energy to the aerial tuned circuit. This is, of course, the familiar reaction circuit. If the feedback is controlled such that the circuit is just short of oscillation the effective Q, or 'goodness', of the aerial tuned circuit is very much increased, resulting in a considerable improvement in performance from the point of view of sensitivity and selectivity.

The simple tuner described in this article employs reaction in a 1-transistor reflex arrangement in which the transistor provides amplification both at a.f. and at r.f. This circuit has proved to be very successful and, because of its selectivity, receives Radio Luxembourg better than the domestic superhet. Indeed, it is so selective when correctly set up that a slow motion drive had to be fitted to the tuning capacitor.

COMPONENTS

Resistors
(All fixed values ⅛ watt 10%)
R1 1.5kΩ
R2 12kΩ
R3 50kΩ potentiometer, linear, miniature
R4 10kΩ

Capacitors
C1 0.01μF ceramic or silver-mica
C2 500pF variable, solid dielectric, miniature
C3 0.002μF ceramic or silver-mica
C4 0.01μF ceramic or silver-mica

Ferrite Aerial
L1 See text and Fig. 4

Semiconductors
TR1 OC171
D1, D2 OA81 (or similar germanium diodes)

Switch
S1 s.p.s.t. toggle

Battery
B1 9-volt battery type PP3 (Ever Ready)

Miscellaneous
2 knobs
Epicyclic slow-motion drive
Turret tags (if used)
Nuts, bolts, etc.

THE CIRCUIT

The circuit shown in Fig. 1, is about as simple an

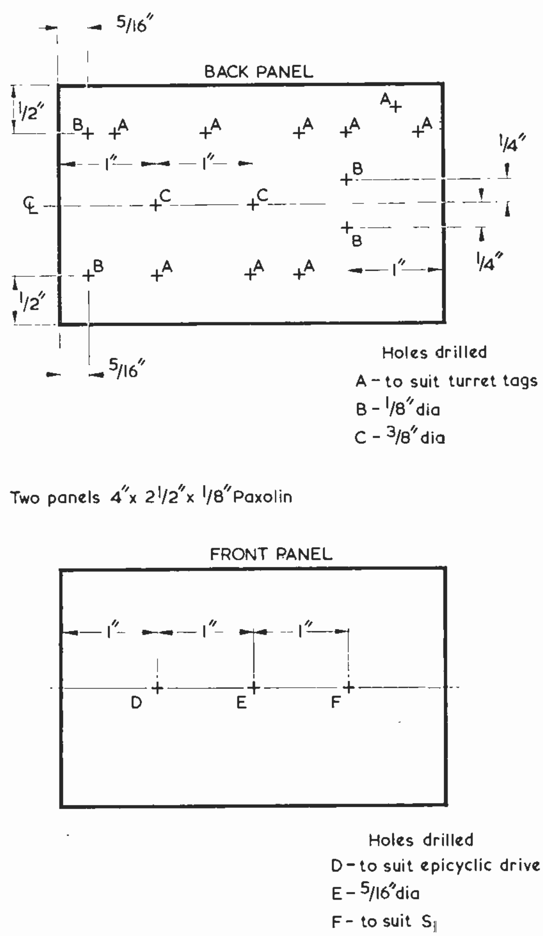


Fig. 3. Drilling details and dimensions for the two panels

arrangement of a reflex receiver as is possible, so no originality can be claimed. There is a ferrite rod aerial coil, L1, which is tuned by a small 500 pF solid dielectric capacitor. The coil has a tap in the winding which feeds to the base of the transistor. The amount of feedback, applied by way of C1, is adjusted by a variable resistor R3. It should be possible, by using R3, to control the feedback smoothly to just below the point at which the transistor begins to oscillate. R3 can also be used as a volume control, but this is not usually required for the applications of this circuit.

The output is taken from across R1, and is at an impedance suitable for most amplifiers and domestic tape recorders. It is important to notice that the return lead of the output is taken to the negative of the power supply. The positive side of the tuner should not, therefore, be connected to the chassis of the tape recorder or amplifier, or the battery will be short circuited. A small 9-volt battery is used for the power supply. The current demands of the single transistor are very small, so the life of the battery will be long.

An OC171 transistor was used in the prototype and proved very successful. The screen lead is left unconnected to aid ease of oscillation. This lead could be cut short, but such a process reduces the value of the transistor, if it should be required later for other applications. Alternatively, the lead may be left intact being covered with a piece of p.v.c. sleeving to insulate the wire from other parts of the circuit.

CONSTRUCTION

The tuner was built on two pieces of Paxolin panel measuring 4 x $2\frac{1}{2}$in. Paxolin of a thickness of $\frac{1}{8}$in. was used, although thicker material is probably better. The main wiring of the circuit is carried out on the back piece of Paxolin, the front Paxolin panel being used to mount the switch and the slow motion drive. The two panels are mounted 1in. apart, as shown in Fig. 2. The panels are spaced by using two 4BA $1\frac{1}{2}$in. long bolts, each with three nuts, to hold the panels apart. The tuning capacitor, the variable resistor and the switch are positioned as shown.

Before cutting out and drilling the panels, the constructor should first obtain the components to be employed in the C2 and R3 positions. If these are miniature types, as used by the writer, it should be possible to mount them with spindle centres spaced by 1in. If slightly larger components are to be used it is necessary to alter the drilling dimensions given in this article accordingly.

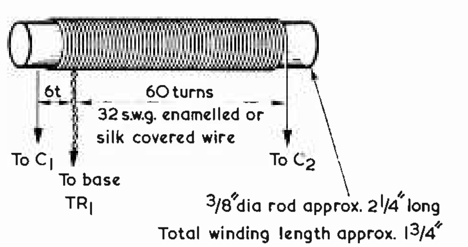


Fig. 4. The ferrite rod assembly. Turns are spaced out to give the winding length indicated

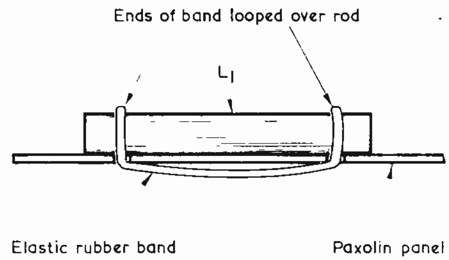


Fig. 5. The method employed for fixing the ferrite rod. The battery is secured in place in a similar manner

The dimensions and drilling pattern for most of the holes in the panels are shown in Fig. 3. The two holes C on the back panel are for C2 and R3. If these components can be mounted with 1in. spacing between their spindle centres, the dimensions given in Fig. 3 apply. If they require to be spaced by, say, $1\frac{1}{4}$in., drill the holes C accordingly and cut the two panels so that they are $\frac{1}{2}$in. (i.e. twice the extra spacing between the holes) wider. The dimensions to the four holes B still apply. On the front panel, the spacing between holes D and E, and between holes E and F, is the same as the spacing between the two holes C.

Drill holes C and holes B in the back panel and temporarily mount C2 and R3. Then mark out suitable positions for the nine holes A, so that they take up the approximate positions shown in the wiring diagram of Fig. 6. Holes A take turret tags or similar wiring anchor points. During this operation it will be helpful to remember that the ferrite rod is centralised on the two holes B at the left, and that the battery is centralised on the two holes B at the right. Remove C2 and R3, then drill the holes A. Drill, also, holes D, E and F on the front panel, together with a 6BA clear hole for anchoring the epicyclic drive locating lug. Finally, mark out and drill four 4BA clear holes, suitably positioned near the corners of each panel, for the four spacing bolts.

The ferrite rod aerial is constructed as shown in Fig. 4. The actual number of turns may be altered to suit individual tuners. If one wished to cover the higher frequency end of the medium wave band, then a few less turns can be wound at the end of the coil which connect directly to C2. If a piece of ferrite rod is available which is not the same diameter as the rod suggested, this could be used and the number of turns required to tune the portion of the medium wave band desired found by trial, although the position of the tapping in relation to the total number of turns should be in about the same ratio.

The ferrite rod aerial and the battery are both mounted to the back panel in the same way. They are secured by elastic bands passing through two holes B, the band ends being looped over the component. This method of mounting is shown in Fig 5. After these have been mounted, C2 and R3 can then be permanently fitted to the panel. The wiring of the back panel is best carried out before the front panel is attached.

The layout of the wiring is shown in Fig. 6. It may be helpful to wire in the connections from L1 before making any other connections. The wiring in

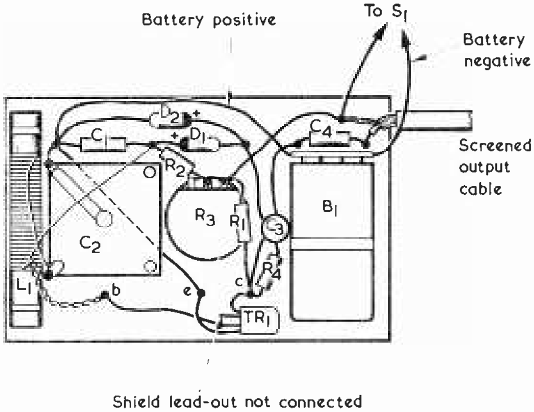


Fig. 6. Rear view illustrating wiring and component layout

of TR1 is probably best left until last, to avoid heat damage to the transistor. Before the back panel can be fitted to the front panel the spindle lengths of C2 and R3 must be adjusted. The spindle of R3 should penetrate the front panel just sufficiently to allow a small knob to be attached. The spindle of C2 must be adjusted to mate with the epicyclic drive mounted on the front panel.

When the wiring is completed the circuit should be checked over, especially with reference to the battery and transistor connections. The tuner may then be connected to an amplifier, or a tape recorder with listen-through facilities.

TESTING

Before switching on the tuner turn R3 fully anti-clockwise. When the tuner is switched on, there should be a faint hissing sound if the volume control of the amplifier is set at a reasonably high level. R3 should now be slowly advanced whereupon the tuner should break into loud oscillation at some point, about mid-way through the travel of R3. This control should be capable of smooth operation; that is, it ought to be possible to maintain the tuner just short of the oscillation point without constantly having to readjust R3.

For normal operation of the tuner, R3 should be set just below the point of oscillation. It might be found that stronger signals cause the tuner to break into oscillation once again, but it should be possible to find a setting which will suit most signal strengths. R3 could have been made a preset control with no access from the front panel, but if the control is easily available speedy adjustment can be made when a strong signal causes oscillation.

The tuner can, naturally, be mounted in a case, with perhaps a coaxial socket for the output. For the prototype, a simple plastic box was used and a pointer, made of stout copper wire was soldered onto the outer ring of the epicyclic drive. A sheet of white card with a tuning scale and the markings 'GAIN' and 'ON' was affixed to the front Paxolin panel. The tuner is, incidentally, ideal for converting a record player into a radiogram, and in such an instance the tuner might find room in the existing case. ■

NOW HEAR THESE

Times = GMT *Frequencies = kHz*

● **EL SALVADOR**
Radio Nacional de El Salvador is now reported to be using **5980kHz** instead of the **6010kHz** channel. Also heard at sign-off, 0500, on **9555kHz.** Both channels have a power of 5kW.

● **EQUATORIAL GUINEA**
Radio Ecuatorial, Rio Muni, EAJ206, has been noted from early August on a measured frequency of **4926kHz,** signing off at 2215 (5kW).

● **CONGO KINSHASHA**
Radio Lubumbashi uses **4750kHz** in parallel with the **7205kHz** channel from 0200 to 2000 (both 10kW). The programmes are partly commercial. Listed channels now inactive are **5955, 9540** and **11862kHz.** The government-owned station can be heard on **15245kHz.**

● **CYPRUS**
Nicosia can now be heard on **17875kHz** with the Greek Service to Western Europe on Sundays from 0900 to 1600 and daily from 1900 to 2100 (30kW).

● **HONDURAS REPUBLIC**
Radio America, Tegucigalpa, can be logged on **6050kHz** around 0430 in Spanish (0.5kW).

● **MALAYSIA**
Radio Malaysia, Kuala Lumpur, may be heard using the Malayan language from 1450 to 1640 on **5965kHz.** From 1100 onwards, try the **6175kHz** channel.

● **NIGERIA**
Ibadan can be logged on **3204kHz** (10kW) where it has been heard at 1945 with a talk in English.

● **MALI**
The unidentified African station recently reported by Dx'ers on **4833kHz** is, in fact, Radio Mali, listed on **4835kHz** (18kW). Alan Thompson of Neath reports that this station has the habit of 'wandering' and of broadcasting for long periods without any station identification.

● **FED. REPUBLIC OF CAMEROONS**
Radio Garoua on **5010kHz** (4/30kW) has been logged with chants in the Arabic style and identification in French at 2100.

● **UNIDENTIFIED**
Almost certainly of African origin, a station has been heard many times recently on a measured **5045kHz.** Announcements are in French and the channel suffers from severe interference at times. This one is also liable to 'wander' and has also been heard on **5044** and **5043kHz.** Listen around 2000. Not Bissau on **5041kHz** or Lome on **5047kHz,** which latter station can be heard with news in English at 1945.

● **UPPER VOLTA**
This country can be logged by listening for Ouagadougou on **4815kHz** around 2030, when it was heard with African chants and drums.

● **UGANDA**
Currently, Kampala may be heard on **4967kHz,** where it was heard with news in English at 1830.

Acknowledgements to our own Listening Post and SCDX. ■

Bare bones

October – and the bare bones of the trees are beginning to be revealed to us in all their stark reality silhouetted against the lowering skies of Autumn. Another summer has passed and we are left with our memories of sunny days amid woodland glades, leisurely hours spent on golden sands and picnics on buttercupped rolling greensward. Talking of bare bones reminds me of a lot of time spent on golden sands – although it was certainly no picnic!

The scene – Iraq; the date – 1943. We had left Mafraq staging post, a place well known to the legendary Lawrence, a good few miles behind and had orders to set up a communications station and relieve the currently resident infantry mob. We could tell they were relieved by the looks on their faces!

The station was duly set up inside a previously laid out large square formed by a boundary of whitewashed stones. Such a boundary was symptomatic of the PBI, it seemed they just couldn't resist the compelling and apparently inherent urge to scour the desert for miles around gathering, at enormous expense to the taxpayer, large rocks which they hastily proceeded to anoint with whitewash.

Gazing with hand-shaded eyes over the vast expanse of the Arabian desert shimmering around us we could detect no sign of life. Barren and utterly silent, nothing stirred – the sun beating pitilessly down from a cloudless brassy sky on to our marooned-to-order little colony. The silence was deafening, shade was non-existent outside the tents and vehicles. The tents were ovens, our khaki shirts, now white with perspiration salt crystals, were abandoned and we became subject to a feeling of lethargy, loneliness and boredom.

Some distance away – it was difficult to assess how far in the arid desert landscape – was a low hillock. This one was presumably a Tell – mounds formed by ancient settlements built one upon another over a long period of history.

Stirring from a fitful midday doze under one of the trucks, a position which was cooler than within the tent, we saw standing nearby two Arabs. Puzzling from whence they had magically appeared, we proceeded to exchange tins of bully-beef for fresh eggs – an act calculated to land us all on a charge sheet (B252) if it became known to the higher-ups. The Arabs existed, it seemed, in a settlement on the far side of the hillock. It was an odd fact of desert life that once the vehicles were static and the inevitable brew-up began, there would appear from an apparently empty desert terrain a group of Arabs in a very short period of time. Wondering since about this inexplicable phenomenon has always had me baffled.

Awakening the next day found the carcase of a large dog laid, unknown to our sentry, just outside our territorial claim bounded by the white stones. The cheek of it! Obviously, from the visual evidence, it had met its demise elsewhere and we mad British were required to decently inter the thing. We temporarily buried it in a shallow grave, resolving to return the canine cadaver to the erstwhile owners at dead of night. We did just that – members of the funeral cortege fondly imagining they had got away undetected with the Burke and Hare episode and the ensuing carcase re-dumping venture at the settlement.

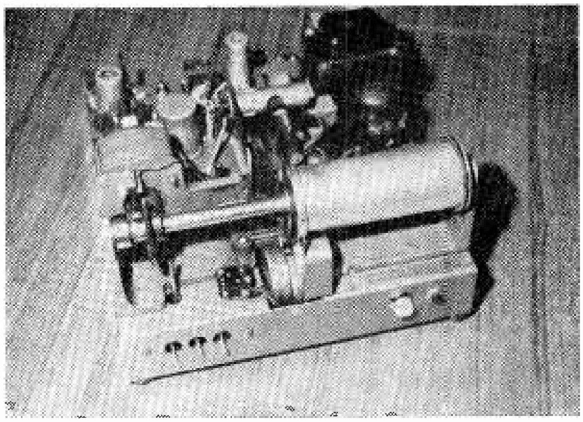
Dawn broke on the second day suddenly and without warning as is the way in those climes and – oh no! – there it was again, only this time it was *within* our domain and unmistakenly showing signs of having gone the way of all flesh! Obviously having been left all the previous day somewhere in the vast spaces around us by the original perpetrators of the grisly plot, the carcase had been picked clean by the hordes of desert scavengers that abounded.

We gave up the unequal contest and hastily consigned Bonzo to Mother Earth, or should I say Sand?

Facsimile Reception for the Radio Amateur

by

ARTHUR C. GEE, G2UK



The Creed Desk FAX equipment

READERS MAY HAVE RECENTLY NOTED IN THE SMALL Advertisment columns of this magazine one inserted by the writer requesting information about FAX – the system by which pictures, maps, etc., can be transmitted by radio.

This system is widely used for sending news photographs and weather maps, etc., by landline, broadcast radio and satellite but as an amateur radio activity little has been heard of FAX. Apart from John Tuke GM3BST and one or two other enthusiasts whose work has been written up in American radio magazines, there seems to have been little amateur activity.

One reason for this is undoubtedly the difficulty of obtaining suitable 'ironmongery'. John Tuke actually built the mechanical part of his equipment from Meccano parts in the first instance and then subsequently ordered a more professional recorder to be built by a mechanic.

Just recently however, suitable equipment has appeared in small quantity on the surplus market, several enthusiasts having succeeded in putting it to use and getting quite good results. The Small Advertisement produced a surprising number of contacts with such enthusiasts. One particularly interesting letter came from G. D. Massey of Broadclyst C.S. School, Exeter. He wrote – "I have been working in the hope of obtaining eventual reception of 'met' broadcasts and can report progress to date. At present I have a Creed Desk FAX equipment converted and almost working. It is working from the mains at the moment but a Tuning Fork unit is almost ready to go. We use RTTY at school for weather work. The whole was inspired by your writings and give good service and pleasure. We hope to use FAX for charts in the same line of experiments".

The Creed Desk FAX referred to is that acquired by most FAX enthusiasts. The writer has such a unit which bears the code number TR103. B. E. Cook, G3IYG, writing from Redhills, Exeter, sent a FAX copy of his QSL card amongst other examples of his results obtained. He mentioned that he had no knowledge of the Creed TR103 which "would seem to be a later edition of the TR100 and 102, both of which I have. I also have the T200 transmitter only and the R300, these are far better for use on radio working". G3IYG has applied for a licence to transmit FAX and has obtained permission from the Post Office but "only on the 430MHz and 1230MHz bands".

Prof. Franco Fanti, I1LCF, of Bologna, Italy, sent the writer a photograph of his recording machine, which is a Desk FAX, almost identical to that acquired by the writer. Prof. Fanti is keen to make contacts with other FAX enthusiasts.

The writer is currently contributing to the British Amateur Radio Teleprinter Group Newsletter a feature relating to FAX and those readers who are interested and are not already members of BARTG will find it worthwhile to join. The Hon. Secretary is – D. Geacher, G3LLZ, 51, Norman Road, Swindon, Wilts. ■

PLASTIC I.C's FROM SGS

The Central Research and Development Laboratories of the SGS group has devised a new technique in plastic encapsulation of integrated circuits. This development programme was initiated because for many years SGS felt that conventional methods of plastic encapsulation resulted in an insufficiently reliable device, and therefore the group did not use this type of encapsulation.

After months of vigorous testing, using quality control and test programmes unsurpassed by any other semiconductor manufacturer, SGS R & D are satisfied that they have achieved plastic encapsulated devices of outstanding reliability.

Manufactured with this technique, the 930 series DTL; T100 series TTL and linear I.C's, all encapsulated in plastic, are now available from SGS for immediate delivery. The 7400 series TTL will be available shortly. For further information: SGS (United Kingdom) Limited, Planar House, Walton Street, Aylesbury, Bucks. Tel: Aylesbury (0296) 5977.

THE 'TRI-add' SERIES

THE 'TRI-add' F

b

F. G. RAYER,

The pre-amplifier described in this seco be employed directly with the Gram A any similar amplifier. The final unit in t unit, is dealt with in next

THIS PRE-AMPLIFIER CAN BE PLUGGED DIRECTLY into the 'Tri-add' Gram Amplifier described last month. The pre-amplifier has two fully variable controls, one allowing up to 15dB bass cut or bass boost, and the other up to 15dB treble cut or treble boost.

The pre-amplifier is thus particularly suitable for use with the simpler type of audio amplifier, where additional control is required over bass and treble or, again, where more amplification is necessary for a low-output pick-up, or for other similar purposes.

