

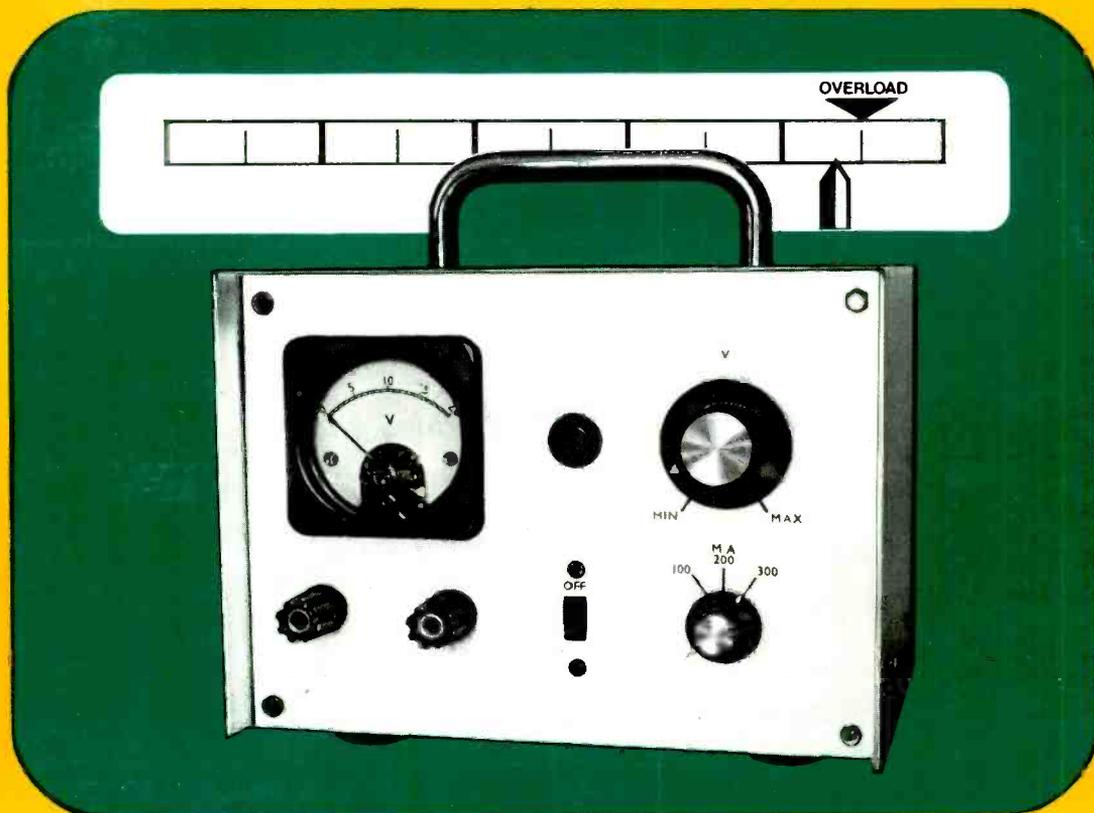
THE

RADIO CONSTRUCTOR

Vol. 24 No. 10

MAY 1971

20p (4/-)



NON-OVERLOAD POWER SUPPLY

- ★ Output Voltages 0.5 to 15
- ★ Cannot be overloaded
- ★ Ideal bench supply

FEATURED
IN THIS ISSUE

LCR TONE CONTROL CIRCUIT
TRANSISTOR R.F. PRESELECTOR

L/Np	£/Np	L/Np	£/Np	L/Np	£/Np
AC107	37	BSY29	25	NK180214	75
AC126	25	BSY95A	15	NK180215	75
AC127	25	BY100	20	NK180216	75
AC128	20	BYX10	15		
AC176	25	BYZ10	40	OAS	20
AC187	30	BYZ12	20	OAS10	25
AC188	30	BYZ13	20	OAA7	8
AC177	29	BZY88 Series		OAO7	8
AC18	20	3.3V to 30V 15		OAO3	8
AC19	20	D13T1	45	OAO9	8
AC20	19	D1E520	75	OAB1	8
AC21	19	MJ480	97	OAB2	8
AC22	19	MJ480	97	OAO9	8
AC24	15	MJ481	1.25	OAB9	8
AC24	15	MJ490	1.00	OAB5	8
AD140	55	MH491	1.35	OAB20	10
AD149	57	MPE102	43	OAB20	10
AD161	37	MPE103	37	OC19	37
AD162	37	MPE104	37	OC20	97
AF114	25	MPE105	40	OC22	47
AF115	25			OC23	60
AF116	25	NKT124	30	OC24	60
AF117	25	NKT125	43	OC25	37
AF118	44	NKT126	37	OC26	33
AF124	25	NKT128	25	OC28	60
AF126	17	NKT135	26	OC29	75
AF139	37	NKT137	32	OC35	50
AF186	40	NKT210	25	OC36	63
AF239	37	NKT211	25	OC41	30
ASV26	25	NKT213	25	OC42	30
ASV27	30	NKT214	23	OC44	15
ASV28	22	NKT215	21	OC45	15
ASV29	30	NKT216	46	OC71	15
ASV21	37	NKT217	50	OC72	23
AU110	1.50	NKT218	25	OC75	23
BA115	8	NKT219	25	OC76	25
BC107	12	NKT223	27	OC77	40
BC108	12	NKT224	28	OC78	23
BC109	12	NKT225	21	OC81D	20
BC147	15	NKT229	29	OC82	55
BC148	15	NKT237	31	OC82	25
BC149	15	NKT238	19	OC82D	15
BC158	17	NKT239	23	OC83	23
BC169C	19	NKT240	20	OC85	25
BC182	12	NKT241	21	OC139	25
BC184	10	NKT242	15	OC140	35
BC183	9	NKT243	56	OC170	25
BC183L	9			OC171	30
BC184	15	NKT244	17	OC190	37
BC184L	15	NKT245	17	OC201	47
BC186	40	NKT261	21	OC202	63
BC212	17	NKT262	19	OC203	37
BC212L	12	NKT264	21	OC204	45
BCY30	22	NKT272	18	OC205	65
BCY31	48	NKT272	17	OC206	75
BCY32	50	NKT274	18	OC207	75
BCY33	20	NKT275	23	OC271/M	47
BCY34	25	NKT279A	12	OC272	11
BCY38	30	NKT281	29	ORF12	50
BCY70	19	NKT302	87	ORP60	60
BCY71	37	NKT304	79	ORP61	40
BCY72	16	NKT351	75	P346A	19
BD121	1.10	NKT401	71	ST140	15
BD123	1.10	NKT402	77	ST141	20
BD124	1.03	NKT403	65	TD116	40
BDY20	1.05	NKT404	60	TIP31A	62
BF115	25	NKT405	79	TIP32A	74
BF163	40	NKT406	62	V405A	46
BF167	25	NKT420	1.83	ZTX108	11
BF173	30	NKT451	58	ZTX100	13
BF178	52	NKT452	54	ZTX302	18
BF180	37	NKT453	50	ZTX303	18
BF181	37	NKT603F	30	ZTX304	18
BF184	25	NKT613F	30	ZTX314	11
BF185	25	NKT674F	30	ZTX320	30
BF194	17	NKT676F	30	ZTX330	18
BF195	15			ZTX330	16
BF195	15	NKT677F	28	ZTX500	16
BF200	35	NKT713	29	ZTX501	16
BFX13	25	NKT717	44	ZTX502	20
BFX29	31	NKT734	26	ZTX503	17
		NKT736	32	ZTX504	40
BFX84	26	NKT773	25	IN34A	20
BFX85	34	NKT781	29	IN60	20
BFX86	25	NKT10339	25	IN64	20
BFX87	30	NKT10419	19	IN82A	47
BFX88	25	NKT10439	27	IN87A	23
BFY50	23	NKT10519	22	IN914	7
BFX51	19	NKT20329	19	IN4001	7
BFY52	20	0013	31	IN4002	7
BFY53	16	NKT80111	67	IN4003	10
BFY90	67	NKT8012	63	IN4004	10
BSX19	16	NKT80113	100	IN4005	12
BSX20	16	NKT80211	75	IN4006	15
BSX21	37	NKT80212	75	IN4007	20
BSY27	20	NKT80213	75	IN4148	7

TERMS: Cash with order please. Postage & packing - 10Np Inland, 25Np Europe, 60Np elsewhere. All goods guaranteed. ALL ORDERS DESPATCHED WITHIN ONE WORKING DAY OF RECEIPT. 1971 Retail Catalogue now available 5Np stamp for postage appreciated.

Telex 99443

LST ELECTRONIC LTD
COMPONENTS LTD

MAIL ORDER DEPT. (RC)
7 COPTFOLD ROAD
BRENTWOOD, ESSEX

Visitors welcome at our new retail shop - same address

Components

RESISTORS
Carbon Film $\frac{1}{4}$ & $\frac{1}{2}$ Watt 5%
Packs of 10 (of one value/wattage)
15 Np per pack.

PRESETS
P.C. Type 0.3 Watt
Standard size 7 Np
Sub-miniature 5 Np
(Available in vertical or horizontal mounting)
Usual values 100 ohms to 5 Meg.

POTENTIOMETERS
Log or Lin Less switch - 17 Np
Log or Lin DP switch - 27 Np
Log or Lin Stereo L/S - 50 Np
Values: 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1 Meg, 2 Meg

CAPACITORS
Multilayer Miniature Electrolytic
Mfd Volt Wkg. - C426 Series
2.5 16 8 Np
10 16 6 Np
20 16 6 Np
40 16 6 Np
80 16 6 Np
1.6 25 8 Np
6.4 25 6 Np
12.5 25 6 Np
25 25 6 Np
50 25 6 Np
80 25 6 Np
1.6 40 8 Np
4 40 6 Np
8 40 6 Np
16 40 6 Np
32 40 6 Np
50 40 6 Np

Mullard Metallised Polyester 250V
Mfd Volt Wkg.
01 3Np 22 5Np
015 3Np 33 7Np
022 3Np 47 8Np
033 3Np 68 11Np
05 4Np 10 14Np
068 4Np 15 20Np
1 4Np 2.2 24Np
15 5Np

Mullard Electrolytic - C437 Series
Mfd Volt Wkg.
9 Np
600 16 12Np
1600 16 15Np
1000 16 18Np
160 25 9Np
250 25 12Np
400 25 15Np
640 25 18Np
100 40 9Np
160 40 12Np
250 40 15Np
400 40 18Np

Mullard Sub-Miniature Ceramic
Plate - C333 Series
63 volt working. Range 18pf to 220pf (usual pref. values)
Packs of 6 (any values) - 30 Np

NEONS
Miniature neon bulbs: 0.6mA 85vac
90vac. Pack of 5 for 30 Np
Panel neon indicators, mains voltage. Red lenses - round, square or arrow-shaped faces. Each 20 Np

VEROBOARD
2.5" x 17" x 15" 57 Np
2.5" x 5" x 15" 23 Np
2.5" x 3.75" x 15" 19 Np
3.75" x 17" x 15" 79 Np
3.75" x 5" x 15" 30 Np
3.75" x 3.75" x 15" 22 Np
2.5" x 5" x 1" 25 Np
2.5" x 3.75" x 1" 23 Np
Spot face cutters - 45 Np
Veropack pack of 50 for 21 Np

HEATSINKS
TO-5 (Clip-on) pack of 4 for 15 Np
FINNED type for 2 x TO-3 ready drilled at 43 Np
FINNED type undrilled for plastic power at 34 Np

BOOKS
G.E. Transistor Manual £1.47
R.C.A. Transistor Manual £1.40
Designers' Guide to British Transistors (data book) £1.25
R.C.A. Hobby Circuits Manual £1.40
New edition now available. Many new circuits. Substitution chart supplied.
110 Semiconductor Projects £1.25
Zener Diode Handbook 84 Np
Photo & Solarcell Handbook 84 Np
Thyristor (S.C.R.) Handbook £1.00

NEW! SN74N SERIES TTL LOGIC

Now from L.S.T. - FULL SPECIFICATION TEXAS INSTRUMENTAL INTEGRATED CIRCUITS AT ECONOMY PRICES

SN7400N	Quad 2-input NAND gate	1-49	50-99	100+
SN7401N	Quad 2-input NAND gate open collector	32	27	22
SN7402N	Quad 2-input NOR gate	35	30	25
SN7403N	Quad 2-input NAND gate open collector	35	30	25
SN7404N	Hex Inverter	32	27	22
SN7410N	Triple 3-input NAND gate	45	40	35
SN7413N	Schmitt Trigger	32	27	22
SN7420N	Dual 4-input NAND gate	45	40	35
SN7421N	8-input NAND gate	32	27	22
SN7440N	Dual 4-input NAND Buffer	£1.12	£1.00	88
SN7442N	BCD to decimal decoder TTL output			
SN7450N	Expandable Dual 2-wide 2-input AND-OR-INVERT gate	32	27	22
SN7453N	Expandable 4-wide 2-input AND-OR-INVERT gate	45	40	35
SN7460N	Dual 4-input expander	50	45	40
SN7470N	J-K Flip-flop	45	40	35
SN7472N	J-K Master-Slave Flip-Flop	50	45	40
SN7473N	Dual J-K Master-Slave Flip-Flop	45	40	35
SN7474N	Dual D-type Edge-Triggered Flip-Flop	55	50	45
SN7476N	Dual J-K Master-Slave Flip-Flop with Preset & Clear	£1.30	£1.20	£1.10
SN7483N	Four-bit Binary Full Adder	£1.12	£1.00	87
SN7490N	Decade Counter	£1.45	£1.30	£1.15
SN7492N	Divide-by-12 Counter			
SN7493N	Four-bit Binary Counter			
SN74141N	BCD to decimal Decoder/Driver (Replaces the obsolete SN74141AN)			

MIX PRICES: Devices may be mixed to qualify for quantity price. Larger quantities - prices on application.

LINEAR AND DIGITAL I/C'S

R.C.A.	FAIRCHILD	I-11	12-24	25+
CA1004	£1.80			
CA3005	£1.20	uL900	40 Np	35 Np
CA3011	£1.75	uL914	40 Np	35 Np
CA3013	£1.05	uL923	50 Np	50 Np
CA3014	£1.25			
CA3018	85			
CA3020	£1.30			
CA3028A	£1.75			
CA3035	£1.25	PA230	Pre-amp	
CA3043	£1.40	PA234	1 Watt Amp	£1.10
CA3044	£1.20	PA237	2 Watt Amp	£1.87
CA3046	75	PA246	5 Watt Amp	£2.43
CA3047	£1.40	PA424	Zero Volt Switch	£2.45
CA3048	£2.05			
CA3052	£1.60			
CA3052	£1.45			
MISCELLANEOUS				
		TH9013P	Toshida 30 Watt Hybrid IC Amp	£4.47
		IC10	Similar	£2.75
		SL403A	Plessey New Design	£2.12
BARGAIN OP-AMPS !!				
LM709C	£0.60	MULLARD		
LM709C	£0.60	LM709C	Linear Amp	75 Np
LM741CN	95 Np	TAA293	General Purpose Amp	£1.00
		TAA320	Record/Playback Amp	£1.50
		TAA320	MOS LF Amp	65 Np
		TAD100	IC Receiver	£1.97
		TAD110	AM/FM Receiver	£1.97



ULTRASONIC TRANSDUCERS

Operate at 40Kc/s. Can be used for remote control systems without cables or electronic links. Type 100K transducers can transmit and receive. FREE: With each pair our complete transmitter and receiver circuit. PRICE £5.90 Pair (Sold only in pairs)



DD119	Heart sink compound - Silicone grease			30 Np
DD170	Bargain pack of five 1 Watt Zener diodes			97 Np
DD175	4 pieces 100 PRV Rectifiers 500mA			50 Np
DD176	2 pieces 200 PRV Rectifiers 500mA			30 Np
DD177	2 pieces 400 PRV Rectifiers 500mA			50 Np
DD180	Bargain Transistor pack 2 AF - RF			57 Np
DD184	Assortment of RF, audio & power transistor solar cell & diode			£1.87
DD190	Pack of 4 assorted solar cells			50 Np
EP50A	Solar motor (operates from 54M)			£1.97
B1M	Silicon Solar cell 10-16mA			95 Np
SAM	Silicon Solar cell 25-40mA			£1.47
B3M	Low cost Selenium solar cell			£3.90
B3M	Selenium cell in protective case			75 Np
CS120	Cadmium Sulphide photoconductive cell			98 Np

Only part of the International Rectifier 'Diamond Line' range are listed. Send for free catalogue or ask your local component stockist.

TRIACS

2N5756	2.5A (RMS) 400 PIV TO-5 Mod.			75 Np
40486	6 Amp (RMS) 400 PIV TO-5 Mod.			£1.20
40410	6 Amp (RMS) 400 PIV TO-46			£1.81
40432	6 Amp (RMS @ 75° Amb.) 400 PIV TO-5 Mod.			£1.50
40512	2.2 Amp (RMS @ 25° Amb.) 400 PIV			£1.47
		* These types have integral triggering.		
40576	15A (RMS) 400 PIV TO-66			£1.75
SC146B	10 Amp 200 PIV Plastic Flat-pack			£1.25
SC146D	10 Amp 200 PIV Plastic Flat-pack			£1.75
ST2	Bi-lateral avalanche trigger diode			47 Np

ZENER DIODES

400mW 10%	GLASS CASE TEXAS INSTR.			
15201	3.0 volt	152082	8.2 volt	
152019	3.3 volt	152100	10 volt	
152043	4.3 volt	152110	11 volt	
152047	4.7 volt	152120	12 volt	
152056	5.6 volt	152160	16 volt	
152062	6.2 volt	152180	18 volt	
152068	6.8 volt	152200	20 volt	
152075	7.5 volt	152250	25 volt	
Prices:	1-24 15Np	25-99 11Np	100- 9Np	

THYRISTORS

CR1705IC	1 Amp 50 PIV TO-5	40 Np
CR1740IC	1 Amp 400 PIV TO-5	50 Np
2N3525	5 Amp 400 PIV TO-66	£1.09
40739	10 Amp 400 PIV Stud Mtg	£1.65

Kit building is so easy

The unique HEATHKIT step-by-step method of construction defies error for the beginner as well as the experienced kit builder

Economy SW Receiver



World wide reception.
1-30MHz plus 550-1620KHz
Kit K/GR-64 £25.00 Carr. 50p

FM Stereo Tuner



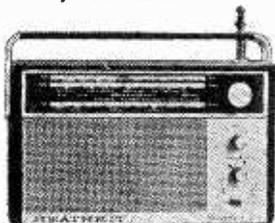
Concert hall realism - Amazing low price. Kit K/AJ-14 £27.00 (Cab. extra) Carr. 40p

Stereo Amplifier

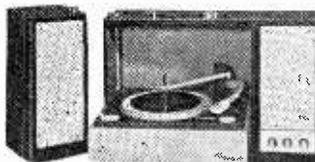


Heathkit unbeatable value - 20W total power output. Kit K/AA-14 £32.00 Carr. 30p (Cab. extra)

'Severn' AM/FM Radio
Beautiful looks - luxury sound
Black 'vynide' case.



Kit K/Severn £19.90 Carr. 50p



Stereo Record Player
Exciting sound - budget price.
Kit K/SRP-1 £32.50 Carr. 80p
(Teak or Black/Rexine)

'Trent' Speaker



Compact size - lowest cost.
Kit K/Trent £15.20 Carr. 60p
(Teak or Walnut)



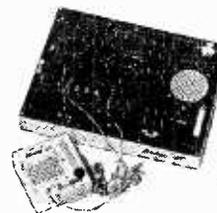
Deluxe Car Radio
Heathkit value - powerful output.
Two tone grey plus chrome trim. Kit K/CR-1 (less speaker)
£13.80 Carr. 30p



Thumb 'Tacho'

Measures RPM on any model engine at low cost.
Kit K/GD-69 £9.50 Carr. 20p

Electronic Workshop



35 exciting experiments.
Kit K/JK-18 £16.40 Carr 40p

Hundreds of HI-FI, Radio, Test & other models to choose from.



A Schlumberger Company
HEATH (GLOUCESTER) LTD
GLOUCESTER GL2 6EE

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Prices and specification may be subject to change.

53/5/71

REVERBERATION UNIT KIT

A new, all silicon version of our self-contained, 6 transistor, reverberation chamber to which microphones, instruments, tuners or tape recorders may be connected for added dimensional effect. The output is suitable for most amplifiers and the unit is especially suitable for use with electronic organs. A ready-built spring and transducer assembly is used (£2.95 (59/-) if bought separately).

Complete easy-to-build kit, with constructional notes and circuits £7.50 (£7.10.0) Pre-drilled and printed case £1.70 (34/-) All parts available separately. Send 5p (1/-) for circuit and construction details.

WAH-WAH PEDAL KIT

SELECTIVE AMPLIFIER MODULE. The basis of the Wah-Wah pedal. Kit contains all the components to build a 2-transistor circuit module, also the sockets, control, etc., required for the constructor to assemble his own design. £1.75 (35/-). Assembled and tested module £2.12 (42/5).

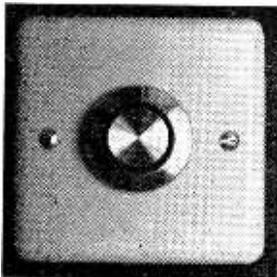
FOOT VOLUME CONTROL PEDAL. Foot pedal unit in very strong fawn plastic. Fitted with output lead and plug for connection to guitar amplifier. May be used for volume control or converted to Wah-Wah by adding the module. Pedal unit now only £5.12 (£5.2.5). Complete kit for Wah-Wah pedal now only £6.50 (£6.10.0).

I.C. STEREO AMPLIFIER KIT

A new kit from Wilsic to build a hi-fi integrated circuit stereo amplifier 3 watts per channel with full tone controls and attractive veneered cabinet, or may be built into plinth unit. Complete amp kit with stabilised power pack £21.45 (£21.9.0) with economy power pack £18.50 (£18.10.0). Cabinet kit: teak 73½p (14/8) mahogany 66p (13/2). Full plans and detailed prices 10p (2/-).

New catalogue 15p (3/-) with special discount order form.

WILSIC ELECTRONICS LIMITED
6 COPLEY ROAD, DONCASTER, YORKSHIRE



THE
LITTE
RE

Dimmerswitch

Will dim up to 400 watts of incandescent lighting from zero to full brilliance. This unit simply replaces the normal light switch, and is fitted in a matter of minutes. An MK mounting frame is supplied, for use when more depth is required.

PRICE: Complete Kit: £2.85 (57/-)
Built & tested: £3.35 (67/-)

Diathane Ltd.

111 Sheffield Road, Wymondham
NORFOLK
£0.10 Postage & Packing

BI-PAK=LOW COST IC'S



BI-PAK Semiconductors now offer you the largest and most popular range of I.C.'s available at these EXCLUSIVE LOW PRICES. TTL Digital 74N Series fully coded, brand new. Dual in-line plastic 14 and 16 pin packages.

BI-PAK Order No.	Description	Price and qty. prices		
		1-24	25-99	100 up
BP00 7400N	Quad 2-Input NAND GATE	23p	20p	15p
BP01 7410N	Quad 2-Input NAND GATE—OPEN COLLECTOR	23p	20p	15p
BP04 7404N	HEX INVERTER	23p	20p	15p
BP10 7410N	Triple 3-Input NAND GATE	23p	20p	15p
BP20 7420N	Dual 4-Input NAND GATE	23p	20p	15p
BP30 7430N	Single 8-Input NAND GATE	23p	20p	15p
BP40 7440N	Dual 4-Input BUFFER GATE	23p	20p	15p
BP41 7441N	BCD to decimal decoder and N.I.T. Driver	87p	77p	67p
BP42 7442N	BCD to decimal decode (TTL O/P)	87p	77p	67p
BP50 7450N	Dual 2-Input AND/OR/NOT GATE—expandable	23p	20p	15p
BP53 7453N	Single 8-Input AND/OR/NOT GATE—expandable	23p	20p	15p
BP60 7460N	Dual 4-Input—expandable	23p	20p	15p
BP70 7470N	Single JK Flip-Flop—edge triggered	35p	32p	29p
BP72 7472N	Single Master Slave JK Flip-Flop	35p	32p	29p
BP73 7473N	Dual Master Slave JK Flip-Flop	43p	40p	37p
BP74 7474N	Dual D Flip-Flop	43p	40p	37p
BP75 7475N	Quad Bistable Latch	47p	45p	43p
BP76 7476N	Dual Master Slave Flip-Flop with preset and clear	47p	45p	43p
BP83 7483N	Four Bit Binary Adder	87p	77p	67p
BP90 7490N	BCD Decade Counter	87p	77p	67p
BP92 7492N	Divide by 12 4 Bit binary counter	87p	77p	67p
BP93 7493N	Divide by 16 4 Bit binary counter	87p	77p	67p
BP94 7494N	Dual Entry 4 Bit Shift Register	87p	77p	67p
BP95 7495N	4 Bit Up-Down Shift Register	87p	77p	67p
BP96 7496N	5 Bit Shift Register	£1.10	£1.00	90p

Data is available for the above Series of I.C.'s in booklet form, price 13p each.

LINEAR I.C.'s

Type No.	Case	Leads	Description	Price
BP 201C - SL201C	TO-5	8	G.P. Amp	63p 53p 45p
BP 701C - SL701C	TO-5	8	OP. Amp	63p 53p 45p
BP 702C - SL702C	TO-5	8	OP. Amp Direct O/P	63p 53p 45p
BP 702 - 72702	D.I.L.	14	G.P. OP. Amp (Wide Board)	53p 45p 40p
BP 709 - 72709	D.I.L.	14	High OP. Amp	53p 45p 40p
BP 709P - uA709C	TO-5	8	High Gain OP. Amp	53p 45p 40p
BP 741 - 72741	D.I.L.	14	High Gain OP. Amp (Protected)	75p 60p 50p
uA 703C - uA703C	TO-5	8	R.F. IF Amp	43p 35p 27p
TAA 263	TO-72	4	A.F. Amp	70p 60p 55p
TAA 293	TO-74	10	G.P. Amp	90p 75p 70p

TTL INTEGRATED CIRCUITS

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

PAK No.	PAK No.	PAK No.
UIC00 = 12 x 7400N 50p	UIC40 = 5 x 7450N 50p	UIC80 = 5 x 7480N 50p
UIC01 = 12 x 7401N 50p	UIC50 = 12 x 7450N 50p	UIC82 = 5 x 7482N 50p
UIC02 = 12 x 7402N 50p	UIC51 = 12 x 7451N 50p	UIC83 = 5 x 7483N 50p
UIC03 = 12 x 7403N 50p	UIC60 = 12 x 7460N 50p	UIC86 = 5 x 7486N 50p
UIC04 = 12 x 7404N 50p	UIC70 = 8 x 7470N 50p	UIC90 = 5 x 7490N 50p
UIC05 = 12 x 7405N 50p	UIC72 = 8 x 7472N 50p	UIC92 = 5 x 7492N 50p
UIC10 = 12 x 7410N 50p	UIC73 = 8 x 7473N 50p	UIC93 = 5 x 7493N 50p
UIC20 = 12 x 7420N 50p	UIC74 = 8 x 7474N 50p	UIC94 = 5 x 7494N 50p
UIC40 = 12 x 7440N 50p	UIC75 = 8 x 7475N 50p	UIC95 = 5 x 7495N 50p
UIC41 = 5 x 7441AN 50p	UIC76 = 8 x 7476N 50p	UIC96 = 5 x 7496N 50p

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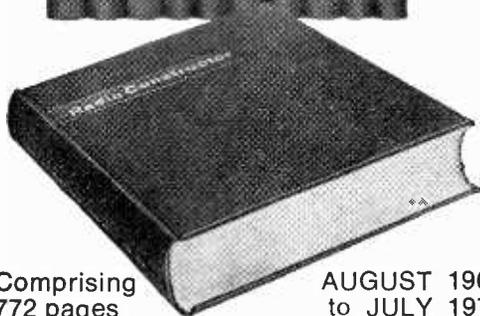
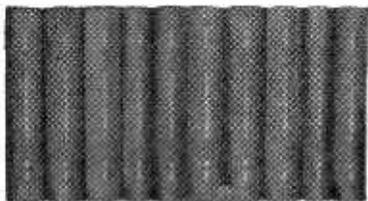
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= BC107 .13	2N1308-9 .35
BC172	2N3819FET .45
= BC108 .13	Power
BF194 .15	Transistors
BF274 .15	OC20 .50
BFY50 .20	OC23 .30
BSY25 .37	OC25 .25
BSY26 .13	OC26 .25
BSY27 .13	OC28 .30
BSY28 .13	OC35 .25
BSY29 .13	OC36 .37
BSY95A .13	AD149 .30
OC41 .13	AUY10 1.25
OC44 .13	2N3055 .63
OC45 .13	25034 .25
OC71 .13	Diodes
OC72 .13	AAV42 .10
OC73 .17	OA95 .09
OC81 .13	OA79 .09
OC81D .13	OA81 .09
OC139 .13	IN914 .09

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THE RADIO CONSTRUCTOR

THE Radio Constructor



Incorporating **THE RADIO AMATEUR**

MAY 1971

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TRANSISTOR R.F. PRESELECTOR

by

D. BURGE

Covering the amateur bands from 160 to 20 metres, this preselector may be inserted between any aerial and short-wave receiver, thereby enhancing both sensitivity and selectivity. It would be desirable to have available a grid dip meter for setting up the tuned circuits

THE R. F. AMPLIFIER TO BE DESCRIBED IN THIS article was envisaged as a general purpose unit capable of being used as a preselector in front of an existing receiver or as part of an experimental set-up. Two small printed circuits are used for mounting the transistors and associated components and therefore from a constructional point of view, the coil assembly can be dealt with as a more or less separate entity.

