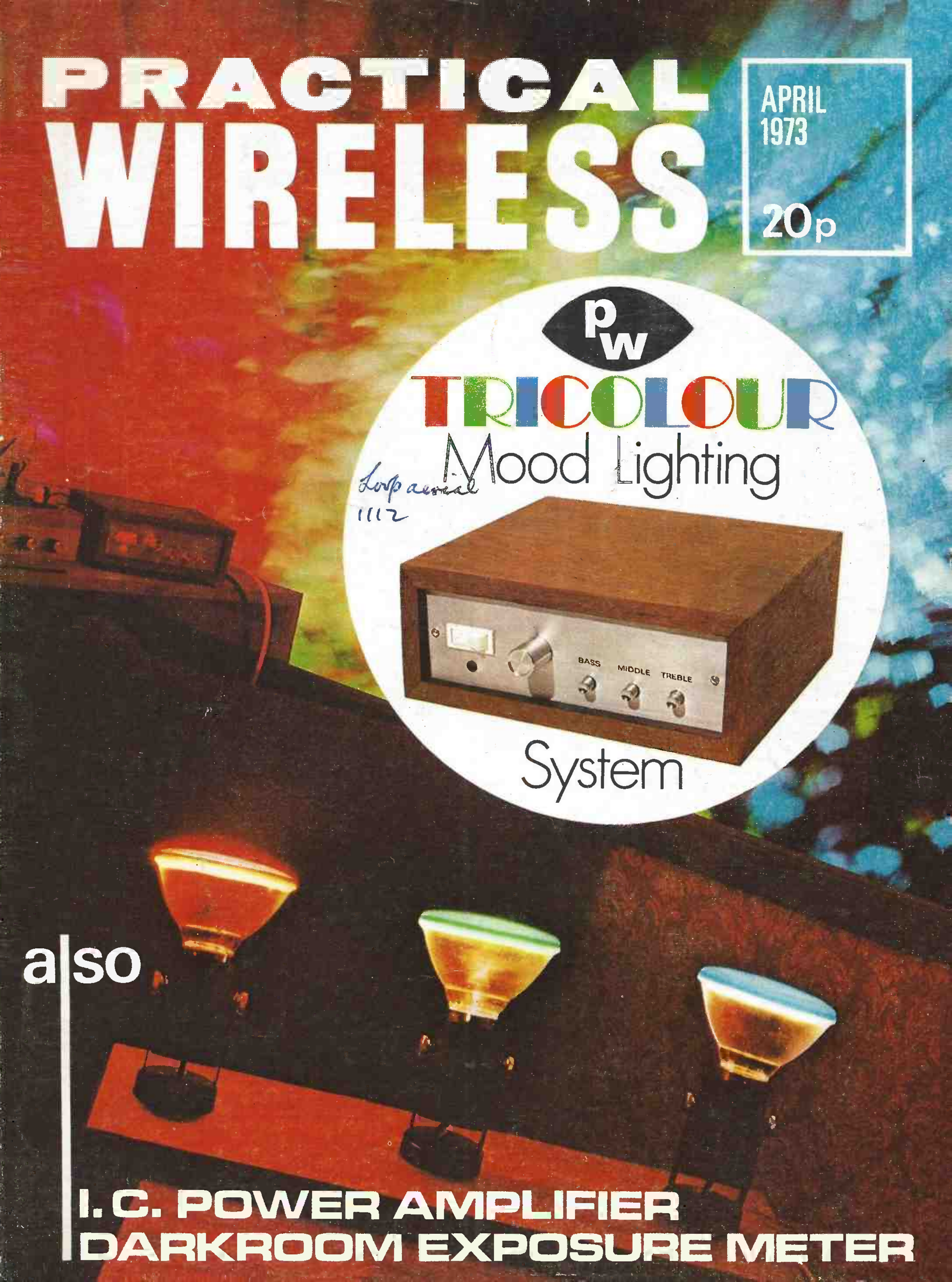
PRACTICAL WIRELESS

APRIL 1973

20p



pw TRICOLOUR Mood Lighting System

Loop aerial
1112

also

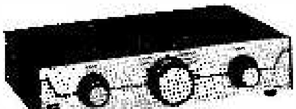
I.C. POWER AMPLIFIER

DARKROOM EXPOSURE METER

TOP QUALITY — LOW COST

AMATEUR RADIO EQUIPMENT

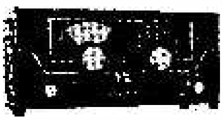
CODAR



P.R.40

SOLID STATE
R.F. PRESELECTOR

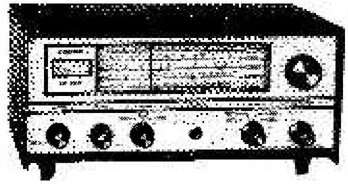
The PR40 R.F. Preselector is the solid state version of the world famous PR30 which it now supercedes.
It employs Silicon "N" Channel FET (Field Effect Transistor) front end, followed by silicon NPN Broad Band R.F. Amp., and will substantially improve receiver performance over the range 1·5 to 35 MHz, providing a considerable increase in gain up to an overall average of 30 dB, with improved image rejection and noise ratio.
Supplied complete with co-ax plug (less standard 9 volt PP6 Battery), 12 months Guarantee . . . **£8·90** Carriage 30p.



MULTIBAND—6

SOLID STATE
SHORT WAVE RECEIVER KIT

All transistor T.R.F. Receiver tunes 550 KHz to 30 MHz (540 to 10 metres) complete coverage—no gaps. Medium waves—Trawlers—Ship/Shore Telephone—All Six Amateur Bands 160-10 metres—International Broadcast from Australia, Far East, Russia, USA etc. using 4 miniature plug in Coils.
Hi-Gain FET Regen. Det./AF/AF Module giving full loudspeaker output to any external 2/3 ohm speaker. Receives AM/CW/SSB.
Separate Electrical Bandspread, Calibrated Main Tuning.
A Quality CODAR-KIT with 12 months Guarantee. No technical knowledge required, simple to build, printed circuit and Pictorial Instruction Manual, fully detailed step by step.
Complete Kit with 4 Coils (less standard PP6 battery). **£13·20** Carriage 35p.
Stamp brings illutrated leaflets.



CR70A

COMMUNICATION RECEIVER

The CODAR CR70A is an outstanding general coverage communication receiver, ideal for the keen S.W.L.
It tunes from 540 metres medium through to 10 metres with no gaps. Covers shipping, coastguard and distress frequencies, all six amateur bands 160-10 metres, International broadcast, Met. stations etc. etc. giving world-wide reception. Exclusive features include Air-spaced CODAR-COIL Hi-"Q" Aerial input, illuminated Meter and Slide Rule Scale, Two Speed vernier tuning, Switched B.F.O. for CW/SSB signals. Separate output for Tape recorder.
Ready to plug in to 200/240 volts A.C. it only needs your aerial and a 2/3 ohm loudspeaker to bring the world to your finger tips. 12 months full guarantee.
Complete ready built £27·50, Carriage 70p.

SEND FOR YOURS TODAY!

NOTE: These CODAR Receivers meet the B.R.E.M.A. specification for Communication Receivers and are FREE of Purchase Tax. Some portable receivers being advertised as Communication Receivers do not meet these requirements.

ON THE DESIGN STAFF—
G3SZM G3IRE

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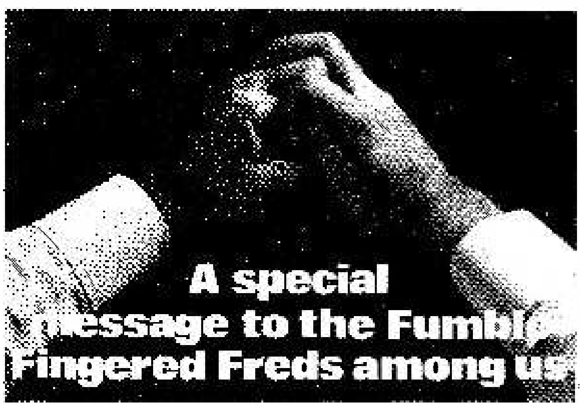

NEW STEPHENSPEAKERS

A new range of loudspeaker kits and cabinets with a style and specification for every purpose. You'll be cheating a bit if you tell your friends "made it myself".
We supply superb craftsmen built fully finished cabinets in beautiful stain and scuff resistant vinyl in white or teak.
Just fit the speaker cloth (supplied) and screw in your speaker.

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SCORPIO CAPACITOR DISCHARGE IGNITION SYSTEM (P.E. Nov. 1971)
Complete kit with full instruction data **£9·50**

"MUSIC MAKER" ORGAN KIT (P.W. Dec. 1972)
Kit includes only capacitors, semiconductors, switches, preset and loudspeaker. **£2·80 OR**
COMPLETE kit including above plus resistors, PC board and box **£4·40**

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Kit of resistors, Capacitors, Transistors, Diodes, Potentiometer and I.C. **£4·95**

LIGHT DIMMER kit contains all parts including circuit and construction data. Fully suppressed, 480 Watts **£2·10**

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Complete kit (less MK box, plate and socket) **£1·05**
Complete kit including MK box, plate and socket **£2·20**

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We are also able to supply other kits for articles published in *Practical Wireless* and other Electronic magazines. Send for details of other kits available. Please enclose a stamped addressed Envelope.

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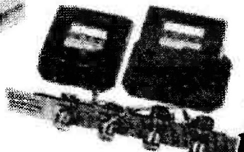
UNISOUND FOR THE NEW SOUND

AT **£26·12** INC. VAT

It's the RT-VC system that screws together to save you pounds! Unisound comprises two superb speakers and an amplifier/record deck plinth—all beautifully finished in simulated teak. The stereo amplifier (4 watts per channel into 8 ohms) is based on the famous Mullard Unilex system brought up-to-date by RTVC using intergrated circuits. Turntable is the proven Garrard 2025TC complete with stereo cartridge and tinted acrylic cover. Speakers are big EMI Twin-cone units all ready for mounting in their elegant cabinets, which simply need screwing and glueing together. Easy step-by-step instructions. **£26·12 complete plus £1·40 packing + £1·40 post.** Diamond Stylus £1·25 extra. Stereo headphones with adaptor £4 extra. Send for leaflet.

AN RTVC EXCLUSIVE DESIGN



UNISOUND MODULES ONLY £6·95 + 50p. p. & p.
For the man who wants to design his own stereo—here's your chance to start, with Unisound—pre-amp, power amplifier and control panel. No soldering—just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips **very low distortion at all power levels. over the audio spectrum.**

RTVC No price in

If you can solder on printed circuit board, you can build this push-button car radio kit. It's simple—just follow the step-by-step instructions.

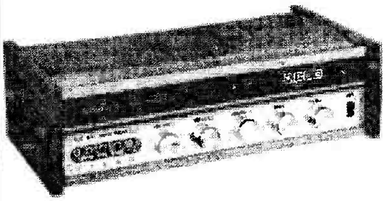
THE TOURIST PB CAR RADIO KIT
AN INCREDIBLE BUY ONLY FROM RTVC

£7·70 inc. vat

The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8ohms speaker. But the Tourist PB will operate into any loudspeaker from 8 to 15 ohms.
Apart from the output stage, which is an intergrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.
The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale. Chassis size is: 7" wide, 2" high and 4 15/16" deep.

* Circuit diagram and comprehensive instructions 50p free with parts.
* Fully retractable lockable car aerial £1·25 post paid.

PRICE ONLY £7·70 p. and p. 55p
Speaker with baffle and fixing strips £1·50. 25 p. & p., post free if bought with the kit. Send for leaflet.



RELIANT MkIV

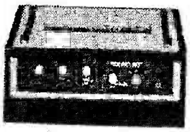
A GOOD QUALITY AMPLIFIER—12 Watts £10·50 (inc. VAT). 20 Watts £13·50 (inc. VAT)

*5 Electrically Mixed inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling INPUTS 1. Crystal Mic or Guitar 9mV. 2. Moving coil Mic. or Guitar 8mV Inputs. 3, 4 & 5 are suitable for a wide range of medium output equipment (Gram. Tuner, Monitor, Organ, etc.) All 250mV sensitivity. Power output: 12/20 watts into 8 ohms. Size approx. 12¼ x 6 x 3½ ins.

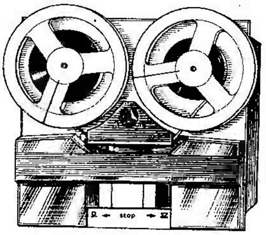
12W version **£10·50** plus 60p p & p
20W version **£13·50**

SOUND 50

50 WATT AMPLIFIER. Output Power: 45 watts R.M.S. (Sine Wave) Frequency Response 3dB points 30Hz and 18KHz. Total Distortion: less than 2% at rated output. Signal to noise ratio: better than 60dB. Bass Control Range: 13dB at 60Hz. Treble Control Range: 12dB at 10KHz. Inputs: 4 inputs at 5mV into 470K. Each pair of inputs conrotlled by separate volume control. 2 inputs at 200mV into 470K. Size: 19¼ x 10⅓ x 8ins. Amplifier £31·85 plus £1·50 p. and p.



£38·51 (inc. VAT)



PE TAPE LINK CONSTRUCTORS
Suitable 3 speed tape deck, less leads. Caters up to 7ins. spools. Unused but store soiled hence no warranty.

£8 plus £1 p & p

* Denotes VAT has been absorbed in the price without increase on VISCOUNT audio systems.

crease* with VAT!

PRICES: SYSTEM I

Viscount III R 101 amplifier	£24·20 + £1 p & p
2 Duo Type II speakers	£15·40 + £2·20 p & p
Garrard SP25 Mk.III with MAG. cartridge plinth & cover	£25·00 + £1·75 p & p
total	£64·60

Available complete for only **£52*** + £3·50 p & p

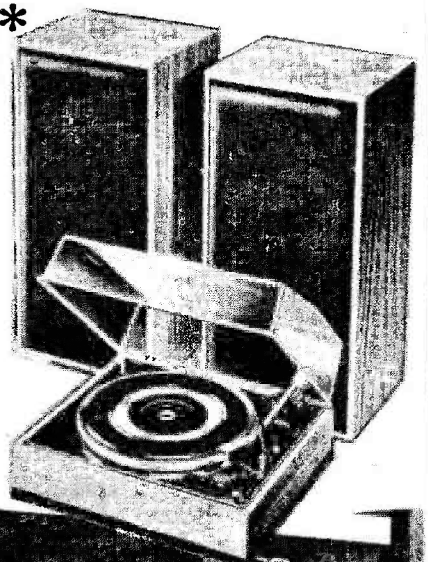
PRICES: SYSTEM 2

Vicount R 101 amplifier	£24·20 + £1 p & p
2 Duo Type III speakers	£35·20 + £3·30 p & p
Garrard SP25 Mk. III with MAG. cartridge plinth & cover	£25·00 + £1·75 p & p
total	£84·40

Available complete for **£69*** + £4 p & p

VISCOUNT III AUDIO STILL ONLY £52*

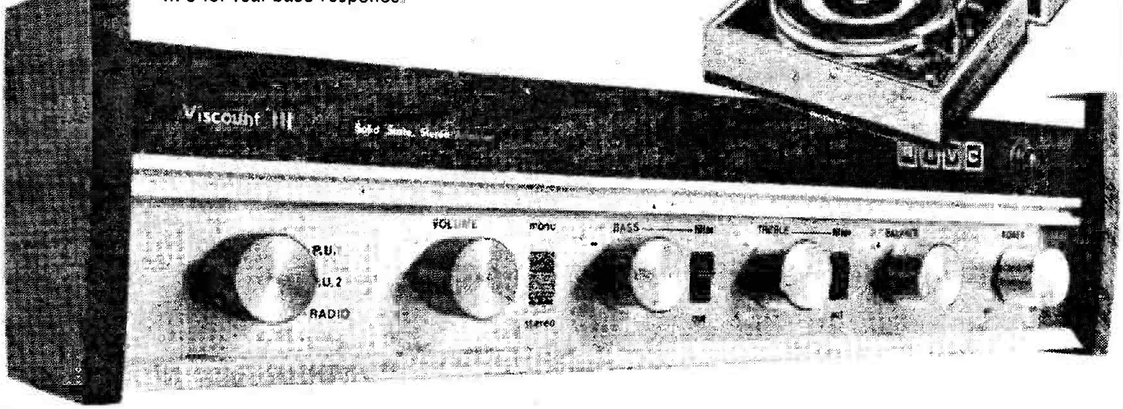
COMPLETE



14 + 14w. r.m.s. 40Hz to 40kHz ± 3dB. Total distortion at 10w. at 1kHz - 0·1%. This is real value for money! We have designed 2 systems and the heart of them both is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet. FET's (Field effect, transistors) are incorporated on the input stages, just like top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder.

For both systems we have chosen the famous Garrard SP25 Mk. III deck, with fitted magnetic cartridge, which comes complete with simulated teak plinth and tinted acrylic cover.

The exclusive Duo loudspeaker systems are incomparable for quality within their price range. Large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.



SPEAKERS: Duo Type II Size approx. 17in. × 10¾in. × 6¾in. Drive unit 13in. × 8in. with parasitic tweeter. Max. power 10 watts ohms. Simulated Teak cabinet. £15·40 a pair (inc. VAT), £3·30 p. and p. Duo Type III Size approx. 23½in. × 11½in. × 9½in. Drive unit 13½in. 8¼in. with H.F. speaker. Max. power 20 watts ohms. Freq. range 20Hz to 20KHz. Teak veneer cabinet.
SPECIFICATION R101: 14 watts per channel into 3 to 4 ohms (suitable 3–15 ohms.) Total distortion @ 10W 1kHz @ 0·1%. P.U.1 (for ceramic cartridges) 150mV into 3 Meg. P.U.2 (for magnetic cartridges) 4mV @ 1kHz into 47K equalised within idB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. Signal-to-noise ratio: (all controls at max.)—P.U.I. and radio —65dB, P.U.2 —58dB. Cross talk better than —35dB on all inputs. Size approx. 13¾in. × 9in. × 3¾in. Send S.A.E. for fully illustrated brochure. 12 month's written guarantee.

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1D5	50
1H5	50
IN5GT	55
IR5	40
IS4	30
IS5	30
IT4	30
3A4	40
3Q4	50
3Q5	50
3S4	35
3V4	48
5R4GY	75
5U4G	35
5V4G	45
5Y3GT	40
5Z4G	40
6/30L2	80
6A7	75
6A8G	40
6AK5	35
6AM5	35
6AM6	33
6AQ5	38
6AS7G	85
6AT6	35
6AU6	25
6B4G	£1·00
6B8G	25

Type	Price
6BA6	25
6BE6	30
6BH6	75
6BJ6	50
6BQ7A	45
6BR7	90
6BR8	70
6BS7	£1·30
6BW6	85
6BW7	80
6C4	33
6C5G	35
6C6	25
6CD6G	£1·25
6CH6	60
6CW4	65
6D6	35
6E5	£1·00
6F1	70
6F5G	90
6F6G	35
6F8G	50
6F11	40
6F13	45
6F14	70
6F23	85
6F24	75
6F25	£1·00
6F28	65
6F32	25
6G6	35
6H6	23
6J5M	50
6J5G	20
6J5GT	30

Type	Price
6J6	20
6J7M	45
6J7G	30
6J7GT	45
6K6GT	60
6K7M	35
6K7G	35
6K7GT	35
6K8M	60
6K8G	40
6K8GT	50
6K25	75
6L6G	50
6L18	45
6Q7G	40
6Q7GT	43
6SA7M	40
6SC7M	75
6SG7M	40
6SH7M	40
6SJ7GT	30
6SK7GT	40
6SL7GT	35
6SN7GT	35
6SQ7GT	40
6U4GT	65
6U5G	£1·00
6V6M	60
6V6G	30
6V6GT	40
6X4	35
6X5G	40
6X5GT	40
7B6	70
7B7	50

Type	Price
7C5	£1·13
7C6	75
7D5	60
7H7	50
7R7	75
7S7	£2·25
7Y4	65
9BW6	60
10C2	63
10F1	75
10F3	90
10F9	60
10F18	50
10LD11	65
10P13	60
11E3	£4·00
12AT6	30
12AT7	35
12AU6	35
12AU7	30
12AX7	30
12BA6	40
12BE6	40
12C8GT	35
12E1	£3·00
12J5GT	30
12J7GT	50
12K7GT	40
12K8GT	50
12Q7GT	40
12SA7GT	50
12SG7	35
12SH7	35
12SJ7	40
12SK7	50

Type	Price
12SR7	40
14H7	50
19AQ5	50
20D1	50
20F2	70
20L1	£1·10
20P1	£1·10
20P5	£1·20
25A6	35
25L6GT	50
25Y5	65
25Z4	30
25Z5GT	55
25Z6	65
30C1	30
30C15	80
30C17	90
30C18	80
30F5	85
30FL1	75
30FL12	£1·20
30FL14	85
30L15	85
30L17	80
30P4	£1·12
30P12	80
30P19	85
30PL1	75
30PL13	93
30PL14	90
35A5	75
35L6	50
35W4	35
35Z3	70
35Z4GT	60
35Z5	50

Type	Price
37	40
42	50
50B5	50
50C5	50
50CD6G	£1·20
50L6GT	55
75	50
78	45
80	55
85A2	50
150B2	60
150C4	60
801	60
807	50
813CSA	£3·75
866A	75
954	60
1625	55
4022AR	£5·50
5763	70
7193	30
7475	50
A61	·48
ATP4	45
ATP5	60
ATP7	60
AU2	£4·00
AU5	75
AZ1	55
AZ31	55
CBL31	£1·00
CCH35	·75
CL33	£1·30
CY30	63
CY31	43
DAC32	50

Type	Price
DAF91	30
DAF96	45
DCC90	£1·35
DF33	55
DF70	45
DF91	30
DF92	20
DF96	45
DH3-91	£7·00
DH77	35
DK32	45
DK91	40
DK92	55
DK96	50
DL66	£1·25
DL92	35
DL93	40
DL94	48
DL95	50
DL96	45
DM70	45
DY86	33
DY87	33
E88CC	65
EA50	20
EABC80	35
EAF42	55
EB91	20
EBC33	50
EBC41	55
EBC90	35
EBF80	40
EBF83	40
EBF89	30
EBL1	£1·00
EBL21	60

Type	Price
EBL31	£1·50
EC90	33
ECC81	35
ECC82	30
ECC83	30
ECC84	30
ECC85	40
ECC88	40
ECH21	63
ECH35	£1·00
ECH42	75
ECH81	30
ECH83	45
ECL80	45
ECL82	35
ECL83	70
ECL86	40
ECLL800	£1·65
EF9	75
EF37A	£1·20
EF39	60
EF41	65
EF50	25
EF52	£1·25
EF80	25
EF85	35
EF86	30
EF89	28
EF91	33
EF92	35
EF98	75
EF183	30
EF184	35
EL32	50
EL33	£1·75

Type	Price
EL34	50
EL41	60
EL42	65
EL84	25
EL95	35
ELL80	£1·00
EM80	45
EM81	60
EM84	35
EY51	40
EY86	40
EZ35	40
EZ40	50
EZ41	50
EZ80	27
EZ81	29
GY501	80
GZ30	40
GZ32	48
GZ34	60
HN309	£1·50
KT36	£1·00
KT61	£1·25
KT66	£2·05
KT81	£1·75
KT81(7C5)	£1·13
KT88	£2·00
KTW61	£1·75
KTZ41	50
ML4	88
ML6	40
MSP4	50
MU14	75
MX40	63

Type	Price
N78	£1·50
N108	£1·50
OA2	38
OC3	38
OZ4	40
PC86	60
PC88	60
PC97	50
PCC84	40
PCC89	50
PCC189	55
PCF80	30
PCF82	35
PCF84	60
PCF86	60
PCF801	50
PCF802	50
PCF805	80
PCF806	70
PCF808	85
PCL82	35
PCL83	65
PCL84	45
PCL85	40
PCL86	45
PD500	£1·30
PENA4	£1·00
PENB4	£1·00
PEN45	75
PEN46	40
PL36	55
PL81	50
PL82	45
PL83	45
PL84	40

Type	Price
PL500	80
PL504	80
PL508	90
PL509	£1·10
PL802	95
PX4	£2·50
PX25	£2·50
PY33	63
PY81	30
PY82	35
PY83	38
PY500	£1·00
PY800	40
PY801	50
R2	75
R19	50
S130	£1·75
SP4	50
SP41	£3·00
SP61	75
STV280/80	£10·00
SU25	£1·00
SC2150	75
T41	£1·00
TDD4	60
U10	75
U14	75
U19	£3·00
U25	80
U26	80
U78	35
U191	75
U251	80
U301	63

Type	Price
U403	60
U404	60
U801	£1·18
UABC80	40
UAF42	55
UBC41	50
UBC81	40
UBF80	40
UBF89	35
UCC84	43
UCC85	40
UCF80	55
UCH42	70
UCH81	40
UCL82	35
UCL83	60
UF41	60
UF89	40
UL41	65
UL84	40
UM80	30
UU9	50
UY21	50
UY41	48
UY85	40
VMP4G	85
VP4B	£1·25
VR105/30	38
VR150/30	35
VU111	75
VU120	£1·00
VU508	£3·00
W81M	63
Y63	£1·25

Transistors

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
				AC128	20	BY100	15	NKT713	25	OC44	17
				ACY20	20	BZY88	15	OA70	10	OC45	12
				ACY39	50	CRS1-40	47	OA71	10	OC57	60
1N914	07	2N2219	20	AD140	50	DD003	15	OA81	08	OC58	60
1S113	25	2N2369A	15	AD149	50	GET102	30	OA85	12	OC59	65
1S202	23	2N2444	£1·91	AD161	37	GET882	25	OA91	07	OC71	12
2G302	22	2N2646	45	AF115	25	GJ7M	37	OA211	30	OC72	20
2G371	22	2N2904	20	AF117	25	KS100A	20	OAZ201	50	OC81	20
2N404	20	2N2926	10	ASY26	25	MJE520	87	OAZ207	47	OC81D	20
2N697	15	2N3055	75	BC107	10	MJE2955	£1·37	OAZ210	32	OC82	25
2N706	10	2N3702	10	BC108	10			OAZ222	45	OC82D	20
2N1132	25	2N3819	35	BC109	10	MJE3055	87	OAZ224	45	OC84	25
2N1305	22	AAZ12	30	BC169C	15	NKT212	27	OAZ241	22	OC170	25
2N2147	75			BFS98	28	NKT214	15	OAZ242	23	OC171	30
2N2160	60	AC126	20	BFY50	22	NKT223	33	OAZ246	23	OC200	40
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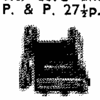

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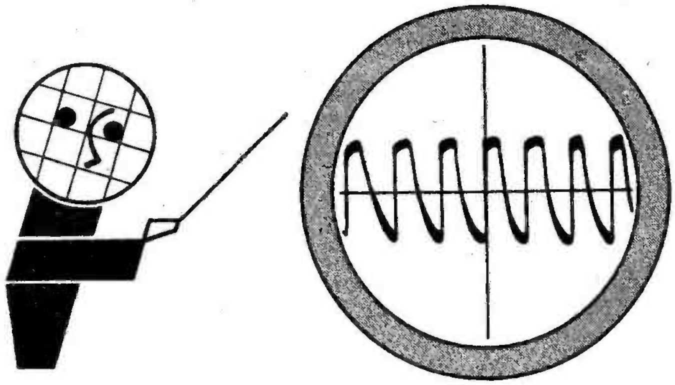

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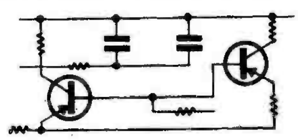

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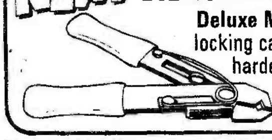

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AC137	0·14	AF125	0·25	BC161	0·50	BD185	0·65	BF263	0·55	OC41	0·20	2N388	0·35	2N2712	0·21	2N3405	0·42	2N4291	0·17
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AC167	0·20	ASY26	0·25	BC179	0·19	BD205	0·80	BFX88	0·22	OC81D	0·15	2N706	0·08	2N2925	0·14	2N3707	0·11	2S305	0·84
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AC178	0·28	ASY51	0·25	BC183	0·10	BF115	0·24	BPX25	0·85	OC139	0·20	2N718	0·24	2N2926 (O)		2N3819	0·28	2S322A	0·42
AC179	0·28	ASY52	0·25	BC183L	0·10	BF117	0·45	BSX19	0·15	OC140	0·20	2N718A	0·50		0·10	2N3820	0·50	2S323	0·56
AC180	0·17	ASY54	0·25	BC184	0·12	BF118	0·70	BSX20	0·15	OC169	0·25	2N726	0·28	2N2926 (R)		2N3821	0·35	2S324	0·70
AC180K	0·20	ASY55	0·25	BC184L	0·12	BF119	0·70	BSY25	0·15	OC170	0·25	2N727	0·28		0·10	2N3823	0·28	2S325	0·70
AC181	0·17	ASY56	0·25	BC186	0·28	BF121	0·45	BSY26	0·15	OC171	0·25	2N743	0·20	2N2926 (B)		2N3903	0·28	2S326	0·70
AC181K	0·20	ASY57	0·25	BC187	0·28	BF123	0·50	BSY27	0·15	OC200	0·25	2N744	0·20		0·10	2N3904	0·30	2S327	0·70
AC187	0·22	ASY58	0·25	BC207	0·11	BF125	0·45	BSY28	0·15	OC201	0·28	2N914	0·14	2N3010	0·70	2N3905	0·28	2S701	0·42
AC187K	0·20	ASZ21	0·40	BC208	0·11	BF127	0·50	BSY29	0·15	OC202	0·28	2N918	0·30	2N3011	0·14	2N3906	0·27	40361	0·40
AC188	0·22	BC107	0·09	BC209	0·12	BF152	0·55	BSY38	0·18	OC203	0·25	2N929	0·21	2N3053	0·17	3N4058	0·12	40362	0·45
AC188K	0·20	BC108	0·09	BC212L	0·11	BF153	0·45	BSY39	0·18	OC204	0·25	2N930	0·21						
ACY17	0·25	BC109	0·10	BC213L	0·11	BF154	0·45	BSY40	0·28	OC205	0·35	2N1131	0·20						
ACY18	0·20	BC113	0·10	BC214L	0·14	BF155	0·70	BSY41	0·28	OC309	0·40	2N1132	0·22						
ACY19	0·20	BC114	0·15	BC225	0·25	BF156	0·48	BSY95	0·12	P346A	0·20	2N1302	0·14						
ACY20	0·20	BC115	0·15	BC226	0·35	BF157	0·55	BSY95A	0·12	P397	0·42	2N1303	0·14						
ACY21	0·20	BC116	0·15	BCY30	0·24	BF158	0·55	Bu105	2·00	OCP71	0·48	2N1304	0·17						
ACY22	0·16	BC117	0·15	BCY31	0·26	BF159	0·60	C111E	0·50	ORP12	0·43	2N1305	0·17						
ACY27	0·18	BC118	0·10	BCY32	0·30	BF160	0·40	C400	0·30	ORP60	0·40	2N1306	0·21						
ACY28	0·19	BC119	0·30	BCY33	0·22	BF162	0·40	C407	0·25	ORP61	0·40	2N1307	0·21						
ACY29	0·35	BC120	0·80	BCY34	0·25	BF163	0·40	C424	0·20	ST140	0·12	2N1308	0·23						
ACY30	0·28	BC125	0·12	BCY70	0·14	BF164	0·40	C425	0·50	ST141	0·17	2N1309	0·28						
ACY31	0·28	BC126	0·18	BCY71	0·18	BF165	0·40	C426	0·35	TI843	0·30	2N1613	0·20						
ACY34	0·21	BC132	0·12	BCY72	0·14	BF167	0·22	C428	0·20	UT46	0·27	2N1711	0·20						
ACY35	0·21	BC134	0·18	BCZ10	0·20	BF173	0·22	C441	0·30	2G301	0·09	2N1889	0·32						
ACY36	0·28	BC135	0·12	BCZ11	0·25	BF176	0·35	C442	0·30	2G302	0·19	2N1890	0·45						
ACY40	0·17	BC136	0·15	BCZ12	0·25	BF177	0·35	C444	0·35	2G303	0·19	2N1893	0·37						
ACY41	0·18	BC137	0·15	BD121	0·60	BF178	0·30	C450	0·22	2G304	0·24	2N2147	0·72						
ACY44	0·35	BC139	0·40	BD123	0·65	BF179	0·30	MAT100	0·19	2G306	0·40	2N2148	0·57						
AD130	0·38	BC140	0·30	BD124	0·60	BF180	0·30	MAT101	0·20	2G308	0·35	2N2160	0·60						
AD140	0·48	BC141	0·30	BD131	0·50	BF181	0·30	MAT120	0·19	2G309	0·35	2N2192	0·35						
AD142	0·48	BC142	0·30	BD132	0·60	BF182	0·40	MAT121	0·20	2G339	0·20	2N2193	0·35						
AD143	0·38	BC143	0·30	BD133	0·65	BF183	0·40	MPF102	0·42	2G339A	0·16	2N2194	0·35						
AD149	0·50	BC145	0·45	BD135	0·40	BF184	0·25	MPF104	0·37	2G344	0·18	2N2217	0·22						
AD161	0·33	BC147	0·10	BD136	0·40	BF185	0·30	MPF105	0·37	2G345	0·16	2N2218	0·20						

DIODES AND RECTIFIERS

AA119	0·08	BY133	0·21	OA10	0·35
AA120	0·08	BY164	0·50	OA47	0·07
AA129	0·08	BYX38/30		OA70	0·07
AAY30	0·09		0·42	OA79	0·07
AAZ13	0·10	BYZ10	0·35	OA81	0·07
BA100	0·10	BYZ11	0·30	OA85	0·09
BA116	0·21	BYZ12	0·30	OA90	0·06
BA126	0·22	BYZ13	0·25	OA91	0·06
BA148	0·14	BYZ16	0·40	OA95	0·07
BA154	0·12	BYZ17	0·35	OA200	0·06
BA155	0·14	BYZ18	0·35	OA202	0·07
BA156	0·13	BYZ19	0·28	SD10	0·05
BY100	0·15	CG62		SD19	0·05
BY101	0·12	(Eg) OA91		IN34	0·07
BY105	0·17		0·05	IN34A	0·07
BY114	0·12	CG651		IN914	0·06
BY126	0·14	(Eq) OA70-		1N916	0·06
BY127	0·15	OA79	0·06	IN414B	0·06
BY128	0·15	OA5	0·35	IS021	0·10
BY130	0·16	OA5SL	0·21	IS951	0·06

NEW COMPONENT PAK BARGAINS

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

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

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MIXED ELECTRONIC COMPONENTS
Exceptionally good value

Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1·50 only.

