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pw
WORKSHOP OSCILLOSCOPE

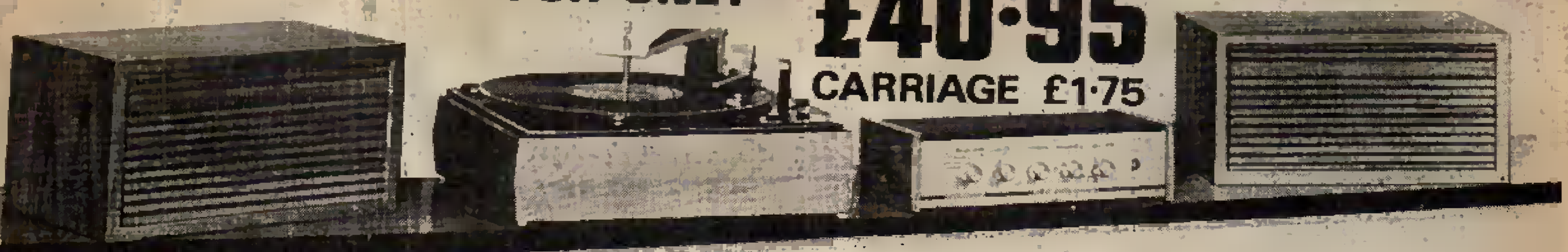
GUIDE TO **Test Instruments** SUPPLEMENT

ALSO:
HIGH IMPEDANCE VOLTMETER

COMPLETE STEREO SYSTEM

FOR ONLY £40·95

CARRIAGE £1·75



PREMIER STEREO SYSTEM "ONE" Consists of an all transistor stereo amplifier. Garrard 2025 T/C auto manual record player unit fitted stereo mono cartridge and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 10 transistor amplifier has an output of 5 watts per channel with inputs for pick-up, tape and tuner also tape output socket. Controls: Bass, Treble, Volume, Balance, Selector. Power on off, stereo mono switch. Brushed aluminium front panel Black metal case with teakwood ends: Size 12 × 5½ × 3½in. high (Amplifier available separately if required £14.95 Carr. 40p.) *NOW AVAILABLE – MATCHING FM TUNER £22.05*

PREMIER STEREO SYSTEM "TWO"
As system 'ONE' above but with Garrard SP25.
PREMIER PRICE £47 Carr. £1.75

MIDLAND AM/FM STEREO TUNER AMPLIFIERS

Two new all solid state receivers from Midland at economical prices. Beautifully styled in slimline cabinets.

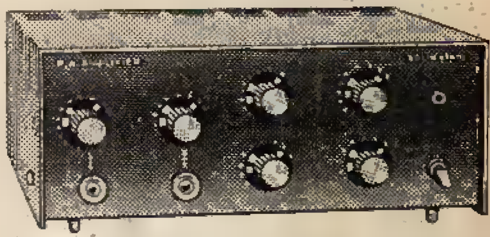
MODEL 19-520

MODEL 19-542

Specifications	MODEL 19-520	MODEL 19-542
Semi conductors	19 transistors, 12 diodes, 2 varistors	22 transistors, 12 diodes
Tuning range	FM 88–108 MHz FM Stereo Multiplex AM 535–1635 kHz	FM 88–108 mHz FM Stereo Multiplex AM 535–1605 kHz
Aerial	Internal AM and external FM	Internal AM and external FM
Frequency response	50–17,000 Hz	35–20,000 Hz
Power output	2½ watts rms per channel (8 watts music power)	4 watts rms per channel (18 watts music power)
Inputs	Ceramic phono	Magnetic/Ceramic phono and aux.
Speaker impedance	4–8 ohm	8 ohm
Controls	Power on/off, Volume, tone, balance, tuning, AFC. Stereo indicator	On/off, Volume, bass, treble, balance, tuning, AFC. Stereo indicator
Function selector	AM, FM, FM Stereo, Phono (Stereo indicator light)	AM, FM, FM Stereo, Ceramic, Magnetic. Aux.
Size	15" x 8$\frac{1}{16}$" x 3½"	16½" x 9¼" x 3¼"
PRICE	£30.45 Carr. & Ins. 50p	£44 Carr. & Ins. 50p

50 Watt Public Address Amplifier

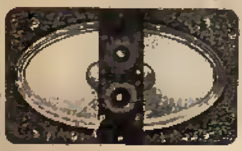
MODEL PA-5000



A top quality amplifier giving 50 watts rms power output (80 watts peak). Incorporates 8 transistors and 4 silicon diodes (silicon output transistors). Inputs for 2 microphones each with individual volume controls, plus radio/aux input. Master volume control and Bass and Treble Controls. Well presented front panel for ease of operation, on/off power flick switch and pilot light. Output impedance 4/8/16 ohms. Mike 1 & 2 sensitivity 2mV (50Kohms). Radio/Aux 300mV (100Kohms). Frequency response 50-20,000 Hz. Fused output and thermal overload protection. A.C. Mains 220-250v. 50/60 Hz. Size 13½" × 9" × 5"

PREMIER PRICE £39 P. & P. 50p

E.M.I. 13×8in. HI-FI SPEAKERS



Fitted two 2½in tweeters and crossover network. Impedance 8 or 15 ohm. Handling capacity 10W. Brand new.

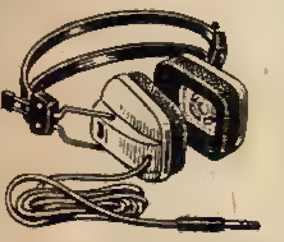
£3.47 P. & P. 40p

VERITAS V-149 MIXER

Battery operated 4-channel audio mixer providing four separate inputs. Size 6 × 3 × 2in. suitable for crystal microphone low impedance microphone, with transformer, radio, tape, etc. Max. input 1·5v. Max. output 2·5v. Gain 6 dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

MONO MODEL **£3** STEREO MODEL **£3.47** P. & P. 12p

HI-FI STEREO HEADPHONES

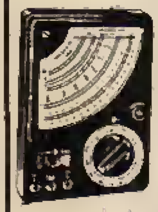


Designed to the highest possible standard. Fitted 2½in speaker units with soft padded ear muffs. Adjustable headband. 8 ohms impedance. Complete with 6ft lead and stereo jack plug.

£2.47 P. & P. 25p.

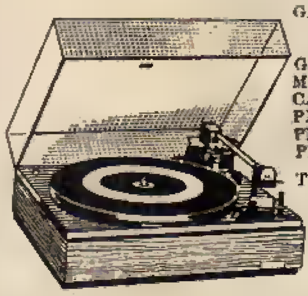
STEREO STETHOSCOPE SET Low imp. £1.25 P. & P. 10p.

MONO STETHOSCOPE SET Low imp. 52p. P. & P. 10p.



POCKET SIZE MULTI-TESTER With wide angle, jewelled meter movement, ceramic long-life, low-loss switching, tough impact resisting case. Sensitivity 20,000 ohms/volt D.C. 10,000 ohms/volt A.C.
19 Ranges: 0-5-25-50-250-500-2500 volts DC. 0-10-50-100-500-1000 volts AC. 0-50µA-2·5 mA-250 mA DC. 0-6000 ohms-6 megohms, 10µ µf-0·001 mfd-1 mfd. −20 to +22dB. Complete battery, test lead and instructions. **£4.90** P. & P. 17p.

SPECIAL OFFER!



GARRARD SP25 MK II SINGLE RECORD PLAYER FITTED GOLDRING 850 MAGNETIC STEREO CARTRIDGE COMPLETE IN TEAK PLINTH WITH RIGID PERSPEX COVER.

Total list price over £24.

PREMIER PRICE **£18.90** P. & P.50p.

"VERITONE" RECORDING TAPE

SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED. TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped–attractively boxed.

LP3	3"	250'	P.V.C.	28p
TT3	3"	450'	POLYESTER	37p
DT3	3½"	600'	POLYESTER	57p
SP5	5"	600'	P.V.C.	42p
LP5	5"	900'	P.V.C.	50p
DT5	5"	1200'	POLYESTER	75p
LP6	5¾"	1200'	P.V.C.	62p
DT6	5¾"	1800'	POLYESTER	£1·12
TT6	5¾"	2400'	POLYESTER	£1·87
SP7	7"	1200'	P.V.C.	62p
LP7	7"	1800'	P.V.C.	75p
DT7	7"	2400'	POLYESTER	£1·25
TT7	7"	3600'	POLYESTER	£2·50

TAPE SPOOLS 3" 10p, 5", 5¾", 7" 9p.
Post and Packing 3" 5p, 5", 5¾", 8p, 7" 10p. (3 reels and over Post Free).

TAPE CASSETTES

C60	(60 min.)	37p	3 for £1.05
C90	(90 min.)	62p	3 for £1.80
C120	(120 min.)	87p	3 for £2.55

P. & P. 5p.

All cassettes can be supplied with library cases at 3p. extra each

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WHY PAY MORE? ALL GOODS ARE BRAND NEW & FULLY GUARANTEED FOR 12 MONTHS

SUPERB PLYNTHS AND COVERS as illustrated

Suitable for Garrard AT60, SP25, 2000, 2500, 3000, 3500, 5100, 2025, 1025, SL65B and B.S.R. McDonald range. Superbly finished plynth, ready cut for use (fully assembled). Complete with tinted perspex cover. This unit is finished in Teak polish and will blend in any home. Please state deck when ordering.

SUPERIOR PLYNTHS AND COVERS for Garrard AP75, AP76, SL72B, SL75B and SL95B **£4.95** + 60p p & p (Recommended list price £10·00).

(£3·50 Plus 50p P & P)

TURNTABLES p.p. 60p

GARRARD 5100 with Cartridge	£7.97
GARRARD 2025 TC with Sonatone 9TAHC Diamond Cart	£8.50
GARRARD 3000 with Sonatone 9TAHC Diamond Cart	£9.50
GARRARD A70MKII	£10.97
GARRARD SP25 MK3	£10.97
GARRARD SL65B	£12.75
GARRARD AP76	£19.97
GARRARD SL72B	£25.00
GARRARD SL75B	£27.97
GARRARD 401	£27.50
GARRARD SL95B	£36.00
THORENS TD125	£61·00

PICK UP ARMS pp. 35p

SME 3009/S2	£25.50
SME 30012/S2	£27.50
GOLDRING LENCO L75	£9·99
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H.L. SA707 with Scratch Filter	£19.00
METROSOUND ST20	£27.75
AMSTRAD 8000	£20.97
TELETON SAQ206	£18.97
SINCLAIR 3000	£35.00
SINCLAIR 2000	£21.00
SINCLAIR PRO 60/2 Z30/PZ5	£15.97
TELETON SAQ 5015	£34·97
QUAD 303 & 33	£87.00
ARMSTRONG 521 (Teak cased)	£43.50

TUNER AMPLIFIERS pp. 75p

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TELETON CR10T WITH SPKS	£29.00
TELETON TFS50	£53.50
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TELETON F2000	£31.00
TELETON 7AT1	£81.00
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TELETON F2300	£40.00
TELETON CR55	£90.00
TELETON 10AT1	£105.00
TELETON 7AT20	£78.00
PHILIPS RH781	£54.00
A.M.C.7500 7 x 7 VHF	£31.00
MIDLAND 19.542 AM-FH MPX	£31.00

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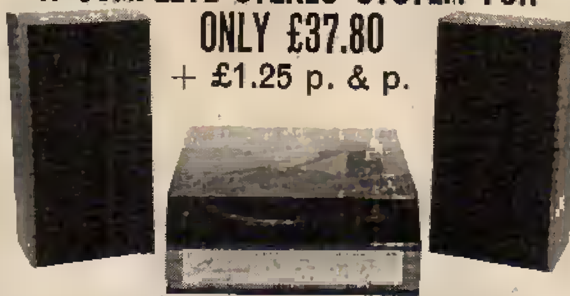
TELETON GT101	£32.97
TELETON STQ 201X	£28.00
TELETON STQ204X	£38.97
SINCLAIR 2000	£19.00
SINCLAIR PRO.60	£20.50
TRIO KT1000	£47.00

A COMPLETE STEREO SYSTEM FOR ONLY £37.80

+ £1.25 p. & p.



ITS PERFORMANCE CAN BE COMPARED WITH EQUIPMENT COSTING AT LEAST £130 THE APOLLO 100% MADE IN ENGLAND

This modern compact unit has been specially designed to give the maximum stereo performance in your home.

Slenderly designed, the unit employs the latest Garrard 2025TC record deck which enables you to play your records manually or allow the machine to auto-change up to eight records automatically. The Garrard record deck is fitted with a cue and pause control which allows you to manoeuvre the arm of the deck to any chosen track of your record. Also used is a locking device to prevent the arm from moving whilst unit is in transit.

The amplifier used in this unit will give a true 5 watts (R.M.S.) per channel with maximum performance of base and treble. The controls are of a simple nature and allow you to adjust the balance of sound through each speaker, also the volume required, bass and treble.

The two speaker systems supplied with this audio unit are designed to give the best possible sound reproduction, the twin cone base unit will give a good bass response and the parasitic tweeter employed will clarify the high notes in your listening pleasure.

Finished in teak, this Hi-Fi compact unit will blend into any modern home and give you hours of listening pleasure in true stereo. 12 months guaranteed SPECIFICATION. Deck—Garrard 2025TC. Cartridge—Garrard G.C.538 with sapphire stylus. Output 5 watts (S.M.S.) per channel. Frequency: 40Hz to 20,000Hz. Speakers: Apollo 66 Three-way general purpose 15–16 ohms. 6" Twin cone base unit: 2½" Parasitic Tweeter; LC Crossover; Suitable acoustic padding. Finish: Polished teak plinth and speaker cabinets: Charcoal tinted Perspex cover; Unit finished silver and black. Size: Unit 14½" x 12¾" x 7½". Speakers 14½" x 8" x 6½".

CARTRIDGES (p. & p. 12½p.)

GOLDRING G850	£4·20
GOLDRING G800	£6·99
GOLDRING G800E	£11·00
GOLDRING G800 super E	£16·00
SONOTONE 9TAHC	£2·35
SHURE M3d	£4·95
SHURE M445/7/c	£7·20
SHURE M55	£9·20
SHURE M75E/11	£15·00

We have the complete SHURE range in stock.

SCOOP BUY
SMC-101 MOVING MAGNET STEREO CARTRIDGE.
PRICE: £3·25.

MCI-3 HIGH FIDELITY STEREO MOVING MAGNET CARTRIDGE.
PRICE: £6·00.