This factor should enable the constructor to make a variety of permutations on the frequency covered by the various ranges, provided he has the facility of a dip-meter available. In fact, although it has not been tried, it should be quite feasible to use commercial coils from the Denco range. The preselector was also the writer's first venture into the production of printed circuits and the relative ease – or luck! – with which the previous hay-wire version was trans-

COMPONENTS

Resistors

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

R1	39k Ω
R2	5.6k Ω
R3	180 Ω
R4	470 Ω
R5	47k Ω
R6	20k Ω potentiometer, linear track
R7	470 Ω
R8	33k Ω
R9	10k Ω
R10	470 Ω
R11	1k Ω

Capacitors

C1	100pF silver-mica
C2	250pF silver-mica
C3	500pF silver-mica
C4	1,000pF silver-mica
C5	1,500pF silver-mica
C6	2,000pF silver-mica
C7	33pF silver-mica
C8	50pF variable, Jackson Bros. Type C804
C9	1,000pF silver-mica
C10	500pF, part of 2-gang variable
C11	0.1 μ F paper or plastic foil
C12	0.1 μ F paper or plastic foil
C13	0.1 μ F paper or plastic foil
C14	1,000pF silver-mica
C15	500pF, part of 2-gang variable
C16	0.1 μ F paper or plastic foil
C17	60pF trimmer

C18	60pF trimmer
C19	60pF trimmer
C20	60pF trimmer
C21	0.1 μ F paper or plastic foil
C22	1,000pF silver-mica
C23	0.1 μ F paper or plastic foil
C24	0.1 μ F paper or plastic foil

Inductors

L1 – L16	See text
R.F.C.	2.5mH r.f. choke, type CH1 (Repanco)

Transistors

TR1	ASZ20
TR2	ASZ20
TR3	ASZ20

Switches

S1	1-pole 6-way rotary, miniature
S2(a), (b), (c), (d)	4-pole 4-way rotary, 2-wafer

Miscellaneous

2 coaxial sockets
Tuning drive, Muirhead Type D
4 knobs
2 extension spindles
3-way tagstrip, centre tag earthed
Materials for chassis and printed circuit boards
Coaxial cable, self-tapping screws, etc.

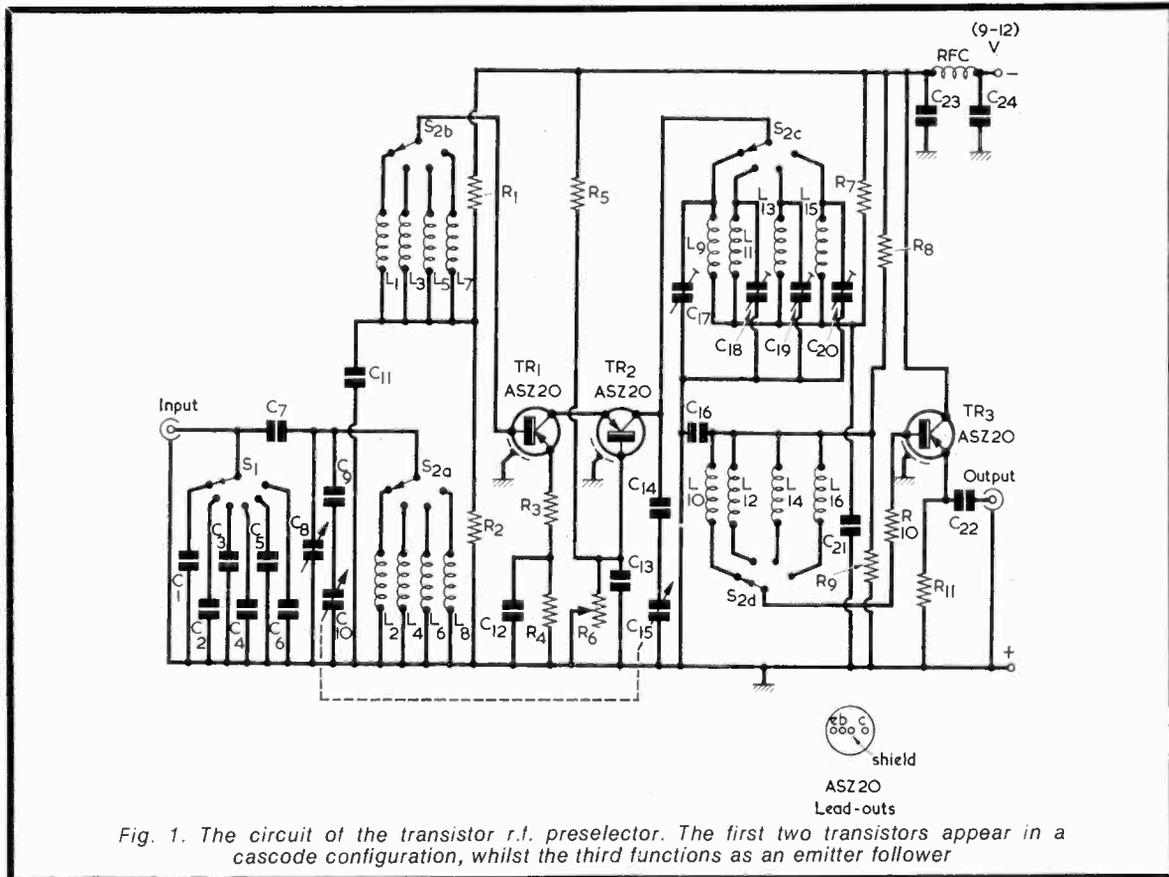


Fig. 1. The circuit of the transistor r.f. preselector. The first two transistors appear in a cascode configuration, whilst the third functions as an emitter follower

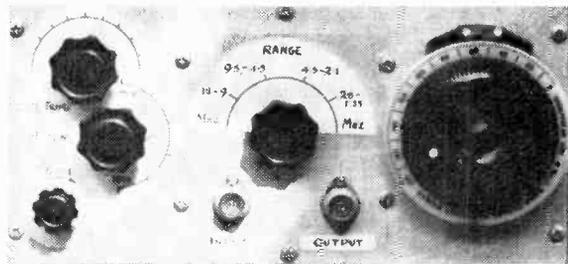
lated to the printed circuit, together with the vastly improved performance, came as a very pleasant surprise.

THE CIRCUIT

Fig. 1 shows the circuit diagram of the complete amplifier which essentially consists of an attenuator in the signal input circuit followed by a cascode r.f. amplifier and emitter follower output. The attenuator was included because previous attempts at constructing r.f. amplifiers had indicated that transistors can easily act as mixers in the presence of strong signals and considerable cross-modulation effects can occur. Therefore, some means of reducing the signal being fed to the base of TR1 was essential if optimum results were to be obtained over a wide range of signal strengths. A resistive network could have been used but the writer's maths are not equal to working out the values required to maintain a constant impedance between input and output; neither is it amenable to the experimental approach, and so a simpler method was sought. The comparatively simple switched capacitive potentiometer across the tuned input circuit provided the answer.

The change of capacitance across the coil caused by using the single capacitor, C7, in the top arm of the potentiometer is very small, since it has only a value of 33pF. Also, the change in capacitance can be compensated for by the aerial trimmer which is brought out as a front panel control. As a small

added bonus, the aerial loading tends to be reduced as the attenuator is advanced towards maximum. The values given to the switched capacitors in the bottom arm of the potentiometer were found by experiment, using a long wire aerial of about 66ft. connected to the input and having the gain control set to the point of maximum gain. On the occasions when propagation conditions produce exceptionally strong signals in the short wave bands, the results obtained with this comparatively simple arrangement are quite dramatic, and weak signals completely overridden by general hash can be resolved. The frequency range covered by the four switched coils is from 1,350 kHz to 18MHz, when tuned by a 2-gang 500pF variable capacitor in series with a fixed capacitor of 1000pF. The highest frequency



The layout of the front panel controls. The input socket is at the left and the output socket at the right

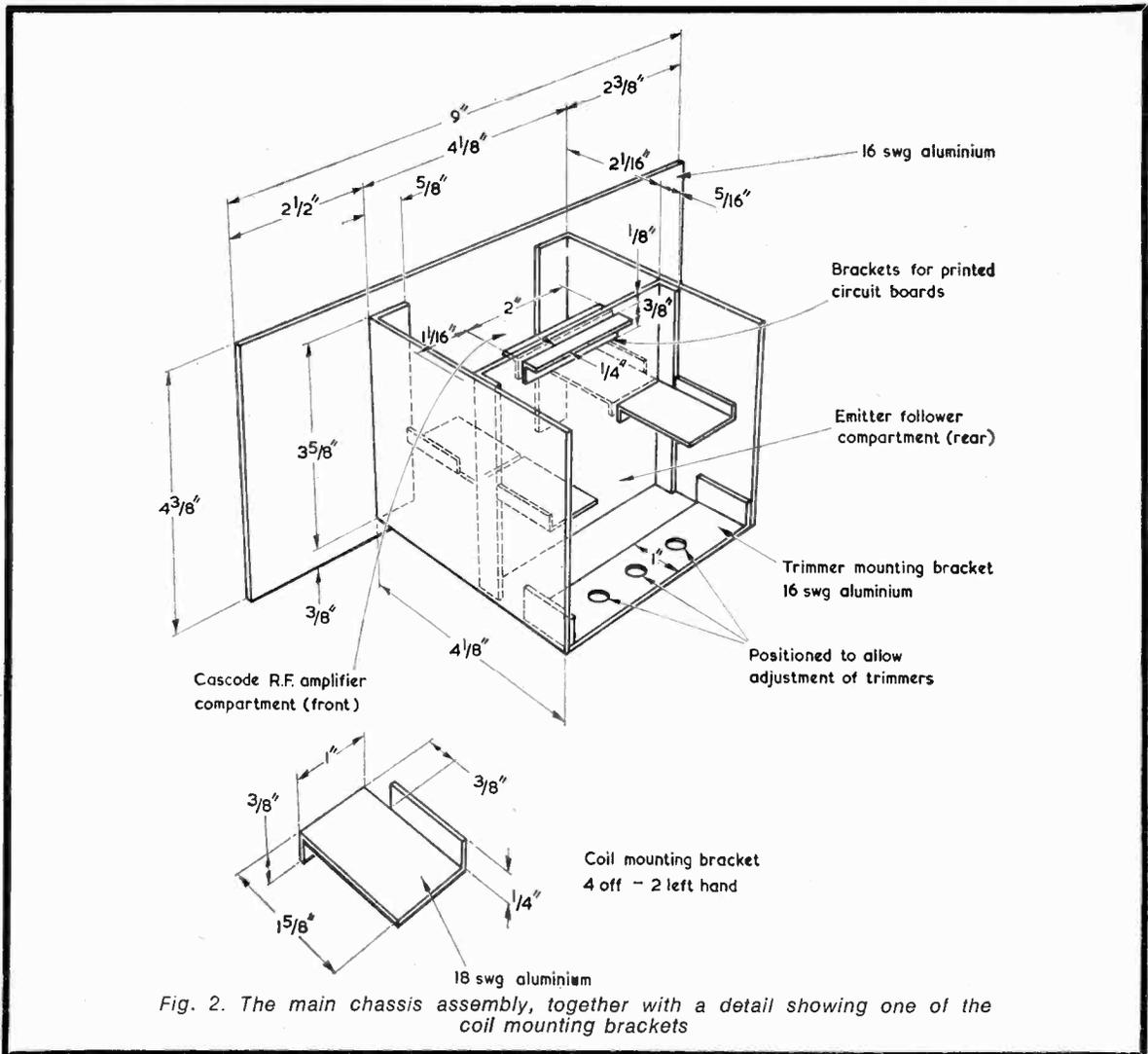


Fig. 2. The main chassis assembly, together with a detail showing one of the coil mounting brackets

that can be amplified is, of course governed, by the cut-off frequency of the transistors used.

In this case, ASZ20's are used. These have a cut-off of 100MHz and, bearing in mind that the cut-off frequency of an r.f. transistor should be at least five times higher than the highest frequency it is intended to amplify, a drop in amplification will begin to occur at about 20MHz. This was found to be the case in the previous version of the present unit, which tuned to 21MHz.

The cascode configuration was decided upon because of the high degree of isolation between output and input, and also because it provides a high output impedance which allows the second tuned circuit to be placed directly in the collector of TR2. The tuning capacitance is connected between the collector of TR2 and chassis, the tuned circuit being completed by the decoupling capacitor C21. Gain is controlled by variation of the bias at the base of TR2. The operation of the gain control R6 is mainly effective over only a small part of its travel. This could be avoided by dividing the lower arm of the bias potentiometer into a fixed and variable part but, in

operation, the change seemed an unnecessary complication.

The small resistor R3 in the emitter circuit of TR1 provides some degeneration and further assists in reducing cross-modulation effects.

A low impedance output is provided by the emitter follower stage, TR3. The r.f. choke in the negative supply line, together with the decoupling capacitor C23, is very necessary to prevent the whole circuit going into oscillation. This is particularly true when a power supply common with the receiver is used. The writer uses a common supply and no provision for an internal battery has been made. However, the power requirements of the amplifier are very modest, being 1.5mA at 9V and 2mA at 12V, whereupon a small 9V battery would suffice. There is ample room, if required, to mount a bracket on the coil compartment screen for such a battery.

CONSTRUCTION

The dimensions and method of constructing the chassis are shown in Fig. 2. The coils are mounted

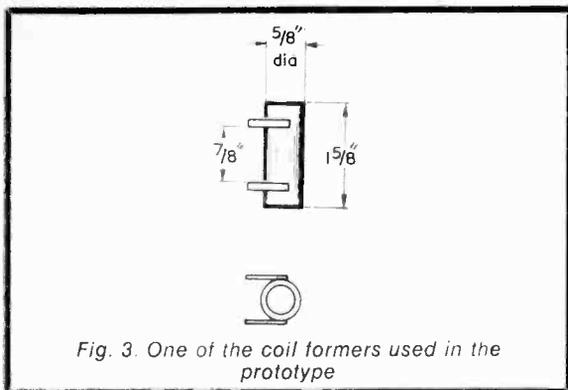
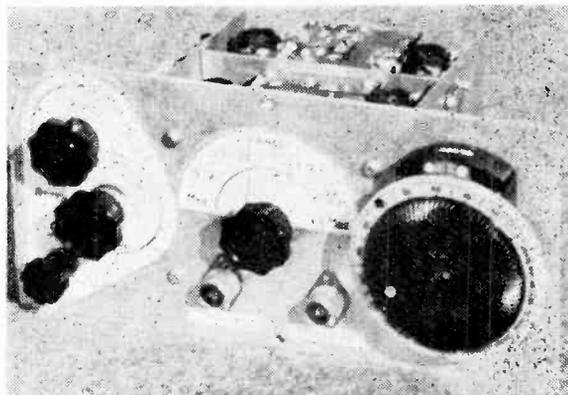


Fig. 3. One of the coil formers used in the prototype



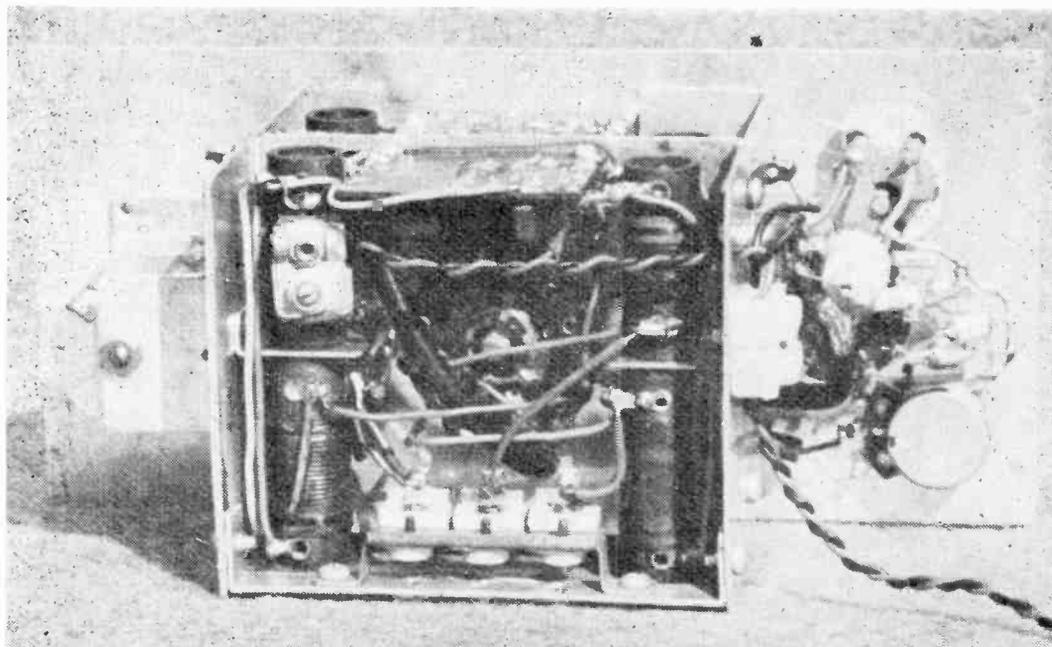
Three-quarter view of the front of the preselector

vertically on the brackets attached to the screens. The writer used coil formers $1\frac{5}{8}$ in. long and $\frac{5}{8}$ in. diameter mounted back to back (with the aid of individual small brackets) above and below each coil mounting bracket. These formers have no iron-dust cores, and are illustrated in Fig. 3. (A suitable material for the coil formers would be Lantex tubing of $\frac{5}{8}$ in. diameter. This is available in 6 in. lengths from Home Radio under Cat. No. ZA22B. — Editor.) If other coils are used with mounting arrangements which require them to be offset, some care will be necessary to avoid fouling the bracket holding the preset trimmer capacitors in the lower part of the rear compartment. The Table gives details of the turns required in the main and coupling windings for both sets of coils to cover the frequency ranges quoted. All winding wire is enamel covered and the coupling windings are wound over the earthy ends of the main windings, a layer of thin tape being interposed between the two. It was found that the

coupling windings were not very critical with regard to number of turns and wire gauge. Coil layout, as seen from the top is given in Fig. 4, which shows how the two switch wafers are positioned on either side of the central screen.

The positioning of individual coils in each of the compartments is not important provided that input and output coils for the same range are not adjacent to each other on either side of the central screen. The best plan here is to have the two coils for each range diametrically opposite each other. Thus, if the 18-9MHz coil on the front section of the screen is at the bottom left, the 18-9MHz coil in the rear section should be positioned top right, and so on.

The four preset trimmers in the rear section can be seen in the accompanying photograph. Three appear in a 3-way unit, whilst the fourth is soldered direct to the tags of the appropriate coil. If a 3-way



Rear view, showing the manner in which the chassis is made up

TABLE
Winding details for coils L1 to L16

Range (MHz)	Tuned Winding			Coupling Winding			Style of Winding
	Coil	No. of turns	S.W.G.	Coil	No. of turns	S.W.G.	
18 - 9	L2, L9	9	18	L1, L10	5	26	Space-wound $\frac{1}{8}$ in. long
9.5 - 4.5	L4, L11	18	24	L3, L12	5	26	Space-wound
4.5 - 2.1	L6, L13	38	34	L5, L14	6	26	$\frac{1}{8}$ in. long
2.8 - 1.35	L8, L15	75	38	L7, L16	6	26	Closewound Closewound

trimmer unit cannot be obtained, alternative methods of mounting the trimmers should be devised, and this should not give rise to any exceptional difficulty.

Details of the front panel, centre screen and right-hand and left-hand screens appear in Figs. 5(a), (b) and (c). The position of the front panel hole for the tuning capacitor depends upon the type employed, and its dimensioning may vary from that shown in Fig. 5(a). The capacitor has an extension spindle and is fitted with a Muirhead Type D slow-motion drive, this being available from Henry's Radio, Ltd. There are two large holes in the centre screen; one takes a coaxial lead from C22 to the output socket on the front panel, whilst the other takes an un-screened lead from the collector of TR2 to the arm of S2(c). The braiding of the coaxial lead is earthed at both ends. Fig. 5(c) shows the right-hand screen (right-hand as viewed from the rear). This has a hole to take a coaxial lead from the aerial input socket to the attenuator switch, the braiding of this lead being earthed at both ends. The attenuator capacitors are mounted on the switch, and C7 couples this to C8, from which an un-screened lead passes back through the screen through a $\frac{1}{4}$ in. hole. Another $\frac{1}{4}$ in. hole takes the lead to the gain control R6. Fitted to the right hand screen at top rear is a 3-way tagstrip to which are soldered C23, C24 and the r.f. choke. In outline, the left-hand screen is the mirror image of the right-hand screen. It has mounting holes for the 2-gang tuning capacitor, their positioning depending on the actual component used,

together with two $\frac{1}{4}$ in. holes to allow the lead-outs of C9 and C14 to pass through to the two stages of the amplifier. In all cases, wiring should be kept as short as reasonably possible.

Self-tapping screws are used throughout. Where they are used to secure chassis sections together, only the holes through which they initially pass are shown in Figs. 5(a), (b) and (c). The corresponding holes into which they tap can be marked out from those through which they pass. The six outer holes in the front panel shown in Fig. 5(a) are not dimensioned; these may be drilled to suit any particular case in which the amplifier is to be housed.

The whole assembly of coils, switch wafers and tuning capacitor must be assembled and wired before the front panel is attached or the printed circuits made up. Having completed the wiring up to this stage, alignment and frequency range can be checked with the aid of a dip-meter, such as the one described in *The Radio Constructor* for February 1967.* The use of a dip-meter at this stage of construction ensures that wiring is correct and avoids a lot of possible frustration at a later stage. In fact, it was found that the unit required very little further adjustment when finally completed and functioning.

As already mentioned, the switch for range selection is mounted on the centre screen. It includes the switch plate as well as the two wafers. An extension spindle is taken through the front panel.

The only precaution needed when fitting the front panel is to ensure that the attenuator switch does not foul the adjacent screen, as there is not much clearance.

Remember to connect long leads to the arms of S2(a), (b) and (c) for later connection to the printed circuits and aerial trimmer. One end of R10 connects to the centre pole of S2(d), its other end later connecting to the rear printed board. The front panel, together with its components, can then be fixed in position. There next remains only the attenuator circuit to assemble and wire, and also the r.f. choke and decoupling capacitors to mount on the tagstrip at the top of the right-hand screen. The two coaxial leads connecting to the input and output sockets on the front panel are fitted after the printed circuit boards have been mounted and wired up.

PRINTED CIRCUITS

The layout of the two boards is shown actual size in Figs. 6(a) and (b). The area of copper to be retained is shaded and the positions of the components indicated by dotted lines. The boards are 2in.

* D. Burge, "Transistorised Grid Dip Meter For The Experimenter", *The Radio Constructor*, February, 1967.

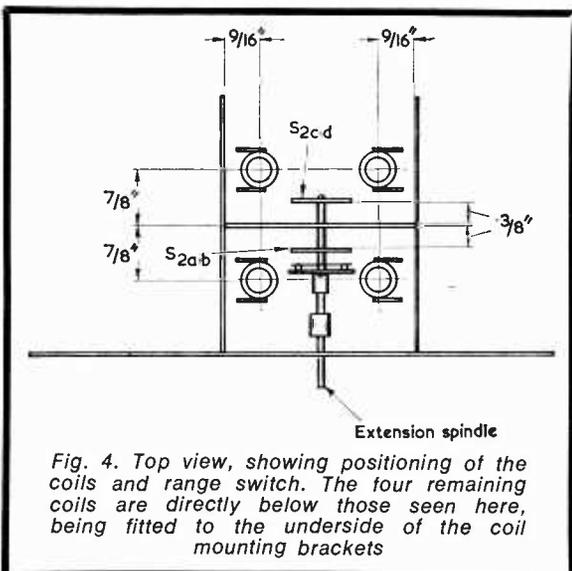
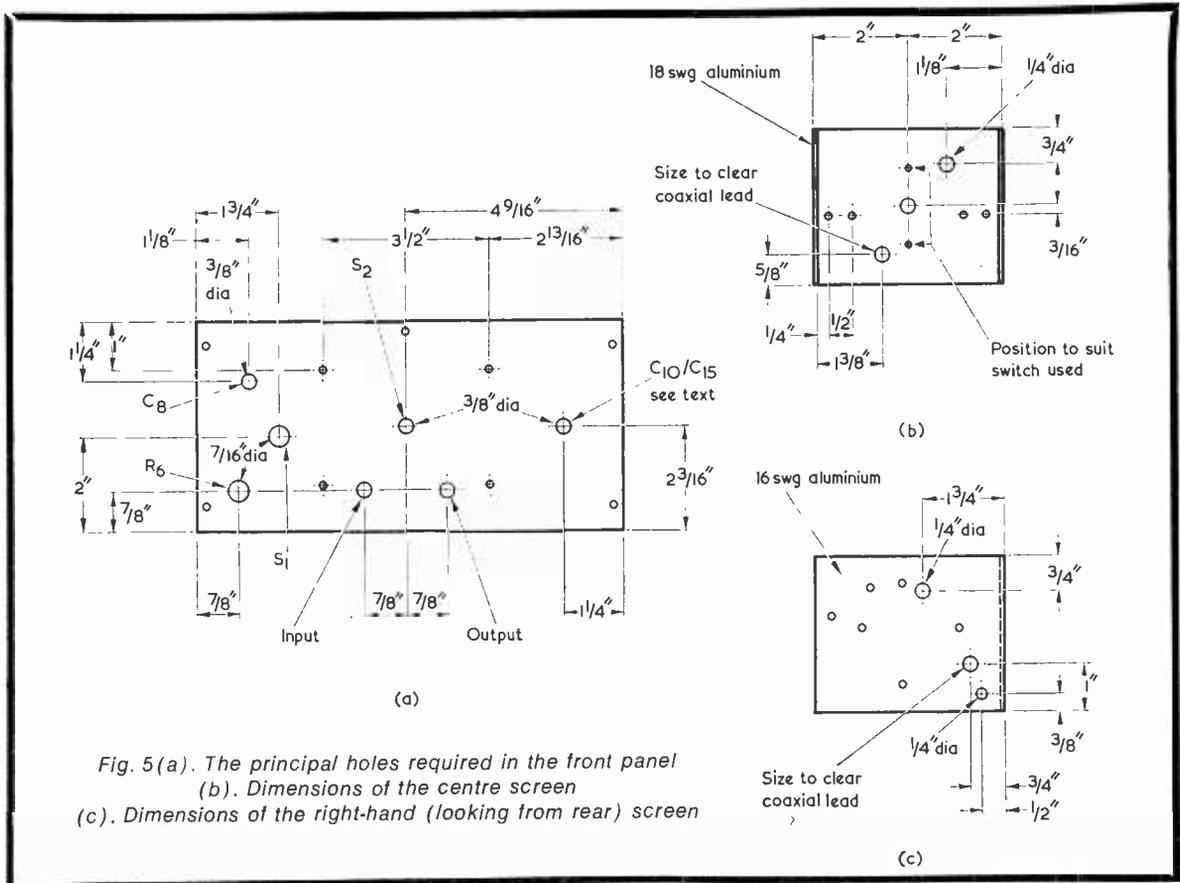


Fig. 4. Top view, showing positioning of the coils and range switch. The four remaining coils are directly below those seen here, being fitted to the underside of the coil mounting brackets



square and secure to the two brackets indicated in Fig. 2 by means of two self-tapping bolts each. C11 and C16 are not mounted directly on the boards. One lead-out of each of these capacitors should be connected at the circuit points indicated, the other lead-out connecting to a solder tag under the nearer bolt-head securing the board in position.

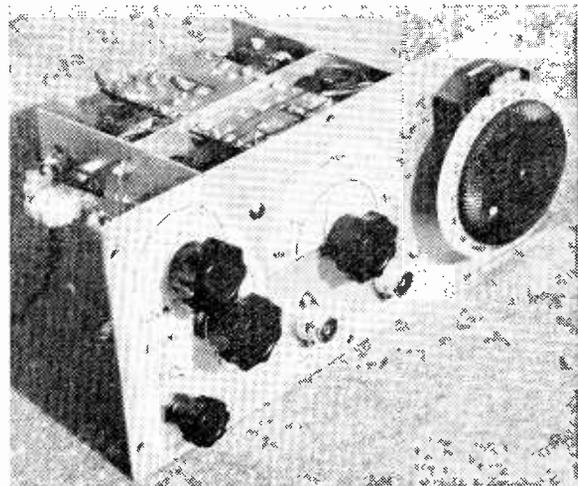
Preparation is quite simple, and commences by covering the shaded area with ink. One of the popular felt tipped marker pens proved ideal for this purpose, but it is necessary to ensure that the type of ink used can be easily removed with petrol.

Having ensured that the copper surface is cleaned of all oxidants and grease marks – “Vim” is just the job for this – cover the shaded areas as just described. If there are any slips at this stage they can easily be remedied with the aid of a pen-knife blade once the ink has dried.

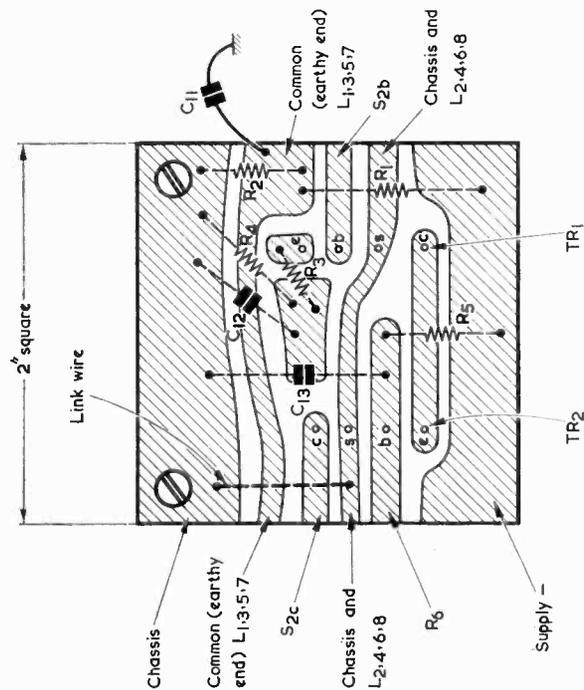
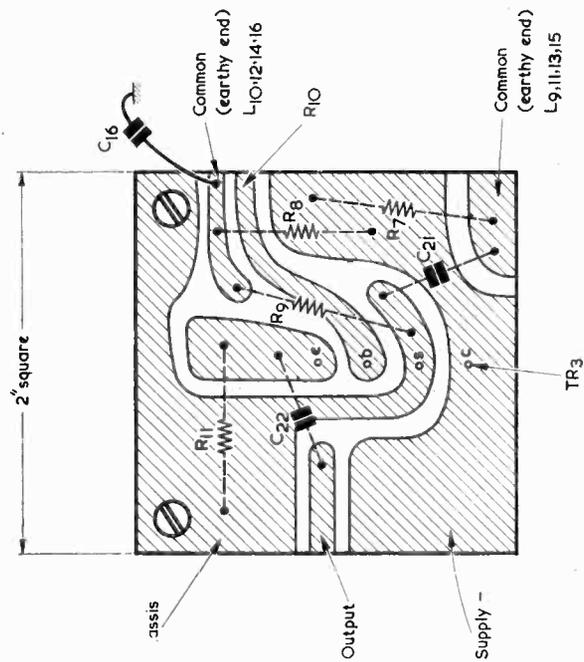
The boards are then immersed in a solution of ferric chloride. A small rectangular polythene bottle cut in half makes a useful tray for this part of the process. The time taken for etching to occur will depend on the strength of the solution and whether it is agitated. When etching is complete remove the board from the solution, using rubber gloves or a clothes peg, and wash the board thoroughly with water. Next remove the ink with petrol.