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3 Watts

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£2·63 each

Modual Tested and Guaranteed. Qty. 1—9 £2·63; 10—25 £2·28 Price each. Larger quantities quoted on request. Full hook-up diagrams and complete technical data supplied free with each modual or available separately at 10p each.

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

PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0·23	0·25	0·35	0·35	0·47	0·50	0·53	1·15
100	0·25	0·33	0·47	0·47	0·50	0·58	0·63	1·40
200	0·35	0·37	0·49	0·49	0 57	0·61	0·75	1·60
400	0·43	0·47	0·56	0·56	0·67	0·75	0·93	1·75
600	0·53	0·57	0·68	0·68	0·77	0·97	1·25	—
800	0·63	0·70	0·80	0·80	0·90	1·20	1·50	4·00

SIL. RECTS. TESTED

PIV	300mA	750mA	1A	1·5A	3A	10A	30A
50	0·04	0·05	0·05	0·07	0·14	0·21	0·60
100	0·04	0·06	0·05	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·25	0·34	0·45	1·86
800	0·10	0·17	0·11	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·14	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·38	0·57	0·75	—

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VBOM	2A TO-1	6A TO-66	10A TO-88
	£p	£p	£p
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200	50	60	90
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T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All 50p each pak

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2-33V. 400mV (DO-7 Case) 13p ea. 1½W (Top-Hat) 18p ea. 10W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

10 amp POTTED BRIDGE RECTIFIER on heat sink. 100PIV. 90p each

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Plastic Encapsulated 2 Amp. BRIDGE RECTS.

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100 v RMS	37p ,,
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Size 15 mm × 6 mm.

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All usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

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50	For	1·00
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500	For	7·50
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40PIV(Min.)	100..1·50
Sub-Min.	500..5·00
Full Tested	1,000..9·00

Ideal for Organ Builders.

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U 4	40	Germanium Transistors like OC81, AC128	0·50
U 5	60	200mA Sub-Min. Silicon Diodes	0·50
U 6	30	Sil. Planar Trans. NPN like BSY95A. 2N706	0·50
U 7	16	Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0·50
U 8	50	Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0·50
U 9	20	Mixed Voltages, 1 Watt Zener Diodes	0·50
U10	20	BAY50 charge storage Diodes DO-7 Glass	0·50
U11	25	PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0·50
U12	12	Silicon Rectifiers Epoxy 500mA up to 800 PIV	0·50
U13	30	PNP-NPN Sil. Transistors OC200 & 2S 104	0·50
U14	150	Mixed Silicon and Germanium Diodes	0·50
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U17	30	Germanium PNP AF Transistors TO-5 like ACY 17-22	0·50
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U20	12	1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0·50
U21	30	AF. Germanium Alloy Transistors 2G300 Series & OC71	0·50
U23	30	MADT's like MHz Series PNP Transistors	0·50
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U26	30	Fast Switching Silicon Diodes like IN914 Micro-Min.	0·50
U27	12	NPN Germanium AF Transistors TO-1 like AC127	0·50
U29	10	1 Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600	1·00
U30	15	Plastic Silicon Planar Trans. NPN 2N2926	0·50
U31	20	Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0·50
U32	25	Zener Diodes 400mW DO-7 case 3-18 volts mixed	0·50
U33	15	Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0·50
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U35	25	Silicon Planar Transistors PNP TO-18 2N2906	0·50
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Code No's. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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Q6	5	OC 72 transistors	0·50
Q7	4	AC 128 transistors PNP high gain	0·50
Q8	4	AC 126 transistors PNP	0·50
Q9	7	OC 81 type transistors	0·50
Q10	7	OC 71 type transistors	0·50
Q11	2	AC 127/128 Complementary pairs PNP/NPN	0·50
Q12	3	AF 116 type transistors	0·50
Q13	3	AF 117 type transistors	0·50
Q14	3	OC 171 H.F. type transistors	0·50
Q15	7	2N2926 Sil. Epoxy transistors mixed colours	0·50
Q16	2	GET880 low noise Germanium transistors	0·50
Q17	5	NPN 2 × ST.141 & 3 × ST.140	0·50
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Q19	3	MADT'S 2 × MAT 101 & 1 × MAT 121	0·50
Q20	4	OC 44 Germanium transistors A.F.	0·50
Q21	4	AC 127 NPN Germanium transistors	0·50
Q22	20	NKT transistors A.F. R.F. coded	0·50
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Q24	8	OA 81 diodes	0·50
Q25	15	IN914 Silicon diodes 75 PIV 75mA	0·50
Q26	8	OA95 Germanium diodes sub-min IN69	0·50
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Q28	2	Silicon power rectifiers BYZ 13	0·50
Q29	4	Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0·50
Q30	7	Silicon switch transistors 2N706 NPN	0·50
Q31	6	Silicon switch transistors 2N708 NPN	0·50
Q32	3	PNP Silicon transistors 2 × 2N1131, 1 × 2N1132	0·50
Q33	3	Silicon NPN transistors 2N1711	0·50
Q34	7	Silicon NPN transistors 2N2369, 500MHz (code P397)	0·50
Q35	3	Silicon PNP TO-5. 2 × 2N2904 & 1 × 2N2905	0·50
Q36	7	2N3646 TO-18 plastic 300 MHz NPN	0·50
Q37	3	2N3053 NPN Silicon transistors	0·50
Q38	7	NPN transistors 4 × 2N3703, 3 × 2N3702	0·50

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The MK Slide Rule, designed to simplify Electronic calculations features the following scales:—Conversion of Frequency and Wavelength. Calculation of L, C and fo of Tuned Circuits. Reactance and Self Inductance. Area of Circles. Volume of Cylinders. Resistance of Conductors. Weight of Conductors. Decibel Calculations. Angle Functions. Natural Logs and 'e' Functions. Multiplication and Division. Squaring, Cubing and Square Roots. Conversion of kW and Hp. A must for every electronic engineer and enthusiast. Size: 2 cm × 4cm. Complete with case and instructions. Price each: £3·35

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INTEGRATED CIRCUIT PAKS

Manufacturers "Fall Outs" which include Functional and Part-Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C's and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	=12 × 7400	0·50	UIC46	=5 × 7446	0·50	UIC86	=5 × 7486	0·50
UIC01	=12 × 7401	0·50	UIC47	=5 × 7447	0·50	UIC90	=5 × 7490	0·50
UIC02	=12 × 7402	0·50	UIC48	=5 × 7448	0·50	UIC91	=5 × 7491	0·50
UIC03	=12 × 7403	0·50	UIC50	=12 × 7450	0·50	UIC92	=5 × 7492	0·50
UIC04	=12 × 7404	0·50	UIC51	=12 × 7451	0·50	UIC93	=5 × 7493	0·50
UIC05	=12 × 7405	0·50	UIC53	=12 × 7453	0·50	UIC94	=5 × 7494	0·50
UIC06	=8 × 7406	0·50	UIC54	=12 × 7454	0·50	UIC95	=5 × 7495	0·50
UIC07	=8 × 7407	0·50	UIC60	=12 × 7460	0·50	UIC96	=5 × 7496	0·50
UIC10	=12 × 7410	0·50	UIC70	=8 × 7470	0·50	UIC100	=5 × 74100	0·50
UIC13	=8 × 7413	0·50	UIC72	=8 × 7472	0·50	UIC121	=5 × 74121	0·50
UIC20	=12 × 7420	0·50	UIC73	=8 × 7473	0·50	UIC141	=5 × 74141	0·50
UIC30	=12 × 7430	0·50	UIC74	=8 × 7474	0·50	UIC151	=5 × 74151	0·50
UIC40	=12 × 7440	0·50	UIC75	=8 × 7475	0·50	UIC154	=5 × 74154	0·50
UIC41	=5 × 7441	0·50	UIC76	=8 × 7476	0·50	UIC193	=5 × 74193	0·50
UIC42	=5 × 7442	0·50	UIC80	=5 × 7480	0·50	UIC199	=5 × 74199	0·50
UIC43	=5 × 7443	0·50	UIC81	=5 × 7481	0·50			
UIC44	=5 × 7444	0·50	UIC82	=5 × 7482	0·50	UICXI	=25 Assorted 74's	1·50
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Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE.:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. T13027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30-170.

PRICE	1–24	25–99	100 up
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SILICON 50 WATTS MATCHED NPN/PNP
BIP 19 NPN TO-3 Plastic. BIP 20 PNP. Brand new. VCBO 100/VCEO 50/IC 10A. HFE type 100/ft 3mHZ.
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-the lowest prices!

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	1	25	100+		1	25	100+		1	25	100+
SN7400	0·15	0·14	0·12	SN7450	0·15	0·14	0·12	SN74123	£2·80	£2·70	£2·60
SN7401	0·15	0·14	0·12	SN7451	0·15	0·14	0·12	SN74141	0·67	0·64	0·58
SN7402	0·15	0·14	0·12	SN7453	0·15	0·14	0·12	SN74145	£1·50	£1·40	£1·30
SN7403	0·15	0·14	0·12	SN7454	0·15	0·14	0·12	SN74150	£3·00	£2·70	£2·50
SN7404	0·15	0·14	0·12	SN7460	0·15	0·14	0·12	SN74151	£1·00	0·95	0·90
SN7405	0·15	0·14	0.12	SN7470	0·29	0·26	0·24	SN74153	£1·20	£1·10	0·95
SN7406	0·35	0·31	0·28	SN7472	0·29	0·26	0·24	SN74154	£1·80	£1·70	£1·60
SN7407	0·35	0·31	0·28	SN7473	0·37	0·35	0·32	SN74155	£1·40	£1·30	£1·20
SN7408	0·18	0·17	0·16	SN7474	0·37	0·35	0·32	SN74156	£1·40	£1·30	£1·20
SN7409	0·18	0·17	0·16	SN7475	0·45	0·43	0·42	SN74157	£1·90	£1·80	£1·70
SN7410	0·15	0·14	0·12	SN7476	0·40	0·39	0·38	SN74160	£1·80	£1·70	£1·60
SN7411	0·25	0·24	0·23	SN7480	0·67	0·64	0·53	SN74161	£1·80	£1·70	£1·60
SN7412	0·35	0·31	0·28	SN7481	£1·20	£1·15	£1·10	SN74162	£4·00	£3·75	£3·50
SN7413	0·29	0·26	0·24	SN7482	0·87	0·86	0·85	SN74163	£4·00	£3·75	£3·50
SN7416	0·43	0·40	0·38	SN7483	£1·10	£1·05	0·95	SN74164	£2·20	£2·15	£2·10
SN7417	0·43	0·40	0·33	SN7484	£1·00	0·95	0·90	SN74165	£2·25	£2·20	£2·15
SN7420	0·15	0·14	0·12	SN7485	£3·60	£3·50	£3·40	SN74166	£3·50	£3·25	£3·00
SN7422	0·50	0·48	0·45	SN7486	0·32	0·31	0·30	SN74174	£2·30	£2·20	£2·10
SN7423	0·50	0·48	0·45	SN7489	£5·50	£5·25	£5·00	SN74175	£1·60	£1·50	£1·40
SN7425	0·50	0·48	0·45	SN7490	0·67	0·64	0·58	SN74176	£2·50	£2·40	£2·30
SN7427	0·45	0·42	0·40	SN7491	£1·00	0·95	0·90	SN74177	£2·50	£2·40	£2·30
SN7428	0·70	0·65	0·60	SN7492	0·67	0·64	0·58	SN74180	£2·00	£1·60	£1·40
SN7430	0·15	0·14	0·12	SN7493	0·67	0·64	0·58	SN74181	£5·50	£5·00	£4·75
SN7432	0·45	0·42	0·40	SN7494	0·77	0·74	0·68	SN74182	£2·00	£1·80	£1·60
SN7433	0·80	0·75	0·70	SN7495	0·77	0·74	0·68	SN74184	£3·50	£3·25	£3·00
SN7437	0·64	0·62	0·60	SN7496	0·87	0·84	0·78	SN74190	£1·95	£1·90	£1·85
SN7438	0·64	0·62	0·60	SN74100	£1·65	£1·60	£1·55	SN74191	£1·90	£1·85	£1·80
SN7440	0·15	0·14	0·12	SN74104	0·97	0·94	0·88	SN74192	£1·95	£1·90	£1·85
SN7441	0·67	0·64	0·58	SN74105	0·97	0·94	0·88	SN74193	£2·00	£1·80	£1·75
SN7442	0·67	0·64	0·58	SN74107	0·40	0·38	0·36	SN74194	£2·70	£2·60	£2·50
SN7443	£1·30	£1·25	£1·20	SN74110	0·55	0·53	0·50	SN74195	£2·00	£1·90	£1·80
SN7444	£1·30	£1·25	£1·20	SN74111	£1·25	£1·15	£1·10	SN74196	£1·80	£1·70	£1·60
SN7445	£1·80	£1·77	£1·75	SN74118	£1·00	0·95	0·90	SN74197	£1·80	£1·70	£1·60
SN7446	0·97	0·94	0·88	SN74119	£1·35	£1·25	£1·10	SN74198	£5·50	£5·00	£4·50
SN7447	£1·00	0·97	0·95	SN74121	0·40	0·37	0·34	SN74199	£5·50	£5·00	£4·50
SN7448	£1·00	0·97	0·95	SN74122	£1·40	£1·30	£1·10				

LINEAR I.C's—FULL SPEC.

Type No.	Price 1-24	25-99	100 up
BP 201C—SL201C	63p	53p	45p
BP701C—SL701C	63p	50p	45p
BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP709—72709	36p	34p	30p
BP 709P—μA709C	36p	34p	30p
BP 710—72710	44p	42p	40p
BP 711—μA711	45p	43p	40p
BP 741—72741	75p	60p	50p
μA703C—μA703C	28p	26p	24p
TAA 263—	70p	60p	55p
TAA 293—	90p	75p	70p
TAA 350	170p	158p	150p

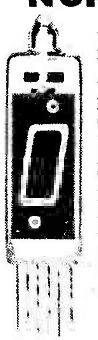
S.G.S. EA1000 2·63

ROCK BOTTOM PRICES LOGIC DTL 930 Series I.C's

Type No.	Price 1-24	25-99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
RP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

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

NUMERICAL INDICATOR TUBES



MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£1·90

All indicators 0·9 + Decimal point. All side viewing. Full data for all types available on request.

RTL MICROLOGIC CIRCUITS

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

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

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14 & 16 Lead Sockets for use with

DUAL-IN-LINE I.C's. TWO Ranges PROFESSIONAL & NEW LOW COST.

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TSO 16 ,, ,,	35p	32p	30p
LOW COST No.			
BPS 14	15p	13p	11p
BPS 16	16p	14p	12p

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50W pk 25w (RMS)

0·1% DISTORTION!
HI-FI AUDIO AMPLIFIER

THE AL50

★ Frequency Response 15Hz to 100,000—1dB.

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than ·1% at 1KHz.

★ Signal to noise ratio 80dB.

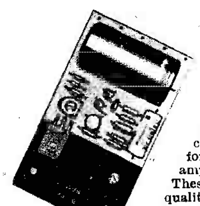
ONLY £3.25p each

★ Supply voltage 10–35 Volts.

★ Overall size 63mm × 105mm × 13mm.

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

STABILISED POWER MODULE SPM80

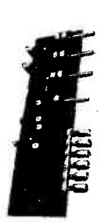


AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address. Intercom Units, etc. Handbook available, 10p **PRICE £2·95**

TRANSFORMER BMT80 £1·95 p. & p. 25p.

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market. the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100. which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATION

Frequency Response	20Hz — 20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs : 1. Tape Head	1·25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1·5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20KHz
Filters : Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than — 65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

ONLY £11·95

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £23·00 FREE p. & p.

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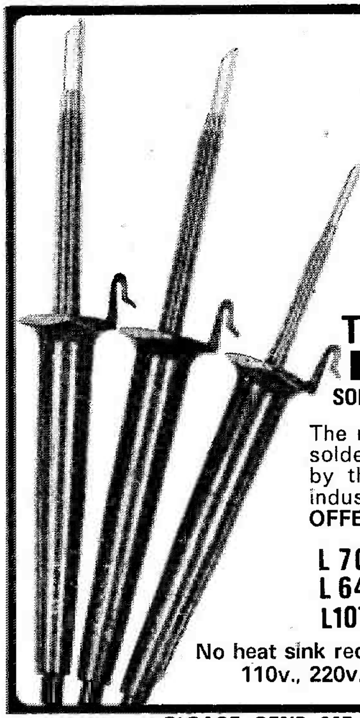

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L 646	23 watts	£2·12
L1076	27 watts	£2·18

No heat sink required. Stock voltages 110v., 220v. and 230/250v.

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The perfect instrument stand for your 'Invader'.

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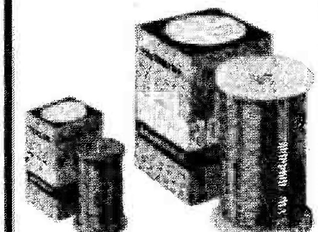
MULTI-CHANNELLED SOLDER



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646 'INVADER'	________
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AMSTRAD Integra 4000	35·50	21·50
ARMSTRONG 521	59·00	43·75
FERROGRAPH F307 Mk. II (cased)	68·00	45·50
GOODWIN RH 25 25	59·95	47·95
GLIXOR MW3000, 15 watts RMS per channel	49·50	23·95
JVC NIVICO VN 300	58·00	48·95
MCA 104Z	85 00	70·95
MCA 105E	130·50	109·95
MCA V5E VN550 Quadraphonic..	89·00	74·95
MCA V9E VN880 Quadraphonic..	148·00	124 95
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KELETRON KSA 1500	39·00	23·95
LEAK Delta 30 (cased)	69·90	46·95
LEAK Delta 70 (cased)	85·90	57·95
METROSOUND ST20E	39·50	24·20
METROSOUND ST60	70·00	45·45
PHILIPS RH521	109·00	89·95
PIONEER SA500A	47·10	32·95
SA600	95·48	57·95
SA800	126·55	75·95
SA1000	155·82	94·95
QL600A Quadraphonic Convertor	118·95	78·95
QD 210 Quadraphonic decoder..	42·85	29 95
QA 800 Quadraphonic	188·60	122 95
Reverberation 202w	54·95	35 95
RANK ROTEL 210	34·90	22 95
RANK ROTEL 310	52·00	34 95
RANK ROTEL 610	78·50	51·95
RANK ROTEL RA 810	105·50	72 95
RANK ROTEL RA 1210	129·00	89 95
ROGERS Ravensbourne	70·00	53 95
Ravensbourne (cased)	75·00	58·95
Ravensbrook Mk. II	52·50	40·95
Ravensbrook (cased) Mk. II	57·50	43·95
SINCLAIR 2000	35·00	22·95
3000	45·00	28·95
PROJECT 605	29·95	18·90
SOLARVOX 20. 10 watts RMS per channel	39·95	24·95
SOLARVOX 30. 15 watts RMS per channel	46·95	32·95
SOLARVOX MA801 2 x 8 watts. RMS plus MATRIX 4 channel..	38·45	26·95
SOLARVOX MA813 2 x 18 watts. plus MATRIX 4 channel	51·38	38·95
TANDBERG TA300	69·90	54·95
TANDBERG TA300M	79·50	65·95
WHARFEDALE Linton amplifier..	65·00	42·95

All take both ceramic and magnetic cartridges.

TUNERS

AMSTRAD Multiplex 3000 FM	39·95	28·95
*ARMSTRONG 523 AM/FM	52·68	40·95
*ARMSTRONG 524 FM	40·97	31·95
ARMSTRONG M8 Decoder	9·50	6·95
*DULCI FMT 7 FM	24·43	14·95
GOODMANS Stereomax	75·74	35·95
JVC Nivico MCT V5E/VT500 AM/FM	86·00	69·95
MCT V7E AM/FM	122·42	99·95
LEAK Delta FM	79·50	57·95
LEAK Delta AM/FM	89·50	69·95
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PHILIPS RH 621	109·00	89·95
PIONEER TX500A AM/FM	75·52	50·95
PIONEER TX600 AM/FM	104·57	73·95
RANK ROTEL 320	59·50	42·95
RANK ROTEL 620	93·50	67·95
ROGERS Ravensbourne Chassis..	60·29	45·95
Ravensbourne in Teak Case	64·97	49·95
Ravensbrook Chassis	43·90	33·50
Ravensbrook (cased)	49·75	38·50
SINCLAIR 2000	45·00	29·95
3000	45·00	29·95
Project 60 Tuner (stereo)	25·00	17·50

All above Tuners are complete with MPX Stereo Decoder except where starred

TUNER/AMPLIFIERS

AKAI CR80T AM/FM Tuner Amplifier with built in Eight Track Tape Recorder	149·84	89·95
AKAI AA8030	139·50	106·95
AKAI AA8080	189·50	145·95
AKAI AA8500	249·00	179·85
AKAI 6300	137·50	79·95
ARENA 2600	111·30	59·95
ARMSTRONG M8 Decoder	9·50	6·95
ARMSTRONG 525	90·14	69·95
ARMSTRONG 526	102·72	77·95
GOODMANS Module 80, 35w. RMS	93·00	69·95
Module 80 Compact	168·00	127·95
Module 90	119·00	91·95
Module 110 FM/MW/LW/SW/ 100w. RMS	139·00	105·95
GOODMANS Module 110, Compact	245·00	187·50
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VR 5521L AM/FM and SEA	175·00	146·95
4VR 5414 Quadraphonic	212·00	179·95
KYOTO 1000 AM/FM Tuner/Amplifier with built in Stereo Cassette Recorder. Complete with two speakers and two microphones..	85·00	61·95

	Rec Retail Price	Comet Price
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PHILIPS RH 720	215·00	179·95
PIONEER SX525	140·53	98·95
SX626	192·49	134·35
SX727	231·74	162·95
SX828	297·20	208·95
QX 4000 Quadraphonic	225·93	164·95
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ROGERS Ravensbrook (cased)	105·35	78·45
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ROTEL RX200A	89·50	65·95
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ROTEL RX 800A	189·50	139·95
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SOLARVOX TAM 1105 2 x 5 watts RMS AM/FM Multiplex comp. with 2 speakers and featuring Matrix 4 channel	38·50	29·95
TANDBERG TR200 MPX	106·00	85·95
TANDBERG TR1000 FM MPX (teak)	156·00	129·60
TANDBERG TR 1010 AM/FM MPX	169·00	139·95
TELETON CR55	125·26	68·50
TELETON R8000 AM/FM	42·16	21·95
WHARFEDALE LINTON WE40	115·00	95·95

All the above take magnetic cartridges except Teleton R8000 and Kyoto 1000 which take ceramic only. All include MPX Stereo Decoder with the exception of Armstrong where M8 decoder is extra

TURNTABLES

CONNOISSEUR BD1 kit	13·34	10·95
CONNOISSEUR BD2 Chassis	32·71	25·95
CONNOISSEUR BD2 P/C/SAU2 ..	41·29	33·95
GARRARD SP25 Mk. III	16·17	10·50
GARRARD 40B	13·63	10·95
GARRARD SL65B	20·93	13·75
GARRARD SL95B	49·21	32·25
GARRARD 401	42·88	29·50
GARRARD SL72B	32·60	21·95
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PIONEER PL12D with base and cover	49·18	34·50
PIONEER PL61 with base and cover	176·83	119·95
THORENS TX25 cover	8·85	6·50
THORENS TD125 Mk. II	82·63	66·50
THORENS TD125AB	115·69	79·95
THORENS TD125AB Mk. II with TP 16 arm	124·54	99·95
THORENS TD160/c including base and cover	69·80	56·95
THORENS TX11 cover	4·49	3·60
WHARFEDALE Linton	37·50	26·95

	Rec. Retail Price	Comet Price
SPEAKERS		
***Speakers are tax free—buy now before V.A.T.**		
*AMSTRAD 138 (pair) Teak	26·00	13·95
*AKAI SW 155	64·50	44·95
*B and W Model 70	159·50	109·95
B and W DM2	69·99	47·50
B and W DM4	49·66	37·95
B and W DM5 (pair)	59·48	43·95
CELESTION COUNTY (pair)	47·94	35·95
Ditton 120 (pair)	56·40	38·50
Ditton 15	37·40	26·00
*Ditton 25	65·00	42·50
*Ditton 44	54·00	35·00
*Ditton 66	99·00	70·95
*FERROGRAPH S1 inc. stand	95·00	67·95
GOODMANS Minister Pair	49·20	35·95
Havant (pair)	57·12	39·40
*Magister	65·63	42·50
Double Maxim (pair)	67·40	47·95
*Mezzo 3	35·70	23·45
*Magnum K2	46·20	29·50
*Goodwood	55·00	36·95
*Dimension 8	72·44	44·95
DIN 20 NT Kit	12·19	8·50
KELETRON KN 400 2-speaker system (pair)	15·44	11·95
KN600 3-speaker system (pair)..	25·82	16·95
*KN800 3-speaker system (pair)..	31·80	18·95
*KN1100 4-speaker system (pair)..	40·80	23·95
*KN1600 3-speaker system	25·20	14·95
*KN2100 3-speaker system	30·60	18·95
LEAK 150 (pair)	50·00	37·50
LEAK 250 (pair)	63·00	47·95
*LEAK 600	49·50	34·50
*LINEAR 10 watt Teak (Pair)	Sp. Price	12·95
METROSOUND HFS 103 (pair)	29·21	20·95
*202	21·50	14·75
*Duplex 15	32·00	23·95
*Duplex 25	56·00	37·50
*PIONEER CS53	46·72	29·95
SINCLAIR Q16	8·98	6·50
TANDBERG Tan 7	29·50	23·60
Tan 11 (pair)	40·00	31·95
TL 12 Teak (pair)	55·50	44·50
TL 25 Teak (pair)	71·50	56·95
*TL 50 Teak	68·00	50·95
TELETON 8000 (pair)	21·08	11·95
*THORPE GRENVILLE TG100 (pair)	28·95	16·95
*TG200 (pair)	41·95	24·95
*TG300 (pair)	55·95	29·95
WHARFEDALE Denton Mark II (pair)	42·00	28·95
Linton Mark II (pair)	52·00	37·50
Triton 111 (pair)	65·00	46·95
*Melton Mark II	35·00	23·75
*Dovedale 3 Mark II	47·50	32·25
*Rosedale	69·00	44·95
Unit 3 speaker kit	12·50	8·95
*Unit 4 speaker kit	19·00	12·95
*Unit 5 speaker kit	27·50	18·75

PICK UP ARMS AND HEADS

AUDIO Technica AT 1005 Mk. 11..	18·78	14·25
AUDIO Technica L2 lifts	2·61	1·95
CONNOISSEUR SAU2	14·61	11·95
GOLDRING Lenco 75	13·96	9·25
GOLDRING Lenco L69	10·46	6·50
GOLDRING PH6 Head Shell	2·97	1·99
SME 3009 ser 11 improved	36·75	28·50
SME 3009-S2 ser 11 improved	40·25	30·95
SME S2 Headshell	2·59	1·95

CHASSIS SPEAKERS

***Items are tax free—buy now before V.A.T.**

GOODMANS Twin-axiom 8	9·12	6·95
Twin Axiom 10	10·06	7·50
*Axiom 401	17·68	11·95
Audiom 8P	5·49	4·15
Audiom 10P	5·97	4·50
*Audiom 12P	13·00	9·15
*Audiom 15P	21·00	14·60
*Audiom 18P	35·70	24·45
*Audiom 100 40 watts din.	12·00	8·35
*ARU 172	4·50	3·20
*Axent 100	6·90	4·80
*Midax 650	13·59	9·50
*Attenuator	3·73	2·60
*Crossover network XO/950	7·77	5·45
WHARFEDALE 8 in. Bronze/RS/DD	4·75	3·30
Super 8/RS/DD	8·50	6·25
Super 10/RS/DD	14·00	9·95

CARTRIDGES

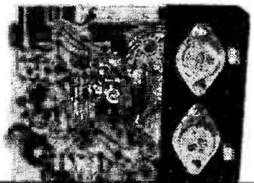
AMSTRAD 900C	5·32	3·40
AMSTRAD 900D	8·10	5·40
AMSTRAD 900 EX	11·90	8·50
AUDIO TECHNICA AT 66	6·47	3·45
*CONNOISSEUR Ceramic SCU1..	6·09	4·95
GOLDRING G850	6·10	3·10
GOLDRING G800	12·21	4·50
GOLDRING G800E	17·67	7·00
GOLDRING G820	11·62	8·25
GOLDRING G820E	17·44	12·25
GOLDRING G820 Super E	23·25	16·25
GOLDRING G800 Super E	24·41	15·25
EMPIRE 1000ZE/X	62·22	39·95
EMPIRE 999VE/X	44·44	28·95
EMPIRE 999TE/X	26·13	18·95
EMPIRE 999SE/X	21·11	13·95
EMPIRE 999E/X	16·36	10·95

SAXON ENTERTAINMENTS.

STANDARD & CUSTOM-BUILT AUDIO & ELECTRONIC EQUIPMENT NEW & SECONDHAND MUSICAL INSTRUMENTS. MAIN DISTRIBUTORS FOR A.K.G. HIGH QUALITY MICROPHONES.

SA25-SA35-SA100

LOW-PRICED AUDIO MODULES FOR DOMESTIC & COMMERCIAL USE



THESE THREE MODULES HAVE ENJOYED UNPARALLELED SUCCESS DURING THE FIRST FEW MONTHS OF THEIR BEING MADE AVAILABLE TO THE GENERAL PUBLIC. WE ARE PLEASED TO ANNOUNCE THAT WE CAN NOW OFFER FAST DISPATCH ON MOST OF OUR ADVERTISED ITEMS, INCLUDING THESE THREE MODULES.

SA25 £2·95 carr. free

25 WATTS RMS. 7 transistors 7 diodes

SA35 £4·45 carr. free

35 WATTS RMS. 7 transistors 7 diodes

SA100 £10·90 carr. free

100 WATTS RMS. 11 transistors 6 diodes

ALL THREE MODULES HAVE OPEN & SHORT CIRCUIT PROTECTION, AND THE SA100 IS PROOF AGAINST OVER-DISSIPATION & FAULTY INDUCTIVE LOADS. ONLY ADVANCED DESIGN TECHNIQUES MAKE THESE EXTRA-ORDINARILY LOW PRICES POSSIBLE.

BRIEF SPEC. FOR ALL THREE MODULES

Freq. response	15–40,000 Hz ± 1dB
Distortion	0·2% at 1 kHz
Loads	4 to 16 ohms
Quiescent current	15 mA
Noise	Better than −75 dB
Supply voltage	25–45 volts SA25/35 40–70 volts SA100
Size	4½" x 4" x 1" (SA100) 4" x 3" x 1" (SA25/SA35)

Circuits, connecting instruction and application data are supplied free with all modules.

POWER SUPPLIES FOR THE SA25/35 & SA100 AUDIO MODULES

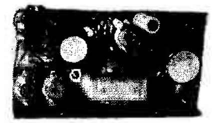
PU45	Unstabilized supply for 2 SA25/35	£4·90
PU70	Unstabilized supply for one or two SA100	£7·75 carr. 40p
MT45	Transformer for above, heavy duty	£2·85 carr. 20p
Stab PS45	Stabilized module for 2 SA25's or two SA35's	£3·50 carr. free
MT30	Transformer for unstabilized supply complete with rectifier diodes mounted	£3·50 carr. 20p
MT70	Transformer for PS70	£4·90 carr. 40p
PS70	Stabilized supply module for one or two SA100's	£4·90 carr. free

ALL MODULES ARE BUILT ON GLASS FIBRE P.C. BOARD AND ARE SUPPLIED FULLY TESTED

OTHER SAXON PRODUCTS . . .

120 WATT HEAVY DUTY MODULE £13·90 + 20p carr. or with supply **£18·95** + 40p carr.

Featuring a rugged class A driver stage, this module will run from all our mixers, etc., and most other makes of mixer. It delivers 120 watts into an eight ohm load and employs 4 T03 can (115 watt) output transistors.



SPECIFICATION

Power output	120 watts into 8 ohms
Freq. response	20-20,000 HZ ± 2dB
Input sensitivity	200 mV into 10K
Construction	Fibreglass board
Size	8" x 4" x 4" (5" with supply)

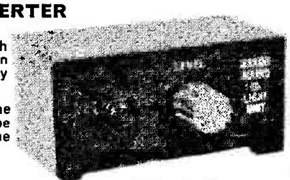
Low distortion parallel push-pull output stage.

NEW 160 watt version & supply **£27·90**

SINGLE CHANNEL SOUND/LIGHT CONVERTER

This compact and reliable unit operates from amplifiers with outputs from 5–100 watts. Does not impose a heavy load on the amplifier, *or*, if connected in the wrong polarity, cause any damage, as with some units.

Operation is simplicity itself and the unit is fully fused. The unit is supplied to function from bass notes but may easily be converted to respond only to treble or mid-range notes by the addition of components costing less than 5p.

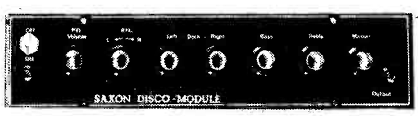


£8·90 carr. free

THREE CHANNEL SOUND TO LIGHT UNIT

Handling the total of 3000 watt (3kw) this unit is unique for its price in that not only bass, middle and treble but also master controls are provided. Two amplifier sockets eliminate the need for split leads etc. Supplied in tough white steel case with a blue hooded cover. Fully guaranteed. **£19·75** carr. 30p

MONO VERSION £6·50 carr. 20p (As illustrated. S.A.E. details 9 volt operation) Outputs up to 1 volt RMS



£15·80 carr. 30p

SAXON STEREO CONTROL UNIT

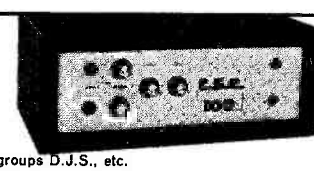
Two decks, and full headphone monitoring. The unit is mains operated and measures 17½" x 3" x 4" deep and is finished with a smart white on black facia. The controls are: Left/Right deck fader, volume, bass, treble, Headphone Selector and volume, Microphone volume, bass, treble, mains on/off.

THIS IS A MUST FOR THE HOME BUILT HIGH QUALITY DISCOTHEQUE AND IS COMPARABLE TO UNITS AT OVER TWICE THE PRICE. (N.B.—Stereo only has mic input.)

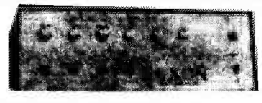
COMPLETE AMPLIFIERS

The CSE 100. £34·90 carr. free

This versatile unit is now available in a black vynide case and so represents even better value than ever delivering speech and music powers of up to 100 watts RMS and continuous signal outputs of 70 watts. Two individually controlled inputs with wide range bass and treble controls. Ideal for small groups D.J.S., etc.