It could be used with other single- or two-stage audio amplifiers, where the circuit may be somewhat similar to that of the 'Tri-add' amplifier. It must not be used with a.c./d.c. type circuits, or those deriving current directly from the mains with no transformer and which have the chassis directly connected to one side of the mains supply.

CIRCUIT POINTS

Fig. 1 gives the circuit. The microphone, pick-up

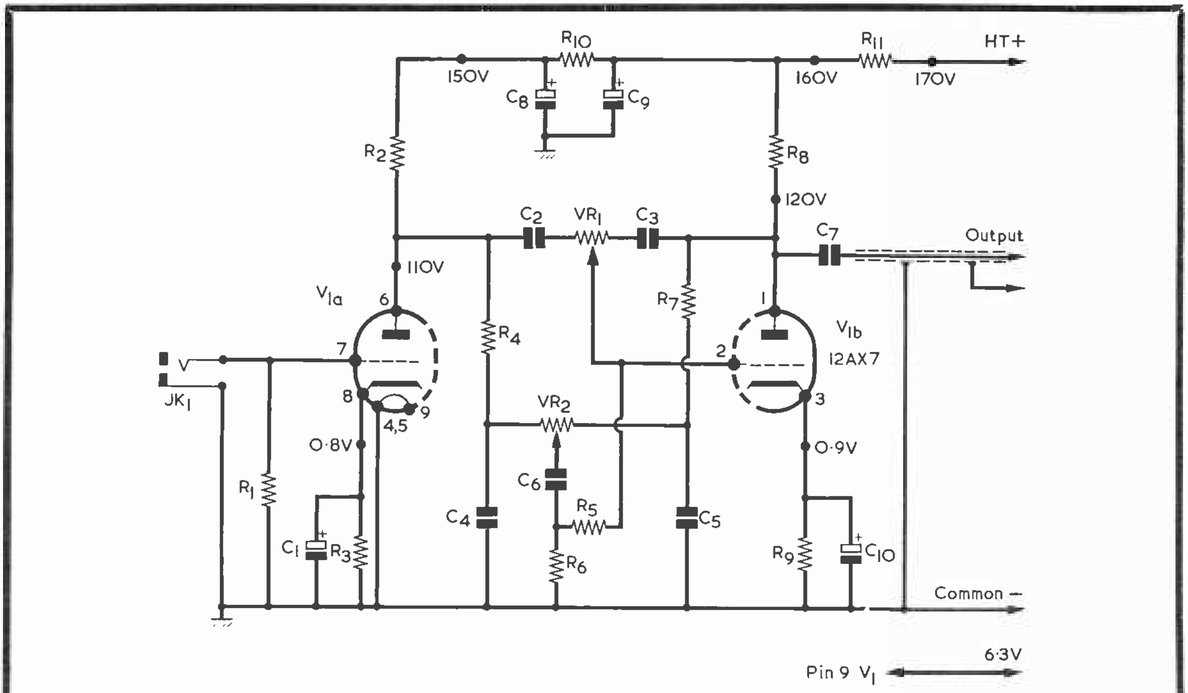


Fig. 1. The circuit of the pre-amplifier. This receives its power from the 'TRI-add' main amplifier, described last month

ɜE-AMPLIFIER

ssoc.I.E.R.E.

article in the 'TRI-add' series may lifier described last month, or with 'TRI-add' series, the superhet radio nth's concluding article

or other input is taken to the grid of the first triode section, which operates as a high-gain audio amplifier. The tone-control circuitry is between the first and second sections of the twin triode.

The potentiometer VR1 is the treble control. C2 carries treble from the anode of the first triode, while C3 provides negative feedback to VR1 of the same frequencies. Adjusting VR1 thus allows treble boost, or treble cut, to take place.

VR2 is the bass control. Bass frequencies are available across C4 from R4. At the same time, negative feedback of bass frequencies across C5 is applied to the other end of VR2 track. Thus the position of VR2 slider controls the level of bass boost or cut.

R5 and R6 complete the d.c. grid circuit for bias purposes. Output is taken from C7, and a screened lead terminated with a jack plug is taken to the Gram Amplifier. Signal level is adjustable by the volume control of the latter. The 'Tri-add' main amplifier already has a simple tone-control. This is of advantage because it improves the characteristics of the output stage, and it is left at about its middle setting when using the pre-amplifier.

R10 and R11, with the large capacitors C8 and C9, are included to remove any ripple that may be present on the high tension line. The output from the pre-amplifier is free from hum.

A jack socket is provided for audio input, thus matching up with the main amplifier input circuit. The pre-amplifier can, in consequence, be immediately put into circuit between signal source and main amplifier, or just as readily removed.

CASE AND CHASSIS

The case listed has a metal panel measuring 6in. by 4in. This is drilled or punched to take VR1 and VR2 above the chassis, as in Fig. 2. The input jack is under the chassis, as shown in Fig. 3. 'Panel Sign' transfers from Set No. 6 are used for the scales. These are moistened and applied directly to the metal panel, in the manner described in the instructions provided with the transfers.

The chassis is 4¾in. wide and 3in. from back to front. In view of its small size it was made from a 7 by 3in. 'Universal Chassis' member (Home Radio Cat. No. CU147). The member is cut across about ⅛in. from each end, to remove the end flanges and leave a channel shaped part about 6¾in. long. A notch is then cut in each side flange 1in. from the member ends. The metal can then be bent, giving a chassis 4¾in. long, 3in. from front to back, and 1in. deep. Drill matching holes in the panel and flanges, so that these can be bolted together.

Holes for the valveholder, large capacitor, and for

COMPONENTS

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

R1	1MΩ
R2	100kΩ
R3	2.7kΩ
R4	100kΩ
R5	1MΩ
R6	2.2MΩ
R7	100kΩ
R8	100kΩ
R9	2.7kΩ
R10	22kΩ
R11	10kΩ ½ watt
VR1	500kΩ pot., linear
VR2	1MΩ pot., linear

Capacitors

C1	100μF electrolytic, 6V wkg.
C2	200pF silver-mica
C3	200pF silver-mica
C4	2,000pF disc ceramic, 500V wkg.
C5	2,000pF disc ceramic, 500V wkg.
C6	0.01μF silver-mica
C7	0.05μF paper or plastic foil, 350V wkg.
*C8,9	16 +32μF electrolytic, 350V wkg.
C10	100μF electrolytic, 6V wkg.

*Dual electrolytic, upright mounting, in can with clip.

Valve
V1 12AX7 (ECC83)

Input Socket
JK1 Jack (Igranic or similar)

Case, Chassis
Dinkicase, 6 by 4in. (Electroniques)
Aluminum chassis 4¾ by 3 by 1in. (see text)

Plugs, Sockets
Jack plug
Plug to match amplifier power outlet socket
B9A Skirted valveholder, with 2in. screening can

Miscellaneous
Paxolin panel (see text)
3-way tagstrip end tag earthed
'Panel-Signs' transfers (Set No. 6)
Two knobs
Insulated screened lead
Wire, nuts, bolts, etc.

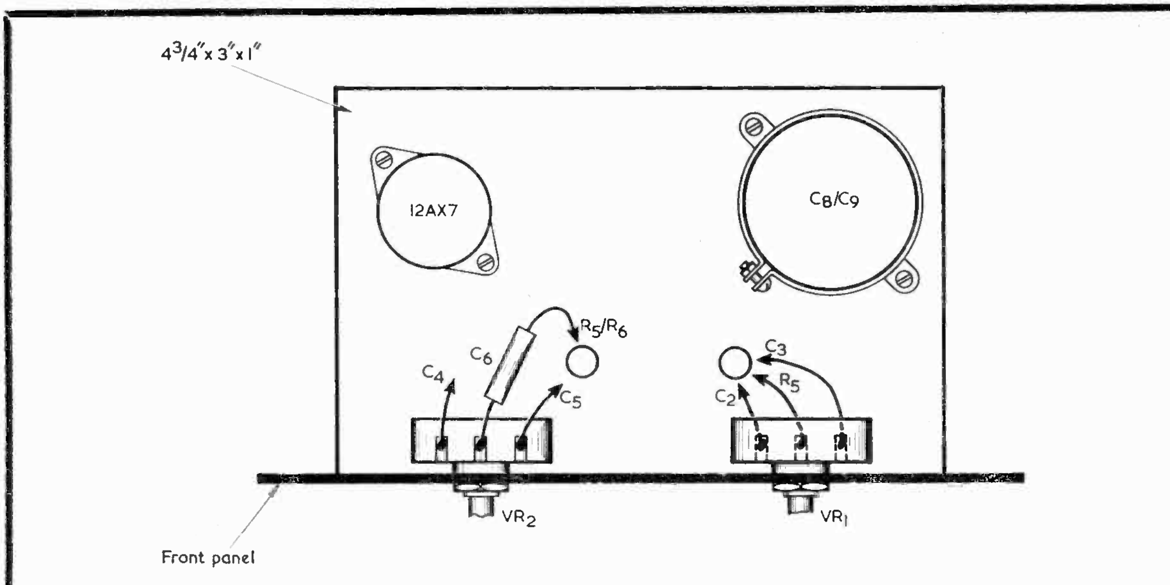


Fig. 2 Above-chassis components and wiring

leads which pass through the chassis can be located from Figs. 2 and 3.

Note that the case has an inner flange, so that the chassis must be fixed just high enough to clear this.

UNDER THE CHASSIS

Bolt the skirted valveholder in position, with solder tags under the fixing nuts. The twin capacitor C8/C9 is held with a capacitor clip. Its can is negative, and is thus in contact with the chassis. The positive tags project through a clearance hole, as in Fig. 3.

A 3-way tagstrip is bolted in the position shown in Fig. 3 to provide anchoring points for the power supply leads. R1, R3, R9, R10, R11, C1 and C10 can then be wired in. Also, the requisite connections can be made to C8/C9.

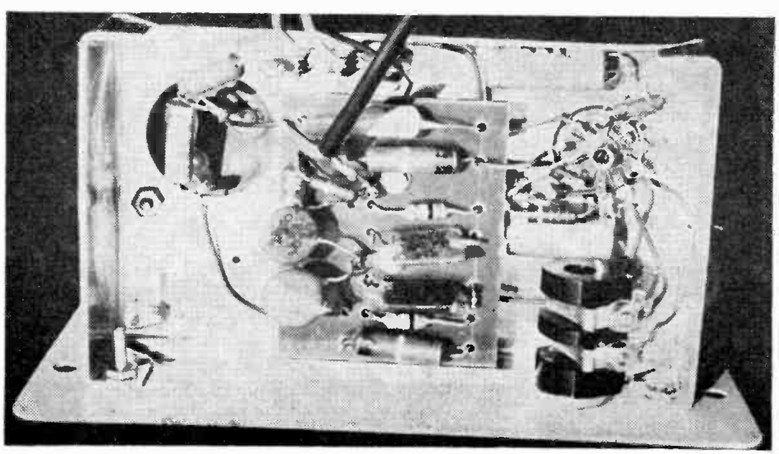
Prepare a 3-core supply lead about 18in. long. The wire colours can be red for high tension positive, blue for the 6.3 volt heater circuit, and black for the common chassis connection. These leads are twisted together and run from the tagstrip, terminating in the plug which is intended for fitting to the power outlet socket of the main amplifier.

The other capacitors and resistors are assembled on a panel measuring $1\frac{7}{8}$in. by $2\frac{3}{8}$in., cut from $\frac{1}{16}$in. thick Paxolin. Drill $\frac{1}{16}$in. or 5/64in. holes for the wire ends of components, and $\frac{1}{8}$in. holes for the two tags marked 'MC'. Each tag is held with a $\frac{3}{4}$in. 6BA bolt, locked tight. Put an extra nut on each bolt, so that when the Paxolin panel is later fixed to the chassis, there is about $\frac{1}{2}$in. clearance underneath.

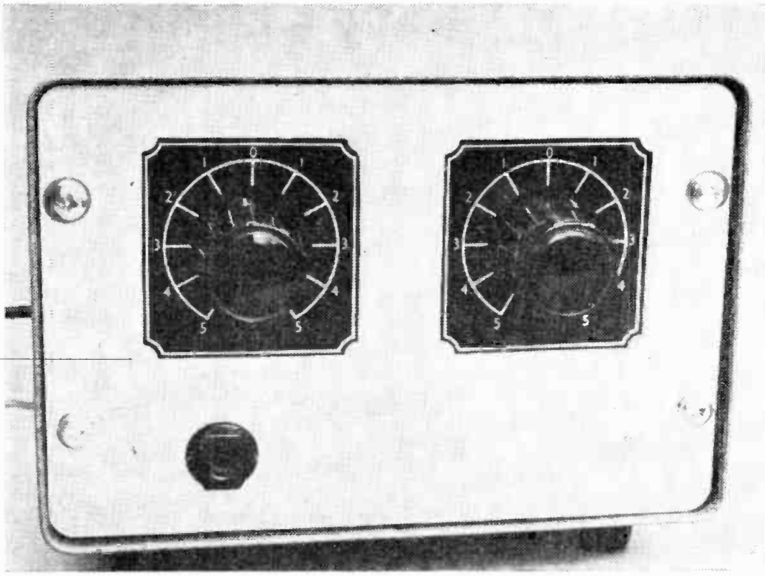
Before mounting the panel to the chassis, fit and wire the small capacitors and resistors, as in Fig. 3. Finish off joints neatly so that they cannot touch the metal chassis when the panel is fixed in place. The components are held in position by bending their lead-outs in the appropriate direction under the Paxolin.

Solder coloured leads to C2, C3 and R5, and take them through the hole near VR1. In the same way, solder on leads from the junction of C5 and

Underneath the chassis of the completed pre-amplifier



THE 'TRI-add' SERIES



THE 'TRI·add' SERIES

Front view of the tone-control pre-amplifier. The scales are provided by 'Panel-Signs' transfers

R7, and the junction of C4 and R4. Also provide a lead from the junction of R5 and R6. Pass these wires through the the hole near VR2.

Further leads required for connections external to the panel are at both ends of R8 and, as shown in Fig. 3, at R5, C2 and R2. The screened lead connection to C7 and the adjacent 'MC' tag is made later.

The Paxolin panel can then be mounted into position, the leads being pulled to take up slack. The bolts pass through matching holes in the chassis, and are held with further nuts, properly tightened. The wires are then connected as in Fig. 2, and as in Fig. 3 under the chassis. Remember to put insulated sleeving on all leads.

The input jack socket is connected as in Fig. 3. All

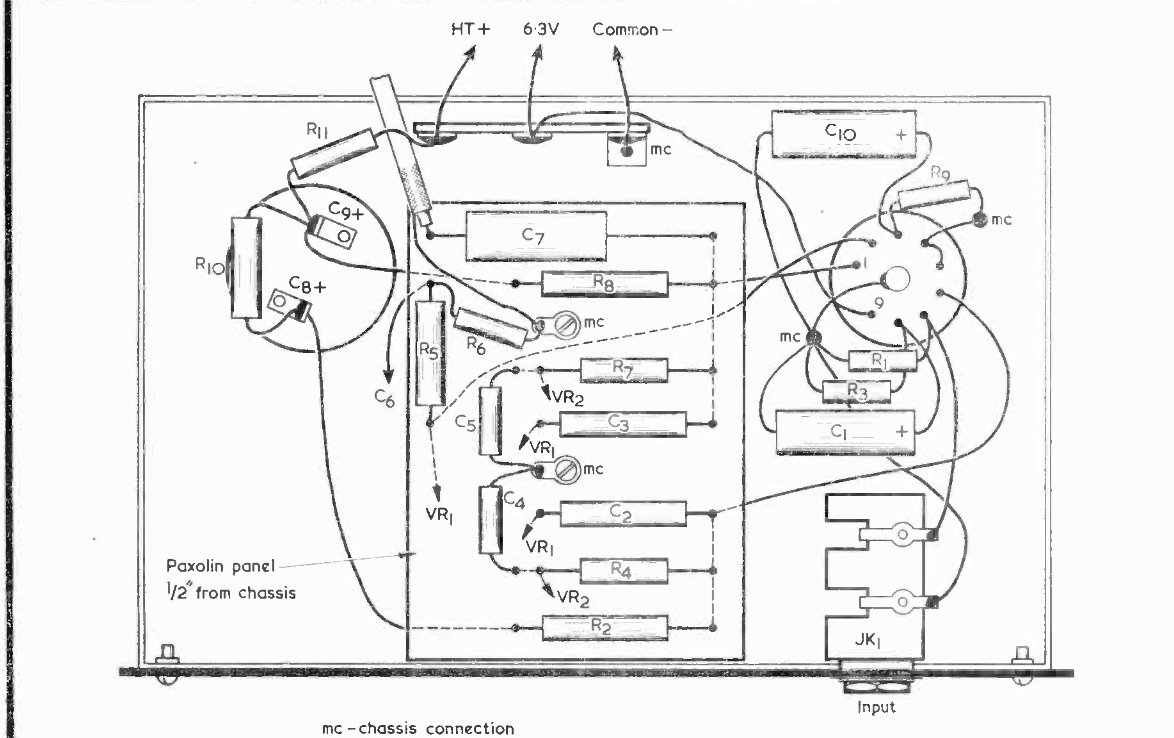


Fig. 3. How the components are wired up below the chassis

THE 'TRI-add' SERIES

connections are reasonably short and direct. The 6.3 volt heater lead runs against the chassis, clear of other wiring.

Solder an insulated coaxial lead, or insulated screened lead, to C7 and the adjacent 'MC' tag, as in Fig. 3. Fit a jack plug to fit into the 'Tri-add' amplifier input socket at the other end of this lead.

VOLTAGES

The voltage readings shown in Fig. 1 were taken with a 10,000Ω per volt meter, after the valve reached working temperature. They can be expected to vary somewhat, according to the exact resistor values and other factors. A meter with a lower internal resistance than 10,000Ω per volt will, also, give somewhat lower readings at C9, C8, and tags 1 and 6 of the valveholder. However, the readings should be useful if a wiring or other fault should be present.

It was found that a mica capacitor was best for C6. Even very slight leakage here will upset bias for the second triode section.

TESTING THE UNIT

Set up the 'Tri-add' Amplifier with pick-up plugged in as before. Adjust volume to a moderately low level, and set the feedback tone control for best results from the record in use.

Now introduce the pre-amplifier by plugging the pick-up into it, and the pre-amplifier output lead into the 'Tri-add' main amplifier. Also insert the power supply plug.

Assuming that the 'Tri-add' volume control has been left untouched, there should now be a *very considerable* increase in volume. Turn back the volume control as required.

To check operation of the tone controls, a musical item is required having an extensive range of instruments or frequencies. VR1 should have a very apparent effect on treble, cutting or boosting this as required. VR2 should be found to have a pronounced effect over low frequencies.

New and old records, and those of different speeds, usually have different degrees of frequency response. So the tone controls are adjusted to give the most pleasing results.

If a microphone is used, a general purpose crystal mike is quite inexpensive, and does well for most home activities of this kind. Sounds from the loud-speaker must not reach the microphone at too high a level, or continuous howling will arise.

(To be concluded)

CURRENT SCHEDULES

Times = GMT *Frequencies = kHz*

★ PAKISTAN

Radio Pakistan is currently using the **9485kHz** channel (100kW) and has been heard with news in English at 1800. The frequency is also used for the East-West link from Islamabad for East Pakistan from 1400 to 1630. Programmes for West Pakistan from Dacca are on **11650kHz** from 1445 to 1630 with English at 1545. (7.5 to 100kW).

★ AUSTRALIA

Radio Australia has been heard on the new channel of **5995kHz** from 1030. Radio Australia can also be logged on **6100kHz** (250kW) at 0900 with news in English.

★ SWEDEN

Radio Sweden has changed two channels. The Western and Northern American service from 0300 to 0430 is now on **9505kHz** instead of **11705kHz.** The Eastern and Northern American service from 2400 to 0230 is now on **5990kHz** instead of **11825kHz.**

★ AUSTRIA

Broadcasts to South America on **9690kHz** are from 2300 to 2400 and on **11725kHz** from 0200 to 0400. The Middle East on **9515kHz** from 1600 to 1800 and on **9602kHz** from 1800 to 2000. In parallel with the **11725kHz** channel are **6155** and **9770kHz.**

★ NORTH KOREA

Radio Pyongyang now has the following schedule. On **9540kHz** at 0900 in Russian, at 1000 in Chinese, at 1100 in English, at 1900 in English, at 2000 in Korean and at 2100 in French. On the off-band frequency of **16320kHz,** Radio Pyongyang can be heard from 2300 to 2400 and from 0100 to 0150 in Spanish and from 2400 to 0100 in Korean.

★ MEXICO

Radio Mexico is still searching for a suitable channel and has been reported on **6055, 9745, 11720** and **15125kHz.** News in English is at 0315 on **6055kHz.** Radio Mexico has additionally been noted on **15135kHz** at 1900 in German and on **9535, 15160** and **15176kHz.**

★ MOZAMBIQUE

Radio Clube de Mozambique now signs on at 1500 instead of 1600 on **3338kHz** (10kW) and **4865kHz** (25kW).