For complete specification on the above see our March issue, Page 889.

SPECIAL OFFERS
SPEAKERS

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Full range in stock at **UP TO 50% DISCOUNT FOR PERSONAL CALLERS ONLY.**

HEADPHONES

For 1 month only we offer 25% OFF list price of all KOSS models.

Example: **PRO4AA. List price £28·00.**

OUR PRICE £21·00 plus 37p p. & p.

SAVE OVER 30% ON A COMPLETE SYSTEM

	List Price
GARRARD SP 25 MK III	£16·45
PLINTH AND COVER	£6·00
G800 CARTRIDGE	£13·00
HL AUDIO SA 707	£27·00
2 APOLLO 8 SPEAKERS	£27·50
	£89·95

OUR PRICE £56·94 + £2·50p. p. & p.

MANY OTHER BARGAINS IN STOCK FOR PERSONAL CALLERS DURING WEEK.

WHY PAY MORE—APOLLO 3-WAY SPEAKER SYSTEMS

The Systems are housed in handsome Slim-Line Cabinets of Modern Design, finished in Polished Teak with Padded Front Panel covered in I.C.I. Vynair Grille.

The **APOLLO 3-WAY SPEAKER SYSTEMS** are designed and built on the Infinite Baffle Principle and are completely Airtight and fully padded to damp out any Panel Resonance. Polished on all sides they can be used either vertically or horizontally and are ideal for Shelf or Wall Mounting.

Below are just a few from the **APOLLO** comprehensive range starting with:

APOLLO-15 3-WAY SPEAKER SYSTEM
Impedance 8 ohms. Power Handling 15 watts. RMS (30 watts peak). Frequency Range: 35 to 18,000Hz. Colour: Teak. Size 21 x 15 x 7½in.
PRICE £18·50 each (p. & p. £1·00).

THE APOLLO-10 3-WAY SPEAKER SYSTEM employs a specially designed 10in. Bass Unit which has a high efficiency Anisotropic Ferrite Magnet and two 4in. Treble Units and LC Crossover Network. Specification: Impedance 4-8 ohms (15-16 ohms to order). Power Handling 10 watts RMS (20 watts peak). Frequency Range 50 Hz to 18,000 Hz. Size 21 x 11½ x 9½. Finish: Polished Teak.
OUR PRICE £13.47 each (65p. p. & p.).

APOLLO-8 3-WAY SPEAKER SYSTEM
As above but 7 watts RMS (14 watts peak). F.R. 55 to 18,000 Hz. Size 20 x 12 x 8in.
£10·12 each (50p p. & p.).

APOLLO-66 3-WAY SPEAKER SYSTEM
As above but 5 watts RMS (10 watts peak). F.R. 75 to 18,000 Hz. Size 14½ x 8 x 6in.
PRICE £6.97 each (37½p p. & p.).

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You have no parking problems when you pay us a visit.

UNBEATABLE VALUE
The largest and best quality range of stock at LOWEST POSSIBLE PRICES is usually available.

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Send Postal Orders, Money Orders, Cheques, etc. to

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AUDIO SUPPLIES (PW4) 50 STAMFORD HILL LONDON, N.16 (The A.10)

Open 9.30 a.m.–6 p.m. Monday to Saturdays. EASY TO FIND. 50 yards from (B.R.) Stoke Newington Station. 67, 149, 247, 76, 243 Buses pass our door.

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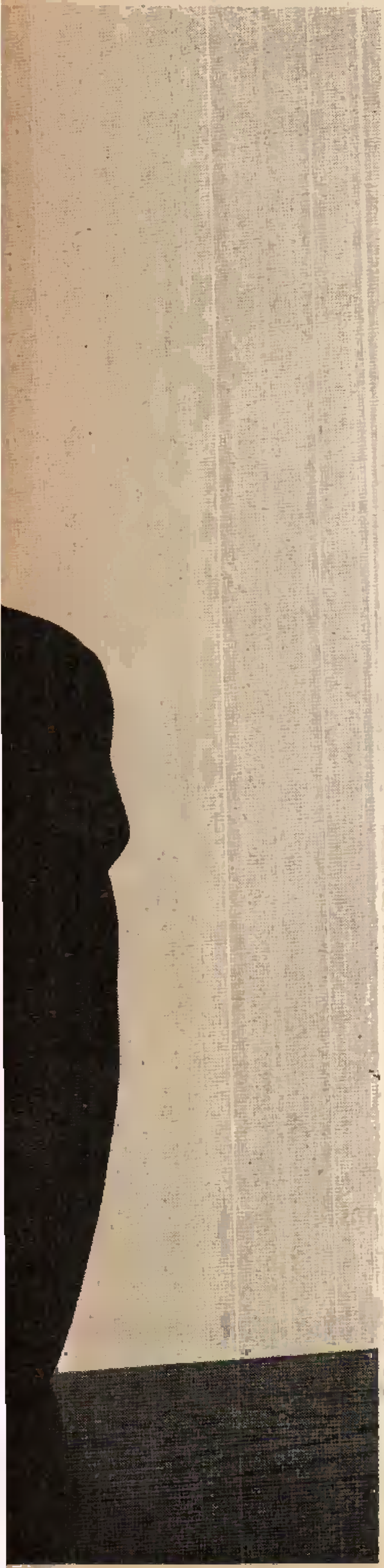
NOTE: Personal callers please note that cheques are only accepted if accompanied by a bank cheque card. (NOTE: NOT BARCLAY CARDS)

The Gerr

Adler Story.



Once upon a time Gerry Adler worked a 25 hour day making and selling valve filament testers. And very efficient they were too.

But at that time the Japanese could make them for about half the price, and sent Gerry one to prove it. It was as good as the ones he was making, so he sold it. And every other one he could get into the country.

After a time Gerry decided to go one step further. He designed some electronic equipment and had it built to his specification in Japan.Then he sold it here under the brand name 'Eagle'. Nothing particularly remarkable about that. But Gerry couldn't stand the idea of a barrier between him and his manufacturers. So he went to Japan. He poked his nose into all the electronics factories to find out how the Japanese worked.And when he got back he started to learn Japanese, and to study their history,culture and way of life.That way he had fewer communication problems and could get what he wanted.

That's what matters to Gerry.He's very fussy about what goes out under the Eagle banner.Because Eagle aren't in the filament testing business any more. They make just about everything electronic: amplifiers, test equipment, PA systems, intercoms, old uncle substation and all. Eagle is now twelve years old, and has opened offices in New York, Tokyo and Brussels.

This isn't just so much chest expansion on Gerry's part. He puts his money where his mouth is. If you think one of his products is not as good as a rival's, or it's faulty, or it's not all it should be, Gerry wants to know.

So write to him personally. He'll do something about it. He wants to make sure the Gerry Adler story has a happy ending.

Eagle International

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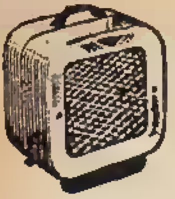


2¼kW FAN HEATER

Three position switching to suit changes in the weather. Switch up for full heater (2¼ kW), switch down for half heat (1¼kW), switch central blows cold for summer cooling—adjustable thermostat acts as auto control and safety cut-out. Complete kit £3·75. Post and ins. 38p.

12 VOLT BATTERY CHARGER

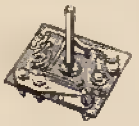
Made in Japan, this is very small and neat. Regular use will keep your car battery in good trim throughout the winter. Silly price £1·25 plus 23p postage and insurance.

QUICK CUPPA

Mini Immersion Heater, 350w. 200/240v. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. £1·25, post and insurance 14p. 12v. car model also available £1.

PLINTH AND COVER

Suitable for most auto changers, teak base with tinted perspex cover £4·25 plus 33p postage.



THYRISTOR LIGHT DIMMERS

Will dim incandescent lighting up to 600 watts from full brilliance to out. Assembled and wired ready to install £3.

AUTO ELECTRIC CAR AERIAL

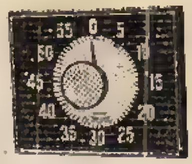
With dash board control switch—fully extendable to 40" or fully retracted Suitable for 12V positive or Neg. earth supplied complete with fitting instructions and ready wired dash board switch £5·95 plus 25p. p. & p.

COMPUTER TAPE

2,400 ft. of the best magnetic tape money can buy. Made by E.M.I., 1in. wide almost unbreakable and on a 10½in metal computer spool. Users have claimed successful results with video as well as sound recordings £1 plus 33p post. Cassette to hold spool 50p extra.

HORSTMANN "TIME AND SET" SWITCH

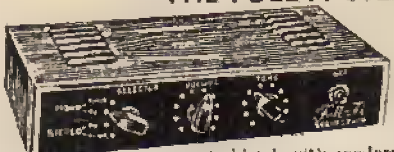
(A 15 amp Switch). Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price £1·50, p. & ins. 23p.



1 HOUR MINUTE TIMER

Made by famous Smiths company, these have a large clear dial, size 4½ x 3¼, which can be set in minutes up to 1 hour. After preset period the bell rings. Ideal for processing, a memory jogger or, by adding simple lever, would operate micro-switch £1·15.

THE FULL-FI STEREO SIX



The amplifier sensation of the year You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled in simulated teak finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6 watts R.M.S. split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners, it has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. Other controls include "treble lift and cut", "balance" and separate mains on/off switch. UNREPEATABLE PRICE is £9 plus 38p post and insurance.

STANDARD WAFER SWITCHES

Standard Size 1¼ wafer—silver-plated 5 amp contact, standard ¼" spindle 2". long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole ..	33p	33p	33p	33p	33p	33p	33p	33p	33p
2 poles ..	33p	33p	33p	33p	33p	33p	33p	55p	55p
3 poles ..	33p	33p	33p	33p	55p	55p	55p	75p	75p
4 poles ..	33p	33p	33p	55p	55p	55p	55p	95p	95p
5 poles ..	33p	33p	55p	55p	75p	75p	75p	£1·15	£1·15
6 poles ..	33p	55p	55p	55p	75p	75p	75p	£1·35	£1·35
7 poles ..	55p	55p	55p	75p	95p	95p	95p	£1·55	£1·55
8 poles ..	55p	55p	55p	75p	95p	95p	95p	£1·75	£1·75
9 poles ..	55p	55p	75p	75p	£1·15	£1·15	£1·15	£1.95	£1·95
10 poles ..	55p	55p	75p	95p	£1·15	£1·15	£1·15	£2·15	£2·15
11 poles ..	55p	75p	75p	95p	£1·35	£1·35	£1·35	£2·35	£2·35
12 poles ..	55p	75p	75p	95p	£1·35	£1·35	£1·35	£2·55	£2·55

Where postage is not stated then orders over £5 are post free. Below £5 add 20p Semi-conductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

SPARTAN Portable RADIO

Long and medium wave, 7 transistor, size 6in. x 4in. x 1¾in. with larger than usual speaker giving very good tone. Built-in ferrite aerial and telescopic aerial for distant stations. A real bargain complete with leather case, carry sling, earpiug and case £3·75 plus 25p post and ins.

MULTI-SPEED MOTOR

Replacement in many well known food mixers. Six speeds are available. 500, 850 and 1100 r.p.m. from either or both of the nylon sockets (Where the beaters of the food mixers normally go) and 8,000, 12,000 and 15,000 r.p.m. (ideal polishing speeds) from the main drive shaft. Very powerful and useful motor size appox. 2in. diameter, 5in. long. Price 90p plus 23p, p. & ins. 12 or more post free.

MAINS OPERATED CONTACTOR

220/240v. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2½ x 2 x 2in. £1 each.

DOUBLE ENDED MAINS MOTOR

On feet with holes for screw-down fixing. To drive models, oven, blower heater, etc. 50p each, plus 18p post and insurance, 6 or more post free.

0.005mFd TUNING CONDENSER

Proved design, ideal for straight or reflex circuits 13p each, £1·20 doz.

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ELECTRIC CLOCK WITH 25 AMP SWITCH

Made by Smith's, these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only **£2**, less than the value of the clock alone—post and insurance 14p.

FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled Kit A—15-20 w. **£1** Kit B—30-40 w. **£1** Kit C—80 w. **£1·20**. Kit E—65 w. **£1·20**. Kit F for 5ft. 125 w. tube **£1·75**. Kit MF1 is for 6in., 9in. and 12in. miniature tubes **£1**. Kit MF2 for 21in. 13 w. miniature tube **£1**. Postage on Kits A and B 23p for one or two kits then 23p for each two kits ordered. Kits C, D and E 23p on first kit then 18p for each kit ordered. Kit F 33p then 23p for each kit ordered. Kit MF1 18p on first kit then 15p on each two kits ordered.

BLANKET SWITCH

Double pole with neon let into side so luminous in dark, ideal for dark room light or for use with waterproof element, new plastic case **30p** each. 3 heat model **40p**.

BLANKET SIMMERSTAT

Although looking like, and fitted as an ordinary blanket switch, this is in fact a device for switching on for varying time periods, thus giving a complete control from off to full heat. Although suitable for controlling the temperature of any other appliances using up to 1 amp. Listed at **£1·40** each we offer these while our stocks last at only **65p**. each.

REED SWITCHES

Glass encased, switches operated by external magnet—gold welded contacts. We can now offer 3 types:

Miniature. 1in. long × approximately 1/8in. diameter. Will make and break up to ½A up to 300 volts. Price **13p** each. **£1·20** dozen.

Standard. 2in long × 3/16in. diameter. This will break currents of up to 1A, voltages up to 250 volts. Price **10p** each. **90p** per dozen.

Flat. Flat type, 2in. long, just over 1/16in. thick, approximately ¼in. wide. The Standard Type flattened out, so that it can be fitted into a smaller space or a larger quantity may be packed into a square solenoid. Rating 1 amp 200 volts. Price **30p** each. **£3** per dozen.

Small ceramic magnets to operate these reed switches **9p** each. **90p** per dozen.

HIGH CAPACITY ELECTROLYTICS

Brand new, not ex-equipment.

100 mf.d 25v., **8p** each. **60p** doz.
250 mfd. 50v., **18p** each. **£1·65** doz.
400 mfd. 40v., **22p** each. **£2·30** doz.
500 mfd. 12v., **10p** each. **£1·05** doz.
500 mfd. 25v., **18p** each. **£1·80** doz.
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500 mfd. 350v., **43p** each. **£4·50** doz.
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2000 mfd. 25v., **34p** each. **£3·95** doz.
5000 mfd. 12v., **24p** each. **£2·40** doz.
10,000 mfd. 6v., **29p** each. **£3** doz.
10,000 mfd. 15v., **43p** each. **£4·50** doz.
15,000 mfd. 10v., **53p** each. **£5** doz.
60,000 mfd. 8v., **£1·10** each. **£10** doz.
70,000 mfd. 18v., **£2** each. **£20** doz.