The SAXON 100 £48·50 carr. free



With an RMS output of 120 watts speech and music, 100 watts continuous power, four individually controlled FET input stages and wide range bass and treble controls, this amplifier has established itself as a unit offering quality and reliability at low cost.

LOUDSPEAKERS British made bargains!!

12" 25 watt 8/15 ohms £5·95 carr. 30p. 15" 50W.8/15 ohm £14·50 carr. 50p.
12" 40 watt 15,000 gauss magnet system 8/15 ohm £11·50 carr. 40p.

A.K.G. MICROPHONES suitable for disco, group or general P.A. use.

D11DHL rrp £11·00 our price £9·45 post free
D190C High Z rrp £21·50 our price £17·45 post free
D1000C 24 ct gold plate rrp £37·00 our price £32·00 post free

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All cash in regd. envelopes please!
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TRADE & EXPORT enquiries invited.

PRACTICAL WIRELESS

VOL 48 NO 12
Issue 794

APRIL 1973

The Buyer and VAT

During these last few weeks before Value Added Tax takes effect, readers will be contemplating whether to buy now or wait until after April 1st. It will undoubtedly pay to wait on such items as domestic receivers, some Hi-Fi equipment and electrical goods, but component suppliers are being hard pressed to meet demand before the infliction of VAT.

One way of circumventing purchase tax has been to supply equipment in kit form, but these items in any form will be liable for VAT at one common percentage rate, since VAT is a tax on the basic purchase price or charge for service.

We would expect that all suppliers will make it quite clear to all customers, at the trading premises and through advertisements, whether quoted prices include VAT. The basic retail price should remain the same as now. Whatever you pay for goods or services from April 1st, you should not be paying any purchase tax or selective employment tax levies; you should be paying VAT on top of the normal retail price, based on the Chancellor's Budget announcement on March 6th.

Kit and component prices should not be raised before April 1st and manufactured goods subject to purchase tax of more than 15% should be noticeably reduced after April 1st.

Shopkeepers and other traders are not legally bound to show the amount of VAT in cash transactions; neither will they necessarily show special "tax invoices" for retail sales, but it is worth remembering that if you purchase at a cut price rate, the VAT charged will be correspondingly lower. Goods obtained by hire purchase or credit agreements will be subject to tax at the current rate at the time when transaction documents are signed. Interest rates on these terms are not taxable. Private sales between individuals do not attract VAT because neither party is defined as a "taxable person", unless the seller is a trader required to register with H.M. Customs and Excise.

Our advice to readers who are thinking of buying goods by mail order during March is to determine first whether purchase tax is chargeable; if it is then wait until April. Items not subject to purchase tax (such as components and secondhand or used goods) should be ordered early. If of substantial value, send your order by P.O. "Recorded Delivery" and keep the counterfoil of your Postal Order, Money Order, or cheque.

You should be prepared for a VAT levy on charges for packing service but not for postage.

continued on next page

NEWS AND COMMENT

CONSTRUCTIONAL

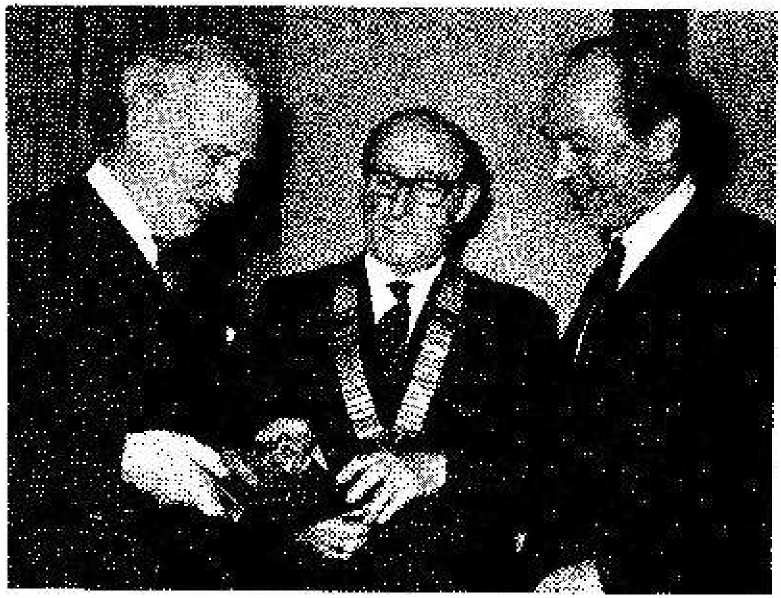
OTHER FEATURES

THE MAY ISSUE WILL BE PUBLISHED ON APRIL 6th

NEWS... NEWS... NEWS...

by Colin Riches

RSGB "Jubilee Year" President



Photograph by P. M. Fletcher.

This picture shows Dr. J. A. Saxton, D.Sc., PhD, CEng, FIEE, FInstP, the new President of the RSGB. On the left of the picture is Swedish Amateur Lt. Col. Per Anders Kinman, SM5ZD, who received the Calcutta Silver Key award. Sir John Eden, the P.M.G. is on the right.

In his address, Dr. Saxton said he felt very proud that he had been chosen as President of the RSGB for its Diamond Jubilee Year. He also said that he was extremely delighted that Sir John had been able to attend and that all there were greatly honoured by his presence.

Dr. Saxton went on to say that the Society would continue to do all in its power to continue to deserve the Ministry's support.

Per Anders Kinman has been made an Honoury Vice President of the RSGB in recognition of his outstanding service with the IARU Region 1 in which he has served for many years.

The Calcutta Key he received was first presented 20 years ago and it has been awarded annually by the RSGB to the person they feel has made, in any one year, the most significant contribution to international friendship and goodwill through the medium of Amateur radio.

VAT

To the best of our knowledge, the prices quoted in this issue were correct at the time of going to press.

From April 1st 1973, there will be no purchase tax but a large number of goods will carry Value Added Tax. For further details, see our Leader article.

Tulip Time Rally

The 1973 "Tulip-Time" mobile rally will be held on Sunday May 6th at Surfleet, 4 miles north of Spalding on the A16.

The Spalding and District Amateur Radio Society will also be operating a Special Activity station, GB3STF on 12th-13th May from The Grammar School, Priory Road, Spalding, in connection with the 1973 Tulip Festival. Operation will be on s.s.b./c.w. on all bands 160-10m. with a.m. on 2m. All contacts will be confirmed by special QSL cards.

Of interest to "Going Back" fans—the Wireless Preservation Society will have an exhibition of vintage radio on show to the public. I hope to be able to publish further details later.

The Buyer and VAT

continued from previous page

If you order from a current catalogue or advertisement after April 1st, you should add the VAT percentage rate to the basic retail price shown. Then add the estimated or stated charge for postage and packing. If a service is chargeable, such as equipment repair or consultation, VAT will be levied at the standard rate. Trading in second-hand and used goods will also be taxable under VAT.

Finally, good news for P.W. readers: newspapers and magazines will be "zero-rated", which means that no VAT is chargeable on these. Transactions of any kind in the U.K. for the direct exportation of goods and services are exempt from VAT.

M. A. COLWELL—Editor.

Feb P.W. Cover

Many enquiries have been received for information on the book and log book shown on the front cover of the February issue of *PW*. Both can be obtained from the Radio Society of Great Britain, 35 Doughty Street, London, W.C.1. "How to Listen to the World" costs £2 post paid. The log book shown is intended for transmitting Amateurs and costs 60p post paid but another one, intended for listeners, is available at 45p post paid.

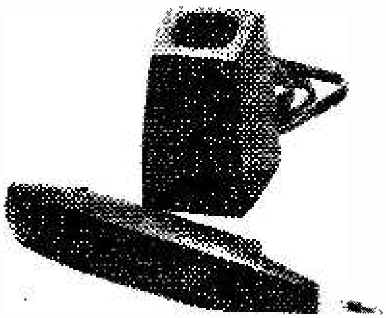
NEWS... NEWS... NEWS...

Cordless Iron

This cordless soldering iron comes from the U.S.A. It is completely portable needing no mains power for operation. It has its own power supply which is automatically charged from the stand which itself is connected to the mains. There is a small light near the tip which is very useful for seeing exactly where you are applying heat.

The iron heats up in under 5 seconds and has an "indestructible" iron-plated bit. It costs £9·25 complete with charging stand and fine bit. A heavy-duty bit is also available.

The exclusive distributors in Great Britain are *Pact International Electronics Ltd., P.O. Box 19, Royston, Herts, SG8 5HH.*



Sonex 1973

The technical author and writer Donald Aldous will be heading a small team to organise the Special Features at "Sonex '73".

Two recital/lecture sessions will be presented each day at the Exhibition's new venue the *Excelsior Hotel, London Airport, Heathrow.*

Speakers will include Bert Webb, who will lecture on pick-ups, arms and turntables and Kenneth Shearer, speaking on listening room acoustics.

There will also be a lecture on tape cassettes and an examination of current loudspeakers and trends.

Sonex '73 will run from Friday, March 30th to Sunday, April 1st, inclusive.

Sound '73

"Sound '73" is the exhibition run by the Association of Public Address Engineers. New P.A. equipment and new techniques in the public address and allied fields will be on show.

As in past years, there will be a lecture programme held in the hotel's "City Room". John Maunder from Shure Electronics will give a lecture and demonstration on microphones on Tuesday, 13th March at 14.30hrs.

Mike Beville from Audio and Design Recordings Ltd. will lecture on Components and Limiters (Wednesday at 14.30hrs.)

On Thursday March 15th at 10.30hrs, a member of the Hornsey College of Art will talk on Industrial design of Public Address Equipment.

Venue will be the Bloomsbury Centre Hotel, March 13-15, from 10.00-18.00hrs.

I.E.E. Conferences

The following new conferences to be held in 1973 and 1974 are being organised by the Institution of Electrical Engineers.

"Electrical Signals from the Brain" 27-30 August 1973—in Oxford.

"Symposium on Electromagnetic Wave Theory" 8-12 July 1974—in London.

Further details of the conferences mentioned above are available from the *Conference Department, IEE, Savoy Place, London WC2R 0BL.*

De-soldering Unit

In the February issue we mentioned the Litesold De-Soldering Unit and a misprint stated the price at £·75. This should have read £2·75. Apologies to Light Soldering Developments and any readers that may have been inconvenienced.

Jermyn Inverters

Jermyn Distribution market two inverters, both giving an output of 250V. Input for the 150W version is 12V and for the 300W type, 24V.

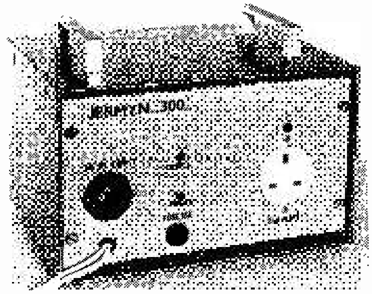
A feature of the design enables these inverters to charge the 12/24V batteries up to 10A when plugged into a power socket.

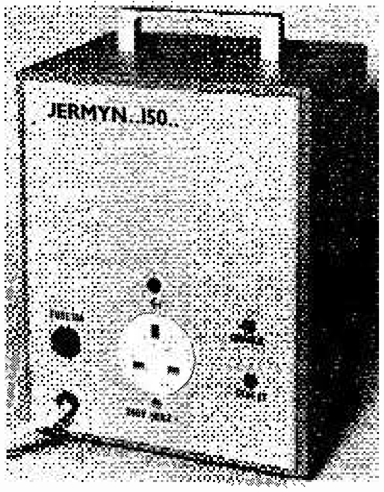
If the mains supply fails, the inverter automatically switches to its "invert mode" providing 240V emergency power immediately.

Should the unit be accidentally overloaded its drive is so adjusted, that the output voltage falls completely, switching the unit off, eliminating any problems.

An internal 15A fuse blows should the battery leads be connected wrongly. Indicator lights illuminate to show whether the unit is charging a battery or providing a 250V 50Hz output.

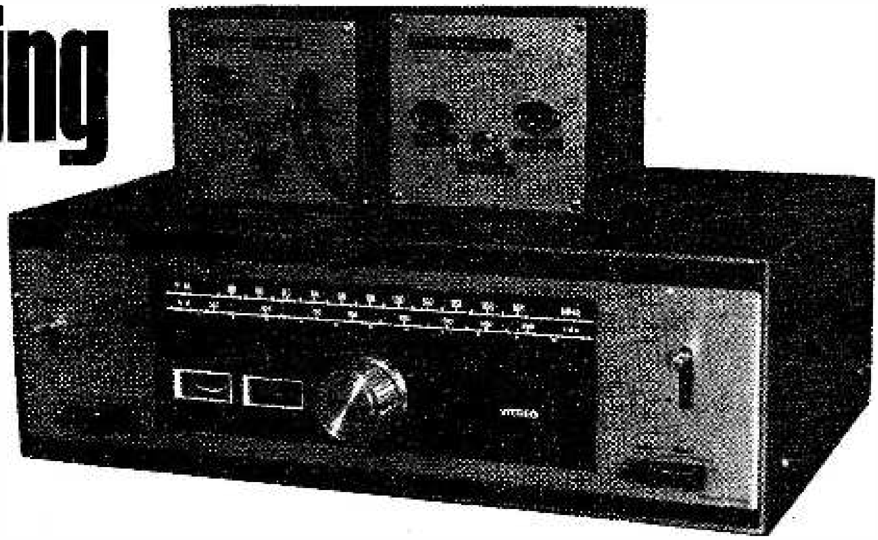
Both types of inverter can be obtained in kit form or already built. The kit for 150W costs £25 (£29 built) and 300W £34 (£39 built). *Jermyn Distribution, Vestry Estate, Sevenoaks, Kent.*





improving VHF radio

A. N. AINSLIE

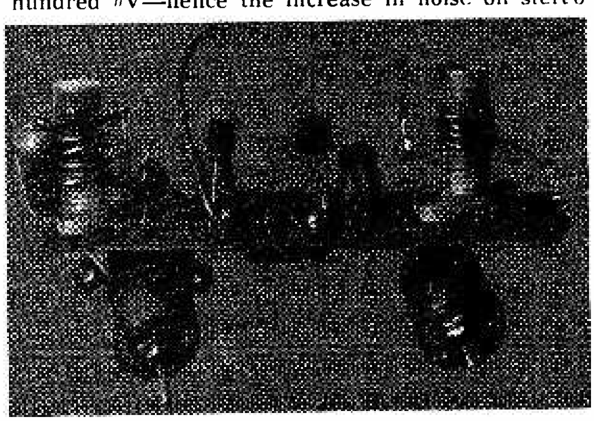


VHF radio provides a most useful signal source for any hi-fi enthusiast and, despite the 15 kHz frequency limits, the live BBC broadcasts are certainly up to the standards of the finest records.

The advantages are numerous—being a non-mechanical system the distortion is very low and the self-generated noise is also very low, the result being a large dynamic range and the possibility of encoding two channels on a single signal. This, plus the excellent BBC technique, makes f.m. radio an invaluable source of material. Unfortunately there are several difficulties in securing top quality f.m., regardless of the equipment used.

SIGNAL-TO-NOISE

Referring to Fig. 1, it can be seen that the performance of a receiver depends on the strength of the signal applied to the aerial socket of the receiver. The mono signal-to-noise ratio assumes an optimum value (usually 50 or 60 dB) with only a few μV input—even on cheap tuners. The signal-to-noise performance does not improve so rapidly on stereo, however, and in many cases could be improved on even with inputs in the region of a few hundred μV—hence the increase in noise on stereo in most situations. A person who gets no increase in noise is indeed most fortunate and need read no further!



First of the two VHF amplifiers described in the article. This one uses field-effect transistors.

As regards crosstalk and distortion, these parameters usually reach optimum values with fairly small inputs and usually there is not much improvement to be had by an increase in the signal.

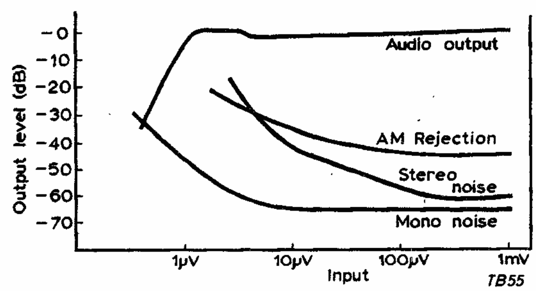


Fig. 1: Graphs comparing receiver performance with the input signal level.

Very few people are fortunate enough to be able to receive "near perfect" stereo without a large aerial, loft or roof mounted. A large aerial, besides having the necessary gain usually has the advantage that it is highly directional and eliminates multi-path distortion from reflected signals. In many situations, a reasonably large aerial, three or more elements, carefully sited, and with a low loss feeder gives good stereo but perhaps not of the very highest quality.

The major downfall in domestic stereo reception is that of "stereo" noise—perhaps not excessive but sufficient to mar an otherwise excellent signal. The obvious way to reduce this noise is to increase the signal feeding the tuner by an "aerial amplifier". At present in this discussion we must assume that the amplifier be perfect, having gain but generating no noise itself.

OTHER NOISE

At this point many readers may well be wondering about the other forms of noise, thermostats, car ignition and other spurious signals. These signals are picked up by the aerial and sometimes, even, by the feeder, and consequently will be amplified, together with the f.m. signal, by our "ideal" amplifier, which we are using to combat stereo noise. This brings us to the last important parameter of f.m. receivers, amplitude modulation limiting.

The "ideal" f.m. tuner is designed to respond to f.m. only and a.m. signals are rejected to an infinite degree. Unfortunately, no receiver is perfect and some degree of sensitivity to a.m. is unavoidable.

The a.m. limiting of the receiver improves with increasing signal input, as seen from Fig. 1, so that increasing the signal and spurious a.m. together actually reduces the level of audible interference. Unfortunately, when the receiver is switched to receive a stereo transmission, the stereo decoder in the receiver is actually only sensitive to amplitude modulation of the stereo subcarrier. In the decoder some measure of a.g.c. is applied to the subcarrier amplifier and this maintains a constant level of stereo interference from an a.m. signal regardless of the actual input voltage to the tuner.

It can therefore be seen that whilst increasing the tuner input with an "ideal" amplifier, the "stereo" interference level remains substantially constant whilst the "mono" component of the audible interference has been reduced by virtue of the amplitude limiting of the f.m. discriminator.

AERIALS

Earlier in this discussion, we talked of elaborate and efficient aerial systems but the previous discussion on aerial signal amplification implies that, with a good amplifier, an aerial providing only a minimal "clean" signal can be used to run an f.m. tuner with a high degree of success.

Unfortunately, some tuners are not so sensitive as others and sometimes require millivolts to function at their best. This means considerable amplification of the few tens of microvolts coming from a rather poor aerial!

The better tuners nowadays use f.e.t.'s in the input circuits to keep noise to a minimum and to keep cross modulation low; so any proposed amplifier should have at least as good a performance as the front end of the tuner.

This is very demanding when tuners such as Sony, Radford and Fisher are considered, but it is possible to improve these tuners on a very poor signal by a remarkable degree.

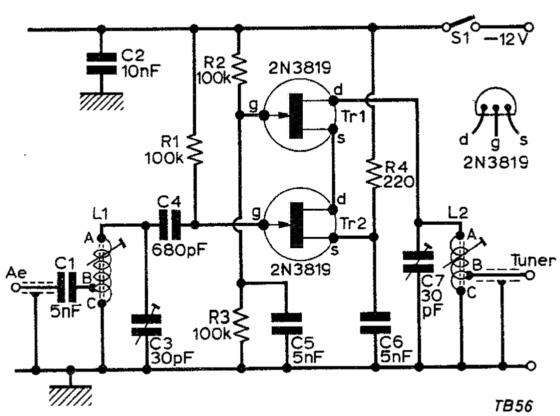


Fig. 2: Circuit of the amplifier using two f.e.t.'s.

To design an amplifier with a front-end comparable to the best tuners use has to made of f.e.t. devices which possess the best noise properties of all the common solid state devices presently available and are responsible for the excellent performance of the best tuners.

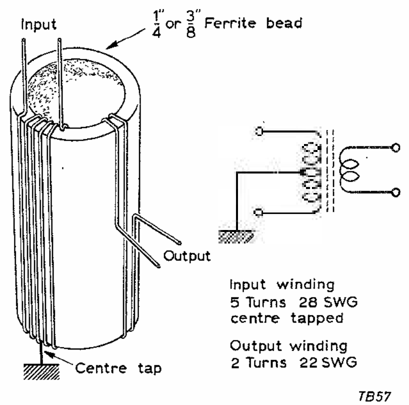


Fig. 3: Details of simple transformer to match balanced 400Ω feeder to 75Ω coaxial feeder.

The design chosen for the amplifiers in this article is not often used with solid state devices but was once very common with valve Band III television tuners. The amplifier is a cascode configuration giving reasonable gain with very low noise and good cross modulation.

The input to the amplifier, Fig. 2, is 75Ω co-axial feeder so Fig. 3 shows a transformer that can be constructed from a small ferrite bead for 400Ω balanced feeder.

THE PCB

The amplifier can be very easily built on a single piece of printed circuit 4″×2″ and it is recommended that fibreglass board be used.

To etch the required print design as shown in Fig. 4 (full size), the diagram is traced on to the copper side of the print with carbon paper and the marked areas painted. in with high quality enamel. When the paint is dry, the print is immersed in the etching solution and agitated until completely etched (only paint and base material can be seen). The etching solution can be ferric chloride solution but a useful alternative is "Liquor-Ferri Perchloridi Fort" which is obtainable from chemists and should be used undiluted. Rub the copper surface of the board with "Ajax" or similar scourer before painting, to ensure a clean surface.

The enamel paint can be removed with paint stripper once the etching is complete and the board washed and cleaned with wire-wool. The holes for the components should be drilled with a 1/32″ drill, preferably in a wheel brace.

Construction is straightforward except that the f.e.t.'s should be left until last and soldered in with the iron disconnected from the mains—surprisingly little voltage will break down the gate junction.

The coils, Fig. 5, are wound on the formers which are located on the board and stuck with Araldite. The 30pF variable capacitors must be connected so that the rotor is connected to the earth line. The author used 30pF Philips beehive trimmers mounted

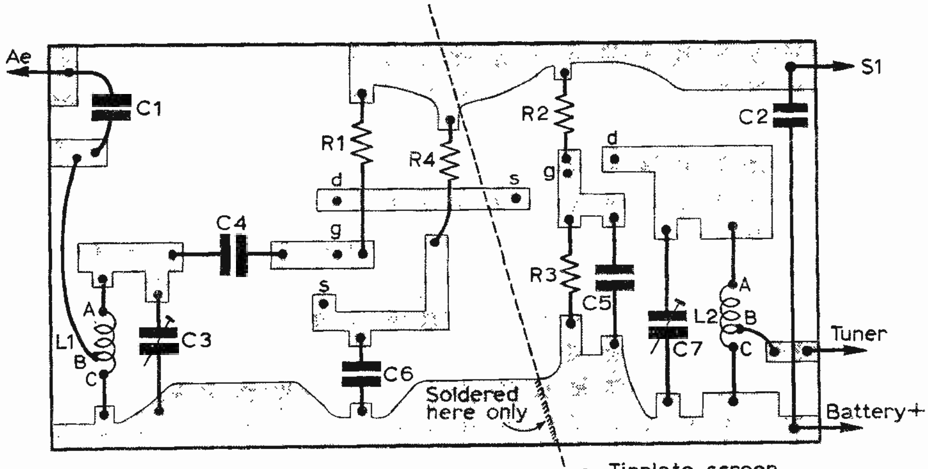
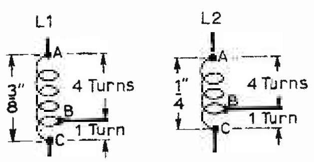


Fig. 4: Printed circuit board, for the circuit of Fig. 2, shown actual size.



Note:
L1 and L2 both wound on 1/4" Dia formers using 18 SWG copper wire

TB59

Fig. 5: Winding information for L1 and L2.

★ components list

FET AMPLIFIER

Resistors

R1 100kΩ R2 100kΩ R3 100kΩ R4 220Ω

All ¼W 5%

Capacitors

C1 5nF 400V C5 5nF 12V
C2 10nF 12V C6 5nF 12V
C3 30pF Trimmer C7 30pF Trimmer
C4 680pF 12V

Miscellaneous

Tr1-Tr2, 2N3819. On-off switch. 12V battery. Co-axial sockets (2). PCB, see text. Coil formers.

BF200 AMPLIFIER

Resistors

R1 1·5kΩ R3 6·8kΩ R5 10kΩ
R2 10kΩ R4 1·5kΩ R6 6·8kΩ

All ¼W 5%

Capacitors

C1 1nF 400V C6 30pF Trimmer
C2 30pF Trimmer C7 10nF 12V
C3 10nF 12V C8 680pF 12V
C4 680pF 12V C9 1nF Feed-through
C5 1nF Feed-through C10 30pF Trimmer

Miscellaneous

Tr1-Tr2, BF200. On-off switch. 12V battery. Co-axial sockets (2). PCB, see text. Coil formers.

POWER SUPPLY

Capacitors

C1 100nF 1kV C3 2000µF 10V C5 100nF 12V
C2 2000µF 10V C4 1000µF 15V

Miscellaneous

R1, 10Ω ¼W 5%. D1-D2, 1N4002. D3, 12V zener 2W, mounted on aluminium 2" × 1" minimum. T1, 8V bell transformer. Fuse, 1A. On-off DP mains switch. LP1, 3·5V 20mA for FET amp + 2 stages or 3·5V 40mA for FET amp + 4 stages.

on the copper side of the board. The resistors should be small low noise types and the capacitors need only be low working voltage.

The completed amplifier should be screened by placing tin plate at the position indicated and soldered to the positive line as support.

The amplifier is mounted in a small wooden box, measuring approx. 4" cube internally, covered inside with tin foil, which is connected to the positive supply line. A front panel can be made from a piece of double-sided copper board with the input and output sockets and the on/off switch. The printed board is soldered to the front panel by the positive line, so earthing the front panel.

With a 12V battery connected, the output is fed to the tuner and the input is fed by an "inefficient" aerial, in most cases a short piece of wire.

With the amplifier on, the tuner is switched to the local stereo station and the tuning capacitors C3 and C7 set midway. The cores in the coils (L1 and L2) are then adjusted to give the strongest signal, best observed on a tuning meter or audibly by judging least noise.

The amplifier is then assembled in the case and the capacitors C3 and C7 tuned to give the best signal. The tuning will be sharp and critical, so care should be taken when adjusting.

The amplifier, when connected between the proper aerial and tuner, should have sufficient gain to overcome most of the tuner noise, without introducing significant noise itself. When used on weak local radio stations, the improvement will be very marked, especially in mono. Unfortunately, this usually requires the amplifier to be re-tuned to the local channels. However, connecting 27Ω resistors across L1 and L2 will broaden the bandwidth considerably, enabling the amplifier to be used over a number of channels.

BF200 AMPLIFIER

However, for many of the "poorer" tuners, this amplifier will still not be good enough to fully drive the tuner on a moderate signal. For optimum stereo in such cases two of the amplifiers could be

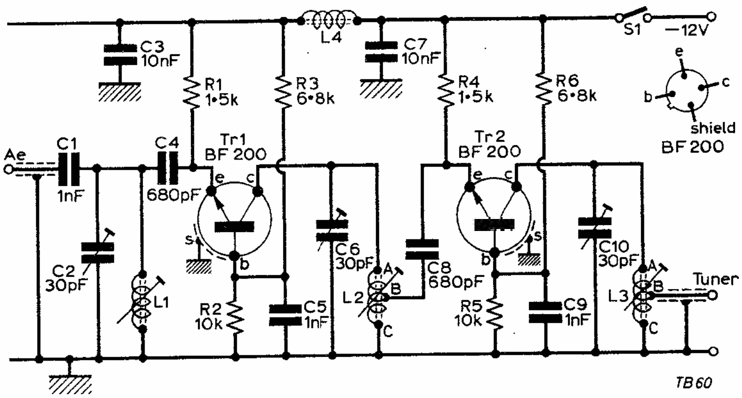


Fig. 6: Circuit of the second amplifier, using BF200 transistors.

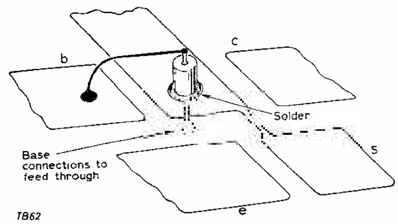


Fig. 8: Method of mounting feed-through capacitors.

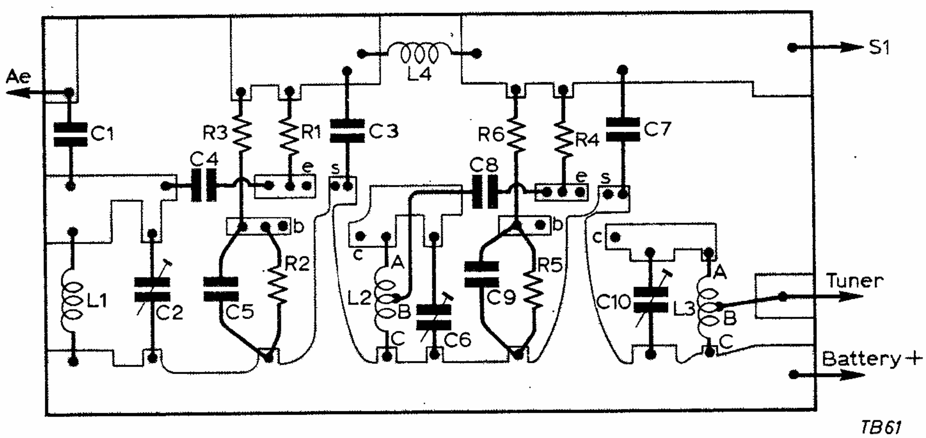


Fig. 7: Illustration, actual size, of the printed circuit board for the BF200 amplifier.

connected in series. The price of f.e.t.'s, however, makes this uneconomical and ordinary low-noise silicon transistors used after the f.e.t.'s work very well. The proposed amplifier, Fig. 6, is two stages of a conventional r.f. amplifier design. Fig. 7 shows a full size print layout for two stages, although for additional gain or bandwidth more stages can be used, although greater than five would be difficult to keep stable.

The board is etched in the same manner as before and a similar front panel and box are prepared. Alignment is the same, tuning the coils and finishing with the capacitors.

The transistors specified are BF200 and these should be used for at least the first two stages to keep the noise level down; after this such transistors as 2N706 work very well. An alternative for the BF200 is BF180 or BF181.

Fig. 8 shows how C5 and C9 are constructed with 1000pF feed-through capacitors. L4 is made by wrapping a few turns of 36s.w.g. d.c.c. copper wire round a ferrite bead. Fig. 9 gives the winding information for L1, L2 and L3.

The two amplifiers just described will enable good stereo to be obtained from a mediocre signal without the need for a "fancy" tuner. The improvement that can be expected depends greatly on the individual circumstances. The author has used the amplifiers with a Sony ST5100 tuner and a poor aerial and found the results almost as good as when a proper aerial was correctly installed on the roof. The cost of a pair of amplifiers is comparable to a decent

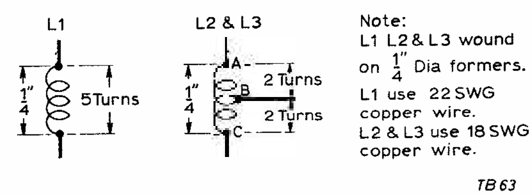
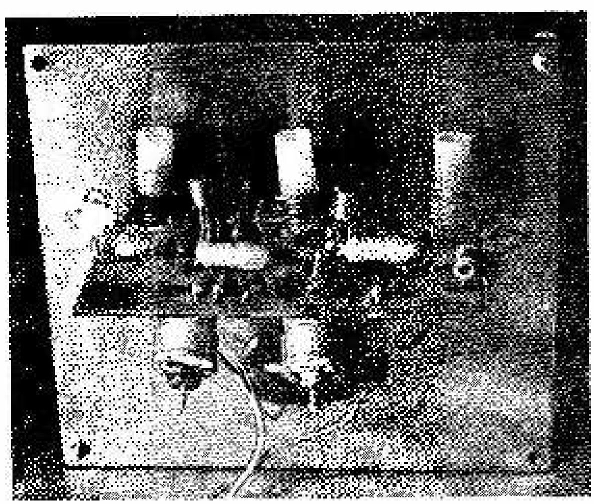


Fig. 9: (above) Details of the three coils shown in Fig. 6. In the photograph (below) the second amplifier board is shown soldered to the front panel consisting of double-sided p.c.b.



aerial less downlead and fitting, so financially it is a viable proposition, although not a substitute for a first class aerial.

In order to split one signal to run several outlets and obtain maximum signal at each of the outlets, a star-splitter is used. This arrangement provides correct impedance matching throughout the system.

Figure 10 shows the circuit of a star-splitter. The value of the resistors R depends upon the impedance of the feeders (Z) usually 75Ω, and on the number of outlets (n) which can be as many as required.

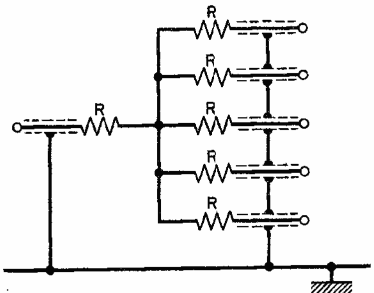


Fig. 10: Circuit of star-splitter enabling several outputs to be obtained from a single input.

The relationship is:— $R = Z(n-1)/n+1$. For example, for a splitter for a 75Ω system with two outputs the resistors to the nearest preferred value are 27Ω. Small ¼W resistors are suitable and indeed preferable to physically larger types.

All of these systems involve a loss of signal and this must be made up by amplification before the splitting. For a distribution system, splitting six or eight ways, two f.e.t.'s followed by three transistors should be adequate. One important point to note is that the outputs of the splitter must all be loaded by a 75Ω resistor when not in use, otherwise a loss of signal results and the splitter may form the node of standing waves in the feeder.

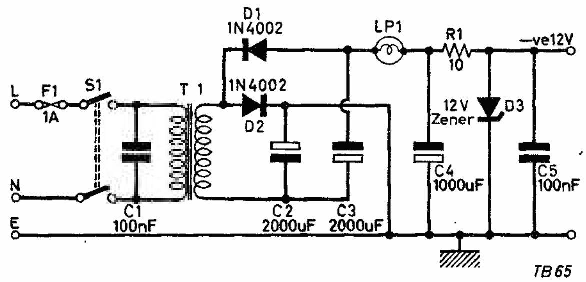


Fig. 11: Suggested power supply for the v.h.f. amplifiers.