Quelimane is reported to have vacated **4895kHz** (1kW) and is now on **4904kHz,** a channel occupied spasmodically by Fort Lamy, Chad (30kW).

★ RHODESIA

Gwelo is not now using the **7175kHz** (100kW) channel, this being replaced by **7125kHz.** Heard from 0530 to 1530 carrying African services. Gwelo can also be heard on **3396kHz** (100kW) in the evenings with English programmes.

★ BELGIUM

Brussels radiates French programes from 1000 to 1230 on **17715kHz** and **21590kHz,** replacing **17845** and **17865kHz.** From 1800 to 2200 on **15335** and **17715kHz** replacing **17845** and **17865kHz.** English from 2305 to 2315 and 0050 to 0100 on usual **15335** and **17715kHz** channels.

Acknowledgements to our own Listening Post and SCDX.

INTEGRATED CIRCUIT GRAM AMPLIFIER

by

H. WILLIAMS

One of the more attractive integrated circuits for amateur use is the General Electric PA237, which consists of an amplifier capable of giving an output of 2 watts into a 15 ohm speaker. The amplifier described in this article incorporates a PA237 and is intended for operation direct from a crystal pickup

INTEGRATED CIRCUITS HAVE BEEN SLOW TO FIND favour with the amateur constructor for a number of reasons. Availability is one of the chief reasons and the high cost is another, also many readers will have been daunted by the vast variety of devices and by their rapid introduction to (and all too often disappearance from) the market. However during the last year the position has clarified and certain types are becoming widely stocked and retailing at reasonable prices.

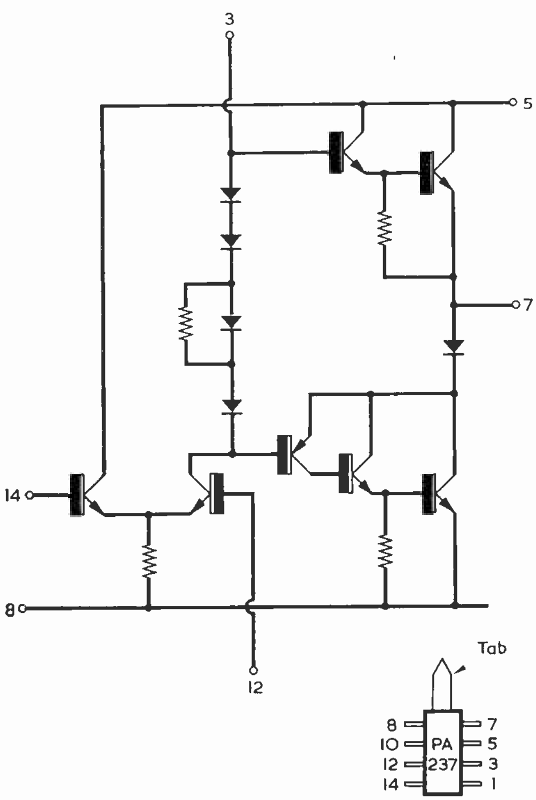


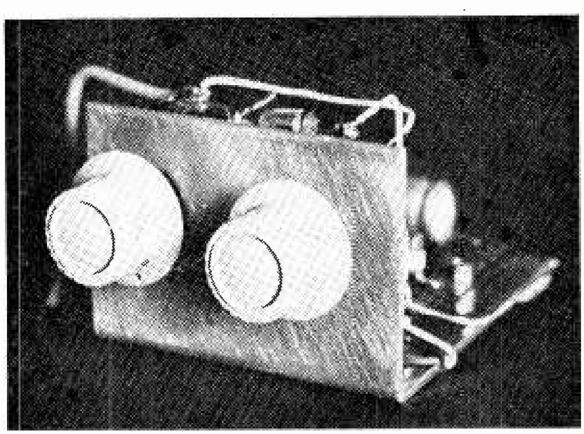
Fig. 1. The internal circuitry of the PA237, together with a top view showing tag numbering

Advanced though integrated circuits are in their construction and operation, they are nevertheless ideal for a number of reasons for the beginner who, having cut his teeth on experimental projects, wishes to graduate to a more advanced and practical project. This article describes a record player amplifier with an input suitable for a crystal pickup, the type almost universally fitted to the less expensive record decks. The output is two watts into a 15Ω speaker which is about average for a normal domestic record player. The quality is rather better than normally found in commercial units, distortion at full output being typically 1%.

Although, as already mentioned, the theory of the amplifier is complicated, the project definitely falls within the beginner category since in addition to the power supply, loudspeaker and i.c. itself, only twelve components are used.

THE INTEGRATED CIRCUIT

The PA237, made by General Electric (U.S.A.), is a monolithic general purpose audio amplifier housed in an 8-lead plastic dual-in-line package. A small heat sink tab is fitted and this should be connected to a heat sink to allow for heat dissipation.



A front view of the completed 2 watt amplifier

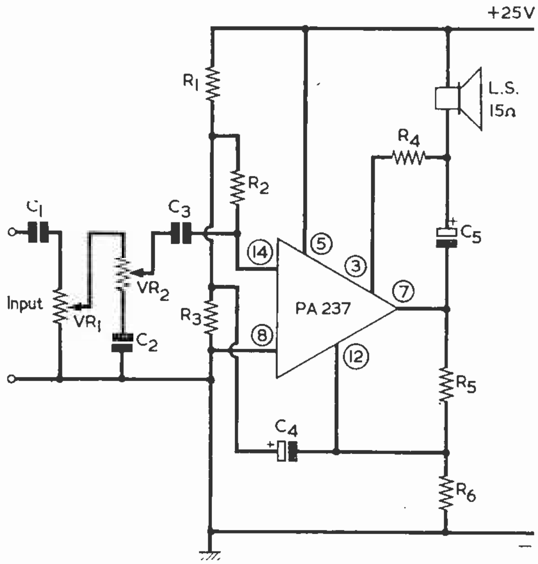


Fig. 2. The overall circuit of the 2 watt i.c. gram amplifier

Fig. 1 shows the internal circuitry of the PA237 and it will be seen that it consists of seven transistors together with a number of diodes and resistors. Anyone who is puzzled by this configuration should study the circuit of almost any modern complementary pair transistor amplifier and the similarities will become apparent. The PA237 is available from a number of suppliers, including L.S.T. Electronic Components, Ltd.

THE CIRCUIT

Fig. 2 shows the overall circuit of the amplifier. The input is connected in a boot-strap configuration which has the effect of raising the input impedance of the first stage to a level that will nicely match the output of a crystal pickup.

The fixed resistors in the circuit are used to supply the correct bias voltages, etc., to the various sections of the integrated circuit. C3 is a d.c. blocking capacitor in the input, C4 is part of the boot-strapping circuit and C5 is the load coupling capacitor. C1, C2, VR1 and VR2 comprise the volume and tone control circuits.

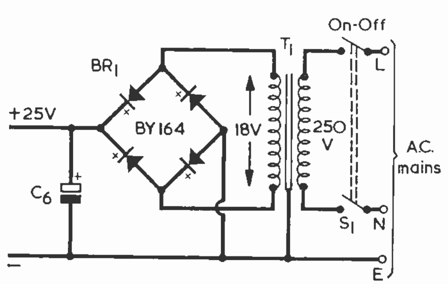


Fig. 3. A suitable power supply circuit. The on-off switch may be ganged with VR1 of Fig. 1

COMPONENTS

Resistors
(All fixed values $\frac{1}{8}$ watt 10%)
R1 560kΩ
R2 100kΩ
R3 56kΩ
R4 18kΩ
R5 330kΩ
R6 56kΩ
VR1 1MΩ potentiometer, log track, with switch
VR2 250kΩ potentiometer, linear track

Capacitors
C1 1,000pF
C2 470pF
C3 0.33μF
C4 32μF electrolytic, 12V wkg.
C5 500μF electrolytic, 25V wkg.
C6 2,000μF electrolytic, 30V wkg.

Transformer
T1 Mains transformer, secondary 18 volts at 250mA min. (see text)

Integrated Circuit
I.C. type PA237 (General Electric)

Rectifier
BR1 Bridge rectifier type BY164 or similar (see text)

Switch
S1 d.p.s.t. switch (part of VR1)

Miscellaneous
Veroboard, 0.1in. matrix, (see Fig. 4)
2 knobs
Aluminium sheet, 5 x 3in. for chassis
4BA solder tag, screened lead, wire, etc.

The circuit of a suitable power supply is shown in Fig. 3 and this can be built separately. A 25 volt supply will give full audio output. However, at the expense of output volume lower supply voltages—down to about 15 volts with this amplifier—may be used. Initially the amplifier can be tested on batteries but the current drain at reasonable outputs, of the order of 100mA, is too high for economic operation. If batteries are used a 1,000μF 30V wkg. capacitor should be connected across the supply otherwise severe distortion will occur.

The bridge rectifier in the author's power supply—BY164—is a single unit in a plastic case with the connections clearly marked but, of course, this can be replaced by other types of rectifier. If individual diodes are used they should have a forward current rating of at least one amp (to withstand switch-on surges) and a p.i.v. of at least 25 volts. The RS50AF (available from Henry's Radio, Ltd) would be satisfactory.

To give a 25 volt output, the secondary of the mains transformer should be 18 volts. If difficulty in

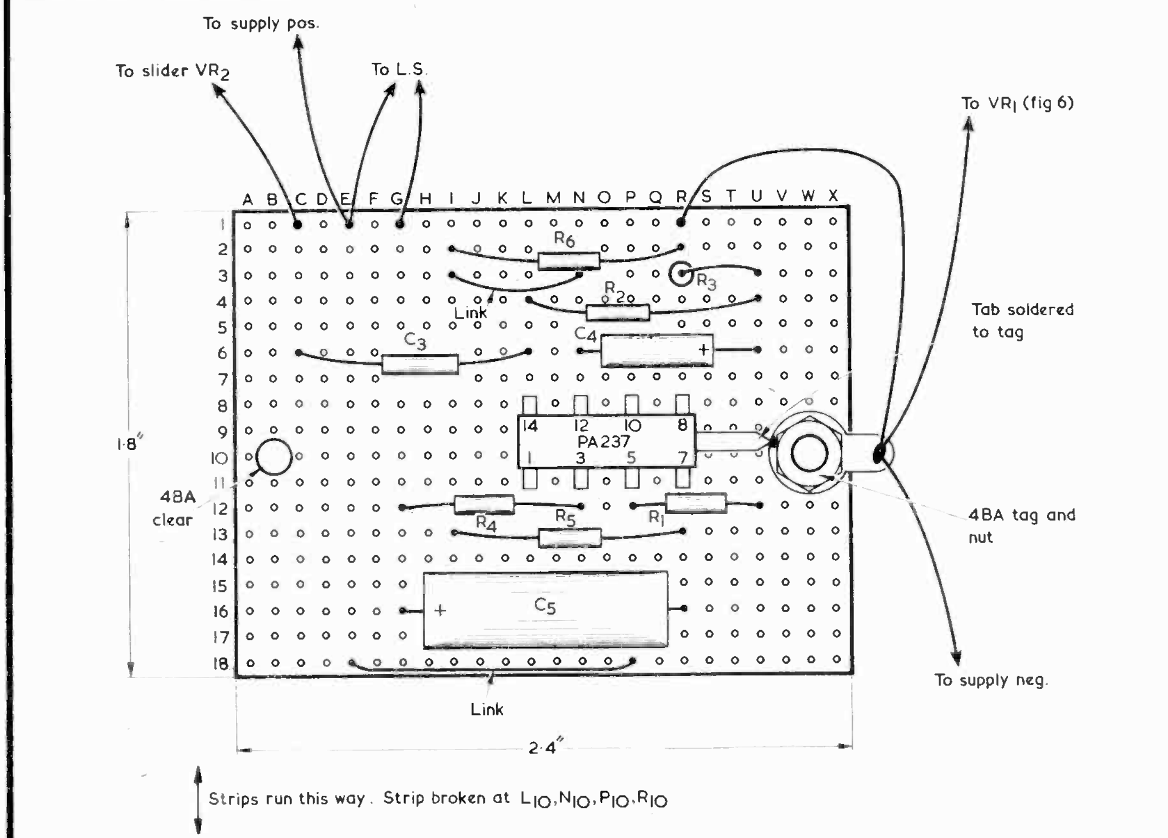


Fig. 4. Layout of the Veroboard panel. This amply demonstrates the external circuit simplicity resulting from the use of an integrated circuit

obtaining a suitable transformer is experienced, an inexpensive 'charger' transformer offering 17 volts at one amp will be sufficient. Secondary voltages above 18 volts should not be used.

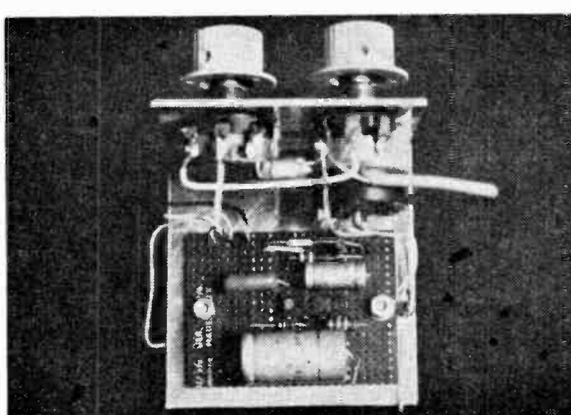
CONSTRUCTION

The actual mounting of the i.c. is not easy unless 0.1in. matrix Veroboard is employed. Mounting the i.c. on drilled Paxolin or pin-board will allow a certain amount of movement and since the tags are rather delicate, and since the package should be securely held, the author does not advise such mounting methods. The pin spacing on the package is 0.2in. and this of course means that the i.c. fits nicely through the holes in the 0.1in. Veroboard. Fig. 4 shows the layout employed. This is not too critical, incidentally, provided it is remembered that the input impedance is high and that consequently the output and input should not be too close together.

More care than usual should be taken in soldering. One reason for this is that the copper strips on the 0.1in. Veroboard are very close together and it is easy for solder to flow across adjacent strips, causing a short-circuit. Also, damage to one section of the i.c. due to overheating will of course spoil the whole device.

The circuit board should be mounted on to the small metal chassis – drilling details of which are shown in Fig. 5 – and stood off by the thickness of two 4BA nuts to ensure the copper strips are sufficiently isolated from the earthed chassis.

A solder tag should be fitted to one of the mount-



Top view of the amplifier, illustrating the clean and uncrowded component layout

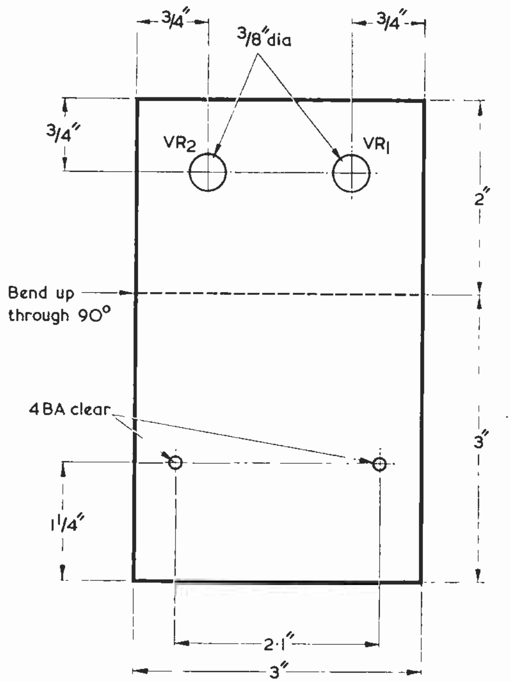


Fig. 5. The chassis has the dimensions shown here. The material is aluminium sheet of any convenient gauge

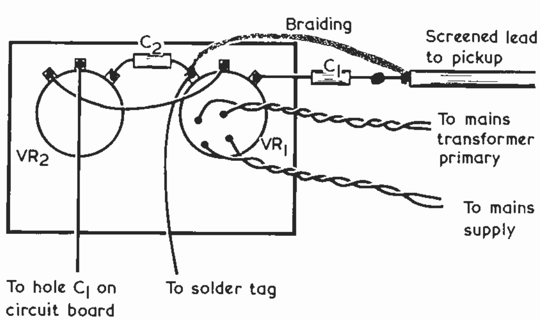


Fig. 6. The connections to VR1 and VR2

ing screws and the heat sink tab should be soldered to this.

Fig. 6 shows the control panel layout. The output of the crystal pickup should be connected to VR1 via C1 by means of a screened lead.

The photographs demonstrate that the unit is very small and that it should fit comfortably into any record player cabinet. The power supply, being comparatively heavy, can be mounted elsewhere in the cabinet.

When initially switching on it is worthwhile holding a finger on the i.c. and, also, to monitor the current consumption. Under no signal conditions the current drain will be about 6 to 15mA and under full output about 150mA. If it is higher or if the package gets hot switch off immediately and check the wiring and components. ■

AMSAT – Policy Outlined

Perry Klein, K3JTE, President of the Radio Amateur Satellite Corporation, writing in the June 1970 AMSAT Newsletter, comments that with amateur satellites orbited to date, enthusiastic response has been apparent, but from a relatively small percentage of the total amateur population. It was of the utmost importance that wider participation be sought for the series of amateur repeater satellites, beginning with AMSAT OSCAR-B, which it is hoped will be launched next year. He gave some reasons for the importance of greater participation.

1. Space represents a new technology in which amateurs should share – as they have in other technological developments in the past.

2. A greater number of amateurs equipped for communications via these repeater-satellites will ensure a larger pool capable of participating in amateur space-oriented scientific studies which may prove to be of great benefit to amateurs and mankind in general.

3. Increased participation in amateur satellite communications will hopefully lead to increased scale of AMSAT's operation in terms of membership and operating revenue. This, in turn, will provide an improved base from which to embark on further amateur space activities.

So far, amateur activities have been limited to use by VHF and UHF enthusiasts, those whose interests are in the HF bands finding little to interest them. Limited lifetime and 'one-of-a-kind' nature of previous satellites was also no doubt a significant deterrent to widespread interest. It was felt that to popularise amateur satellite communication, a programme should be designed to motivate, inform and educate the general amateur population regarding satellite communication.

One point which to us seems important, is the suggestion that the choice of frequencies used should, as far as possible, be consistent, so that once an amateur radio station is equipped for satellite communication, changes in aerial systems, etc., will not be necessary with each succeeding satellite.

Much more information on amateur space communication techniques would appear to be necessary in the form of magazine articles, handbooks, etc., and encouragement is needed for manufacturers to produce equipment specifically designed for this purpose—such as, for instance, 144/432MHz arrays with azimuth-elevation mounts.

From the same Newsletter, some details of the next amateur radio satellite are given here. It will be designated AMSAT-OSCAR-B prior to launching and immediately after will be given a number in the OSCAR series. It is planned to equip the satellite with two transponders, two command receivers and two telemetry transmitters. It is hoped that the power will be provided by solar cells and have an operating life of one year. It is likely to have a near-Polar orbit, 700 to 900 miles high. Frequencies used will be in the 144 and 432MHz bands. A.C.G. ■

by W. G. Morley

This sixth article in our short series on tape recording commences by examining bias and erase oscillator design, after which it turns to the subject of record level indicators

In last month's issue we commenced an examination of the electronic circuit design encountered in the tape recorder. We looked at the overall circuit of a simple domestic tape recorder employing valves, and this enabled us to obtain a general idea of tape recorder operation using familiar valve amplifier stages. The tape amplifier employed the ECC83-ECL 86 line-up, which has tended to become 'standardised' in lower-cost machines, whereupon we were able, in addition, to become familiar with the basic operation of a wide number of tape recorders currently in use.

We shall now turn our attention to the ancillary stages of the tape recorder, and will also take in features found in the more expensive and comprehensive models. For the time being, we shall continue to work in terms of recorders employing valves.

ERASE OSCILLATOR

The erase oscillator described in last month's article used a circuit in which the oscillator valve is employed as an audio output valve when the replay function is selected. In higher grade recorders a separate valve is employed as erase oscillator, it being switched into circuit during record. The oscillator may be a single valve working in one of the standard resonant LC oscillator configurations (e.g. Hartley, Colpitts, etc.), but it is more usual to employ two valves in a push-pull arrangement As was stated earlier in this series, the output of a push-pull oscillator has a very low second harmonic content and is therefore particularly suitable for the generation of erase and bias signals.

A representative push-pull oscillator circuit is shown in Fig. 1. In this diagram, winding L1 and the tuning capacitance given by C3, C4 and C5 in series form a resonant LC circuit. C3 and C5 also function as the grid capacitors for leaky-grid bias with the two triodes. When the circuit is oscillating, maximum amplitude at oscillator frequency appears at the outside ends of L1, there being a point near the centre of this winding where oscillator amplitude with respect to chassis is zero. The position of the zero amplitude point along the winding depends upon the actual values, within tolerance, of the three capacitors C3, C4 and C5, and upon the relative gains of the two triodes, and will probably not be exactly at the physical centre-tap of the winding. It is for this reason that the h.t. positive supply is applied to the physical centre-tap of L1 by way of the low value resistor, R1, this resistor allowing for the presence of any small oscillatory voltage which may be present at this tap due to slight unbalance in the circuit. Normally, C3, C4 and C5 are close tolerance capacitors (plus or minus 5% or better) to provide reasonable symmetry and to ensure that the point of zero amplitude is close to the physical centre-tap of L1.