3 amp 12v Battery Charger Kit—comprising 230/40 mains transformer with 3 amp secondary and 3 amp rectifier **£1·15** plus 23p post.

12 volt 1½v amp Power Pack. This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d/smoothing. Price **£1·40**.

Sonotone Stereo Cartidge. Turnover type, ref. No. 19 T1. This fits most British pick-ups and is a really excellent reproducer. Limited quantity, **£1**.

5 amp 3 pin Sockets. These are always good stock, you never know when you will need some. Famous make, brown bakelite, standard size, 12 for **65p** plus 23p post.

Ditto but with switch. 12 for **£1** plus 23p post.

13 amp sockets, flush mounting. Bakelite, creamless switch. 6 for **£1**.

Bakelite Panels, many thicknesses. We have just taken delivery of approximately 10 tons of bakelite in varying thicknesses from 2in. to a few thou. If you have a need for any of this then we would be glad to supply. The thickest is very heavy and could be used, for instance, as a bed for a motorised unit. Medium thickness is useful for front panels of instrument, etc., etc. Cut to your size price is **30p** per lb. plus **30p** cutting charge plus carriage.

2 amp 3 pin Switched sockets for surface mounting, brown bakelite. Made by famous maker. **13p** each or **£1·20** dozen.

100 Assorted Silicon Rectifiers G.P. and switching diodes. Small and very small sizes. A real snip for experimenters, **65p** per 100.

20 AMP ELECTRICAL PROGRAMMER

Learn in your sleep: Have Radio playing and kettle boiling as you awake—switch-on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an Electrical Programmer. Made by the famous Smiths Instrument Company. This is essentially a 230/240 volt mains operated Clock and a 20 amp Switch, the switch-off time of which can be delayed up to 12 hours (continuously variable not stepped). Similarly the switch-on time can be delayed. This is a beautiful unit, size 5¾ × 3¾ × 2½in. deep. Metal encased, glass fronted with chrome surround. Offered at **£2.40** plus 23p postage and insurance.

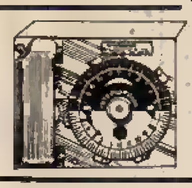
HI-FI SPEAKERS (15, 30, 40 & 100W)

FULL FI12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address. Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Cone Moulded fibre—Freq. response 30-10,000 c.p.s.—Specify 3 or 15 ohms—Mains resonance 60 c.p.s.—Chassis Diam. 12in.—12¾in. over mounting lugs—Baffle hole 11in. Diam.—Mounting holes 4, holes—¼in. diam. on pitch circle 11¾in. diam.—Overall height 5¼in. A £6 speaker offered for only **£4** plus **37p** p. & p. 12in. 40 watt **£7** carr. 43p. 15in. 25 watt **£8** carr. 53p. 18in. 100 watt **£19·50** carr. **£1·50**.

INTEGRATED CIRCUIT BARGAIN

A parcel of integrated circuits made by the famous Plessey Company. A once-in-a-lifetime offer of Micro-electronic devices well below cost of manufacture. The parcel contains 5 ICs all new and perfect, first-grade device, definitely not sub-standard or seconds. 4 of the ICs are single silicon chip GP amplifiers. The 5th is a monolithic NPN matched pair. Regular price of parcel well over **£5**. Full circuit details of the ICs are included and in addition you will receive a list of many different ICs available at bargain prices 5/- upwards with circuits and technical data of each. Complete parcel only **£1** post paid. *DON'T MISS THIS TERRIFIC BARGAIN.*

THIS MONTH'S SNIP
24-HOUR ELECTRIC TIME SWITCH



Made by Smiths, these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5 amp changeover contacts will switch circuit on or off during these periods. **£2·50** post and ins. 23p. Additional time contacts **50p** pair

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Suppled complete with 7 feet of heavy cable. Wired up ready to work, **£2** less plug **£2·25** with fitted 13 amp plug; **£2·40** with fitted 15 amp plug, plus **23p** P. & I.

BARGAIN OF THE YEAR
MICROSONIC KEYCHAIN RADIO

7 transistor Keychain Radio in very pretty case, size 2⅞ x 2⅛ x 1¼in.—complete with soft leather zipped bag. Specification:—Circuit: 7 transistor superheterodyne. Frequency range: 530 to 1600 Kc/s. Sensitivity: 5 mv/m. Intermediate frequency: 465 Kc/s or 455 Kc/s. Power output: 40mW. Antenna: ferrite rod. Loudspeaker: Permanent magnet type.
In transit from the East these sets suffered slight corrosion as the batteries were left in them but when this corrosion is cleared away they should work perfectly—offered without guarantee except that they are new. Price only **£1·25** less batteries plus **13p**. post 6 for **£7** post free. Pair of rechargeable batteries and charger **85p**.

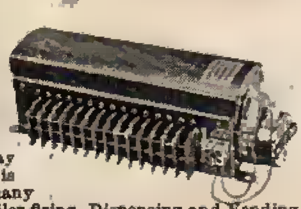
4 AMP VARIAC CONTROLLERS

With this you can vary the voltage applied to your circuit from zero to full mains without generating undue heat. One obvious application therefore is to dim lighting. Ex equipment but little used—as good as new offered at approx. half price. **£5** plus 75p. post and ins.

19 PIECE SOCKET SETS

Complete with wall or bench rack. Most useful sizes from ¼" to 15/32" **80p** plus 23p post and insurance.

HONEYWELL PROGRAMMER



This is a drum type timing device, the drum being calibrated in equal divisions for switch setting purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 revs per min. Some of the many uses of this timer are Machinery control, Boiler firing, Dispensing and Vending machines, Display lighting animated and signs, Signalling, etc. Price from makers probably over £10 each. Special snip price **£5.75** plus 25p post and insurance. Don't miss this terrific bargain.

Where postage is not stated then orders over £5 are post free. Below £5 add **20p**. Semi-conductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

Mains Connector

A quick way to connect equipment to the mains safely and firmly—L, N, and E, coded to new colour scheme; disconnection by plugs prevents accidental switching on: has sockets which allow insertion of meter without disconnection; cable inlets firmly hold one hair wire on up to four 7.029 cables. **65p** each.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1·50** plus 13p post and insurance. Made up model also available, **£1·90** plus 13p post & p.

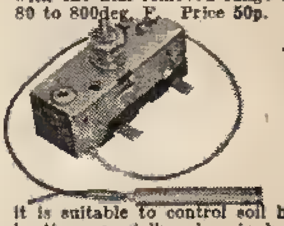
BALANCED ARMATURE UNIT

500 ohm. operates speaker or microphone, so useful in intercom or similar circuits. **33p** ea. **£5.30** doz.

PROTECT VALUABLE DEVICES FROM THERMAL RUNAWAY OR OVER - HEATING:

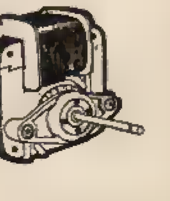
Thyristors, rectifiers, transistors, etc., which use heatsinks can easily be protected. Simply make the contact thermostat part of the heat sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90deg. to 190 deg. F. or with the dial removed range setting is between 80 to 800deg. F. Price **50p**.

THERMOSTAT WITH PROBE



This has a sensor attached to a 15A switch by a 14in. length of flexible capillary tubing—control range is 20°F to 150°F so it is suitable to control soil heating and liquid heating especially when in buckets or portable vessels as the sensor can be raised out and lowered into the vessel. This thermostat could also be used to sound a bell or other alarm when critical temp. is reached in stack or heap subject to spontaneous combustion or if liquid is being heated by gas or other means not controllable by the switch. Made by the famous Teddington Co., we offer these at 63p each. Postage and insurance 14p.

MAINS MOTOR



Precision made — as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at **50p**. Postage 15p for first one then 5p for each one ordered.

NEED A SPECIAL SWITCH?

Double Leaf Contact. Very slight pressure closes both contacts. **6p** each, **60p** doz. Plastic push-rod suitable for operating, **5p** each, **45p** doz.

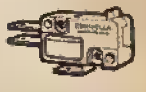
MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—3 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at **13p** each, **£1·80** dozen, your assortment.

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. **50p** post free.

MICRO SWITCH



5 amp. changeover contacts, **9p** each, **£1** doz. 15 amp. Model **10p** each or **£1·05** doz.

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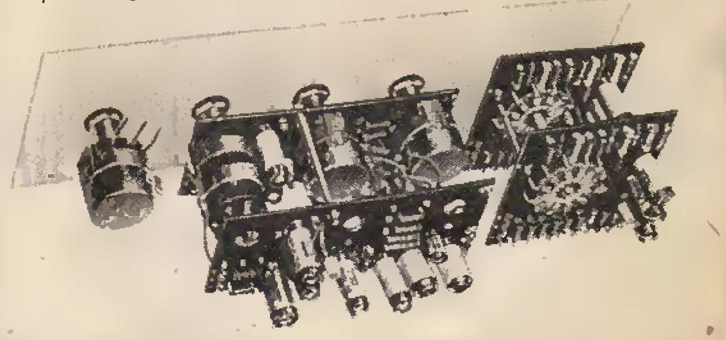
LEWIS AUDIO SYSTEMS

Fine equipment competitively priced

(BUILT OR KIT)

MARTIN AUDIOKITS

For the do-it-yourself enthusiast, the return of a great range of hi-fi modules



You are going to enjoy better listening for less cost and greater reliability

ready to play

LEWIS AUDIO SYSTEMS comprise ready built equipment designed and built to advanced technical standards of efficiency and styling. Their prices make true hi-fi available to a wider public than ever. Based on the excellent **Lewis Audio SA. 55** stereo amplifier in which FETS are used in the pre-amp to ensure better quality throughout, the range offers choice of free-standing amplifier with separate playing unit in plinth with plastic hard top or the *Compact* assembly in which the amplifier is built into the base of the plinth and motor assembly. Separate matched speakers are available for either system. Illustrated above is the Lewis S.55 Mk. II Compact System.

LEWIS AUDIO SYSTEMS

SA.55 STEREO AMPLIFIER—8 watts RMS output per ch. into 15 ohm speakers Controls— Input selector/Vol/Bass/Treble/Balance/ On-Off. Tape Record and replay facilities. DIN socket connections. Modern teak finished cabinet. R.R.P £18·90

PLINTHS WITH HARD TOPS & FITTED GARRARD UNITS

Garrard 2025T C with Sonotone 9TA/HC R.R.P. £15·50

Garrard 40B with Sonotone 9TA/HC R.R.P. £20·16

Garrard SP.25 Mk. III less cartridge R.R.P. £20·16

SC.55 Mk. II 'Compact' with Garrard 2025TC and SA.55 amplifier built into plinth R.R.P. £40·32

LOUDSPEAKERS

LS. 16 'Major'—13" x 8" three way system in American Walnut finished cabinet. 8 ohms R.R.P. £11·70

LS.17 6" three way system in teak or Am. walnut finish. 15 or 8 ohms R.R.P. £10·80

LS.18 8" three way system in teak or Am. walnut finish 15 or 8 ohms. R.R.P. £12·60

for the constructor

MARTIN AUDIOKITS were first to make modular unit construction available to the hi-fi enthusiast keen to save by building his own assembly. AUDIOKITS were first to feature "add-on-ability" by which a simple system could be expanded to high performance stereo equipment by the addition of easily added on units. Many who built with MARTIN AUDIOKITS years ago continue to enjoy unsurpassed quality and reliability from them to this day. **NOW YOU CAN BUY AUDIOKITS AGAIN** to allow you to build a high fidelity system to your personal choice and which will satisfy completely on performance, simplicity of assembly, robustness and reliability. These units are beautifully engineered and solidly built for a lifetime of trouble-free service. You can start with mono and add on units to make stereo, or build with stereo throughout.

TYPICAL MARTIN ASSEMBLIES

1478E	Five stage matched input selector unit; controls and pre-amp; power amp. (10 watts RMS into 15 ohms) power supply; front escutcheon plate (mono)	Total price £17·50
1478SE	Similar to above but for stereo.	Total price £29·95
9748SE	Stereo assembly for use with high grade ceramic and low power mag. pick-ups.	Total price £32·95

All units are obtainable separately. State pick-up when ordering.

- **EACH MARTIN AUDIOKIT MODULE IS COMPLETE IN ITSELF AND REQUIRES THE ADDITION OF NO FURTHER COMPONENTS TO IT.**
- **ALL UNITS INDIVIDUALLY TESTED AND CHECKED BEFORE LEAVING OUR FACTORY.**

● TRADE ENQUIRIES WELCOME

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I am particularly interested in MARTIN AUDIOKITS ......
Please send details, (post free) to: LEWIS AUDIO SYSTEMS ......

NAME ....

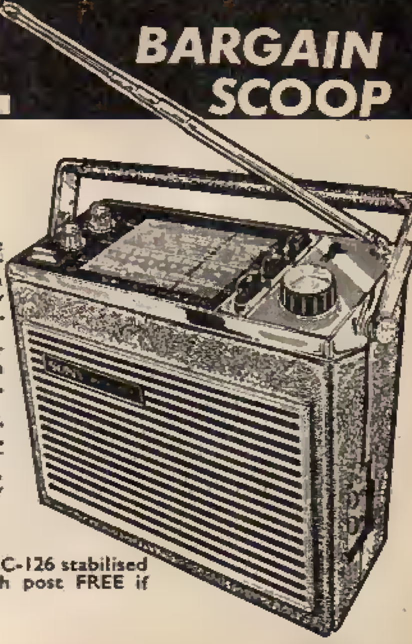
ADDRESS ....

.... PW.1

SONY TFM 8030L

BARGAIN SCOOP

HIGH PERFORMANCE 11 TRANSISTOR THREE WAVEBAND PORTABLE BATTERY/MAINS RADIO



This is a really top performance, top quality solid state receiver packed with SONY know-how and backed by the outstanding reliability for which SONY are renowned. Now this outstanding set is available from Lasky's at over 27% below the manufacturer's list price making it without a doubt the NUMBER ONE SCOOP of 1971! Just look at these outstanding features. Covers MW, LW and FM (VHF). 11 transistor circuit for high sensitivity and stability Powerful output to 5" P.M. Dynamic speaker with rich clear tone quality. AFC for drift free VHF reception. Push-button wavechange selectors and tone control.