If either of the amplifiers is built as a distribution system, it is perhaps a good idea to build a small mains unit to power the whole system. It is desirable that this supply be stabilised to guard against changes in the tuning of the f.e.t.'s if the supply voltage changes.

Fig. 11 gives a circuit of a simple power supply based on an 8V bell transformer with voltage doubling and zener stabilisation. The lamp, LP1, can be used to give on/off indication.

It is hoped that this article has given sufficient information for the home constructor to build an amplifier system to improve the performance of a tuner to reach the very high standards of the B.B.C. stereo transmisions. ■

EXPERIMENTERS CORNER

NOVEL TONE GENERATOR

N. NAUGHTON

WHENEVER home constructors and experimenters need to build a source of audio frequency, the choice nowadays is usually a transistor multivibrator. The reasons for this selection are easily understood. It requires few components, avoids the need for a transformer and gives a strong output signal. These virtues outweigh the fact that the square-wave output does not make for a particularly pleasing sound when amplified and fed to a loudspeaker.

In designing the a.f. tone generator to be described, the author set out to devise a circuit which would possess all the aforementioned merits of the multivibrator and at the same time give a better audio tone. In the circuit shown in Fig. 1—which, as a transistor circuit, is thought to be original—the writer believes these objectives have been largely achieved.

It will be noticed that the circuit is actually simpler than a multivibrator and basically it is a sawtooth generator. Like all sawtooth generators it depends upon the charge and discharge times of a

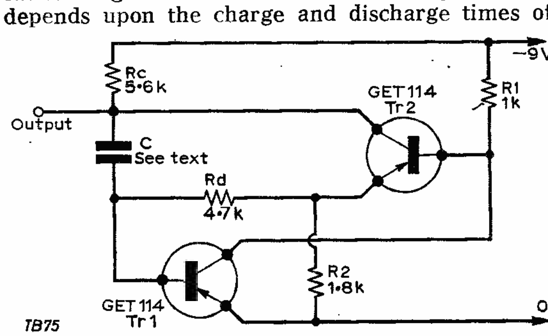


Fig. 1; Circuit of tone generator.

capacitor for its action. But as linearity of the sawtooth ramp is not important for the required purpose, the provision of constant current is omitted in the circuit shown.

In Fig. 1 the two transistors perform the function of switches and the circuit operates as follows:—capacitor C charges via the charging resistor Rc and the base-emitter junction of Tr1. The charging current flowing through the B-E junction turns on Tr1 and the flow of collector current causes a voltage drop across R1 which results in the potential on the base of Tr2 dropping to a level low enough to turn off Tr2. As the charge on C rises the charging current diminishes so that the potential on the base of Tr1 decreases to a point where Tr1 turns off. The base of Tr2 now goes strongly negative causing Tr2 to turn on and C now discharges via Tr2 into the discharge resistor Rd. While discharge current is flowing in Rd it maintains a positive potential on the base of Tr1 thus preventing further switching action during the period of discharge. When C has discharged, it again draws current through Tr1 once again turning off Tr2. The cycle then repeats.

The foregoing is a simplified description of the operation but many will find it interesting to measure the balance of currents and potentials which exist in the circuit under static conditions when C is removed.

The frequency of oscillation is not readily calculated since it is influenced by several factors one of which will be determined by the type of coupling employed to connect the output. However, for practical purposes values of C ranging between 2μF and 5000pF will cover the audio spectrum.

APPLICATIONS

A useful feature of the circuit is that it uses only one capacitor. With the values given, the generator should oscillate at any point within the a.f. range the actual point being determined by the value of C selected. Thus it becomes a simple matter to construct a signal generator giving a number of spot frequencies as desired; the only extra components needed being a multi-pole switch and a few capacitors. Many other audio applications will doubtless occur to readers.

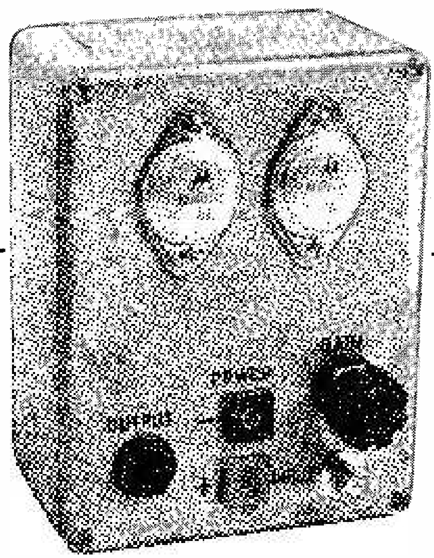
For those interested, an interesting feature of the circuit is that because the charge and discharge paths of C are independent, the circuit can readily be made to produce right-handed or left-handed sawtooth waveforms. Moreover, by choice of p.n.p. or n.p.n. transistors, the polarity of either slope can be created as desired at source, thereby eliminating inverting stages. Although some value of Rd is essential for circuit function, in practice this can be less than 100Ω thus allowing fast flyback times. There is no reason why C can not be a very large value electrolytic so that the circuit can easily be adapted for timing application.

GENERAL

No constructional details are given since the generator will mostly be incorporated in some larger project. Experimenters can assemble the components on a length of Veroboard or tagboard.

As stated at the outset, the circuit is primarily intended as an a.f. generator and the values given have been chosen to give a roughly pyramid waveform at the collector of Tr2. A strong output signal is also available at the collector of Tr1 but this is a steep sided pulse and the "softer" toned signal at the Tr2 output can be readily appreciated. Coupling of the output is perhaps best determined to suit the individual case but too tight a coupling to the Tr2 output is best avoided. This is less important if the Tr1 output is used.

With the component values given, the circuit places no critical demands on the transistors' characteristics. Seven widely differing types, in various combinations, have been tried with success. However, experimenters using low values of Rd—especially with a high value of C—should note that Tr2 must then be a device capable of handling the heavier discharge current. Tr1 and Tr2 must both be either p.n.p.'s or n.p.n.'s, the −9V becoming +9V if n.p.n.'s are used. ■



IC POWER AMPLIFIER

D. SILVESTER

THE audio amplifier to be described was designed to deliver in excess of 10W r.m.s. into an 8Ω load, whilst being constructed in a $4\frac{1}{2}$in. x $3\frac{1}{2}$in. x 2in. diecast aluminium box. The size of the box is, in fact, limited not by the size of the i.c. but by the passive components, especially the output capacitor which must be included in the circuit. The use of the i.c. has added one inestimable advantage in that the current through (and the power dissipated by) the output stage under overload conditions can be limited. It is thus possible for the output to be short circuited without disastrous results.

The i.c., although capable of giving a 1 watt output without any other transistors, has been primarily designed for use as the driver stage of an amplifier capable of delivering up to 35 watts into an 8Ω load.

A description of the working of the i.c. has not been included as it is not necessary for the constructor to completely understand the operation of the device for it to be used successfully.

Two transistors in the i.c. are responsible for the current and power limiting facility. It was calculated that under maximum current limiting and with the normal current gain of a power transistor, the output stage of the i.c. would be overloaded. One way of curing this fault is to use a Darlington transistor. This in fact was done, the Darlington pair being contained in the TO3 metal case of the power transistor. The current gain of the complementary Darlington pairs is in excess of 1000.

CALCULATIONS

The final circuit used for the prototype amplifier is shown in Fig. 1 but since other constructors may wish to use different power supply voltages and load impedances from those used by the author, the method of calculation of the current and power limiting components is given. The basic circuit should be adhered to as it is only the values of R6, R8, R9 and R11 which need to be changed.

The following section shows the worked equations used to give the value of the components in Fig. 1.

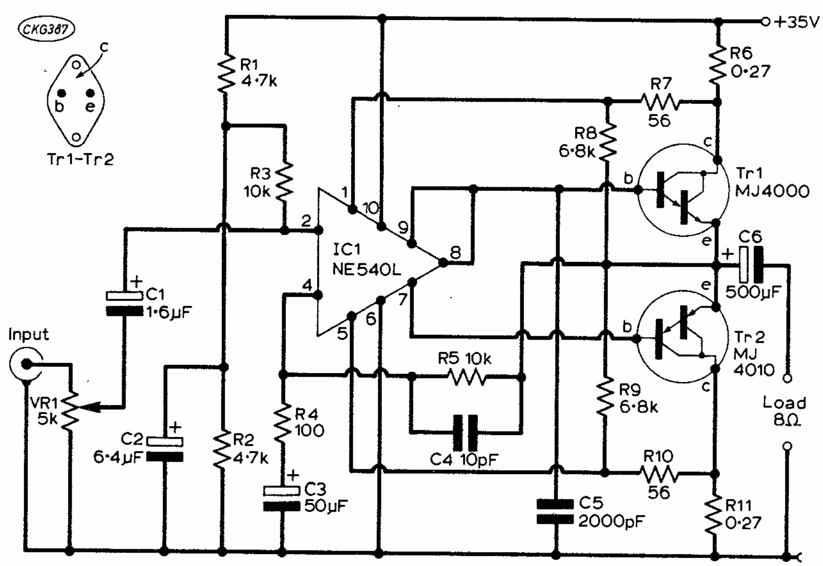


Fig. 1: Circuit diagram of the amplifier and pin connections for the output transistors.

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2G345B	0·25
2G371	0·15
2G374	0·15
2G381	0·22
2G417	0·20
2N109	0·49
2N174	1·40
2N176	0·75
2N274	0·75
2N335	0·75
2N551	0·95
2N376	1·00
2N384	0·93
2N388A	0·40
2N404	0·23
2N404	0·20
2N456	0·75
2N456A	0·75
2N457A	0·80
2N491	3·25
2N584	0·26
2N591	0·34
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2N698	0·25
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2N706A	0·12
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2N2221	0·20
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2N2222	0·31
2N2222A	0·41
2N2368	0·11
2N2369	0·39
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2N2646	0·41
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2N2711	0·12
2N2712	0·12
2N2713	0·17
2N2714	0·17
2N2904	0·18
2N2904A	0·25
2N2905	0·26
2N2905A	0·23
2N2906	0·18
2N2906A	0·23
2N2907	0·18
2N2907A	0·25
2N2913	0·75
2N2923	0·12
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2N2925	0·12
2N2926	
Green	0·10
Yellow	0·10
Orange	0·10
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2N4062	0·11
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2N4303	0·32
2N4913	0·80
2N4914	0·87
2N4915	0·95
2N4916	0·11
2N4917	0·17
2N4918	0·50
2N4919	0·53
2N4920	0·60
2N4921	0·50
2N4922	0·55
2N4923	0·60
2N4926	0·90
2N4927	1·00
2N4928	1·80
2N4929	2·23
2N4930	2·25
2N4931	2·70
2N5172	0·08
2N5174	0·22
2N5175	0·26
2N5176	0·32
2N5245	0·43
2N5190	0·92
2N5191	0·96
2N5192	1·24
2N5193	1·01
2N5194	1·10
2N5195	1·46
2N5245	0·43
2N5457	0·30
2N5458	0·33
2N5459	0·33
3N128	0·63
3N138	1·37
3N199	1·36
3N140	0·76
3N141	0·69
3N142	0·54
3N143	0·64
3N152	0·79
3N153	0·74
3N154	0·74
3N159	1·00
3N187	1·30
3N200	2·07
3N201	1·05
40050	0·78
40251	0·81
40309	0·33
40310	0·50
40313	0·92
40316	0·50
40318	0·92
40322	0·92
40360	0·46
40361	0·48
40362	0·44
43063	0·88
40389	0·46
40394	0·56
40395	0·50
40406	0·44
40407	0·33
40408	0·50
40409	0·52
40410	0·53
40411	2·00
40414	3·55
40438	1·44
40467A	0·69
40468A	0·44
40600	0·69
40601	0·67
40602	0·46
40603	0·58
40604	0·56
40636	1·10
40673	0·56
AC107	0·35
AC113	0·16
AC115	0·16
AC117	0·20
AC121	0·13
AC126	0·20
AC127	0·20
AC128	0·20
AC141K	0·30
AC142K	0·25
AC151V	0·14
AC152V	0·17
AC153	0·22
AC153K	0·25
AC154	0·20
AC176	0·18
AC176K	0·20
AC187K	0·20
AC188K	0·26
ACY17	0·25
ACY18	0·15
ACY19	0·20
ACY20	0·20
ACY21	0·18
ACY22	0·13
ACY28	0·18
ACY30	0·42
ACY39	0·55
ACY40	0·17
ACY41	0·17
ACY44	0·31
AD136V	0·96
AD140	0·50
AD140	0·55
AD142	0·50
AD143	0·45
AD149V	0·66
AD149V	1·26
AD150	0·63
AD161	0·37
AD162	0·37
AD161 }	PR
AD162 }	0·69
ADZ11	1·50
ADZ12	1·75
AF106	0·27
AF109R	0·40
AF114	0·25
AF115	0·24
AF116	0·25
AF117	0·20
AF118	0·50
AF121	0·22
AF124	0·24
AF125	0·20
AF126	0·19
AF127	0·20
AF139	0·38
AF170	0·25
AF172	0·25
AF178	0·55
AF179	0·65
AF180	0·50
AF186	0·40
AF200	0·35
AF239	0·41
AF240	0·72
AF279	0·54
AF280	0·54
AFY42	0·74
AF211	0·55
AL102	0·75
AL103	0·70
ASY26	0·30
ASY27	0·36
ASY28	0·28
ASY29	0·30
ASY50	0·20
ASY55	0·35
ASZ21	0·55
AU103	1·25
BC107	0·14
BC108	0·13
BC109	0·14
BC113	0·13
BC114	0·12
BC115	0·15
BC116	0·15
BC116A	0·18
BC117	0·21
BC118	0·11
BC119	0·27
BC121	0·23
BC123	0·29
BC125	0·15
BC126	0·20
BC132	0·30
BC134	0·11
BC135	0·11
BC136	0·15
BC137	0·15
BC138	0·20
BC140	0·34
BC141	0·39
BC142	0·24
BC143	0·21
BC144	0·24
BC145	0·21
BC147	0·11
BC148	0·10
BC149	0·13
BC153	0·18
BC154	0·18
BC157	0·14
BC158	0·13
BC159	0·14
BC160	0·37
BC167B	0·11
BC168B	0·13
BC168C	0·11
BC169B	0·13
BC169C	0·13
BC170	0·11
BC171	0·13
BC172	0·11
BC182	0·10
BC182L	0·10
BC183	0·09
BC183L	0·09
BC184	0·11
BC184L	0·11
BC186	0·25
BC187	0·25
BC204	0·11
BC205	0·10
BC206	0·11
BC207	0·10
BC208	0·09
BC209	0·10
BC211	0·30
BC212K	0·10
BC212L	0·12
BC214L	0·14
BC236	0·16
BC237	0·09
BC238	0·09
BC239	0·09
BC251	0·20
BC252	0·18
BC253	0·23
BC257	0·09
BC258	0·09
BC259	0·13
BC261	0·20
BC262	0·18
BC263	0·23
BC300	0·42
BC301	0·34
BC302	0·27
BC303	0·54
BC304	0·43
BC307	0·10
BC307A	0·10
BC307VI	0·10
BC308	0·09
BC308A	0·09
BC308B	0·09
BC309	0·10
BC309A	0·10
BC309B	0·10
BC313	0·30
BC327	0·24
BC328	0·22
BC337	0·19
BC338	0·19
BCY30	0·35
BCY31	0·40
BCY32	0·60
BCY32	0·75
BCY33	0·34
BCY34	0·35
BCY38	0·40
BCY39	1·05
BCY40	0·50
BCY42	0·15
BCY43	0·15
BCY58	0·21
BCY59	0·22
BCY66	0·66
BCY67	0·94
BCY70	0·17
BCY71	0·22
BCY72	0·13
BCY87	3·47
BCY88	2·40
BCY89	0·80
BCZ10	0·35
BCZ11	0·50
BD115	0·75
BD116	0·75
BD121	0·75
BD123	0·82
BD124	0·67
BD130	0·57
BD131	0·40
BD132	0·50
BD135	0·43
BD136	0·49
BD137	0·55
BD138	0·63
BD139	0·71
BD140	0·83
BDY10	1·25
BDY11	1·50
BDY17	1·50
BDY18	1·75
BDY19	1·97
BDY20	0·92
BDY38	0·65
BDY60	0·90
BDY61	0·85
BDY62	0·75
BF115	0·23
BF117	0·43
BF119	0·58
BF121	0·25
BF123	0·27
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BF166	0·35
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BF180	0·35
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BF182	0·30
BF183	0·40
BF184	0·17
BF185	0·17
BF194	0·14
BF195	0·15
BF196	0·15
BF197	0·15
BF198	0·15
BF199	0·18
BF200	0·35
BF224J	0·14
BF225J	0·19
BF237	0·22
BF238	0·22
BF244	0·16
BF245	0·33
BF246	0·43
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BF254	0·14
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BF273	0·25
BF274	0·28
BF457	0·46
BF458	0·57
BF459	0·57
BFS21	2·10
BFS21A	2·30
BFS28	0·92
BFS61	0·27
BFS98	0·28
BFW10	0·61
BFW11	0·61
BFW15	0·35
BFX13	0·23
BFX29	0·25
BFX30	0·25
BFX37	0·30
BFX44	0·33
BFX63	2·48
BFX68	0·30
BFX84	0·24
BFX85	0·29
BFX86	0·24
BFX87	0·25
BFX88	0·20
BFX89	0·45
BFY10	0·35
BFY11	0·45
BFY17	0·90
BFY18	0·25
BFY19	0·25
BFY20	0·50
BFY29	0·40
BFY37	0·20
BFY41	0·48
BFY43	0·62
BFY50	0·16
BFY51	0·16
VFY52	0·16
BFY53	0·15
BFY56	0·34
BFY64	0·41
BFY75	0·40
BFY76	0·22
BFY77	0·24
BFY78	0·36
BFY90	0·60
BRY39	0·30
BSX19	0·13
BSX20	0·14
BSX21	0·20
BSX26	0·34
BSX27	0·34
BSX28	0·25
BSX29	0·47
BSX30	0·68
BSX59	0·78
BSX60	0·54
BSX61	0·42
BSX76	0·15
BSX77	0·20
ASX78	0·25
BSW70	0·28
BSY24	0·20
BSY25	0·15
BSY26	0·20
BSY27	0·15
BSY28	0·15
BSY38	0·15
BSY39	0·15
BSY51	0·25
BSY52	0·25
BSY53	0·25
BSY54	0·30
BSY56	0·79
BSY65	0·15
BSY78	0·40
BSY79	0·40
BSY790	0·45
BSY95A	0·09
BU104	1·42
BU105	2·25
C111	0·53
D40N3	0·62
GET111	0·45
GET113	0·20
GET114	0·20
GLT115	0·50
GET119	0·35
GET120	0·25
GET535	0·20
GET536	0·20
GET538	0·20
GET873	0·12
GET880	0·30
GET883	0·20
GET887	0·20
GET890	0·22
GET895	0·25

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Post & Packing 13p per order. Europe 25p. Commonwealth (Air) 65p (MIN.) Matching charge (audio transistors only) 15p. extra per pair. Prices subject to stock availability.

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	1–24 £p	25+ £p		1–24 £p	25+ £p		1–24 £p	25+ £p
SN7400	0·20	0·18	SN7428	0·50	0·41	SN7460	0·20	0·18
SN7401	0·20	0·18	SN7430	0·20	0·18	SN7470	0·30	0·26
SN7402	0·20	0·18	SN7432	0·48	0·42	SN7472	0·30	0·25
SN7403	0·20	0·18	SN7433	0·71	0·62	SN7473	0·40	0·34
SN7404	0·20	0·18	SN7437	0·52	0·45	SN7474	0·40	0·34
SN7405	0·20	0·18	SN7438	0·52	0·45	SN7475	0·45	0·35
SN7406	0·30	0·24	SN7439	0·52	0·45	SN7476	0·44	0·39
SN7407	0·56	0·48	SN7440	0·20	0·18	SN7480	0·75	0·70
SN7408	0·20	0·18	SN7441AN	0·75	0·72	SN7481	1·25	1·07
SN7409	0·20	0·18	SN7442	0·79	0·68	SN7482	0·87	0·61
SN7410	0·20	0·18	SN7443	1·04	0·88	SN7483	1·00	0·82
SN7411	0·22	0·20	SN7444	1·04	0·88	SN7484	0·95	0·85
SN7412	0·42	0·36	SN7445	1·85	1·70	SN7485	2·50	2·30
SN7413	0·30	0·27	SN7446	2·00	1·60	SN7486	0·45	0·40
SN7416	0·45	0·40	SN7447	1·30	1·20	SN7488	12·40	11·80
SN7417	0·45	0·40	SN7448	1·04	0·92	SN7489	4·97	4·40
SN7420	0·20	0·18	SN7449	Price to be		SN7490	0·80	0·75
SN7421	0·22	0·20		announced shortly		SN7491	1·20	1·06
SN7422	0·48	0·42	SN7450	0·20	0·18	SN7492	0·75	0·70
SN7423	0·52	0·45	SN7451	0·20	0·18	SN7493	0·75	0·70
SN7425	0·48	0·42	SN7452	0·20	0·18	SN7494	0·84	0·80
SN7426	0·32	0·28	SN7453	0·20	0·18	SN7495	0·80	0·74
SN7427	0·48	0·42	SN7454	0·20	0·18	SN7496	1·00	0·90

SUB-MIN ELECTROLYTIC

Axial lead — **6p each**

Values: (μF/V); 6·64/64; 1/40; 1·6/25; 2·5/16; 2·2/63; 4·7/16; 4·7/25; 6·4/6·4; 6·4/25; 10/16; 10/25; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/10; 32/40; 40/16; 50/6·4; 50/25; 50/40; 64/10; 80/16; 80/25; 100/6·4; 125/10; 125/16; 200/10.

SILICON RECTIFIERS

PIV	50	100	200	400	600	800	1000	1200
1A	8p	9p	10p	11p	12p	15p	20p	—
3A	15p	17p	20p	22½p	25p	27p	30p	35p
6A	—	—	25p	30p	32½p	35p	—	—
10A	30p	35p	40p	47p	56p	66p	75p	—
15A	36p	45p	48p	55p	65p	75p	87p	—
35A	70p	80p	90p	£1·00	£1·40	£1·70	£2·75	—

1 amp and 3 amp are plastic encapsulation.

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IN34A	10p	AA119	7p	BAX16	12½p	FST3/4	22½p
IN914	7p	AA129	15p	BAY18	17½p	OA5	17p
IN916	7p	AAZ13	12p	BAY31	7p	OA10	20p
IN4007	20p	AAZ15	12p	BAY38	25p	OA9	10p
IS44	7p	AAZ17	10p	BY100	15p	OA47	8p
IS113	15p	BA100	15p	BY103	22p	OA70	7p
IS120	12p	BA102	25p	BY122	47½p	OA73	10p
IS121	14p	BA110	25p	BY124	15p	OA79	7p
IS130	8p	BA114	15p	BY126	15p	OA81	8p
IS131	10p	BA115	7p	BY127	17p	OA82	10p
IS132	12p	BA141	17p	BY164	57p	OA90	7p
IS920	7p	BA142	17p	BYX10	22p	OA91	7p
IS922	8p	BA144	12p	BYZ10	35p	OA95	7p
IS923	12p	BA145	17p	BYZ11	32p	OA200	7p
IS940	5p	BA154	12p	BYZ12	30p	OA202	10p
		BAX13	5p	BYZ13	25p	TIV307	50p

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MINITRON 3015F 7-SEGMENT INDICATOR (16 PIN DIL) £2·00
May be driven by SN7447

TIL 209 LIGHT EMITTING DIODE. Made by TEXAS INST. (Red). 35p

B9900 PHOTORESISTOR 38p

VEROBOARD

	0.15 Matrix	0.1 Matrix
2½ × 3¾in	17p	23p
2½ × 5in	25p	25p
3¾ × 3¾in	25p	25p
3¾ × 5in	30p	29p
5 × 17in (Plain)	82p	—

Vero Pins (Bag of 36) 20p
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Pin insertion Tools (·1 and ·15 matrix) at 55p.

"SCORPIO" CAP DISCHARGE IGNITION SYSTEM
(As published in P.E. November 1971)
Complete kit £10·00
P. & P. 50p.

SLIDE POTENTIOMETERS

58 mm, TRACK
SINGLE GANGED. LOG or LIN 1k to 1M. 40p each.
TWIN GANGED. LOG or LIN 1k to 500k 60p each

MULLARD C280 M/FOIL CAPACITORS

0·01, 0·022, 0·033, 0·047	3p each
0·068, 0·10	4p each
0·15, 0·22, 0·33	5p each
0·47	9p
0·68	11p
1μF	14p
1·5μF	21p
2.2μF	25p

WIRE-WOUND RESISTORS

2·5 watt 5% (up to 270 ohms only), 7p
5 watt 5% (up to 8·2k Ω only), 9p
10 watt 5% (up to 26k Ω only), 10p

POTENTIOMETERS

Carbon:
Log. or Lin., less switch, 16p
Log. or Lin., with switch, 27p
Wire-wound Pots (3W), 38p
Twin Ganged Stereo Pots, Log. or Lin. 43p.

PRESETS (CARBON)

0·1 Watt	6p	VERTICAL
0·2 Watt	6p	OR
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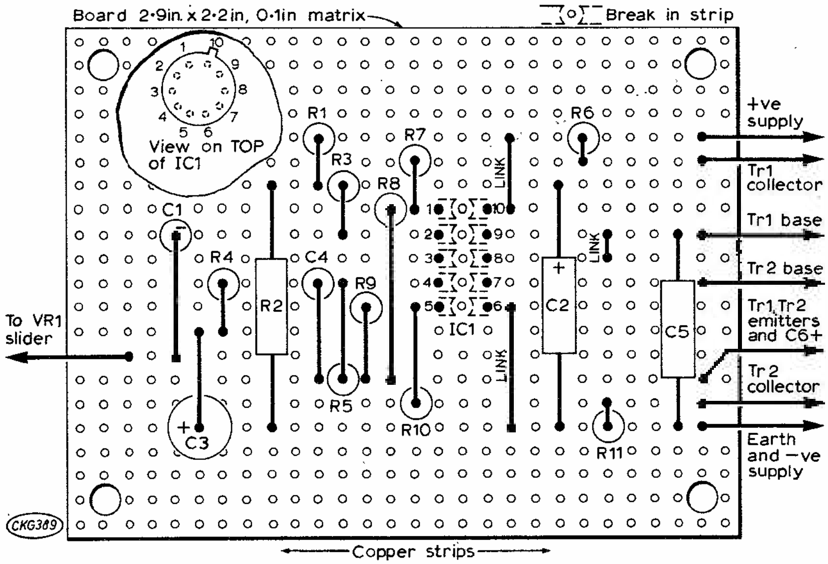


Fig. 3: Component layout on top of veroboard, the copper strips running horizontally underneath.

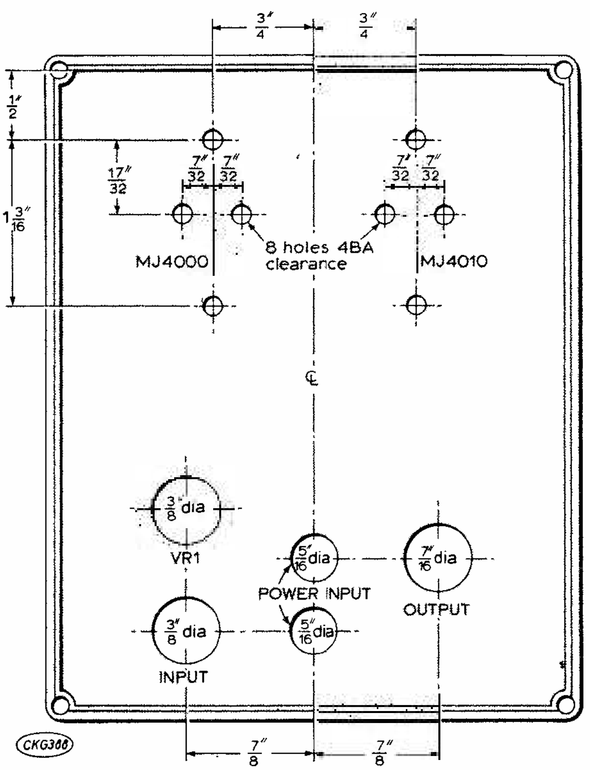
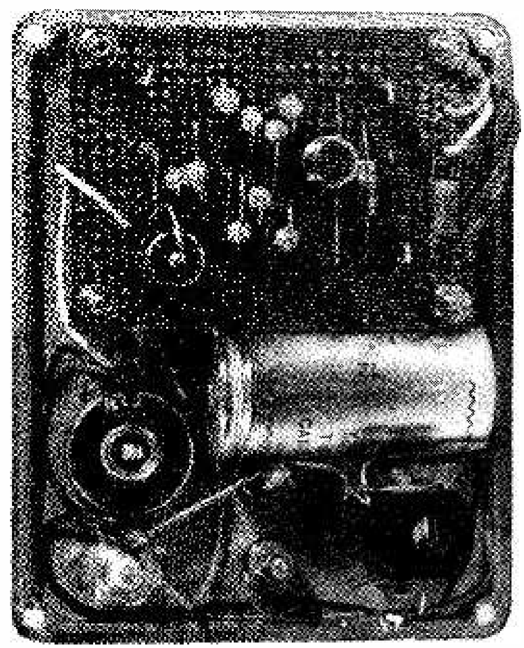


Fig. 2: Drilling details for the box lid on which components are mounted



This view of the completed amplifier emphasises the restrictions on the physical size of the output capacitor C6.

They are based on a supply voltage (Vcc) of 35V and a loudspeaker impedance of 8Ω (R_L). Before beginning the calculations it must be remembered that there are two limitations imposed by the active devices used; the supply voltage must be in the range 10 to 40V, and the maximum current through the transistors Tr1, Tr2 must not exceed 4A. We can calculate:

Peak current in transistors is:

$$\frac{V_{cc}}{2R_L} = 2{\cdot}2\text{A } (I_{pk})$$

If this value is above 4A we must use either a lower supply voltage or higher load impedance. To provide current limiting of this value and assuming no voltage drop across R7, R10 we calculate the values of R6 and R11 as:

$$R6 = R11 = \frac{650\text{mV}}{I_{pk}} = \frac{0{\cdot}65}{2{\cdot}2} = 0{\cdot}296\ \Omega$$

The nearest preferred value of resistor, which must be lower in value than the calculated value, is 0·27Ω. The basis of the working of the power limiting facility is difficult to explain in such a short article but works on the principle that both a high voltage across or a high current through a transistor and its network of resistors (Tr1, R6, R7 and R8) will tend to turn off the transistor. The resistor network acts to sense the power dissipation in the transistor and to limit this dissipation. The value of R7 and R10 is 56Ω. In all cases the value of R8 and R9 is:

$$R8 = R9 = \frac{V_{cc}}{6mA} = 5{\cdot}8k\Omega$$

The next highest preferred value, 6·2kΩ, is rather difficult to obtain and the value has been increased to 6·8kΩ. The voltage gain of the circuit is 100 and although this may be altered by changing the value of R4, the effect of such a change on the stability of the amplifier is difficult to predict. Under d.c. conditions the capacitor C3 represents an open circuit and the d.c. gain becomes zero, the voltage at the emitters of the two transistors, determined by the ratio of the values of R1 and R2, being at half the supply voltage.

★ components list

Resistors

R1 4·7kΩ	R5 10kΩ	R9 6·8kΩ
R2 4·7kΩ	R6 0·27Ω ± ·02	R10 56Ω
R3 10kΩ	R7 56Ω	R11 0·27Ω ± ·02
R4 100Ω	R8 6·8kΩ	VR1 5kΩ log

All ½W 5% except R6 and R11

Capacitors

C1 1·6μF 40V	C4 10pF
C2 6·4μF 25V	C5 2000pF
C3 50μF 35V	C6 500μF 50V

Note: C6 should not be over 2¼" long and 1" dia.

Semiconductors

Tr1 MJ4000 Tr2 MJ4010
(both with mica washers and bushes)
IC1 NE540L
Available from SCS Components, POB 26, Wembley, Middlesex

Miscellaneous

Diecast box, 4½" x 3½" x 2". Veroboard 2·9" x 2·2", 0·1" matrix. Input socket, Output jack socket.

CONSTRUCTION

The complete circuit is constructed in a diecast aluminium box using the lid to hold all the components and the rest of the box as the cover. Fig. 2 shows the lid marked out for drilling, after which the power transistors are mounted (the NPN transistor Tr1, MJ4000 on the left as seen in Fig. 2) **using mica washers with bushes.** It is best at this stage to check whether the collectors of the transistors have been accidentally shorted to the box lid. The remainder of components should be fixed to the box lid, a tag washer under the input socket nut providing the main connection to the lid.

The component board is a 2·9in. x 2·2in. piece of 0·1 matrix veroboard, with the copper strips running along the 2·9in. length of the board, Fig. 3. After cutting the strips below the i.c., drilling the mounting holes and cleaning up the rough edges, a few moments should be spent with a meter checking that no lines are shorted together and that the strips below the i.c. are completely severed.

There should be no difficulty in constructing the board, but it is advisable to use different coloured wires for the flexible connections as this assists in the final wiring. The capacitor C6 is held in place by its wire leads, the positive end of the component being connected to the emitter of Tr1. The circuit board is held above the transistors on four 4BA screws with either two sets of nuts and washers or 1in. long spacers. The nut heads are stuck on the box lid with epoxy resin adhesive.

The final stage of wiring consists of connecting all the leads from the board to their respective terminations, wiring a negative supply earth lead to the earth end of the output socket, the negative supply socket, and the solder tag on the input socket. Lastly a wire is taken from the centre of the input socket to one side of VR1, the remaining potentiometer connection being taken to earth (the slider goes to the input on the board).

A power supply capable of delivering the maximum requirements of the amplifier must be used. In the author's case a supply of 35V at 2·5A. Under these conditions the amplifier was able to deliver nearly 15W r.m.s. into an 8Ω load. ■

CQ! CQ! CQ! CQ! CQ!

ISSUES WANTED

...an issue of July 1972 P.W. for Texas Amp. Gen:—A. Palfreyman G3UHD, 39 Gledhow Park Avenue, Chapel Alleton, Leeds, LST 452.

...1971 issues of Practical Wireless, January, May & July issues.—Mr. Ong Choo Sian, Flat 12B, Jalan Berhala, Off Jalan Brickfields, Kuala Lumpur.

...Practical Wireless No. 5 Vol. 47—1971—E. Blackham, 89 Myatt Avenue, Parkfields, Wolverhampton, Staffs, WV2 2DN.

...May, June, July, September Practical Wireless for the year 1971. Also Jan. 71 P.E.—J. Nolan, 274 Packington Square, Islington, London, N1. 7VH.