Holes for mounting the components can then be drilled with a suitable size bit, drilling from the copper side to avoid lifting the copper foil from the

surface of the board. The exact positions of the holes were assessed by assembling all the components, suitably bending the wire ends, positioning them one at a time on the board and marking with a bradawl. This is not quite as tedious as it sounds and it does allow for various sizes of components.



Another front view. The printed circuit boards may be seen mounted to the top of the centre screen



s - transistor shield

s - transistor shield

(a) (b)
 Fig. 6. The layout of the two printed circuit boards, with the copper side towards the reader. The cascode stage is in (a) and the emitter follower stage in (b). The boards are reproduced full-size, and the diagrams may be traced if desired

The resistors and capacitors are next soldered in position, followed by the transistors, after which the boards are mounted on their brackets, copper side uppermost. The connecting leads from the switch wafers, together with the free lead-out of R10, can next be cut to length and soldered to the boards. Finally fit the two coaxial leads, one from the aerial socket to the arm of the attenuator switch, and the other from the board containing the emitter follower circuit to the output socket. After checking the wiring for any possible faults, it only remains to connect a suitable supply.

ALIGNMENT

Final alignment was carried out with the aid of the S-meter on the receiver and a signal from the dip-meter loosely coupled to the aerial. The aerial trimmer is set to mid-position, the main tuning to mid-band and the preset trimmers adjusted for maximum deflection on the S-meter. Any subsequent mistuning due to slight lack of tracking in the ganged circuits or to different settings of the attenuator can be compensated for by adjustment of the aerial trimmer. To obtain optimum results on weak signals the main tuning and aerial trimmer adjustments are carried out together, as adjustment of one has a slight effect on the other.

It was found that a small amount of regeneration occurred on the 160 metre band when the gain control was turned nearly to the full position, this resulting from circuit measures designed to improve sensitivity on the other three ranges. Since the regeneration on 160 metres could be cleared without loss of sensitivity by backing off the gain control, it was felt that this circumstance did not present a serious disadvantage.

Results obtained have been very gratifying both as regards sensitivity and selectivity. The tuning is relatively sharp, but not so sharp as to raise any problems in finding the correct frequency, which is indicated by a considerable rise in background noise as the main tuning is swung through its 180° traverse.

NEW I.C. FOR AM RADIO

SGS announce the TBA651, a new linear circuit, which has been designed for use in high quality car radios and radio receivers. It combines the functions of an RF amplifier, oscillator, mixer and IF amplifier. As the device contains an internal voltage regulator, it can be operated with a supply voltage from 4½ - 18 volts. It has been designed with a view to reducing the number of external components to a minimum, with the resulting reduction in costs. The range of applications for the circuit is considerably increased by its ability to perform at a frequency up to 27 MHz.

The main features of the circuit are: high gain, low noise and high sensitivity. Typical S/N ratio of 26dB can be achieved for an input of 10uV. Good signal handling characteristic by virtue of its wide AGC range. Typically 80dB variation in input level produces only a 10dB output variation. Low distortion.

This device is supplied in a 16 lead plastic split DIP Package. Technical Bulletin reference 108 is available covering this device.

MAY 1971

NOW HEAR THESE

Times = GMT

Frequencies = kHz

● FRANCE

ORTF Paris now has an outlet on **7180**. This is in parallel with the old **15245** and **21620** (both 100kW) channels.

● WINDWARD ISLANDS

The Windward Islands Broadcasting Service on **15115** (100kW) now radiates its English programme, directed to the UK, from 1945 to 2133.

● ETHIOPIA

ETLF 'Radio World of the Gospel', Box 654, Addis Ababa, has changed the **15230** channel to that of **15260** (100kW) for the Arabic programme from 1615 to 1715.

● INDIA

All India Radio, Delhi, radiates a newscast in English at 1445 on **7125** and **9575** (10/100kW).

● IRAQ

Radio Baghdad has been changing from channel to channel for many months in an effort to find a satisfactory outlet for the European Service (English at 1930, German at 2030 and French at 2110). Latest reports state the frequencies at **9635** on Thursdays and Sundays but changed to **9745** for the remainder of the week.

● PHILIPPINES

FEBC Manila has been heard from 0000 to 0200, in various languages, on **17810** with English identification at 0130. DZI6 has a variable power output from 2 to 50kW.

● TAIWAN

The 'Voice of Free China' has a transmission in English to North America from 0200 to 0350 on **15345** (25kW), **17720** (50kW) and on **17890** (50kW).

● AFGHANISTAN

Radio Kabul has a Foreign Service to Europe from 1730 to 1830 on **9530** (100kW) and **11790** (50kW). German from 1730 to 1800 and in English from 1800 to 1830.

● VATICAN

Vatican City may be heard with an English programme at 2045 on **7250** (100kW).

● U.A.R.

Cairo Radio can be heard with an Arabic/English language lesson at 1400 on **17920** (50/100kW). See Current Schedules for further information.

● CHINA

Peking radiates a programme in English from 1400 on **15095**.

● ROUMANIA

An English programme from Radio Bucharest can be heard at 1930 on **7195** (120kW).

● CZECHOSLOVAKIA

A transmission in English from Radio Prague can be heard at 1900 on **7345** (100kW).

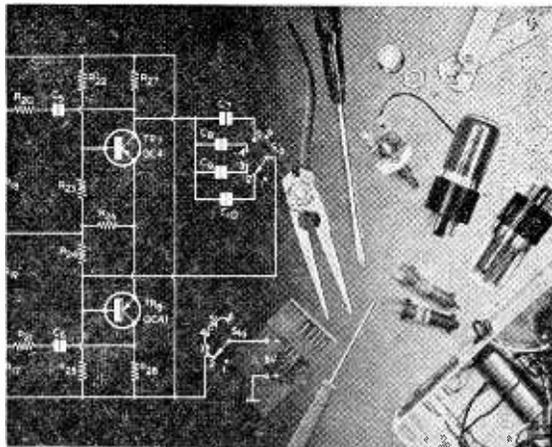
● UGANDA

Kampala can be heard at 2100 with a programme in English on **4976** (3/8kW).

Acknowledgements:- Our Listening Post, SCDX. ■

DRY JOINT DETECTOR

by G. A. FRENCH



THE TITLE OF THIS MONTH'S article in the 'Suggested Circuit' series is not intended to be descriptive of the Australian who found the pub had no beer. It is, instead, the title chosen for a simple piece of test equipment capable of locating dry solder joints. This process is achieved by measuring the resistance between the two conductors which are soldered together to form the joint, and the instrument is capable of giving useful indications of resistance down to less than 0.01Ω . So far as the detection of dry joints is concerned, the normal rule of thumb is to assume that a good soldered joint presents a resistance of less than 0.05Ω , whilst dry joints give resistances of 0.5Ω or more. A joint which exhibits a resistance greater than 0.1Ω is a potential source of trouble and should be re-soldered.

The test unit incorporates a 0 - 1mA moving-coil meter which can be any type having an internal resistance between 50 and 110Ω . Apart from a few imported models, most panel-mounting 0 - 1mA meters on the home-constructor retail market have internal resistances within these limits.

SHUNT OHMMETER

As many readers will already be aware, it is possible to obtain low resistance measurements with the aid of a shunt-connected ohmmeter circuit. This circuit differs from that employed in the more usual method of measuring resistance, which consists essentially of inserting the resistance to be measured in series with a battery and the meter.

With the shunt-connected approach, the meter is coupled to a battery via a series resistor, and the resistance to be measured is connected in parallel with the meter.

See Fig. 1. The series resistor has a value which causes the meter to read f.s.d. when no resistance is connected across the test terminals. If a resistor is then connected across these terminals part of the current from the battery flows through it, and the meter needle is deflected backwards by an amount dependent upon the value of the resistor. Naturally, the backward deflection of the needle increases as the value of the resistor across the test terminals decreases; and if a short-circuit appears across the test terminals the meter needle is deflected back to the zero mark on the scale. This technique allows surprisingly low values of resistance to be measured, these ranging down to about one-fiftieth of the internal resistance of the meter.

If the resistor in series with the meter has a high value relative to the internal resistance of the meter, the current from the battery can be considered to increase by only a negligible amount when a short-circuit is applied across the previously open test terminals. The assumption can then be made that a virtually constant current flows from the battery. Since this is the current which produces an f.s.d. reading in the meter when the test terminals are open, the virtually constant current is equal to the f.s.d. current of the meter. Under these conditions it can be shown that, when a resistor is connected, across the test terminals, in shunt with the meter, the current flowing in the meter (I_m) is given by

$$I_m = \frac{I_c R_s}{R_m + R_s}$$

where I_c is the constant current, R_s is the value of the resistor in shunt and R_m is the internal resistance of the meter.

This equation is of value in the present context because of two factors. First, since I_m is the current flowing in the meter when the shunt is applied, I_m is also the current indicated by the meter needle on its scale. Second, since I_c is the constant current which causes the meter needle to indicate f.s.d., I_c is equal to the f.s.d. current shown on the scale. It then becomes possible to omit reference to actual current values when taking advantage of the equation, and to simply look upon I_m as a fraction, or percentage, of f.s.d. It is helpful here to say that f.s.d. consists of 100 'units of current', and to give the I_c term the value of 100.

To take an example, let us say that, in the circuit of Fig. 1, we have a meter of internal resistance 5Ω and we connect across it, by way of the test terminals, a 20Ω resistor. What will the meter needle indicate? Working from the equation and ascribing the value of 100 to I_c we

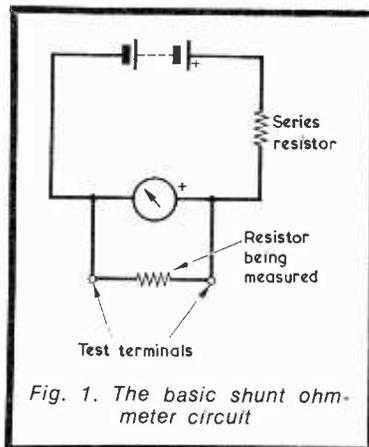


Fig. 1. The basic shunt ohmmeter circuit

may say:

$$I_m = \frac{100 \times 20}{5 + 20}$$

$$= \frac{2,000}{25}$$

$$= 80.$$

Thus, the meter reading resulting from the connection of the 20Ω resistor is 80% of f.s.d. Had the scale been printed 0 to 100, the meter needle would have pointed at the figure 80. Had the scale been printed 0 to 10, the meter needle would have pointed at the figure 8, and so on.

The accompanying Table I, which applies to meters having an internal resistance of 1Ω, shows calculated values of I_m in terms of percentage of f.s.d. for shunt resistances from 0.01 to 10Ω. As is to be expected, a shunt resistance of 1Ω causes a reading of 50% of f.s.d., since

TABLE I

Values of I_m for R_s from 0.01Ω to 10Ω, with $R_m = 1Ω$.

R_s (Ω)	I_m (% of f.s.d.)
0.01	0.99
0.02	1.96
0.03	2.91
0.04	3.85
0.05	4.76
0.06	5.66
0.07	6.54
0.08	7.40
0.09	8.26
0.1	9.09
0.2	16.7
0.3	23.1
0.4	28.6
0.5	33.3
0.6	37.5
0.7	41.2
0.8	44.4
0.9	47.4
1.0	50
2.0	66.7
3.0	75
4.0	80
5.0	83.3
6.0	85.7
7.0	87.5
8.0	88.9
9.0	90
10.0	90.9

equal currents then flow in the shunt resistance and the meter. Table I can be used for meters having internal resistance other than 1Ω. With such meters, all the figures in the resistance column are multiplied by the internal resistance, in ohms, of the meter. Indeed, Table I applies to any meter employed in the circuit of Fig. 1, provided that the series resistance is much higher than the internal resistance of the meter and, as just

mentioned, the resistance values are multiplied by that internal resistance.

LOWER RESISTANCE VALUES

If we require to use a circuit of the type shown in Fig. 1 for checking the very low resistances given by solder joints we will need to have an internal meter resistance less than the 1Ω assumed in Table I. It will be unlikely that we can obtain a practical meter having such a low resistance, but we can artificially reduce the internal resistance of a normal meter by permanently connecting a shunt resistor across it, as in Fig. 2. What we now have, effectively, is a meter whose internal resistance is equal to the combined parallel resistance given by its actual internal resistance and the shunt resistance. Naturally, it will be necessary to increase the current from the battery to cause the f.s.d. reading to be given once more, and the value of the series resistor will need to be adjusted accordingly. After this has been done, meter indications resulting from resistors connected across the test terminals will correspond to the resistance figures in Table I multiplied by the new 'internal resistance' of the meter. So far as the rest of the circuit is concerned, the meter with its permanent shunt is the same as a meter on its own with an equivalent internal resistance.

The fact that the scheme shown in Fig. 2 necessitates an increased battery current to achieve the f.s.d. value places a practical limit on the level to which the meter resistance can be artificially reduced in this way. In the dry joint detector the meter resistance is artificially reduced to 0.3Ω, whereupon all the resistance figures of Table I become multiplied by 0.3. The resultant values are shown in Table II, where it may be seen that 0.05Ω is now equal to 14.3% of f.s.d. and that 0.5Ω is now equal to 62.5% of f.s.d. These needle deflections are more than adequately disparate for the detection of dry joint resistance.

COMPLETE CIRCUIT

The complete circuit of the dry joint detector is shown in Fig. 3. In this diagram, the 12.6 volt secondary of a mains transformer feeds into rectifier D1 and capacitor C1, causing approximately 15 volts direct voltage to be produced across the capacitor. This voltage is applied to the meter, with R2 in parallel, via R3 and variable resistor R1, R1 being set up to give an f.s.d. reading in the meter when the test terminals are open-circuit.

For our present purpose we require the meter to have an 'internal resistance' of 0.3Ω and we can

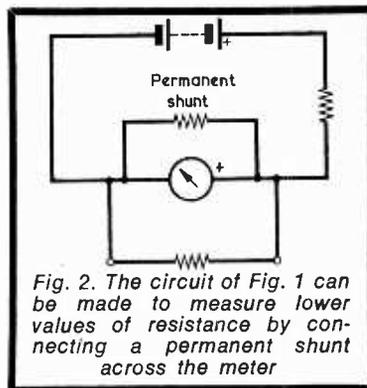


Fig. 2. The circuit of Fig. 1 can be made to measure lower values of resistance by connecting a permanent shunt across the meter

achieve this in practice by the simple process of giving this value to the shunt resistor R2. The parallel combination of 0.3Ω with a meter internal resistance lying between

TABLE II

Values of I_m for R_s from 0.003 to 3Ω, with $R_m = 0.3Ω$.

R_s (Ω)	I_m (% of f.s.d.)
0.003	0.99
0.006	1.96
0.009	2.91
0.012	3.85
0.015	4.76
0.018	5.66
0.021	6.54
0.024	7.40
0.027	8.26
0.03	9.09
0.05	14.3
0.06	16.7
0.09	23.1
0.1	25
0.12	28.6
0.15	33.3
0.18	37.5
0.21	41.2
0.24	44.4
0.27	47.4
0.3	50
0.5	62.5
0.6	66.7
0.9	75
1.2	80
1.5	83.3
1.8	85.7
2.1	87.5
2.4	88.9
2.7	90
3.0	90.9

50Ω and 110Ω gives a resistance slightly lower than 0.3Ω but, even with the 50Ω meter, the error is less than 1%. The error is not sufficiently high to justify the tedium of selecting a special resistor for R2 in an instrument whose prime function is to detect resistance values that are relatively widely separated.

The value of R3 lies between 82Ω (for a meter with an internal resistance of 50Ω) and 33Ω (for a

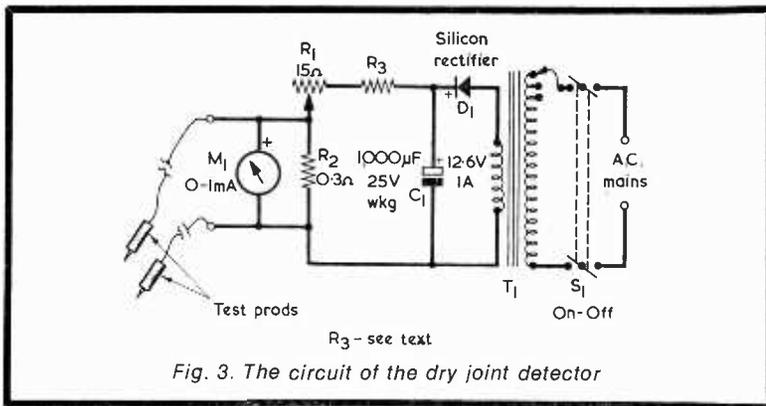


Fig. 3. The circuit of the dry joint detector

meter with an internal resistance of 110Ω). These values are calculated in the following manner. A 0 - 1mA meter with an internal resistance of 50Ω has 0.05 volt across its terminals when it gives a full-scale reading. Since the voltage across C1 is approximately 15 volts the value of the series resistance required is about $\frac{15}{0.05} \times 0.3$ ohms, which works out as 90Ω. This value is given when R3 is 82Ω and R1 is at a reasonable mid-setting. The current which then flows through R1 and R3 is 167mA. Similar calculation shows that R3 should be 33Ω for a meter with an internal resistance of 110Ω, and that the current which then flows is 375mA. Note that nearly all the current in R1 and R3 flows in the circuit whose resistance is being checked if this resistance has a low value, and that the detector should not, in consequence, be used to check the resistance of circuits which incorporate very fine wire.

The value required in R3 for any particular milliammeter can be calculated but, in practice, it is easier to find the value experimentally. The experimental approach has the advantage of taking in spreads in the actual voltage appearing across C1 and the fact that the internal resistance of the meter may not be pre-

cisely the figure printed on its scale or that quoted in the appropriate scales literature. A suitable test set-up is shown in Fig. 4, and this should be used in the following manner. With the mains supply applied and the meter disconnected, first connect the fly-lead from R1 to point A at the end of the chain of 10Ω resistors. Then connect the meter across R2 by means of its own fly-lead and see whether an

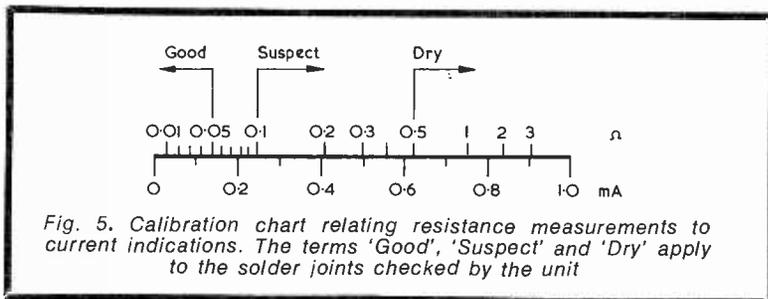


Fig. 5. Calibration chart relating resistance measurements to current indications. The terms 'Good', 'Suspect' and 'Dry' apply to the solder joints checked by the unit

f.s.d. reading can be obtained by adjustment of R1. If not, disconnect the meter, reconnect R1 to point B, and repeat the operation. Continue along the chain to the right until a resistance is found which enables an f.s.d. reading to be given in the meter for a reasonably central setting in R1. The final resistance required in R3 is then

approximately equal to that which has been found experimentally and a single component can be permanently soldered into circuit. For values in R3 between 82Ω and 55Ω, this component should be a 4 watt type. For values between 55Ω and 33Ω it should be a 6 watt type.

It may have been noted that, in the setting-up procedure just described, the meter was only connected to the 0.3Ω resistor, R2, after the current had been established in the latter. This approach should always be used in experimental circuits where sensitive meters are required to indicate high currents with the aid of a low resistance shunt. First ensure that the current flows reliably in the shunt and then connect the meter. Never have the situation where the meter is permanently in circuit and the shunt is applied across it.

COMPONENTS

Apart from R3, the components required in the circuit are conventional readily-available types. R1 should be a wirewound potentiometer capable of passing the currents in-

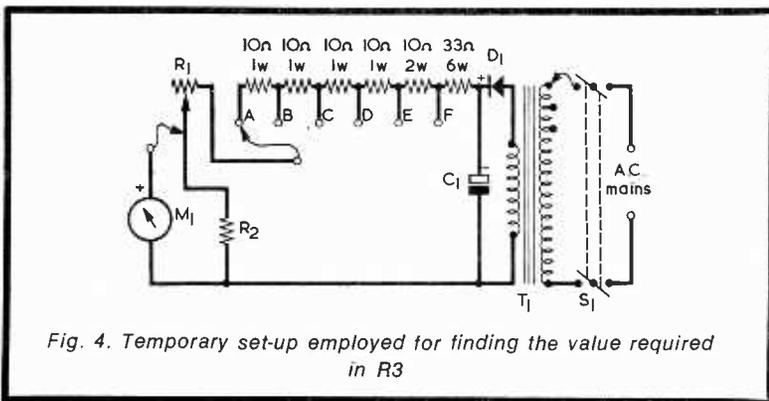


Fig. 4. Temporary set-up employed for finding the value required in R3

involved and a suitable type is the Bulgin type I.V.C.2, which is available from Home Radio under Cat. No. VR22A. The meter and R3 have already been dealt with. The mains transformer can be any type having two 6.3 volt heater windings rated at 1 amp or more. These are then connected in series to provide the 12.6 volts required here. A suitable component is the Radiospares filament transformer available from Home Radio under Cat. No. TH5C. D1 can be any silicon rectifier with a p.i.v. greater than 50 volts and a forward current rating of 1 amp or more. The author used a BY100.

Resistor R2 is not readily available as a single component. Readers who have access to an accurate bridge may be able to make it up with the aid of resistance wire. It can, alternatively, be given by a parallel combination of other resistors. Thus, four 1.2Ω 1 watt miniature wirewound resistors (Home Radio Cat. No. R13C) in parallel will give the desired value with a reasonable tolerance. Yet again, a

value of 0.3Ω is given by four lengths of 36 s.w.g. copper wire, each 6ft. 8in. long, connected in parallel. Dissipation in R2 is less than $\frac{1}{4}$ watt.

The test leads should consist of heavy flexible wire, and thick wire should be employed for connecting these, from the test terminals, to the meter. Even with thick wiring it may still be found that the meter needle does not return completely to zero when the test prods are short-circuited together! The prods should incorporate thick brass rods

brought out to sharp points, in order that good contact can be made to the conductors of the joint.

The whole unit may be assembled in a neat case which incorporates the mains transformer. Some readers may decide to change the scale markings on the meter so that these correspond to its new function, but this procedure is not recommended for those who have not had experience with work of this nature, as it is very easy to damage the delicate movement of a meter if appropriate care is not taken.

Fig. 5 shows a calibration scale, which may be copied, or cut out, and affixed to the front panel of the instrument.

When complete, the dry joint detector is employed in much the same manner as a conventional ohmmeter. After switching on, the unit is set up to give an f.s.d. reading in the meter by adjustment of R1, which should be mounted, with a knob, on the front panel. The test prods are then applied to the circuit whose resistance is to be measured. ■

RECENT PUBLICATIONS



FOUNDATIONS OF WIRELESS AND ELECTRONICS, 8th Edition. By M. G. Scroggie, B.Sc., C.Eng., F.I.E.E. 551 pages, $5\frac{1}{2} \times 8\frac{1}{2}$ in. Published by The Butterworth Group. Price: hard covers £3, limp £1.80.

This authoritative and deservedly well-known book initially appeared in 1936 as 'Foundations of Wireless', and it has undergone many changes since its first edition. The present edition has been extensively rewritten and fully takes in semiconductor devices and their applications. An interesting feature is that Page one starts *after* an 'initiation into the shorthand of wireless', the latter taking up 14 pages and dealing with fundamentals such as algebra, graphs and circuit diagrams.

The book assumes that the reader has no previous technical knowledge, but this does not prevent it from taking him to such relatively fairly advanced matters as *h* parameters for transistors, f.m. pulse counting discriminators and operational amplifiers. Mathematics is kept to an absolute minimum, what little appears being of a very elementary nature. There is no over-simplification or 'talking-down' to the reader; points are presented succinctly, precisely and accurately in terms applicable to the professional engineer. At the same time the style is relaxed, with occasional touches of humour.

The first eight chapters deal with basic electronics up to the tuned circuit, after which six chapters discuss diodes, valves and transistors. Eight succeeding chapters cover transmission, detection, and low and high frequency amplification. The last four chapters are devoted to television, radio, waveform generators, computers and power supplies. Symbols, abbreviations and technical terms are covered in an appendix, which may be used for reference, if necessary, when reading the book.

'Foundations of Wireless and Electronics' is a book which provides an excellent source of information for the newcomer in electronics. There is little doubt, also, that it will be of help to the more advanced worker who allowed himself to become rusty on the basic fundamentals of the art.

ELECTROACOUSTICS. By M. L. Gayford, B.Sc., C.Fng., M.I.E.E., A.C.G.I., D.I.C. 301 pages, $6\frac{1}{2} \times 9$ in. Published by The Butterworth Group. Price £4.50.

This book is one of a series of monographs produced in collaboration with Standard Telephones and Cables Limited. The author, who has been a practicing professional engineer for over 30 years, is Senior Engineer at I.T.T. Components Group, Harlow.

With a background like this, the reader can look forward to handling a volume which offers reliable information in depth on the subject being covered, and such is, indeed, the case. The book is full of facts and figures on virtually all aspects of electroacoustics, ranging from the carbon microphone to helium speech correction. Even with so apparently simple a device as a carbon microphone there is much that one can learn. Thus, the microphone section of a telephone handset has to be designed to avoid air compression blast on the diaphragm resulting from the user placing a hand over the microphone front horn to prevent a remark being heard. And did you know that the reason why speech frequency increases in an oxygen-helium mixture (as is breathed by deep-sea divers) is because the velocity of sound in the mixture is some 2 to 2.5 times that in normal air?

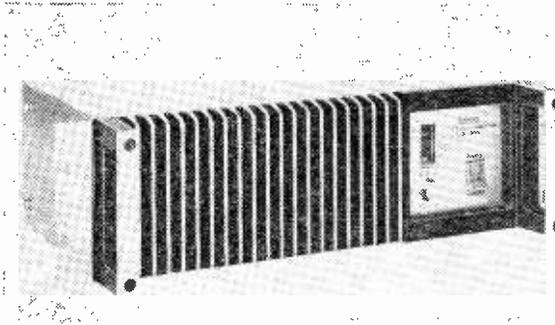
'Electroacoustics' discusses all types of microphone, earphone and loudspeaker and includes details of development history where these are of interest and importance. Although intended primarily for the student and professional engineer there is much that will appeal to high-fidelity enthusiasts, including in particular a chapter on loudspeakers and their enclosures.

RADIO VALVE AND TRANSISTOR DATA, Ninth Edition. Compiled by A. M. Ball. 240 pages, $8\frac{1}{4} \times 10\frac{1}{2}$ in. Published by Iliffe Books. Price £0.75.

In the late 1930's, when there was a great proliferation of valve types and bases, there was much wringing of hands in the industry and bewailing of the lack of planning which had allowed such an untidy state of affairs to take place. It was fortunate for the piece of mind of the engineers of that time that they were not able to visualise the far more chaotic situation which exists with transistors today. Not only is there a vast multiplicity of types and coding systems, but there is also a wide range of encapsulations and lead-out layouts. To be fair, though, it should be stated that the last has been reasonably well rationalised.

'Radio Valve and Transistor Data' takes up from the 1966 eighth edition, and gives characteristics for a very large number of the transistors likely to be encountered in the UK. It also covers valves, cathode ray tubes, diodes, rectifiers and integrated circuits. 3,000 valves and c.r.t.'s are listed, whilst the diodes, rectifiers, transistors and integrated circuits total 4,500. So far as the receiver is aware, this is the first edition of the book which credits a specific compiler, and Mr. Ball is to be commended for the clear and logical system of ordering the listing of the various valves and semiconductors. The book includes valve base diagrams and lead-out layouts for transistors and integrated circuits. Reverting to transistors, the characteristics given for each of these include typical *f_T*, maximum power dissipation, absolute maximum VCBO, VCEO, VEB0 and IC, typical hFE, maximum ICBO, lead-out layout and application. ■

NEW RANGE OF AMPLIFIERS FROM GRAMPIAN



This illustration shows the Amplifier Type 744 fitted with output meter

In an era when high quality amplifiers are almost taken for granted, the announcement of any new model or range of such equipment can sometimes pass with little comment unless it has outstanding design features coupled with a performance to match. Into such a category falls the new Grampian Series 7 range. The first two items now announced, are designed for the reliability requirements of professional and rental use.

The 744 (100 watts) and 743 (50 watts) certainly show what appears to be optimum value in regard to features versus cost. Built from interchangeable modules, which may be replaced without any adjustment, all access is from the front. The machined die-cast, matt-black and brushed aluminium front panel is the actual heatsink. Amplifiers may thus be stacked one immediately above another with no ventilation problems.

Such assembly and component features as the latest Kapton printed flexible wiring and long life computer-grade heavy duty power-supply capacitors are used.

The technical specification obtainable from the manufacturers discloses a strict conformity to I.E.C. publication 268/3 and it is claimed that published data is based on worst case figures taken over a quantity of amplifiers constructed with the widest spread of component tolerances. The rated RMS output power figures are to the I.E.C. four hour test, and available from the amplifier at 100 volts level or at low impedance.

It is claimed that this approach has resulted in a performance which exceeds in most cases the expected requirements for high fidelity use, e.g. DIN 45-500 at rated output power. Such features as four separate protection circuits, including programmed protection against incorrect output loading are included.

Further details are obtainable from H. T. Greenfield, Grampian Reproducers Ltd., The Hanworth Trading Estate, Feltham, Middlesex, England. (Telephone: 01-894 9141).

SHOENBERG MEMORIAL LECTURES COMMENCE

'THE LIFE and Work of the late Sir Isaac Shoenberg' — pioneer of electronic television techniques in the 1930's — was the subject of a Royal Television Society lecture given recently at the Institution of Electrical Engineers, Savoy Place, London.