Choice of three power sources—9V battery, household mains or car battery with suitable adaptors. Dial light for use in the dark. External jacks for earphone, tape recording, external power input and car aerial. Ultra modern styling and superb finish with padded leatherette covered cabinet for superior sound damping with chrome trim, strong carrying handle.

The SONY TFM 8030L will enliven your leisure hours anywhere, anytime with exciting sound, news, sport, music, etc. Technical specification: Freq. range, FM 87-108MHz, LW150-285kHz, MW530-1,605kHz. Circuit: 11 transistors, 7 diodes and 2 thermistors. Aerial System: Directional telescopic for FM, internal ferrite bar for LW/MW. Power Output: 1.85W max. Speaker PM Dynamic—4Ωimp. Power Source: 9v power pack battery (Ever-Ready PP9 or equiv.). AC mains with adaptor. Car battery with adaptor. Size: 9⅜(W) x 8⅛(H) x 3⅜(D). Complete with earphone and battery and full instruction manual.

MANUFACTURER'S LIST PRICE £29.75

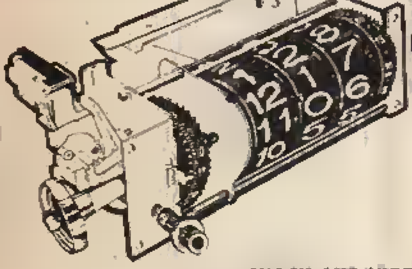
LASKY'S SPECIAL OFFER PRICE £21.50

Optional Extras. SONY AC-90e AC adaptor £4.00 DCC-126 stabilised car battery cord £6.00. Both post FREE if purchased with radio.

Post 35p

EXCLUSIVE

DIGITAL CLOCK SCOOP!



- MADE ESPECIALLY FOR LASKY'S BY FAMOUS MAKER
- MAINS OPERATION
- 12 HOUR ALARM
- AUTO "SLEEP" SWITCH
- HOURS, MINUTES AND SECONDS READ-OFF
- FORWARD AND BACKWARD TIME ADJUSTMENT
- SHOCK AND VIBRATION PROOF
- BUILT IN ALARM BUZZER
- SILENT OPERATION SYNCHRONOUS MOTOR

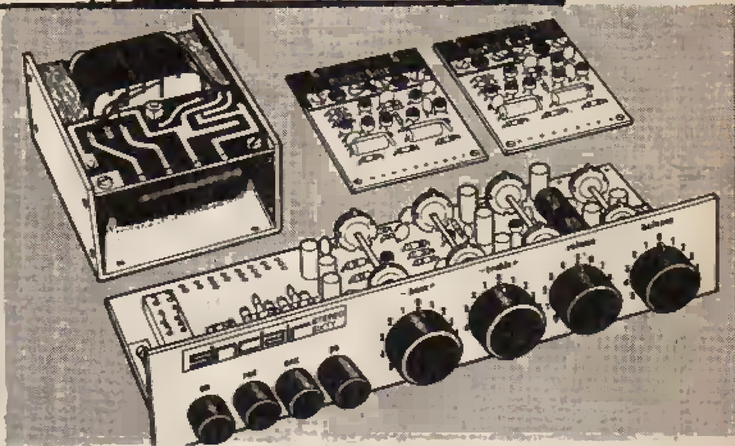
SPECIAL QUOTATIONS FOR QUANTITIES

This unique DIGITAL CLOCK is now available EXCLUSIVELY FROM LASKY'S in chassis form for you to mount in any housing that you choose.
All settings are achieved by two dual-concentric controls at the front including: ON-OFF-AUTO and AUTO ALARM, "sleep" switch, 10 minute division "click" set alarm (up to 12-hour delay), time adjustment. Ultra simple mechanism and high quality manufacture guarantee reliable operation and long life.
The sleep switch will automatically turn off any appliance—radio, TV, light etc. at any pre-set time up to 60 min. and in conjunction with the AUTO setting will switch on the appliance again next morning.
The clock measures 4½W x 1¾H x 3¾D (overall from front of drum to back of switch) SPEC: 210/240V AC, 50Hz operation; switch rating 250V. 3A. Complete with instructions. **HUNDREDS OF APPLICATIONS. COMPLETE WITH KNOBS**

LASKY'S PRICE **£6.95** Post 18p

SPECIAL QUOTATIONS FOR QUANTITIES

sinclair Project 60



Project 60 is a range of modules which connect together to form a complete stereo amplifier. The modules are: 1. Z-30 high gain power amp. 2. Stereo-60 pre-amp. control unit. 3. The PZ-5 unstabilised and PZ-6 stabilised power supplies. A complete system comprises two Z-30's, one Stereo-60 and a PZ-5 or PZ-6.

STEREO 60 SPECIFICATION
Input sensitivities: Radio up to 3mV. Magnetic Pick-up 3mV: correct to R.I.A.A. curve ±1dB; 20 to 25,000Hz. Ceramic Pick-up to 3mV: Auxiliary up to 3mV ● Output: 1 volt ● Signal to noise better than 70dB ● Front panel: brushed aluminium with black knobs and controls ● Size: 5¼ x 1½ x 4in. **£8.95** Post 18p

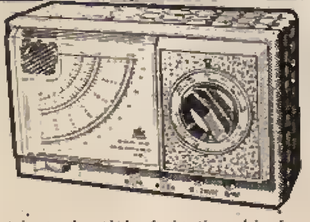
Z-30 SPECIFICATION
● Power output: 15 w. R.M.S. into 5 ohms using a 35 volt supply ● Frequency response: 30 to 300,000Hz ± 1dB ● Distortion: 0.02% ● Signal to noise: better than 70dB ● Input sensitivity: 250mV into 100 K ohms ● Loudspeaker imp: 3 to 15 ohms ● Power requirements: from 8 to 35V DC (The Z30 will operate from batteries if required)–Size: 3½ x 2¼ x ½in. **£4.25** Post 18p

PZ5 30V unstabilised—sufficient to drive two Z-30's and a Stereo 60 for domestic applications. **£4.50** Post 13p

PZ6 35V stabilised—ideal for driving two Z-30's and a Stereo 60 for low efficiency speakers. **£7.50** Post 13p

PACKAGE PRICE For Stereo 60, two Z-30's and one PZ-5 **£19.25** Post 50p

TTC C-1051 METER



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1S5	.22
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1U5	.48
2D21	.35
3D6	.19
3Q4	.33
3Q5GT	.35
3S4	.29
3V4	.32
5V4G	.38
5Y3GT	.28
5Z4G	.35
6/30L2	.58
6A8G	.33
6AC7	.15
6AG5	.25
6AK5	.25
6AL5	.12
6AQ5	.28
6AT6	.20
6AU6	.25
6AV6	.30
6B8G	.13
6BA6	.23
6BE6	.24
6BH6	.43
6BJ6	.43
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6BW6	.72
6BW7	.65
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6C9	.73
6CD6G	1.15
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6CW4	.63
6F1	.63
6F6	.63
6F6G	.25
6F13	.33
6F18	.45
6F23	.72
6F24	.68
6F25	.65
6F28	.70
6H6GT	.15
6J5G	.19
6J6	.18
6J7G	.24
6J7GT	.33
6K7G	.10
6K7GT	.23
6K8G	.20
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6L7GT	.63
6L18	.45
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6Q7	.43
6Q7G	.30
6R7	.55
6R7G	.35
6SA7GT	.35
6SA7M	.35
6SC7GT	.33
6SG7GT	.33
6SH7	.53
6SJ7	.35
6SK7GT	.23
6SQ7GT	.38
6V6G	.18
6V6GT	.33
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10F1	.75
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10LD11	.58
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12AD6	.40
12AE6	.48
12AT6	.23
12AT7	.19
12AU6	.24
12AU7	.23
12AV6	.28
12AX7	.23
12BA6	.30
12BE6	.30
12BH7	.40
12E1	.85
12J7GT	.33
12K5	.50
12K7GT	.34
12Q7GT	.28
12SA7GT	.40
12SC7	.35
12SG7	.23
12SH7	.15
12SJ7	.23
12SK7	.24
12SQ7GT	.60
14S7	1.15
19AQ5	.24
20F2	.70
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20P1	.88
20P3	.90
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20P5	1.00
25A6G	.29
25L6G	.29
25Y5	.38
25Y5G	.43
25Z4G	.30
25Z5	.40
25Z6G	.43
30C1	.30
30C15	.65
30C17	.80
30C18	.64
30F5	.80
30FL1	.64
30FL2	.75
30FL12	.80
30FL14	.73
30L1	.32
30L15	.64
30L17	.78
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30PL13	.78
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CY31	.38
DAC32	.35
DAF91	.22
DAF96	.35
DF33	.39
DF91	.14
DF96	.35
DF97	.63
DH63	.30
DH76	.28
DH77	.20
DK40	.55
DK92	.43
DK96	.37
DL96	.37
DM70	.30
DM71	.38
DW4/350	.38
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DY86/7	.29
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E80F	1.20
E83F	1.20
E88CC	.60
E180F	.95
E182CC	1.13
E1148	.53
EA50	.18
EA76	.88
EABC80	.33
EAC91	.38
EAF42	.50
EB34	.20
EB41	.50
EB91	.12
EBC41	.48
EBC81	.33
EBC91	.30
EBF80	.34
EBF83	.40
EBF89	.32
EBL21	.60
EC86	.63
EC88	.60
EC92	.35
ECC33	1.58
ECC40	.60
ECC81	.19
ECC82	.23
ECC83	.23
ECC84	.30
ECC85	.28
ECC86	.40
ECC88	.35
ECC189	.48
ECC804	.58
ECC807	1.35
ECF80	.33
ECF82	.33
ECF86	.65
ECF804	2.10
ECH21	.63
ECH35	.29
ECH42	.64
ECH81	.29
ECH83	.40
ECH84	.38
ECL80	.35
ECL82	.33
ECL83	.52
ECL84	.60
ECL85	.55
ECL86	.40
EF22	.63
EF36	.33
EF37A	.35
EF39	.40
EF40	.50
EF41	.50
EF42	.33
EF54	.98
EF73	.33
EF80	.23
EF83	.48
EF85	.29
EF86	.32
EF89	.25
EF91	.17
EF92	.13
EF97	.55
EF98	.65
EF183	.30
EF184	.30
EH90	.38
EL32	.18
EL34	.53
EL37	.87
EL41	.55
EL42	.53
EL81	.50
EL83	.38
EL84	.24
EL85	.40
EL86	.40
EL91	.23
EL95	.35
EM34	.90
EM80	.38
EM81	.42
EM84	.34
EM87	.38
EY51	.37
EY81	.35
EY83	.55
EY84	.50
EY86/7	.33
EY88	.43
EY91	.53
EZ40	.40
EZ41	.43
EZ80	.23
EZ81	.24
EZ90	.22
FW4/500	.75
FW4/800	.75
GZ30	.35
GZ32	.45
GZ33	.70
GZ34	.58
GZ37	.75
HABC80	.45
HL23DD	.40
HL41DD	.98
HL42DD	.50
HN309	1.38
HVR2	.53
HVR2A	.53
KT2	.25
KT8	1.73
KT44	1.00
KT66	.83
KT88	1.70
KTW61	.63
KTW62	.63
KTW63	.50
MHLD6	.75
N78	2.05
N308	.98
N339	1.25
P61	.50
PABC80	.35
PC86	.52
PC88	.52
PC95	.53
PC97	.40
PC900	.38
PCC84	.32
PCC85	.38
PCC88	.49
PCC89	.48
PCC189	.49
PCC805	.64
PCF80	.30
PCF82	.33
PCF84	.40
PCF86	.50
PCF200	.67
PCF801	.35
PCF802	.45
PCF805	.64
PCF806	.64
PCF808	.73
PCH200	.62
PCL82	.37
PCL83	.50
PCL84	.38
PCL805/85	.45
PCL86	.43
PCL88	.75
PD500	1.44
PEN4DD	1.38
PEN36C	.75
PEN45	.35
PEN45DD	.75
PEN46	.20
PEN453DD	.98
PENDD-4020	.88
PFL200	.59
PL36	.48
PL81	.48
PL81A	.63
PL82	.33
PL83	.33
PL84	.33
PL302	.60
PL500	.68
PL504	.68
PL505	1.44
PL508	1.40
PL509	1.44
PL802	.75
PM84	.39
PX4	1.18
PX25	1.18
PY32/3	.50
PY80	.33
PY81	.27
PY82	.27
PY83	.29
PY88	.34
PY500	1.08
PY800	.38
PY801	.34
PZ30	.48
QQV03/10	1.20
QV04/7	.63
R10	.75
R11	.98
R16	1.75
R17	.88
R19	.33
SP42	.75
SP61	.33
TH4B	.50
TH233	.98
TP2620	.98
UABC80	.33
UAF42	.52
UBC41	.45
UBC81	.40
UBF80	.29
UBF89	.34
UBL21	.55
UC92	.35
UCC84	.40
UCC85	.37
UCF80	.42
UCH21	.60
UCH42	.63
UCH81	.33
UCL82	.35
UCL83	.50
UF41	.50
UF42	.60
UF80	.35
UF85	.34
UF86	.63
UF89	.34
UL41	.59
UL84	.33
UM80	.33
UY1N	.50
UY21	.55
UY41	.38
UY85	.29
U10	.45
U12/14	.38
U18/20	.75
U19	1.73
U22	.39
U25	.65
U26	.59
U45	.78
U191	.63
U251	.73
U281	.40
U282	.40
U301	.53
U403	.33
U404	.38
U801	.95
U4020	.38
VP23	.40
VP41	.38
VR105	.33
VR150	.33
VT61A	.35
VU111	.44
VU120	.60
VU120A	.60
VU133	.35
W76	.34
W107	.50
W729	.60
X41	.50
X61	.29
X65	.50
X66	.50
2S323	.50
AA119	.15
AA120	.15
AA129	.15
AAZ13	.18
AC107	.15
AC113	.25
AC127	.20
AC128	.20
AC156	.20
AC157	.25
AC166	.25
AC168	.38
AC176	.55
AC177	.23
ACY17	.25
ACY18	.20
ACY19	.19
ACY20	.18
ACY21	.19
ACY22	.16
ACY28	.18
AD140	.38
AD149	.50
AD161	.45
AD162	.45
ADT140	.63
AF102	.90
AF106	.50
AF114	.25
AF115	.15
AF117	.20
AF121	.30
AF124	.25
AF126	.18
AF139	.65
AF178	.68
AF180	.48
AF186	.55
AF239	.38
B1181	.50
BA102	.45
BA115	.14
BA116	.25
BA129	.13
BA130	.10
BC107	.13
BC108	.13
BC113	.25
BC115	.15
BC116	.25
BC118	.23
BCY10	.45
BCY12	.50
BCY33	.20
BCY38	.23
BCZ11	.38
BD119	.45
BF159	.25
BF163	.20
BF173	.38
BF180	.30
BF181	.40
BF185	.40
BFY50	.23
BFY51	.19
BFY52	.20
BY100	.18
BY105	.18
BY114	.18
BY126	.15
BY127	.18
BYY23	1.00
BYZ10	.25
BYZ11	.25
BYZ12	.25
BYZ13	.25
CG12E	.20
FSY11A	.23
GD9	.20
GET113	.20
GET116	.40
GET118	.20
GET119	.20
GET573	.38
GET587	.43
GET873	.15
GET887	.23
GET897	.23
GET898	.23
M1	.15
M3	.15
MAT100	.39
MAT101	.43
MAT120	.39
MAT121	.43
OA5	.28
OA9	.13
OA10	.43
OA47	.10
OA70	.15
OA73	.15
OA79	.09
OA81	.09
OA85	.08
OA90	.13
OA91	.09
OA95	.09
OA200	.09
OA202	.10
OC22	.38
OC23	.38
OC24	.38
OC25	.38
OC26	.25
OC28	.60
OC29	.63
OC35	.32
OC36	.43
OC42	.63
OC43	1.18
OC44	.10
OC45	.13
OC46	.15
OC70	.13
OC71	.13
OC72	.13
OC74	.23
OC75	.13
OC76	.15
OC77	.27
OC78	.15
OC78D	.15
OC81	.13
OC81D	.13
OC82	.13
OC82D	.15
OC83	.20
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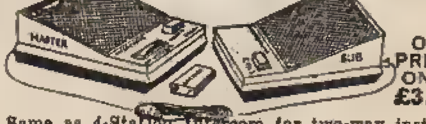