...April 1970, Practical Wireless. To buy or borrow. All postage etc. paid.—A. Lythaby, 25 Greenhill Road, Otford, Sevenoaks, Kent.

...P.W. issues March 1972 to October 1972, will consider any offer.—Mr. J. Holland, 10 Coburg Road, Ramsey, Isle of Man.

...April, June, July 1967 and Feb. 1968 Practical Television—B. C. Meek, 39 Horsebrook Lane, Brewood, Stafford.

...(in good condition) August 1971 and April and March 1972 issues P.W. Full price plus postage paid.—D. Mooney, 85 Aughincork Road, Glenanne, Co. Armagh, N. Ireland.

...P.W. Oct. 1971 Wall chart circuit building bricks. December 1971 issue of PW and Oct 1972 Aerial Data Wall Chart of P.W.—Loong Kok Choong, 1477, Main St. Jinjang North K. Lumpur, West Malaysia.

...P.T. Nov. 1971 to Feb 72.—K. Dodman, 2 Beaumont Road, Carlton Colville, Lowestoft, Suffolk.

...P.W. December 71, January & February 72 on loan. Will be returned.—S. G. Christian, Mulginagar Colony, Block ii/B. Nizampura, Baroda, Gujarat State, India.

...P.W. containing the article on the Double Conversion Communications receiver. R. Thorneycroft, 12 Orchard Mead, Hatfield, Herts.

...Television for March, April, May and June 1972.—R. T. McCoy 34, Karana Avenue Grovedale, Victoria 3221, Australia.

...March 1972 "Television" with the servicing of the Bush TV103/TV105.—M. V. Gardner, 180 Clonkeen Crescent, Dun Lasghair, C. Dublin, Ireland.

...issues of P.W. about ten years ago that covered an article on an oscilloscope. I have been given a scope but do not know the function of the controls.—P. Leyser, 17 Lapal Lane North, Lapal, Halesowen, Worcs.

...all back issues of P.W.—F. Murphy, 10 Upton Court. Upton, L49 6LS. Wirral, Cheshire.

...issues of P.W. that contained details of capacitive discharge systems:—J. Smith, 9 Amherst Avenue, Handsworth Wood, Birmingham. B20 2LH.

...P.W. Jan. 1972. April 1972, E.E. Nov. 1971. Feb. 1972, March 1972. Will pay face value plus postage and packing. All replies answered. Redwood, 45A Lulworth Avenue, Poole, Dorset, BH15 4DH.

...P.W. February and April 1972.—Ramesh Udyawar, C/O Post Box 610, Bombay 1, India.

...P.W. February 1972 issue containing details of the "Transistor Scope".—Mr. A. Chaplin, 26 Wakering Avenue, Shoeburyness, Nr. Southend-on-Sea, Essex.

...P.W. January 1972—T. Fresson, Fernilee, Churt, Farnham, Surrey.

...May 1972 edition of Television or a photostat of the second part of the colour television project.—C. A. Wilson, 23 Friars Oak Road, Hassocks, Sussex.

...P. W. February, March, June and July 1968.—D. Appleford, 34, Dennistead Crescent, Headingly, Leeds.

...wanted P.W. November 71 to March 72. Mr. C. S. Hodgson, 18 Kensington Avenue, Normanly. Teesside.

...January 1972. PW. or circuit and data for B.F.O.—E. Caines, 13 Bates Close, Pennywell Road, Bristol 5.

...November and December 1971 of P.W.—G. J. Dummett, 67D Shooters Hill Road, Blackheath, London, S.E.3.

...The issues of P.W for September and October 1971.—J. Balicki, 3 Millfields, Writtle, Essex.

HOTLINES

ON RECENT DEVELOPMENTS

FOR some time now, weather satellites have been happily orbitting the earth some 800 miles up. These animals transmit a picture of the earth and a suitably equipped station below can receive these pictures. They show cloud distribution which is useful in helping to guess whether it will rain or not on the following washday.

3D RAIN?

Now comes news about a satellite built by the RCA. It is equipped with special sensors and boasts the distinction of being the very first operational satellite to provide a three-dimensional picture of the earth's weather. It is equipped with some very impressive sounding equipment; a scanning radiometer, a very high resolution radiometer and a vertical temperature profile radiometer.

The very high resolution radiometer (v.h.r.r.) has two channels and offers images from both the visible and infra-red regions. It can sense the thermal energy given off by objects below, down to half a mile in area.

Resolution is far better than the pictures provided by television cameras or the radiometers used in earlier satellites. The solar cells in the satellite, NOAA-2, generate some 500 watts and over 10,000 individual cells are used to achieve this power. Who knows—television announcers of the future may be forecasting that three dimensional rain is on the way.

LIQUID CRYSTALS

It now seems a certainty that liquid crystal displays will have a big impact on the electronics market. I reported these as being already built into a multi-digit display being marketed at the Electronica exhibition in Germany late last year. Now, the U.S. giant, North American Rockwell is reported to be mass-producing liquid crystal devices.

The liquid crystal phenomenon was first discovered way back, as long ago as 1888. The basic principle is that certain liquids become opaque when they are subjected to an electric field. With no field present, they are transparent. The North American Rockwell displays consist of two small plates of glass. Although these are bonded together, they are separated by a tiny gap—about a thousandth of an inch. This tiny gap is filled with the special liquid which is affected by an electric field. The cell is thus completely transparent.

However, when a small electric field is applied (this takes about 25V to achieve the desired effect) the cell becomes opaque. Without a field, the molecules in the liquid are uniformly and regularly oriented. The application of the electric field causes this molecular structure to become disoriented and the molecules thus scatter the light giving an opaque effect.

The voids or spaces into which the liquid is put can be formed into figures or letters for the purposes of forming a display. Conductors to the liquid are formed from tin oxide which is a transparent conductor. The liquid crystal display draws almost no power—about 10mW or one hundredth of a watt. Perhaps we will have windows some day which will be clear until we press a button?

OZONE SPEEDS UP RESIST REMOVAL

Integrated circuits (i.c.'s) are delicate little beasts especially during their manufacture. Part of this process is a photographic one. There is a particular stage in the printing of each mask where unwanted photo-resist has to be removed. Considering the size of elements on individual i.c.s this removal is a delicate business. The General Electric Company in the U.S.A. have come up with a new method of removing unwanted photoresist. It consists of exposing the resist to ultra-violet rays in the presence of air. It takes about 40 minutes for a typical film of resist to be removed. The depolymerisation of the resist happens at a rate of about a thousand angstroms per minute. By injecting 2% ozone gas into the chamber with the specimen the process is speeded up some ten times.

Earlier, I talked of liquid crystals and many have leapt in claiming that the solid state flat tube television screen is here. One British manufacturer, however, is obviously unimpressed. Mullard has opened a new factory in County Durham. The sole purpose is to manufacture shadow mask colour television tubes.

Although only officially opened in December last year, pilot production was already said to be running at the rate of 100,000 tubes delivered from this plant. By the end of this year, production is estimated to be in the region of 500,000 tubes and by the end of this present decade, production will be running at some 900,000 tubes/annum. All this adds up to a lot of colour television receivers—have you got yours yet?

LASERS ARE BACK

Lasers are back in the news again, this time in America where the Optical Physics Division of the National Bureau of Standards is applying one to monitor pollution. A major contributor to atmospheric pollution is nitrous oxide. It is found lurking in such jolly jollop as flue gases and in the exhaust fumes from motor vehicles.

The laser beam is directed through a magnet whose coils are driven by an audio amplifier and is detected by an infra-red device. The amplifier generates a modulating magnetic field which has the effect of sweeping the absorption line through the laser line. The detector produces a signal which has a direct relationship to the amount of nitrous oxide in the sample being investigated.

Concentrations of nitrous oxide as low as 20 parts per million (p.p.m.) can be detected but workers believe that concentrations right down to 0·1 p.p.m. will be detectable as the method is improved.

FLYING SPOT

Useful things oscilloscopes. Have you ever wondered just how fast that tiny spot of light travels across the cathode ray tube? Before you start to make calculations, think of the latest fast writing oscilloscope, the HP 184A. The writing speed for this unit is so fast that the spot travels 400cm in one millionth of a second.

Ginsberg

NAUTICAL RADIO AIDS

IAN SINCLAIR

EVER since the day when Marconi equipped the yacht *Elettra* with radio to act as a mobile test-bed, electronics and boats have been closely associated. The first really extensive use of radio was at sea, and after the Titanic disaster all ships were required to keep radio watch continuously for distress signals. The requirement for ships to be fitted with radio and staffed with trained operators did not, however, extend to small boats at that time, and it is only fairly recently that radio and electronic aids for pleasure craft have become more of a necessity for serious boating.

MARINE HAZARDS

Electronic devices for use at sea present some design problems which do not appear in land-based equipment. The most obvious hazard is moisture, not the fresh water moisture of a foggy day on land but the salt-laden moisture which corrodes its way through soldered joints, cable terminations, plugs and sockets, and most other metal-to-metal joints in a remarkably short time. As well as the corrosion problem, which can be completely solved only by total encapsulation, there is the problem of insulation resistance.

Salt spray is quite a good conductor and in valve equipment in particular, operating at high voltages, protection of equipment from saline elements is a problem to designer and operator alike.

It was largely the water-spray problem, as well as the cost factor, which has kept electronics out of small craft for so long. In large vessels, the radio and radar equipment could at least be mounted in an enclosed space at a reasonable height above the deck, well away from the direct spray except in the most extreme conditions. In small boats, such spray-free havens cannot be found, and there is little chance of keeping the equipment free of water by heating coils, as were once used on bridge-mounted radio and radar.

The advent of solid state equipment has opened up a new dimension in marine applications, especially with the possibility of cutting down on interconnections by using integrated circuits. Vibration is one of the most pressing problems in small craft, where the rumble of even a small diesel engine is enough to loosen plugs from sockets or wires from soldered joints.

Some of the most up-to-date equipment used for pleasure craft can be seen at the annual Boat Show, held each year in London in January. This year you would have found amongst other more glamorous displays, several kinds of communications equipment.

One stand showed a "triple-standard" television receiver, complete with inverter for use with ship batteries, for use in most yachting centres in the world. But for those who insist on wind in their sails, there was a complete analogue computer, taking information on wind speed and direction, water speed, currents, intended course, and displaying the optimum trim on a model.

RADIO AIDS

Radio is still the mainstay of marine electronics, and it is hardly surprising that there should not be many advances in this direction as there are in instrumentation. The latest ranges of transmitter/receivers are geared to the most recent International regulations, which call for s.s.b. working in the marine bands between 250kHz and 4·1MHz and the use of all solid state equipment has resulted in very compact apparatus.

A large number of v.h.f. and u.h.f. radiotelephones were also shown, and one interesting new development is the Marconi "Pocketphone" intended for communication on large vessels, such as tankers, and during docking and cargo handling operations.

The v.h.f. and u.h.f. equipment uses frequency modulation, and most make provision for the reduction of channel spacings to 25kHz, which will soon be a Post Office requirement. The bands used are within the range 148MHz to 174MHz in v.h.f. and 440MHz to 470MHz in u.h.f. Communications equipment was being shown by (among others) Marconi Marine, Electronic Laboratories (Marine), Ajax Electronics and S.P. Radio A/S of Denmark.

The latter firm was showing a receiver operating under the spray from a waterfall, whose salt content I did not sample, and also showed the "Dual-watch" facility on receivers. This enables the operator to fulfil the requirements of listening for distress signals along with normal working. The distress frequency is preset, so that the set is tuned permanently to that frequency in the watching circuits.

Working can be continued on other channels, and if a signal is received on the distress frequency (or any other being watched) the receiver output is instantly and automatically switched to the watched frequency. A lamp indicator also shows when a call is being received on the watched channel, and flashes during normal operation to show that the watch is being carried out.

DIRECTION INDICATOR

An interesting device for the small boat is the "Seafix", a hand-held radio direction indicator by Electronic Laboratories (Marine). This consisted of a t.r.f. transistor receiver with "autodyne" detection over the range 200 to 400kHz, with the calibration most accurate at 300kHz, the centre of the Marine Beacon band.

Switched to NAV, the autodyne circuit is used to receive beacon transmissions, and the highly directional ferrite rod aerial can be used for finding the bearing of the beacon within 2° (at half rated range). Switched to BC, the "Seafix" can be used to pick up the long-wave shipping forecasts broadcast on this band. A stethoscope headset was used in preference to loudspeakers or conventional phones, and water sealing was by the conventional compressed rubber gaskets.

RADAR

Radar has for a long time been one of the most important navigational aids for larger vessels, but is seldom seen on smaller craft. There are several reasons for this: the cost of any radar installation is high, since it must include the cost of modifications to the vessel as well as the provision of the apparatus.

Radar equipment is often unavoidably large, heavy and dependent on high voltages, since the cathode-ray tube and the magnetron must use high voltages, although it is now possible to replace the klystron local oscillator by Gunn diodes or other semiconductor devices.

The Hepplewhite Marine Check radar detector lets you know if you are on a collision course.

Manufacturers are not dragging their heels over these problems, but are commendably cautious, since they know only too well how much the readings of a radar receiver come to be relied on. Any compression of size or cost must therefore not be made at the expense of accuracy of plotting if we are not to have a rash of "radar-assisted" collisions. All the big names in marine radar (Decca, E.M.I., Marconi Marine) showed small radar outfits, but these were not really intended for the amateur.

The Hepplewhite "Marine Check" is a continuous scanning self-powered instrument designed to minimise risk of collision with other vessels whose radar may not pick up small boats in bad weather or low visibility—the "Marine Check" will however, detect the other vessel's radar transmission and allow you to take avoiding action.

The scanning head is a miniature, precision, solid-state detector and amplifier of continuous, pulsed and modulated X-band radar transmission (9,000 to 11,500MHz) with electronics mounted in a shock-proof case and will receive radar transmissions at sighting distance.

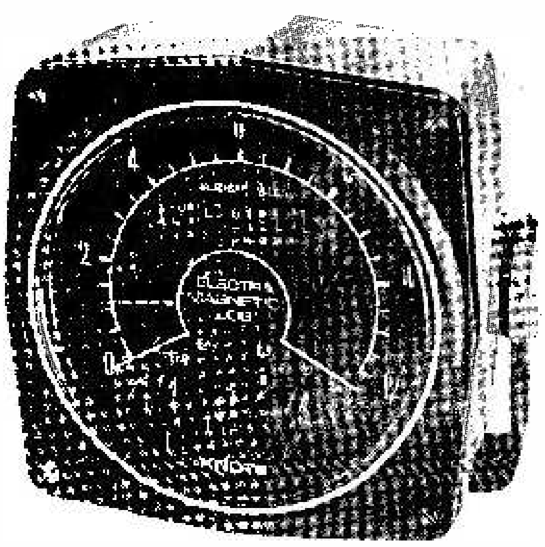
As the sensitivity is reduced, the directional power of the antenna is proportionately increased to a point where the bearing is located on a narrow sector. If this bearing, which is indicated on a compass scale, remains constant, you may be on a collision course, also as the pulse length increases as the distance decreases, it is possible, within limits to determine if the transmitting vessel is approaching or receding.

The "Seascan" radar by Electronic Laboratories (Marine) is designed for the amateur, and has a power consumption of only 48W from 12V, 24V or 48V battery supplies. The only vacuum devices used are the display tube and the magnetron, the local oscillator being a Gunn diode whilst the magnetron modulator uses a thyristor. Unfortunately no circuit details were available and all the units on the stand were dummies.

One interesting new development in radar for the small craft is a passive radar detector by Hepplewhite Marine. This picks up the X-band (9,000 to 11,500MHz) transmissions from other vessels, and has a small directional aerial consisting of a Perspex "horn" on which waves are guided (along the surface) by the effect of the permittivity of the material. The received radar signals are mixed with the output of a local oscillator, and the beat note amplified. The point of strongest signal can be identified by altering the mixer bias so that only a signal of the maximum strength will produce a beat note; this enables the operator to find the bearing of the craft carrying the radar.

SPEED MEASUREMENT

Water and wind speed instruments have for a long time been a weak point in the instrumentation of boats. The traditional methods of measuring speed have depended on anemometers for wind speed and submersible "logs" for water speed. The anemometer is the device using three or four cups at the ends of radial rods pivoted so that the effect of wind is to revolve the assembly about its axis. The



The Electra Magnetic Log is an impellerless speed and distance indicator.

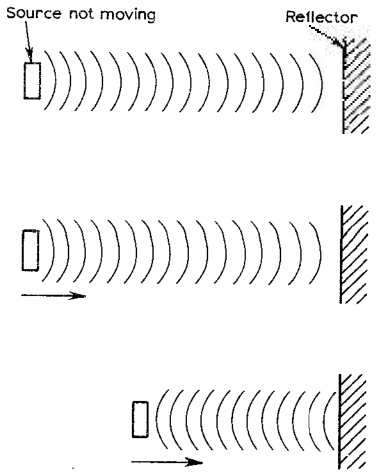


Fig. 1: The Doppler Principle.
Imagine a transducer giving out sound waves. These waves travel in water at a speed of about 1,000 metres per second. Speed equals frequency multiplied by wavelength.
If the transducer moves at a speed "V", the speed of the waves towards the reflector is now 1,000+V metres per second. We have not changed the frequency of transmission, so the wavelength must now be less.
($1{,}000+V=f\times$ new wavelength.)
The waves are now reflected to a moving object, so that more waves per second hit the receiving transducer. The frequency is now higher by a factor $\frac{c+V}{c}$ where c is the normal wave speed and V is the speed of the transducer and boat. The final effect is to receive waves of shorter wavelength and higher frequency.

speed of rotation, which depends on the wind speed, is measured by counting the number of switching operations of a reed switch under the influence of a magnet on the rotating shaft. This count is converted into an analogue signal which drives a meter. Wind direction is found by using a vane coupled to a potentiometer to show the angular position by voltage detection on a meter.

The traditional submersible "log" consists of a small propeller whose shaft is held in a casing containing a reed switch. The rotation of the propeller as the "log" is towed behind then registers relative water speed just as the anemometer registers relative wind speed. The snag is that the propeller of the log is easily jammed by anything encountered in the water from jellyfish to seaweed, and this can have the effect of making calculation of speed and distance incorrect.

SPEED-LOGS

Two novel speed-logs were shown, each representing refreshingly different thinking about the problem. Space Age Electronics showed their Doppler speed log. This uses a ceramic transducer to project a 1MHz sound beam ahead of the ship. Most of the beam is dissipated in the water, but a small part is reflected from the layer of relatively still water (the boundary layer) close to the boat.

When the boat is moving, the reflected frequency is not the same as the transmitted frequency (Doppler Effect). If the boat is moving ahead, the reflected frequency is higher than the transmitted frequency; if the boat moves astern, the reflected frequency is lower.

Referring to Fig. 1, the transmitter, because of its movement, "packs in" more waves between itself and the still layer than it would if it were not moving. Because more waves are travelling, the wavelength seems shorter. Also, when the waves reflect from the boundary layer, the receiver has also moved towards them, making the frequency of the received waves seem higher.

When the reflected wave is detected, the shorter wavelength appears as a higher frequency (speed = frequency × wavelength), whose value depends on the difference between the speed of sound in water and the speed of the boat. By beating the transmitted frequency against the reflected frequency, a measure of speed can be obtained.

The method is dependent on obtaining a reflection from relatively still water, and so the transmitting/receiving head must be located where such a layer is within range. Precise location varies from boat to boat. To allow for variations in installation, the calibration is adjustable, so that the distance log can be checked against accurately known distances (between two land-marks, for example). The circuitry uses three integrated circuits, 17 transistors and eight diodes. A "log" accuracy of better than ± 1½% (typical) is claimed.

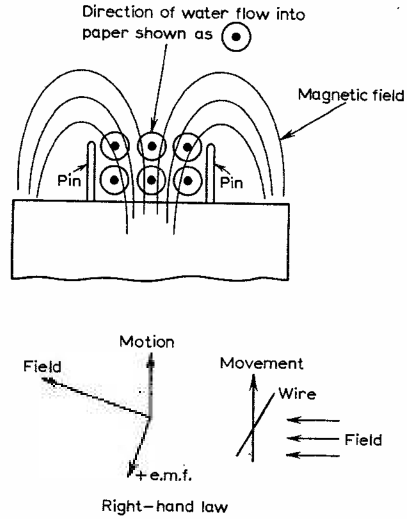


Fig. 2: An e.m.f. is produced between two metal contacts, providing the direction of flow is at right-angles to the line joining the contacts.

The "Electra" magnetic log, produced by E.M.I. marine uses the magnetohydrodynamic principle for its operation; this is the generation of a voltage by induction when a conducting liquid flows past a magnetic field.

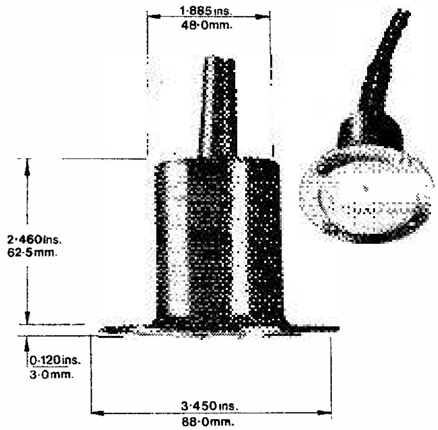
By arranging a magnetic field to cut the direction of water flow at right angles, an e.m.f. is induced between two metal contacts in the moving water, provided that the direction of flow is at right angles to the line joining the contacts (Fig. 2)

The Electra Magnetic Log operates on this principle, but with some ingenious modifications. The magnetic field used is an alternating field. In this way, the voltage generated is also alternating, which disposes of two problems at once. One problem is polarisation; when a steady voltage exists between two contacts in sea water, an electrolysis action takes place causing corrosion of the metal. The use of a.c. avoids polarisation problems and makes it easy to amplify and display the output from the contacts. As with the previous method, the positioning of the measuring head is critical.

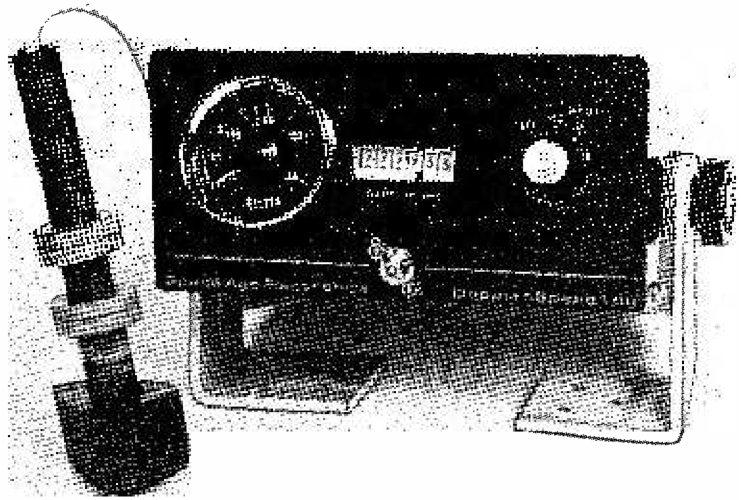
ECHOSOUNDERS

Echosounders have been used for a considerable time, and changes have been in detail rather than in concept. Basically, a marine echosounder consists of a pulse generator working at ultrasonic frequencies in the region 20kHz to 150kHz (the higher frequencies are used for inshore work). A transducer converts the electrical pulses into sound waves directed from the bottom of the boat into the sea, and a receiver, using the same transducer, detects the pulse reflected from the bottom of the sea.

The shape of the received pulse provides a guide to the nature of the sea bed, for example, a muddy



The electro-magnetic transducer for the magnetic log. As the boat moves along, a small e.m.f. is produced and sensed by two probes. This signal is then amplified and displayed in speed and distance units.



The Doppler speed-log does not rely on the flow of water to move a mechanical part like an impeller or paddle wheel. A small streamlined transducer, mounted flush with the underside of the hull, transmits a high frequency ultrasonic signal 70cms ahead. A small part of this signal is reflected back from the boundary layer between the hull and the water.

sea bed is indicated by a broad pulse, a sandy bed by a narrow pulse, a rocky bed gives multiple reflections. Pulses received from intermediate depths can indicate shoals of fish. The time delay between transmission and reception is proportional to the depth of sea.

Because the pulses are travelling in the water at the speed of sound (around 1,000 metres per second) rather than at the speed of radar waves in space (some 30 million metres per second), scanning rates have to be lower than the 1,000Hz commonly used in radar. Scanning rates of once per second are common, although this is rather too low for display on a long persistence cathode ray tube screen.

The display method traditionally used is a rotating wheel carrying, or illuminated by, a neon which flashes on transmission of the pulse and again when the echo is received. The stationary bezel round the wheel is then calibrated in metres of depth (now replacing fathoms on the latest charts).

The large number of echo sounders at the show demonstrated several novel points of design. Most interesting was the use of electro-luminescent diodes to replace neons, so avoiding the need to generate a high voltage supply (Brookes & Gatehouse). A common feature of all the echo sounders was the use of high scan rates for the shallow water ranges (up to six pulses per second) so giving better definition in critical conditions.

Lead zirconate titanate crystals were in evidence as transducers, encapsulated in various plastics. For professional use, chart recording echosounders were shown (these, of course, have been around for a long time). The Marconi Marine chart-maker used electrosensitive paper which changed colour when a small voltage was applied between the front of the paper and the back.

WATER-LEAK AND WATCH

In addition to the displays of electronics for communication and navigation, there were some interesting exhibits in the "miscellaneous" class. Space-Age Electronics were showing their water-leak and watch alarm, and judging by the sound which could be heard all over the first floor of Earls Court, almost every chandlery firm was demonstrating it.

The instrument is basically a conventional leakage detector using stainless steel pins as probes. If the pins are immersed in water for more than four seconds, an alarm is given, but only if the immersion is for longer than four seconds, a time carefully chosen to avoid continual false alarms in heavy seas. When there is no conductivity between the pins, all transistors are biased off, so ensuring practically no standby current. The sound given out is a rising frequency note which is most easily distinguished amongst other sounds.

The watch facility also provided on this instrument gives an alarm note of gradually increasing amplitude every three minutes. If an alarm button is pressed during the alarm, or before it, the instrument remains silent until another three minutes has passed. If the helmsman is asleep and does not press the alarm button, the alarm warning increases to maximum intensity.

GAS ALARM

The Electra gas alarm, from E.M.I. Marine, is of considerable interest. Unlike previous gas alarms, which used heat conduction from a hot wire to detect changes in the air composition, the Electra gas alarm uses semiconductor sensors. No details were given, but it is possible that the sensors consisted of infra-red electroluminescent diodes and detectors. Any change in the air composition caused by petrol vapour, butane or propane gas, carbon monoxide, smoke, paraffin fumes, diesel fumes is indicated by two visual warnings in the form of a meter reading and a red warning lamp.

In addition, a loudspeaker gives out a 2·5kHz note when the gas concentration exceeds the safe limit. In this way, no panic is caused by small concentrations of gases, since only the discreet visual warning is given, but dangerous amounts operate the audible alarm so that evacuation or other measures can be taken. Remote warnings can also be fitted.

All in all, the Boat Show is developing considerable interest from the point of view of electronic aids. It is unfortunate that so few exhibitors were able to cope with technical queries, but all of them were most helpful. ■

practically wireless commentary by HENRY

No. 98
First in the Field

I HAD a chap in the shop today, searching for an SP4. It is true: even in the glitter of a hi-fi establishment, where every prospect teases and only valves are vile, we still get enthusiasts with thirty-year-old equipment, hopeful of our being able to provide the missing link.

Which leads us, philosophically, to a contemplation of some of the 'firsts' we nowadays take for granted.

Example: the quasi-complementary transistor amplifier circuit, which has given us so much trouble since its inception. I have come across the September 1956 copy of *Electronics,* a McGraw-Hill publication, in which R. C. Lin, then of RCA, Princeton, first propounded his output circuit in which, to quote: '. . . the two upper transistors conduct during the negative half-cycle and the two lower transistors conduct during the positive half-cycle.'

In his summary, he gave amplifier distortion at 100cps (sic) and 400cps as below 1 per cent at six watts, and though he admitted that the distortion might be expected to rise at 5,000cps, he made no mention whatsoever of its fierce spikiness at a fraction of a watt, which is the mariner we've had wrapped around our necks ever since.

The mariner wrapped around our necks.

Inventions, especially world-shaking innovations such as the transistor proved to be, have a habit of spawning themselves much more prosaically than we would like to imagine. No technologist runs screaming through the corridors of the M.I.T. with 'Eureka' echoing behind him. More likely, something as laconic as the 12/29/39: 4.15 p.m. entry in William Shockley's notebook may be handed down to posterity: 'It has today occurred to me that an amplifier using semiconductors rather than vacuum tubes is in principle possible.'

In principle: hardly in practice. He was thinking of a Schottky-barrier FET kind of device, with copper-oxide as the semiconductor. And, as Henry could have told him*, it didn't work. Instead, the experiments of the team included covering metal points with wax and pushing them down on to p-type silicon treated to give an n-type surface. They surrounded the point with water and found they could obtain power amplification.

To quote Brattain: '. . . the group was jubilant that day.'

Trouble was that the water would evaporate. Maybe it was all that heavy breathing. So they switched to glycol borate to reduce evaporation. One trouble: amplification was obtainable only below 8Hz—hardly hi-fi yet.

There were lots more experiments, culminating in evaporated gold spots and germanium, and then, on Dec. 23rd 1947, two gold contacts less than two-thousandths of an inch apart were made to the same piece of germanium and the first transistor happened.

No sudden breakthrough—no inspirational brainchild—and no immediate christening, I may add. It was a month later that a chap called John R. Pierce of the Bell technical staff mooched into Brattain's office and pointed out that the 20dB point-contact amplifier they had made was the

Runs screaming through the corridors.

'. . . dual of a vacuum-tube, circuit-wise.' He mentioned the important valve parameter, transconductance. Then he went on to talk about its electrical dual, transresistance. To quote Brattain once more: '. . . then he said 'transistor', and I said, 'Pierce, that is it!!'

What about a few more firsts in our field? Who developed the first p-n junction? Bet you can't even say his name, let alone remember it. Well Henry can, with the benefit of some help from Edward A. Torrero, who is Associate Editor of *Electronic Design.* He was William Pfann (with the aid of a chap called Jack Schaff; let's give credit where it is due). They also worked for Bell Laboratories.

But Bell eschewed silicon for germanium, because the impurities, back in the early 1940's, were easier to control. It was left to Texas Instruments to develop silicon types of transistor, and to Motorola to introduce the diffused base transistor.

So I could continue. Henry hasn't the space to name those to blame.

But the "first" we are all concerned with is that original all-transistor radio. And who made that? A firm called Regency, in 1954. How's that for a significant 'first'?

* With the benefit of hindsight. Ed.

EXTRA!!! IN NEXT MONTH'S PRACTICAL WIRELESS

SIMPLE PROJECTS FOR THE HOME

8 PAGE SUPPLEMENT

P.W's reputation for plenty of simple and straightforward constructional projects is excelled next month by an extra large issue. In addition to the usual constructional articles and features, the May issue will include a special extra 8-page coloured supplement describing eight easy projects for the home, designed and described by one of our top designers; you are bound to find *at least* one of these of interest. This supplement is fully illustrated with all the details on how to build these projects.

RADIO ALARM CLOCK

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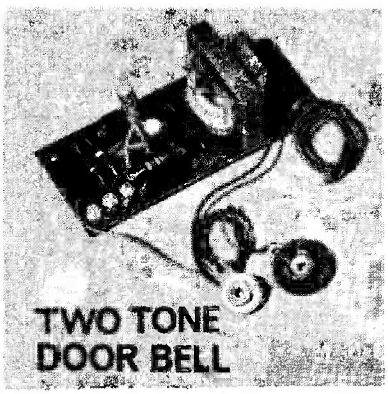
LIGHT POWERED RADIO

BABY ALARM



TWO TONE DOOR BELL

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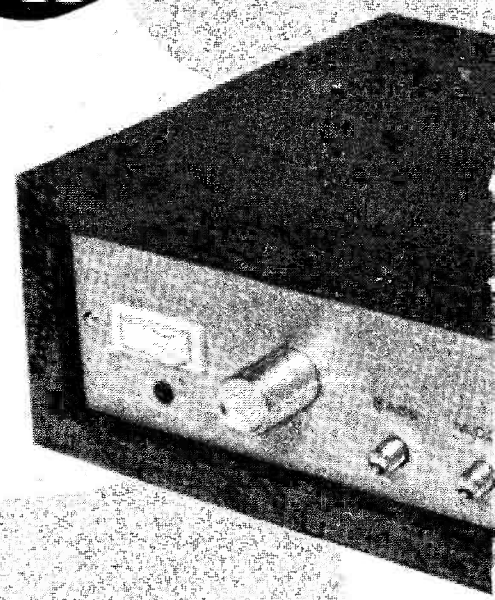
Following the success of the Texan amplifier published in this magazine during May to August 1972, the applications laboratory of Texas Instruments Ltd. have developed exclusively for *P.W.*, a compatible unit for the control of Psychedelic lights from a sound source. The initial design features zero voltage control. A more sophisticated design incorporating lamp dimming facilities will also be covered in this series of articles. For stereo operation two *P.W. Tricolour* units are required.

PW TRI



MONO/STEREO CAPABILITY

ZERO VOLTAGE SWITCHING

NEGLIGIBLE RADIO INTERFERENCE

LAMP OVER-RIDE CONTROL

OPTIONAL LAMP DIMMING

Mood

PART ONE

If I had been asked, a couple of years ago, what "psychedelic lights" were, I could only have made a wild guess: was it perhaps a medical term referring to some sort of ultra-violet treatment for disorders of the mind? Or, possibly, the latest in pet food: some extra tantalising form of offal? The truth, however, dawned slowly. What my "trendy" young friends were talking about was the latest innovation, the offspring of a marriage between light and music. It was not simply a question of a 'pop' version of 'son et lumière' but a more intimate relationship between the two media. Light could be made to respond directly to sound: flashing furiously for a fanfare, discreetly dimmed for Debussy. It is, however, unlikely that psychedelic lights will be installed in the Royal Festival Hall, but those of our readers who occasionally frequent the discotheque or dance hall will be familiar with this innovation. It is probable, too, that many have given thought to the incorporation of this feature into their own domestic lighting systems. What, it might be asked, does this involve?

In essence a 'psychedelic' light system works like this: sound controlled modulators convert bass, middle and treble frequencies into corresponding bursts of light thus adding a new "visual" dimension to the beat of the music. This is achieved by taking a signal from across the loudspeaker terminals and feeding it into a filter circuit whose output provides pulses which correspond to the sound spectrum—bass, middle and treble and any combination of these three channels. These pulses then pass through an interface circuit and energise appropriate triacs. The latter, as will be seen, act as electronic switches and turn on the lamps.