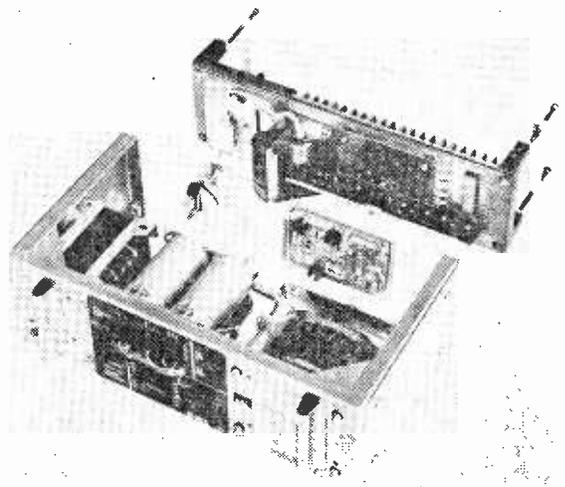
The speaker was Professor J. D. McGee, FRS, Professor of Applied Physics at Imperial College of Science and Technology, and former colleague of Sir Isaac at EMI's research laboratories.

The lecture, chaired by Sir Joseph Lockwood, was the first in a series of annual lectures to commemorate Sir Isaac Shoenberg, famous EMI director of research who died in 1963.

Sir Isaac led a team of scientists and engineers who developed the world's first high-definition television system in the early 1930's. Adopted by the BBC in 1937, this EMI 405-line system was to remain the only UK standard for both the BBC and ITA until the introduction of 625-line transmissions in 1962.

The 'Shoenberg Memorial Lectures' are arranged by the Royal Television Society and sponsored by EMI. Each year an internationally recognised authority will be invited to speak on a significant aspect of the television industry.

Amongst those present at the memorial lecture were the Shoenberg family and others closely connected with Sir Isaac Shoenberg's work.

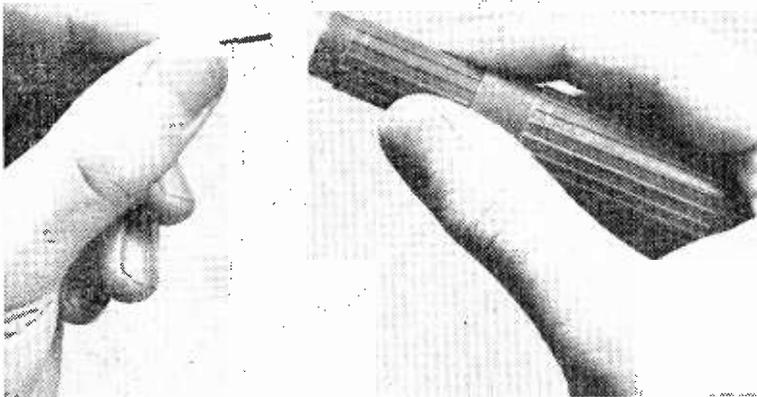


An exploded view from the rear, illustrating the interchangeable modular construction of the Amplifier

THE RADIO CONSTRUCTOR

COMMENT

CHUCK-GRIP – THE SCREWDRIVER THAT HOLDS THE SCREW



The Chuck-Grip screwdriver is the first screwdriver to use a four-sectioned nylon chuck to firmly grip and hold any type of screw (dome, flat or counter sunk) and allow a one handed screwing operation in those awkward and inaccessible places. No more fumbling or dropping.

This versatile screwdriver also has interchangeable blades for standard and Phillips type screws, which operate on a retraction mechanism allowing the blades to be pushed back into the handle – a big safety factor when being carried in a pocket.

Constructed of only four working parts and a two-piece extremely strong injection-moulded handle, this screwdriver will prove extremely valuable and trouble-free. The unit is fully insulated and will take up to 50,000V.

Recommended retail price 57p.

IN BRIEF

● A radio valve made in 1923 is still in use today! It is incorporated in an amateur radio transmitter constructed by the manufacturers of the valve, the Mullard Company, as part of the celebrations of their fiftieth anniversary.

It should perhaps be stated that the valve has not been in constant use all its life, but it is none the less very creditable that it has remained serviceable.

● Readers of advertisements for some of our publications will notice that with this issue, the postal charges have been rounded up or rounded down, to the nearest even figure, so that remittances can be sent in whole pence.

Overall we shall not receive any extra remuneration, it will however simplify our procedures. Readers drawing cheques will no longer have to decide whether to add or subtract a halfpenny from their remittance.

● A comprehensive publication on stroboscopes is available from Dawe Instruments Limited.

Written by W. V. Richings, the Company's Technical Director, it describes the basic principles of stroboscopy and the various stroboscopic devices with particular emphasis on the modern electronic stroboscope using a high-power discharge lamp. The design criteria and technical features of stroboscopes are discussed and details are given of accessories and typical applications.

● A conference on computer aided design is to be held at the University of Southampton from 25 to 28 April 1972.

One of the aims of the conference is to provide potential users and management with the opportunity to experience practical use of on-line systems where there is conversation between engineer and computer during the design process and thereby to evaluate its application to their specific interest. The breadth and depth of papers selected for presentation will assist the process of cross fertilisation between expert and prospective user; and high-light areas of immediate and long term promise.

Further details may be obtained from the Manager, IEE Conference Department, Savoy Place, London WC2R 0BL.

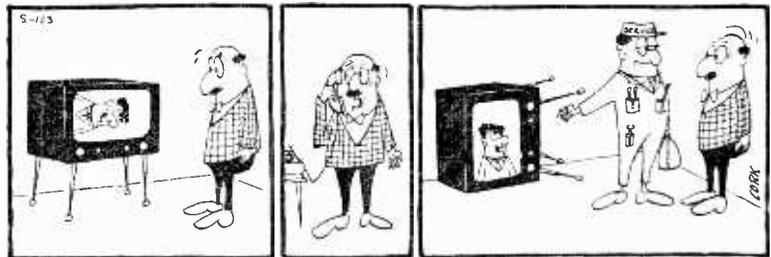
● The International London Electronic Component Show at

Olympia, London, will be held from 18th to 21st May.

It will be a battleground for world markets, and one of the fiercest contenders will be the British component industry. Although sales have increased of recent years, so have imports, and in fact the balance of trade has been deteriorating recently.

● The Independent Television Authority has appointed Mr. John Guinery to the post of press and public relations officer in succession to Mr. Donald Cullimore, who has joined Thames Television. Mr. Guinery took up his appointment on April 5th.

Since 1967, Mr. Guinery has been central press and information officer for Vickers Limited, in charge of the news department at the group's London headquarters. He was previously London editor and chief political correspondent of the Bristol Evening Post, and a member of the executive committee of the Newspaper Conference.



LGR TONE CONTROL CIRCUIT

by

G. W. SHORT

Professional designers avoid using a.f. inductors because of the expense. Amateur constructors, on the other hand, usually have a selection of old transformers and chokes languishing in their junk boxes, waiting for a job to do. This article shows how to use one to provide true bass cut and lift. The circuitry is simple and adaptable and will work from any supply voltage above about 3V. An equally simple treble control completes the circuit

THE TONE CONTROL CIRCUITS DESCRIBED HERE ARE based on the transistor equivalent (Fig. 1) of what, in the valve era, used to be called a 'concertina' phase splitter. If the impedance in the collector circuit is equal to the impedance in the emitter circuit then the two outputs are equal in magnitude but opposite in phase. The 'gain' from input to either output is a little less than 1.

The necessary equality of collector and emitter impedances is achieved by giving corresponding components the same values: i.e.

$$R3=R4; \quad R5=R6; \quad C2=C3.$$

CONTROL PURPOSES

For tone control purposes we are not, of course, interested in push-pull outputs, but it so happens that the phase splitter circuit also has a very useful property which suits our purposes nicely. The arrows in Fig. 1 show the paths taken by the a.c. parts of the emitter current (I_e) and collector current (I_c). These flow in opposite directions in the centre-tap 'earth' connection, via point 'X,' and since, for a high-beta transistor, the collector current is within a fraction of one per cent of the emitter current they virtually cancel. An a.c. meter inserted at 'X' would read zero. It follows that an impedance inserted at

'X' would have no voltage across it. It could not, therefore, affect the balance of the circuit.

In the tone controls which are about to be described this state of balance corresponds to the 'flat' condition. In this condition an inductance or capacitance inserted at point 'X' has no effect on the frequency response. If, however, the circuit is then thrown off balance by making R5 and R6 unequal the result is to give 'cut' or 'lift'.

BASS CONTROL

The circuit for bass control is shown in Fig. 2. The single output is taken from the collector side of the circuit, and the two resistors R5 and R6 are replaced by a potentiometer RV5 which enables the circuit to be unbalanced at will. An inductance L1 is inserted at point 'X.'

With the slider of RV5 at the end of the track marked 'B,' L1 is effectively placed in parallel with R4. (The impedance of C3 is negligible.) The consequent effect is to bypass R4 at low frequencies, where the impedance of L1 is small. Since R4 is normally unbypassed, and is in the emitter circuit, it creates negative feedback and so reduces the gain. The effect of putting L1 in parallel is therefore to increase the gain at low frequencies, by reducing the amount of negative feedback. In other words, we now have bass lift.

At high frequencies, the impedance of L1 is so much larger than R4 that to all intents and purposes the shunting effect is nil and the circuit behaves as if L1 were not there: the 'gain' is less than 1. Sliding L1 to 'B' gives true bass lift: the treble response stays put but the gain at bass frequencies is raised.

As the slider of RV5 is moved away from 'B' towards the middle of the track the bass lift becomes less pronounced until, at the balance point, the 'flat' condition is reached.

What happens when the slider is moved on through the balance point to the other end of the track, marked 'A'? In this position L1 is effectively in parallel with R3. Since R3 is the collector load and is now shunted by L1 at low frequencies the result is bass cut. One inductor (L1) and one potentiometer (RV5) are enough, with the help of the 'phase splitter' TR1 to give both cut and lift.

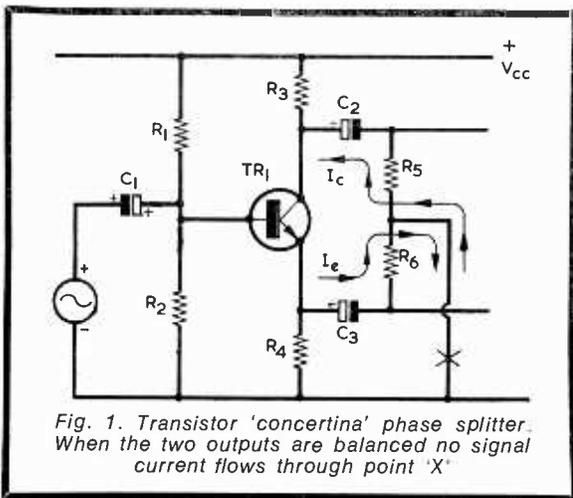


Fig. 1. Transistor 'concertina' phase splitter. When the two outputs are balanced no signal current flows through point 'X'

TREBLE CONTROL

Replacing L1 by a capacitance has a very different effect on the frequency response. Position 'B' now gives top lift, because R4 is bypassed at high frequencies, and position 'A' gives top cut. So to incorporate a treble control all you have to do is connect a second potentiometer, RV6, in parallel with RV5, as shown dotted in Fig. 2, with a suitable capacitor C4 in the slider-to-earth lead.

COMPONENT VALUES

You may well ask what value the 'suitable capacitance' C4 should have. To understand how to select one, imagine that both sliders are at 'A,' giving simultaneously maximum bass cut and maximum treble cut.

Nothing should be left but the middle frequencies, and a little thought shows why this is in fact so: L1 and C4 now form a parallel tuned circuit across R3. The frequency response of the stage is the response of a tuned circuit, damped rather heavily by R3. The peak frequency is the resonant frequency $f_0 = 1/(2\pi \sqrt{L_1 C_4})$. This resonant frequency is the centre frequency or turnover frequency of the tone control circuit.

TABLE

Reactance, at 1kHz, of capacitances from 0.002 μ F to 0.2 μ F.

Capacitance	Reactance
0.002 μ F	79,600 Ω
0.004 μ F	39,800 Ω
0.005 μ F	31,800 Ω
0.008 μ F	19,900 Ω
0.01 μ F	15,900 Ω
0.02 μ F	7,960 Ω
0.04 μ F	3,980 Ω
0.05 μ F	3,180 Ω
0.08 μ F	1,990 Ω
0.1 μ F	1,590 Ω
0.2 μ F	796 Ω

A suitable treble capacitance C4 is therefore one which tunes L1 to a suitable turnover frequency. Most tone control responses are centred on 1kHz or thereabouts, so C4 must tune L1 to 1kHz. The precise frequency is not important, nor is it necessary to know the inductance of L1. Which is just as well, since most of the inductors in the junk box will be unmarked.

Some way of telling that the correct resonant frequency has been obtained is, of course, necessary. A measuring bridge or an audio test oscillator calibrated in frequency make the job of matching L1 to C4 easy, but if you don't possess either, rig up the simple oscillator shown in Fig. 3 and try out combinations of inductor and capacitor until something like 1kHz is heard in the loudspeaker or a low-impedance headphone in the same position. The volume will be low, but fortunately the human ear is very sensitive to 1kHz. In the prototype oscillator both transistors were BC169C, but any high-beta silicon type will do. (This applies equally to the tone control circuit

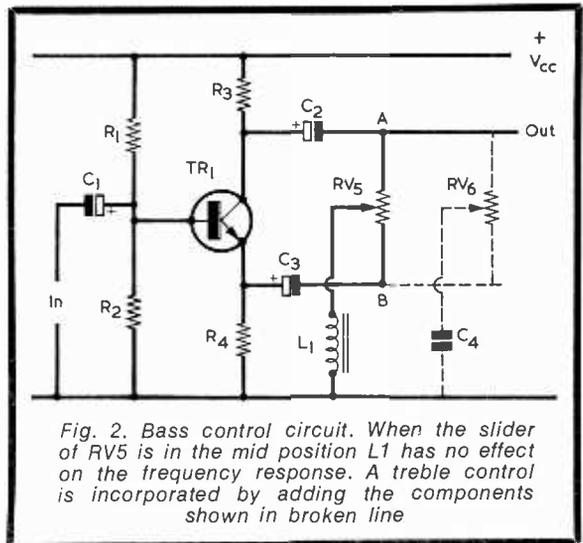


Fig. 2. Bass control circuit. When the slider of RV5 is in the mid position L1 has no effect on the frequency response. A treble control is incorporated by adding the components shown in broken line

itself.) The capacitance marked C5 is not at all critical. As indicated in Fig. 3, it should ideally have a value of 100 times C4, but of course we don't know what C4 is going to be to begin with. However, it turns out that with usable inductors C4 lies in the range 0.002 to 0.2 μ F, and a value for C5 of about 2 μ F is good enough. (In fact, the writer used a 2.5 μ F electrolytic.) Experts will realise that the oscillator is a sort of Colpitts circuit, so the effective tuning capacitance is C4 and C5 in series. So long as C5 is considerably bigger than C4 its effect is negligible for our rather rough and ready purposes.

It is, of course, necessary to be able to recognise 1kHz. Should you have perfect pitch, try for two octaves above middle C. (If you have a piano, you can use that as a frequency standard.) For others, the B.B.C. radiates a stereo test tone of 900Hz, which is near enough, on Radio 3 on Wednesdays and Saturdays at approximately 23.44 hours. (There are other frequencies in the test transmission, but they are so far from 900Hz that if you can't tell the difference you don't need tone controls anyway!) Failing all these, balance an old-fashioned pre-decimal English copper penny on your little finger

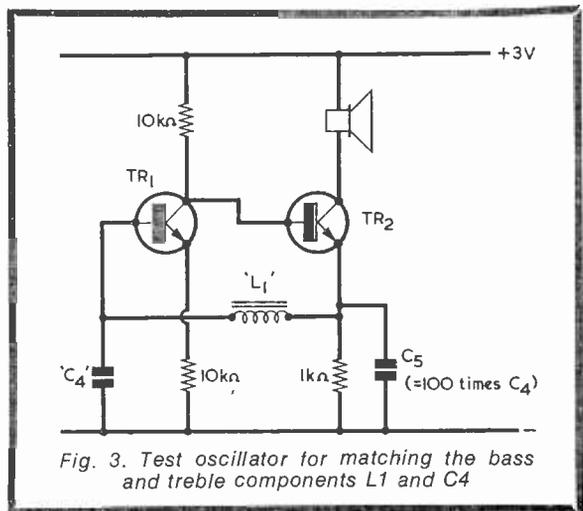


Fig. 3. Test oscillator for matching the bass and treble components L1 and C4

and tap it gently with a screwdriver. It will ring at very nearly 1kHz.

REMAINDER OF CIRCUIT

Having now got the right combination of L1 and C4 you can design the rest of the circuit. Everything stems from the value of C4, so you can't use an unmarked component for that. The resistance of R3 and R4 is made equal to the reactance of C4 at the turnover frequency. (This ensures, among other things, that in the 'simultaneous bass and treble cut' situation the resulting tuned circuit has a Q of less than 1 and is thoroughly flattened.) The accompanying Table lists reactance at 1kHz for values of capacitance from 0.002 μ F to 0.2 μ F. The two potentiometers, RV5 and RV6, should have linear tracks and require a resistance of ten times R3. In the bias network, R1 is 200 times R3 and R2 is 100 times R3. Alternatively, if the hFE of TR1 is known, a single bias resistor of hFE times R3 can be used in place of R1 and R2. The single bias resistor is shown as RB in Fig. 4. This arrangement is useful when the input impedance has to be maximised.

That takes care of the resistances. Now for the capacitances. Once again, the value of one component is used as the starting point, and it is the value of C4. The input coupling capacitor C1 is 100 times C4. The other two, C2 and C3, are each 1,000 times C4. The working voltage can be equal to the supply voltage VCC, or higher. The circuit will work over a very large range of supply voltages. The minimum is about 3 volts and the maximum depends only on the ratings of the transistors and components. (The current drawn by TR1 is approximately $V_{CC}/3R_3$.)

Apart from matching L1 and C4, which must be about right, there are no critical values. The potentiometers, for example, need not have exactly equal resistance, and if the calculated value is 10k Ω then using as low as 5k Ω or as high as 20k Ω will have little effect. Paired components need not be accurately matched.

LOADING EFFECTS

Amenable though the circuit may be, it still has to be compatible with what goes before and after it in a complete working installation. The circuit which follows it will usually be the one that needs watching, so we'll deal with it first.

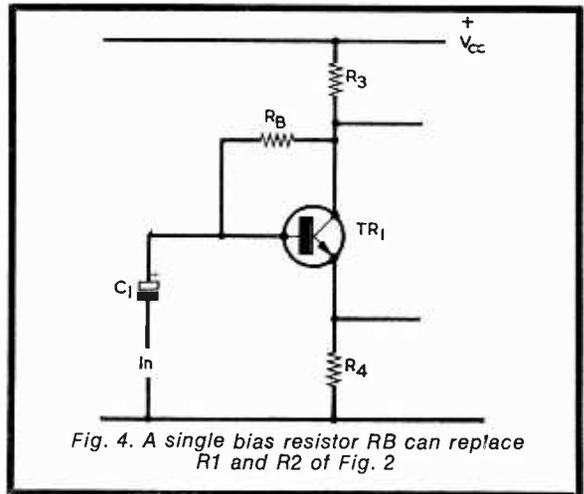
The output impedance of the tone control circuit is always less than R3, at all settings of the controls. If the following circuit has an input impedance of at least five times R3 there should be no appreciable loading effect. As the impedance of the next circuit is reduced, however, gain is reduced and the 'flat' position moves away from the centre of the tracks of RV5 and RV6.

Since the value of R3 depends on L1, you can, if you have a choice of inductors, select one which will give an outlet impedance compatible with the input impedance of the next circuit in the chain. The lowest usable inductance is about 150mH, which makes R3 roughly 1k Ω . You can see that, since R3 and L1 increase in the same proportion, that a high inductance leads to a high output impedance. The highest usable L1 is about 15H, which calls for a value in R3 of about 100k Ω . Clearly the output impedance may easily be too high to suit the next circuit, which

may well be a power amplifier with an input impedance of, say, 10k Ω .

In this case, a unity-gain buffer can be placed between the tone control stage and the amplifier. It can be designed just like Fig. 2 but without the tone control components. Start by selecting R3 to suit the next stage. Thus, if the next stage has an input impedance of 20k Ω , R3 can be about a tenth of this, say 2.2k Ω . Now R4 is equal to R3, R1 is 200 times R3, and R2 is 100 times R3. C1 should have a reactance, at 1kHz, about equal to R3, and C2 should be ten times as great in capacitance as C1. The other components are not needed in the buffer.

Turning to the circuit which precedes the tone control stage, this will often be a pre-amplifier with an output impedance of a few thousand ohms or less. If so, it should be quite compatible. For some purposes, however, the input impedance of the tone control stage, which falls to a few thousand ohms when the controls are in the maximum-lift position, may be too low. In this case it is possible to add a buffer stage at the input. This buffer may be of the same form as before, but the starting point for the selection of component values is to make R2 twice the required input impedance.



LIKELY INDUCTORS

If you have a rich store in your junk box these hints will help your initial choice. Old output transformers from Class B transistor amplifiers are a good bet. If the primary inductance is too great use half the primary, which gives a quarter of the inductance. A transistor interstage transformer or driver transformer is also a likely candidate, but in this case it is the secondary windings which are most frequently useful.

If the only available component has too high an inductance remember that you can reduce it by removing turns or laminations. The resistance of L1 limits the amount of bass control which can be achieved. It is not the absolute resistance but the ratio of resistance to inductance which matters. Amounts up to about 1 Ω per millihenry will be all right, or, in terms of known quantities, the resistance of L1 should not be more than about one tenth of R3, if 20dB bass cut and lift is needed, or one third of R3 if 8dB will suffice. ■



**Q
S
X**
by

FRANK A. BALDWIN

(All Times GMT)

With the change of season from Winter to that of Spring, the interest of Amateur band listeners will switch from the low to the higher frequency bands. As was to be expected, Top Band Dx has declined rather rapidly over the past two months whilst, at the same time, the 14 and 21MHz bands have livened up somewhat. This change is reflected below.

For the Broadcast band enthusiast, and more specially the Latin American specialist, the interest will be the other way round – for the present time is that most favourable for LA reception on the low frequency bands – see *Latin American Quest* in this issue.

● AMATEUR BANDS

1.8MHz

Whilst the Trans-Atlantic CW signals were still coming through, albeit only just audible at times (mid-February) the following were heard. KV4FZ, W1BB, W1BHQ, W1HGT, W1PL and W9UCW.

More up to date, the following U.K. and European Dx has been logged over the past few weeks at the LF end of the band.

CW: DJ9TK, DKØKC, DL8AM, DL9KRA, EI9BG, GC2LU, GM3KMR/A, GM3LWS/A, GM3OXX, GM3YCB, GM3ZSP, GW3GWX, GW3HGL, GW3ZPA, GW3ZQG, HB9CM, HB9NL, OK1AES, OK1ATP, OK1AUT, OK1BLC, OK1IAH, OLkKRS, OK1MDY, OK2BMH, OK2BOB, OK2BNR, OK2PAW, OK2VX, OK3TOA, OK3YCL, OL7AOF, PAØLOU, PAØPN.

7MHz

Occasionally it pays to visit this band during an early morning or late evening session for, if conditions are right, some Dx may be gathered – although usually the QRM is high – mostly from intruder Broadcast stations and a host of local CW signals all busily fighting it out for a contact. One late evening session did pay off as shown here.

CW: F9XH/6V (Senegal), KP4DKX, KZ5ZZ, PY1MB, W4BVV.

14MHz

Here of course we have 'good old twenty', the greatest of Dx providers throughout the year and with-

out a doubt the most popular of all the Amateur bands.

CW: CP6FG, CR4AE, CR6BX, CX8JF, FM7WF, HC1CS, HC2HM, HK3AVK, JA8MP, JH1QOJ, JW7UH, LU6FB, LU8DSA, PJ2PS, PJ2CC, PY5AVV, PY7AWE, PYØAD, PZ1AV, TA2SS, VK2BNB, VK3CP, VK4VX, VP9GP, ZE2KL, ZD5X, ZS6JK.

SSB: CR6TD, ET3DS, FY7AB, HKØBKK, HS1AEG, MP5TA, PZ1AP, VK3SE, VP2LA, ZL1GD, ZS1MS, ZS6AUL, 8P6BQ, 9F3USA, 9Q5CR, 9Q5RD, 9Y4BFC.

21MHz

Although not so reliable as 'twenty', this band often provides Dx which is more easily logged owing to the comparative lack of QRM.

CW: FL8AB, JA1UKS, JA3WIR, JA3WNR, JA3WZT, JA4DN, JA6MWT, JA8ZO, KP4UW, LU2JV, PZ1AV, VK6SA, YBØAAF. **SSB:** VS9MB (Gan), 9U5AC, 9Y4HR.

● BROADCAST BANDS

Africa, that huge continent to the south of us, provides the Broadcast bands Dx-er with a whole host of stations operating from many different countries. Most of these stations are to be found on frequencies below 5MHz, the reception of some of these transmissions being well worthwhile – they are colourful to say the least. A dominant sound to be heard is that of the African drum, often accompanied by rhythmic songs and chants and sometimes by shrill female cries!

Apart from programmes and announcements in local dialects, one can often hear those using the English language, mainly from former British colonial possessions, and those using French from former French territories. Often, in the former case, the announcements are made in both English and local vernaculars. Newscasts in English can often be heard, for instance, from Ghana and Nigeria as well as from other Commonwealth countries in Africa.

Listed here are a few African stations that have recently been logged and which should interest those new to Broadcast band operating.

● AFRICAN STATIONS

3380kHz 1906 Blantyre, Malawi with a talk in dialect. News in English is radiated, according to the schedule, at 1800 and 2000 weekdays and at other times.

4765kHz 2010 Brazzaville, Republic of Congo. Radio TV Congolaise has a power of 50kW on this channel, uses French and local dialects. Heard with African songs and music.

4793kHz 2015 CR6RG Sa da Bandeira, Angola with identification in Portuguese "Radio Commercial

de Angola" followed by music and advertisements. Listed on 4795kHz.

4839kHz 1945 Bukuvu, Congo Dem. Republic, with a talk in French and music.

4890kHz 2000 Dakar, Senegal with news in French. The power is 25kW and the evening schedule is from 1800 to 2400.

4910kHz 0607 Conakry, Guinea Republic with talk in vernacular. This one is listed on 4900kHz. Do not confuse the 4910 Conakry transmission with that of Lusaka, Zambia on 4911kHz.

4926kHz 2015 EAJ206 Bata, Equatorial Guinea, heard with programme of African-type music and songs. This one is worth listening for, identification is "Transmite Radio Bata, La Voz de Rio Muni" and the power is 5kW.

4932kHz 1956 Benin City, Nigeria, with colourful African songs and music.

4940kHz 0618 Abidjan, Ivory Coast, logged with a programme of typical African drums and rhythmic chants. The power is 25kW, the main language is French.

4965kHz 1944 SABC Johannesburg with announcements in English.

4980Hz 2032 Ejura, Ghana, with a programme of English 'pop' records and announcements in vernaculars.

11810kHz 0535 Algiers with Arabic songs, music and announcements.

11835kHz 0525 Omdurman, Sudan, with a programme of Arabic music in the Home Service transmission.

17920kHz 1400 Cairo, U.A.R., radiating an Arabic/English language lesson.

There are, of course, many other transmissions emanating from the 'Dark Continent' that one can hear other than those listed above. For those who would like a fairly 'tough' assignment, why not try **3232kHz** around 1930 or so. Listen for Radio Brazzaville in the Republic of Congo with the programme for local and Madagascan consumption. The power is just 4kW, the address – P.O. Box 108, Brazzaville. Good luck with the QRM!

● BEGINNERS CORNER

For a nice easy one, try **7250kHz** at 2045 and listen to the English programme from Vatican Radio.

11735kHz 0545 HCJB 'The Voice of the Andes', Quito, Ecuador, with an English programme directed to Europe. If this is rather early for you, try **17755kHz** at 1930 for the evening transmission in English.

17760kHz 2000 WNYW, New York, U.S.A., news in English to Europe, or try **17785kHz** at 2000 for Greenville (Voice of America) with English newscast to Europe. ■

TRI-BAND RANGER

PART 2

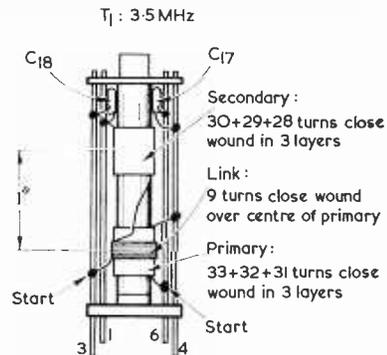
by
DAVID M. PRATT (G3KEP)

In this concluding article, constructional details are provided for drilling the chassis and panel, and for wiring and assembly. Finally, information is given on the process of alignment and setting up

DETAILS OF THE COMPONENTS SPECIFIED, TOGETHER with coil winding information, were given in the Components List published last month. Substitute components may be used provided they meet the necessary electrical and physical requirements.

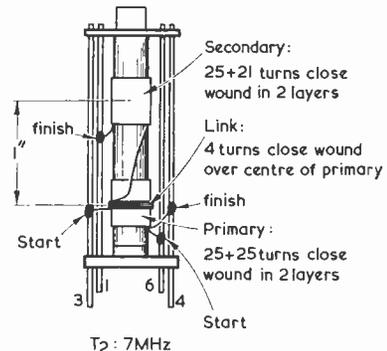
The only components which require comment are the two wide-band coupling transformers, T1 and T2. They were originally designed by B. J. P. Howlett (G3JAM)* and the information is included in the present article by courtesy of *Short Wave Magazine*, to which journal grateful acknowledgement is made. The transformers are home-wound on Aladdin PP5937 or Neosid 5000B TV type of i.f. formers. The formers, top plates and dust cores required are available from Denco (Clacton) Ltd. Full winding details for both transformers are given in Fig. 3, and the correct bandwidth will be obtained if the specifications are followed closely. One layer of self-adhesive paper tape should be wound on the former initially at the position of each winding so as to prevent the wire slipping on the former. Tape is also used between each layer of the windings, but this should be used sparingly otherwise the Q-factor and self-capacitance will be affected.

Fig. 3. Assembly and winding details for the wide-band coupling transformers



Capacitors: 5pF 5% silvered-mica connected between spills 1 & 3 and 4 & 6

(a)



T2: 7MHz

(b)

All coils wound with 32 swg enam. copper wire, each layer insulated with paper self-adhesive tape.

Formers: Aladdin PP No.5937 or Neosid 5000B with screening cans, top plates and grade 900 dust iron cores. Spills made from 18 swg tinned copper wire.

Connections: Pin 1 - grid } Secondary
Pin 3 - earth }
Pin 4 - H.T. } Primary
Pin 6 - anode }

Fig. 7 shows the inter-section screen for the v.f.o. box. The material is 16 s.w.g. aluminium and the flanges should be bent up along the dotted lines. The locations of the holes for fixing are best marked out with the screen in position.