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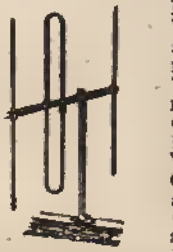

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BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. £1·40; 60 yd. £2.
FRINGE LOW LOSS Ideal 625 and colour. **10p** yd.

WIRE-WOUND 3-WATT POTS. Small type with small knob. Values 10 Ω to 30 K., Carbon 30 K to 2 meg. **25p**

WIRE-WOUND 3-WATT STANDARD SIZE POTS. LONG SPINDLE 10 OHMS to 100 K. **40p**

VEROBOARD 0·15 MATRIX
2½ × 5in. 19p. 2½ × 3¾in. 16p. 3¾ × 3¾in. 19p. 3¾ × 5in. 26p.
EDGE CONNECTORS 16 way 25p; 24 way 33p.
PINS 36 per packet 17p. FACE CUTTERS 33p.
S.R.B.P. Board 0·15 MATRIX 2½in. wide 3p per 1in., 3¾in. wide 4p per 1 in.; 5in. side 5p per 1in. (up to 17in.).
S.R.B.P. undrilled 1/16 in, Board 10 × 8in. 15p.

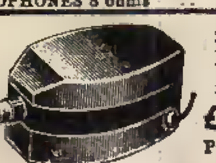
BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides. 6 × 4in. 45p; 8 × 6in. 50p; 10 × 7in. 70p; 14 × 9in. 90p; 16 × 6in. 90p; 12 × 3in. 90p.
ALUMINIUM PANELS 18 s.w.g. 6 × 4in. 8p; 8 × 6in. 15p; 10 × 7in. 17p; 12 × 8in. 23p; 14 × 9in. 27p; 12 × 12in. 32p.

1½ inch DIAMETER WAVE-CHANGE SWITCHES.
2 p. 2-way, or 2 p. 6-way or 3 p. 4-way 25p each. 1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way 25p each. 1 inch DIAMETER Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way, 1 wafer 60p, 2 wafer 90p. 3 wafer £1.20, 4 wafer £1.50, 5 wafer £1.80, 6 wafer £2.10
TOGGLE SWITCHES, sp. 14p; dp. 18p; dp. dt. 23p.

ALL PURPOSE HEADPHONES

H.R. HEADPHONES 200 ohms Super Sensitive	£1·75
LOW RESISTANCE HEADPHONES 3-5 ohms	£2·00
DE LUXE STEREO HEADPHONES 8 ohms	£3·25

"THE INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER



200/250 v. A.C. Leaflet S.A.E. **£2.35** Post 15p

GENERAL PURPOSE TRANSISTOR PRE AMPLIFIER BRITISH MADE

for Mike, Tape, P.U., Guitar

Battery 9-12v or H.T. line 200-300v D.C. operation. Size 1½" x 1½" x ¾". Response 25 c.p.s. to 25 Ks/s. 26db gain. For use with valve or transistor equipment. Full instructions supplied. Brand new. Guaranteed. Details S.A.E. **90p** Post 10p

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2/350V	14p	100/25V	10p	16+16/500V	55p
4/350V	14p	250/25V	14p	50+50/350V	35p
8/450V	14p	500/25V	20p	60+100/350V	58p
16/450V	15p	8+8/450V	18p	32+32/250V	18p
32/450V	20p	8+16/450V	20p	32+32/450V	33p
25/25V	10p	16+16/450V	25p	32+32+32/350V	43p
50/50V	10p	32+32/350V	25p	100+50+50/350V	48p

SUB-MIN. ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p; 500, 1000mF 12V 18p; 2000mF 25V 35p.
CERAMIC 1pF to 0·01 mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V-0·1 4p, 0·5 13p; 1mF 15p; 2mF 150V 15p. 500V-0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p. 1,000V-0·001, 0·0022, 0·0047, 0·01, 0·02, 8p; 0·047, 0·1, 14p.
SILVER MICA. Close tolerance 1% 2·2-500pF 8p; 500-2·200 pF 10p; 2,700-5,600pF 20p; 6,800pF-0·01, mfd 30p; each.
TWIN GANG. "0-0" 208pF+176pF, 65p; Slow motion drive 365+365 with 25+25pF, 55p; 500pF slow motion, standard 45p; small 3-gang 500pF £1·10. SHORT WAVE. Single 25pF 55p
CHROME TELESCOPIC AERIAL, swivel base, 23in. 20p.
TUNING. Solid dielectric. 100pF, 500pF, 35p each.
TRIMMERS. Compression 30, 50, 70pF, 5p; 100pF, 150pF, 8p; 250pF, 18p; 600pF, 750pF 10p; 1000 pF 10p.
RECTIFIERS CONTACT COOLED ½ wave 60mA 38p; 85mA 48p. SILICON BYZ13 30p; BY100 50p.
Full wave Bridge Rectifiers 75mA 50p; 150mA 98p.
EX-GOVERNMENT RECTIFIERS 250v, 200mA, 30p.
NEON PANEL INDICATORS 250V AC/DC Red or Amber 20p.
RESISTORS. Preferred values, 10 ohms to 10 meg.
¼ w., ½ w., 20% 1p; 2 w. 5p.
HIGH STABILITY. ½ w. 2% 10 ohms to 10 meg., 10p.
Ditto 5% Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K, 10p each; 2½ watt, 1 ohm to 8·2 ohms 10p.

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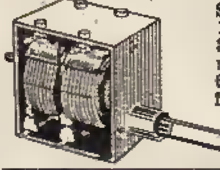
Complete: a die, a punch, an Allen screw and key

⅜in.	83p	⅝in.	88p	1⅛in.	98p	1⅜in.	£1·20	2 3/32in.	£2·21
½in.	83p	1in.	98p	1¼in.	£1·03	1⅝in.	£1·45	2½in.	£2·86
⅝in.	84p	1 1/16in.	98p	1⅞in.	£1·08	2in.	£1·99	1in.sq.	£1·83

AM—FM/VHF TUNING GANG



Super quality small size 1½ × 1½ × 1¼in., plus spindle 1½ × ¼in. 365 + 365 pF with 25 + 25 pF. British made. Geared slow motion drive 6:1. Plastic dust cover. 6BA tapped front fixing. Cast aluminium frame **50p** Post Free

MAINS TRANSFORMERS

Post 25p each

250-0-250 50 mA. 6·3 v. 2 amps, centre tapped	£1·10
250-0-250 80 mA. 6·3 v. 4 amp.	£1·40
250-0-250 80 mA. 6·3 v. 3·5 a. 6·3 v. 1 a. or 5 v. 2 a.	£2·00
350-0-350 80 mA. 6·3 v. 3·5 a. 6·3 v. 1 a. or 5 v. 2 a.	£2·00
300-0-300 v. 120 mA., 6·3 v. 4 a. C.T.; 6.3 v. 2 a.	£2·50
MINIATURE 200 v. 20mA., 6·3 v. 1 a. 2½ × 2½ × 2in.	75p
MIDGET 220 v. 45 mA., 6·3 v. 2 a. 2⅝ × 2½ × 2in.	90p
HEATER TRANS. 6·3v. 1½ a.	70p
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6·3 v. 1½ amp.	80p

GENERAL PURPOSE LOW VOLTAGE. Tapped Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 amp. £2·00
1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60, £2·00
AUTO TRANSFORMERS 0-115-230 v. Input/Output, 150w. £2·00; 500w. £5; 1000w. £12.
CHARGER TRANSFORMERS. Input 200/250v. for 6 or 12v., 1½ amp., £1·20; 4 amp. £1·90.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12 v. outputs, 1½ amp. 40p; 2 amp. 55p; 4 amp. 85p.

E.M.I. 13½ × 8in. LOUDSPEAKERS

With flared tweeter cone and ceramic magnet, 10 watts. Bass res. 45-60 cps. Flux 10,000 gauss. **£2.25**
State 3 or 8 or 15 ohm. Post 15p each

Also with twin tweeters. With crossover, 10 watt. **£4**
State 3 or 8 or 15 ohm. Post 15p each

Recommended Teak Cabinet Size 16 × 10 × 9in. Post 25p **£5**

10W MINI-MODULE LOUDSPEAKER KIT **£3.25** Post 25p

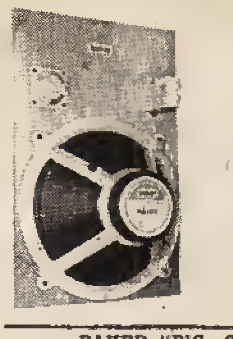
Triple speaker system combining on ready cut baffle. ½ in. chipboard 15 in. × 8½ in. Separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5 in. Bass Wooter unit has a low resonance cone. The mid-Range unit is specially designed to add drive to the middle register and the tweeter recreates the top end of the musical spectrum. Total response 20-15,000 cps. Full instructions for 3 or 15 ohm.

TEAK VENEERED BOOKSHELF ENCLOSURE. 16½ × 10½ × 6in. Modern Design, dark grey Tygan covered baffle **£5** Post 25p

★ RADIO BOOKS—LIST S.A.E. ★

ALL MODELS "BAKER SPEAKERS" IN STOCK

BAKER 12in. MAJOR £9



30-14,500 c.p.s., 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c.p.s. Rated 20 watts. Voice coils 3 or 8 or 15 ohms. Post Free

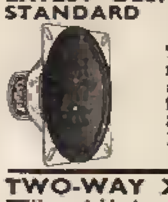
Module kit, 30-17,000 c.p.s. with tweeter, crossover, baffle and instructions. **£11.50**

BAKER "BIG—SOUND" SPEAKERS

'Group 25'	'Group 35'	'Group 50'
12 inch 25 watt **£7**	12 inch 35 watt **£9**	15 inch 50 watt **£19**
3 or 8 or 15 ohm	3 or 8 or 15 ohm	8 or 15 ohm

TEAK HI-FI SPEAKER CABINETS. Fluted wood front
For 12in. round Loudspeaker .... £9. Post 25p
For 13 × 8in. Loudspeaker .... £5. Post 25p
For 10 × 6in. round Loudspeaker .... £4. Post 25p
LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft.

THIS ELAC CONE TWEETER IS OF THE VERY LATEST DESIGN AND GIVES A HIGHER STANDARD OF PERFORMANCE THAN MORE EXPENSIVE UNITS.



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3½ × 3½ × 2in. deep. Rating 10 watts. 3 ohm or 15 ohm models. **£1.90** Post 10p

TWO-WAY XOVER NETWORK 3000 c/s.

With variable tweeter attenuator giving accurate high/low frequency balance. Mounted on panel 5½in. × 4in. with control knob, tweeter and woofer leads and input terminals. Suitable for 3 to 8 ohm imp. **£1.90** Post 10p

Horn Tweeters 2-16kc/s, 10W 8 ohm or 15 ohm £1·50.
De Luxe Horn Tweeters 2-18 Kc/s, 15W, 8 ohm £3.
TWO-WAY 3000cps CROSSOVERS 3 or 8 or 15 ohm 95p.
SPECIAL OFFER! 80 ohm, 2¾in., 2½in. dia.; 35 ohm. 3in. 25 ohm, 3in. dia.; 6 × 4in.; 8 × 5in. 15 ohm 3½in. dia; 7 × 4in.; 8 × 5in. 8 ohm, 6 × 4in., 3 ohm, 2½in, 3in. 5in. 5 × 3in. 7 × 4in. **90p** EACH TYPE
LOUDSPEAKERS P.M. 3 OHMS. 6½in. £1.10; 8 × 5in. £1·25; 8 × 2½in. 90p; 8in. £1.75; 10 × 6in. £1.90.
5in. WOOFER 8 watts max. 20-10,000 cps. 8 or 15 ohm. £1·80.
ELAC 8 in. De Luxe Ceramic 8 ohm or 15 ohm £2·50.
RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8in. dia. 4 watt; 10in. dia. 5 watt; 12in. dia. 6 watt 3 or 8 or 15 ohm models £1.95 each. Post 15p.
OUTPUT TRANS. EL34 etc. 25p; MIKE TRANS. 50:1 25p.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.
GOODMAN'S OUTPUT TRANSFORMER 4 watt push-pull for valves EL84 etc., 3, 8 and 15 ohms 85p, Post 20p.

100 WATT HIGH POWER P.A. AMPLIFIER

4 inputs speech and music. Response 10-30,000 cps Matches all loudspeakers. Weight only 12 lb. A.C. mains 200/250V. Details S.A.E. **£36** Post Free

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SUPPLIED AT LOWEST PRICES
ILLUSTRATED EAGLE CATALOGUE 25p. Post Free.