The two triodes can be sections

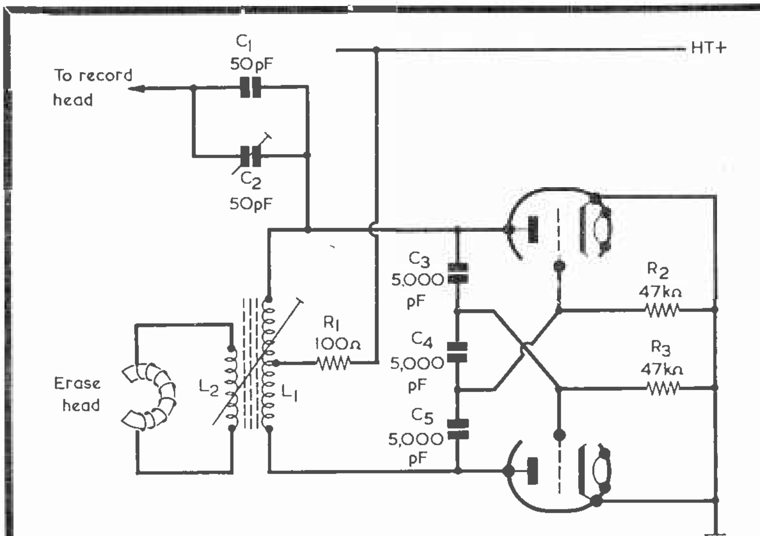


Fig. 1. A typical push-pull erase oscillator circuit, with representative component values

of a double-triode, such as the ECC 82 (12AU7). Since a double-triode takes up no more space than a single valve on the same base, the use of a push-pull oscillator instead of a single valve oscillator becomes an attractive proposition.

In Fig. 1. a secondary winding. L2, on the same ferrite core as L1 couples directly to the erase head. It may be briefly mentioned at this stage that the coupling between any erase oscillator tuned circuit and its erase head has to be designed very carefully to ensure that an adequate level of power is fed to that head with optimum overall efficiency. In some designs the erase head may, indeed, be made resonant at or near the bias frequency to ensure that it operates at a sufficiently high power level, one method of achieving this end consisting of inserting a capacitor in series with the head so that the two form a series resonant circuit. The fact that a relatively high level of power is handled by the erase head is very evident in some recorders, in which this head can become noticeably warm after the recorder has been in use, switched to the record function, for a period of time. Even if the head is not purposely intended to enter a resonant circuit, its inductance and stray capacitance may still have a considerable effect on the frequency of oscillation provided by the erase oscillator, and this is another factor which has to be taken into account during initial design of the circuit.

In Fig. 1 the bias voltage for the record (or record-playback) head is taken from one end of L1 via C1 and trimmer C2 in parallel, C2 being adjusted for optimum bias voltage across the head. In valve

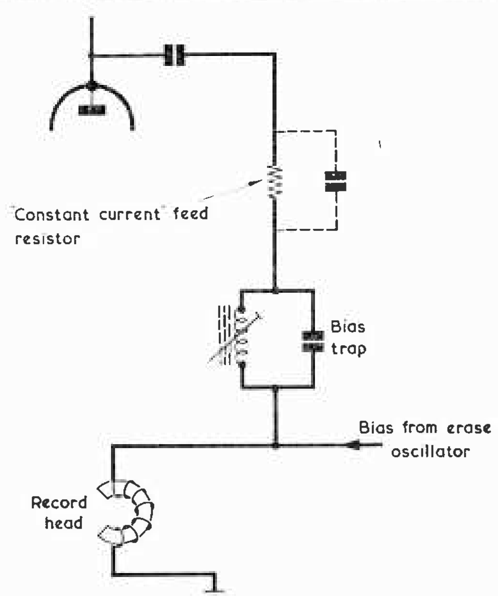


Fig. 3. Inserting a bias trap in the a.f. feed circuit to the record head

recorders the record head will normally have a higher impedance (due to its coil being wound with more turns of wire) than the erase head and will require a relatively large bias voltage, of the order of 50 volts r.m.s. or more, across its terminals. If, for a particular head, the basic circuit of Fig. 1 cannot supply a sufficiently high bias voltage, this could be obtained by using a larger coupling capacitance than that indicated in the diagram, but such a capacitance might then upset conditions at a.f. in the record head circuit. In consequence it is common, in cases of this nature, to add further turns at one end of L1, as in Fig. 2. These provide a high bias voltage for the record head, and at the same time allow a low value to be retained for the coupling capacitance to that head.

It is normally desirable to prevent the bias voltage at the record head from appearing at the anode of the amplifier valve which drives that head, since the bias voltage could upset operating conditions in the anode circuit. To prevent the bias voltage reaching the anode it is common practice to insert a *bias trap* in the a.f. feed circuit to the record head, as in Fig. 3. This trap is simply a parallel tuned circuit resonant at bias oscillator frequency, and it acts as a rejector circuit at that frequency. The trap is more necessary if the 'constant current' feed resistor has a low value capacitor (shown in broken line in Fig. 3) across it to give treble boost during record. The bias trap is frequently omitted in recorders which do not have such a parallel capacitor. This is mainly because the output anode, partly due to the circuit in which it appears, usually presents a relatively low impedance (both resistive and capacitive) to chassis, whereupon sufficient attenuation is provided by the 'constant current' resistor itself.

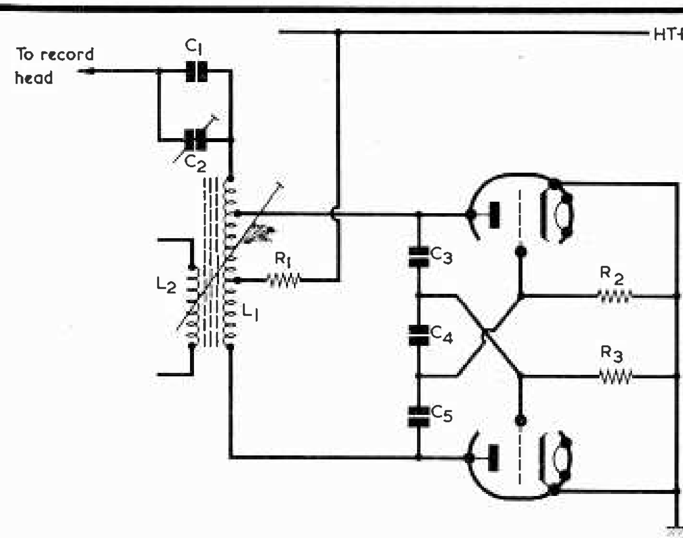


Fig. 2. If a high bias voltage is required at the record head this may be obtained, without increasing the values of C1 and C2, by adding extra turns at one end of L1

LEVEL INDICATORS

It is necessary to provide some form of audio level indication during recording to ensure that the signal passed to the record head is neither too small (whereupon the signal-noise ratio on replay becomes

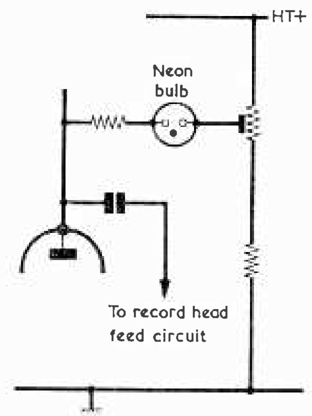


Fig. 4. A record level indicator employing a neon bulb

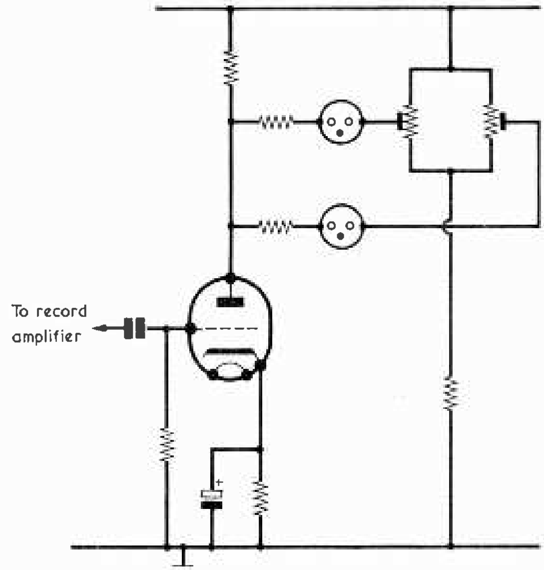
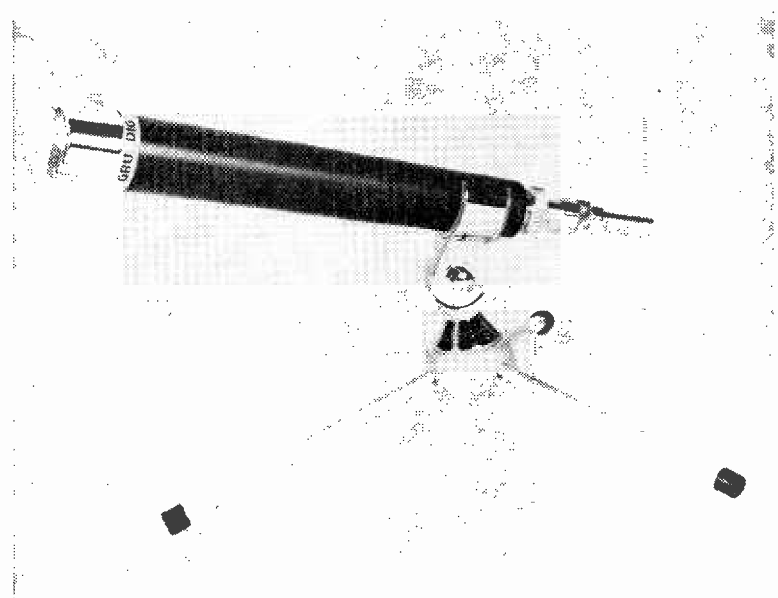


Fig. 5. A more comprehensive level indicator using two neon bulbs

low) nor too large (whereupon the tape would be overloaded).

A very simple level indicator, and one which is encountered in some of the more inexpensive machines, is provided by a neon bulb. This may be connected into circuit in a manner similar to that shown in Fig. 4, where it couples to the anode of the valve feeding the record head. The pre-set potentiometer in Fig. 4 is adjusted so that, at correct recording level, the neon bulb just fails to ignite. Higher audio levels then cause the neon to become illuminated on negative peaks of the a.f. waveform at the anode, whereupon it gives indication that the recording level is too high and is approaching overload. Whilst this circuit has the advantage of being very cheap in terms of cost of components, it suffers from the serious disadvantage that the indication provided is, to some extent, of a negative nature. The operator of the recorder can only tell if the recording level is satisfactory by observing that the neon bulb flashes occasionally only, when higher signal levels are fed to the recorder. Otherwise, he has to experimentally increase the record amplifier gain to a setting where the neon bulb flashes for most of the record signal amplitudes passed to the recorder, and then reduce the gain below that setting. Another disadvantage becomes evident in the cases where the valve to which the neon bulb is connected is a voltage amplifier, as occurs in Fig. 4, because the neon bulb adds extra loading when it becomes illuminated and thereby introduces distortion.

A more satisfactory type of neon bulb level indicator is illustrated, in basic form, in Fig. 5. In this instance there are two neon bulbs, each coupling to its own pre-set potentiometer. One potentiometer is adjusted so that the associated neon bulb ignites when the audio signal is at an adequate level for recording, and the other potentiometer is adjusted so that the second neon bulb becomes illuminated when the record level approaches overload. In this case the operator of the recorder can set record level gain so that the first neon bulb flashes almost continually in the presence of signal, whilst the second flashes only occasionally or not at all. To avoid introducing distortion the two neon bulbs need to be fed by a separate valve outside the record



A tape recorder requires a high-grade microphone for optimum results. The moving-coil microphone shown here is type GDM321 in the Grundig range, and it offers a frequency response from 40 to 20,000Hz

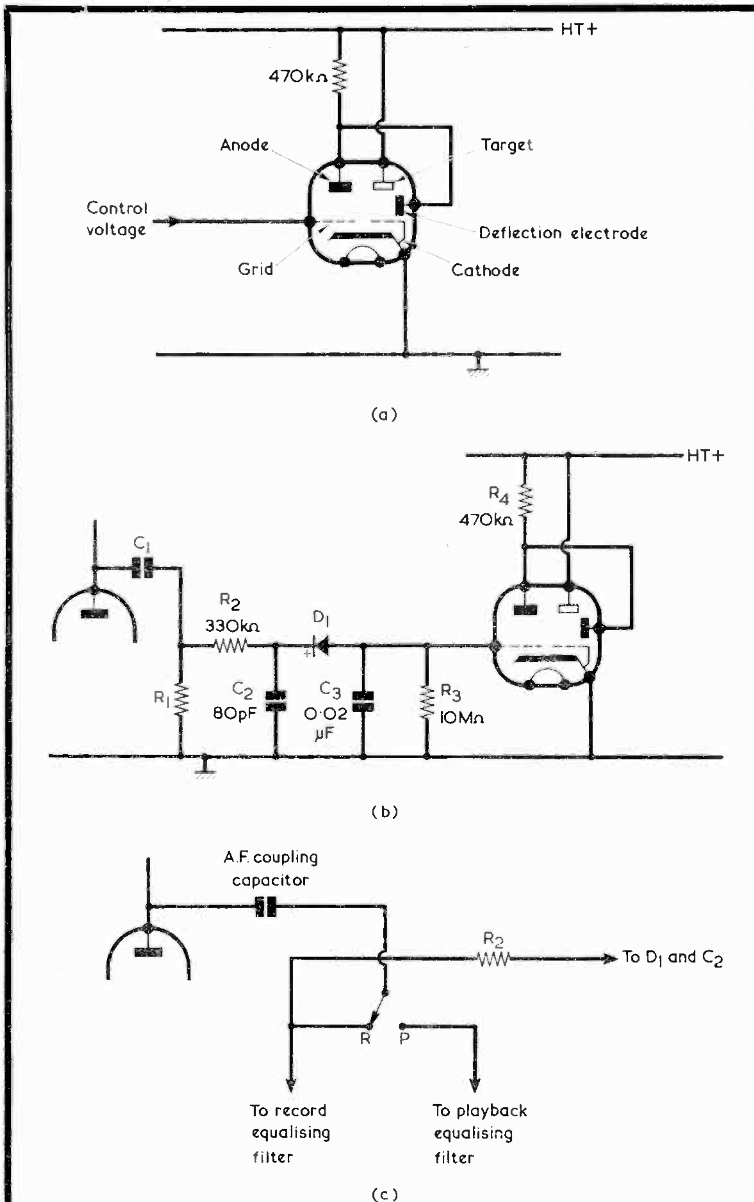


Fig. 6(a). The circuit symbol for an electron beam tube, as employed for level indication in tape recorders
(b). The electron beam tube connected in a level indicator circuit. The component values shown are representative
(c). In many practical instances, C1 and R1 of (b) are not required, as the level indicator may be coupled into the input circuit to the record equalising filter, as shown here

amplifier proper, this valve obtaining an a.f. input by coupling its grid into the amplifier at a suitable point. Unfortunately, this means that an extra valve is required in the recorder and the economy of components, which is the only real advantage conferred by the use of neon bulbs, becomes largely cancelled out.

ELECTRON BEAM TUBE

A much better form of level indication is one which continually monitors the audio level during record. A very popular indicator in this class is provided by the electron beam tube, of which typical examples are the EM84 and EM87. An electron beam tube displays a column of fluorescent light which varies in length according to the value of a direct voltage applied to its control grid.

The circuit symbol for an electron beam tube is shown in Fig. 6(a), which also indicates the manner in which it connects into circuit. A direct voltage corresponding to the audio level in the record amplifier is applied to the control grid in the left hand section of the tube, as shown in the diagram. This grid forms part of a triode, the anode of which couples to the h.t. positive line of the recorder amplifier via a resistor of, typically, 470kΩ. The right hand section of the tube, as shown in Fig. 6(a), is that which produces the fluorescent display, this being caused by a flow of electrons from the cathode towards the positively charged target. As will be seen, the latter is connected direct to the h.t. positive rail.

The right hand section of the tube also includes a deflection electrode, which is connected to the anode of the left hand section. It will be realised that if the direct voltage at the grid of the left hand section is changed gradually – starting at the negative cut-off voltage for the triode and ending at zero volts with respect to cathode – the anode current will continually increase and the anode voltage will continually fall. This changing anode voltage is applied to the deflection electrode and the latter then causes the length of the fluorescent column to change from minimum to maximum over the range of changing control voltage at the triode grid. Thus, the electron beam tube provides a relatively inexpensive visual indication of the magnitude of the direct voltage at the grid of its triode section.

The electron beam tube is shown connected in a typical level indicator circuit in Fig. 6(b). The valve anode in this diagram is that supplying the record head, and it couples to rectifier D1 via resistor R2. D1 is connected into circuit such that it passes negative half-cycles of the audio waveform, whereupon capacitor C3 charges up to very nearly the peak value of these half-cycles. The rectified voltage on the upper plate of C3 is passed to the grid of the electron beam tube which then shows, by the length of its fluorescent column, the amplitude of the audio signal fed to the diode.

In Fig. 6(b) capacitor C3 has resistor R3 connected across it. In normal circuits of this type, R3 has a much higher value than the resistor, R2, which passes the audio signal to the diode. In consequence, capacitor C3 charges more quickly in the presence of sudden signal increases than it discharges into R3 during the intervals between such increases. The result is that the level indicator is quick to respond to sudden signal peaks, the indication it provides decaying afterwards at a lower rate. This is a desirable feature in a record level indicator as the indication then tends to correspond to average signal level but is always capable of responding quickly to any sudden peaks which could cause overload.

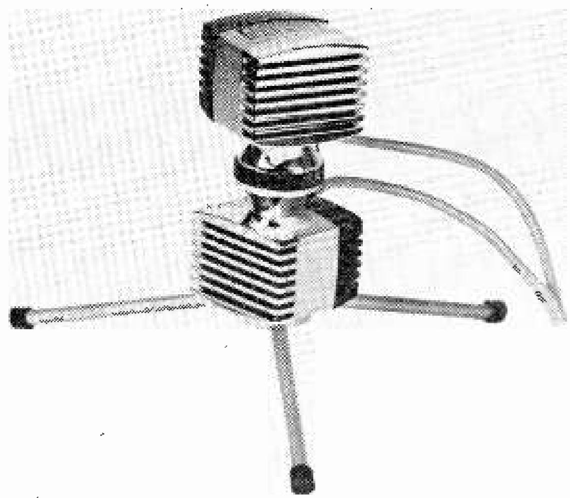
Although resistor R2 is smaller in value than R3 it is still high enough to ensure that negligible loading is placed on the amplifier anode circuit to which it is coupled. The low value capacitor C2 is usually encountered in indicator circuits of this nature, particularly when no bias trap is fitted, and it bypasses any bias voltage which might otherwise be applied to the diode and which would cause deflection of the indicator display in the absence of audio signal. Diode D1 may be a standard germanium diode, such as the OA81.

Resistor R2, in Fig. 6(b), couples to the anode of the amplifier valve by way of coupling capacitor C1 and resistor R1. The function of these last two components is to ensure that the end of R2 which is remote from the diode has an average potential which is equal to chassis potential, this being an essential requirement for correct rectification of the a.f. signal voltage. In domestic recorders of the type we examined last month, in which the negative feedback equalisation filter circuits are also connected to the anode which feeds the record head, it is usual to connect R2 to the record filter circuit after the appropriate section of the record-playback switch, as in Fig. 6(c). In this diagram the existing a.f. coupling capacitor takes the place of C1 in Fig. 6(b), whilst the record-playback switch ensures that the indicator input is taken out of circuit during playback, when level indications are not required. The d.c. path to chassis provided by R1 in Fig. 6(b) is now given by the resistor network in the filter circuit itself.

METER LEVEL INDICATOR

As already stated, the electron beam tube has the advantage of providing a relatively inexpensive record level indicator. It is particularly suited for domestic tape recorders because it offers a display which is visually attractive and because non-technical people can readily interpret the indications it provides. On the other hand, it does not give a *precise* indication at all record levels. Tape recorders with a more comprehensive specification employ meters to indicate record level. (So also do transistor tape recorders, which do not have the h.t. supply necessary for the operation of an electron beam tube.)

Level indicator circuits employing meters vary considerably but they all have the same basic function, which is that of causing the meter needle to be deflected from its zero position according to the level of the audio signal applied during recording to the record head. The scale of the meter fitted to the recorder may be calibrated in linear manner in arbitrary units, say from zero to 10, or it may simply have a single mark at about two-thirds full-scale deflection to indicate the level above which overloading is liable to occur. Level meters in the more comprehensive recorders may be calibrated in decibels.