Details of the transparent dial cover are given in Fig. 8. The material here is $\frac{1}{8}$ in. Perspex sheet.

Fig. 9 gives details of the mounting pillar for the p.a. r.f. choke. The material is $\frac{1}{4}$ in. diameter Perspex rod drilled and tapped 6BA at each end. Two pillars are required.

The accompanying Table gives a key to the hole diameters in the applicable drawings.

TABLE

Key to chassis diagram hole diameters.

- A $\frac{1}{8}$ in. dia. (6BA clearance)
- B $\frac{5}{32}$ in. dia. (4BA clearance)
- C $\frac{1}{8}$ in. dia. (2BA clearance)
- D $\frac{1}{2}$ in. dia.
- E $\frac{3}{8}$ in. dia.
- F $\frac{7}{8}$ in. dia.
- G $\frac{15}{32}$ in. dia.
- H $\frac{3}{4}$ in. dia.
- J $\frac{3}{4}$ in. dia.
- K $1\frac{1}{4}$ in. dia.
- L $1\frac{1}{2}$ in. dia.

CONSTRUCTION

Anyone with a transmitting licence will be conversant with the constructional techniques required in equipment of this kind but, for guidance, detailed wiring diagrams of the v.f.o. unit and transmitter chassis underside are given in Fig. 10 and Fig. 11.

All the components in the v.f.o. and buffer stage are mounted inside the Eddystone die-cast box with the exception of the variable capacitor C1 which is fitted to the large side. The variable capacitor is a good quality single gang type with ceramic insulation and ball race bearings at each end of the spindle. It is the type used in the ex-surplus RF27 unit but is also available as a new item from Jackson Bros. The output from the v.f.o. is fed via a nylon lead-through insulator in the screen to the buffer amplifier grid. Nylon lead-through insulators are also used for the supply leads and output connections of the v.f.o. unit.

The v.f.o. drive comprises a Jackson Bros. epicyclic slow motion drive fitted to the spindle of C1 and retained by a screw mounted on the front panel. The pointer is made from a short length of polished brass wire fitted to the drive, and the scale is made from paper trapped to the front panel by the Perspex sheet detailed in Fig. 8. A suitable scale is shown in Fig. 12. This is reproduced actual size and may be traced or cut out.

The stabiliser valve V3 and its associated dropping resistor R2 are mounted external to the v.f.o. unit in order to keep heating effects to a minimum.

Having constructed the v.f.o. unit as a separate entity the remainder of the components may now be affixed to the main chassis. The valveholder for V4 has a skirt to take a screening can.

The rest of the transmitter may now be wired up as illustrated in the wiring diagram, taking care to

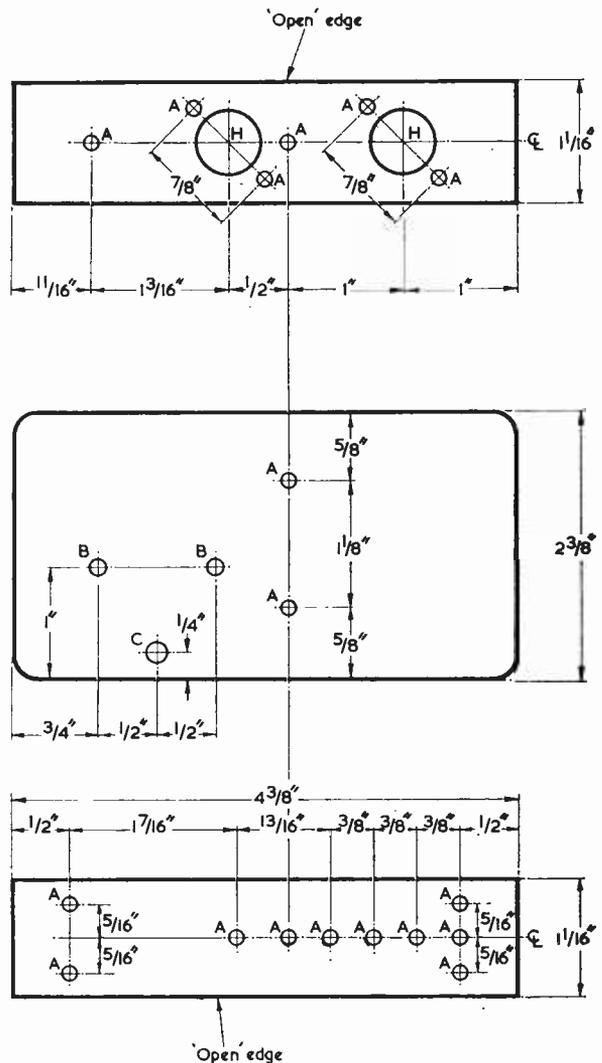


Fig. 6. The holes required in the Eddystone die-cast box in which the v.f.o. components are fitted

use screened wire where shown. The earthy end of R10 should be accessible as this will need to be disconnected for the alignment procedure. The dual smoothing capacitor C37 should be the last item fitted under the chassis as this will tend to hide other components previously fitted.

Most of the p.a. anode circuit is contained above the chassis, the parasitic stopper resistor R13 being fed from the anode pin to a nylon lead-through insulator on the main chassis. The p.a. r.f. choke RFC3 is mounted on small 'Perspex' stand-off insulators as detailed in Fig. 9. P.A. coil L2 is mounted vertically and is held in position by the same 4BA bolt that secures the 4-way tagstrip below the chassis.

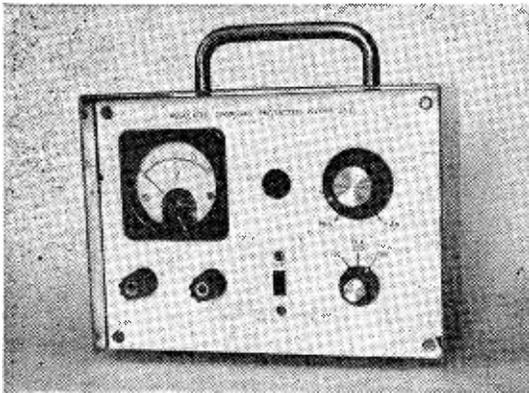
The photograph giving a rear view of the upper side of the chassis will be helpful in indicating the above-chassis layout. Along the rear of the chassis, from left to right, are the mains transformer, the

(Continued on page 619)

NON-OV POWER

J. THO

Offering output voltages from 0.5 to be overloaded. The maximum current exceeded even when a short-circuit



IT IS INTERESTING TO FOLLOW THE DEVELOPMENT OF a particular item of electronic equipment, and the power supply circuit to be described has a history which can be readily traced through the pages of the technical journals.

INITIAL DESIGN

The idea of a current limiting design for a power supply originally appeared in the American journal *Electronics World*, in an article by Hugh L. Moore.¹ Faced with the necessity of providing robust power supply units for experimental projects, Hugh L. Moore devised the basic circuit approach shown in Fig. 1. Here, a high voltage power supply couples via a current limiting resistor to a zener diode whose zener voltage is equal to the output voltage that is required from the supply. Since the high voltage is considerably larger than the zener voltage, it follows that the limiting current which flows through the series resistor will only be marginally higher if the zener diode is short-circuited than it is when the full zener voltage appears across the zener diode.

With no load connected to the output terminals all the limiting current flows through the zener diode. If a load is connected, part of the limiting current flows in the load and the remainder flows in the zener diode. If for any reason, the load attempts to draw more than the limiting current at zener voltage, the voltage across the output terminals simply

falls below that voltage. Should the load become short-circuit the voltage across the output terminals drops to zero, and only the limiting current flows in the short-circuit.

The advantages offered by this circuit technique are obvious. At all output currents below the limiting value the output is regulated by the zener diode. The power supply, itself, cannot be damaged by accidental short-circuits or overloads across its output terminals. Also, a considerable measure of protection is offered to the equipment which forms the load. If, under normal circumstances, this equipment would not be expected to draw more than say 100mA, the value of the series limiting resistor can be chosen so that currents in excess of this value cannot be drawn from the supply. The risk of burn-outs in the supplied equipment resulting from faults is therefore very markedly reduced.

The power supplies using the scheme of Fig. 1 made by Hugh L. Moore incorporated a 10 volt zener diode and a 20 volt zener diode, both of these being capable of dissipating a relatively high power. They were switched into circuit singly or in series, so that output voltages of 10, 20 and 30 were available from the supply units. Various values of series resistance could also be switched in to provide different levels of limiting current.

The series limiting resistor idea was subsequently taken up in two "Suggested Circuit" articles in this journal by G. A. French.^{2,3} In the first of these the single zener diode was replaced by a power transistor acting as an emitter follower with its base returned to a potentiometer coupled across a regulated supply. The second article improved on this approach and had two emitter followers in tandem instead of the single transistor. The circuit employed is shown in Fig. 2. This has the advantages that the zener diode does not have to dissipate a high power and that the output voltage is continuously variable by means of the potentiometer. The OC36 in Fig. 2 now takes the place of the zener diode in Fig. 1; it passes all the limiting current when no load is connected to the output terminals, and it shares the limiting current with the load when a load is connected. As with Fig. 1, the series resistance

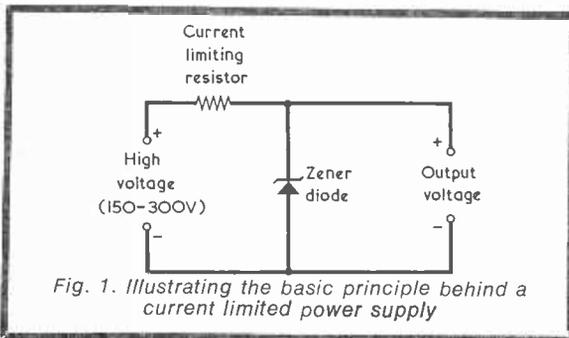


Fig. 1. Illustrating the basic principle behind a current limited power supply

ERLOAD SUPPLY



Cover Feature

PERSON

volts, this power supply unit cannot for which the unit is set up is not placed across the output terminals

(that connected into circuit by the 3-way switch) limits the current which can pass through the load even under short-circuit conditions. The use of two emitter followers in tandem ensures that base current variations in TR1 due to changes in load current are relatively small. The output voltage control potentiometer can, in consequence, have a relatively high value whilst still allowing good regulation to be given.

CONSTANT CURRENT TRANSISTOR

The story was taken yet a stage further in "In Your Workshop" in the December 1967 issue of *The Radio Constructor*. Here, the indefatigable Dick

and Smithy introduced a power supply unit in which the series current limiting resistor was replaced by a 'constant-current' transistor, with a consequent considerable simplification in design. Not only was the high wattage series resistance eliminated but so also was the need for a high voltage, high current, d.c. supply. In the "In Your Workshop" power supply a single low voltage d.c. supply was all that was required for both the emitter follower circuit and the current limiting section.

The power supply to be described here, and whose circuit diagram is given in Fig. 3, is based upon that described in "In Your Workshop". The transistor types employed in the emitter follower and current limiting sections are the same, as also is some of the immediate circuitry about them. There is little point in altering what has already been successfully and carefully designed. However, the zener diode reference voltage is now obtained by way of an emitter follower, thereby enabling the zener diode to dissipate much less power than it was previously called upon to handle. Also, constructional details, not given in the previous article, are provided here.

If the circuit of Fig. 3 is examined, it will be seen that the mains supply is applied to a transformer offering a secondary voltage of 17 volts, this being passed to the bridge rectifier, D1 to D4. A rectified direct voltage then appears across the large-value

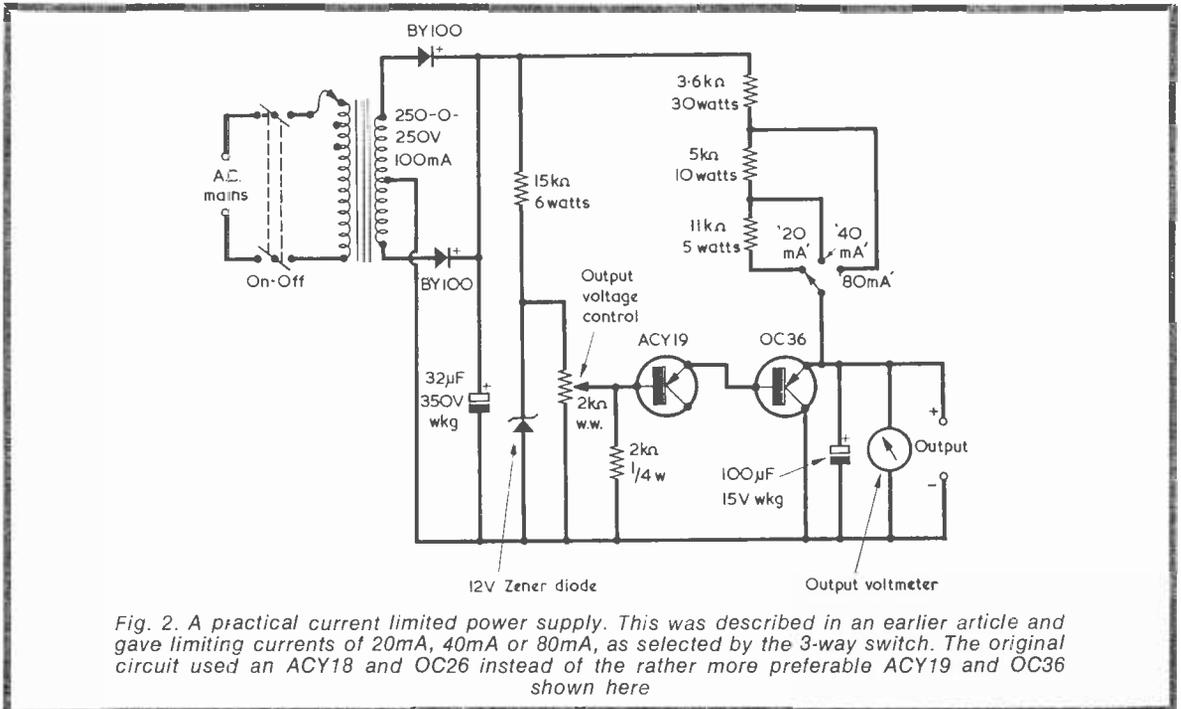


Fig. 2. A practical current limited power supply. This was described in an earlier article and gave limiting currents of 20mA, 40mA or 80mA, as selected by the 3-way switch. The original circuit used an ACY18 and OC26 instead of the rather more preferable ACY19 and OC36 shown here

electrolytic capacitor, C1. The direct voltage across this capacitor supplies all the subsequent circuits in the unit.

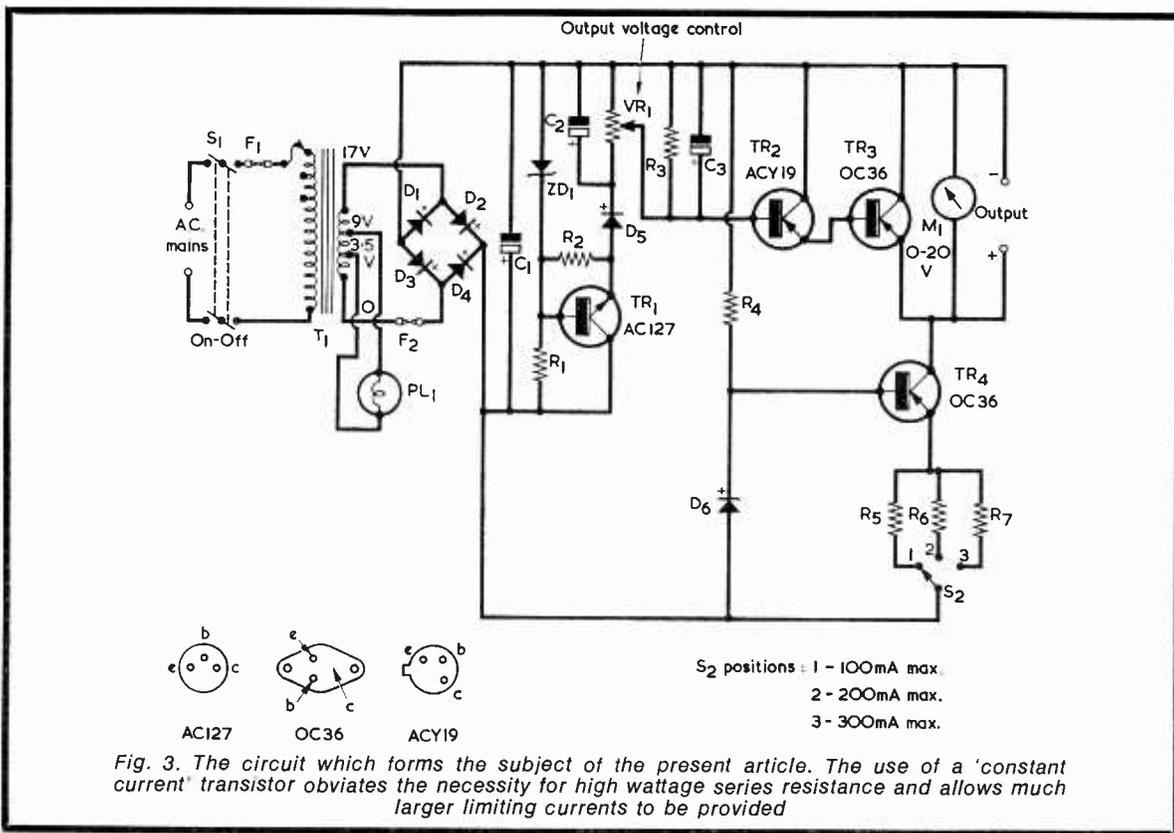
As will shortly be explained, a zener-regulated reference voltage appears across the output voltage control, VR1. The voltage tapped off by the slider of VR1 is applied to the base of TR2, whose emitter couples to the base of TR3. TR2 and TR3 function in exactly the same manner as did the two transistors of Fig. 2, the circuit presentation now causing them to be turned upside-down. The voltage across the output terminals of the supply is equal to that appearing between the upper supply rail and the slider of VR1, plus the base-emitter voltage drops in TR2 and TR3. Since both of these are germanium transistors their base-emitter voltage drops add up to about 0.4 volt.

The high wattage series resistance in Fig. 2 is now replaced by the 'constant current' transistor TR4. The base of this transistor is held at a constant potential by means of the voltage dropped across silicon diode D6, which is heavily forward biased by R4. TR4 functions, in consequence, as a grounded-base transistor, and offers the flat collector current/collector voltage characteristic that is a distinctive feature of transistors operating in this mode. Provided that maximum power dissipation is not exceeded, the collector current of TR4 remains virtually unaltered at any preset level for different collector voltages (relative to base) ranging from just above zero to the maximum rated voltage for the transistor. The collector current is controlled by the emitter current, the latter being set by S2 which switches in R5, R6

or R7, as required. In the present circuit the three positions of S2 correspond to maximum current outputs, from the supply, of 100mA, 200mA and 300mA.

An interesting feature of the circuit is that, with no load connected, the limiting current is passed by TR4 and TR3 in series. If the slider of VR1 is set to the lower end of its track, some 15 volts appears across TR3. The dissipation in this transistor is then equal to the product of 15 volts and the limiting current selected by S2. The dissipation in TR4 is the remaining direct voltage available from C1 (about 4 volts) less the 0.6 volt dropped across D6, multiplied by the selected limiting current. When the slider of VR1 is at the top of its track the voltage across TR3 is only about 0.4 volt, and TR4 dissipates a power equal to nearly all the direct voltage across C1 multiplied by the selected limiting current. Thus, TR3 and TR4 'share' the power dissipated under no-load conditions, the ratio of the dissipation in each depending upon the setting of VR1.

In the previous circuit, zener diode ZD1 provided the reference voltage for VR1 directly, and passed a higher current than occurs with the present circuit. In Fig. 3 the zener diode is called upon to dissipate 80mW only and gives rise to no difficulties due to long-term thermal effects. The voltage across ZD1 is applied to the output voltage control, VR1, by way of the emitter follower TR1, which is a germanium n.p.n. device. Silicon diode D5 and resistor R2 prevent the possibility of an excessive reverse base-emitter voltage being applied to TR1 if, on switch-off, capacitor C2 should retain its charge for a much longer period than C1. The forward voltage drop



COMPONENTS

Resistors

(All fixed values $\frac{1}{4}$ watt 10% unless otherwise stated)

R1	120 Ω
R2	1M Ω
R3	47k Ω
R4	270 Ω 3 watts
R5	See text
R6	See text
R7	See text
VR1	5k Ω potentiometer, wirewound, 1 watt

Capacitors

C1	1,000 μ F electrolytic, 25V wkg.
C2	400 μ F electrolytic, 25V wkg.
C3	25 μ F electrolytic, 25V wkg.

Transformer

T1	Charger Transformer Type CT1/1, secondary 0/3.5/9/17 volts at 1 amp (Henry's Radio Ltd.)
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Semiconductors

TR1	AC127
TR2	ACY19
*TR3	OC36
*TR4	OC36
D1 - D4	Silicon rectifiers type 100/1.25 (Henry's Radio Ltd.) or equivalents
D5	DD000
D6	DD000
ZD1	16 volt zener diode type Z16 (Henry's Radio Ltd.)

* TR3 and TR4 require mica washers and insulated mounting bushes.

Switches

S1	D.P.S.T., toggle
S2	1-pole 3-way rotary, wafer

Meter

M1	0-20V moving-coil voltmeter
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Pilot Lamp

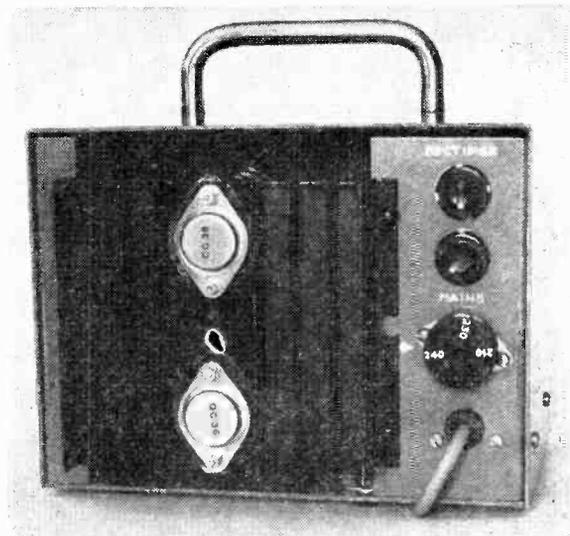
PL1	6V 100 or 150mA pilot lamp, complete with panel-mounting holder and bezel
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Fuses

F1	1 amp cartridge fuse with holder (see text)
F2	2 amp cartridge fuse, with holder (see text)

Miscellaneous

1	Output terminal, black
1	Output terminal, red
4	5-way tagstrips, type LK-2231 (Lektrokit)
1	Heat sink type H11 (Henry's Radio Ltd.)
2	Knobs
4	Rubber feet
Material for chassis and case, wire, nuts, bolts etc.	



Rear view of the supply, showing how the heat sink is mounted. The sink employed was painted black, but this is not really essential as adequate cooling is provided with the sink in an unpainted condition

across D5 also ensures that the slider of VR1 cannot too closely approach the potential on the base of TR1, a condition which can cause a small ripple voltage to become evident on the output of the supply.

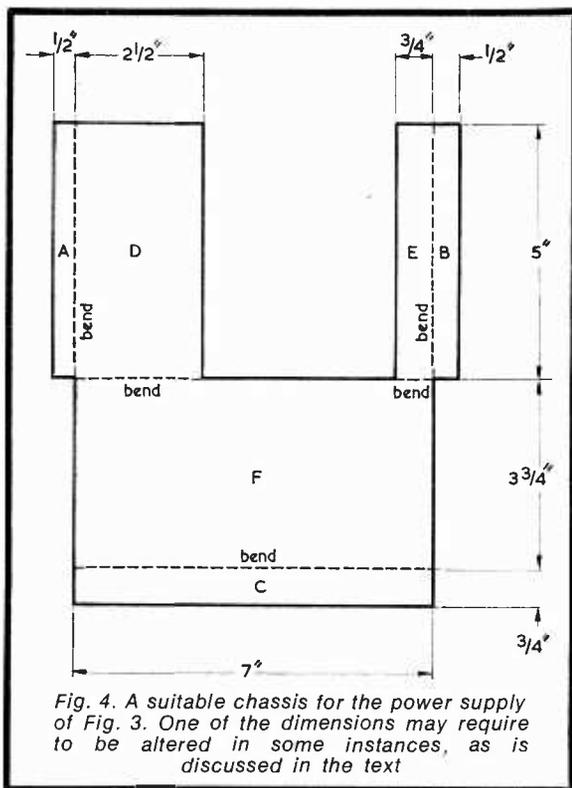
Capacitors C2 and C3 are simply smoothing components for the voltage applied to TR2 base. C3 also causes the output to be at low impedance for audio frequencies. R3 is included to ensure that the output voltage from the supply always drops if, for any reason, there should be a lack of contact between the slider of VR1 and its track.

The fuses F1 and F2 are optional and are included merely to provide the ultimate in safety. Fuse F2 protects the transformer and rectifiers in the event of a short-circuit in C1. Fuse F1 is included to satisfy a policy that all mains-operated items of equipment employed in experimental work are fitted with input fuses.

A component whose existence is not apparent from Fig. 3 is the heat sink on which TR3 and TR4 are mounted. This is a Henry's Radio heat sink type H11 and the transistors are mounted to it by way of mica washers and insulating bushes, which are also available from Henry's Radio. It should be noted, in this respect, that there is no connection between the supply circuit and any metal chassis on which it is assembled or metal case in which it is housed. The whole circuit is 'floating.'

In the power supply unit shown in the photographs a mains voltage selector switch taken from an old television receiver is incorporated. Since, however, the unit will in most instances be operated from the standard 240 volt supply, it is probable that most readers will connect permanently to the appropriate tap of the mains transformer primary and will not include a mains tapping switch.

The four rectifiers, D1 to D4, can be any silicon types having a p.i.v. of 50 or more and with a con-



tinuous forward current rating of at least 1 amp. A suitable component is the 100/1.25 available from Henry's Radio. To make certain that the rectified voltage is not applied to C1 with incorrect polarity it is advisable to check the polarity of whatever rectifier is used by temporarily connecting it in series with the 17 volt transformer winding and a moving-coil voltmeter. This is a wise precaution when wiring any unfamiliar rectifiers into a power supply circuit.

Resistors R5, R6 and R7 do not have their values quoted in the Components List. These resistors are dealt with later when the setting-up procedure is described.

CONSTRUCTION

The construction of the power supply can follow any particular preference of the constructor, since layout is not at all critical. To make up a unit similar to that shown in the photographs the chassis and wiring diagrams of Figs. 4 and 5 respectively may be followed.

In Fig. 4 the sections marked A and B are first bent up through 90° towards the reader. Sections D and F are then also bent up through 90° towards the reader as, afterwards, is section C. The front panel is simply a flat metal sheet measuring 5 in. by 7 in. and it bolts to section C at its bottom. The heat sink bolts across section D and E at the rear, imparting strength to these. A suitable material for the chassis and front panel is 16 s.w.g. aluminium.

A housing can be made by bending a further piece of metal in the form of an inverted U, this then

fitting down over the sides as shown in the photographs. It may be secured with self-tapping screws passed through the sides and sections A and B. The front panel may be secured at the top by fitting internal angle brackets at the top left and right corners. Since components are mounted on section F of the chassis, their mounting bolt heads appear underneath. In consequence four rubber feet are secured at the corners of section F to raise these bolt heads above the surface on which the power supply stands.

The wiring diagram is given in Fig. 5. This assumes the use of four small Lektrokit 5-way tagstrips type LK-2231 (which are available, in packets of 10, from Home Radio under the same Cat. No.). These tagstrips are small in size and have upper and lower 'eyes' in each tag, thereby enabling a relatively large number of connections to be made to a tag.

For clarity, both the back and the front panel are shown in the same plane in Fig. 5. Component positioning is approximate and the various holes can be marked out and dimensioned from the components themselves. VR1, PL1 and M1 should lie along the same horizontal line on the front panel, as also should S2, S1 and the output terminals. PL1 and S1 are on the vertical centre line of the panel and are symmetrically balanced on one side by VR1 and S2, and on the other by the meter and the output terminals. It will be found helpful to fit the panel to the chassis after wiring, with the exception of R5, R6 and R7, has been completed. Otherwise it is difficult to reach some of the connection points on the chassis. R5, R6 and R7 are fitted during the setting-up procedure.

As already mentioned, TR3 and TR4 are secured to the heat sink by way of mica washers and insulating bushes. Connection to their collectors is made via solder tags fitted under the securing nuts. In Fig. 5 the mains input lead from fuse F1 is shown soldered to the 240V tap of T1. It can, alternatively, be connected to the 210V or 225V tap if the local mains voltage requires such a connection. Zener diode ZD1 should be connected with the polarity indicated in the circuit diagram of Fig. 3.

One important point is that the meter shown in Fig. 5 is a small instrument and that switch S2 does not project far behind the front panel. It is possible that these front panel components may foul components mounted on section F of the chassis if they are larger than is indicated in Fig. 5. In consequence, the constructor is strongly advised to obtain all components first and then ensure that they will fit into the space provided before making up the chassis. If necessary, the 3 3/4 in. dimension of section F may be increased, as appropriate. Since the wiring is somewhat compact, some constructors may prefer to increase this dimension in any case, in order to ease the process of assembly.

SETTING-UP

After construction has been completed with the exception of wiring in R5, R6 and R7, it becomes necessary to find the values in those resistors which cause the limiting current in the power supply to be 100mA, 200mA and 300mA respectively. The resistors cannot be specified precisely because of spreads in the forward voltage of D6, in the base-emitter voltage of TR4 and in the gain of TR4. The approxi-

mate values required are 4.5Ω for R5, 3.5Ω for R6 and 2.5Ω for R7. The resistors are reduced in value experimentally until TR4 passes the desired collector current. It is possible to measure this by connecting a meter capable of reading the appropriate current directly across the output terminals of the supply, but some constructors may not have access to meters capable of reading currents of the order of 100 to 300mA, and there is also a slight risk that damage will occur to the meter if the resistor being adjusted is accidentally set up to too low a value.

An alternative course consists of taking advantage of the voltmeter which is already installed in the unit. If VR1 is set to its maximum position (where its slider is at the D5 end of its track) and a 50Ω 2 watt resistor connected across the output terminals, the meter will indicate 5 volts for a current of 100mA and 10 volts for a current of 200mA. If the 50Ω resistor is replaced by a 30Ω 3 watt component, the meter will indicate 9 volts for a current of 300mA. Other values of resistor may be used for this procedure, if those mentioned are not readily available, the only criterion being that, working from Ohm's Law, they allow the voltmeter to give a reading between 4 and 11 volts when they pass the appropriate current.