BARGAIN AM TUNER. Medium Wave. Transistor Superhet. Ferrite aerial. 9 volt. **£4**

BARGAIN 4 CHANNEL TRANSISTOR MIXER Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt. **£3**

BARGAIN FM TUNER 88-108 Mc/s Six Transistor. 9 volt Printed Circuit. Calibrated slide dial tuning. Walnut Cabinet. Size 7 × 5 × 4inch **£10**

BARGAIN FM TUNER as above less cabinet **£7.50**

FM STEREO MULTIPLEX ADAPTOR. For above or general use. Ready made with 4 transistors, 6 diodes. **£5**

BARGAIN 3 WATT AMPLIFEIR. 4 Transistor Push-Pull Ready built, with volume control. 9v. **£3.50**

COAXIAL PLUG 6p. PANEL SOCKETS 6p. LINE 18p. OUTLET BOXES, SURFACE OR FLUSH 25p.
BALANCED TWIN FEEDERS 5p yd. 80 ohms or 300 ohms.
JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead Socket 38p. Phono Plugs 5p. Phone Socket 5p.
JACK PLUGS Std. Chrome 15p; 3·5mm Chrome 14p. DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p. DIN SOCKETS Lead 3-pin 18p; 5-pin 25p. DIN PLUGS 3-pin 18p; 5-pin 25p.
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E.M.I. TAPE MOTORS
120v. or 240v. AC. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187 × 0·75in. Size 3¼ × 2½ × 2¼in. (illustrated). Post 15p. **£1.25**

BALFOUR GRAM MOTORS
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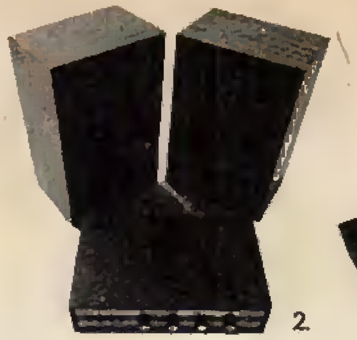

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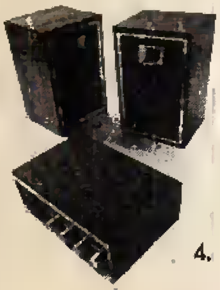

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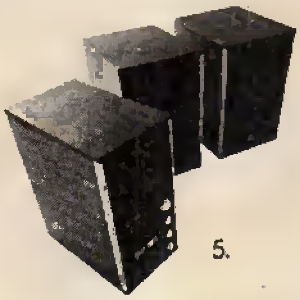

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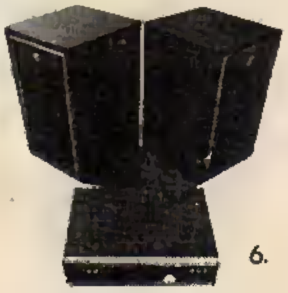

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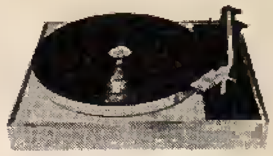

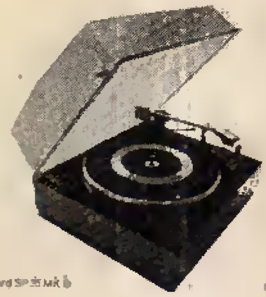

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TELEPHONE: 01-723 6211

System I. Price: £39·90

Amplifier
Output: 4 Watts per channel
Frequency Response: 50–10000 Hz.
Inputs: Tuner, Ceramic Cartridge
Controls: Volume, Tone & Balance

Speakers:
Capacity: 6 Watts
Frequency Response: 40–16000 Hz.
Turntable: Garrard 2025TC, Ceramic Cartridge, Base and Cover
Matching AM/FM/FM Stereo Tuner

System II. Price: £49·90

Amplifier
Output: 8 Watts per Channel
Frequency Response: 40–18000 Hz.
Inputs: Tuner, Tape, Ceramic Cartridge
Controls: Volume, Bass, Treble and Balance

Speakers:
Capacity: 10 Watts
Frequency Response: 40–19000 Hz.
Turntable: As system I.

System III. Price: (A) £59·90 (B) £69·90

Amplifier
Output: 15 Watts per Channel
Frequency Response: 30–18000 Hz.
Inputs: Tuner, Tape, Magnetic & Ceramic
Controls: Volume, Bass, Treble and Balance

Speakers: As System II

Turntable: System IIIA Garrard 2025TC, Ceramic Cartridge, Base and Cover
System IIIB Garrard SP.25 MK III, Magnetic Cartridge, Base and Cover

System IV. Price: £79·90

Amplifier
Output: 20 Watts per Channel
Frequency Response: 25–20000 Hz.
Inputs: Tuner, Tape Magnetic & Ceramic Cartridge
Controls: 2 Volume, Bass, Treble and Loudness

Speakers:
Capacity: 20 Watts
Frequency Response: 35–20000 Hz.
Turntable: Garrard SP.25 MKIII, Magnetic Cartridge, Base and Cover
Matching AF/FM/FM Stereo Tuner: £36·00

System V. Price: £115·00

Tuner Amplifier
Output: 18 Watts per Channel
Frequency Response: 30–20000 Hz.
Inputs: Tape & Magnetic Cartridge
Controls: 2 Volume, Bass, Treble and Tuning
FM Sensitivity: 2·5 micro volts
AM Sensitivity: 100 micro volts
Speakers:
Capacity: 20 Watts
Frequency Response: 35–20000 Hz.
Turntable: As System IV

System VI. Price: £182·00

Amplifier
Output: 30 Watts per Channel
Frequency Response: 20–30000 Hz.
Inputs: Auxilliary, Magnetic & Ceramic Cartridge
Controls: Volume, Bass, Treble, Balance, Loudness and Monitor

Speakers:
Capacity: 30 Watts
Frequency Response: 35–20000 Hz.
Turntable: Thorens TD150AB Magnetic Cartridge, Base & Cover

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AKG K50 Dynamic Stereo headphones

Complete with spare ear muffs.

(*Total value £10·40*) *Our Price* **£5·90** *+ 23p p. & p.*

Available only from us at this price. Due to entire purchase of manufacturer's remaining stock this fantastic offer is open only while stocks last.

★ High-fidelity reproduction due to broad frequency response (20-20,000Hz) ★ Substantially increased stereo effect ★ Headphones fit the head gently and do not shift ★ Earpieces fit ears snugly (Cardanic suspension) ★ Tone quality superior to conventional loudspeakers. ★ Only expensive studio loudspeakers can match the reproduction quality of the K50. ★ Music can be reproduced at concert hall volume (!), preserving the lower bass notes and brilliant treble tones without causing any strain to the listener.

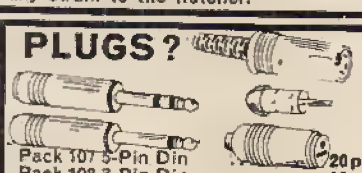
GARRARD SP25

mk II £11.50 *Plus 50p carriage*

Normal price £15·57

Single record playing unit. Features include cue and pause and automatic pick-up return and switch off.
Wired with mains cable and 5ft. twin screened stereo cable, 5 pin din plug. 53p extra.
AP75 Complete with base and cover £25 plus 75p carriage.

PLUGS?



Pack 107 5-Pin Din ..	20p
Pack 108 3-Pin Din	18p
Pack 135 ¼" Jack	25p
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Pack 103 Loudspeaker Plug ..	15p
Pack 100 Phono Plug	6p
Pack 230 3-Pin Socket ..	23p
Pack 236 5-Pin Socket ..	30p
Pack 234 Loudspeaker Socket..	30p

Ready-made Leads

3-pin to 3-pin Din	63p
3-pin to open end	53p
5-pin to 5-pin Din	80p
5-pin to open end	65p
5-pin to 4 phono plugs	93p

Speaker lead Din to spade 12ft 38p. Extension lead Din plug to socket 12ft. 65p
All leads approx. 6ft. in length. Post free, by return.

PLINTH & COVER £5·25

Unbeatable Value *plus 50p p. & p*

Suitable for AT60; SP25; 3000; 2500; 3500. Superb finish. Spindle can be left in position with cover on. Cover of neutral smoke tint perspex.
Also available for AP75; SL99; SL75 £6·88 plus 50p carr.

Replacement Stereo
DIAMOND STYLI

8TA 9TA 9TAHC GP91 ST4 ST9 EV26 GC8 others on request **75p** each p. & p. 13p

Countdown SPEAKER

Teak Cabinet

£12 insurance & carr. 38p

A speaker of outstanding specifications and technical merit. Solid teak cabinet size: 14" x 10" x 6". Originally designed for use with our Countdown stereo budget system but now available separately.

EMI 10w matched loudspeaker set 450

Our price **£3.75** *inc. 25p p. & p.*

13½" x 8¼" elliptical loudspeaker and independent high frequency units with associated crossover network. Frequency range 55 to 13000Hz. The cone of the base unit has a surround designed for high travel giving freedom from distortion when operated at low frequencies.
Also 350 KIT 20W Frequency range: 20 to 20,000Hz. Normal price £12.50 **£7.50** *plus* 40p *p & p*
Also 150 KIT 10W 3, 8 or 15 ohms **£2.50** *plus* 40p *p & p*

SINCLAIR Project 60

SAVE nearly £5 Normal price £23·90

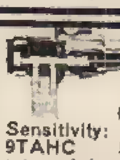
Designed for building into plinths etc., complete with two Z30 Output stages (20 watt) and power supply unit. Send S.A.E. for full technical brochure. **£19** *plus 50p carr.*

SINCLAIR 2000 AMPLIFIER *SAVE £6·30* *Our price* **£24.15**

Magnetic cartridges

Diamond styli **£4.75** *plus 13p p. & p.*

Today's value £6.
Stylus replacement can be carried out without removing cartridge. Fully guaranteed.



SONOTONE Cartridge ...

(Fitted Diamond Styli) (Ceramic) list price £4·10

Sensitivity: 9TAHC 55mV/cm/sec rms minimum at 45° at 1,000Hz measured on Decca SXL2057 **£2.50** *plus 13p p. & p.*

Ronette 105 Stereo cartridge (Sapphire 78 Diamond LP) £1·25 13p. *p. & p.*

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AMPLIFIER UNIT TYPE A1413. Complete with 5Z4 and 6V6GT valves 250/230 volt. 50 cycle. Transformer, Clean Condition, Untested. **£1·25p** (25/–). Carriage **75np** (15/–).

AIR POSITION INDICATORS. Contains Gears, Ball Races, Dimmer Units, Lamps, Four numbered counters, 24 volt Motor etc. Great interest to the model makers. In good condition. **75pn** (15/–). Carriage **50np** (10/–).

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RECLAIMED T.V. TUBES with 12 months Guarantee. 17" AW 43/80 **£1·50p** (30/–). MW 43/69 **£1·50p** (30/–). AW 43/88 **£2·00** (40/–). Carriage and Insurance on any tube **£1·00** (20/–).

12 CHANNEL COMPLETE UNTESTED T.V. SETS. **£2.50p** (50/–). Carriage and Insurance **£1.50p** (30/–).

SPEAKERS REMOVED FROM T.V. SETS. All 3 Ohm and P.M. 6×4. **15np** (3/–). 7×4. **25p** (5/–). 8×2½ **25np** (5/–). Post on any Speaker **20np** (4/–).

VALVE LIST—Ex Equipment 3 months guarantee. Single valves. Post **3np** (7d), over 3 valves P. & P. Paid.

ARP12	5np (1/–)	PCC84	10np (2/–)	PY82	8np (1/7)
EB91	4np (9d)	PCF80	10np (2/–)	PZ30	25np (5/–)
EF85	15np (3/–)	30P12	25np (5/–)	U191	25np (5/–)
EBF80	15np (3/–)	30F5	15np (3/–)	U251	25np (5/–)
ECC81	15np (3/–)	PCL84	20np (4/–)	6BW7	10np (2/–)
ECC82	15np (3/–)	PCL82	20np (4/–)	6U4	25np (5/–)
ECL80	10np (2/–)	PCL83	25np (5/–)	6P28	25np (5/–)
EF50	5np (1/–)	PL36	25np (5/–)	20D1	15np (3/–)
EF80	8np (1/7)	PL81	20np (4/–)	20P1	25np (5/–)
EF91	4np (9d)	PY33	25np (5/–)	20P3	15np (3/–)
EY86	25np (5/–)	PY81	8np (1/7)	30P4	25np (5/–)

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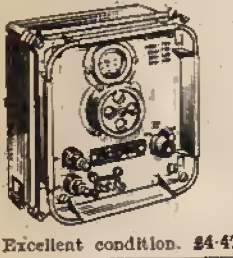
Battery operated, fully transistorised. Sensitivity 100mΩ/v.
Measures AC/DC Voltages 12mV to 1,200v.
AC/DC Current 12nA to 1.2 Amp.
Resistance 12 ohm to 120 mΩ
HF, VHF, UHF Voltage with multiplier 4v to 400v up to 50 Mc/s, 40mV to 4v up to 1,000 Mc/s.
Offered in perfect condition.
£55 each. Carr. 50p.

CRYSTAL CALIBRATORS NO. 10



Small portable crystal controlled wavemeter. Size 7 × 7½ × 4in. Frequency range 500 Kc/s–10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300V. D.C. 15mA and 12V D.C. 0.3A.
Excellent condition. £4·47½. Carr. 37½p.

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latest release 125 KHz—20 MHz. Excellent condition. Fully tested and checked and complete with calibrator charts.
£27·50 each. Carr. 50p.

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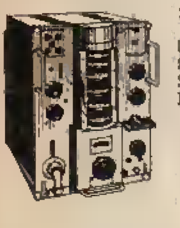
AVO CT.38 ELECTRONIC MULTIMETERS

High quality 97 range instrument which measures A.C. and D.C. Voltage. Current, Resistance and Power Output Ranges D.C. volts 250mV–10,000v. (10 meg Ω –11 0meg Ω input). D.C. current 10μA–25 amps. Ohms, 0–1,000 meg Ω A.C. volt 100mV.–250V (with R.F. measuring head up to 250 Mc/s) A.C. current 10μA–25 amps. Power output 50 micro-watts–5 watts. Operation 0/110/200/250V. A.C. Supplied in perfect condition complete with circuit lead and R.F. probe. £25. Carr. 75p.