This stereo microphone, type GDSM330, and also manufactured by Grundig, features two high quality directional moving-coil microphones. The two microphone system can be rotated or used separately

A simple level indicator circuit incorporating a meter is shown in Fig. 7. This works with a rectifier circuit which has similar components and operates in the same manner as did that of Fig. 6(b). This time, however, the rectified voltage is applied to the grid of a triode instead of to the control grid of an electron beam tube. In the absence of signal, pre-set potentiometer VR2 is set up such that the meter has zero deflection. When a signal is applied to the rectifier the grid of the triode goes negative and its anode goes positive, thereby causing a forward deflection of the meter needle. Pre-set potentiometer VR1 is then set up so that the meter gives the requisite indication when the record audio level approaches the overload condition.

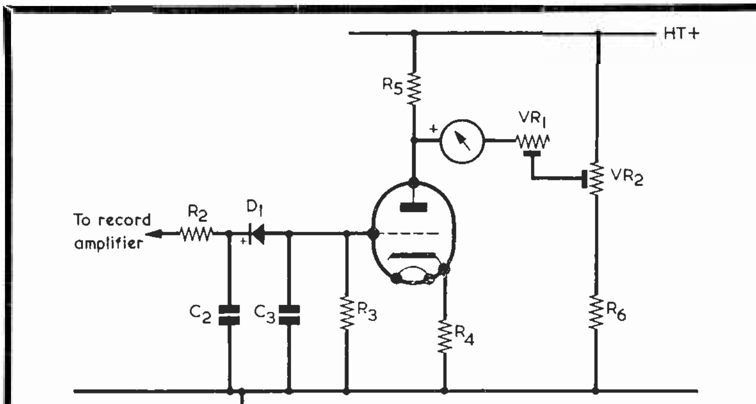


Fig. 7. A simple meter level indicator circuit. The components in the grid circuit of the triode may have the same values as in Fig. 6(b), and they couple into the record amplifier in the same manner

In Fig. 7 the meter may, typically,

be a 0-1mA instrument. Its mechanical design should be such that needle movement is only lightly damped, thus enabling it to respond quickly to sudden increases in record signal level. A slow decay after peaks will still be given, as with the electron beam tube indicator, due to the values chosen for R3 and C3. Under the circuit conditions shown in Fig. 7, the meter offers a roughly linear indication of record level amplitude, in so far that its deflection is approximately proportional to the peak voltage of the audio signal applied to the diode rectifier. If the meter is to be calibrated in decibels it would be preferable for it to be calibrated in fairly linear manner in these units, whereupon the meter is required to offer a logarithmic response. This can be achieved by arranging for its deflection current to be supplied by a variable-mu valve, which has an Ia-Vg characteristic that approximates sufficiently closely to a logarithmic curve to enable it to be employed for this purpose.

NEXT MONTH

In next month's issue we shall continue our examination of the electronic features of tape recorder design. ■

CONFERENCE ON AEROSPACE ANTENNAS

The IEE Electronics Division, in association with the Institution of Electronic and Radio Engineers is organising a Conference on 'Aerospace Antennas', to be held at the Institution of Electrical Engineers, Savoy Place, London, on 8, 9, 10 June, 1971.

The Conference is intended to be of interest to those responsible for the design, installation and use of radio and radar antenna systems for aircraft and other aerospace vehicles. Both military and civil applications will be considered.

Offers of contributions for the Conference programme are invited and intending authors should submit a synopsis of about 250 words to the IEE Conference Department before Monday, 2 November, 1970.

Further details and registration forms will be available in due course from the Manager, Conference Department, IEE, Savoy Place, London WC2R 0BL.

In your workshop

"INTEGRATED CIRCUITS," snorted Dick, "life seems to be nothing else but integrated circuits these days."

Smithy's assistant threw the trade journal he had been reading down on his bench with a gesture of disgust.

"Well," said Smithy mildly, as he took a further sip of tea from his tin mug, "you can't stop progress, you know, and you'll just *have* to get used to integrated circuits. We're going to see more and more of them in the future, because they're bound to replace a lot of the discrete components in the radios and TV's we service. In fact, they've already made an appearance in some sets."

LOGIC GATES

"What," asked Dick suspiciously, "do you mean by that word 'discrete'? It seems to me to be a funny word to apply to radio and TV components."

"I didn't use the word that's spelt with double-E and a T at the end," explained Smithy, as he absentmindedly flicked from his trousers a crumb from the lunch-time sandwiches he had just consumed. "The word I used ends in E-T-E. And it means separate or individual components, as opposed to the components that are actually embodied in the integrated circuit itself."

"Oh, I get it," remarked Dick. "Well, I certainly don't mind seeing a few i.c.'s in the future sets I fix. What riles me so much is the mumbo-jumbo that seems to be building up around these integrated circuits."

He picked up the journal from his bench and pointed to a full-page advertisement in it.

"Just look at that ad.," he continued aggrievedly. "It's been put in by a company that's flogging i.c.'s, and all they describe them as are r.t.l.'s d.t.l.'s and t.t.l.'s. So far as I'm concerned, these initials just don't make any sense at all."

"What those initials stand for," replied Smithy, "are 'resistor-transistor logic', 'diode-transistor logic' and 'transistor-transistor logic'. The i.c.'s concerned are digital types which are intended for computer work."

"Your explanation," pronounced Dick, "leaves me just as baffled as I was before!"

Smithy pondered for a moment.

"I don't think it would be a bad idea," he remarked eventually, "if I were to give you a bit of background on these digital i.c. gates. The basic principles involved are quite simple and, with computer technology advancing at the rate it is these days, it's wise for anyone who works in electronics to take an interest in them."

"I'll certainly agree with that," said Dick keenly. "And it will certainly be pleasant to be able to understand those darned initials."

"Fair enough," replied Smithy.

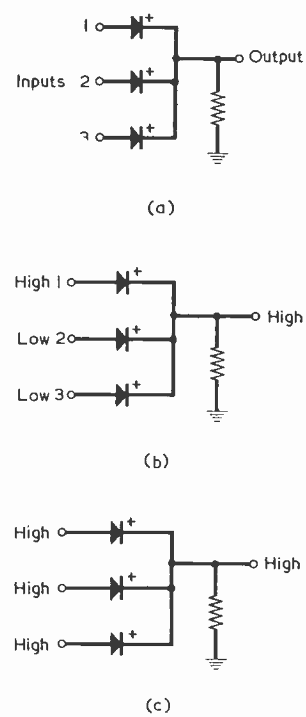


Fig. 1(a). A simple diode OR gate (b). If one input goes high (i.e. goes positive of earth) so also does the output (c). The output also goes high when all three inputs are high

"Well, the first thing I should tell you is that those initials are mainly applied to gates which are built up in integrated circuit chips. We've discussed gates in the past and there's been quite a bit published in the technical press about them. So let's start off with your telling me all you know about gates."

"Now let me think," responded Dick. "Ah yes, this bit's easy! There's four main types of gate, these being the OR gate, the AND gate, the NOR gate and the NAND gate."

"Good." commended Smithy. "Well then, let's next take a look at a simple OR gate using diodes."

Smithy pulled his note-pad towards him and scribbled out a circuit. (Fig. 1(a)).

"Here's one of the simplest OR gates you can have," he remarked, as he laid down his pen. "As it happens I've given it three inputs, but it could have any number of inputs within reason. Now, we're going to make the assumption that the inputs of this gate are in one of two states, voltage-wise. One state is given with the input at earth potential, and the other state is given when the input is at a positive potential above earth. We'll say that when an input is at earth potential it's 'low', and that when it's at the positive potential it's 'high'."

"What about the output of the gate?"

"The same words apply there, too," said Smithy. "Now, if all the inputs to our gate are low, so also is the output. If, however, input 1 goes high the diode at input 1 conducts and causes the output to go high, too. (Fig. 1(b)). The remaining diodes are then reverse-biased and do not conduct. The output will also go high if any other input goes high, if two inputs go high or if all three go high." (Fig. 1(c)).

"Which," chimed in Dick, "is just what an OR gate is supposed to do. Using the words 'high' and 'low', the output goes high when any single input goes high. It also goes high when more than one input goes high, or when all inputs go high."

"That's the idea," said Smithy approvingly. "We'll next look at an AND gate using diodes. Once again I'll give it three inputs. This time we need a d.c. supply, which can be around 5 volts positive of earth. (Fig. 2(a)). Now, if all inputs to the gate are low the three diodes conduct and keep the output low, too. Should one input go high, the output still remains low, because the remaining diodes at the other two points are still conducting. (Fig. 2(b)). The output will only go high when *all* the inputs go high."(Fig. 2(c)).

"In other words," remarked Dick, "the output goes high if, and only if, *all* inputs are high. Which is the proper function of an AND gate."

From time to time Smithy the Serviceman takes his able assistant Dick through some of the basic principles of digital computers. This month he proceeds to explain the meaning of those mysterious initials that are applied to integrated circuit logic gates: r.t.l., d.t.l. and t.t.l.

NOR AND NAND GATES

"Exactly." confirmed Smithy. "Now let's turn our attention to simple NOR and NAND gates. We can change our OR gate to a NOR gate by adding a transistor after it to act as an inverter."

Smithy sketched out the new circuit. (Fig. 3(a)).

"In this case," he resumed, "the diodes function just as they did when they were on their own. Their output now connects to the base of the transistor via a resistor to limit base current and we take the output of the gate from the collector of that transistor. When all the inputs are low there is no base current in the transistor and it's cut off. The output is then high, as no voltage is dropped across the resistor in the collector circuit. If any of the inputs go high, base current flows in the transistor and it bottoms, whereupon the output goes low."

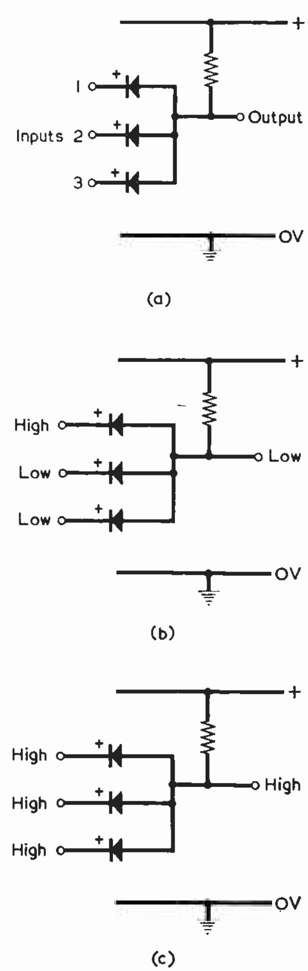


Fig. 2(a). A diode AND gate (b). If only one or two inputs go high, the output stays low (c). The output only goes high when all three inputs go high

"In other words," put in Dick, "the output is normally high, but goes low when any input goes high. It's just the same as the OR gate but the output is inverted."

"You've got the idea," confirmed Smithy, sketching out a further circuit. (Fig. 3(b)). "If I add a transistor after the diode AND gate I get a NAND gate. The functioning of the transistor is just the same as with the NOR gate and it inverts the output. This output is now normally high, and it goes low when all, and only all, the inputs go high."

Smithy reached for his mug and, with a flourish, drained it in one prodigious swallow.

"Gosh," said Dick, awed at this feat. "Your Adam's apple shot up about four inches then."

"Did it?" replied Smithy interestedly. "Anyway, get me a spot more tea, and then I'll continue with this gate business."

Obediently, Dick took Smithy's mug over to the sink and filled it from the cracked and stained Workshop tea-pot. He returned and placed the mug on Smithy's bench. The Serviceman picked it up and took a further gargantuan draught.

"Ah," he said, wiping his mouth with the back of his hand, "that's better; this nattering always makes me thirsty. Anyway, to return to these gates of ours. Now, you'll remember that, a few moments ago, I made an assumption that all inputs and outputs are either at a positive potential above earth, or were at earth potential itself, these states being called 'high' and 'low' respectively. This is an example of what is known as 'positive logic'."

"Blimey," said Dick frowning, "things are beginning to get difficult now."

"No, they aren't," retorted Smithy. "When the gates are used in a computer they'll very probably be handling binary numbers which, as you know, consist either of 0 or 1.

(Continued on page 181)

NEW PRODUCT – SELF-INDICATING ELECTRONIC SWITCH

Recently introduced by English Electric Valve Co. Ltd., the QT1256 is a cold cathode tube designed as a self-indicating electronic switch which is actuated by touch, or by otherwise altering its capacity to earth.

A two-electrode device, it is a special type of trigger tube, which may be switched to the conducting state by the touch of a finger on an external control electrode situated at the end of the tube. In the conducting state, the current flowing through the tube may be used to operate a relay and a visible glow is emitted until the h.t. supply is momentarily interrupted for a time exceeding the tube deionisation time. The glow serves as an ON/OFF indicator.

In addition to providing a combination of switch and indicator, this tube also offers a completely silent method of switching.

Ratings of the QT1256: Minimum anode-cathode d.c. breakdown voltage 475V; anode-cathode d.c. maintaining voltage at 10mA, 185V; maximum continuous cathode current, 25mA; maximum peak cathode current, 100mA. Mechanical data: height (maximum) 64.22mm (2.529in.); diameter (maximum) 31.83mm (1.253in.); base, International Octal.

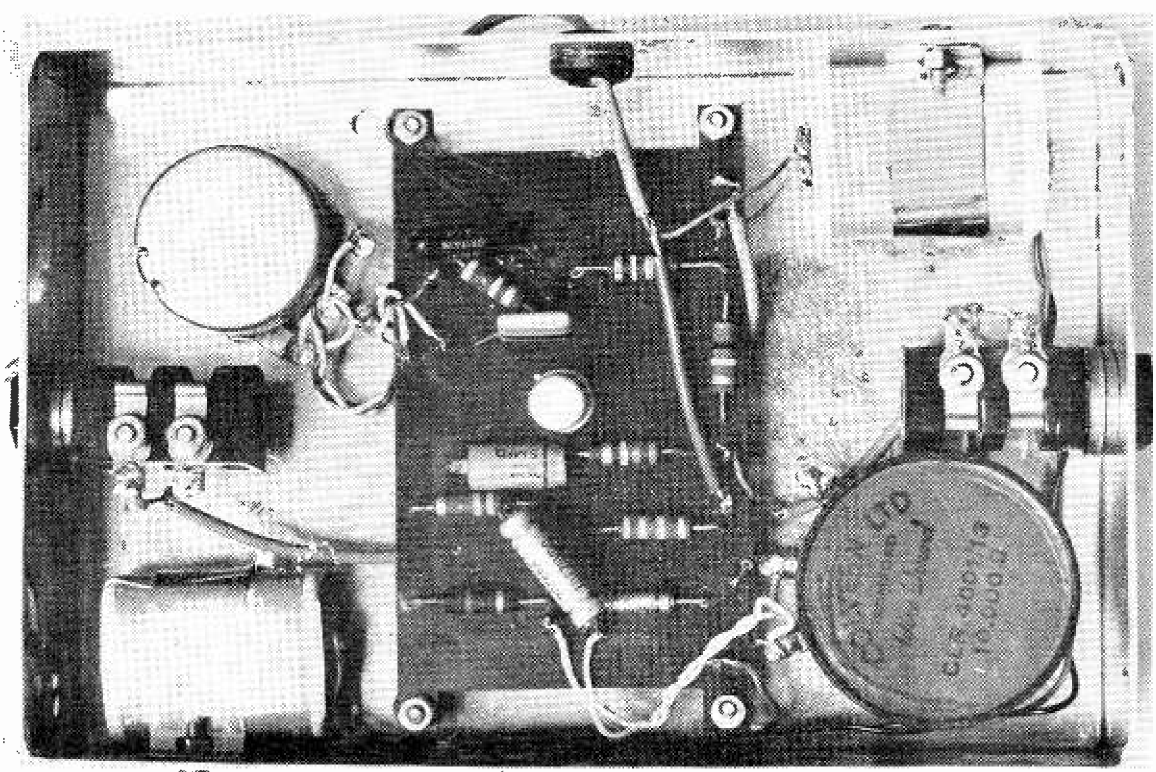
ULTRA-SIMPLE TREMOLO UNIT

(Continued from page 147)

base for the unit is optional but, with the writer's unit, a box inset lid was constructed out of perforated aluminium and four rubber feet attached to this.

USING THE UNIT

To use the tremolo unit simply plug the jack plug from the guitar into the input of the device and take an extension lead from the output of the unit to the main amplifier. By depressing the footswitch the oscillator part of the circuit is connected in, and the modulated sound effect is obtained. Speed and depth of modulation are determined by potentiometers VR1 and VR2 respectively.



The internal components and wiring in the tremolo unit. (A 10kΩ potentiometer was fitted in the VR1 position when this potograph was taken)

Cut along this line

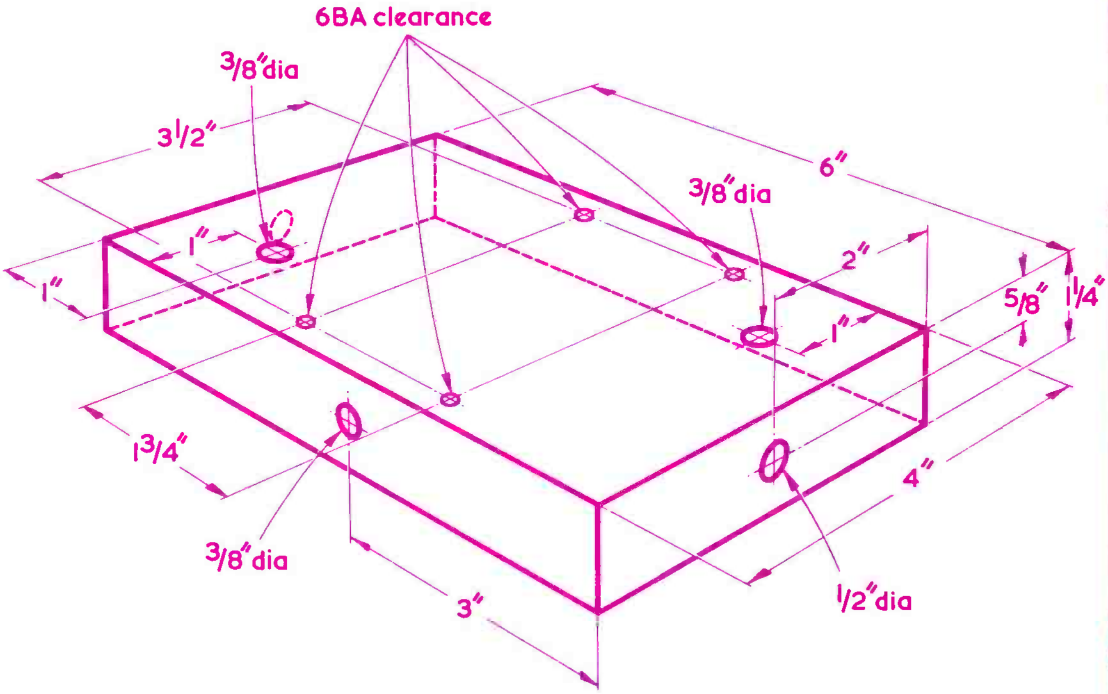


Fig.5. Dimensions of the metal case

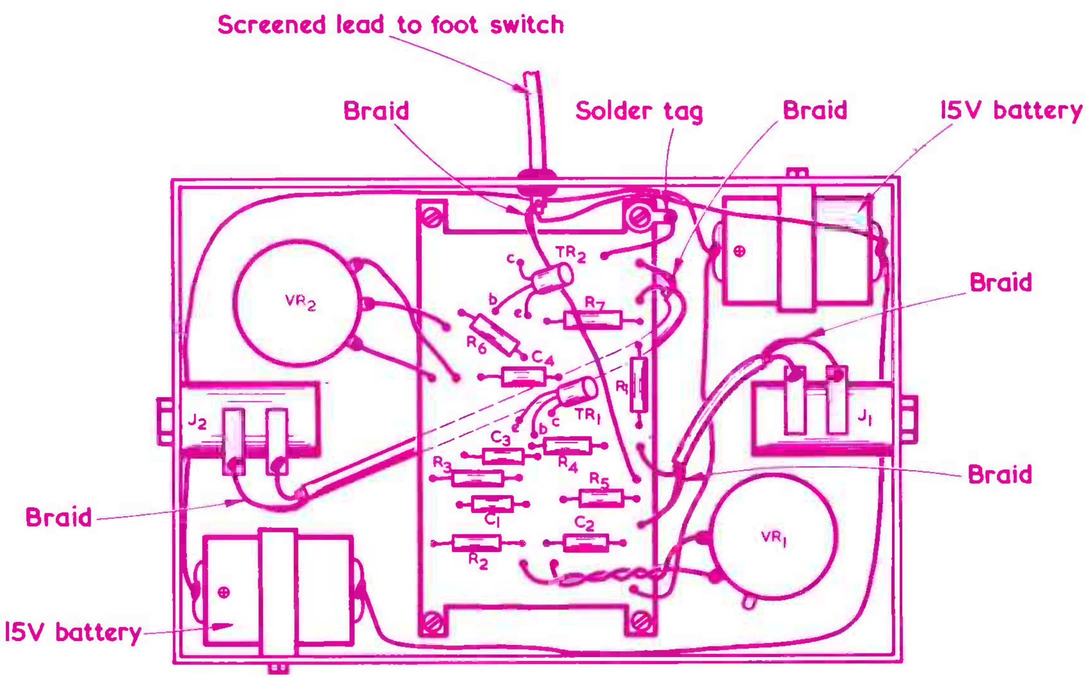


Fig.6. Final details of wiring and layout

RECENT PUBLICATIONS

SERVICING WITH THE OSCILLOSCOPE. By Gordon J. King, Assoc.I.E.R.E., M.I.P.R.E., M.R.T.S. 176 pages, 5½ x 8½in. Published by Newnes-Butterworths. Price 28s.