Constructors will have their own ideas on the best method of experimentally adjusting the values in R5, R6 and R7. One good scheme consists of initially fitting a resistor which is just slightly higher in value than the expected final resistance, and of then temporarily shunting across it in turn a second resistor of continually decreasing value until the desired parallel combination is found. *Great care must be taken not to accidentally insert too low a resistance in the R5, R6 or R7 positions, or to accidentally short-circuit the emitter of TR4 to the positive supply rail, as the resultant current surge may cause damage to the transistors and to other parts of the circuit.* R5, R6 and R7 each dissipate less than $\frac{1}{4}$ watt.

When the required values for R5, R6 and R7 have been found and these resistors have been finally wired into circuit, the supply unit is ready for use. Set S2 to the maximum limiting current desired and switch on by means of S1. The voltmeter needle will rise, and it will then be possible to select any output voltage between about 0.5 and 15 volts by adjustment of VR1.

REFERENCES

1. Hugh L. Moore, 'Current-Limiting Power Supply', *Electronics World*, October 1965.
2. G. A. French, 'Variable Voltage Regulated Supply With Excess Current Protection', *The Radio Constructor*, April 1966.
3. G. A. French, 'Improvement Power Supply With Excess Current Protection', *The Radio Constructor*, May 1966.
4. 'In Your Workshop', *The Radio Constructor*, December 1967.

'TRIO'

9R-59DE Receiver Modifications. The October 1970 issue of *Radio Constructor* which contained details of modifications to the 'Trio' Communications Receiver Model 9R-59DE is now completely sold out. Copies of the March and April 1971 issues are still available at 22p each post paid.



CONTINUED
FROM
PAGE 611

modulation choke, V7, V6, V3 and the rear of the v.f.o. box. Valve V5 and valve V4 (the latter in a screening can) are forward of V7 and V6 respectively. On the panel, C28 is at the extreme left, with S2 and the meter to its immediate right. C1, at the right hand end of the panel, is bolted to the v.f.o. box. P.A. coil L2 appears between S2 and the modulation choke. RFC3 is horizontal and is positioned

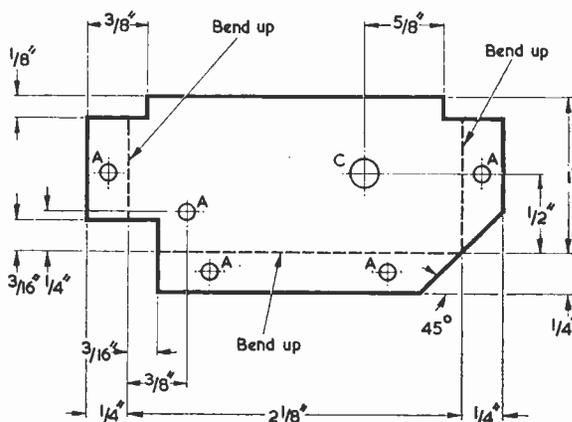
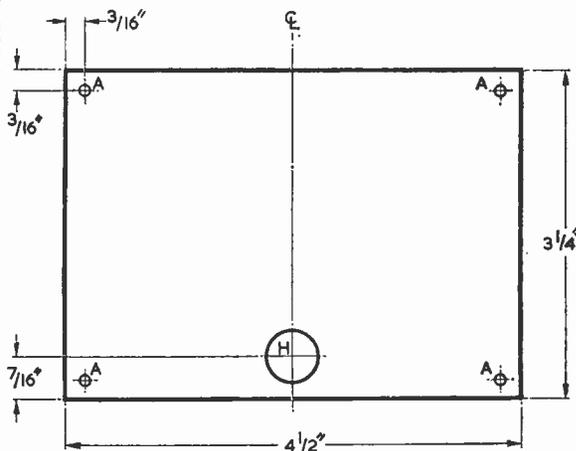


Fig. 7. Inter-section screen for the v.f.o. box. The material is 16 s.w.g. aluminium and the flanges should be bent up along the broken lines. The locations of the holes for fixing are best marked out with the screen in position



Material - $\frac{1}{16}$ Perspex sheet

Fig. 8. The transparent scale cover

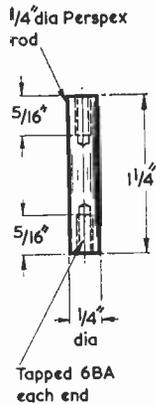


Fig. 9. Mounting pillar for r.f. choke RFC3. Two pillars are required



below the meter. It is secured to tags at the top of the pillars of Fig. 9.

ALIGNMENT

The first step in the alignment of the transmitter is to ensure that the v.f.o. is covering the required frequency range. With the component values specified the prototype covers 1.75 to 2 MHz when the trimmer capacitor C2 has its vanes approximately at half mesh. Because of the limited space available in the v.f.o. compartment the value of this trimmer is lower than that which would normally be used in

a v.f.o. circuit on this frequency. Due to differences in stray capacitance and small variations in the inductance of the coil L1 may be necessary to adjust slightly the value of the fixed capacitor C3.

A 0.5 mA moving-coil meter may now be temporarily connected in series with the earthy end of the P.A. grid resistor R10, the positive terminal being connected to chassis. The earthy end of R10 should be bypassed to chassis with 0.01 μ F disc ceramic capacitor. With the transmitter switched to the 1.8 MHz band and its output matched to a dummy load resistor an indication of approximately 1.5 mA of grid current will be obtained at 1.9 MHz.

The transmitter should then be switched to 3.5 MHz and the top core of the wide-band coupler T1 adjusted for maximum grid current at 3.5 MHz. The bottom core should be adjusted for maximum at 3.8 MHz.

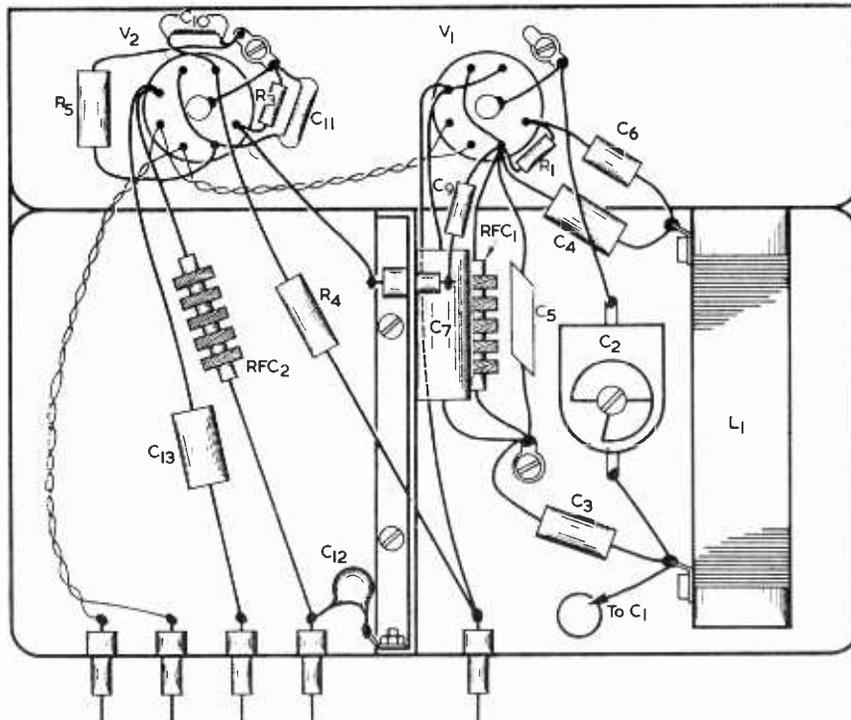


Fig. 10. Wiring inside the v.f.o. unit die-cast box. Lektrokit lead-through insulators are used for output and supply connections, and for the connection between C9 and pin 1 of V2

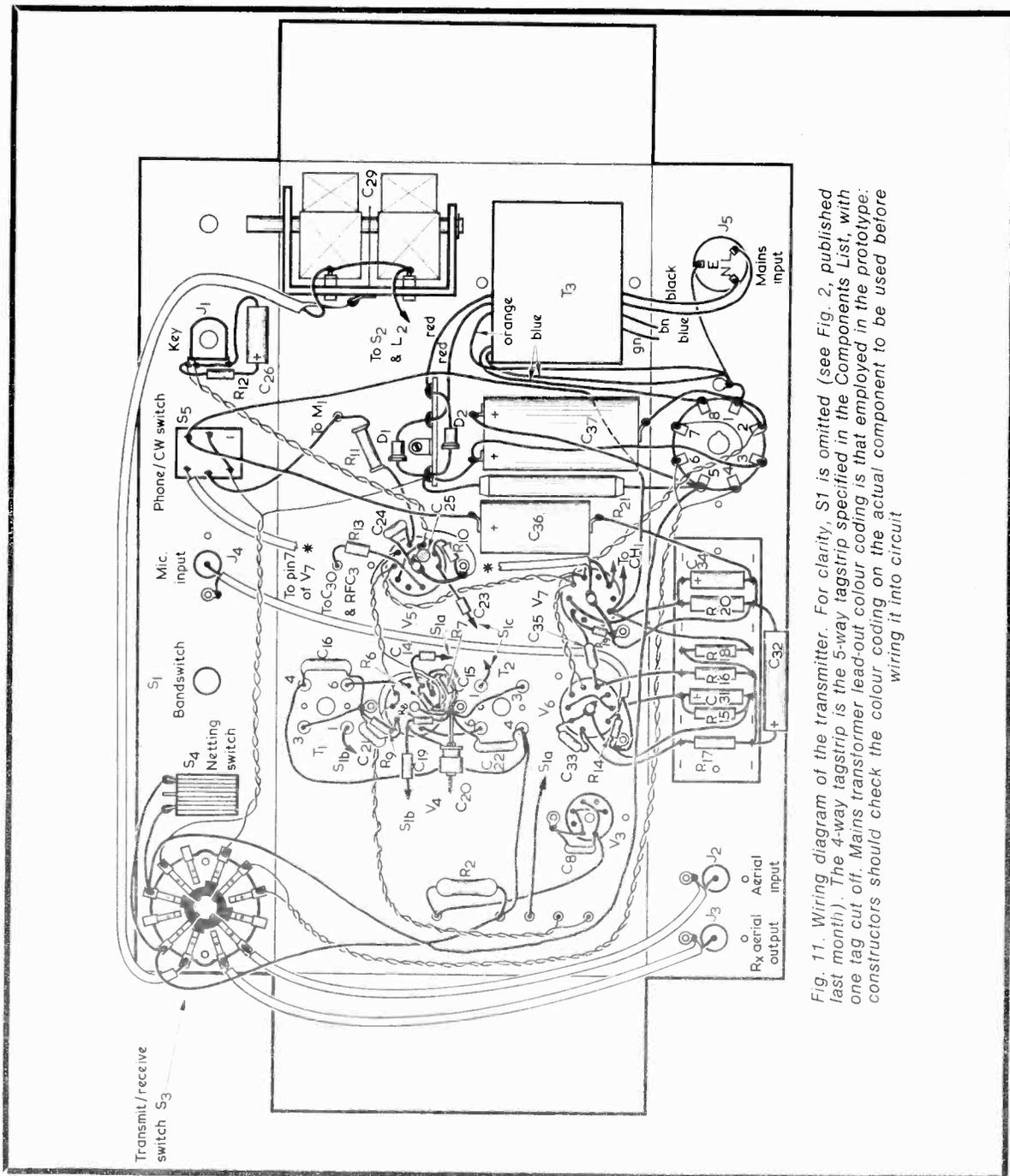


Fig. 11. Wiring diagram of the transmitter. For clarity, S1 is omitted (see Fig. 2, published last month). The 4-way tagstrip is the 5-way tagstrip specified in the Components List, with one tag cut off. Mains transformer lead-out colour coding is that employed in the prototype: constructors should check the colour coding on the actual component to be used before wiring it into circuit

Next, switch to 7 MHz and adjust the top core of T2 for maximum at 7.0 MHz, and the bottom core for maximum at 7.1 MHz. Finally, adjust C20 for maximum at 7.05 MHz. The grid current on the 3.5 and 7 MHz bands will be of the order of 1 mA. The meter may now be removed and the earthy end of R10 permanently connected to chassis.

RESULTS

The transmitter described has had much use since

its initial construction. It has been employed at a local National Field Day event, and has had extensive use as a fixed station by many newly licensed radio amateurs. A good note is produced on c.w. and the modulation quality on a.m. is better than the average transmission on the amateur bands. The transmitter is ideal for the person with limited space available and for those who are interested in exploring the low frequency bands on low power 'phone and c.w.

3. THE TWO-TERMINAL TRANSISTOR

by
PETER WILLIAMS

A transistor with base and collector connected together can outperform the diode it replaces

THE IDEAL DIODE USED AS A RECTIFIER SHOULD have zero voltage drop for any forward current, and pass zero current for any reverse voltage. In the previous note, published last month, we saw that a finite forward voltage exists across a p.n. junction which increases by a few tens of millivolts every time the current doubles. For silicon the typical voltage levels range from perhaps 500mV to 800mV for currents from microamps to amps.

REDUCING VOLTAGE DROP

If this voltage drop is too large, is there any way of reducing it? The question is only fair if we limit ourselves to devices with a given junction area. Consider Fig. 1. The base and collector junctions of a transistor are short-circuited together. With most silicon transistors the current gain is little less under these conditions than with a V_{cb} of several volts. Thus the current in the base is very much less than the total current. Hence the base-emitter voltage is appreciably less than the drop that would occur in the junction if the collector were open-circuit.

To score a decisive advantage over the single-diode, the transistor-diode, as it is sometimes called, would need to have a good reverse characteristic as

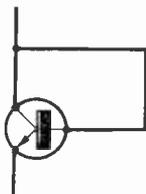


Fig. 1. A transistor with base short-circuited to collector behaves as a diode

well. In the reverse direction the base-emitter junction becomes reverse-biased and the choice of transistor is important. A planar transistor will have a very low leakage current, but only up to fairly low reverse voltage – for example 6 to 9 volts for many of the popular p.n.p. silicon planar transistors. Alloy junction transistors will have somewhat significant leakage currents, but many withstand reverse voltages up to 20 or 30 volts. So if you lack a diode for rectifying low voltages almost any low-cost silicon transistor is worth considering.

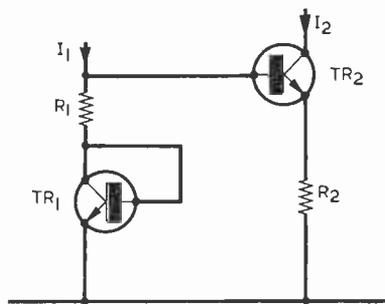


Fig. 2. Using a transistor-diode, TR1, to counteract changes in the V_{be} of TR2 due to temperature drift

A second application is indicated in Fig. 2. Where a transistor is to be biased accurately over a wide range of temperatures, the change in base-emitter voltage is important. A similar transistor, diode-connected and placed close to it, will cancel both the initial base-emitter p.d. and the temperature drift. In Fig. 2 the collector current I_2 is given by

$$I_2 \approx \frac{R_1 I_1}{R_2}$$

This approach is used in many of the integrated circuits intended for linear applications. In the next note in this series, some other two-terminal transistor ideas will be given. ■

RONSON BLOWTORCH

Because of its micro-flame adjustment, the Ronson Blowtorch RBT 3 is ideal for soldering, especially if used in conjunction with the soldering tip attachment. For many soldering jobs, the Blowtorch eliminates the necessity of using a special soldering iron. As a direct heat source, the Blowtorch can be used for bending metal or glass, annealing or hand forging. The Blowtorch is designed to be self-supporting when laid on a horizontal surface with burner head pointing up. This makes it an excellent tool for heating containers such as beakers or test tubes or for melting lead, wax or glues.

The RBT 3 is offered at a recommended public price of £2.25 complete with the Hi-Heat refill.

The range of Ronson Blowtorches is completed by the RBT 4, which includes a copper soldering tip, at a recommended price of £2.60 and the complete Blowtorch Kit (RBT 5) with diffuser head, soldering tip and flame spreader at a recommended price of £3.99.



Latin American Quest

(2) 60 METRE TROPICAL BAND

IN PART 1 OF THIS SERIES, PUBLISHED IN THE LAST issue, the writer attempted to acquaint the Broadcast Bands beginner with the rudiments of listening for, and successfully logging, some of the more powerful – and therefore more easy to receive – Latin American stations. Having identified at least some of those listed, the beginner will no doubt be spurred on by enthusiasm to attempt logging the more progressively difficult to receive stations.

It is assumed that the communications receiver is correctly aligned in all respects and that the aerial and earth systems are efficient. There are some ancillary equipments such as a Preselector and Q-Multiplier, that will considerably assist the operator in receiving not only the LA stations but also Dx transmissions from other distant parts of the world.

WHICH BAND?

For the budding Broadcast Bands operator there is no doubt that the best range of frequencies is that of the 60 metre Tropical Band (4750 to 5060kHz) when aspiring to log the more difficult to receive LA stations.

WHAT TIME?

To obtain the maximum results from the listening session, the beginner should ideally be at the receiver controls – with the receiver warmed-up and free from frequency drift – by 0100GMT at least. From this time onwards the LA's commence to close down, beginning with some of the Brazilian stations. Sign off (SO in the language of the Dx'er) usually occurs on the hour or half hour with the station identification followed by the National Anthem. The identification is usually complete with a chime or series of chimes or other sound effects.

The foregoing however should not be taken literally, as pointed out last month some of the endearing things about LA stations is their ability to fool the Dx'er by (a) having an extended schedule and closing much later than is listed, (b) signing off suddenly without warning and identification, (c) signing off a few minutes either side of the listed time and (d) closing without any National Anthem!

Another unfortunate trait of LA stations is the growing practice of pre-recording the station identification with an echo-effect, thereby making a positive logging somewhat uncertain at times – especially when atmospheric noises are apparent and fading (QSB) is deep.

All of this is not the end of the story however. Some LA transmitters have the charming habit of radiating slightly off their listed frequency.* Moreover, a few of them are afflicted with wanderlust and such stations tend to shift frequency every so often by quite a considerable degree – presumably just to make the Dx'ers life more difficult! It is part of the fun and games involved in the LA Quest, from which the beginner will gather that logging LA's is not so easy as it might first appear. Fortunately, many of the LA's do restrict themselves to their allocated channels and scheduled times, although the latter are subject to variations during national or religious holidays.

In general, South American stations can be heard in Europe from 2200 to 0700GMT but this varies with the time of year and propagation conditions. Most of the Latin Americans operate on the 49 (5950 to 6200kHz), 60 and 90 metre (3200 to 3400kHz) bands although a few radiate on the higher frequency bands, mainly from Brazil. These latter stations carry programmes intended for international consumption as opposed to the purely local programmes of the lower frequency LA stations. The 60 and 90 metre bands also carry many utility transmissions and in Europe these often cause severe interference (QRM) with the LA's.

CONDITIONS

Reception conditions for S. America vary considerably from excellent to downright hopeless! On occasions, if one is lucky, the band will be full of the colourful sounds emanating from Hispanic America coming in at good signal strength with little or no fading and interference, whilst at other times conditions will be so bad that the only recourse is to go back to that inviting warm bed!

Being at the controls at the right time is largely a matter of luck and from then on all depends on the efficiency of the equipment and the skill and experience of the operator.

As a general rule there is however a quick way of determining the advisability of continuing the LA Quest. After switching on, listen for some of the stations listed last month. If they are coming through almost like local stations, with good signal strengths,

* Listed frequencies, schedules and much other information on Broadcast stations may be obtained from the World Radio-TV Handbook published annually in December. A Summer Supplement is published every June and these may be obtained from the Modern Book Company, 19 Praed Street, London, W.2.

then one can assume that this is the time to settle down and have an LA session!

STATIONS ?

There are many that you *could* hear and below are a few that have been logged over the past few months. Although more difficult to log than those stations listed last month, it is all part of the LA Quest.

- 4795kHz** HIAS Santa Domingo, Dominican Republic at 0400GMT with identification 'Onda Musical' followed by Latin American music (LA mx). HIAS closes at 0430. (1kW).
- 4895kHz** PRF6 'Radio Bare', Manaus, Brazil with a commentary and then suddenly signing off without playing the National Anthem! (5kW).
- 4905kHz** HJAH Emissora Atlantica, Barranquilla, Colombia carrying the news in Spanish at 0250. (1kW).
- 4915kHz** HJSG Valledupar, Colombia with LA mx and identification as 'Radio Guatapuri' at 0415. (1kW).
- 4917kHz** HCAH3 Radio El Trebol, Zaruma, Ecuador with LA songs and identification at 0257 (listed on 4916kHz). (3kW).
- 4923kHz** HCRQ1 Radio Quito, Ecuador with identification and LA mx at 0259. (5kW).
- 4960kHz** YVQA Radio Sucre, Cumana, Venezuela with identification (Id.) at 0115. (1kW).
- 4995kHz** ZYX2 Radio Brazil, Goiania, Brazil with LA mx at 0110. (5kW).
- 5025kHz** HCOB5 Cuenca, Ecuador with LA songs and Id. as 'Radio Splendit' at 0330. (3kW).
- 5035kHz** ZYW22 Goiania, Brazil, with Id. as 'Radio Anhanguera' at 0335. (1kW).
- 5043kHz** La Paz, Bolivia with echo-effect Id. as 'La Voz del Altiplano' at 0347. Listed on 5045kHz. (5kW).

A study of the above will bring out some of the points made in the earlier paragraphs when dealing with some of the difficulties associated with LA reception.

If you would like to try and log a difficult one in the 60 metre band tune to—

- 4730kHz** HCEH3 Radio Nacional Progreso, Ecuador at 0400. If it is still on that channel (listed 4725kHz) the power is just 200 watts!

(To be continued)

HE MADE HIS PILE !

Alessandro Conte Volta (1745-1827) is well-known among the radio fraternity for having made his pile — termed the Voltaic Pile — but did you know that he also invented the Electrophorus, a device for producing an electric charge by induction?

The Voltaic Pile consisted of a stack of metal discs of two differing metals, copper and zinc, arranged alternatively, between which were discs of cloth moistened with an electrolyte. Each set of two discs corresponded to a cell and the whole to an electric battery.

The Voltaic Cell is an electric cell consisting of two dissimilar metals suspended, without touching each other, in a solution of an acid or a salt.

MAY 1971

CURRENT SCHEDULES

Times = GMT

Frequencies = kHz

★ KUWAIT

Radio Kuwait has moved from **9640** to **11705** (250kW). The English programme is from 1800 to 2100. The English transmission from 0400 to 0600 is now on **17700** (250kW).

★ IRAQ

Radio Baghdad has an English programme from 1930 to 2020, a German programme from 2020 to 2110 and from then until 2200 in French. These programmes are radiated on either **9632** or **9745** (50kW) depending on conditions. A transmission in Turkish is broadcast from 1930 to 2030 on **3240** (50kW) and on **6030** (100kW). Address for reports is — Directorate Gen. of Broadcasting & TV, Salihiya, Baghdad.

★ U.A.R.

A special programme for Europe is radiated from Radio Cairo from 1915 to 2300 on **9805** (100kW). From 1915 to 2030 in French, from 2030 to 2145 in German and from 2145 to 2300 in English. Address — U.A.R. Broadcasting & TV Corporation, Radio & TV Building, Kornish Road, Cairo.

★ ALBANIA

Radio Tirana broadcasts a programme in Portuguese from 2130 to 2200 on **6130** and **9500** (both 50/500kW). Address — Radiodiffusion Television Albanaise, Rue Ismail Quemal, Tirana.

★ CEYLON

Radio Ceylon broadcasts a daily overseas service from 1100 to 1200 on **17830** (35kW). Address — Ceylon Broadcasting Corporation, P.O. Box 574, Colombo 7.

★ POLAND

The Polish Pathfinders Station, Warsaw, can be heard daily except Monday, from 1100 to 1700 and on Sunday from 0900 to 1700 on **6850** and **7306** (both 0.35kW). Reports wanted, address — Konopnickiej 6, Warsaw.

★ SOUTH AFRICA

RSA has replaced the **11875** with the new **11970** channel for the English programme beamed to North America from 2330 to 0320. Also to be heard on **9695**, **9705** and **15220** in parallel.

★ CONGO BRAZZAVILLE

ORTF relay can be heard, in French, from 2015 to 2100 on **15190**, **15295** and **15315**.

★ LIBERIA

ELWA Monrovia has moved from **15230** to **15260** for the Arabic transmission from 1615 to 1715.

★ GREENLAND

Radio Greenland is reported to have been heard regularly on **9575** (10kW) with a newscast in Danish from 2202 to 2228, at which latter time Rome opens on the channel and covers the transmission from Godthaab.

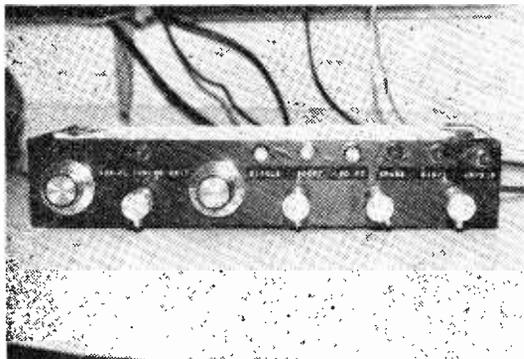
★ NEW CALEDONIA

Noumea has been heard on the new frequency of **9510** in parallel with the usual **7170** channel, in French, from 0630 to 1000.

Acknowledgements:- Our Listening Post, SCDX. ■

RADIO CONSTRUCTOR

JUNE ISSUE



AERIAL SWITCHING AND TUNING UNIT

This article provides details of a neat short-wave receiver ancillary unit enabling various aerials to be switched to different receivers, circuit conditions being indicated by small pilot lamps. An aerial tuning unit can be switched in when required.

LOGARITHMIC SPEECH COMPRESSOR

This unit provides smooth compression of audio peaks instead of abrupt clipping. Originally designed for amateur transmitter use, it has many other potential applications where microphones and amplifiers are employed in combination.

'CRUSADER' RECEIVER— FURTHER NOTES

Describing some circuit additions to this popular superhet design (published in the January, February and March 1971 issues).

PLUS

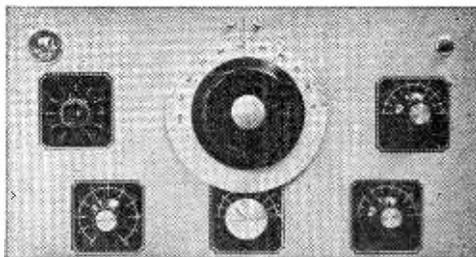
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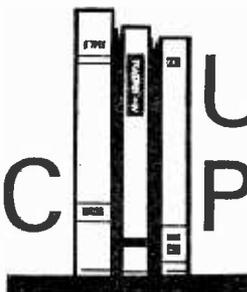
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BLOCK LETTERS PLEASE

BASIC UNDERSTANDING PRINCIPLES



by W. G. Morley

IN LAST MONTH'S ARTICLE we dealt with capacitance and inductance, and referred briefly to the fact that a capacitor and an inductor (or, as it is more frequently called, a coil) can be combined together to form a resonant, or tuned circuit. We shall return to the resonant circuit later in the present article, which commences with an examination of alternating voltage and current.

ALTERNATING QUANTITIES

The voltage provided by a battery is a *direct voltage*, and the current which flows from it into a circuit containing resistance is a *direct current*. The adjective 'direct' is applied to the voltage because this does not change polarity; the positive terminal of the battery always remains positive and the negative terminal always remains negative. Similarly, 'direct' applies to the current because this always flows in the same direction.

The electricity fed to our houses via the mains does not consist of a direct voltage. It is supplied instead as an *alternating voltage*, and it causes an *alternating current* to flow in the electric light bulbs, electric fires, and other resistive loads that are connected to it. Alternating voltage is used because it has considerable advantages over direct voltage in the field of power generation and distribution.

Fig. 1(a) shows an alternating voltage generator, which is a scaled-down version of the type used for generating mains electricity, coupled to a resistor, whilst Fig. 1(b) presents a graph illustrating the voltage at the top of the resistor (point A) relative to that at the bottom of the resistor (point B). The horizontal axis of the graph represents time. In consequence, the graph consists of a line joining individual plotted points which go up or down according to the voltage at point A and which also travel steadily to the

In the third article of this short series, which has been specially written for the beginner, we discuss alternating voltage and current, frequency and resonant circuits

right as time proceeds. We start at a point where the voltage at A is zero. After this, the voltage starts to go continually more positive until it reaches maximum value at the positive peak. The voltage then decreases until it reaches zero again, after which it becomes negative and increases to a negative peak. Subsequent to the peak it decreases again, until it reaches zero once more. The voltage will then start to increase in the positive direction just as it did at the start of the graph.

If we were to draw a graph for the current flowing in the resistor we would find that it had the same shape as that for the voltage. As voltage increases so, in proportion, does the current. When the voltage goes through zero, in passing from positive to negative or back again, the current similarly goes through zero and then changes its direction.

The graph of Fig. 1(b) tells us what happens during a period when the voltage starts from zero, goes positive, goes negative, then returns to zero again. If we continue the graph to the right, as we do in Fig. 2, we find that the process is repeated continually. Each section of the graph which contains the single basic sequence - starting from zero, going positive, going negative, and returning to zero again - is referred to as a *cycle*. We also have *half-cycles*, as shown, and these may be further specified as 'positive half-cycles' or 'negative half-cycles' as applicable.

Since the generator of Fig. 1(a) was similar to that used for mains electricity generation the shape of the graph illustrates what is referred to as a *sine wave*. A sine wave may be produced geometrically by the method shown in Fig. 3. Here, a radius rotates in an anti-clockwise

direction inside a circle. The graph then shows the vertical height of point P above or below OR plotted against the number of degrees, from 0° to 360° , in the angle between lines OP and OR. The term 'sine' derives from the fact that the height of point P varies according to the sine (perpendicular divided by hypotenuse) of the angle between OP and OR. The connection between the sine wave and rotational motion in a circle is reflected in the fact that the points along a sine wave may be identified in terms of de-

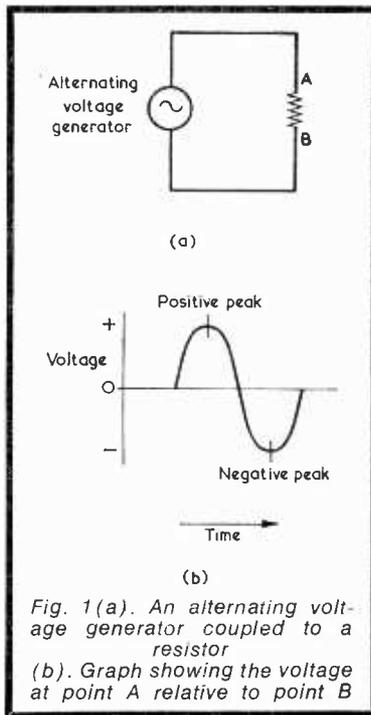


Fig. 1(a). An alternating voltage generator coupled to a resistor
(b). Graph showing the voltage at point A relative to point B

degrees from 0° to 360° , exactly as is shown in Fig. 3.