ADMIRALTY 62B RECEIVERS

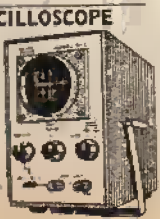


High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 150-300 Kc/s, 560 Kc's–1.5Mc/s; 3.9–30.5 Mc/s I.F. 500/Kc/s. Incorporates 2 R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O. calibrator I.F. output, etc. Built-in speaker, output for phones. Operation 150/230 vol A.C. Size 19½ × 13½ × 16in. Weight 114lb. Offered in good working condition. £22·50. Carr. £1.50. With circuit diagrams. Also available B41 L.F. version of above, 15 Kc/s–700 Kc/s. £17·50. Carr. £1.50.

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 1.5 cps –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 15½ lb. 220/240V. A.C. Supplied brand new with handbook. £37·50. Carr. 50p.

TO-2 PORTABLE OSCILLOSCOPE



A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS–1 MHZ. Input imp. 2 meg Ω 25 P.F. Illuminated scale. 2in. tube. 115 × 180 × 230mm. Weight 8lb. 220/240 V a.c. Supplied brand new with handbook. £22.50. Carr. 50p.

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100 x 80 mm.

50μA	£3·47½	20V. D.C. ..	£2·97½
50–0–50μA	£3·37½	50V. D.C. ..	£2·97½
100μA	£3·37½	300V. D.C.	£2·97½
100–0–100μA	£3·25	1 amp. D.C.	£2·97½
500μA	£3·12½	5 amp. D.C.	£2·97½
1mA	£2·97½	300V. A.C.	£2·97½
		VU Meter ..	£3·75

BAKELITE PANEL METERS

TYPE S-80
80 mm.
square fronts

50μA	£3·12½	50V. D.C...	£2·47½
50–0–50μA	£2·97½	300V. D.C.	£2·47½
100μA	£2·97½	1 amp. D.C.	£2·47½
100–0–100μA	£2·87½	5 amp. D.C.	£2·47½
500μA	£2·62½	300V. A.C.	£2·62½
1mA	£2·47½	VU Meter ..	£3·37½
20V. D.C...	£2·47½		

"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4½in. × 4¼in. fronts.

50μA	£3·60	50mA	£2·60
50–0–50μA	£3·10	100mA	£2·60
100μA	£3·10	500mA	£2·60
100–0–100μA	£3·10	1 amp.	£2·60
200μA	£2·87½	5 amp.	£2·60
500μA	£2·75	15 amp.....	£2·60
500–0–500μA	£2·60	30 amp.....	£2·60
1mA	£2·60	20V. D.C...	£2·60
1–0–1mA ..	£2·60	50V. D.C. ..	£2·60
5mA	£2·60	150V. D.C.	£2·60
10mA	£2·60	300V. D.C.	£2·60
		15V. A.C. ..	£2·60
		300V. A.C.	£2·60
		S Meter 1mA	£2·87½
		VU Meter ..	£3·60
		1 amp. A.C.*	£2·60
		5 amp. A.C.*	£2·60
		10 amp. A.C.*	£2·60
		20 amp. A.C.*	£2·60
		30 amp. A.C.*	£2·60

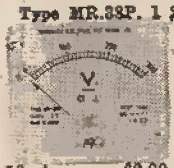
Type MR.52P. 2½in. square fronts.

50μA	£3·10	10V. D.C. ..	£2·00
50–0–50μA	£2·60	20V. D.C. ..	£2·00
100μA	£2·60	50V. D.C. ..	£2·00
100–0–100μA	£2·37½	300V. D.C.	£2·00
500μA	£2·25	15V. A.C. ..	£2·00
1mA	£2·00	300V. A.C.	£2·00
5mA	£2·00	S Meter 1mA	£2·10
10mA	£2·00	VU Meter ..	£3·10
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.65P. 3½in. × 3¼in. fronts.

50μA	3·37½	10V. D.C. ..	£2·10
50–0–50μA	£2·75	20V. D.C. ..	£2·10
100μA	£2·75	50V. D.C. ..	£2·10
100–0–100μA	£2·60	150V. D.C. ..	£2·10
200μA	£2·60	300V. D.C.	£2·10
500μA	£2·37½	15V. A.C...	£2·10
500–0–500μA	£2·10	50V. A.C...	£2·10
1mA	£2·10	150V. A.C.	£2·10
5mA	£2·10	300V. A.C.	£2·10
10mA	£2·10	500V. A.C.	£2·10
50mA	£2·10	S Meter 1mA	£2·37½
100mA	£2·10	VU Meter ..	£3·37½
500mA	£2·10	50mA A.C.*	£2·10
1 amp.	£2·10	100mA A.C.*	£2·10
5 amp.	£2·10	200mA A.C.*	£2·10
10 amp.....	£2·10	500mA A.C.*	£2·10
15 amp. ..	£2·10	1 amp. A.C.*	£2·10
20 amp. ..	£2·10	5 amp. A.C.*	£2·10
30 amp. ..	£2·10	10 amp. A.C.*	£2·10
50 amp. ..	£2·37½	20 amp. A.C.*	£2·10
5V. D.C. ..	£2·10	30 amp. A.C.*	£2·10

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



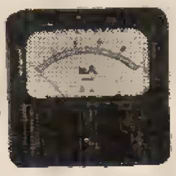
50μA	£2·00	200mA	£1·37½
50–0–50μA	£1·87½	300mA	£1·37½
100μA	£1·87½	500mA	£1·37½
100–0–100μA	£1·75	750mA	£1·37½
200μA	£1·75	1 amp.	£1·37½
500μA	£1·50	2 amp.	£1·37½
500–0–500μA	£1·37½	5 amp.	£1·37½
1mA	£1·37½	10 amp. ..	£1·37½
1–0–1mA ..	£1·37½	3V. D.C. ..	£1·37½
2mA	£1·37½	10V. D.C...	£1·37½
5mA	£1·37½	15V. D.C...	£1·37½
10mA	£1·37½	20V. D.C...	£1·37½
20mA	£1·37½	100V. D.C.	£1·37½
50mA	£1·37½	150V. D.C.	£1·37½
100mA	£1·37½	300V. D.C.	£1·37½
150mA	£1·37½	500V. D.C.	£1·37½
		750V. D.C.	£1·37½
		15V. A.C...	£1·37½
		50V. A.C...	£1·37½
		150V. A.C.	£1·37½
		300V. A.C.	£1·37½
		500V. A.C.	£1·37½
		S Meter 1mA	£1·60
		VU Meter ..	£2.10

Type MR.45P. 2in. square fronts.

50μA	£2·25	5 amp.	£1·50
50–0–50μA	£2·10	10V. D.C. ..	£1·50
100μA	£2·10	20V. D.C. ..	£1·50
100–0–100μA	£1·87½	50V. D.C. ..	£1·50
200μA	£1·87½	300V. D.C.	£1·50
500μA	£1·60	15V. A.C. ..	£1·50
500–0–500μA	£1·50	300V. A.C.	£1·50
1mA	£1·50	S Meter 1mA	£1·87½
5mA	£1·50	VU Meter ..	£2·25
10mA	£1·50	1 amp. A.C.*	£1·50
50mA	£1·50	5 amp. A.C.*	£1·50
100mA	£1·50	10 amp. A.C.*	£1·50
500mA	£1·50	20 amp. A.C.*	£1·50
1 amp	£1·50	30 amp. A.C.*	£1·50

"SEW" BAKELITE PANEL METERS

Type MR.65. 3½in. square fronts.



25μA	£3·50	500mA	£1·75
50μA	£2·37½	1 amp.	£1·75
50–0–50μA	£2·25	5 amp.	£1·75
100μA	£2·25	15 amp.....	£1·75
100–0–100μA	£2·25	30 amp.....	£1·75
500μA	£2·10	50 amp.....	£1·75
1mA	£1·75	5V. D.C. ..	£1·75
1–0–1mA ..	£1·75	10V. D.C. ..	£1·75
5mA	£1·75	20V. D.C. ..	£1·75
10mA	£1·75	50V. D.C. ..	£1·75
50mA	£1·75	150V. D.C.	£1·75
100mA	£1·75	300V. D.C.	£1·75
		30V. A.C.*	£1·75
		50V. A.C.*	£1·75
		150V. A.C.*	£1·75
		300V. A.C.*	£1·75
		500mA A.C.*	£1·75
		1 amp. A.C.*	£1·75
		5 amp. A.C.*	£1·75
		10 amp. A.C.*	£1·75
		20 amp. A.C.*	£1·75
		30 amp. A.C.*	£1·75
		50 amp. A.C.*	£1·75
		VU Meter ..	£3·10

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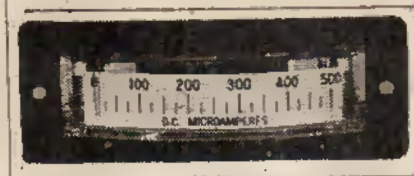
EDGWISE METERS



Type PE.70. 3 17/32in. × 1 15/32in. × 2¼ in. deep.

50μA	£3·00	500μA	£2·60
50–0–50μA	£2·87½	1mA	£2·37½
100μA	£2·87½	300V. A.C.	£2·37½
100–0–100μA	£2·75	VU Meter ..	£3·25
200μA	£2·75		

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50 WATT. 10/25/50/100/250/500/1000/2500 or 5000 ohms, £1·05 P. & P. 7½p.
100 WATT. 1/5/10/25/50/100/250/500/1000 or 2500 ohms, £1·37½ P. & P. 7½p.

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Excellent condition. Fully tested. £20. Carr. 75p.

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

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 meg Ω 6 Ranges ±1% L.1 μ H – 111 HENRYS 6 Ranges – 2% C. 10pF ±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7½ × 5 × 2in. £20. P. & P. 25p

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TE-20 RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kc/s–260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instruction. £15. P. & P. 37½p. S.A.E. for details.

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Frequency 0–20 Kc/s. on 2 ranges. Output 500 Ω or 5k Ω. Operation 200/250V. A.C. Supplied in perfect order. £12·50. Carr. 50p.

MARCONI TF885 VIDEO OSCILLATORS

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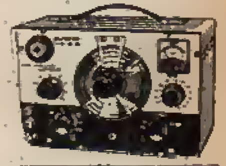
LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER



2 pF–2000 mFd
2 ohms 200 megohms. Also checks impedance, turns ratio, insulation. 200/250V. A.C.
Brand New £17·50.
Carr. 37½p.

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VM79. UHF MILLIVOLT METER. 100 Kc/s to 1,000 Mc/s. AC. 10mV to 3v. DC. 10 mV to 3v. Current 0.01 uA to 0.3 mA. Resistance 1 ohm to 10 megohm. £125.
TT1S. TRANSISTOR TESTER. Full range of facilities for testing PNP or NPN transistors in or out of circuit. £37·50. Carriage 50p per item.

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IN4004	10p	ACY19	25p	BYZ11	35p
IN4005	12p	ACY20	22p	BYZ12	30p
IN4006	15p	ACY21	22p	BYZ13	25p
IN4007	20p	ACY22	17p	MJ480	97p
IN4148	7p	ACY28	17p	MJ481	£1·25
IN5054	22p	ACY40	15p	MPF102	42p
2G301	20p	AD140	50p	MPF103	35p
2G302	22p	AD149	50p	MPF104	37p
2G303	25p	AD161	37p	MPF105	40p
2G306	30p	AD162	37p	NKT213	25p
2G308	30p	AF114	25p	NKT214	15p
2G309	30p	AF115	25p	NKT216	37p
2G371	22p	AF116	25p	NKT217	40p
2G374	27p	AF117	25p	NKT224	22p
2G381	25p	AF118	62p	NKT241	27p
2N696	17p	AF119	20p	NKT261	20p
2N697	17p	AF124	25p	NKT271	25p
2N698	42p	AF126	17p	NKT272	25p
2N706	10p	AF127	17p	NKT274	20p
2N706A	12p	AF139	30p	NKT275	25p
2N708	15p	AF178	47p	NKT278	25p
2N914	22p	AF180	52p	NKT281	27p
2N916	22p	AF181	42p	NKT403	75p
2N918	37p	AF186	40p	NKT404	62p
2N929	22p	AF239	42p	NKT405	75p
2N930	25p	ASY26	25p	NKT773	25p
2N1131	30p	ASY27	32p	NKT10439	
2N1132	30p	ASY28	25p		37p
2N1302	20p	ASZ17	42p	OA5	20p
2N1303	22p	AUY10	97p	OA10	25p
2N1304	25p	BAY31	7p	OA47	10p
2N1305	25p	BC107	12p	OA70	10p
2N1306	25p	BC108	12p	OA79	10p
2N1307	25p	BC109	12p	OA81	10p
2N1308	30p	BC113	25p	OA85	12p
2N1309	25p	BC116	40p	OA90	10p
2N1613	22p	BC125	55p	OA91	7p
2N1711	25p	BC126	55p	OA95	7p
2N1889	32p	BC147	17p	OA200	7p
2N1893	50p	BC148	12p	OA202	10p
2N2147	75p	BC149	20p	OA210	17p
2N2160	65p	BC167	15p	OC19	37p
2N2193	47p	BC172	17p	OC20	97p
2N2217	40p	BC177	25p	OC22	50p
2N2218	30p	BC186	25p	OC23	60p
2N2219	32p	BC182L	10p	OC24	60p
2N2368	17p	BC184L	12p	OC25	37p
2N2369	20p	BC212L	12p	OC26	25p
2N2369A	20p	BCY30	25p	OC28	62p
2N2484	35p	BCY31	30p	OC29	62p
2N2613	35p	BCY32	50p	OC35	50p
2N2646	50p	BCY33	25p	OC36	62p
2N2904	30p	BCY34	30p	OC41	25p
2N2923	17p	BCY38	40p	OC42	30p
2N2924	17p	BCY42	15p	OC44	10p
2N2925	17p	BCY43	20p	OC45	15p
2N2926G	12p	BCY71	30p	OC46	27p
2N2926Y	12p	BCY72	15p	OC70	12p
2N29260	12p	BCZ11	40p	OC71	15p
2N3053	25p	BD121	65p	OC72	25p
2N3054	50p	BD123	80p	OC73	30p
2N3055	75p	BD124	80p	OC74	30p
2N3391A	30p	BF115	25p	OC75	25p
2N3416	37p	BF117	47p	OC76	25p
2N3570	£1·25	BF167	25p	OC77	40p
2N3702	12p	BF173	30p	OC78	20p
2N3703	12p	BF180	37p	OC81	25p
2N3704	17p	BF181	37p	OC81D	20p
2N3705	15p	BF182	32p	OC83	25p
2N3706	22p	BF184	25p	OC84	25p
2N3707	15p	BF185	25p	OC139	25p
2N3708	17p	BF194	17p	OC140	37p
2N3709	12p	BF195	15p	OC169	20p
2N3710	12p	BF200	37p	OC170	25p
2N3711	12p	BF224	30p	OC171	30p
2N3819	35p	BF225	30p	OC200	40p
2N3903	25p	BF244	47p	OC201	60p
2N3904	25p	BFX12	22p	OC202	75p
2N3905	30p	BFX13	25p	OC203	40p
2N3906	30p	BFX29	30p	OC204	40p
2N4058	17p	BFX30	32p	OC205	62p
2N4059	25p	BFX44	37p	OC207	75p
2N4061	15p	BFX85	40p	OCP71	97p
2N4062	22p	BFX86	32p	ORP12	50p
2N4286	15p	BFX87	32p	ORP60	40p
2N4287	17p	BFX88	25p	P346A	25p
2N4288	15p	BFY18	25p	PL4001	14p
2N4289	17p	BFY20	62p	PL4002	15p
2N4290	15p	BFY50	22p	PL4003	16p
2N4291	15p	BFY51	20p	PL4004	17p
2N4292	15p	BFY52	22p	PL4005	19p
2N5354	27p	BFY90	67p	PL4006	20p
2N5355	27p	BSX19	17p	PL4007	24p
2S102	25p	BSX20	17p	T1S43	40p
2S103	37p	BSX21	37p	T1S44	12p
2S104	37p	BSX76	15p	T1S45	17p
40250	50p	BSY26	17p	T1S46	17p
40361	55p	BSY27	20p	BC107/8/9	
40362	60p	BSY28	17p	25+	10p
AC107	37p	BSY38	20p	100+	9p
AC126	25p	BSY39	22p	500+	7p
AC127	25p	BSY51	32p	2N3055	
AC128	25p	BSY56	90p	25+	62p
AC154	15p	BSY95A	15p	100+	50p
AC176	25p	BY100	15p		