The very first thing one notices on turning through the pages of this book is the large quantity of photographs taken direct from the c.r.t. of the oscilloscope. These are backed up by pictures taken from the television screen to illustrate the results of faulty operation. The space ratio of photographs to text is, indeed, of the order of 1 : 2. Such an approach is to be particularly commended as it takes the reader direct to the source of information with which he will be working. Very many of the photographs are marked up with legends defining the symptoms that the traces demonstrate, these including such things as overshoot, tilt, rounding and the like.

The book commences with a description of the oscilloscope itself and the manner in which it should be coupled to the equipment being serviced. There are, next, three separate chapters devoted to video waveforms, synchronising waveforms and timebase waveforms respectively, these being followed by a chapter covering TV hum and distortion tests, wobbulator alignment and the waveforms to be encountered in colour television receivers. The last two chapters describe the use of the oscilloscope with stereo radio receivers and with audio equipment.

The book is written in a clear and concise style and the approach is non-mathematical. It will be found of considerable use to the service engineer, particularly in the realm of colour television.

THE PRACTICAL AERIAL HANDBOOK, Second Edition. By Gordon J. King, Assoc.I.E.R.E., M.I.P.R.E., M.R.T.S. 232 pages, 6 x 9¼in. Published by Newnes-Butterworths. Price £2 14s.

Another work by one of the most prolific of British technical journalists, this book is the second edition of a volume which originally appeared as recently as 1967. The new edition incorporates added information on several new aerial designs and takes in a number of suggestions made by readers and reviewers.

As the author points out, far too many radio and television receivers are operated with inadequate aerials whereupon, in their struggle to pick up as much signal as possible, the sets reproduce interference, including self-generated interference, at a much higher level than should normally occur. Virtually every class of receiving aerial from the ferrite rod to the u.h.f. Yagi is discussed in the book under review, and advice is given on obtaining the best possible results with each type.

"The Practical Aerial Handbook" commences by considering propagation and the principles of aerials and feeders, then carries on to practical aerial systems and their erection and maintenance. Further chapters deal with signal combining and splitting, signal boosting and shared aerial systems. The final chapter describes radio and television interference and discusses how such interference may be avoided or suppressed.

The book is well illustrated with clear diagrams and photographs, and will be helpful to anyone who is concerned with what is, after all, the most essential element of any receiving installation.

HOW TO USE INTEGRATED CIRCUIT LOGIC ELEMENTS. By Jack W. Streater. 142 pages, 5½ x 8½in. Published by W. Foulsham & Co. Ltd. Price 28s.

This book is in the Foulsham-Sams Technical Book series, and consists of a text initially intended for American readers, preceded by an added introductory chapter for the English reader. It is primarily aimed at the engineer or designer who has not previously used or designed digital logic circuits. In consequence, it is written at a level which can be followed by anyone who has a good working knowledge of entertainment electronics or has a similar familiarity with an allied branch of the art. The subjects covered are binary notation and Boolean algebra, gates, bistable elements, comparison of logic elements and the use of currently available logic elements.

In the reviewer's opinion this books meets a want which has not previously been adequately satisfied. it is refreshing to pick up a book that takes the reader painlessly through such items as DTL, TTL, J-K flip-flops and the like without resorting to the somewhat esoteric jargon that nowadays flourishes in the field of computer electronics. The book should be of considerable interest to the advanced amateur experimenter who wishes to take advantage of the latest devices now appearing on the home-constructor retail market. It will appeal also to the professional engineer who wishes to bring his knowledge on logic elements up to date.

The components and integrated circuits mentioned in the book will not be as readily obtainable in this country as they are in America, but this should not put off the keener reader who is more interested in circuit principles and is capable of using alternative devices. (DTL and TTL, by the way, stand for "diode-transistor logic" and "transistor-transistor logic".)

ULTRA SIMPLE TREMOLO UNITS

(Continued from page 179)

If the unit is found not to function correctly check initially that the oscillator circuit is working. This may be done by connecting an oscilloscope or valve voltmeter between TR1 collector and chassis. If this part of the circuit is functioning correctly the voltmeter needle will oscillate at several times a second. The same result should be given by a sensitive voltmeter (10,000 ohms per volt or more) connected across R5. Check that the circuit oscillates over the entire range given by VR1. If this does not occur, substitute the transistor for another one of higher gain. In fact, however, it was found that practically any small audio transistor will function in the circuit quite satisfactorily. If the oscillator still does not function check the resistors and capacitors and ensure that these have the correct values. ■

IN YOUR WORKSHOP

(Continued from page 177)

If we consider the high condition to correspond to binary 1, and the low condition to correspond to binary 0, then we are once again using positive logic. Positive logic is being employed whenever you work to the assumption that the significant state is the one which corresponds to a potential removed from earth, and the less significant state to the potential which is closer to earth potential. We used the words 'high' and 'low', but you'll find other terms employed as well, such as 'up' and 'down'."

"If," said Dick thoughtfully, "you can have positive logic, can you also have negative logic?"

"You can," confirmed Smithy. "In negative logic you work to the assumption that binary 1 corresponds to the earthy state and binary 0 to the potential removed from earth. It's interesting to note that, with negative logic, the OR gate I drew up at the beginning becomes an AND gate. This is because if all inputs are positive, which in negative logic counts as binary 0, the output is positive too, and it can only be brought down to earth potential by bringing *all* inputs down to earth potential."

"Oh, I see," said Dick brightly. "The OR gate is then working like an AND gate upside-down, isn't it?"

"That's right," agreed Smithy. "With negative logic, you'll also find that the AND gate becomes an OR gate, the NOR gate becomes a NAND gate and the NAND gate becomes a NOR gate. But don't worry too much about this negative logic business, because it's more usual to work with positive logic. Nevertheless, it's worth knowing what negative logic is, because you're liable to encounter references to it if you ever start working seriously with gate circuit."

R.T.L. GATE

Smithy picked up his mug and once more drank deeply.

"Right," he said briskly. "After that little bit of introduction we can next get down to those sets of initials which have been puzzling you. Also, we now move into the realm of integrated circuits and away from circuits employing discrete components, whereupon we encounter rather a different sort of world. This is because the integrated circuit designer does not have to restrict the number of transistors and diodes he uses and he can afford to be quite lavish with these if he wants to be. The only other components we'll meet here, so far as the digital i.c.'s we're now going to discuss are concerned, are resistors. Having said that, let's commence with a resistor-transistor logic gate, as is employed in an r.t.l. integrated circuit. We'll keep on using positive logic, and we'll continue to employ the terms 'high' and 'low' as before."

Smithy tore the top sheet from his note-pad and sketched out a further circuit on the clean page underneath. (Fig. 4.)

"Take a look at this." he remarked. "It's a typical example of an integrated circuit r.t.l. gate. As you'll see in a moment, it's a NOR gate. When both inputs are low, the output is high because both the transistors are cut off. If one, or both, inputs go high the associated

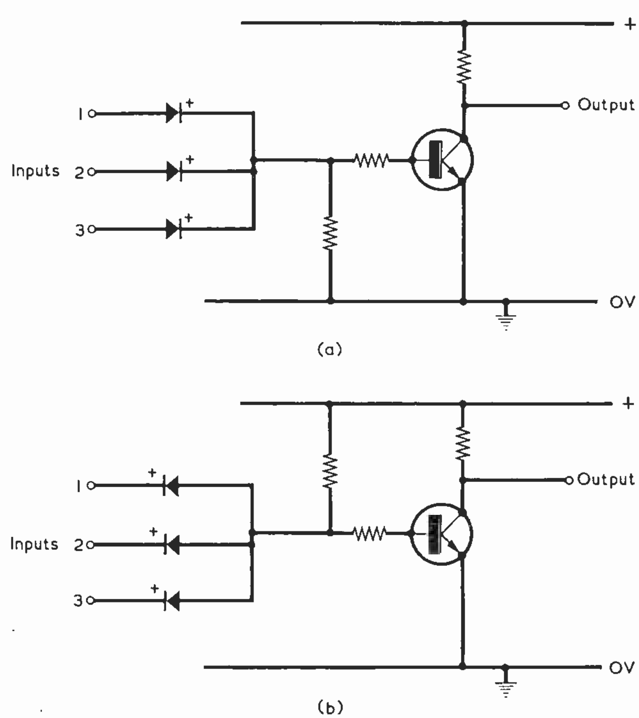


Fig. 3(a). Adding a transistor after the diode OR gate converts it to a NOR gate. (It is assumed here that there is zero forward voltage drop in the diodes)
(b). A transistor following the diode AND gate results in a NAND gate

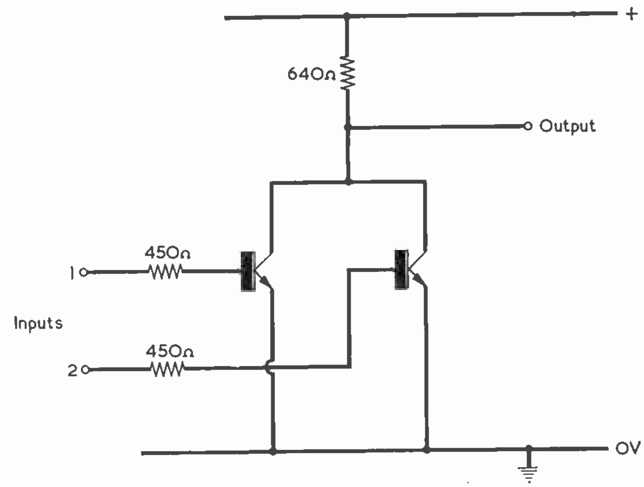


Fig. 4. An integrated circuit r.t.l. NOR gate. Component values given in this and subsequent diagrams are representative of current practice

transistor or transistors become turned fully on and the output goes low."

"Can you," asked Dick, "couple the output of one r.t.l. NOR gate to the input of another r.t.l. NOR gate?"

"Oh yes," replied Smithy. "In a practical logic function circuit you can couple the output of one gate to the inputs of several other gates. Like this."

Smithy sketched out a further circuit. (Fig. 5.)

"You'll note," he went on, "that it's possible to couple the gates directly. When the output of the first gate is low so also are the inputs of the following gates, and their associated transistors are cut off. When the output from the first gate is high, current flows through its collector resistor into the bases of the transistors in the subsequent gates, causing them to become bottomed."

"I can see a snag here," remarked Dick.

"What's that?"

"Well," said Dick, "if you couple too many gates to the first gate, the collector resistor in the first gate won't be able to pass enough current to turn on all the following transistors."

"That's a very good point," commended Smithy. "And you've described exactly what can happen in practice. Because of this effect, the maximum number of subsequent gates which a gate can drive is quoted in the gate's specification. It's known as it's 'fan-out number'. If a gate has a fan-out number of 6, for instance, it cannot be used to drive more than this number of subsequent gates. In this context the subsequent gate inputs are, incidentally, often referred to as 'loads'. Whilst we're on the subject of specifications I think I had better point out that, although we've been talking up to now of the low input state as being at earth potential, it will in practice be a little higher. For instance, with an r.t.l. gate the output voltage in the low state is, actually, the voltage across the collector and emitter of the transistor when it's bottomed. This fact needn't worry you too much so far as basic operation is concerned, but it has to be borne in mind when you're getting down to detailed examination of these gates."

"I got the impression from that advertisement I was reading just now," said Dick, "that r.t.l. gates aren't as good as the other types."

"They aren't so fast in operation," explained Smithy. "This being partly due to the stray capacitance between the transistor base and earth inside the integrated circuit chip, together with the series input resistor. Because of this combination of C and R, the circuit takes a little longer to operate than do the other types of gate which we'll next be considering. Incidentally, the r.t.l. gate was the first to be produced in integrated circuit form, the reason for this being that it was the easiest to make up. After manufacturers obtained experience with integrated circuit production, the more complicated d.t.l. and t.t.l. gates were developed and produced. I think I should add, too, that a single i.c. chip need not contain a single gate only. It normally has quite a quantity of them, all of them running from the same earth and supply terminals."

D.T.L. GATE

Smithy paused and drank deeply

from his mug.

"After the r.t.l. gate had come into use," he resumed, "the d.t.l. gate was the next to appear. It has a basic circuit like this." (Fig. 6.)

Dick waited until Smithy finished, then examined the circuit the Serviceman had drawn.

"From the polarity of those diodes at the left," he remarked, frowning thoughtfully, "it looks as though the input section carries out an AND function in the same way as did the simple AND gate we looked at in the beginning."

"It does," confirmed Smithy. "Actually, the whole thing is a NAND gate. If the inputs are low, the base of TR1 in the gate is held down at a low level and can only go positive when *all* inputs go high. With one or more of the inputs low, TR1 is cut off and no base current flows in TR2. This transistor is also cut off, whereupon the output is high. When, due to all inputs going high, the base of TR1 goes positive, it causes TR2 to bottom and the output to go low."

"What's that other diode doing?" asked Dick.

"Which diode?"

"The one between the two transistors. The one you've marked as D4."

"Ah," said Smithy, looking at his circuit. "Well now, that diode is included to provide a forward voltage drop. You have to remember that, since we're dealing with integrated circuits, all the diodes and transistors are silicon types, with the result that you get a drop of about 0.6 volt across any forward-biased diode or junction. Now, imagine that the output of this gate is coupled directly to an input of another similar gate. When the output of the first gate is high current can flow into the second gate via R4. When the output of the first gate is low, however, the voltage at that output is equal to the voltage appearing across the emitter and collector of TR2 in the bottomed condition. A further voltage also appears across the input diode of the second gate. This means that the base of TR1 in the second gate is positive of earth by the voltage across a bottomed transistor plus the voltage across a forward-biased

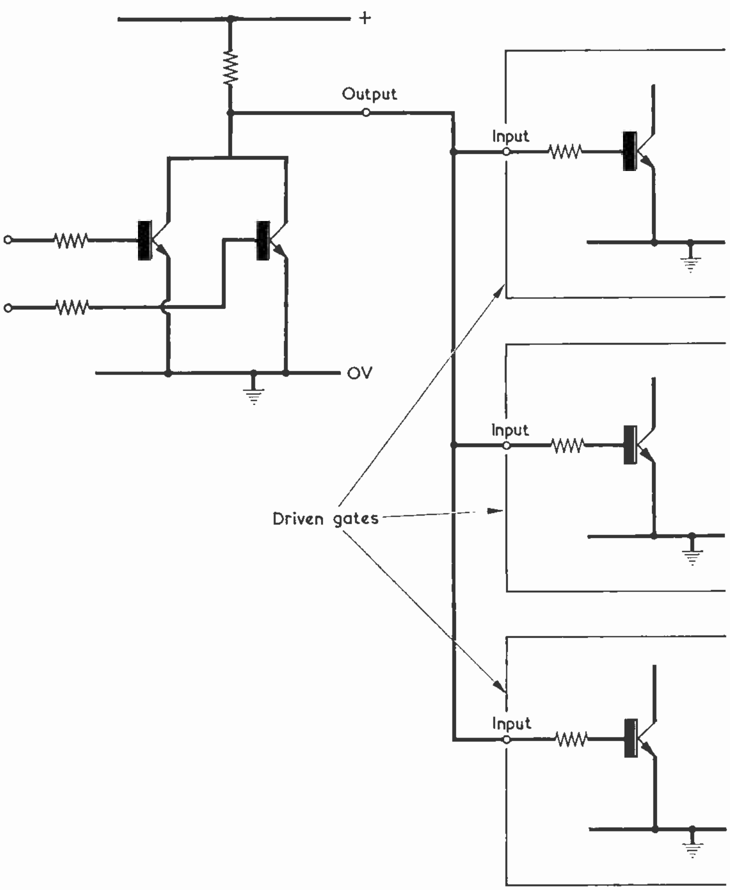


Fig. 5. An r.t.l. gate output may couple directly into the inputs of more than one succeeding gate. Here, three gates are driven by the gate at the top left

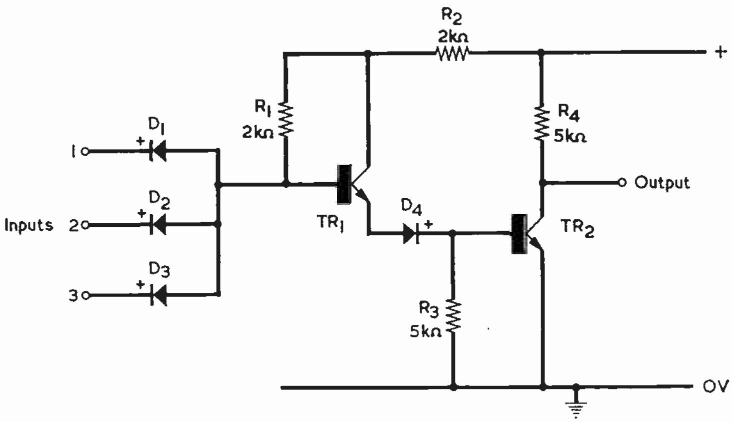


Fig. 6. A common type of d.t.l. NAND gate

diode. If D4 were not in circuit, the emitter of TR1 in the second gate would have only the base-emitter junction of TR2 in its circuit path to earth, and TR1 would then be very liable to become turned on by, say, a small noise voltage at the input. With D1 in circuit, the noise voltage would have to be at least 0.6 volt before it could affect TR1."

"Blow me," remarked Dick. "That's crafty, I must say. Hang on a minute! I've just thought of something that applies to all these gates we're discussing."

"What's that?"

"We seem to be talking all the time about NOR and NAND gates. Are these the only types used?"

"They're the ones that are used most frequently," replied Smithy, "and especially so far as integrated circuit gates are concerned. Without going into detail, pretty well all logical gate operations can be carried out using either combinations of NAND or NOR gates. Also, the fact that these gates incorporate a transistor to give inversion means that amplification is automatically provided at each gate, and so there are no losses to contend with when a lot of gates are strung together to produce a logic function. Getting back to that d.t.l. gate, though, I should mention that there are other versions than the one I've just shown you. Here's a typical example."

Dick looked on as Smithy drew a further circuit. (Fig. 7.)

"This," announced Smithy, "is another NAND gate, with fewer frills than the one I showed you previously."

T.T.L. GATE

The top sheet of the Serviceman's notebook was once more covered with sketches and he tore this one from his pad as well, after which he re-applied himself to his mug of tea.

"Right," he said, patently refreshed. "Before concluding on this d.t.l. gate I think I should draw your attention to the fact that when the output is high, the output potential is equal to the supply potential minus any voltage that is dropped across the output collector resistor."

"Which is," observed Dick, "pretty well the same as occurs with the r.t.l. gate."

"Correct," agreed Smithy briskly. "Now let's press on to the t.t.l. gate. I'll start off by drawing a typical t.t.l. circuit."

Yet again, the Serviceman's pen passed busily over the surface of his pad as he drew the circuit diagram. (Fig. 8.)

"Cor luvaduk," gasped Dick. "What's that horrible thing on the left with all the arrows sticking out of it?"

"That's a transistor."

"I've never," pronounced Dick fimly, "seen a transistor like that before."

"Well, you're seeing one now," replied Smithy. "As it happens, it's just an ordinary transistor with more than one emitter. The one I've shown here has got four emitters, but they make them with up to eight emitters on some t.t.l. gates, or even more."

"How are the emitters formed?"

"In the usual way that transistor emitters are produced in integrated circuits," replied Smithy. "In a normal i.c. transistor a single bit of n-type silicon is diffused in the p-type base to form an emitter. With these multi-emitter types, a number of separate bits of p-type silicon are diffused into the base, and they form individual emitters. Each emitter on its own can independently control the collector current of the transistor."

Dick scowled at the circuit symbol for the transistor with its prodigality of emitters, then shrugged his shoulders.

"Fair enough," he said grudgingly. "I must say, though, that a young lad who has been brought up on single emitter transistors tends to be shattered somewhat at seeing a transistor with all *that* lot poking out of its base."

"Well, at any rate I'm glad you've accepted the fact that such transistors do exist," said Smithy drily. "So let's next get on to seeing how this gubbins operates. It's a NAND gate, and we'll start off with all the inputs in the low state. These cause transistor TR1 to bottom, with the result that its collector takes up a potential that is of the same order as the potential at the inputs. Under these conditions TR2 is cut off and so also is TR4. At the same time, a base current flows into TR3 via R2 and the transistor bottoms, causing the gate output to be high. Okay?"

"Yes," replied Dick. "Everything seems nice and clear so far."