This article will attempt to explain fully the construction of psychedelic light control units for both mono and stereo equipment. It is aimed at the home constructor who possesses nothing more than an average amount of skill.

Zero Voltage Switching

As stated, the lights are turned on and off by utilising a device called a triac, i.e. a semiconductor bidirectional switch (Fig. 1). This replaces two thyristors connected back to back, thus controlling the positive and negative cycle of the supply voltage. Whereas the thyristor requires a positive gate to cathode voltage and will turn on only when the anode voltage is positive with respect to the cathode, triacs will turn on when the gate voltage polarity is the same as voltage between mt2 and mt1 (main terminal 2 and 1), i.e. positive for the positive half cycle and negative for the negative half cycle. In addition a triac will turn on with the gate negative with respect

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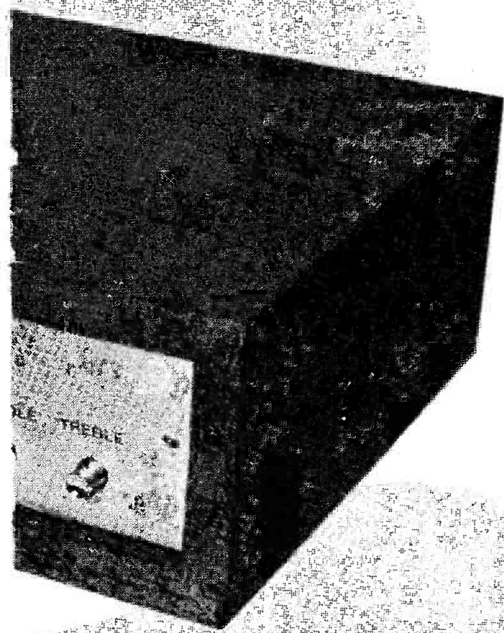
COLOUR



Lighting System

JUREK BUDEK*

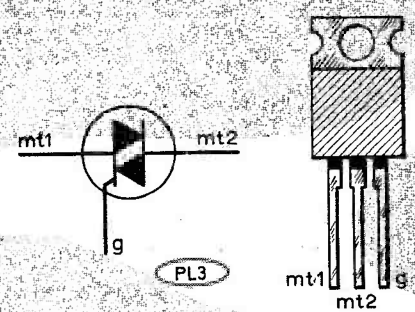


Fig. 1: The TIC226D bidirectional switch

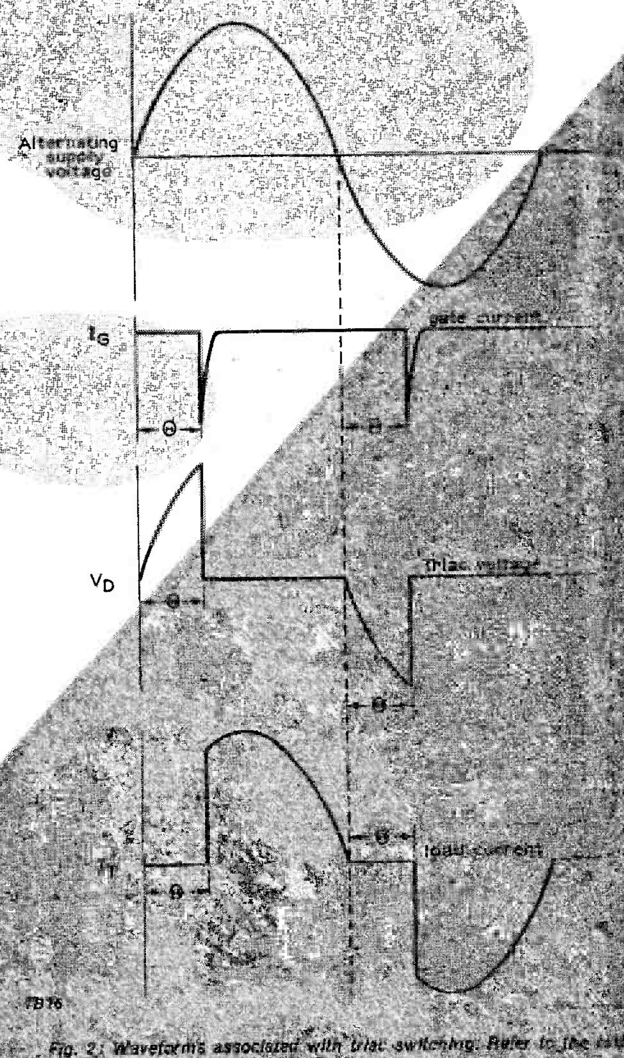


Fig. 2: Waveforms associated with triac switching. Refer to the text for clarification

to the mt1 terminal for either polarity of mt2. It is the latter factor which accounts for the techniques used in the circuits to be discussed in this article.

A further point about the triac is that there is only 2-3 volts between the gate and terminal 1, whereas there may be many hundreds or even a thousand volts between terminal mt2 and mt1.

Triacs used in a phase control mode, as shown in Fig. 2, produce considerable radio frequency interference (r.f.i.) due to the step change in current. The noise thus generated is spread by means of conduction through the wiring system or by radiation. Suppressing r.f.i. becomes more difficult and expensive as the load increases. Uncontrolled switching of "psychedelic" lamps *on* and *off* will have a similar effect and will also introduce additional noise in the loudspeakers. A simple solution to this problem is to arrange the switching so that it always takes place at the point where the mains supply voltage crosses zero, as shown in Fig. 3.

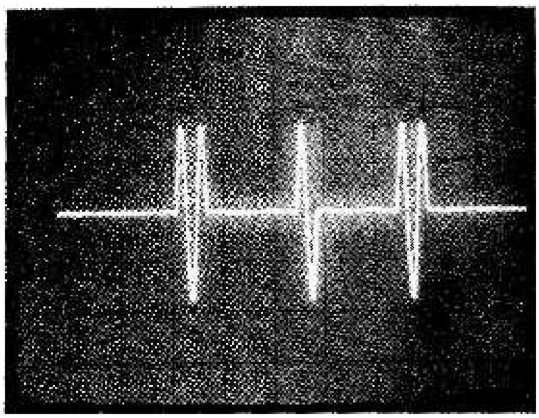


Fig. 3: Waveform depicting zero voltage switching.

This technique is called 'zero voltage switching' or 'burst firing.' In this way isolated numbers of half or full cycles will pass through the lamps and thus avoid step change in currents, which also has the additional advantage of increasing the life of the lamp.

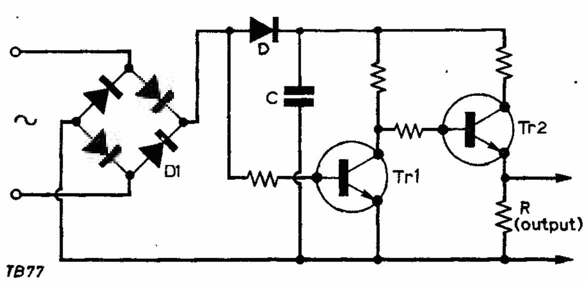


Fig. 4: Basic circuit which generates the pulses at the point of zero voltage crossing.

Fig. 4 shows the circuit used to generate the pulses at the point of zero voltage crossing. Transistor Tr1, whose base is connected to the unsmoothed supply from the bridge rectifier D1 is *on* most of the time.

However, each time the mains voltage crosses zero, its base voltage is taken below the holding on voltage and it thus turns *off*, giving positive pulses on its collector. In order to reduce the loading on transistor Tr1, transistor Tr2 has been added. Positive pulses appear as an output across resistor R each time the mains voltage crosses the zero point.

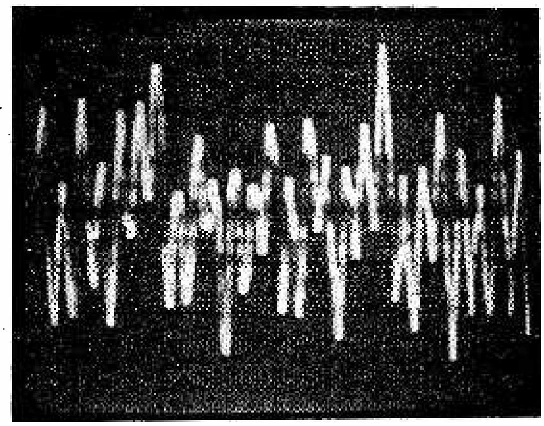


Fig. 5: Typical music voltage waveform at the terminals of a loudspeaker.

In order to control the lamp switching with respect to the frequency bands, we need a circuit which will separate out the low, middle and high frequencies from the voltage waveform appearing at the terminals of a loudspeaker. A typical voltage waveform appearing at this point is shown in Fig. 5.

Filter

A circuit which separates frequencies into bands is called a filter. There are various types of filters which could be employed; e.g. one commonly used is a resistor/capacitor (r.c.) network for high and low pass filters and an inductor/capacitor (l.c.) network for middle frequencies. The elegant way, however, specially developed for the *P.W. Tricolour* is to employ integrated circuit (i.c.) operational amplifiers, in a positive fixed-gain configuration, as the active filter element and resistors and capacitors as passive elements. By choosing suitable component values a sharp separation between bass, middle and treble frequencies can be obtained.

The shape of the filter response is determined by a factor known as the damping ratio (ζ). The lower this ratio, the sharper the cut-off and there is a *peaking* effect. This *peaking* effect is of no importance in our application. As approximately 1·5 volts is required to turn *on* the interface circuit, and thus to switch on the appropriate lamps, the filter characteristics are expressed in volts against frequency and not in the more usual decibels against frequency.

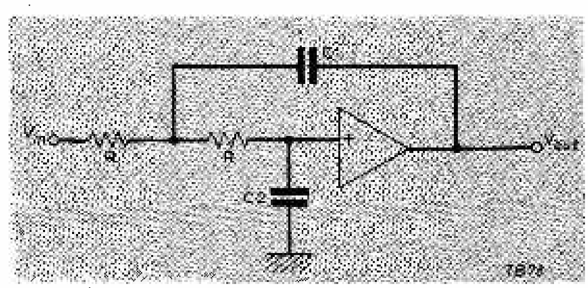


Fig. 6: Basic low pass filter as used in the P.W. Tricolour.

The theory of filter design is quite extensive and complex. We will however only outline the necessary basic concepts and give some simplified formulae.

Let us first look at a basic low pass filter (i.e. one which will stop all frequencies except those below a chosen frequency). The circuit of such a filter is shown in Fig. 6.

Here the angular cut off frequency, $\omega o = \dfrac{1}{R\sqrt{C1\ C2}}$

and the damping factor $\zeta = \sqrt{\dfrac{C2}{C1}}$

Critical damping occurs when $\zeta = \dfrac{1}{\sqrt{2}}$

and, for the reason explained before, i.e. to improve the sharpness, this value is reduced to 0·5. From these equations, the filter component values can be established.

The high pass filter (passing all frequencies above a chosen one) is shown in Fig. 7 and again requires only one operational amplifier, two resistors and two capacitors.

Here the angular cut-off frequency, $\omega o = \dfrac{1}{C\sqrt{R1\ R2}}$

and the damping factor $\zeta = \sqrt{\dfrac{R1}{R2}}$

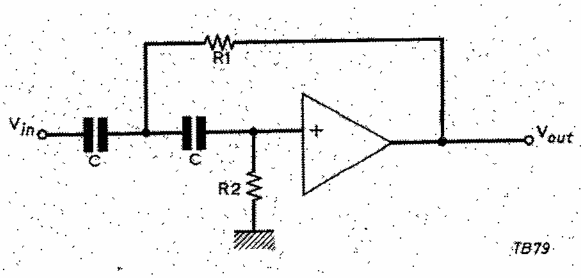


Fig. 7. Basic high pass filter. ▲

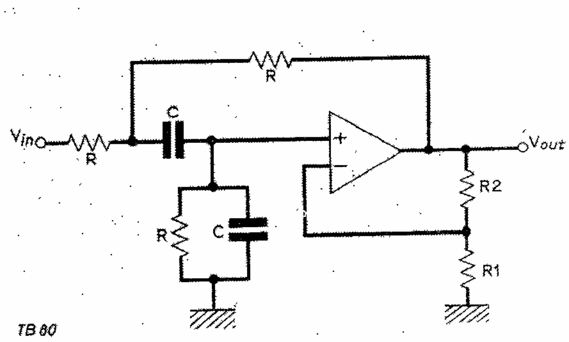


Fig. 8: Basic band pass filter.

Once more from these equations, the filter components values can be established. Finally, the band pass filter; which, of course, as its name suggests, passes a band of frequencies. This, as can be seen from Fig. 8, is a little more complicated than the other two.

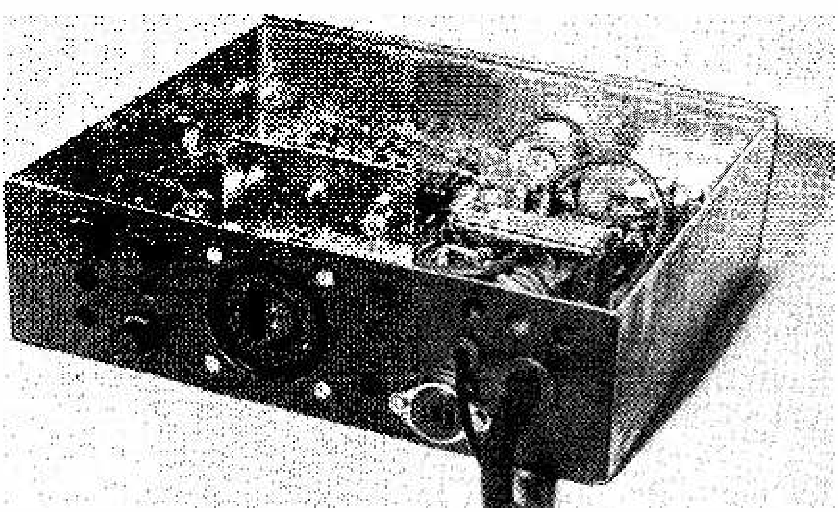
The centre angular frequency $\omega o = \dfrac{\sqrt{2}}{RC}$

and the quality factor $Q = \dfrac{\sqrt{2}}{4 - \dfrac{R2}{R1}}$

$Q = \dfrac{2\Delta f}{fo}$, where $2\Delta f$ is the difference between two frequencies at which the voltage output of the filter is $\dfrac{1}{\sqrt{2}}$ of its maximum value. From the above formulae, relevant component values can be obtained.

Musically oriented readers will recall the 'unisono' note played on the oboe during the orchestra's tuning-up time, just before the concert begins. This note is middle 'A' with a frequency of 440Hz; a frequency which has been chosen as the centre frequency for the middle band-pass filter in

Rear view of the P.W. Tricolour. ▶



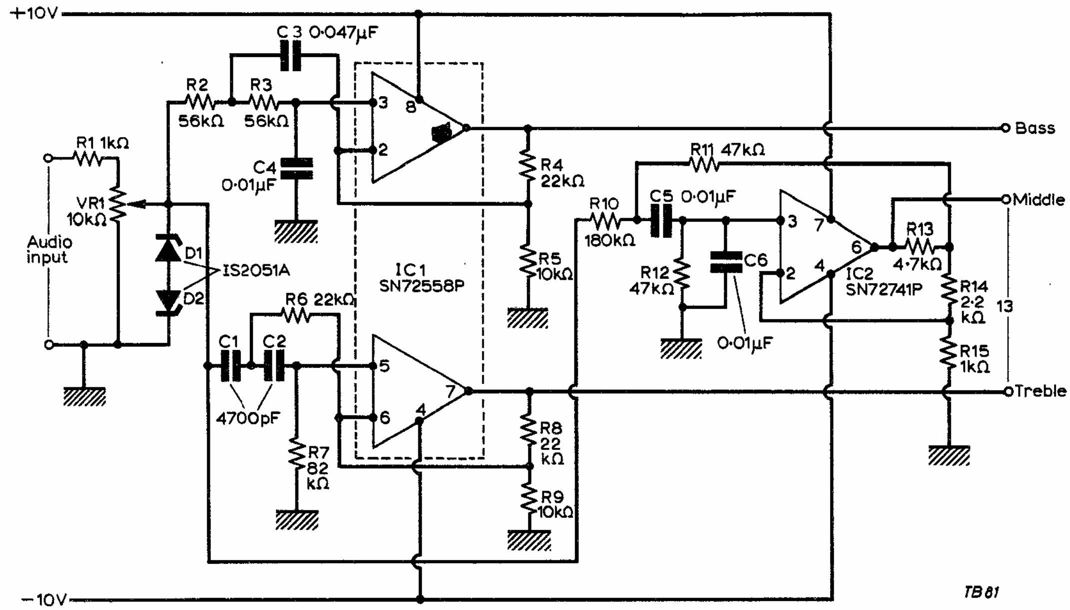


Fig. 9: Complete P.W. Tricolour filter circuit. This unit is used without modification, with either the zero voltage switching unit (Fig. 12) or with the lamp dimming unit, to be described later in this series.

this design. Cut-off frequency for the low pass filter has been chosen to be around 200Hz and that of the high pass filter (treble) about 1kHz.

Based on the above assumptions, a complete filter has been developed with the component values as shown in Fig. 9. The alert reader will notice that some of the component values differ from the figures obtained using the formulae. This has been done intentionally in order to improve the separation between the various frequency ranges.

The input to the filter circuit has been limited to 5 volts peak to peak by using two 5 volt zener diodes connected back to back. Three i.c. operational amplifiers are used. Two of which are contained in one 8 pin package, SN72558P and the other i.c. is contained in a second 8 pin package, SN72741P.

Fig. 10 shows output voltage response of the three filters plotted against frequency for a peak input signal of 0·5 volts. The effectiveness of the filters are obvious. The solid state switches—triacs—turn on their corresponding lamps at filter output voltages equal to and higher than 1·5 volts.

Figs. 11a to 11d show four oscilloscope photographs. These show traces with the vertical axes representing voltages and the horizontal one time. In each instance the four traces were taken simultaneously (i.e. they have a common time axes). In the oscillograms the top trace corresponds to the voltage at the loudspeaker terminal. The other three traces were taken at the outputs of the respective filters.

Fig. 11a was taken at a time when the treble

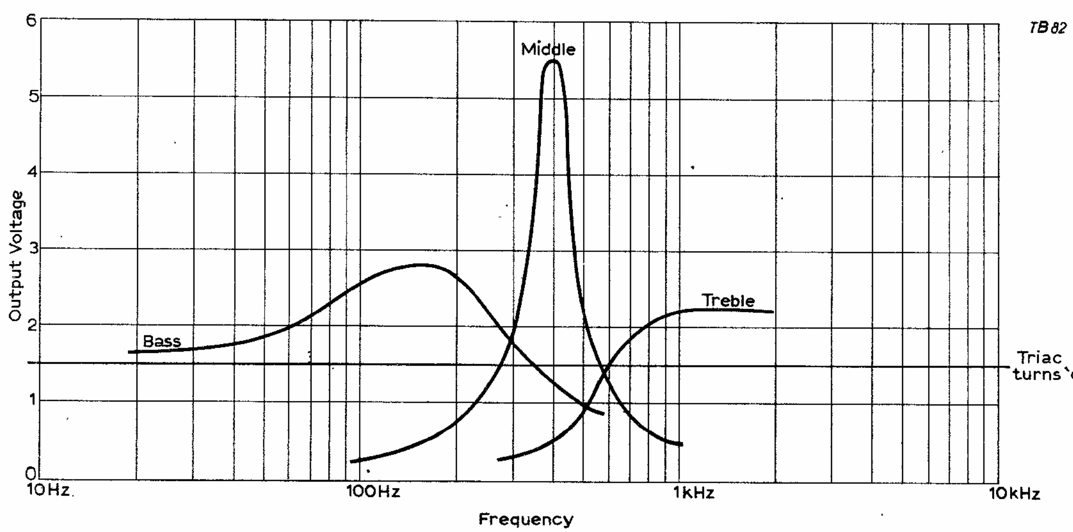


Fig. 10: Output voltage/frequency response of the filter circuit shown in Fig. 9.

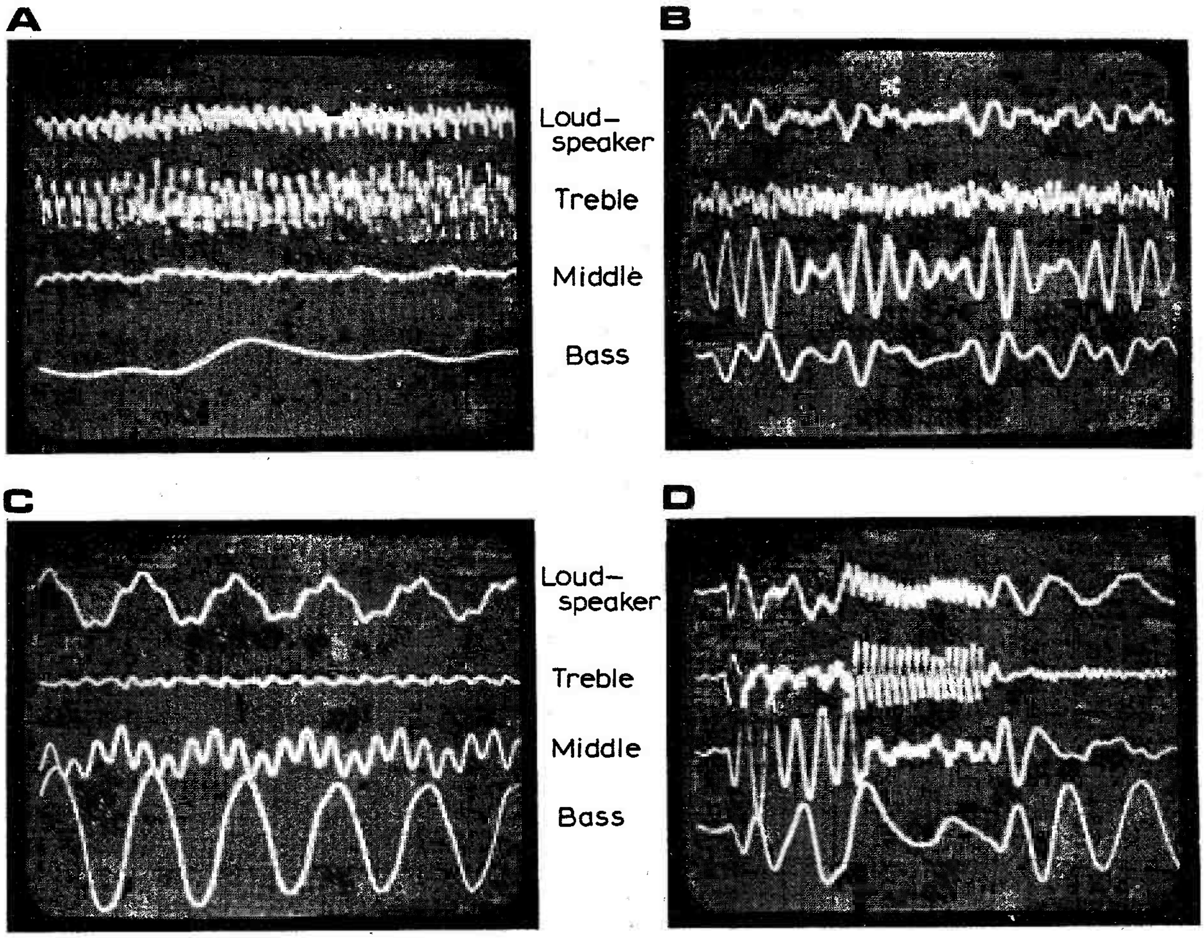


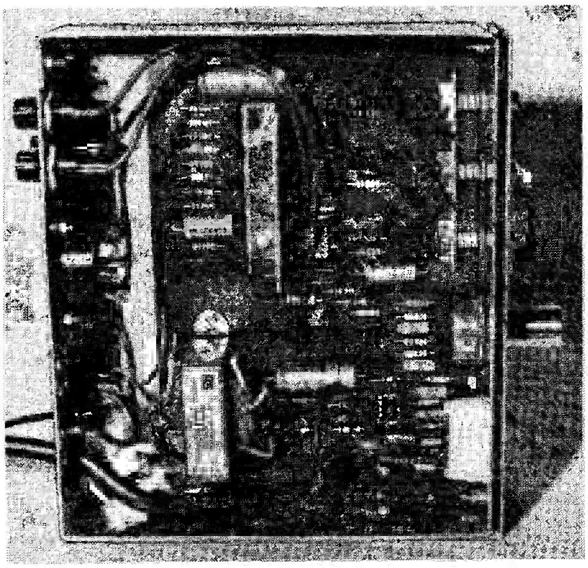
Fig. 11: (a–d) A full explanation of these waveforms is given in the accompanying text.

frequency was predominant. In Fig. 11b the middle frequency is the strongest signal, while in Fig. 11c it is the bass. Fig. 11d shows some interesting combinations of all three frequencies. The middle frequencies predominate at the beginning of the trace, then the treble takes over at the centre of oscillogram and towards the end of the trace it is the turn of the bass to predominate.

A 10kΩ potentiometer has been added at the input to the filter circuit to allow the voltage level at which the lamps are switched to be controlled. In this way it is possible to establish the best effect for 'soft' or 'party' type music.

The *P.W. Tricolour* is suitable for use with 4 to 15Ω loudspeakers. The load represented by the filters is negligible compared to the loudspeaker impedance.

It should be noted that the simple filter circuits illustrated at the beginning of this article used operational amplifiers. An operational amplifier has high input impedance, very high gain, and low output impedance, enabling the filter component values to be determined independent of the amplifier parameters. The amplifiers used were shown having a voltage gain of unity. This means that the output voltage of the high and low pass filters can never



Underside view of the P.W. Tricolour *with zero voltage switching.*

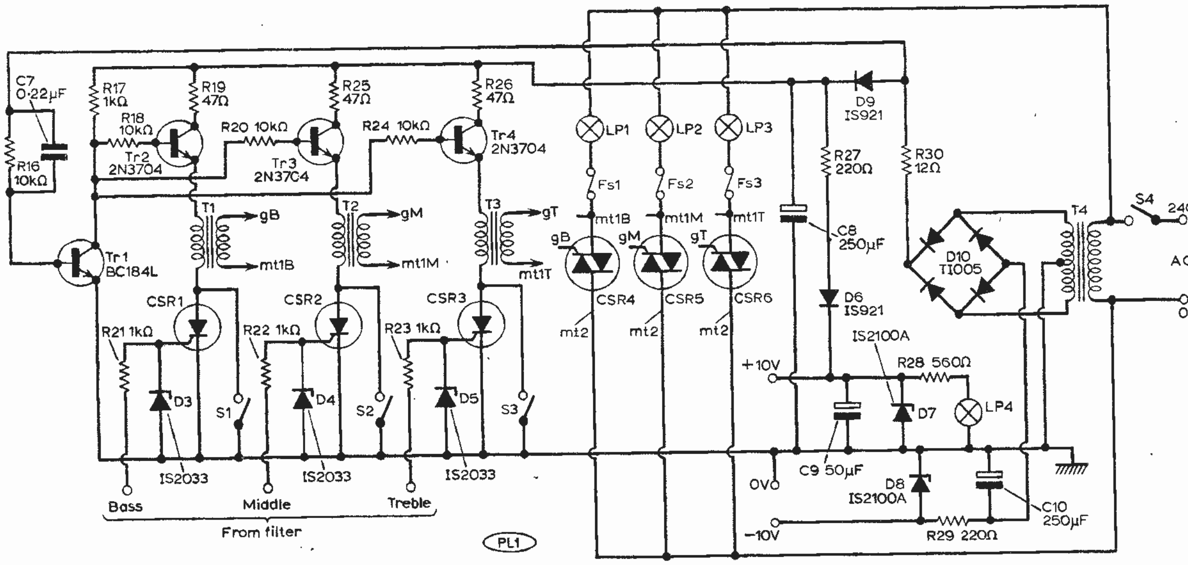


Fig. 12: Zero voltage switching control unit. The positive and negative 10V supply lines are the d.c. supplies to the filter unit (Fig. 9).

be more than the input voltage. In order to achieve voltage gain so that sufficient output can be obtained to drive the interface circuit at low volume levels, the basic circuit must be modified. This involves reducing the proportion of output voltage from the amplifier that is used as feedback to the filter capacitors and resistors. This is achieved by the use of a resistive potential divider at the output of the amplifier. This is shown in Fig. 9. The resistor ratio determines the gain of the filter in the pass-band.

The *P.W. Tricolour* is suitable for either mono or stereo record playing. In the case of the stereo system, the lights will flash in accordance with the signals appearing at the terminals of one of the speakers. However, for stereo enthusiasts who wish to use two units, the interconnecting arrangement will

★ components list

Resistors:

R1 1kΩ
R2 56kΩ
R3 56kΩ
R4 22kΩ
R5 10kΩ
R6 22kΩ
R7 82kΩ
R8 22kΩ
R9 10kΩ
R10 180kΩ
R11 47kΩ
R12 47kΩ
R13 4·7kΩ
R14 2·2kΩ
R15 1kΩ
R16 10kΩ
R17 1kΩ
R18 10kΩ
R19 47Ω
R20 10kΩ
R21 1kΩ
R22 1kΩ
R23 1kΩ
R24 10kΩ
R25 47Ω
R26 47Ω
R27 220Ω
R28 560Ω
R29 220Ω
R30 12Ω ½W

All 10%, ¼W unless otherwise specified

Capacitors:

C1 4700pF
C2 4700pF
C3 0·047μF
C4 0·01μF
C5 0·01μF
C6 0·01μF
C7 0·22μF
C8 250μF 25V
C9 50μF 25V
C10 250μF 25V

Transformers:

T1, T2, T3 Pulse transformer, type PT-ATA ITT Ltd.
T4 Miniature mains transformer 240V primary 0-12V, 0-12V r.m.s. 6VA, type 12V R.S. Components

Integrated Circuits

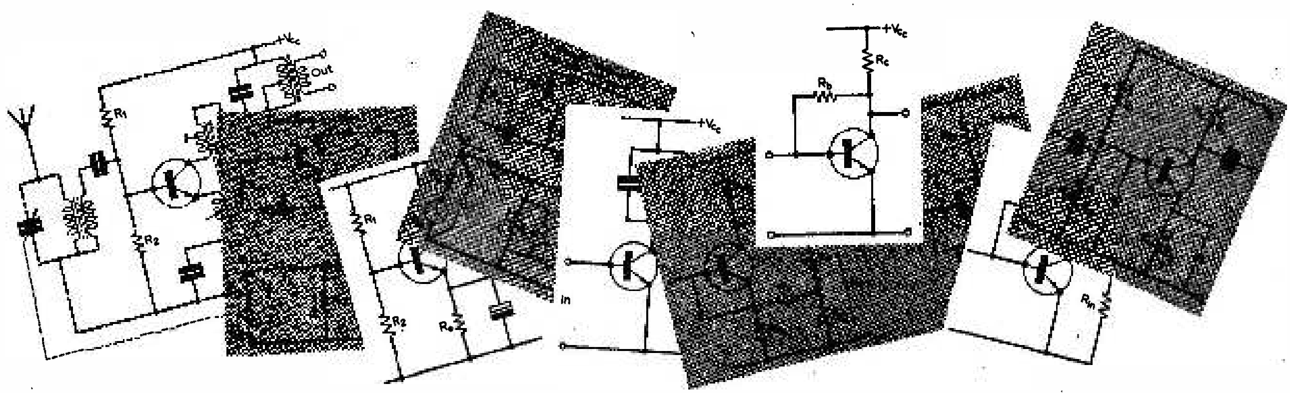
IC1 SN72558P
IC2 SN72741P
Texas Instruments Ltd.

Semiconductors:

Tr1 BC184L
Tr2 2N3704
Tr3 2N3704
Tr4 2N3704
D1 IS2051A
D2 IS2051A
D3 IS2033
D4 IS2033
D5 IS2033
D6 IS921
D7 IS2100A
D8 IS2100A
D9 IS921
D10 T1005 Bridge rectifier
CSR1 TIC44
CSR2 TIC44
CSR3 TIC44
CSR4 TIC226D
CSR5 TIC226D
CSR6 TIC226D
Texas Instruments Ltd.

Miscellaneous:

VR1 10kΩ linear potentiometer
FS1, FS2, FS3 5A fuses and panel mounting holders
LP1, LP2, LP3 Colour flood lamps, 240V 100W
LP4 TIL 209 Indicator lamp Texas
S1, S2, S3 Push on-push off
S4 Single pole mains on-off rocker



TRANSISTOR CIRCUITRY for beginners

PART 15

H.W. HELLYER & MICHAEL HOLLIER

Tone control circuitry

Toward the end of the last part of this series of articles that was published, we were concerned with frequency-dependent feedback. Without being intentionally devious, we skated over some of the finer points and here shall try to keep our promise of digging more deeply into the matter of tone controls, their design and their limitations.

The utter purist will not deign to acknowledge the need for tone controls! Everything should be flat, he says. There should be, he further asserts, no need to alter the frequency response of an amplifier if all the other parts of the audio system are in order. True, but Utopia has not yet arrived, whatever the politicians promise, and there will be nasty pops and crackles from our records, hiss from our tape, peaks and troughs from many a cartridge and even worse deviations by the time the sound escapes from the loudspeakers.

Even then, we are not finished. If the little woman insists on foot-deep rugs and wall-to-wall drapes, or if your pad is scoured to its functional austerity, man, you will need same trimming of the ideally flat response to compensate for—in the first case, the premature absorption of treble, and in the second, the 'hardness' of the sound. Tone controls may be regarded as necessary evil, but as long as we are obliged to have them, let's make sure they do not detract from the best possible performance. And in so many commercial designs, they do.