In electrical and electronic work a sine wave is looked upon as representing alternating voltage or current in its purest form. It is possible to have alternating voltages and currents whose shapes, when drawn in the form of a graph, are very different from that of a sine wave, and it can be shown that these more complex shapes are made up of a number of individual sine waves, all added together.

Since an alternating voltage consists of a succession of cycles we find it necessary to take account of its *frequency*. The frequency is measured in cycles per second which term, until some years ago, was represented by the abbreviation 'c/s'. Unfortunately, this obvious abbreviation has now been replaced, after international agreement, by the term 'Hertz' or Hz. One Hertz is equal to one cycle per second. The mains electricity supplied to our houses has a frequency of 50Hz. This means that the current in an electric light bulb operated from the mains reaches peak value 100 times per second (100 times because there are two peaks in each cycle) and similarly passes through zero level 100 times per second. Despite this, the bulb offers an apparently steady level of illumination, partly because its filament cannot cool sufficiently in the time between peak and zero current levels for a noticeable diminution in light to be evident. In any case, persistence of vision in the human eye would prevent any small changes in illumination that are present from being perceived. For all normal requirements, the bulb functions just as though it had a direct current flowing through its filament. The same applies to an electric fire, the element of which achieves a steady temperature, despite the fact that the current flowing through it is changing 100 times a second. The fact that the current changes direction during each cycle has no effect on its heating effect. Heat is produced whichever way the current flows.

We measure the magnitude of an alternating voltage or current in

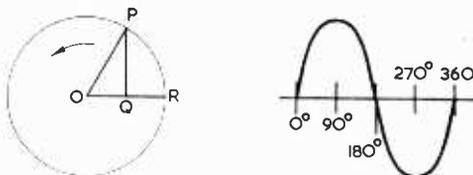


Fig. 3. A sine wave cycle may be constructed by geometric means. The amplitude of the wave is proportional to the sine of the angle between OP and OR, and the sine wave can be divided into 360 degrees

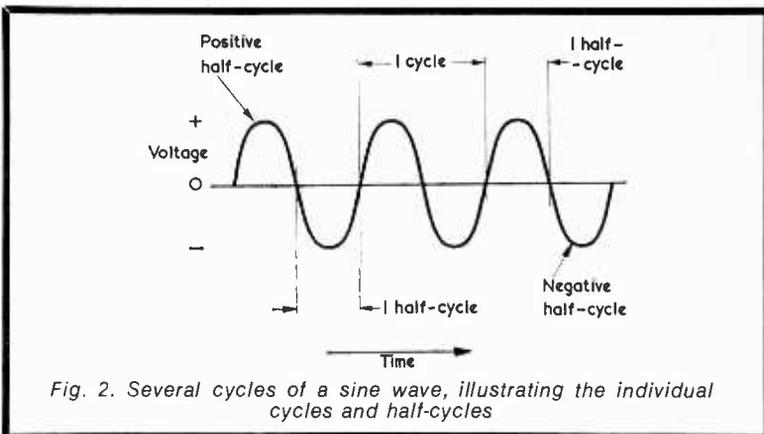


Fig. 2. Several cycles of a sine wave, illustrating the individual cycles and half-cycles

several ways, some of these being illustrated in Fig. 4. One of these measures is the *peak* value of the voltage or current, this being the value between zero and the peak on either half-cycle. There is also a *peak-to-peak* value, which is the sum of the peak values in each half-cycle. If the wave is symmetrical above and below the zero line, as a sine wave is, the peak-to-peak value is twice the peak value. A third measure is the *r.m.s.* (short for 'root mean square') value, and this is the value which gives the same heating effect as an equivalent direct voltage or current. With a sine wave the peak value is 1.414 times the r.m.s. value for either voltage or current. The figure 1.414, it may be added, is the square root of 2. Another way of saying the same thing is that the r.m.s. value is 0.707 times the peak value. 0.707 is 1 divided by the square root of 2.

OTHER FREQUENCIES

The electricity supplied by the mains offers a convenient and familiar introduction to alternating voltage and current, but we must now turn our attention to other alternating quantities, as are encountered, in particular, in radio work.

The first of these are the frequencies which are audible to the human ear. These are known as *audio frequencies*, and they extend from about 50Hz to 20,000Hz, or 20kHz. (1 kilohertz, or kHz, is equal to

1,000Hz). Sound, in air, consists of a series of rarefactions and compressions which, when they impinge on the ear-drum of the ear, cause it to vibrate in sympathy and produce the sensation of hearing. If sound impinges on the diaphragm of a microphone, the latter transforms it into an electrical alternating voltage in which the half-cycles of one polarity correspond to the rarefactions and the half-cycles of the other polarity correspond to the compressions in the sound wave. This alternating voltage comprises an audio frequency, or a.f., signal, and we can make it larger, or *amplify* it, by means of circuits containing transistors or valves. To render the electrical audio frequency signal audible again it is applied to a loudspeaker or an earphone. A diaphragm in the latter vibrates in sympathy with the electrical signal, and produces corresponding rarefactions and compressions in the adjacent air which may be perceived as sound.

A second set of frequencies are the *radio frequencies*. These are the frequencies of the radio waves which are broadcast by a transmitter and received by a receiver. They extend from about 10kHz to 300,000MHz (1 megahertz, or MHz, is equal to 1,000kHz or 1,000,000Hz) and the various sub-divisions are listed in the accompanying table. Radio waves constitute a section of the spectrum of *electromagnetic waves*. Electromagnetic waves having frequencies higher than those of radio waves include infra-red waves, visible light waves and ultra-violet waves. All these electromagnetic waves have a speed which is almost exactly 300,000,000 metres per second.

This speed enables us to relate the frequency and *wavelength* of a radio wave. The wavelength of a radio wave is the distance between successive 'crests', as shown in Fig. 5(a), where it may be assumed that the waves are travelling in the direction of the arrow at 300,000,000

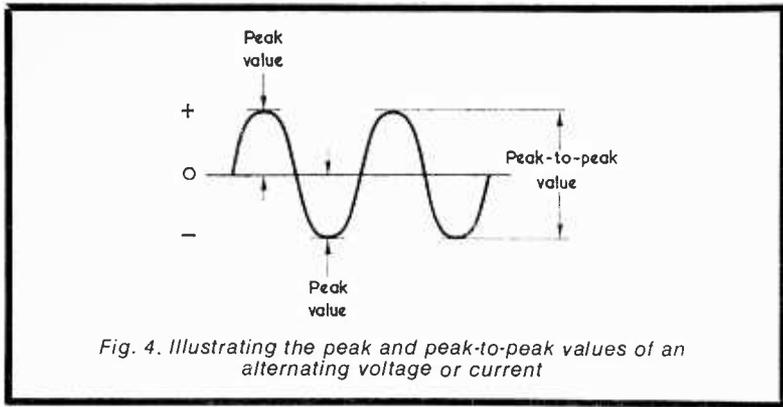


Fig. 4. Illustrating the peak and peak-to-peak values of an alternating voltage or current

metres per second. In Fig. 5(b) we introduce a stationary observer, whose function is to count the crests of the radio wave that pass

where frequency is in kHz, or

$$\text{Frequency} = \frac{300}{\text{Wavelength}}$$

TABLE	
RADIO FREQUENCY SUB-DIVISIONS	
Sub-Division	Frequency Range
v.l.f. (very low frequency)	Below 30kHz
l.f. (low frequency)	30 - 300kHz
m.f. (medium frequency)	300 - 3,000kHz
h.f. (high frequency)	3 - 30MHz
v.h.f. (very high frequency)	30 - 300MHz
u.h.f. (ultra high frequency)	300 - 3,000MHz
s.h.f. (super high frequency)	3,000 - 30,000MHz
e.h.f. (extremely high frequency)	30,000 - 300,000MHz

him in one second. (In practice, this could be carried out by a radio receiver suitably coupled to an electronic counting device.) If the wavelength of the radio wave is 1,000 metres, 300,000 crests pass the observer in one second. This corresponds to a frequency of 300,000Hz or 300kHz. If the wavelength were 1 metre, then 300,000,000 crests would pass the observer in one second, corresponding to a frequency of 300,000,000Hz, or 300 MHz.

These two examples tell us that the frequency of a radio wave can be deduced by dividing its speed by its wavelength. Thus:

$$\text{Frequency} = \frac{\text{Speed}}{\text{Wavelength}}$$

It will be realised that this relationship will hold good for all other radio wavelengths.

Expressing the relationship in figures we may say:

$$\text{Frequency} = \frac{300,000,000}{\text{Wavelength}}$$

where frequency is in Hz and wavelength is in metres. But it would be more convenient to say:

$$\text{Frequency} = \frac{300,000}{\text{Wavelength}}$$

where frequency is in MHz.

This relationship explains the apparently odd choice of the series of numbers 3, 30, 300, in the frequency column of the accompanying table. We can now see, for instance, that the v.h.f. sub-division contains wavelengths ranging from ten metres to one metre. So, in terms of wavelength, the table employs a rational 1, 10, 100 series of figures.

Radio waves are most frequently referred to in units of frequency but it is also quite common to define them in terms of wavelength instead, a fact which tends to confuse the newcomer to radio until he becomes more used to the figures involved. To take an example, one of the amateur transmitter bands in this country, 7 to 7.1MHz, is commonly referred to as the '40 metre band' since the corresponding wavelengths are 42.9 and 42.3 metres respectively. Nearly all the other amateur bands are similarly referred to in terms of their approximate wavelength. Another anomaly is to be found in domestic radio receivers capable of picking up long-wave, medium-wave and v.h.f. signals. The long and medium wave tuning scales of these receivers are marked up in terms of wavelength, whilst the v.h.f. tuning scale is marked up in terms of frequency!

A final minor point, before concluding on this particular subject, is that the term 'radio frequency' may be abbreviated to 'r.f.'

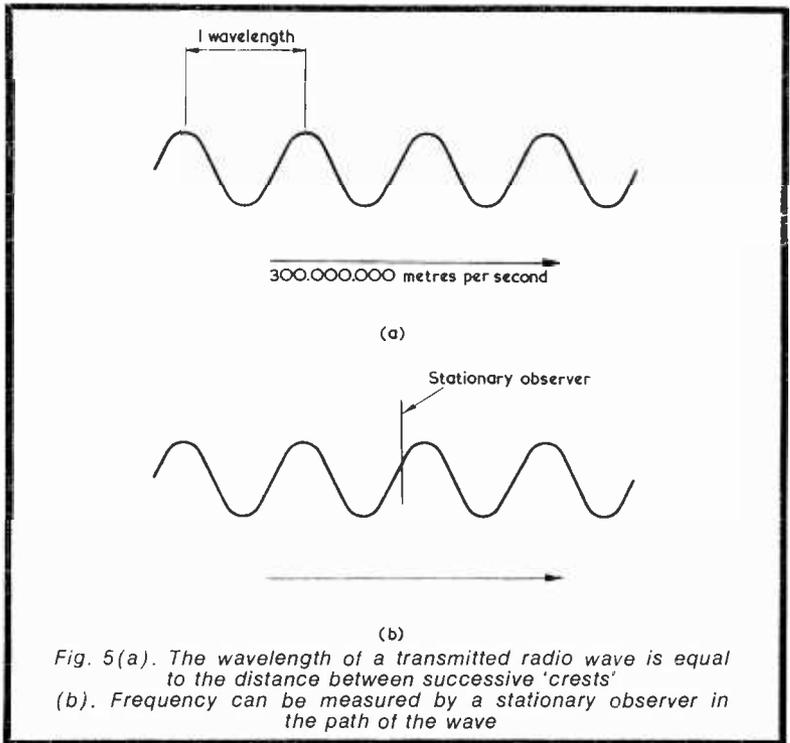


Fig. 5(a). The wavelength of a transmitted radio wave is equal to the distance between successive 'crests'
 (b). Frequency can be measured by a stationary observer in the path of the wave

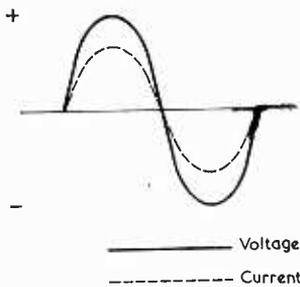


Fig. 6. When an alternating voltage is connected to a resistor the current is in phase with the voltage

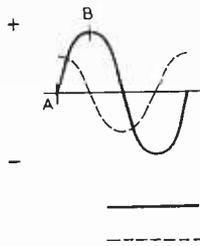
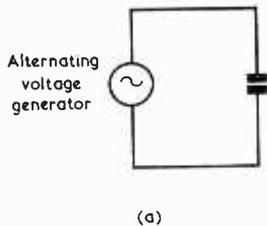


Fig. 7(a). Connecting an alternating voltage generator to a capacitor
(b). The current in the circuit of (a) leads by 90° on the voltage

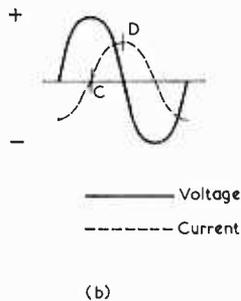
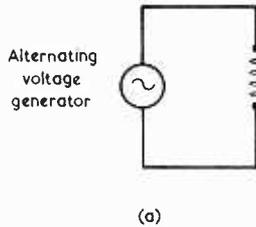


Fig. 8(a). The alternating voltage generator connected to an inductor
(b). In this case the current lags by 90° on the voltage

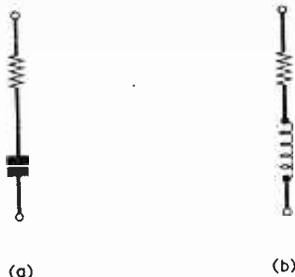


Fig. 9. The series combination of a resistor and a capacitor (a) and an inductor (b) causes the appearance of impedance between the two outside terminals

REACTANCE AND IMPEDANCE

When an alternating voltage generator is connected to a resistor, as it was in Fig. 1(a), an alternating voltage appears across the resistor and an alternating current flows through it. As we have already seen, the alternating current is in step with the alternating voltage; that is to say, the alternating current is at a peak when the alternating voltage is at a peak and is zero when the alternating voltage is zero. We can draw graphs for the two quantities on a common base line representing time, whereupon we get the composite graph shown in Fig. 6. We say that both of the waves are in phase with each other.

In Fig. 7(a) we connect an alternating voltage generator to a capacitor. Again, an alternating voltage appears across the capacitor and again an alternating current flows. This alternating current cannot, however, flow through the capacitor because there is an insulating dielectric in the way. The current which flows is, instead, a current which either charges the capacitor or discharges it as the alternating voltage changes.

Fig. 7(b) shows the resultant voltage and current curves. It will be at once apparent that the voltage and current are not now in phase. They are, instead, one quarter-cycle or 90° out of phase. The current reaches its peak 90° of the cycle before the

voltage reaches its peak, and so we make the further statement that, when an a.c. generator is applied to a capacitor, the current leads the voltage by 90° .

The reason for this effect becomes clear if we examine the rate of change of voltage along the voltage curve and if we remember, from last month's article, that one of the attributes of a capacitor is that it opposes changes in voltage across its plates. At point A of Fig. 7(b) the voltage, as it passes through zero level, is changing at its fastest rate. In consequence maximum charging current has to flow into the capacitor to overcome its opposition to change of voltage. Proceeding from point A to point B, the rate of change of the voltage reduces and so, in consequence, does the charging current. At point B itself there is an instant when there is no change of voltage at all. At this instant the current is zero. After point B the voltage starts to fall and it is now a discharge current which flows. And so the process continues throughout the cycle, the magnitude of the current always being proportional to the rate of change of the voltage.

In Fig. 8(a) we next connect the alternating voltage generator to an inductor (the wire in which is assumed to have zero resistance), and the resultant relationship between voltage and current is shown in Fig. 8(b). Here we have the opposite to the situation in the capacitor, and the current is now 90° later than the voltage. We say that the current lags by 90° on the voltage.

It will be recalled that an inductor opposes a change in current. A simple way of explaining the effect shown in Fig. 8(b) consists, then, of thinking primarily in terms of the rate of change of the current. The rate of change of current is at its maximum at point C in the diagram, whereupon the applied voltage has to be at maximum to enable this rate of change to be achieved. The rate of change of current reduces between points C and D and so does the applied voltage. There is an instant at point D where the current does not change at all, and the voltage at that instant is, correspondingly, zero. This explanation takes us to the conclusion that the voltage leads on the current by 90° , which is just another way of saying that the current lags on the voltage by 90° .

Both the capacitor and the inductor oppose the flow of alternating current. Since, in both cases, the current is 90° out of phase with the voltage we cannot refer to this opposition as resistance, and so we use the term reactance instead. When it is necessary to distinguish between the reactance offered by a

capacitor and that offered by an inductor we refer to *capacitive reactance* and *inductive reactance*, as applicable. Both of these reactances are measured in ohms.

The reactance of a capacitor is given by

$$XC = \frac{1}{2\pi fC}$$

where XC is reactance in ohms, f is frequency in Hz, and C is capacitance in farads. In practice the equation becomes easier to handle if we say that f is in megahertz and C is in microfarads. Since one unit is then divided by 1,000,000 and the other multiplied by 1,000,000 the value of reactance remains the same. Note that the reactance decreases as the capacitance and frequency increase. This is to be expected, as the charge and discharge currents will then become larger.

The reactance of an inductor is given by

$$XL = 2\pi fL$$

where XL is reactance in ohms, f is frequency in hertz and L is inductance in henrys. This time, reactance increases as inductance and frequency increase.

When a capacitor or inductor is connected in series with a resistor as in Figs. 9(a) and (b), the opposition to current flow at the two outside terminals is described as *impedance*. This is because the resistor qualifies the current lead or lag as applicable, and the latter becomes less than 90°. Impedance is given by the equation

$$Z = \sqrt{R^2 + X^2}$$

where Z is impedance in ohms, R is resistance in ohms and X is reactance in ohms.

RESONANT CIRCUITS

We now come to the special case given by resonant, or tuned, circuits.

In Fig. 10(a) we have a capacitor, an inductor and a resistor in series, with an alternating voltage generator connected to them. The frequency of the generator is capable of being varied. The resistor has a low value. It is not a physical component and is included in the circuit diagram merely to represent the resistance of the wire in the inductor plus any 'losses' (due to iron cores, etc.) which it may have. Now, the only electrical quantity common to all these three components is the common current from the generator that flows through them. The voltage across the capacitor will then lag on that current by 90°, whilst the voltage across the inductor will lead on that current by 90°, so that the phase difference between the two voltages becomes 180°. This relationship is shown in Fig. 10(b), which shows two voltages

that are exactly 180° out of phase with each other.

At a high frequency the reactance of the inductor will be higher than the reactance of the capacitor and the circuit will behave as though it had inductance and resistance in series. Similarly, at a low frequency the reactance of the capacitor will be higher than the reactance of the inductor and the circuit will behave as though it had capacitance and resistance in series. Between these two extremes there will be a frequency at which the reactance of the inductor and the reactance of the capacitor are equal. At this frequency, the two voltages across the inductor and the capacitor become equal and opposite, and they cancel out. Current flow is then limited by the resistor only. Under these conditions the series combination of inductor, capacitor and resistor becomes a resonant, or tuned, circuit. If a graph is drawn showing current flow against frequency, it would have the appearance shown in Fig. 11.

Fig. 12 shows an inductor and capacitor in parallel, with an alternating voltage generator connected to them. For the moment we shall assume that both the capacitor and inductor are 'perfect' components, and so we shall not add any resistance to represent the resistance of the wire in the coil and other 'losses'. In Fig. 12 the electrical

quantity common to both the inductor and the capacitor is the voltage that appears across them. This means that it is now the two *currents*, that in the inductor and that in the capacitor, which are 180° out of phase with each other. At a high frequency, the reactance of the capacitor will be lower than that of the inductor and the circuit will behave as though it had capacitive reactance only. At a low frequency the reactance of the inductor will be lower than that of the capacitor and the circuit will behave as though it had inductance reactance only. At the frequency where the two reactances are equal, the two out-of-phase currents cancel out, and *no current is drawn from the generator*. This is the resonant frequency, and the capacitor and resistor form a resonant, or tuned, circuit. In practice, it is impossible to have 'perfect' components in the tuned circuit, and a small current due to resistance and to 'losses' (mainly in the inductor) will still be drawn from the generator.

If the generator were capable of supplying a steady current at a voltage proportional to the reactance and resistance in the circuit, the voltage across the capacitor and inductor would rise very markedly at the resonant frequency, in the same way as does the current in Fig. 11.

The circuit of Fig. 10(a) is known

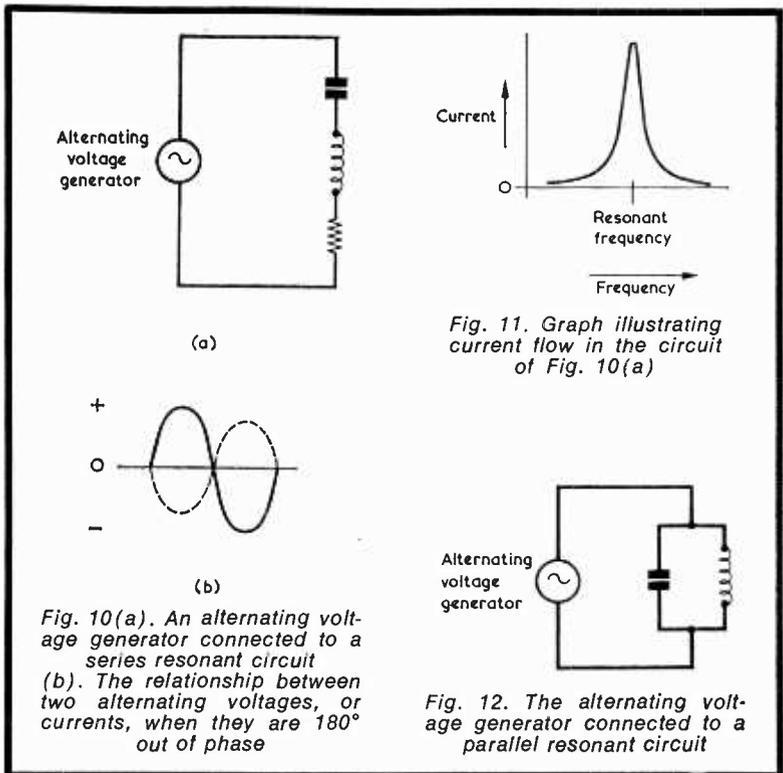


Fig. 10(a). An alternating voltage generator connected to a series resonant circuit
(b). The relationship between two alternating voltages, or currents, when they are 180° out of phase

Fig. 11. Graph illustrating current flow in the circuit of Fig. 10(a)

Fig. 12. The alternating voltage generator connected to a parallel resonant circuit

as a *series resonant circuit*, whilst that in Fig. 12 is referred to as a *parallel resonant circuit*. To reiterate, the series tuned circuit allows maximum current to flow through it at the resonant frequency, and the parallel tuned circuit allows maximum voltage to appear across it at the resonant frequency.

The fact that resonance occurs when the inductive reactance is

equal to the capacitive reactance enables us to work out an equation for resonant frequency in a tuned circuit. Thus,

$$2\pi fL = \frac{1}{2\pi fC}$$

$$f^2 = \frac{1}{(2\pi)^2 \times LC}$$

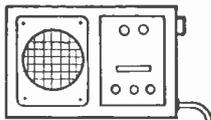
$$f = \frac{1}{2\pi\sqrt{LC}}$$

where f is in Hz, L is in henrys and C is in farads.

NEXT MONTH

In next month's article, we shall introduce the transformer and then show how tuned circuits are used in radio receivers. ■

In your workshop



“A H!” SAID SMITHY. “THAT’S better!” With a sigh of intense satisfaction the Serviceman placed his empty tin mug on his bench. Without a word Dick rose, picked up the mug and refilled it from the cracked and stained tea-pot which maintained its station near the Workshop sink. He added a little milk and four spoonfuls of sugar. He then returned and, silently, replaced the mug on Smithy’s bench. This was a ritual of long standing.

Smithy took a six-inch steel rule from his overall pocket and used it to stir the contents of his mug vigorously. He then carefully wiped the rule on a rag and returned it to his pocket. After this, he picked up the mug and drank greedily.

A TO Z AGAIN

Dick watched the Serviceman with fascination. Despite all his years in the Workshop he had still not completely lost his awe at the vast quantities of tea which Smithy was capable of absorbing. Suddenly, a thought struck him.

“I’ve just remembered,” he remarked, “there was something I was going to ask you about.”

This month Dick and Smithy devote their lunch-break to a tour of the simple, the not-so-simple and the downright unusual in a tour of electronics which takes them through the alphabet from A to Z

“Fire away.”

Replete with the lunch he had just consumed and approaching saturation level with respect to tea, Smithy had ascended to a mood of serene benignity.

“It was something I was reading the other day,” continued Dick. “about crystals being anti-resonant. How on earth can a crystal be *anti-resonant*, Smithy?”

“It’s a term that’s grown up with crystal technology,” replied Smithy. “Incidentally, I think we should establish, before going any further, that the crystals we’re talking about are the ones that are used for controlling the frequency of r.f. oscillators. You can draw an equivalent circuit for these crystals, and it consists of a coil, a capacitor and a resistor in series, together with a capacitor across the lot to represent the capacitance between the plates of the crystal holder. (Fig. 1). The internal coil and capacitor correspond to the mechanical resonance of the crystal, and the resistor corresponds to the crystal’s resistance to mechanical vibration.”

“Oh,” interrupted Dick. “It’s the resistance that’s anti-resonant, then.”

“No it isn’t,” replied Smithy, losing a little of his benevolence. “I’ll be getting on the anti-resonant bit in a jiffy. Now, first of all the crystal can resonate at a frequency corresponding to the series tuned circuit given by the internal coil and capacitor. This is its resonant condition and it exhibits a low impedance at the resonant frequency. But it can also resonate at a frequency corresponding to the coil with the series combination of the internal capacitance and the crystal holder capacitance *across* it. This is the parallel resonant frequency and it’s a wee bit higher than the series resonant frequency. The parallel resonant frequency is the one normally employed in crystal oscillators and, since the crystal is functioning as a parallel tuned circuit, it offers a high impedance

at the parallel resonant frequency. To finally get down to your question, you will sometimes hear the series resonant frequency referred to as the ‘resonant frequency’ of the crystal, and the parallel resonant frequency as the ‘anti-resonant frequency’ of the crystal.”

“I see,” said Dick thoughtfully, “what you’ve just told me explains something else that’s puzzled me in the past too, this being that you can change the resonant frequency of a crystal in an oscillator over a small range by connecting a trimmer across it. Since the crystal will be working at its anti-resonant frequency the trimmer then provides a variable capacitance in parallel with the crystal holder capacitance.”

“That’s the idea,” said Smithy, pleased at his assistant’s brightness. “You get trimmers across the crystal in things like reference oscillators which are required to work at a very accurate frequency. The usual thing with these oscillators is to trim the crystal to a zero-beat with a standard frequency transmission such as is radiated by MSF at Rugby, or with the long-wave BBC2 carrier on 200kHz. It may be necessary to use harmonics of the

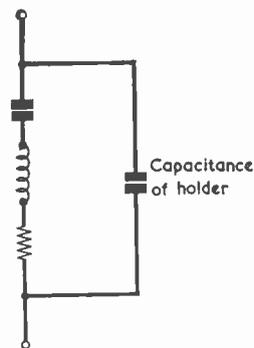


Fig. 1. The equivalent circuit for a crystal, as employed for frequency control.

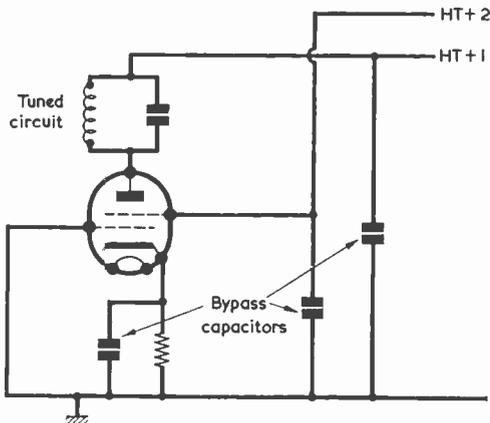


Fig. 2. The dynatron oscillator. The h.t. voltage applied to the screen grid is higher than that at the anode.

crystal oscillator or the standard frequency transmission, or both, to find a frequency on which they can beat together."

Smithy paused and took a prodigious draught from his mug.

"Talking about kHz reminds me of a rather corny technical gag," he said, smacking his lips. "If we used the letter 'c' to stand for 'coulombs', what would '1c/s' represent?"

"Blimey," said Dick, shaken at this sudden change in subject. "I don't know."

"It would represent 'one amp,'" replied Smithy cheerfully. "A flow of one coulomb per second is equal to a current of one amp."

"Is it?" returned Dick blankly. "Incidentally, there's something funny here."

"How d'you mean, funny?"

"Well," said Dick, "we started off by nattering about anti-resonant crystal frequencies, then we went on to beats, and now we're talking about coulombs."

"Well?"

"Don't you see? We've just talked about things which start with A, B and C in that order. We've got ourselves hooked onto another A to Z game!"

"Why, so we have," chuckled Smithy. "Well, I enjoy these A to Z games, so let's continue with it and carry on to letter D. What's a dynatron?"

"That's an easy one," replied Dick. "It's a negative resistance oscillator in which the tuned circuit appears in the anode circuit of a tetrode valve. The screen grid of this valve has a higher h.t. potential than that applied to the anode." (Fig. 2).

"Very good," commended Smithy. "You ask me one now."

"Righty-ho," said Dick. "What's an end-fire array?"

"It consists basically," replied Smithy, "of an aerial having two parallel tuned sections which are fed out of phase. (Fig. 3). The result is that, assuming the aerial is fed by a transmitter, much of the upwards radiation is cancelled and the remaining radiation is horizontal and in the plane of the array. There are quite a few variations on this basic theme, and the end-fed array is an aerial which is much favoured by amateurs. Well now, let's see. F is next, so you tell me what 'form factor' is."