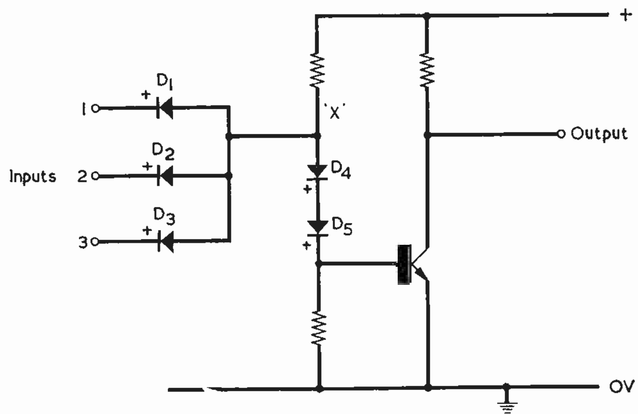


Fig. 7. A simpler form of d.t.l. NAND gate. Diodes D4 and D5 ensure that the transistor cannot be turned on until the potential at 'X' equals their two forward voltage drops plus the drop in the base-emitter junction of the transistor

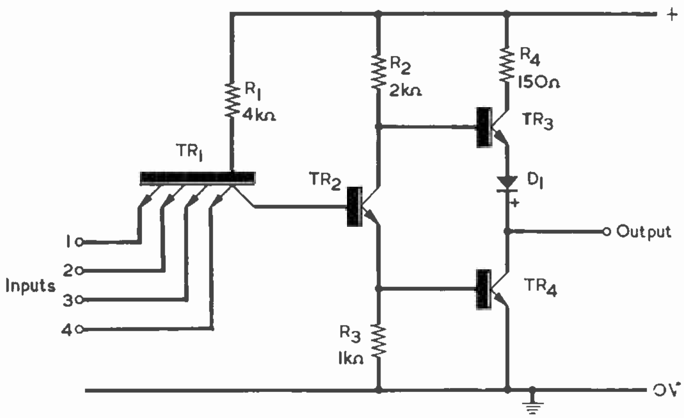


Fig. 8. A conventional t.t.l. NAND gate with 'active pull-up' output circuit

"Good," responded Smithy. "Now, if any one, two or three of the inputs are taken to the high state there is no change in circuit conditions, because the emitter or emitters at the remaining inputs still suffice to keep TR1 bottomed. However, when *all* the inputs go high TR1 becomes cut off. Its collector voltage rises and becomes higher than that on the emitter of TR2. Current next flows into the base of TR2 via R1 and the base-collector junction of TR1, which now acts like a forward-biased diode. TR2 comes on and, in its turn, causes TR4 to become bottomed. Also, the collector of TR2 goes negative of the base of TR3 and the latter cuts off. The result is that the output is now low."

"I see," remarked Dick thoughtfully. "What's the purpose of diode D1?"

"It's there to ensure that TR3 *does* turn off when all the inputs go high," replied Smithy. "When TR4 bottoms, its collector potential is lower than its base potential, whereupon the voltage between the collector of TR4 and the collector of TR2 is of the same order as that which would appear across a forward-biased silicon diode. Without D1 in circuit there would then be a risk that TR3 could be at least partly turned on. However, the presence of D1 ensures that the voltage between the collectors of TR2 and TR4 would have to be at least a further 0.6 volt or so higher before TR3 can be made to pass current. By the way, some t.t.l. gates don't have a diode D1. In these gates an emitter follower appears between TR2 and TR3, whereupon the requisite forward voltage appears

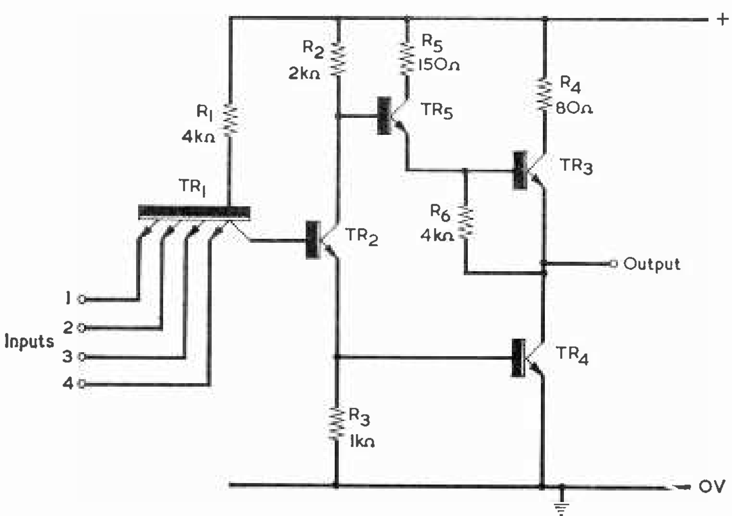


Fig. 9. An alternative t.t.l. gate design, which omits D1 of Fig. 8 and introduces an emitter follower (TR5) between TR2 and TR3

between the base and emitter of the added transistor." (Fig. 9.)

"Fair enough," remarked Dick. "I can understand all this. There's another component you haven't explained – R4. What's that for?"

"R4 is a current limiter in both versions of the gate," replied Smithy. "A bottomed transistor normally takes a tiny bit longer to turn off than a cut-off transistor takes to turn on. In consequence, during a change-over in output states there is a very brief instant when both TR3 and TR4 are conductive. The current that passes is then limited by R4. This is one minor disadvantage with the t.t.l. gate, because it means that short pulses of relatively heavy current are drawn from the supply during change-overs. In consequence, the supply has to be adequately bypassed at each gate to ensure that these pulses don't get along the supply line and upset the working of other gates. However, this point doesn't normally raise too many difficulties in practice."

up' idea has, however, now been incorporated in some d.t.l. gates, whereupon it affords the same advantages. Here's the basic circuit."

END OF SESSION

Smithy drew out the circuit for a d.t.l. gate with active pull-up output (Fig. 10), then picked up his mug and drained it.

"There you are then, Dick," he remarked. "I've now given you a reasonable bit of background on r.t.l., d.t.l. and t.t.l. gates, as used in digital integrated circuits. Some of the gate circuits used in practice differ in detail slightly from those I've just shown you, but their basic operation still remains the same. There are other types of integrated circuit gate which work on somewhat different principles, but these are used less frequently than the ones I've told you about. Most modern computers seem to be using d.t.l. and t.t.l. mainly, with t.t.l. preferred."

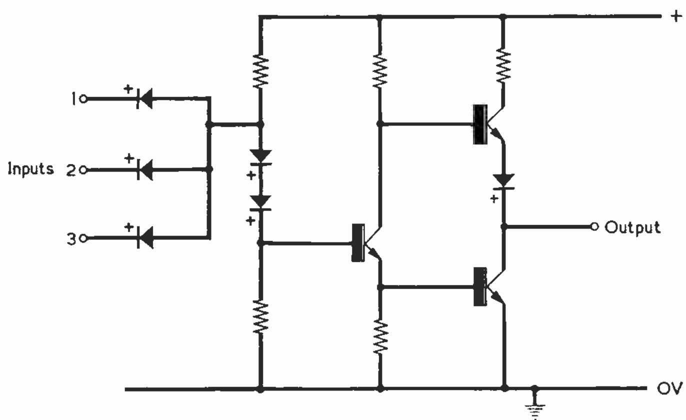


Fig. 10. A d.t.l. NAND gate with 'active pull-up' output circuit

"Are t.t.l. gates better than r.t.l. and d.t.l. gates?"

"Yes," replied Smithy. "The main reason being that, when the output goes high, it is held up by a bottomed transistor instead of by the collector load resistor you have in the r.t.l. and d.t.l. gates. The limiter resistor R4, incidentally, is much lower in value than the collector load resistors of the r.t.l. and d.t.l. gates. The t.t.l. circuit is described as providing 'active pull-up' because the output voltage is taken up by a conducting transistor. In consequence, there is less time delay to stray capacitances to earth at the output circuit, and the t.t.l. gate provides faster operation. Also, since the output is at low impedance to earth in both the high and low states, there is less chance of the output connections picking up noise from other gate systems nearby. T.T.L. gates made their appearance after d.t.l. gates. The 'active pull-

"Thanks for the gen, Smithy," said Dick warmly. "You've certainly opened my eyes to one or two new things today."

"Have I?" said Smithy, rising and switching on his soldering iron in preparation for the afternoon's work. "In that case, this little session has not been wasted. As I've already said, everybody who is concerned with electronics should keep in touch with what is going on in the field of digital computers. We're entering the Computer Age, my boy, and it's just common-sense to be prepared for what that Age may hold for us."

With which pronouncement, the Serviceman turned towards his bench with a grandiose gesture, then proceeded to immerse himself in the repair of a vintage medium and long wave superhet complete with energised loudspeaker and Mazda octal valves.

■

SCOTCH TAPE AT AUDIO FAIR

Visitors to the Scotch magnetic tape stand at this year's Audio Fair (Olympia, October 19–24) will be able to enter a free contest featuring mystery animal voices. Six Cybervox language laboratory booths will be used for the competition, which offers a portable cassette recorder and a supply of Scotch tape cassettes as first prize.

3M's 800 sq. ft. display, which is upstairs on Stand 3, features the complete range of Scotch magnetic tapes and cassettes with emphasis on the recording stars, tape recorder manufacturers and professional sound studios recommending the low-noise qualities of Scotch Dynarange magnetic tapes.

Entry forms will be available for 3M's wildlife sound recording contest, now in its third year, and there will be a bank of quality tape recorders from manufacturers such as Tandberg, Ferrograph, Teac, Revox and Akai on which visitors will be able to compare, via headphones, identical musical excerpts prerecorded on Scotch Dynarange tape. The newly-introduced Scotch 360/361 helical scan video tapes, which feature a unique textured backing for improved handling and cleaner performance, will also be demonstrated on VTR equipment for visiting educationists.

GUIDE TO EMI PHOTOMULTIPLIER TUBES

Specification details of over 140 EMI photomultiplier tubes are contained in a new 64-page publication from the Electron Tube Division of EMI. For those who specialise in fields other than electronics, it also includes general information on the selection and use of photomultiplier tubes.

The introduction describes the operation of p.m. tubes, the parameters involved, and factors influencing the selection of tubes for specific purposes. It also gives notes on typical applications.

The specification pages give full electrical and mechanical characteristics of the complete range of EMI standard and special types of photomultipliers, together with details of sockets and shields.

Copies of this new publication (reference P001/fP70) are available free of charge from the Marketing Department,

Electron Tube Division, EMI Electronics Limited, Blyth Road, Hayes, Middlesex.

Radio Topics

By Recorder

Even nowadays not everybody who works in electronics has become completely familiar with transistor basics. This fact was brought home to me quite forcibly the other day by a service engineer friend who was having a little bother over a silicon n.p.n. transistor in a TV i.f. strip. He sorted through some replacement transistors and finally concluded, with the healthy distrust displayed by all service engineers, that someone at the factory had off-loaded a whole batch of p.n.p. transistors fitted into n.p.n. cases!

This hadn't of course happened, but the little episode does bring home the fact that people still seem to get confused over transistor polarities. My own personal answer to this problem follows the "classical" approach by assuming the existence of "conventional current" which, you will recall, is supposed to flow from positive to negative.

FOLLOW THE ARROWS

To show you what I mean, let's start off with any semiconductor rectifier or diode. Now the circuit symbol for a rectifier consists of an arrowhead plus a line, and the arrowhead points in the direction in which conventional current flows when the diode is conducting. Look at a mains power supply circuit using one or more semiconductor rectifiers and you'll see what I mean.

Carry on next to the n.p.n. transistor, in the circuit symbol of which the emitter arrow points outwards. Now when a transistor is used as a conventional linear amplifier the diode formed by its base-emitter junction is forward-biased; and the emitter arrow shows the direction in which conventional current flows in this diode. If an n.p.n. transistor is used as, say, a common emitter i.f. amplifier, you find that conventional current flows from the positive supply rail through the base bias resistor to the base-emitter junction and carries on, via the emitter resistor, to the negative supply rail. This direction of current flow is that indicated by the outward-pointing emitter arrow.

If the transistor is p.n.p. the emitter arrow points inwards and the supply polarity is reversed. In this case, conventional current flows from the positive supply rail through the emitter resistor to the emitter-base junction of the transistor, and then carries on via the base bias resistor to the negative supply rail. Once again, the emitter arrow shows the direction in which conventional current flows.

Simple, isn't it?

I've become so used to this method of looking at transistor operation that, whenever I encounter a complicated semiconductor diagram such as the diode-encrusted ones the integrated circuit boys dream up, my eye automatically hops to the positive supply terminal and then follows all the semiconductor arrows through to the negative supply point.

An exception to the arrowhead rule occurs, of course, with the zener diode. This is purposely taken up to breakdown voltage in the reverse direction, with the result that the arrowhead in the zener diode circuit symbol points in the opposite direction to conventional current flow.

NEW SIGNAL LAMP

The accompanying photograph shows a new sub-miniature Signal Lamp which is due to go into production very shortly. The manufacturer is A. F. Bulgin & Co. Ltd., Bye-Pass Road, Barking, Essex.

The Signal Lamp is ideally suited to the modern trend towards high density panel grouping and will be available with a lens choice of five transparent or five translucent colours. The lamps (not supplied by A. F. Bulgin) are 3mm. tubular, with voltage ratings of 5, 12 or 28 volts, as required. The solder tags at the rear are electrically isolated from the fixing device, which consists of a push-on rear spring. The fixing hole required is ¼in. with a keyway, and the lamp can be fitted to any panels up to ⅛in. in thickness.

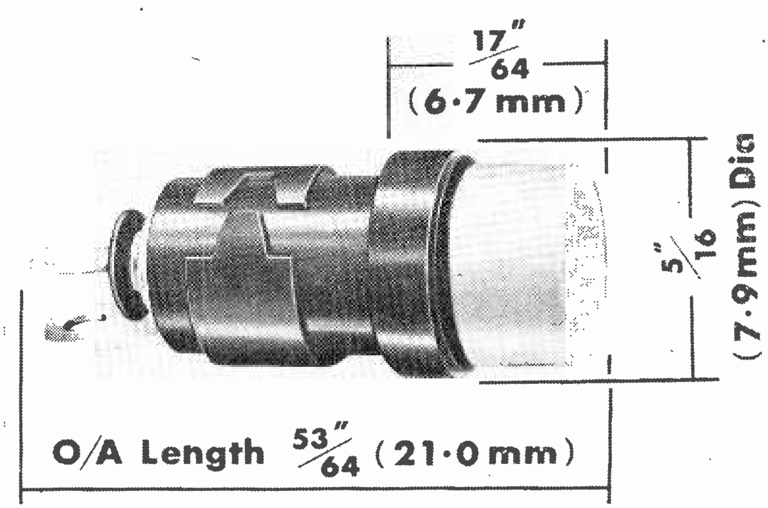
I don't have to tell you what the more important dimensions are because A. F. Bulgin & Co. very obligingly added them to the photograph before they sent it to us.

LASER CONSTRUCTION AID

When it first appeared, the laser used to be referred to as "the solution in search of problems". It is pleasant to see that the practical problems it can solve are now making themselves fully evident, and that the laser is taking up its rightful place in the general world of engineering.

The latest application for the laser is announced by Elliott Automation Radar Systems Limited, of Airport Works, Rochester, Kent. The Elliot device is referred to as the "Laserline" and it is intended to give an accurate visible reference line for constructional work.

The "Laserline" comprises a portable battery powered unit projecting a beam of red light. This can be picked up with a simple reflector,



Subminiature Signal Lamp, shortly to go into production at A. F. Bulgin & Co. Ltd.

even in sunlight, at any range up to a quarter of a mile or more, and the beam is not disturbed by the passage of vehicles or equipment. Once set up on its tripod with the aid of its telescopic sight, the "Laserline" is left unmanned. The beam can be detected at any point at which work is in progress, thereby eliminating the necessity of a second man at the instrument, as is the case with a theodolite or level. The "Laserline" is safe in operation.

The laser beam forms an accurate reference level for laying pipes at precise gradients, constructing tall or long buildings, and observing movement in tunnels and mining galleries. By traversing the beam, precise planes can be defined for excavating and laying roadways and runways. The "Laserline" has, indeed, already been in use for some time to provide a vertical reference for the accurate and rapid raising of the mould shuttering required for the continuous pouring operation employed in the construction of tall concrete silos.

The "Laserline" unit contains a 1mW helium neon laser light source whose beam is expanded to a diameter of about ⅝in., being focused to a parallel beam by a precision optical lens system integral with the laser unit. This last feature improves rigidity and reduces warm-up drift. The advantages of the "Laserline" are its low cost and its ability to stand up to the same conditions as a normal theodolite. The telescopic aiming sight is mounted on top of the main housing, which measures 28 by 3½ by 3½in., and which weighs 15lb. 6oz. without the tripod.

The future potential of this device looks very interesting, and the manufacturer claims that it may well be the first of a new generation of low cost multi-purpose laser instruments with applications right across the board. The "Laserline", in particular, shows great promise in the construction and civil engineering fields, in mining and pipe laying, and even in agriculture.

METERS AND MOTORS

As most readers will be aware, it is a wise precaution to short-circuit the terminals of a sensitive and expensive moving-coil meter before transporting it from one place to another. The damping on coil movement resulting from this short-circuit then ensures that the pointer and coil assembly will not move violently if the instrument is accidentally bumped during transit.

This fact was mentioned by W. G. Morley, in his "Understanding Radio" series on pages 303 and 304 of the December 1969 issue, and he also made the allied point that if the current to be measured by the meter is provided by a source of low internal resistance the meter takes longer to indicate a change in current than occurs when the source has a high internal resistance. The sluggishness is, again, due to coil damping, this being given by the low internal resistance.

These statements have prompted a reader to enquire recently whether the same applies to a small permanent magnet motor. Would a lead-acid accumulator cause such a motor to revolve slower than a dry battery of the same voltage?

This is quite an interesting query, because the motor and meter appear, at first sight, to be analogous. However, for this apparent analogy to hold good, the question should really be changed to something like "would the motor *accelerate*, from rest, to its final running speed at a lower rate with the lead-acid accumulator than it would with the dry battery?" The acceleration of the motor could then be assumed to correspond with the rate of change of meter pointer movement.

The question seems valid because the motor coil presents a back e.m.f. to the source of current in just the same manner as does the meter coil. Also, due to the motor commutator, the source "sees" what appears to be a single coil passing through the magnetic field all the time, just as it "sees" the single coil which passes through the magnetic field in the meter. One could be tempted, therefore to think that the rate of acceleration in the motor *would* be lower with the lead-acid accumulator.

Why, then, do large d.c. motors have a starting control which initially inserts a high value of series resistance and which then progressively reduces this resistance as the motor speeds up to its final running speed? Obviously, the acceleration with high series resistance is less than with low series resistance.

Which brings us, at last, to the true answer to the problem. A motor requires greater current to take it up to final running speed than it requires at that speed, with the result that the acceleration with a high resistance source of e.m.f. would be lower. The greater current requirement outweighs any damping factor on motor coil movement.

Perhaps the only true analogy between the behaviour of the motor and the meter appears in the case where a permanent magnet motor is brought quickly to rest by disconnecting its supply and putting a short-circuit across its terminals.

Still, it makes you think a bit, doesn't it? ■

CONFERENCE

ELECTRICAL SAFETY IN HAZARDOUS ENVIRONMENTS

The Institution of Electrical Engineers, in association with The Association of Mining and Mechanical Engineers, The Institution of Electronic and Radio Engineers, The Institute of Measurement and Control, The Institution of Mechanical Engineers, and The Institution of Mining Engineers is organising a Conference on "Electrical Safety in Hazardous Environments", to be held at the Institution of Electrical Engineers, Savoy Place, London WC2, from 16–18 March 1971.

During this three-day Conference it is anticipated that approximately 30 contributions will be presented in sessions which cover the following topics:–

Evaluation and definition of hazard, including: safety techniques, test apparatus and methods, and static hazards. Selection of techniques and their implementation, including: power applications, light current applications. Safety procedures, including: installation and maintenance procedures, standards and codes of practice, earthing and bonding methods.

It is also planned to include a session devoted to the practical consideration of particular applications and equipment designs. Additionally, one or two survey contributions may be arranged.

Manuscripts are currently being developed and a provisional programme and registration form will be published in the late autumn. Those wishing to obtain copies should apply to the Manager, Conference Dept., IEE, Savoy Place, London WC2R 0BL.

LATE NEWS

Times = GMT *Frequencies = kHz*

★ AMATEUR BANDS

● **WEST PAKISTAN**
AP2KS has been heard using s.s.b. on **14165** and **14195kHz** around 1830 to 2130.

● **NETHERLANDS ANTILLES**
PJ2PS logged several times using c.w. on **14008kHz** during late evenings.

● **PANAMA**
HP1BR heard busily dodging the resultant pile-up to his c.w. CQ call on **14058kHz** at 2200.

● **RYUKYU ISLAND**
KR6TK calling CQ on **14005kHz** c.w. and busily working W's during the early mornings.

● **ETHIOPIA**
9F3USA heard on **21353kHz** s.s.b. at 1820 and **21365kHz** s.s.b. at 1310.