First steps

Before delving into the tone control circuit as a whole, we must take a look at the effect of the passive components with a change in frequency. Back in the days when Poppa bought his radiogram because it sounded 'mellow', the tone control was simply a network of passive components, usually across the output stage, with variation of the resistive part of a series capacitor-resistor shunt that drained away progressively more and more of the upper frequencies. It was, in other words, a variable treble-cut device. One or two more enterprising makers

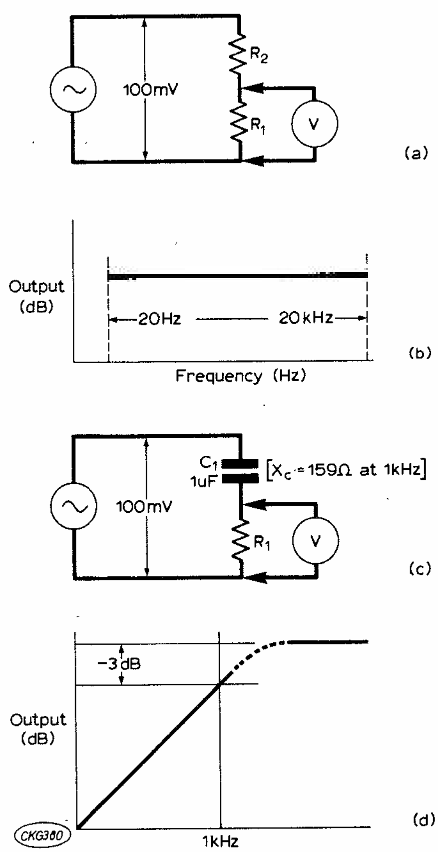


Fig. 74: (a) For a simple resistive network the output shown by the voltmeter is in proportion of the ratio of the resistors to the applied input voltage. In (b) theoretically, the output should not change with frequency, giving a "straight-line" graph. (c) Substituting a capacitor for R2 makes the output frequency dependent while (d) shows an example of the curve we might expect from a simple network such as (c) having a "slope" of 6dB per octave.

fitted alternative resistor-capacitor combinations in the grid circuit of output valves, and others even went so far as to label these Bass or Treble Boost and Cut, but all such passive networks, i.e., those which do not have inbuilt amplification, must attenuate the overall signal.

The point about the passive tone controls is that the attenuation varies the frequency. Take the case of a simple resistive network, as in Fig. 74(a). If we have two resistors of equal value, fed by a signal generator, the output across the measured one will be half the input signal in amplitude, but will not change in frequency. A graph of the situation would be a straight line, as Fig. 74(b).

But if we now substitute the upper resistor with a capacitor, C1 in Fig. 74(c), we find that the measured output will be exactly half the input **at only one frequency.** Reactance $X_c = \frac{1}{2\pi fC}$ where X_c is in ohms, C in farads and f is the frequency at which the test is made, in hertz.

Working out the reactance of a 1μF capacitor at 1kHz, we get $\frac{10^6}{6{\cdot}28 \times 1000 \times 1} = 159$ ohms.

But if we now measure the voltage across a similar-value resistor, we find that instead of half the signal input, we have slightly more. Instead of our attenuator dropping the output by 6dB (to half voltage) at 1kHz, it will have dropped the output only 3dB. This is because the voltage across the capacitor is 90° out of phase with the voltage across the resistor. The output voltage ratio is 0·707:1, not 0·5:1. In fact, if we alter the frequency of the generator, we will find that the measured output drops as the frequency falls. The rate of 'slope', as shown in Fig. 74(d), is 6dB per octave, an octave being a frequency change of 2:1.

This 3dB drop has a further significance when we tackle power output stages, for if the drive voltage to the amplifier fell sufficiently for the power output to drop 3dB, this would be the well-known 'half-power-point'. This is the figure normally quoted in amplifier specifications—a point to which we shall return later. Below this −3dB point in Fig. 74(d), the slope of the curve falls away regularly by 6dB per octave, i.e., a ratio of 2:1, a reduction of output by a half each time the frequency is halved.

Making it active

It helps to regard tone control as a method of frequency correction. The introductory remarks we have made, and references to frequency-dependent feed-back in previous articles, should have prepared the regular reader for this approach. Simple tone controls are types of filters. We shall deal thoroughly with filter circuitry later, but at the moment it is necessary to observe that the 'filter' of Fig. 74(c), for example, is called a 'first order filter', having a 'slope' of 6dB per octave. Second order filters have slopes of 12dB/octave and third-order filters, 18dB/octave. As we shall see, **real** filters, used in well-designed audio amplifiers, should ideally have a third-order slope to be effective.

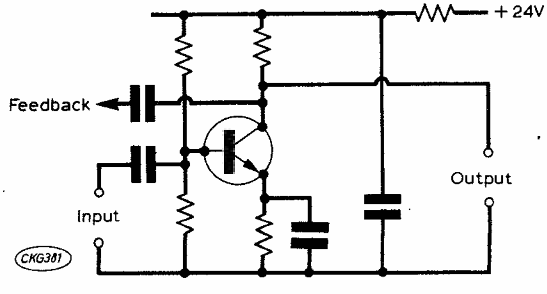


Fig. 75: A collector-follower amplifier arranged so that its output can be measured with and without feedback.

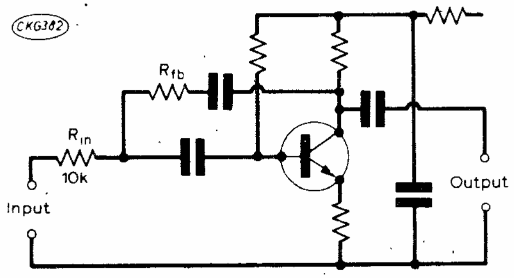


Fig. 76: The basic circuit used for tests.

These filters are passive devices. They contain no amplifying stage or stages to put back the signal attenuated by their action. If we make a marriage of the virtual earth circuitry we talked about in Parts 12 and 13 of this series and the fundamentals of tone control circuitry touched upon in Part 11, we get an amplifier with frequency-dependent feedback, which becomes, if we correctly design it, a better tone control circuit.

First, we need what is known as an 'inverting amplifier'. If you take a look at Fig. 75, you will see that this can be a collector-follower circuit, so arranged that we can measure its gain with or without the feedback. In practice, this is a useful circuit, and the component calculation will be discussed as we go along. It is convenient to use the 24-volt supply described in Part 13, December PW. Fig. 76 shows the circuit devised by Mike and used for tests on the prototype.

With an input from the audio generator, and an output measured with a millivoltmeter, we can measure the open-loop gain. This is the gain of the amplifier with no feedback connected. Here, a word of warning is required: in many erudite theoretical articles, 'open-loop gain' is bandied about freely, but an inspection of the circuit will often show that it would be virtually impossible to measure it in practice. Our aim in this case is to show what we mean by the term, then, by applying the feedback we need, to modify the gain and achieve our controlled response, i.e., effect a tone control.

In our prototype, the open-loop gain, (G_0) was 260. It is absolutely essential when carrying out these measurements to mount the circuit in a screened box, use screened input and output leads and make sure our construction is 'solid'. We use Veroboard for convenience: it allows connection of additional components while retaining the versatility of wired circuitry. We use the very convenient Norman Rose aluminium boxes, because they are inexpensive, easily worked for outlet holes, tag-strip mountings, etc., and have a simple lid which not only completes the screening but also affords an easy access for modifications.

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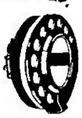

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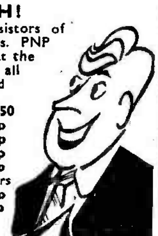

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2/4-input Gate	BMC961	12p	11p	10p
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100–0–100µA	£3·70		
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500µA	£2·20	20V. D.C. ..	£2·15
1mA	£2·15	50V. D.C. ..	£2·15
5mA	£2·15	300V. D.C.	£2·15
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100–0–100µA	£3·30	1 amp.......	£3·10
200µA	£3·30	5 amp.......	£3·10
500µA	£3·20	15 amp.	£3·10
500–0–500µA	£3·10	30 amp	£3.20
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100µA	£2·85	50V. D.C. ..	£2·20
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500µA	£2·55	15V. A.C. ..	£2·30
1mA	£2·20	300V. A.C. ..	£2·30
5mA	£2·20	S Meter 1mA	£2·30
10mA	£2·20	VU Meter ..	£3·50
50mA	£2·20	1 amp. A.C. *	£2·20
100mA	£2·20	5 amp. A.C. *	£2·20
500mA	£2·20	10 amp. A.C. *	£2·20
1 amp	£2·20	20 amp. A.C. *	£2·20
5 amp	£2·20	30 amp. A.C. *	£2·20

Type MR.65P. 3½in. x 3¼in. fronts

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50–0–50µA	£3·00	20V. D.C. ..	£2·40
100µA	£3·00	50V. D.C. ..	£2·40
100–0–100µA	£2·90	150V. D.C.	£2·40
200µA	£2·90	300V. D.C.	£2·40
500µA	£2·65	15V. A.C. ..	£2 55
500–0–500µA	£2·40	50V. A.C. ..	£2·55
1mA	£2·40	150V. A.C. ..	£2·55
5mA	£2·40	300V. A.C. ..	£2·55
10mA	£2·40	500V. A.C.	£2·55
50mA	£2·40	S Meter 1mA	£2 60
100mA	£2·40	VU Meter ..	£3·70
500mA	£2·40	50mA A.C. *	£2·40
1 amp.......	£2·40	100mA A.C. *	£2·40
5 amp.......	£2·40	200mA A.C. *	£2·40
10 amp.	£2·40	500mA A.C. *	£2·40
15 amp.	£2·40	1 amp. A.C. *	£2·40
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5V. D.C. ..	£2·40	30 amp. A.C. *	£2·40

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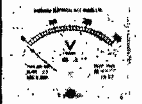
Type MR.38P. 1 21/32in. square fronts



50µA	£2·30	200mA	£1·75
50–0–50µA	£2·10	300mA	£1·75
100µA	£2·10	500mA	£1·75
100–0–100µA	£1·95	750mA	£1·75
200µA	£1·95	1 amp.......	£1·75
500µA	£1·80	2 amp.......	£1·75
500–0–500µA	£1·75	5 amp.......	£1·75
1mA	£1·75	10 amp.	£1·75
1–0–1mA ..	£1·75	3V. D.C. ..	£1·75
2mA	£1·75	10V. D.C. ..	£1·75
5mA	£1·75	15V. D.C. ..	£1·75
10mA	£1·75	20V. D.C. ..	£1·75
20mA	£1·75	50V. D.C. ..	£1·75
50mA	£1·75	100V. D.C.	£1·75
100mA	£1·75	150V. D.C.	£1·75
150mA	£1·75	300V. D.C.	£1·75
		500V. D.C.	£1·75
		750V. D.C.	£1·75
		15V. A.C. ..	£1·85
		50V. A.C. ..	£1·85
		150V. A.C. ..	£1·85
		300V. A.C. ..	£1·85
		500V. A.C. ..	£1·85
		S Meter 1mA	£1·85
		VU Meter ..	£2·30

Type MR.45P. 2in. square fronts

50µA	£2·50	5 amp.......	£1·85
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100µA	£2·30	20V. D.C. ..	£1·85
100–0–100µA	£2·05	50V. D.C. ..	£1·85
200µA	£2·05	300V. D.C.	£1·85
500µA	£1·95	15V. A.C. ..	£2·00
500–0–500µA	£1·85	300V. A.C. ..	£2·00
1mA	£1·85	S Meter 1mA	£2·05
5mA	£1·85	VU Meter ..	£2·50
10mA	£1·85	1 amp. A.C. *	£1·85
50mA	£1·85	5 amp. A.C. *	£1·85
100mA	£1·85	10 amp. A.C. *	£1·85
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1 amp.......	£1·85	30 amp. A.C. *	£1·85

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100–0–100µA	£3·20	VU Meter ..	£3·75
200µA	£3·20		

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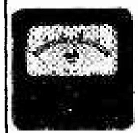
Type MR.65. 3½in. square fronts



25µA	£3·85	1 amp.......	£2·15
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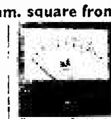
50–0–50µA	£2·60	15 amp.	£2·15
100µA	£2·60	30 amp.	£2·15
100–0–100µA	£2·50	50 amp.	£2·15
500µA	£2·45	5V. D.C. ..	£2·15
500–0–500µA	£2·15	10V. D.C. ..	£2·15
1mA	£2·15	20V. D.C. ..	£2·15
1–0–1mA ..	£2·15	50V. D.C. ..	£2·15
5mA	£2·15	150V. D.C.	£2·15
10mA	£2·15	300V. D.C.	£2·15
50mA	£2·15	50mV. D.C.	£2·40
100mA	£2·15	100mV. D.C.	£2·40
500mA	£2·15	30V. A.C. *..	£2·20
		50V. A.C. *..	£2·20
		150V. A.C. *	£2·20
		300V. A.C. *	£2·20
		500mA A.C. *	£2·15
		1 amp. A.C. *	£2·15
		5 amp. A.C. *	£2·15
		10 amp. A.C. *	£2·15
		20 amp. A.C. *	£2·15
		30 amp. A.C. *	£2·15
		50 amp. A.C. *	£2·15
		VU Meter ..	£3·40

Type S-80 80 mm. square fronts



50µA	£3·50	5 amp. D.C.	£2·85
50–0–50µA	£3·40	300V. A.C. ..	£2·85
100µA	£3·40	VU Meter ..	£3·70
100–0–100µA	£3·30		
500µA	£3·05		
1mA	£2·85		
20V. D.C. ..	£2·85		
50V. D.C. ..	£2·85		
300V. D.C.	£2·85		
1 amp. D.C.	£2·85		

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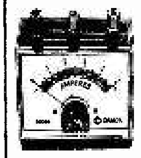

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50–0–50µA	£5·10		
1–0–1mA	£4·85	Dual range	
1A d.c.	£4·85	500mA/5A d.c.	£5·10
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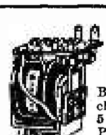
1000 W	£7·50	P. & P. 38p
1500 W	£10·20	P. & P. 43p
2250 W	£17·25	P. & P. 50p
5000 W	£35·00	P. & P. £1

230 VOLT A.C. 50 CYCLES RELAYS



Brand new. 3 sets of changeover contacts at 5 amp rating. **50p each.** P. & P. 10p (100 lots £40) Quantities available.

MCA.220 AUTOMATIC VOLTAGE STABILISER

Input 88 125 VAC or 176 250VAC. Output 120V AC. or 240 VAC. 200 VA rating. £11·97, carr. 50p.

BH.001 HEAD SET AND BOOM MICROPHONE

Moving Coil. Ideal for language teaching, communications. Headphone imp. 16 ohms. Microphone imp. 200 ohms. £4·62. P. & P. 15p.

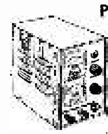
240° Wide Angle 1mA Meters

MW 1-6 60mm square £3·97
MW 1-8 80mm square £4·97
P. & P. extra

RP214 REGULATED POWER SUPPLY

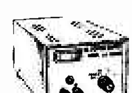
Solid state. Variable output 0–24V DC up to 1 amp. Dual scale meter to monitor voltage and current Input 220/240V AC. Size 185 × 85 × 105mm. £8·97 P. & P. 25p.

PS.200 REGULATED P.S.U.



Solid state. Variable output 5-20 volt D.C. up to 2 amp. Independent meters to monitor voltage and current. Output 220/240 V. A.C. Size 7½" × 5¾" × 3¾". £14·97. P. & P. 25p.

PS.1000B REGULATED POWER SUPPLY



Solid state. Output 6, 9 or 12 volt DC up to 3 amps. Meter to monitor current. Input 220/240v AC. Size 4" × 3¼" × 6¼". £11·97. P. & P. 25p.

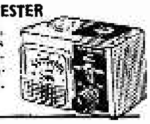
230V/240V SMITHS SYNCHRONOUS GEARED MOTORS

Built in gearbox. All brand new and boxed. 30 RPH CW; 2 RPH CW; 20 RPH CW; 2 RPH ACW; 30 RRH CW;
50p each Post 12p.

LB4 TRANSISTOR TESTER

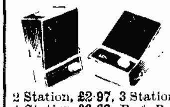
Tests PNP or NPN transistors. Audio indication. Operates on two 1·5v batteries. Complete with all instructions, etc. £4·50. P. & P. 20 p.

LB3 TRANSISTOR TESTER



Tests ICO and B, PNP / NPN. Operates from 9v battery. Complete with all instructions, etc. £3·95. P. & P. 20p.

HOMER INTERCOMS



Ideal for home, office, stores, factories, etc. Supplied complete with batteries, cable and free instructions.

2 Station, £2·97, 3 Station £5·25, P. & P. 15p. 4 Station £6·62, P. & P. 17p.

SEND SAE FOR LIST OF SEMI CONDUCTORS & VALVES

G. W. SMITH & CO. (RADIO) LTD.
Also see next three pages

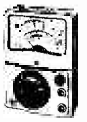
MULTIMETERS for EVERY purpose!

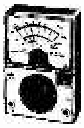
TS60 POCKET MULTIMETER

High-precision at low-cost. Ranges: D.C. 15V, 150V, 1,000V (10,000 opv). A.C. 15V, 150V, 100V (1,000 opv). D.C. Current 150mA. Resistance 100k ohms. £1·85. Post 15p.

MODEL 1092 TESTMETER

5,000 O.P.V. 0/3/15/150/300/1200 V. D.C. 0/6/30/300/600 V. A.C. 0/300μA/300 MA 0/10K/1 meg Ω Decibels −10 to +16db £2·75 each +15p P. & P.

HIOKI MODEL 720X

20,000 O.P.V. Overload protection 5/25/100/500/1000 V DC. 10/50/250/1000 VAC. 50μA/250mA. 20K/2 meg ohm. −5 to +62dh. £4·97. P. & P. 15p.

HIOKI MODEL 730X

30,000 O.P.V. Overload protection. 6/30/60/300/600/1200 VDC. 12/60/120/600/1200 VAC. 60/μA/30 mA/300 mA. 2K/200K/2 megohm. −10 to +63db. £6·50. P. & P. 15p.

MODEL TE-12

20,000 O.P.V. 0/0·6/6/30/120/600/1,200/3,000/6,000v. D.C. 0/6/30/120/600/1,200v. A.C. 0/60μA/6/60/600mA. 0/6K/600K/6Meg./60 Meg. Ω 50pF-0·2mFd. £5·97. P. & P. 17p.

MODEL TE-200

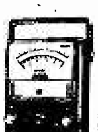
20,000 O.P.V. Mirror scale. overload protection. 0/5/25/125/1,000V. D.C. 0/10/50/250/1,000V. A.C. 0/50 μA/250 mA. 0/60K/6 meg Ω. −20 to +62db. £3·95. P. & P. 15p.

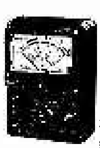
MODEL 500

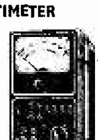
30,000 O.P.V. with overload protection mirror scale 0/·5/2·5/10/25/100/250/500/1,000v. D.C. 0/2·5/10/25/100/250/500/1,000V. A.C. 0/50μA/5/50/500mA. 12 amp. D.C. 0/60/K/6 Meg./60 Meg Ω £8·87. Post paid.

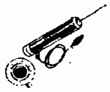
HIOKI MODEL 750X

50,000 o.p.v. 43 ranges 0–0·3 to 1,200v D.C. 0–3 to 1,200v A.C. 0–30μA/300mA. 0–3K/30 meg ohms. − 10 to + 17dB. £8·97. Post 20p.

HT100B4 MULTI-METER

Features A.C. current ranges. 100,000 o.p.v. Mirror Scale. Overload protection. 0/·5/2·5/10/50/250/500/1000 V D.C. 0/2·5/10/50/250/1000 V. A.C. 0/10/250μA/2·5/25/250 MA/10 Amp. D.C. 10 Amp A.C. 0/20K/200K/2 MEG/20 MEG. − 20 +62db. £12·50. P. & P. 25p.

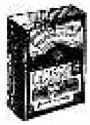
370 WTR MULTI-METER

Features A.C. current ranges. 20,000 o.p.v. 0/·5/2·5/10/50/250/500 1000 V. D.C. 0/2·5/10/50/250/500/1000V AC 0/50uA/1/10/100mA/1/10 Amp D.C. 0/100mA/1/10 Amp AC 0/5K/50K/500K/5 MEG/ 50 MEG. −20 +62db. £15. P. & P. 25p.

RUSSIAN 22 RANGE MULTIMETER

Model U437 10,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1000v D.C. 2·5/10/50/250/500/1000v A.C. DC Current 100wA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3m Ω. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE £5·97. P. & P. 25p

ROUND SCALE TYPE PENCIL TESTER MODEL T.S.68

Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0·20K ohms. ONLY £1·97 P. & P. 13p.

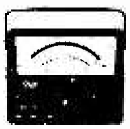
LT601 MULTIMETER

New style 20,000 o.p.v. pocket multimeter. 5/25/50/250/500 / 2500 V. D.C. 10 / 50 / 100 / 500 / 1000V. A.C. 50μA / 250mA. 6K / 6 meg ohms. −20 to + 22 dB. £3·75. Post 20p.

MODEL TH-12

20,000 o.p.v. Overload protection. Slide switch selector 0 / ·25 / 2·5 / 10 / 50 / 250 / 1000V. D.C. 0 / 10 / 50 / 250 / 1000V. A.C. 0 / 50μA / 25 / 250mA. D.C. 0 / 3K / 30K / 300K / 3 meg − 20 to + 50dB £4·97. Post 15p.

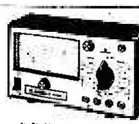
MODEL TE-300

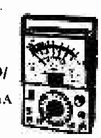
30,000 O.P.V. Mirror scale. overload protection 0/·6/3/15/60/300/1,200V. D.C. 0/6/30/120/600/1,200V. A.C. 0/30μA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. ohm −20 to +63 db. £5·97. P. & P. 15p.

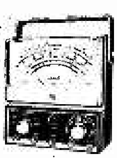
MODEL PL436

20k Ω/Volt D.C. 8k Ω/Volt AC. Mirror scale. ·6/3/12/30/120/600 V D.C. 3/30/120/600 V A.C. 50/600μA/60/600 mA. 10/100K/1 Meg/10 Meg Ω −20 to +46db. £6·97. P. & P. 12p.

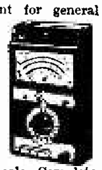
TMK MODEL TW-50K

46 ranges, mirror scale, 50K/Vol. D.C. 5K/Volt A.C. D.C.: Volts ·125, ·25, 1·25, 2·5, 5, 10, 25, 50, 125, 250, 500, 1000V, A.C. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1000V. D.C. Current: 25, 50μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEG Ω. Decibels: −20 to +81·5db £8·50. P. & P. 17p.

MODEL K228A

Taut band suspension. Overload protection. Polarity reversing switch. 30,000 o.p.v. 0 / ·5 / 2·5 / 15 / 50 / 250/500 / 1000 / 2500V. D.C. 0 / 15 / 50 / 150 / 500 / 1000V. A.C. 0 / 50μA / 5 / 50 / 150 / 500mA / 5A D.C. 0 / 3K / 300K / 3 meg. £8·95. Post 20p.

HIOKO MODEL 700X

100,000 O.P.V. Overload protection. Mirror scale. ·3/·6/1·2/1·5/3/6/12/30/60/120/300/600/1200V DC 1·5/3/6/12/30/60/150/300/600/1200 V. A.C. 15/30μA/3/6/30/60/150/300mA 6/12 AMP. DC. 2K/200K/2 Meg/20 Meg ohm −20 to +63dB. £13·50. P. & P. 20p.

MODEL C-7080 EN

Giant 6" mirror scale. 20,000 o.p.v. 0 / ·25 / 1 / 2·5 / 10 / 50 / 250 / 1000 / 5000V. D.C. 0 / 2·5 / 10 / 50 / 250 / 1000 / 5000V. A.C. 0 / 50μA / 1 / 10 / 100 / 500mA / 10 amp. D.C. 0 / 2K / 200K / 20 meg − 20 to + 50 dB. £13·95. Post 35p.

U4312 MULTIMETER

Extremely sturdy instrument for general electrical use. 667 o.p.v. 0/·3/1·5/7·5/30/60/150/300/600/900 VDC and 75mV. 0/·3/1·5/7·5/30/60/150/300 600/900 VAC. 0/300μA/1·5/6/15/60/150 600MA/1·5/6 AMP. D.C. 0/1·5/6/15/60/150/600MA/1·5/6 AMP. AC. 0/200 Ω/3K/30K Ω. Accuracy DC 1%. AC 1·5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. £9·50 plus P. & P. 25p.

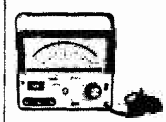
Selected TEST EQUIPMENT

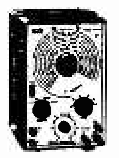
FTC-401 TRANSISTOR TESTER

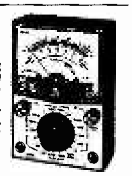
Full capabilities for measuring A, B and ICO. NPN or PNP. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. £7·50. Post 20p.

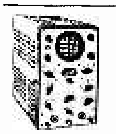
Model S-100TR MULTIMETER TRANSISTOR TESTER

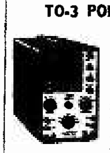
100,000 o.p.v. mirror scale/overload protection. 0/·12/·6/3/12/30/120/600 V DC. 0/6/30/120/600. V AC. 0/12/600μA/ 12/300mA/12 AMP DC. 0/10 K/1 MEG/100MEG. −20 to +50db. 0·01–2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13·50. P/P 25p.

MODEL 449A IN CIRCUIT TRANSISTOR TESTER

Checks true A.C. beta in / out. Checks Icbo. Checks diodes in / out. Checks SCR, etc. Beta HI 10 − 500, LO 2 − 50. Icbo 0–5000μA. 220/240 V A.C. operation £17·50. Post 25p.

TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 Kc/s 500 Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions £15. Carr. 37½p. Size 140 × 215 × 170 mm.

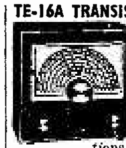
MODEL L-55 FET V.O.M.

Input impedance 10 meg ohms. 0 / ·3 / 1·2 / 6 / 30 / 120 / 600V. D.C. 0 / 3 / 12 / 60 / 120 / 600V. A.C. 0 / 120μA / 120mA D.C. 0 / 1K / 100K / 10 meg /100 meg ohms £15·97. Post 15p.

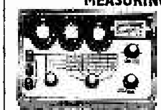
CI-5 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100KHz VRMS/mm. ·1·25; HOR. AMP. Bandwidth 500KHz. Sensitivity at 100KHz, V RMS/mm. ·3·25; Preset triggered sweep 1-3,000usec.; free running 20·200,000Hz in nine ranges. Calibrator pips. 220 × 360 × 430mm. 115-230V. AC operation. £39·00. Carr. paid.

TO-3 PORTABLE OSCILLOSCOPE

3in. tube, Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1·5cps–800kHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps 300 kHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb. 220/240V. A.C. Supplied brand new with handbook. £40·00. Carr. 50p.

RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE

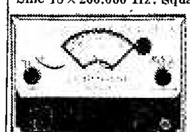
5 mc/s Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in. × 4in. C.R.T. Calibrated triggered sweep from ·2 u/sec. to 100 milli-sec. per cm. Free running time base 50 c/s-1 mc/s. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual £87. Carr. Paid.

TE-16A TRANSISTORISED SIGNAL GENERATOR

5 ranges 400kHz–30mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide easy to read scale. 800kHz modulation. 5¼ × 5¼ × 3½in. Complete with instructions and leads. £7·97. Post 25p

TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1 Ω 11·1 meg Ω 6 Ranges ±1% L.1 μ H − 111 HENRYS 6 Ranges 2 = % C.10pF ±1110mFd 6 Ranges ± 2%. TURNS RATIO 1 : 1/1000–1 : 1/100. 6 Ranges ± 1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7⅞ × 5 × 2in. £20. P. & P. 25p.

MODEL TE.15 GRID DIP METER

Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440Kc/s–280Mc/s in 6 coils. 500μA Meter. 9V battery operation. Size 180 × 80 × 40mm. £12·50. Post 20p.

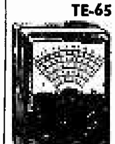
BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR
Sine 18 × 200.000 Hz: Square 18 × 50,000 Hz

Output max. + 10 dB. (10 K ohms) Operation internal batteries Attractive 2-tone case 7¾" × 5" × 2". Price £17·50. Carr. 17½p.

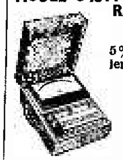
MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19–220,000Hz Sine Wave 19–100,000 Hz Square Wave. Output Sine or Square wave 10v. P. to P. Size 180 × 90 × 90mm. Operation 220/240v. A.C. £17·50. Post 37p.

MODEL AT201 DECADE ATTENUATOR

Frequency range 0–200KHz. Attenuator 0–111db, 0·1db step. Impedance 600 ohms. Max. input power 30dbm. Size 180 × 90 × 55mm. £12·50. Post 37p.

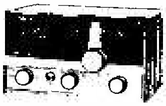
TE-65 VALVE VOLTMETER

28 ranges. D.C. volts 1·5–1,500v. A.C. volts 1·5–1,500v. Resistance up to 1,000 megohms. 200/240v. A.C. operation Complete with probe and instructions. £17·50. P. & P. 30p. Additional probes available: R.F. £2·12½; H.V. £2·50.

MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER

Sensitivity 330 ohms/Volt AC and DC. Accuracy 5% D.C. 1% AC. Scale length 165mm. 0/300/750μA/1·5 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750mA / 1·5 / 3 / 7·5AMP DC 0 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750mA / 1·5 / 3 / 7·5 AMP AC 0 / 75 / 150 / 300 / 750mV / 1·5 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750V DC 0/750mV / 1·5 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 /750V AC. Automatic cut out. Supplied complete with test leads, manual and test certificates. £49·00. Post 50p.

G. W. SMITH & CO (RADIO) LTD.

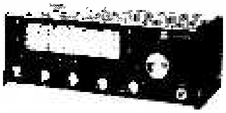
Also see opposite page and next two pages

UNR-30 RECEIVER



4 Bands covering 550Kc/s - 30Mc/s. B.F.O. Built-in Speaker 220/240v A.C. Brand new with instructions. £15·75. Carr. 37p.

UR-1A SOLID STATE COMMUNICATION RECEIVER



4 Bands covering 550Kc/s–30Mc/s. FET S Meter. Variable BFO for SSB, Built-in Speaker, Bandspread, Sensitivity Control. 220/240v. A.C. or 12v. D.C. 12⅞" × 4⅞" × 7" Brand new with instructions. £25. Carr. 37p.

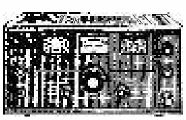
SKYWOOD CX203 COMMUNICATION RECEIVER

Solid state. Coverage on 5 bands 200-420 KHz and ·55 to 30 MHz. Illuminated slide rule dial. Bandspread. Aerial tuning BFO, AVC, ANL, 'S' meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220/240v AC or 12v DC. Size 325 × 266 × 150 mm. Complete with instructions and circuit. £32·50. Carr. 50p.

LAFAYETTE HA-600 SOLID STATE RECEIVER

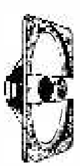
General coverage 150–400Kc/s. 550 Kc/s–30Mc/s. FET front end. 2 mech. filters, product detector, variable B.F.O., noise limiter. S. Meter, Bandspread, RF Gain. 15" × 9¾" × 8¼". 18 lbs. 220/240v. A.C. or 12v. D.C. Brand new with instructions. £50, Carr. 50p.

TRIO 9R59DS COMMUNICATION RECEIVER



4 band covering 550Kc/s. to 30 Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW. ANL. Variable BFO. S meter. Sep. bandspread dial. IF frequency 455 Kc/s. audio output 1·5w. Variable RF and AF gain controls 115/250v. A.C. Size: 7" × 13" × 10" with instruction manual. £49·50. Carr. Paid.

EMI LOUDSPEAKERS

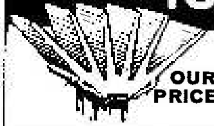


Model 350. 13" × 8" with single tweeter/crossover. 20–20,000 Hz. 15 watt RMS. Available 8 or 15 ohms. £7·25 each P. & P. 37p.
Model 450. 13" × 8" with twin tweeter/crossover. 55–13,000 Hz. 8 watt RMS. Available 8 or 15 ohms. £3·62 each. P. & P. 25p.

HONEYWELL DIGITAL VOLTMETER VT.100

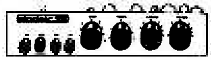
Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt. current and ohms with optional plug in cards. Specification: Accuracy: ± 0·2, ±1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power. 110–230v. A.C. 50/60 cycles. Overall size: 5⅜in. × 2 13/16in. × 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED. £35·50. Carr. 50p.

SINCLAIR IC-12



List Price £2·98
OUR PRICE £1·80
P. & P. 10p

SINCLAIR EQUIPMENT



Project 60 Package offers.
2 × Z30 amplifier, stereo 60 pre-amp. PZ5 power supply. £15·95 Carr. 37p. Or with PZ6 power supply £18·00 Carr. 37p. 2 × Z50 amplifier, stereo 60 pre-amp, PZ8 power supply. £20·25. Carr. 37p.
Transformer for PZ8. £2·97 extra.
Add to any of the above £4·45 for active filter unit and £13·00 for pair of Q16 speakers.
All other Sinclair products in stock.
2000 Amp £21·95 Carr. 37½p.; 3000 Amp £28·50 Carr. 37p.; Neoteric Amp £43·95. Carr. 37p IC12 £1·80 p. & p. 10p.
NEW PROJECT 605 — £20·97. Carr. 37p.

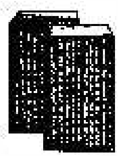
SPECIAL OFFER! GOODMANS AXIOM 301

Hi Fi 12" 20 watt twin cone full range speaker. 30–16,000 Hz. 16,500 gauss. 8 ohm impedance. Brand new and boxed.
(List price £21.72) · OUR PRICE £12·50 each. Carr. 50p.

EA.41 REVERBERATION AMPLIFIER

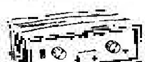
Self contained, transistorised, battery operated. Simply plug in microphone, guitar, etc., and output into your amplifier. Volume control, depth of reverberation control. Beautiful walnut cabinet. 7¼ × 3 × 4¼in. £5·97. P. & P. 15p.

SPECIAL OFFER! STEREO SPEAKERS



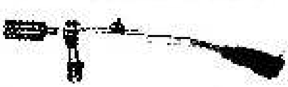
Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size 14½" × 9" × 7¼". 8 ohms. 8 watt RMS. 16 watt peak. Complete with DIN lead. £12·95 pr. Carr. 50p.

HA-10 STEREO HEADPHONE AMPLIFIER



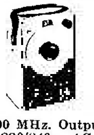
All silicon transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9v battery. Inputs 5MU/100MU. Output 50MW. £5·97. P. & P. 15p.

SPECIAL PURCHASE ! NEAT G30J STATIC BALANCE PICK-UP ARMS



Identical specification to NEAT G30 arm but with two-tone chrome and black finish. Complete with head shell, pick up rest and plug in phono leads.
BRAND NEW—
FULLY GUARANTEED
ONLY £8·95. P. & P. 25p.

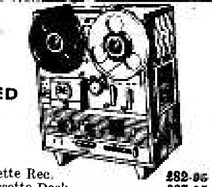
ARF-300 AF/RF Signal Generator



All transistorised, compact, fully portable. AF sine wave 18 Hz to 220 KHz. AF square wave 18 Hz to 100 KHz. Output sine / square 10v. P-P. RF 100KHz to 200 MHz. Output 1v. maximum. Operation 220/240v. AC. Complete with instructions and leads. £29·95. Post 50p.