"'Form factor'," repeated Dick musingly. "I don't think I've ever even heard of it."

"It's the r.m.s. value of an alternating voltage or current," said Smithy, "divided by its average value."

"Fair enough," replied Dick. "Well, it's my turn next with the letter G and—hey, wait a minute! Did you say *average* value?"

"Yes I did," grinned Smithy. "Anything wrong with that?"

"There's got to be. The average value of an alternating voltage or current is zero."

"Dear me, so it is," chuckled Smithy. "Well, I'm glad you've spotted that. I should have added that it's the r.m.s. value divided by the average value after the alternating voltage or current has passed through a perfect rectifier. To give you an idea of the figures you meet in practice, the form factor of a full-wave rectified sine wave is 1.11 and that of a half-wave rectified sine wave is 1.57." (Fig. 4).

"Come to think of it," confessed Dick, "I've never been *entirely* certain what the r.m.s. value of an alternating voltage or current actually represents."

"It's the value which gives the same heating effect in a resistance as does a direct voltage or current

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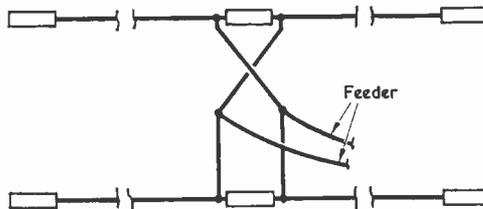


Fig. 3. Basic version of the end-fire array. Element length may vary between a half-wavelength and a full-wavelength, according to individual design.

of the same value," replied Smithy. "Which is pretty easy to visualise when you consider that an a.c. mains supply of 240 volts, which is an r.m.s. figure, will raise an electric light bulb filament to the same temperature as would a 240 volt d.c. supply. Incidentally, the r.m.s. value is sometimes called the 'effective' value."

Dick absorbed this information silently.

"I know," he remarked after a moment, "that the letters r.m.s. stand for 'root mean square'. But, there again, I've never really understood what 'root mean square' means, either!"

"It's the square root," explained Smithy, "of the average, or mean, of the squares of all the instantaneous values in a cycle. Which makes sense when you realise that heating effect is equal to I^2R or $\frac{R}{V^2}$. Well,

that's enough about form factor, so let's get on to the letter G. We were talking about kilohertz just now, so tell me what 'gigahertz' are."

"You've pinched my turn," protested Dick. "I was going to ask you one for G."

"You can have the next one after this," promised Smithy. "What are 'gigahertz'?"

"I've got an idea I know this one," said Dick, frowning thoughtfully. "Would a gigahertz be 1,000 megahertz?"

"It would," confirmed Smithy. "Giga' is a prefix meaning 1,000 million."

H-PARAMETERS

"Right," said Dick promptly. "H is next. What are transistor h-parameters?"

"They're a set of parameters which are used to define transistor operation," replied Smithy. "The quantities involved are diverse in character and the letter 'h' stands for 'hybrid' because of this. There used to be numbers after the letter 'h' but this idea has been largely dropped, and letters are nowadays used instead of the numbers. I haven't got time to go into all the parameters now, so I'll just deal

with the ones you're most likely to meet. We'll start off with h_{ib}, h_{ie} and h_{ic}. These apply to the small signal value of the input impedance of the transistor when the output is short-circuited for alternating voltage, as would happen if a large capacitor were connected across the output. The letter 'i' in each of the three terms stands for 'input' and the letters 'b', 'e' and 'c' refer to the transistor in common base, common emitter and common collector respectively. This parameter, which used to be known as h_{il} for both the h_{ib} and h_{ie} applications, is measured in ohms or kilohms. Another parameter is covered by h_{fb}, h_{fe} and h_{fc}. This is the small signal current gain with the output short-circuited for alternating voltage, and the three terms apply to common base, common emitter and common collector respectively. The letter 'f' stands for 'forward current transfer ratio', which is a posh way of referring to current gain. All three terms are expressed in pure numbers, as they apply to a ratio. Also, h_{fb} and h_{fe} used to be referred to as h₂₁ in the numbering system."

"Sometimes," said Dick, "the letters after the 'h' are shown as capital letters."

"Capital letters apply," replied Smithy, "to static conditions instead of small signal conditions. Thus, h_{IB} is the static value of the input resistance with the output voltage held constant. Similarly, h_{FE} is the static value of current gain, also with the output voltage held constant. Well, that's cleared up your turn and the letter H. I's next."

"You can't say that. It's bad grammar."

"What's bad grammar?"

"To say 'I's next'. You should say 'I'm next' or 'I am next'."

Smithy turned an irate glance at his assistant.

"Are you presuming," he growled, "to take the mickey?"

"Of course I'm not," returned Dick primly. "It's just that it's bad grammar to say 'I's next'."

"You great moronic buffoon," roared Smithy, "I meant it's the letter I that's next."

"Did you?" replied Dick. "In that case what you said was acceptable grammar. Please proceed."

Medusa would have conceded a point or two to Smithy had she seen the baleful glance he bestowed on his assistant. That worthy appeared, however, to be completely unaware of anything untoward, and he looked expectantly at the SerVICeman.

"Very well, then," snorted Smithy, as his ire gradually subsided, "now that you've been kind enough to give me permission to carry on. I'll get on with the letter I. What's an isotope?"

"Let me think now," said Dick, frowning in concentration. "Ah yes, I know! An isotope of an atom has the same number of protons and electrons, but a different number of neutrons in the nucleus."

"That's fair enough," conceded Smithy reluctantly. "Now, you ask me one for J."

"What's a 'jar'?"
 "This isn't another of your crummy attempts at humour, is it?" asked Smithy suspiciously. "If it's one of your efforts along 'when is a door not a door' lines, so help me there will be mayhem done in here today."

"I'm dead serious," protested Dick. "What's a 'jar'?"

"Well," said Smithy pensively, "the only 'jar' I know about is the one they used to use in the Navy. It was a unit of capacitance."

Dick looked crestfallen.
 "Blow me," he complained, "I thought I'd catch you out with that one."

"Was I right?"
 "Dead right."

"Good," said Smithy pleased. "Here's an easy one for you. What's a 'keeper'?"

"It's a bit of soft iron," replied Dick without delay, "which you put across the poles of a permanent magnet to help it retain its magnetism. Here's another easy one. What's 'Litz wire'?"

"The *original* Litz wire," replied Smithy, "had a number of strands of thin insulated wire interwoven together in such a way that the strands appeared at the surface at regular intervals, with the result that all the strands in a length of wire had equivalent lengths at the surface. The idea was to reduce losses due to skin effect, which causes r.f. currents to travel mainly on the outside of conductors. With litz wire, all the strands are equally capable of passing r.f. current, since they all have relatively long and equal lengths at surface level. In practice, litz wire is very effective in coils running at frequencies up to some 8MHz or so."

"You referred," stated Dick, "to the *original* litz wire. Have there been any changes in it?"

"You can nowadays," replied Smithy, "get an alternative which is known as 'bunched' litz wire. This hasn't got the special type of litz wire interweaving but, so far as I'm aware, is just about as effective in practice."

"That's something I hadn't known," remarked Dick. "Anyway it's you to go next, with the letter M."

MILLER EFFECT

"Okay," said Smithy promptly. "Then, what's 'Miller Effect'?"

"Isn't that," asked Dick, "the effect which causes an apparent increase in the input capacitance of a triode valve due to the voltage amplification it provides?"

"That's correct," confirmed Smithy. "You get the effect in transistors, too."

"I've never," said Dick, "really understood what causes it."

"Then I'll explain it to you," replied Smithy. "The explanation is easier with a valve, so let's assume that we've got a triode which offers a voltage gain of 50 times and to whose grid is connected an a.c. generator. (Fig. 5). At first sight it looks as though the generator has to supply no current to the grid at all, but this isn't true because, as its output voltage changes, it has to charge and discharge the inter-electrode capacitance between the grid and the cathode, and the inter-electrode capacitance between the grid and the anode. It's this last capacitance which causes Miller Effect. Let's say that the generator causes the grid to go one volt more positive. The anode counteracts this by going 50 volts *negative*. The charging current which flows into the grid-anode capacitance is then that needed to charge the capacitance on its own plus a further charging current, 50 times greater.

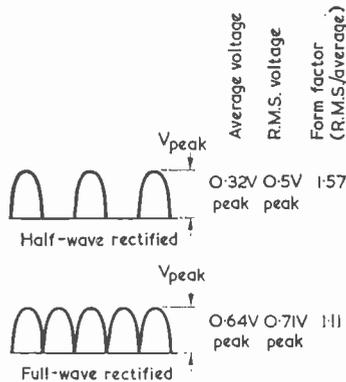


Fig. 4. Illustrating the form factor for half-wave and full-wave rectified sine waves.

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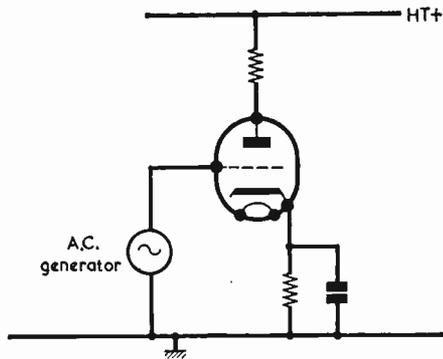


Fig. 5. Due to Miller effect, the input capacitance of a voltage amplifier triode is considerably greater than the actual inter-electrode capacitances.

to take up the 50 volt change in anode potential. So the total charging current is 51 times greater than it would be if the anode had a fixed potential."

"I get it now," chimed in Dick. "The result is that, so far as the generator is concerned, it is working into an input grid capacitance 51 times greater than the actual capacitance between the anode and the grid."

"That's it," confirmed Smythy. "The same relation holds good, of course, for amplification factors other than 50. To sum up, Miller Effect in a triode valve effectively multiplies the grid-anode capacitance by A plus 1, where A is the voltage gain of the valve."

"Well now," said Dick, "that's got M done. N is next, so what's a 'node'?"

"It's a point of zero amplitude along a wave," said Smythy. "If, for instance, you have a standing wave on an aerial, the points where current or voltage amplitude is at zero are known as 'nodes'. Also, the points where current or voltage amplitude is at maximum are referred to as 'antinodes' (Fig. 6). Let me give you another easy one. What are 'overtones'?"

"They're the same as harmonics." "They aren't, you know," stated Smythy. "A harmonic is always an exact multiple of the fundamental frequency. An overtone does not necessarily have to be an exact multiple of the fundamental. To be precise, an overtone is a component part of a complex signal having a frequency which is higher than the basic frequency of that signal. Okay?"

"Yes, sure. Shall I go on next, with P?"

"If you would, please."

PICCOLO

"I've got a real stinker I've been

saving for you here," said Dick with relish. "I'll bet you won't know the answer to this one. What's 'Piccolo'?"

"Do you mean," queried Smythy, "the receiving system that was developed by the British Diplomatic Wireless Service?"

"I should have known it was hopeless," snorted Dick disgustedly. "Yes, that's the system I do mean."

"Well," said Smythy guardedly. "I don't know a great deal about it, but I have a rough idea of how it works. In the Piccolo system the idea is to receive a signal modulated in accordance with the Piccolo code, and apply the a.f. signal after detection to a set of 33 resonant circuits. Of these resonant circuits, 32 each correspond to a teleprinter character whilst the remaining one is a stand-by. The circuits are resonant at frequencies spaced at 10Hz intervals between some 300 and 700Hz, and are kept in a condition where they are completely free of losses by means of carefully adjusted regenerative feedback circuits. Since each resonant circuit is free of losses the result is that, when a signal at its resonant frequency is applied to it, it stores up energy at that frequency. During transmission, the transmitter sends one of these resonant frequencies,

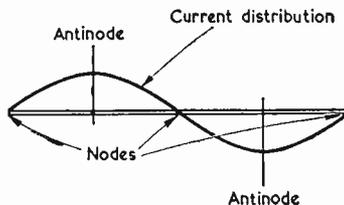


Fig. 6. Current distribution in a full-wave aerial, showing the points at which nodes and antinodes appear.

according to the teleprinter character it is desired to transmit, and this causes the appropriate resonant circuit at the receiver to store up energy. All the resonant circuits at the receiver are then checked by a voltage sensing device, whereupon the resonant circuit which has stored the energy becomes identified, the frequency sent by the transmitter becomes known, and the receiver teleprinter can be operated accordingly. The resonant circuits are next all brought back to zero level, after which the transmitter sends the resonant frequency corresponding to the next character in the message, and the process is repeated. Each of these cycles occupies about 0.1 second, so the process is quite fast. The great advantage of the Piccolo receiving system is that it can operate with fantastically low signal strengths at its aerial. It works reliably at a received signal level which is lower than noise level, and when all other types of receiver are incapable of resolving a signal at all. That's why it was originally developed for use in the diplomatic service."

"I don't know," said Dick despondently. "The next letter is Q, but so far as getting one past you today is concerned it might as well stand for Queer Street!"

Smythy picked up his tin mug and drained it with one prodigious swallow. He presented it to his assistant who proceeded once more to the Workshop sink to refill it.

"Don't be too down-hearted," called out Smythy. "Anyway it's my turn for Q, so the one I'll give you is Q-factor."

"That's simple," replied Dick, returning with Smythy's mug. "The letter Q is normally used to define the efficiency of a tuned circuit at resonance and it's equal to the reactance of either the capacitor or the inductor in ohms divided by R, which represents a series resistor equal to all the losses."

"Very good," said Smythy. "And, of course, you can work to the reactance of either the capacitor or inductor because both reactances are equal at resonance."

SURFACE WAVE FILTER

"R's the next letter," stated Dick. "So, what's a reflex stage in a receiver?"

"It's a stage which first amplifies the r.f. signal before detection," replied Smythy, "and which then amplifies the same signal, as a.f., after detection. Reflex stages are very popular with home-constructors because of the economy in transistors that they offer and because of the simplicity of their circuits. Right now, S is next. What's a 'surface wave filter'?"

Dick looked baffled.

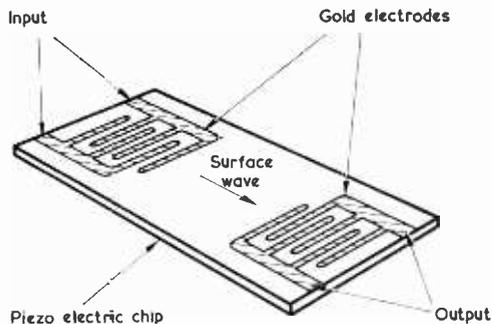
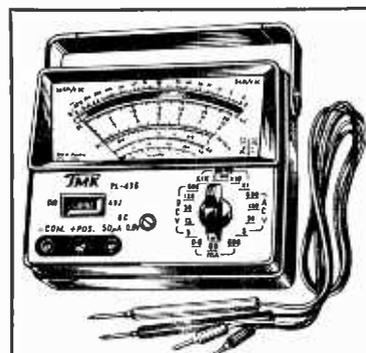


Fig. 7. Simplified diagram illustrating a surface wave filter. In practice, there are more interleaving electrode strips than are shown here and the lengths of individual strips vary.



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"Search me," he said "I've never seen one."

"Neither have I," chuckled Smithy. "As it happens, the surface wave filter is an extremely new device which has been developed by Mullard Limited, and which is still in the laboratory stage. It's a mechanical filter comprising a chip of piezoelectric ceramic measuring 7 by 4 millimetres and it is hoped that, by combining this chip with an i.c. amplifier chip, all the i.f. circuitry of a TV receiver can be provided in one single encapsulation."

"Gosh," said Dick impressed. "Some of these new developments are becoming *really* fantastic. How does a surface wave filter work?"

"By artificially disturbing the surface of the ceramic material at one end," replied Smithy. "Acoustic surface waves then travel along the surface in the same way as waves travel along the surface of a liquid. The waves travel at a fixed velocity, and frequency selectivity is given when the frequency of the disturbance coincides with the wavelength of the consequent wave. In practice, the waves are generated by a series of thin interleaving strips of gold deposited on one end of the chip, and are picked up at the other end by a second series of interleaving strips. (Fig. 7). Since the chip material is piezoelectric, signals applied to the input end cause changes in shape due to the piezoelectric effect, these changes producing the surface waves. The waves travel to the other end of the chip and produce voltages at the output, again because of the piezoelectric effect."

"Well," remarked Dick. "you certainly won't have trouble with i.f. stages going out of alignment in a TV set incorporating one of those filters."

"Indeed you won't," agreed Smithy. "And the saving in space is just about phenomenal. The frequency response of practical chips lies between some 33 and 40MHz,

as is required for TV sets, and the lengths of the individual interleaving strips differ from each other in order to provide the required frequency response pattern."

"The poor old tuned circuit," remarked Dick, "seems to be having a hard old time of it these days. Anyway, let me ask you the next one. What, exactly, is 'Teflon'?"

"It's a trade name," replied Smithy. "And it applies to polytetrafluoroethylene."

"Poly-what?"
"Polytetrafluoroethylene," repeated Smithy. "Or p.t.f.e. for short. It's a plastic which, amongst other things, is capable of withstanding high temperatures. I've got one for you. now. What's 'unity'?"

"Unity?" said Dick frowning. "Isn't that someone who used to write books?"

"I mean unity in mathematics."
"In mathematics? Gosh, Smithy, you know what *my* maths is like. I haven't even got used to decimal coinage yet!"

"It's an easy one, anyway," grinned Smithy. "In mathematics, unity is simply the figure 1. That's all."

"I'll take your word for it," conceded Dick. "What's the next letter?"

"V."
"V, eh?" said Dick pensively. "Ah yes, there's something I was reading about the other day which rather baffled me. What are Venn diagrams?"

"They're diagrams," replied Smithy, "which can be used for representing situations in logic and for simplifying calculations in Boolean algebra. Logic situations are illustrated by drawing circles or other shapes which lie inside each other, are separate, or partially overlap. They can be used instead of truth tables, and they were invented by a mathematician called John Venn, who lived in the nineteenth century."

The
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"The nineteenth century?" repeated Dick incredulously. "Why, they hadn't even got valves in those days."

"True enough," agreed Smithy. "Nevertheless, they were still pretty well on the ball. I often wonder if people like George Boole and John Venn could even remotely have conceived the twentieth century computers for which they were doing all the spade-work."

Smithy picked up his mug, drank from it, then gave a nostalgic sigh.

"Even in my own time," he went on reflectively, "developments have far outstripped anything we could possibly have imagined. If somebody had walked into a service repair shop in the thirties with a transistor radio playing, we'd all have thrown fits. And we'd have thrown further fits after taking the back off the set, when all we could see were just tiny resistors and capacitors and little round gubbins with three wires poking out of them."

"The next letter," interrupted Dick impatiently, "is W. And it's your turn."

"Is it?" said Smithy vaguely, as he reluctantly roused himself from his reverie. "Well, let me see, now, Oh yes, 'Wagner earth'."

"Blimey, Smithy," protested Dick, "you aren't half giving me some tough questions today. That's another one I've never heard of."

"A Wagner earth," said Smithy, "is employed in measuring bridges. To take an example, let's say you're using the bridge to measure very high impedances at audio frequency. One of your first problems is finding a suitable method of connecting the null indicator to the bridge. You can't earth one side of the null indicator directly because this will introduce unbalances in the bridge. At the same time, if the null indicator isn't earthed it can itself cause unbalances. A typical instance is given when the null indicator is a pair of phones whose leads will have a varying capacitance to earth as they move around."

"Does the Wagner earth overcome this problem?"

"It does," replied Smithy. "You can apply a Wagner earth by connecting a potentiometer across the input to the bridge and taking its slider to earth. (Fig. 8(a)). The input, which may be taken from the secondary of a transformer, is 'floating', as also are the phones or whatever other null indicator is employed. To set up the Wagner earth, you first roughly balance the bridge then set the Wagner potentiometer for minimum a.f. tone in the headphones. The process is then repeated several times until the bridge is perfectly balanced and the minimum possible tone is heard in the phones. Both terminals

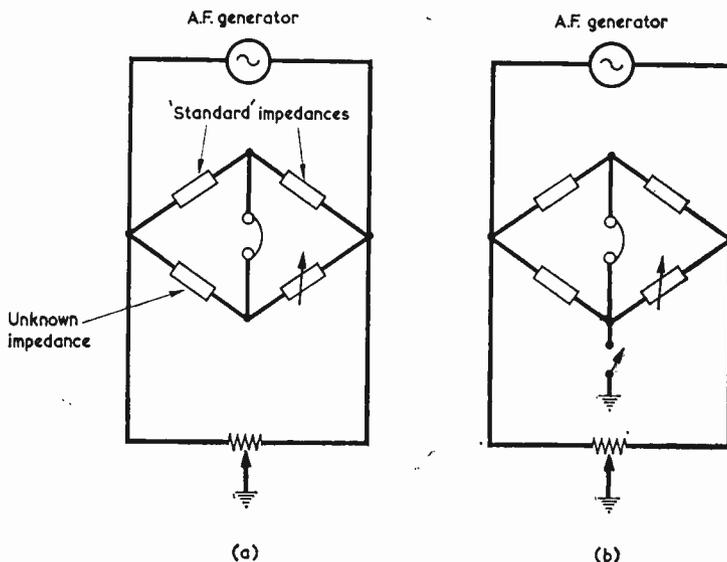


Fig. 8(a). A Wagner earth connected to an impedance measuring bridge. It is assumed that the null indicator consists of earphones.

(b). Adjustment of the Wagner earth potentiometer can be carried out more quickly if one side of the null indicator is temporarily switched to earth.

of the phones are then at earth potential even though they aren't actually connected to earth. A quicker and more reliable method of setting up the Wagner earth consists of temporarily switching one terminal of the null indicator to earth, and then setting up the pot for minimum output." (Fig. 8(b)).

XYLONITE

"Blimey, that's a neat idea," enthused Dick. "X is next, so I'm going to try you out with 'Xylonite'."

"You're very keen on plastics today, aren't you?" remarked Smithy. "Xylonite is another trade name, and it applies to nitrocellulose plastic. You'll probably know this plastic better by its other trade-name, 'Celluloid'. Okay then, let me ask you what a yoke is. And if you come out with any references to eggs I'll do you a mischief."

"A yoke," said Dick quickly, "is the deflection assembly in a TV set. It fits on the tube neck."

A gleam came into Dick's eye.

"Even if I didn't get you with 'Piccolo,'" he gloated, "I'm dead certain I'll catch you with this next one. It's another I've been saving up for you."

"Let's hear it, then."

"What," asked Dick, "is the Zanderoll Process?"

"Do you mean the Zanderoll method of varnish impregnation for iron-cored coils?"

"Ye gods," wailed Dick. "Don't tell me you know the answer to that one too!"

"Well," replied Smithy cautiously. "I don't know all the details without looking them up. But, basically, the Zanderoll impregnation process consists of raising the temperature of the components to be impregnated, passing them through the impregnating varnish and then heating them again afterwards to bake the varnish. The components are hung from a conveyor and the two heating sessions are given by passing them between gas or electric radiant elements. Also, the components are slowly rotated all the time they are on the conveyor."

The Serviceman held up his now empty tin mug.

Dick took the hint and yet again provided Smithy with the fluid that was so necessary for his well-being. With the result that we now have no alternative but to close this particular A to Z session at the unlikely letter T.

ACKNOWLEDGEMENT

The information on surface wave filters was abstracted from "Surface Wave Filters" by R. F. Mitchell, R. G. Pratt, J. S. Singleton and W. Willis, published in *Mullard Technical Communications* for November 1970.

LATE NEWS

Times = GMT

Frequencies = kHz

★ AMATEUR BANDS

● AUSTRALIA

Several VK5's have been active of late on 14MHz CW. Among those noted have been VK5QI on **14018** at 0727 and VK5RG on **14040** at 0720.

● NIGERIA

5N2AAK has recently been very active on 14MHz CW, being heard on **14018** at 0725 working into the U.K.

● HONDURAS

HR2WTA has been logged several times on 14MHz SSB around **14200** during the evenings - from 2100 onwards.

● SAN MARINO

9A1T has been heard using CW on **21040** at 2015 busily working 'strings' of U.S.A. stations.

● REUNION IS.

FR7ZW is very active on 21MHz SSB and has been heard using **21240** at 1215.

● HAITI

HH9AR was recently heard on **14018** at 1950 using CW and busily working into the U.S.A.

● SOUTH AFRICA

ZS410 is very active on 21MHz using SSB. Logged on **21120** at 1840.

● GIBRALTAR

The Rock can be heard in the form of ZB2AV on 14MHz CW. Heard on **14025** at 0830 warding off a 'pile-up' of U.S.A. stations calling him.

★ BROADCAST BANDS

● ETHIOPIA

ETLF 'Voice of the Gospel', Addis Ababa, now broadcasts in English from 0530 to 0555 to West Africa on **11850** (100kW); in English from 1300 to 1325 to Ceylon on **15315** (100kW); in English from 1330 to 1345 to India on **15315**; from 1655 to 1710 for local consumption on **6065** (100kW) and from 1930 to 2115 in English to West Africa on **11910** (100kW).

● ALBANIA

Radio Tirana can be heard with programmes in English at 0630 on **9505** (50/500kW); at 0000 on **9750** (50/500kW) and at 0700 and 1400 on **11975** (50/500kW).

● CEYLON

The Commercial Service in English from Colombo can now be heard on the new channel of **6075** in parallel with the usual **5020** (10kW) outlet.

● LESOTHO

This country has been reported for the first time on the short waves operating on **4805** at 1810 by a South African listener. Power is suspected to be 10kW.

● TANZANIA

Radio Tanzania is reported to have a new outlet on **6105**, being heard with the news in English at 1600.

● SEYCHELLES

FEBA Victoria is reported to have been heard on **15265** in parallel with the usual **15185** (50kW) channel from 1400 to 1440.

Acknowledgements: - Our Listening Post, SCDX. ■

LATER NEWS

AFGHANISTAN

Radio Kabul has been reported radiating a programme in German at 1730 on **11790** and **15255kHz**.

PHILIPPINES

FEBC has been heard with a programme in German on Mondays, Wednesdays and Fridays from 0315 to 0330 on **15300kHz** (10/50kW).

South East Asia Radio Voice, Manila, is reported to have daily test transmissions from 1430 to 1450 on **15145kHz**.

AUSTRALIA

Radio Australia is now broadcasting to Europe from 0645 to 0745 on **15125kHz**. **11755kHz** is added at 0700.

LIBERIA

ELWA Monrovia broadcasts to West Africa in English and other languages from 0615 to 0745 on **11950** (50kW); from 0615 to 0815 on **4770** (10kW); from 1645 to 2255 on **4770** and from 2000 to 2100 on **11940kHz**.

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(Continued on page 641)

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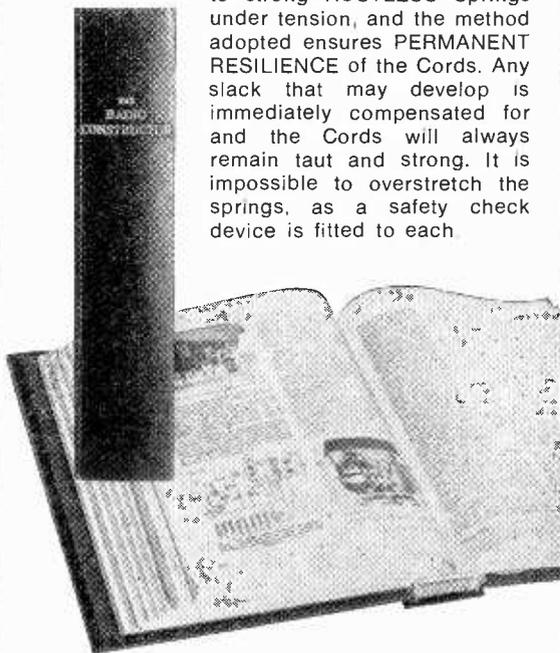
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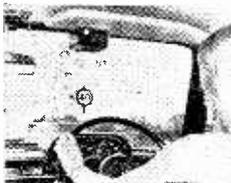
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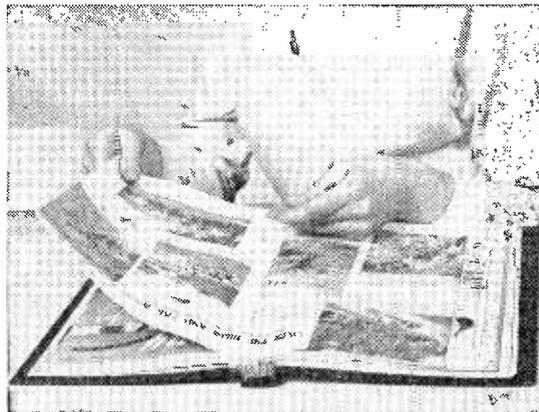
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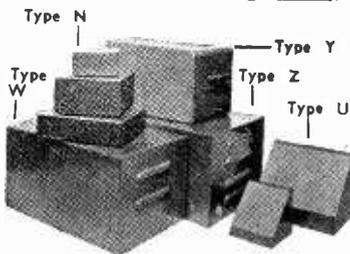
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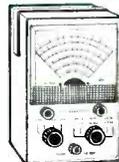
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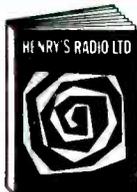
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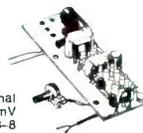
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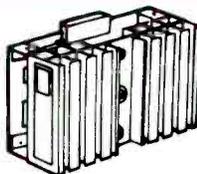
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SIMPLICITY TO MOUNT - EASY TO USE - DESIGNED FOR QUALITY, PERFORMANCE AND PRICE.

All units no soldering - just edge connectors and plugs.



25 WATT & 50 WATT SILICON AMPLIFIERS LOOK AT THE SPECIFICATIONS!

- At full power 0.3% distortion.
- At full power - 10dB 11 c/s to 40 kc/s
- Response - 10dB 11 c/s to 100 kc/s.
- Rise time 2µ sec.
- Short circuit proof.
- Virus limiting cct.

FREE LEAFLET
No. 25 on request

PA 25 10 transistor all silicon differential input 400 mV sensitivity 25 watts Rms into 8 ohms. Supplied with edge connector harness size 5" x 3" x 2"

PA 50 12 transistor version 50 watts Rms into 3 to 4 ohms. Size 5" x 3" x 4"

MU 442. Power supply for one or two PA 25 or one PA 50.

PA25 £7.50 PA50 £9.50 MU442 £6.00 p.p. 20p each

AS SPECIFIED FOR MANY
"PRACTICAL WIRELESS" 1970 PROJECTS

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