● **SUDAN**
ST2SA heard on **14020kHz** c.w. at 1430, **14040kHz** c.w. at 0400 and on **21033kHz** c.w. from 1930 to 2100.

● **CHAGOS**
VQ9CD heard on **14021kHz** c.w. at 1527 and on **14026kHz** at 1151.

● **TCHAD REPUBLIC**
TT8AF heard using s.s.b. on **14290kHz** at 0705.

● **ANGOLA**
CR6RW Radio Clube de Cabinda (1kW) has changed frequency from **5033kHz** (listed **5035kHz**) to **4970kHz.**

● **EQUATORIAL GUINEA**
EAJ206 Radio Equatorial, Rio Muni. Logged by our Listening Post from early August on the old **4926kHz** channel (5kW).

● **FEDERAL REPUBLIC OF CAMEROON**
Radio Garoua on **5010kHz** (4/30kW) can be heard at 2100 with identification in French. Heard with chants in Arabic style.

● **COLOMBIA**
La Voz de Colombia, Bogota, which has been off the air for some time, is now back on the old channel of **6020kHz.**

● **JAPAN**
The European Service of Radio Japan, evening transmission, is now from 1930 to 2100 on **9735** and **11950kHz.** The morning transmission remains unchanged, from 0645 to 0845 on **17825** and **21535kHz.**

● **CANADA**
Radio Canada to Europe is now from 1217 to 1313 on **15325kHz.** Mondays to Fridays from 2115 to 2150, Saturdays and Sundays from 2100 to 2150 on **15325, 17820** and **21595kHz.** To North and South America from 1217 to 1313 on **9625** and **11720kHz** and from 2300 to 2330 on **9625, 15190** and **17855kHz.**

Acknowledgements to our own Listening Post and SCDX. ■

ASIAN BROADCAST Dx

For broadcast Dx enthusiasts, this month heralds the commencement of the 'season' for reception of Asian stations.

Initially, listen on 4800kHz for signals from the Indian local transmitter at Hyderabad (10kW). This station often represents a good pointer for prevailing conditions and successful reception of other Asian stations – including those of Indonesia.

As the 'season' progresses, signal strengths tend to build up, December and January being the peak periods.

Some of the Indian stations to listen for are:– 4820kHz Calcutta, 4840kHz Bombay, and 4895kHz Kerseong.

If conditions prove to be good, listen for YDK6 Djambi, Indonesia on 4927kHz. This station put the most consistent Indonesian signal into this country last year.

Read South East Asian Quest in next months' issue. ■

LAST LOOK ROUND

NEW HOME RADIO CATALOGUE

As has been advertised in recent issues, the July 1970 edition of the Home Radio catalogue is now available. Profusely illustrated, it lists over 8,000 components with clear descriptions of their specifications and functions. All items have Catalogue Numbers, a factor which greatly facilitates the ordering of components through the mail. Also included are forms explaining the Home Radio Credit Account and Order Pack Schemes.

The Home Radio catalogue will in future be reprinted every two years, but customers will be kept up-to-date with the availability of new components by means of supplements, which will be issued two to three times a year. All supplement items are transferred to the catalogue at the next reprint.

The July 1970 edition of the catalogue can be obtained from Home Radio (Components) Ltd., 234-240 London Road, Mitcham, Surrey, CR4 3HD, at 8s. 6d. plus 4s. post and packing. ■

SMALL ADVERTISEMENTS

Rate: 9d. per word Minimum charge 12/-

Box No. 2/- extra.

Advertisements must be prepaid and all copy must be received by the 4th of the month for insertion in the following month's issue. The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the *bona fides* of advertisers. (Replies to Box Numbers should be addressed to: Box No. ——, *The Radio Constructor*, 57 Maida Vale, London, W.9.)

SERVICE SHEETS. Radio, Television, Transistors, Tape Recorders, Record Players. Catalogue 2/6d. S.A.E. please. Hamilton Radio. 54 London Road, Bexhill, Sussex.

MUSICAL MIRACLES. Send s.a.e. for details of Drum Sound Modules, versatile bass-pedal accompaniment unit, self-contained with unique effects. Kits for Waa-waa pedals, 49/- Also bargain components. reed switches, etc. D.E.W. Ltd.. 254 Ringwood Road. Ferndown, Dorset.

NEW CATALOUGE NO. 18. containing credit vouchers value 10/-, now available. Manufacturers new and surplus electronic and mechanical components. price 4/6d. post free. Arthur Sallis Radio Control Ltd.. 28 Gardner Street, Brighton. Sussex.

WANTED: Teleprinter instruction manuals. etc. All types. All letters answered. R. J. Goode. P.O. Box 6070. Auckland, New Zealand.

RADIO BARGAINS. Guaranteed. Internet 10. transistor radios, two band. leather case. earpiece, batteries. size 6in. x 3¾in. x 1¾in. Excellent value at £4 10s. 0d. plus 3/- p. & p. C.W.O. to: G. & S. Electric. Greatness Mill Yard. Mill Lane. Sevenoaks. Kent.

BUILD IT in a DEWBOX robust quality plastic cabinet 2in. x 2½in. x any length. S.A.E. for details. D.E.W. Ltd., 254 Ringwood Road. Ferndown. Dorset. Write now – right now.

EX-GOVT. COMMUNICATION RECEIVERS, signal generators. calibrators. components. etc.. with money back guarantee. S.A.E. list. P. R. Golledge. G3EDW. Glen Tor. Torrington. Devon. Telephone: (STD 08-052) 2411.

HOLIDAY ACCOMODATION. Burwood Lodge Hotel. Dawlish Road, Teignmouth. S. Devon. Especially for parents with young children. Facing south. on the cliffs, direct access by private path to sea. Mothers' kitchen. automatic washing machines. baby listening service. Licensed lounge. Ample free parking.

TEST EQUIPMENT – Taylor 61A Sig. Gen. £25. Heathkit RF1U Sig. Gen. £12 10s. 0d. and 012U Oscilloscope £20. All in good condition. Telephone: Staines 53601.

MINIATURISED TOP BAND mains powered Tx. Top Band command Rx. £15 o.n.o. Box No. G129.

WANTED: Teleprinter. type TT4 or other miniaturised equivalent. G2UK. "East Keal". Romany Road. Oulton Broad. Suffolk.

(Continued on page 193)

SMALL ADVERTISEMENTS

(Continued from page 191)

JOIN THE INTERNATIONAL S.W. LEAGUE. Free services to members including Q.S.L. Bureau, Amateur and Broadcast Translation, Technical and Identification Dept.—both Broadcast and Fixed Stations, DX Certificates, contests and activities for the SWL and transmitting members. Monthly magazine, *Monitor*, containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section and League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc., are available at reasonable cost. Send for League particulars. Membership including monthly magazine, etc., 35s. per annum. Secretary ISWL, 1 Grove Road, Lydney, Glos., GL15 5JE.

"MEDIUM WAVE NEWS" Monthly during Dx season.—Details from: K. Brownless, 7 The Avenue, Clifton, York.

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, "Dancer's End", St. Winifred's Road, Biggin Hill, Kent.

WANTED: Books, brochures, pamphlets, etc. re FAX. Any information of interest. G2UK, "East Keal", Romany Road, Oulton Broad, Suffolk.

BOOKS FOR SALE: *"The Story of the Ionosphere"* 5/-. *"Alfred Nobel"*, Bergengren, 15/-. *"Science Survey 3"*, Vista Books, 10/-. *"Science Today & Tomorrow"*, 2nd series, 5/-. *"Basic Astro Navigation"*, Dixon, 17/6d. *"The Sextant Simplified"*, Watts, 7/6d. *"The Book of the Sextant"*, Hughes, 5/-. *"An Introduction to Charts and their Uses"*, Chriss & Hayes, 17/6d. *"Teach Yourself Russian"*, 5/-. *"The Colour of Canada"*, 30/-. *"Space"*, Patrick Moore, 55/-. *"The Professor in Two Worlds – The Earl of Birkenhead"*, 30/-. *"The Message of the Genes"*, Sullivan, 15/-. *"Yacht Racing"*, 5th edition, Sturges, 30/-. *"Health Physics"*, Rees, 55/-. *"Practical Yacht Racing"*, Schiottz, 10/-. *"Astronautics in the Sixties"*, Gatland, 10/-. *"Space Research & Exploration"*, edited by Bates, 10/-. *"Earth's Envelope"*, Theo Lobsack, 10/-. *"Man on the Moon"*, Ryan, 10/-. *"Jane's Fighting Ships"*, 1965-66, £6. Box No. G130.

FREE GIFT when you request our quality stamps, supplied on approval. Generous discounts. Details from: Watson's Philatelic Service, 6 Beech Avenue, Brentwood, Essex.

WANTED: Dial cord restringing instructions, or manual, for Philips radio, model B3G.74.A. Box No. G131.

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.

DEVICES & SEMICONDUCTORS available, large variety. Your requirements exchanged for interesting small Victorian/Edwardian articles, e.g. jewellery, statuettes, mechanical items, oil lamp, letter balance. W.H.Y.? Send description, offer by return. Box No. G132.

(Continued on page 195)

RSGB BOOKS FOR YOU

AMATEUR RADIO TECHNIQUES

By Pat Hawker, G3VA

Third edition just published. Revised and enlarged. Now contains 208 pages and nearly 500 diagrams.

22s post paid

A GUIDE TO AMATEUR RADIO

By Pat Hawker, G3VA

Fourteenth edition. 100 pages.
The new edition of this indispensable aid to all who want to know more about amateur radio. Designed to assist the newcomer to this unique hobby.
Revised and expanded. **8s 10d post paid**

RADIO COMMUNICATION HANDBOOK

832 pages of everything in the science of radio communication. The Handbook's U.K. origin ensures easy availability of components. Complete coverage of the technical and constructional fields. A superb hard bound volume. **69s post paid**

These are three of a complete range of technical publications, log books and maps, all obtainable from:

RADIO SOCIETY of GREAT BRITAIN

35 DOUGHTY STREET, LONDON, WC1N 2AE

FREE TO AMBITIOUS ENGINEERS
—THE LATEST EDITION OF ENGINEERING OPPORTUNITIES

Have you sent for your copy ?
ENGINEERING OPPORTUNITIES is a highly informative 164 page guide to the best paid engineering posts. It tells you how you can quickly prepare at home for a recognised engineering qualification and outlines a wonderful range of modern Home Study Courses in all branches of Engineering. This unique book also gives full details of the Practical Radio & Electronic Courses administered by our Specialist Electronics Training Division – explains the benefits of our Appointments Dept. and shows you how to qualify for five years promotion in one year.

"Satisfaction or refund of fee" terms
Whatever your age or experience you cannot afford to miss reading this famous book. Send for your copy of "ENGINEERING OPPORTUNITIES" today – FREE.

Practical Equipment including Tools
The specialist Electronics Division of B.I.E.T. NOW offers you a real laboratory training at home with practical equipment.
Basic Practice and Theoretical Courses for beginners in Radio, T.V., Electronics, etc. Ask for details.

Which is your pet subject ?
A.M.I.E.R.E. City & Guilds ☐ Radio Amateur's Exam. ☐ R.T.E.B. Certificate P.M.G. Certificate ☐ Practical Radio ☐ Radio & Television Servicing ☐ Practical Electronics ☐ Electronics Engineering ☐ Automation ☐

The B.I.E.T. is the leading institute of its kind in the world.

Please send Free Books and Full Information

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

NAME……………………………

ADDRESS……………………………

……………………………

Subject of interest…………… Age………

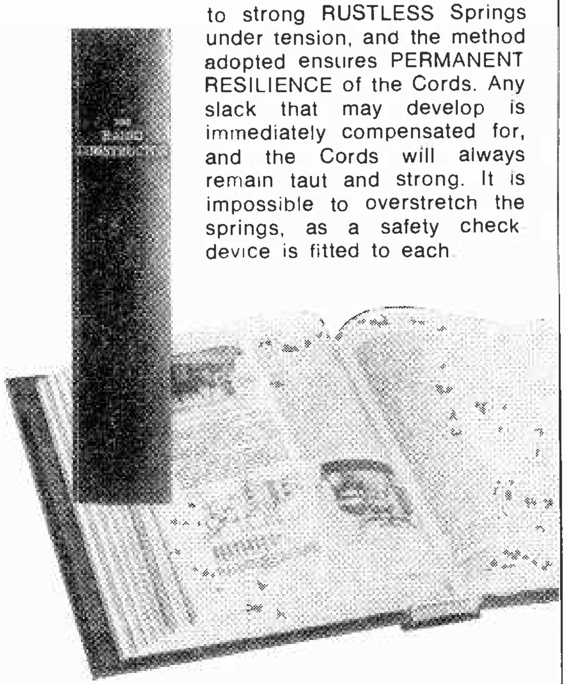
ALDERMASTON COURT, Dept 480D, Aldermaston, Reading, RG7 4PF

NEW STYLE SELF-BINDER

for "The Radio Constructor"

The "CORDEX" Patent Self-Binding Case will keep your issues in mint condition. Copies can be inserted or removed with the greatest of ease. Rich maroon finish, gold lettering on spine.

Specially constructed Binding Cords are made from Super Linen of great strength, very hard twisted and twice doubled. They are attached to strong RUSTLESS Springs under tension, and the method adopted ensures PERMANENT RESILIENCE of the Cords. Any slack that may develop is immediately compensated for, and the Cords will always remain taut and strong. It is impossible to overstretch the springs, as a safety check device is fitted to each



PRICE 14/- Postage 1/6

Available only from:—

Data Publications Ltd.

57 Maida Vale London W9

SHORT WAVE MAGAZINE

The journal for the Radio Amateur, established in 1937 and now circulating in all English-speaking countries. In the last 25 years it has become the most widely-read radio amateur magazine in the U.K. Includes regular SWL feature and much operating news covering all bands HF/VHF. Also articles on theory, design and construction of amateur-band equipment. At least 64 pages every month. Price **4s.** by order through any newsagent (subscription **45s.** year of 12 issues, post free).

★ ★ ★

Our Publications Dept. also offers a wide range of books of radio amateur and SWL interest, including the International *DX Call Book* (**58s. 3d.**), *ARRL Handbook* (**55s.**), *World Radio/TV Handbook* (**43s. 6d.**), *DX Zone Map* (**14s. 9d.**), latest editions, post free, from stock — and many others, as listed in any issue of *Short Wave Magazine*.

SHORT WAVE MAGAZINE, Ltd.
55, Victoria Street,
London, S.W.1.
(Tel: 01-222 5341/2)

INTERNATIONAL SHORT WAVE LEAGUE

Membership 35s. 0d. per annum (U.S.A. $5.00) including 12 monthly issues of *Monitor* — the League journal. Including free use of all Services, QSL Bureau, etc.

THE LARGEST S.W.L. ORGANISATION IN THE WORLD

For full details write to:

The Secretary,
I.S.W.L.,
1, GROVE ROAD, LYDNEY,
GLOS. GL15 5JE.

SMALL ADVERTISEMENTS

(Continued from page 193)

WORLD DX CLUB covers all aspects of SWLing on Amateur and Broadcast Bands through its monthly bulletin *"Contact"*. Membership costs 25s. a year. Enquiries to Secretary, WDXC, 17 Taunton Road, Bridgwater, Somerset.

FOR SALE: *Radio Constructor* magazines for sale 1/6d. each. 70 issues. Various dates. 1960 to 1970. All enquiries answered. Box No. G133.

LINEAR AMPLIFIER FOR SALE. G2DAF design. £25. S.A.E. for details. Box No. G134.

POSTAL ADVERTISING? This is the Holborn Service, Mailing lists, addressing, enclosing, wrappering, facsimile letters, automatic typing, copy service, campaign planning, design and artwork, printing and stationery. Please ask for price list.—The Holborn Direct Mail Company, Capacity House, 2-6 Rothsay Street, Tower Bridge Road, London, S.E.1. Telephone: 01-407-1495.

FOR SALE: 2.5kV power supply. 250mA. solid state. with Variac control and volt meter. Box No. G135.

CIMBRER DX CLUB features S.W., M.W. Utility and TV DX in monthly bulletin *Cimbrer DX News*. Sample copy and details of membership for one IRC to:- CDXC, Box 27, Aars, Denmark or to 32 Bromwich Street, Bolten, Lancs. BL2 1JF.

EXCHANGE American radio mags for American yachting mags. W.H.Y? Box No. G136.

WANTED: Spectrometer for general laboratory use. Box No. G137.

ESSEX GARDENERS. Buy your bedding and rock plants, shrubs, etc., also cacti from May's Nurseries, 608 Rayleigh Road, Hutton, Brentwood, Essex. Callers only. Monday to Saturday.

FOR SALE: Ultra-violet light demonstration box. S.A.E. for details. Box No. G138.

2 WATT TRANSISTOR RECORD PLAYER AMPLIFIERS. Not a kit, but built and tested. Complete amplifier measures 2½ x 3½ ins. Standard 3 ohms output, frequency response ± 2dB from 12 to 12,000 c.p.s. Can be used for baby alarms, intercoms, etc. Supplied with full connection details, only 22/6d, p.p. 1/6d. 500mW amplifier kit, 3 transistor, with circuit, 10/6d, p.p. 1/-. Tested transistors 8/- dozen, 1/- each, similar to 2N697, 2N706, OC44, OC71, OC81, BFY50. Assorted NPN PNP silicon germanium, untested but guaranteed 60% good, 25 for 4/-, p.p. 6d. A. Manley, 111 Mayow Road, Sydenham, London S.E.26.

WANTED: Sextant and chronometer. Details to Box No. G139.

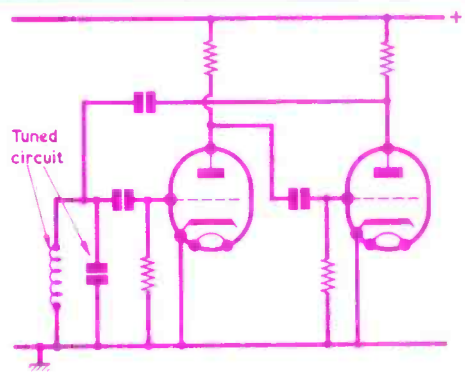
PROPERTIES for sale and to let in London and suburbs. Apply to Maggs & Stephens, Estate Agents, 229 Maida Vale, London, W.9 MAIda Vale 8123.

Please mention **THE RADIO CONSTRUCTOR** when writing to advertisers

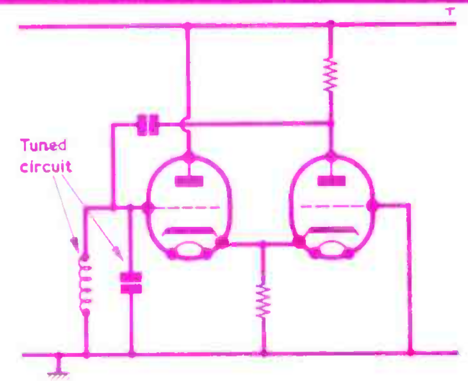
CONSTRUCTOR'S DATA SHEET 43

TWO-TERMINAL L.C. OSCILLATORS

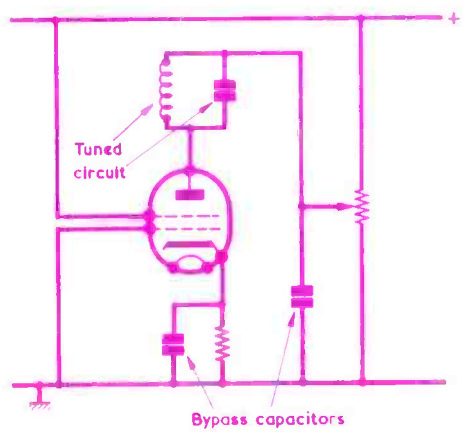
The diagrams illustrate four LC oscillators which require no tap into either the inductive or capacitive half of the tuned circuit. Those shown in (a) and (b) are Franklin and cathode-coupled oscillators respectively. In both these oscillators a signal at the grid of the left-hand triode is fed back in phase from the anode of the right-hand triode. The dynatron oscillator in (c) is a negative resistance oscillator and functions due to secondary emission from the anode of a tetrode (*not* a pentode) when the anode supply potential is lower than that of the screen-grid. The tunnel diode negative resistance oscillator in (d) should have a supply potential of 1 to 1.5 volts and the potentiometer should be some 10 to 30Ω.



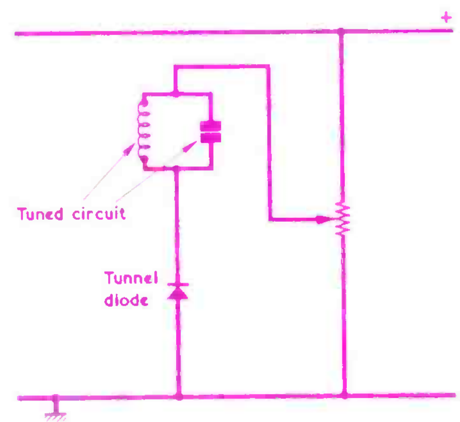
(a)



(b)



(c)



(d)