AKAI BARGAINS

SUPER MONEY SAVING OFFERS—
BUY NOW WHILE STOCKS LAST !
BRAND NEW AND FULLY GUARANTEED



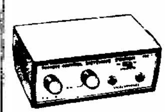
1721 Tape Rec.	£73·95
X5000 Tape Rec.	£99·95
GX370 Tape Deck	£259·95
4000DS Tape Deck	£73·95
4000DS Dust Cover	£4·75
X200 Tape Deck	£99·95
X201D Tape Deck	£132·95
X221D Tape Deck	£169·95
GX220D Tape Deck	£148·50
GX280D Tape Deck	£249·40
X1810D Tape/8 track Deck	£169·95
GX1900D Tape/Cass Deck	£177·95
X2000SD Tape/Cas/8 Track Rec.	£223·30
CR81 8 track Rec.	£80·95
CR81D 8 track Rec.	£65·95
CR81T 8 track/Receiver	£118·90
CR80DSS 8-track	£121·95
CR80SS 8 track system	£145·00
GXC40 Cassette Rec.	£82·95
GXC40D Cassette Deck	£67·95
GXC40T Cassette/Receiver	£123·95
GXC45D Cassette Deck	£89·95
GXC46D Cassette Deck	£103·50
GXC46 Cassette Recorder	£115·95
GXC60D Cassette Deck	£111·25
GXC65D Cassette Deck	£110·25
CS35D Cassette Deck	£59·50
AA6300 Receiver	£79·95
AA8030 Receiver	£106·95
AA8080 Receiver	£144·95
AA8500 Receiver	£175·00
ADM11 Microphones (Pair)	£7·50

Carriage 50p extra. (Recorders & Decks 75p)

DOLBY SYSTEM NOISE REDUCTION UNIT

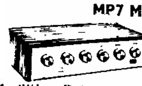
Improves the performance of cassette and semi-professional recorders. Reduces tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Controls for input levels and noise reduction on record and replay. 2 meters for Dolby level. Off tape monitoring. Frequency response: 20Hz to 15kHz ± 1dB 19kHz −35dB. Size 15¾" × 9" × 3¼". AC 200/250V.
OUR PRICE £32·50 Carr. 50p.

1021 STEREO LISTENING STATION



For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6" × 4" × 2¼". £2·25, P. & P. 15p.

MP7 MIXER PREAMPLIFIER



5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9¼" × 5" × 3" Inputs Mics: 3 × 3mV 50K: 2 × 3mV 600 ohm. Phono meg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K. £8·97. P. & P. 20p.

TE-1035 STEREO HEADPHONES

Low cost high performance stereo headphones. Foam rubber ear cups Adjustable head-band. 8 ohm impedance 25–18,000 Hz. With lead and stereo jack plug. ONLY £1·97. P. & P. 12p.

NEW GARRARD MODULES

Popular range of Garrard decks with Shure cartridge fitted in deluxe plinth with hinged lid.

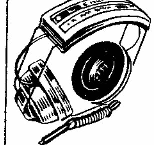
SP25 III Module/M75-6	£23·50
AP76 Module/M75-6	£33·80
AP96 Module/M75-6	£38·75
Zero 100S Module/M93E	£52·60

Carr. 50p extra any item.

HOSIDEN DH-08S DE-LUXE STEREO HEADPHONES

Features unique mechanical 2 way units and fitted adjustable level controls. 8 ohm impedance 20–20,000cps. Complete with spring lead & stereo jack plug £7·97. P. & P. 12p.

GENUINE BARGAIN! KOSS SP.3XC STEREO HEADPHONES



Response 10–15,000Hz. Impedance 4–6 ohms. Brand new, Boxed & fully guaranteed (List £9.50). OUR PRICE £6·50. P. & P. 25p.

HOSIDEN DH-02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head-band. 8 ohm impedance. 20-12,000 cps. Complete with lead and plug. ONLY £2·37. P. & P. 12p.

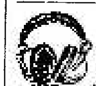
TAPE CASSETTES

Top quality Hi-Fi Low Noise in Library cases.

C60	3 for 75p.	10 for £2·35
C90	3 for £1·05	10 for £3·30
C120	3 for £1·35	10 for £4·20

Tape Head Cleaner 30p each.
P. & P. 10p extra.

SPECIAL OFFER! ROTEL RH700 STEREO HEADPHONES



20–20,000Hz. 8–16 ohm. (List £9·95). OUR PRICE £6·75. P. & P. 25p.

TRANSISTORISED FM TUNER

6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6 × 4 × 2½in. 3 I.F. stages. Double tuned discriminator, Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88–108Mc/s. Ready built ready for use. Fantastic value for money. £6·37½. P. & P. 12½p. Stereo multiplex adaptors £4·97½.

TE 1018 DE-LUXE MONO HIGH IMPEDANCE HEADSET

Sensitive, soft earpads, adjustable headband. Magnetic, impedance 2,600 ohms.
£1·97, P. & P. 15p.

HAND HELD 2-WAY WALKIE TALKIES

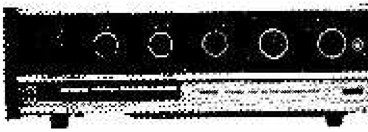
Industrial quality in robust metal cases. Battery operation. Volume and squelch controls. Call button and press to talk button. Telescopic aerial. Complete carrying cases.

2 channel 300 mW	£52·50	Pair. Post 50p.
3 channel 2 watt.	£79·50	Pair. Post 50p.

G. W. SMITH & CO (RADIO) LTD.
Also see previous pages and opposite page

FANTASTIC OFFER!

NIKKO TRM 50 STEREO AMPLIFIER



17 + 17 watts rms stereo amplifier with inputs for Magnetic and Crystal phono, Tuner, Tape, Aux and Tape Monitor. Outputs for two pairs of stereo speakers and Tape. Stereo headphone socket. Full range of controls including loudness control, scratch filter, etc. Size 13" × 9½" × 3¾". Unrepeatable offer—limited stocks!

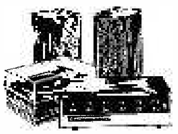
List price £59·50
OUR PRICE
£39·95
Carriage 50p

HI-FI EQUIPMENT

SAVE UP TO 33⅓% OR MORE

SEND S.A.E. FOR FULL DISCOUNT PRICE LISTS AND PACKAGE OFFERS!

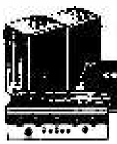
NIKKO TRM.50 SYSTEM



NIKKO TRM50 17 + 17 watt rms. stereo amplifier, BSR MP60, plinth & cover. Goldring G800 cartridge, pair of Linton 2 speakers and all leads.

OUR PRICE £104·90 Carr. and Ins. £1·50

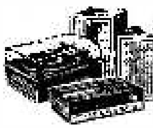
LEAK DELTA 30 SYSTEM



Leak Delta 30 stereo amplifier, Goldring GL75, plinth, cover and G800 cartridge. Pair of Leak 150 speakers and all leads.

OUR PRICE £123·50 Carr. and Ins. £1·50

TELETON SAQ206B SYSTEM

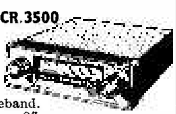


Teleton SAQ206B 8 + 8 watt Amplifier, BSR MP60, plinth & cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

OUR PRICE £54·40 Carr. £1·50

Amplifier only, **£22·95**. Carr. 50p.

AUDIOTRONIC ACR.3500 MW/LW CAR RADIO



Fully transistorised, dual waveband. Size 6½" × 4¾" × 2". 12v. D.C. Neg. or Pos. earth. Complete with fixing kit, speaker and leads. ONLY **£7·50**. Post 20p.

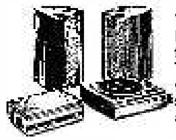
SUPER BARGAIN! AUDIOTRONIC ACP.8 8-TRACK CAR STEREO TAPE PLAYER

Tone, volume and balance controls. Track selector. Complete with matched pair of stereo speakers, connections and fittings. ONLY **£15·95**. Post 30p. (Illus is example only).

BH.001 HEAD SET AND BOOM MICROPHONE

Moving Coil. Ideal for language teaching, communications. Headphone imp. 15 ohms. Microphone imp. 200 ohms. **£4·62**, P. & P. 15p.

WHARFEDALE LINTON SYSTEM



Wharfedale Linton Amplifier, Linton Turntable, pair of Linton 2 speakers and all leads.

OUR PRICE £106·00 Carr. and Ins. £1·25

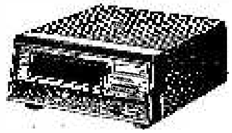
LINTON RECEIVER SYSTEM **£155·00**. Carr. & Ins. £1·25.

AMSTRAD 8000 II SYSTEM

Amstrad 8000 II 7 + 7 watt amplifier. BSR MP60, plinth and cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

OUR PRICE £48·25 Carr. £1·00

Amplifier only, **£16·95**. Carr. 50p.



B.S.R. TD8S 8-TRACK STEREO TAPE PLAYER DECK

Integrated preamps (output 125 mV) to feed into any stereo amplifier. Automatic and manual programme selector. 4 pole synchronous motor. 210/240 V.

OUR PRICE £16·25 Post 50p

SPECIAL PURCHASE!

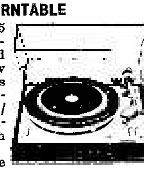
FERGUSON 3414 STEREO TUNER AMPLIFIER TURNTABLE UNIT

10+10 watts rms.

Five push buttons with separate scales for pre-tuning to desired FM station. Housed in a handsome walnut finished cabinet with BSR P128/MP60 record deck with Goldring G800H stereo magnetic cartridge. Offered complete with cover and a pair of matching Medway Speakers, size 18"×11"×8". TODAY'S VALUE AT LEAST £125!

OUR PRICE £75·00
Carr. & Ins. **£1·50**.

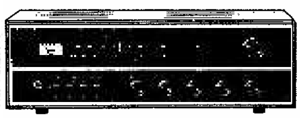
SAVE £££'s PHILIPS GA308 TRANSCRIPTION TURNTABLE



2 speeds 33⅓ and 45 rpm. Lightweight tubular counterbalanced arm. Belt driven low speed synchronous motor. Viscous damped pick up lift/lower device. Complete with teak plinth and hinged cover. GA308 less cartridge (List £36·55).
OUR PRICE **£24·50**. P. & P. 50p.
GA308 PU with GP400 stereo magnetic cartridge (List Price £47·65)
OUR PRICE **£29·95** P. & P. 50p.
LIMITED NUMBER ONLY!

ROTEL BARGAINS!

All brand new and guaranteed



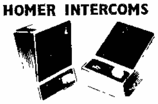
RA210 Amp	£22·50
RA310 Amp	£34·95
RA610 Amp	£48·25
RX150 Receiver	£45·95
RX200 Receiver	£57·50
RX400 Receiver	£70·95

P. & P. 50p extra any item.

WHARFEDALE MID-RANGE HI-FI UNITS

As used in world famous system. 5" dia. Impedance 4/8 ohms. High flux ceramic magnet, 20 watts rms. Brand new **£1·50**. Carr. 37p.

HOMER INTERCOMS



Ideal for home office, stores, factories, etc. Supplied complete with batteries, cable and free instructions.

2 Station, **£2·97**, 3 Station **£5·25**, P. & P. 15p
4 Station **£6·62**, P. & P. 17p.

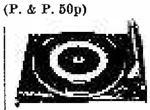
CREDIT TERMS FOR CALLERS
ACCESS & BARCLAYCARD WELCOME

V.A.T. INFORMATION

All mail orders received on or after April 1st. will be subject to Value Added Tax.

THIS MUST BE ADDED TO THE TOTAL VALUE OF GOODS ORDERED (INCLUDING POSTAGE/CARRIAGE) AND ENCLOSED WITH ORDER.

RECORD DECKS (P. & P. 50p)



B.S.R. McDONALD

C114 Mini	£4·97
C129 Mono	£6·50
C137	£8·35
MP60	£9·50
610	£12·95
810	£31·25
210/TPD3	£8·75
MP60/G800	£12·95
MP60/TPD1	£16·05
MP60/TPD1/G800	£19·50
MP60/TPD2	£14·35
610/TPD1	£18·95
510/TPD1	£17·95
HT70	£13·99
HT70/G800	£17·25
HT70/TPD1	£20·35
HT70/TPD1/G800	£23·90
810 Plinth/Cover	£9·25

CONNOISSEUR

BD1 Kit	£10·90
BD1 Chassis	£13·60
BD1/SAU2/Plinth	£33·10
BD2/SAU2/Chassis	£25·95
BD2/SAU2/Plinth/C	£33·85

GARRARD

2025 T/C Stereo	£8·50
SP25 III/Acos GP104 Ceramic	£10·25
SP25 III	£10·25
SP25 III/M75-6	£15·95
SP25 III Module/ M75-6	£23·50
SL65B	£13·75
AP76	£17·95
AP76 Module/ M75-6	£33·80
SL72B	£21·95
SL95B	£32·25
401	£25·95
ZERO 100A	£38·95
ZERO 100S	£36·95
ZERO 100S Mod/ M93-E	£52·60
AP96 Module/ M75-6	£38·75

GOODMANS

TD100 Teak	£51·95
TD100 White	£58·25

GOLDRING

GL69/2	£18·50
GL72	£20·95
GL72/P	£27·50
Plinth 69/72	£7·02
LID 72	£3·25
GL75	£26·95
GL75P	£35·25
Plinth 75	£7·35
LID 75	£3·60
G99	£19·25
GL85P/C	£56·95
G101P/C	£20·50

HACKER

GP45/30	£49·50
T45 Table	£4·95

LEAK

Delta Turntable	£52·50

MICRO-SEIKI

MR111	£29·50
MR111 Plinth & Cover	£9·50

PHILIPS

GA105	£16·95
GA160	£27·00
GA308 Teak	£24·50
GA308PU Teak	£29·95
GA212	£56·75

PIONEER

PL12D	£34·50
PL15C	£51·35
PLA35	£82·65
PL50	£111·85
PL41D	£118·50
PL61	£119·95

THORENS

TD125 II	£66·50
TD125AB II	£99·95
TX25	£6·95
TD160C	£56·95
TD150A II	£35·95
TD150AB II	£39·95

WHARFEDALE

Linton Turntable	£26·95

PLINTHS & COVERS (P. & P. 50p)

Budget SP25, etc.	£3·20
Budget AP76/Zero 100S	£4·50
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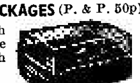

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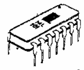

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7403	15p	14p	7454	15p	14p	7495	77p	74p
7404	15p	14p	7460	15p	14p	7496	77p	74p
7405	15p	14p	7470	29p	26p	74100	1·75p	1·65p
7408	18p	17p	7472	29p	26p	74104	97p	94p
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7420	15p	14p	7476	43p	40p	74111	1·00p	95p
7430	15p	14p	7480	67p	64p	74118	1·00p	95p
7440	15p	14p	7481	97p	94p	74119	1·35p	1·25p
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7442	67p	64p	7483	1·10p	1·05p	74141	67p	64p
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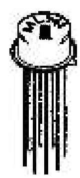

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22µF	6p
47µF	6p
100µF	7p
150µF	7p
220µF	9p
470µF	12p
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150µF	9p
220µF	10p
470µF	17p
680µF	23p
1000µF	23p
2200µF	40p

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6·8µF	6p
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22µF	6p
68µF	9p
100µF	10p
150µF	12p
220µF	17p
330µF	20p
470µF	24p
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1600µF	74p
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AC128	12p
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AC176	14p
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AC187K	18p
AC188	12p
AC188K	18p
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ACY18	19p
ACY19	23p
ACY20	20p
ACY21	21p
ACY22	16p
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BC126	22p
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BC134	14p
BC135	14p
BC137	14p

BC138	24p
BC142	30p
BC143	30p
BC144	26p
BC145	24p
BC147	8p
BC148	8p
BC149	8p
BC153	15p
BC154	16p
BC157	12p
BC158	11p
BC159	12p
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BC169	10p
BC177	14p
BC179	14p
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2N2924	16p
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2N3053	24p
2N3054	50p
2N3055	48p
2N3405	40p
2N3663	52p
2N3702	8p
2N3703	8p
2N3704	8p
2N3705	8p
2N3706	8p
2N3707	8p
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2N3711	8p
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1S131	10p
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1S940	5p
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AA129	10p
AAZ13	10p
AAZ15	12½p
AAZ17	12½p
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BA102	22½p
BA115	7½p
BA144	12½p
BA145	20p
BA154	12½p
BAX13	12½p
BAX16	12½p
BAY18	17½p
BAY31	7½p
BY100	17½p
BY126	15p
BY127	17½p
BYX10	22½p
OA5	17½p
OA9	10p
OA10	22½p
OA47	8p
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OA81	8p
OA85	10p
OA90	7p
OA91	7p
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160V: 0·01µF, 0·015µF, 0·22µF, 0·033µF, 0·047µF, 0·068µF, **3p.** 0·1µF **3½p.** 0·15µF, **4½p** 0·22µF, **5p.** 0·33µF, **6p.** 0·47µF, **7½p.** 0·68µF, **11p.** 1·0µF, **13p.**

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Single type with D.P. switch **12p** extra.

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All valves 100-5 meg ohms.
·1 watt **5p** each
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600	IN4005 7p	PL4005 12p
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P.I.V.	1 AMP	2 AMP	5 AMP	10 AMP
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600	40p	62p	£2·20p	£2·50p
800	45p	—	—	—

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PIV	50	100	200	300	400
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3 Amps	40	45	55	—	60
7 Amps	—	87	92	—	1·12

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¼ watt 5% carbon **1p** each
½ watt 10% carbon **1p** each
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Range 10 ohms to 4·7 meg.
½ watt m/o 2% **3p** each
Range 10—1 meg ohms

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IN4148
50p

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Plastic BC109
50p

Pack of 10
BC169 **50p**
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but tested

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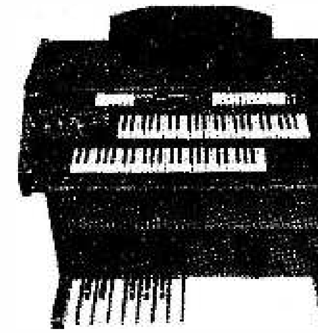

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3V4	·47	30FL12	·69	EBC81	·30	EY51	·36	PCL85	·38	UBF80	·34
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6AU6	·20	30PL13	·89	ECC804	·54	GZ32	·40	PL81	·43	UF41	·52
6LA6	·20	30PL14	·80	ECF80	·30	KT41	·77	PL81A	·47	UF89	·30
6BE6	·21	35L6GT	·45	ECF82	·26	KT61	·55	PL82	·31	UL41	·53
6BJ6	·41	35W4	·25	ECH35	·55	KT66	·78	PL83	·33	UL84	·30
6BW7	·50	35Z4GT	·25	ECH42	·59	LN319	·63	PL84	·30	UM84	·22
6F14	·35	50CD6G	·68	ECH81	·29	LN329	·80	PL500	·63	UY41	·39
6F23	·68	807	·49	ECH83	·38	LN339	·65	PL504	·63	UY85	·25
6F25	·50	AC/VP2	·77	ECH84	·35	N78	£1·05	PM84	·30	VP4B	·77
6J5GT	·20	B349	·70	ECL80	·30	P61	·40	PX25	·95	W77	·43
6J7G	·24	B729	·54	ECL82	·29	PABC80	·31	PY32	·52	Z77	·22
6K7G	·12	CCH35	·67	ECL86	·35	PC86	·47	PY33	·52	**Transistors**	
6K8G	·36	CY31	·28	EF39	·38	PC88	·47	PY81	·25	AC107	·17
6Q7G	·35	DAF91	·22	EF41	·57	PC96	·42	PY82	·25	AC127	·18
6SL7GT	·32	DAF96	·36	EF80	·23	PC97	·33	PY83	·26	AD140	·37
6SN7GT	·32	DF91	·16	EF85	·28	PC900	·29	PY88	·33	AF115	·20
6V6G	·28	DF96	·36	EF86	·30	PCC84	·29	PY800	·31	AF116	·20
6V6GT	·28	DH77	·20	EF89	·26	PCC85	·23	PY801	·31	AF117	·20
6X4	·23	DK32	·33	EF91	·13	PCC88	·38	R19	·30	AF125	·17
6X5GT	·28	DK91	·28	EF92	·27	PCC89	·43	R20	·70	AF127	·17
10P13	·53	DK92	·50	EF98	·65	PCC189	·48	U25	·73	OC26	·25
12AT7	·17	DK96	·45	EF183	·27	PCC805	·70	U26	·65	OC44	·12
12AU7	·20	DL35	·40	EF184	·29	PCF80	·26	U47	·73	OC45	·12
12AX7	·22	DL92	·26	EH90	·36	PCF82	·33	U49	·70	OC71	·12
19BG6G	·75	DL94	·47	EL33	·55	PCF86	·46	U52	·31	OC72	·12
20F2	·67	DL96	·38	EL34	·48	PCF800	·58	U78	·24	OC75	·12
20P3	·75	DY86	·24	EL41	·54	PCF801	·28	U191	·68	OC81	·12
25L6GT	·19	DY87	·24	EL84	·23	PCF802	·39	U193	·31	OC81D	·12
25U4GT	·57	DY802	·33	EL90	·26	PCF805	·72	U251	·61	OC82	·12
30C1	·26	EABC80	·32	EL95	·33	PCF806	·56	U301	·38	OC82D	·12
30C15	·58			EL500	·62			U329	·66	OC170	·23

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Minimum post/packing on 1 valve 7p., on each additional valve, (3p. per. valve extra)

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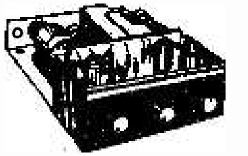
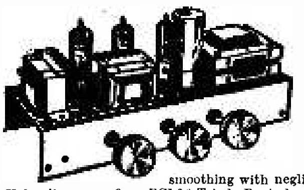
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohm. Frequency response 12Hz—30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high x 6" wide x 7½" deep. AC 200/250V.
PRICE £10·50. P. & P. 25p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built & tested to a high standard. **PRICE £8·92** P.&P. 45p.

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E.M.I. 13½ × 8in. with high flux ceramic magnet with parasitic tweeter 3, 8 or 15 ohm **£3·20**, P. & P. 30p. E.M.I. 13 × 8in. 3, 8 or 15 ohm with two inbuilt tweeters and crossover network **£4·20**, P. & P. 30p.
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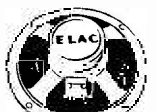

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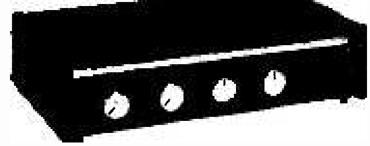

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A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled fibreglass printed circuit board, smart brushed anodised aluminium front panel with matching knob, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification; Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12-30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12-15,000 Hz. Bass boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1.0 amp.
Overall Size 12"w. x 8"d. x 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 18p plus large S.A.E.

AMPLIFIER KIT	**£10·50**	P. & P. 15p
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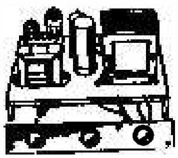
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi Fi Discotheque use, etc.



3-VALVE AUDIO AMPLIFIER HA34 MK II.
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½" w. × 4" d. × 4¾" h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4·95.** P. & P. 35p.
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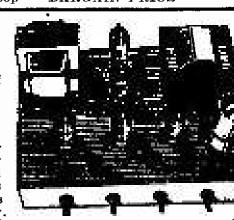
A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3.5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240v. Supplied absolutely Brand New completely wired and tested with good quality output transformer.
P. & P. 35p BARGAIN PRICE **£2.95**

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 Ω speaker and 2 independent volume controls, and separate base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 13p (Free with parts). **All parts sold separately.** ONLY **£7·97** P. & P. 55p. Also available ready built and tested **£10·97** P. & P. 60p.

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Stereo 60 Pre-amp/control unit

Designed specifically for use on Project 60 systems, the Stereo 60 is equally suitable for use with any high quality power amplifier. Since silicon epitaxial planar transistors are used throughout, a really high signal-to-noise ratio and excellent tracking between channels is achieved. Input selection is by means of press buttons, with accurate equalisation on all input channels. The Stereo 60 is particularly easy to mount.

SPECIFICATIONS—Input sensitivities: Radio – up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A. curve ±1dB: 20 to 25,000 Hz. Ceramic p.u. – up to 3mV: Aux – up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE +12 to —12dB at 10KHz: BASS +12 to —12dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.

Built, tested and guaranteed. **£9.98**

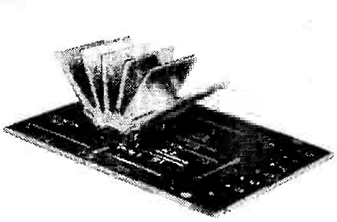
Project 60 Stereo F.M. Tuner

The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other advanced features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stero decoder and switchable squelch circuit for silent tuning between stations. In terms of high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with most other high fidelity systems.

SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108MHz. **Sensitivity:** 7μV for lock-in over full deviation. **Squelch level:** Typically 20μV. **Signal to noise ratio:** >65dB. **Audio frequency response:** 10Hz – 15KHz (±1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2μV. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. maximum **Operating voltage:** 25–30VDC. **Indicators:** Stereo on; tuning. **Size:** 93 x 40 x 207mm.

Built and tested. Post free. **£25**

Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with pick-up, F.M. radio or small P.A. set up. etc. The free 40 page manual supplied, details many other applications which this remarkable IC. make possible. It is the equivalent of a 22 transistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

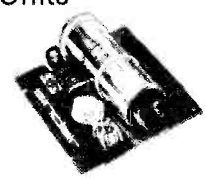
Output power: 6 watts RMS continuous (12 watts peak). 6–8Ω. **Frequency Response:** 5Hz to 100KHz ±1dB. **Total Harmonic Distortion:** Less than 1%. (Typical 0·1%) at all output powers and frequencies in the audio band (28V). **Load Impedance:** 3 to 15 ohms. **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback. **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22×45×28mm including pins and heat sink..

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual.

£2.98 Post free

Power Supply Units The new PZ.8 Mk.3



The most reliable power supply unit ever made available to constructors. Brilliant circuitry makes failure from over load and even direct shorting of the output impossible. This is due to an ingenious re-entrant current limiting principle which, as far as we know has never before been available in any comparable unit outside the most expensive laboratory equipment. Ripple and residual noise have been reduced to the point of almost total elimination. This is, of course, the perfect unit for Project 60 assemblies, particularly where the new Z.50 MK.2 amplifiers are used. Nominal working voltage – 45.

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(not suitable for Project 60 tuner) £4.98
PZ.6 35v. stabilised
(not suitable for IC. 12) £7.98

Project 605

the easy way to buy and build Project 60 without soldering

Project 605 in one pack contains: one PZ.5, two Z.30's, one Stereo 60 and one Masterlink, which has input sockets and output components grouped on a single module and all necessary leads cut to length and fitted with clips to plug straight on to the modules thus eliminating all soldering.

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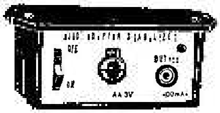

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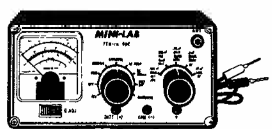

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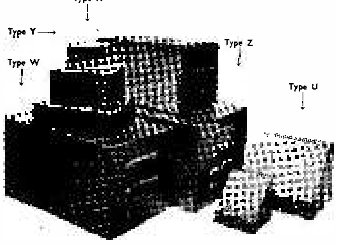

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8x4x2"	38p	19p	13x8x2½"	76p	38p
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PCC85	0.40
PCC88	0.55
PCC89	0.55
PCC189	0.60
PCC805	0.95
PCC806	0.95
PCF80	0.30
PCF82	0.35
PCF84	0.60
PCF86	0.60
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U76	0.40
U78	0.40
U191	0.75
U201	0.50
U281	0.55
U282	0.55

U301	0.55
U403	0.70
U404	0.70
U801	0.80
UABC80	0.40
UAF41	0.70
UAF42	0.60
UB41	0·65
UBC41	0.55
UBC81	0.45
UBF80	0.40
UBF89	0.40
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UBL21	0.70
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UCL81	0.60
UCL82	0.35
UCL83	0.65
UF9	0.65
UF11	0.60
UF41	0.65
UF42	0.65
UF43	0.65
UF80	0.35
UF85	0.40
UF89	0.40
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2N698	0.30
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2N706	0.10
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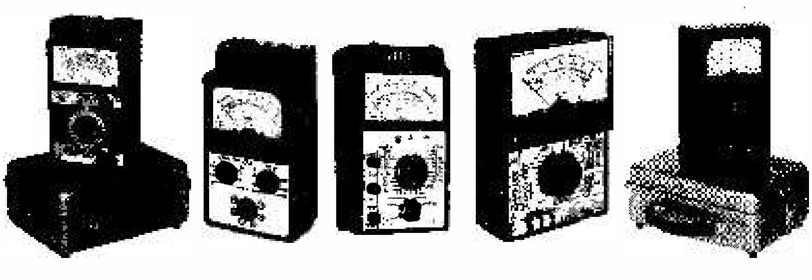
2N930	0.20
2N987	0.30
2N1131	0.25
2N1132	0.25
2N1184	1.25
2N1302	0.17
2N1303	0.17
2N1304	0.20
2N1305	0.20
2N1306	0.25
2N1307	0.25
2N1308	0.25
2N1309	0.25
2N1613	0.17
2N1711	0.20
2N1756	0.75
2N2147	0.75
2N2160	0.60
2N2217	0.25
2N2218	0.20
2N2219	0.20
2N2369A	0.15
2N2477	0.65
2N2646	0.40
2N2905	0.25
2N2923	0.12
2N2924	0.13
2N2926	0.10
2N3053	0.20
2N3054	0.50
2N3055	0.60
2N3133	0.25
2N3134	0.25
2N3391	0.17
2N3392	0.17
2N3393	0.15
2N3394	0.15
2N3395	0.20
2N3402	0.15
2N3403	0.15
2N3404	0.32
2N3414	0.20
2N3415	0.15
2N3417	0.25
2N3702	0.10
2N3703	0.10
2N3704	0.12
2N3707	0.12
2N3709	0.10
2N3710	0.10
2N3819	0.35
2N3906	0.25
2S702	0.50
2S746	0.25
AC113	0.15
AC125	0.30
AC126	0.20
AC127	0.17

AC128	0.15
AC132	0.35
AC153	0.20
AC154	0.15
AC157	0.17
AC169	0.10
AC176	0.17
AC187	0.25
AC188	0.25
ACY17	0.25
ACY18	0.20
ACY19	0.25
ACY20	0.20
ACY21	0.20
ACY22	0.10
AD140	0.50
AD149	0.45
AD161	0.35
AD162	0.35
ADZ11	1.25
ADZ12	1.25
AF114	0.17
AF115	0.17
AF116	0.17
AF117	0.17
AF118	0.30
AF125	0.20
AF127	0.20
AF180	0.35
AF181	0.35
AF186	0.40
AF239	0.36
AFZ11	0.45
AFZ12	1.00
ASY26	0.25
ASY27	0.30
ASY28	0.25
ASY29	0.30
ASY54	0.25
ASZ15	0.70
ASZ16	0.70
ASZ17	0.75
ASZ18	0.75
ASZ20	0.25
ASZ21	0.40
AUY10	1·00
BC107	0.10
BC108	0.10
BC109	0.10
BC113	0.10
BC118	0.20
BC134	0.20
BC147	0.10
BC148	0.10
BC149	0.12
BC152	0.15
BC158	0.15
BC175	0.20
BC186	0.25
BCY30	0.25
BCY31	0.30
BCY33	0.25
BCY34	0.30
BCY72	0.15
BCZ10	0.30
BCZ11	0.40

BD121	0.65
BD123	0.80
BD124	0.60
BD131	0.75
BD132	0.80
BF115	0.20
BF167	0.18
BF173	0.20
BF179	0.30
BF180	0.30
BF181	0.30
BF184	0.20
BF185	0.20
BF194	0.14
BF195	0.14
BF196	0.12
BF197	0.12
BF200	0.35
BFW87	0.25
BFW88	0.20
BFW89	0.20
BFW91	0.20
BFX88	0.20
BFY17	0.40
BFY19	0.25
BFY50	0.20
BFY51	0.20
BFY52	0.20
BSY26	0.17
BSY27	0.15
BSY28	0.17
BSY65	0.20
BSY95A	0.12
OC16	0.50
OC22	0.50
OC23	0.60
OC24	0.60
OC25	0.35
OC26	0.25
OC28	0.50
OC29	0.60
OC35	0.50
OC36	0.45
OC42	0.20
OC44	0.15
OC45	0.12
OC70	0.10
OC71	0.12
OC72	0.12
OC73	0.30
OC75	0.15
OC76	0.15
OC78	0.25
OC78D	0.20
OC81	0.20
OC81D	0.20
OC83	0.20
OC139	0.30
OC140	0.35
OC141	0.60
OC170	0.25
OC171	0.25
OC200	0.30
OC201	0.60
OC202	0.65
OC203	0.40
OC204	0.40



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SYNCHROSCOPE TYPE C1-5

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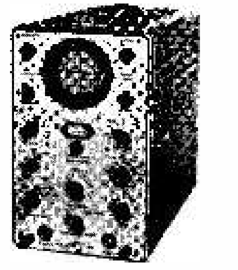
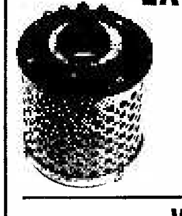


3-in tube fitted with telescopic viewing hood, giving bright display in full daylight. Sensitivity 10mV/mm (narrow band) to 30mV/mm (wide band).
Bandwidth 10 c/s—10 mc/s. Triggered sweep pre-set at 1-2-5-10-30-100-300-1000-3000 µsec per stroke. Free-running time base 20 c/s to 200kc/s with built-in crystal calibrator providing timing marks at ·05-·2-1·5-20-100 µ sec.
Amptitude calibrator directly calibrated in volts.
Input attenuator 1-10·100.
Power supplies 127/230v AC.
PRICE £39·00. Packing and carriage £1·50.

HIGH CURRENT THYRISTORS

BTX47-1000R ; 1000V 11·5A		£2·00
BTX47-1200R ; 1200V 11·5A		£2·50
BTX48-1000R ; 1000V 16A		£2·50

VARIABLE AUTOTRANSFORMER LATR2M



Made in USSR
Max. current 2 amps
Input voltage 115-220-250V
Output voltage 0 to 255V
Bench mounting

PRICE £6·55

V.A.T.

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