THYRISTORS

PIV	50	100	200	300	350	400
1A	25p	27p	37p	40p	—	47p
3A	30p	37p	40p	45p	—	50p
5A	—	55p	65p	—	—	75p
7A	—	55p	65p	70p	—	97p

VALVES

OA2	38p	25Z4	30p	EL95	35p
OB2	45p	25Z5	42p	EM80	40p
OZ4	30p	25Z6	65p	EM81	50p
1L4	20p	30C15	80p	EM84	35p
1R5	35p	30C17	85p	EM85	£1·00
1S5	25p	30C18	75p	EM87	43p
1T4	25p	30F5	85p	EY51	40p
1U4	27p	30FL1	70p	EY86	40p
1U5	50p	30FL12	92p	EY87	42p
2D21	35p	30FL14	75p	EZ40	45p
3Q4	40p	30L15	85p	EZ41	45p
3S4	35p	30L17	80p	EZ80	25p
3V4	45p	30P12	80p	EZ81	28p
5R4	60p	30P19	80p	GZ32	48p
5U4	33p	30PL1	70p	GZ34	60p
5V4	42p	30PL13	93p	KT66	£1·70
5Y3	32p	30PL14	90p	KT88	£1·75
5Z4G	40p	35L6	50p	MU14	60p
6/30L2	75p	35W4	30p	PABC80	40p
6AC7	25p	35Z4	30p	PC86	60p
6AG7	40p	35Z5	40p	PC88	60p
6AK5	30p	50B5	45p	PC97	45p
6AK6	57p	50C5	40p	PC900	48p
6AL5	20p	80	50p	PCC84	40p
6AM6	33p	85A2	45p	PCC85	40p
6AQ5	35p	807	50p	PCC88	55p
6AS6	37p	1625	50p	PCC89	50p
6AT6	30p	5763	70p	PCC189	55p
6AU6	25p	6146	£1·50	PCF80	30p
6AV6	30p	AZ31	50p	PCF82	34p
6BA6	25p	CY31	35p	PCF84	50p
6BE6	30p	DAF91	25p	PCF86	60p
6BH6	45p	DAF96	42p	PCF800	80p
6BJ6	45p	DF91	25p	PCF801	50p
6BQ7A	40p	DF96	42p	PCF802	50p
6BR7	85p	DK91	35p	PCF805	75p
6BR8	65p	DK92	50p	PCF806	70p
6BW6	85p	DK96	42p	PCF808	75p
6BW7	70p	DL92	35p	PCL82	35p
6BZ6	35p	DL94	45p	PCL83	65p
6C4	38p	DL96	42p	PCL84	45p
6CD6	£1·15	DM70	32p	PCL85	40p
6CL6	50p	DY86	33p	PCL86	45p
6CW4	63p	DY87	35p	PFL200	70p
6F1	62p	E88CC	65p	PL36	55p
6F6G	30p	E180F	95p	PL81	50p
6F13	38p	EABC80	35p	PL82	45p
6F14	65p	EAF42	35p	PL83	45p
6F15	65p	EB91	20p	PL84	40p
6F18	45p	EBC41	55p	PL500	75p
6F23	80p	EBC81	30p	PL504	80p
6H6	20p	EBF80	40p	PY32	55p
6J4	50p	EBF83	40p	PY33	63p
6J5	20p	EBF89	32p	PY80	35p
6J5GT	30p	EBL21	60p	PY81	30p
6J6	20p	EC86	60p	PY82	30p
6J7	45p	EC88	60p	PY83	38p
6K8G	35p	ECC40	60p	PY88	40p
6L6GT	45p	ECC84	30p	PY800	50p
6LD20	40p	ECC85	60p	PY801	50p
6Q7	40p	ECC88	40p	U25	75p
6SA7	40p	ECF80	35p	U26	75p
6SG7	35p	ECF82	35p	U30	32p
6SJ7	40p	ECF86	65p	U52	33p
6SK7	35p	ECH21	57p	U191	75p
6SL7	35p	ECH35	60p	U281	40p
6SN7	35p	ECH42	70p	U282	40p
6SQ7	40p	ECH81	30p	U301	40p
6U4	60p	ECH83	40p	U801	£1·00
6V6G	25p	ECL80	40p	UABC80	35p
6V6GT	32p	ECL82	35p	UAF42	55p
6X4	30p	ECL83	65p	UBC41	50p
6X5G	30p	ECL86	40p	UBC81	45p
6X5GT	27p	EF37A	60p	UBF80	40p
10C2	50p	EF39	40p	UBF89	35p
10F1	90p	EF40	50p	UCC84	49p
10P13	55p	EF41	65p	UCC85	40p
10P14	£1·10	EF42	70p	UCF80	55p
12AT6	30p	EF80	25p	UCH21	60p
12AT7	30p	EF85	35p	UCH42	70p
12AU7	30p	EF86	30p	UCH81	35p
12AX7	30p	EF89	28p	UCL82	35p
12AV6	33p	EF91	33p	UCL83	60p
12BA6	35p	EF92	40p	UF41	60p
12BE6	35p	EF183	30p	UF80	35p
12BH7	40p	EF184	35p	UF85	40p
19AQ5	35p	EH90	40p	UF89	35p
20D1	45p	EL34	50p	UL41	65p
20F2	75p	EL33	£1·25	UL84	30p
20L1	£1·10	EL41	55p	UY41	45p
20P1	50p	EL42	58p	UY85	30p
20P3	60p	EL81	65p	VR105/30	38p
20P4	£1·10	EL84	25p	VR150/30	35p
20P5	£1·20	EL85	43p		
25L6	45p	EL91	32p		

SEND SAE FOR FULL LISTS!
DISCOUNTS 10% on 12+ any one type. 15% on 25+ any one type.
Large quantity discounts on application.
Postage: Semi-Conductors 8p; Valves 15p.

ZENER DIODES

200mw. (3.3 to 33v) 15p; 1.5watt (2.4 to 400v) 20p; 40 watt (3.9 to 100v) 25p.

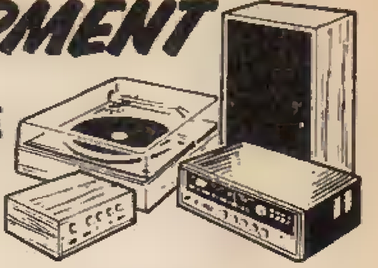
INTEGRATED CIRCUITS

L900 40p; L914 40p; L923 60p; IC-10 £2·50; SL403 £2·25; MC1303 £2·62; MC1304 £2·75; PA246 £2·45; CA3005 £1·17; CA3011 74p; CA3052 £1·65; FCH131 50p; FCH161 50p; FJH141 25p; FJH171 25p; FJH181 25p; FJH221 25p; FJH231 25p; FJH241 25p; FJH251 25p; FJJ121 60p; FJJ131 60p; FJJ211 £1·25; FJY101 25p

HI-FI EQUIPMENT

SAVE UP TO 33⅓% OR MORE

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



GARRARD

FULL CURRENT RANGE OFFERED BRAND NEW AT FANTASTIC SAVINGS

40 Mk II stereo	£8·40	SL72B	£26·97
2025T/C stereo	£9·87½	AP76	£20·97½
3000 stereo	£10·50	SL75	£25·97½
SP25 Mk III	£11·75	SL75B	£30·75
		SL95B	£40·97
SL65B	£14·97½	401	£29·97

Carriage 37½p extra each item.

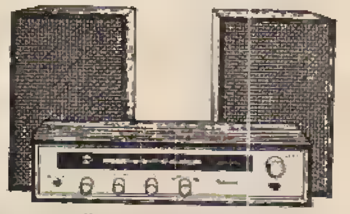
TEAK PLINTHS & PERSPEX COVERS
1. For SP25, SL65, SL55, 3000, 2025 T/C 2025, 1000. £3·97½.
2. For AP75, SL75, SL95. £5·97½.
3. For SP25 etc. to operate with lid in place £5·97½. Carriage 37½p extra each type. Full range of Garrard accessories available.

SPECIAL OFFERS!

Garrard SP25 MK III fitted Goldring G800 cartridge and wooden plinth and plastic cover. Ready wired. Total list price £35.
OUR PRICE **£22.50** Carr. 50p

GOLDRING GL69/2 fitted Goldring G800 cartridge complete with deluxe base and cover. Total list price £50.80.
OUR PRICE **£39** Carr. 50p

TELETON SPECIAL OFFER!



CR10T AM/FM STEREO TUNER AMPLIFIER WITH MATCHING PAIR SA1003 SPEAKER SYSTEMS. Output 4 watts per channel. Excellent reception, AFC, built-in MPX. Cer/XTAL Input. Total List £50·25. OUR PRICE £29·95. Carr. 62½p.

Also available with Garrard 2025T/C Record Changer, Plinth, cover and stereo cartridge. Ready wired £45. Carr. £1·00.

B.S.R. McDONALD

MP60	£11·95	610	£15·95
510	£12·95	310	£10·95

Carriage 37½p extra each item

TEAK BASE AND PERSPEX COVER for above BSR range £3·97½. Carriage 37½p

TPDI SERIES with plinth and cover and ready wired.
MP60 £19·50 610 £22·95
510 £20·95
Carriage 50p extra each item

TAPE CASSETTES

Top quality in plastic library boxes.
C90 60 min 42½p, 3 for £1·22½.
C60 90 min 62½p, 3 for £1·80.
C120 120 min 75p, 3 for £2·17½.
Cassette Head Cleaner 56p. *Post Extra.*

GOODMANS SPECIAL OFFERS!

MAXAMP 30 Stereo Amplifier 15+15 watt r.m.s. with matching STEREOMAX AM/FM Tuner. Total list price £136·52.
OUR PRICE **£89** THE PAIR Carriage £1

GOODMANS SPEAKERS!

MEZZO III, teak.
OUR PRICE £25.50 pr. Carr. £1
MAGNUM K2, teak.
OUR PRICE £33·00 pr. Carr. £1
MAMBO, teak. List £44·65 pr.
OUR PRICE £32·50 pr. Carr. 50p
MARIMBO
OUR PRICE £35·00 pr. Carr. 50p.
MAGESTER, teak. List £57 each.
OUR PRICE £37·97½ each. Carr. £1
Magister stand £2·97½ extra

HOSIDEN DHO4S 2-WAY STEREO HEADSETS

Each headphone contains a 2½in. woofer and a ⅝in. tweeter. Built in individual level controls. 8 Ω imp. 25–18,000c/s with cable and stereo plug. £5.97½ P. & P. 12½p.

TE-1035 STEREO HEADPHONES

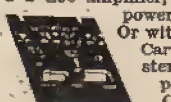
Low cost high performance stereo headphones. Foam rubber ear cups. Adjustable head-band. 8 ohm impedance. 25-18,000 Hz. With lead and stereo jack plug. ONLY £1·97½. P. & P. 12½p

TELETON SAQ-206 STEREO AMPLIFIER

Latest exciting release. Brand new model. 6 + 6 watts rms. Inputs for mag, xtal, aux tape. Volume, bass, treble, sliding balance, scratch filter and loudness controls. Rec. List £29. OUR PRICE £19·97 Carr. 37p.

SINCLAIR EQUIPMENT

Project 60. Package offers.
2 x Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. £19. Carr. 37½p. Or with PZ6 power supply £21. Carr. 37½p. 2 x Z50 amplifier, stereo 60 pre-amp, PZ8 power supply. £21·50. Carr. 37½p.



Transformer for PZ8, £2·97½ extra.
Add to any of the above £4·87½ for active filter unit and £16 for a pair of Q16 speakers.
Project 60 FM Tuner £20·97½. Carr. 37½p.
All other Sinclair products in stock.
2000 Amplifier £22·97½ Carr. 37½p.
3000 Amplifier £35. Carr. 37½p.
Neoteric Amplifier £45·97½ Carr. 37½p.

AMERICAN TAPE

First grade quality American tapes. Brand new. Discount on quantities.

3in. 225ft. L.P. acetate	17½p
3¾in. 600ft. T.P. mylar	50p
5in. 600ft. std. plastic	42½p
5in. 900ft. L.P. acetate	50p
5in. 1,200ft. D.P. mylar	75p
5¾in. 1,200ft. L.P. acetate	62½p
5¾in. 1,200ft. L.P. mylar	80p
5¾in. 1,800ft. D.P. mylar	£1·12½
5¾in. 2,400ft. T.P. mylar	£1·97½
7in. 1,200ft. std. acetate	62½p
7in. 1,800ft. L.P. acetate	75p
7in. 1,800ft. L.P. mylar	£1·00
7in. 2,400ft. D.P. mylar	£1·25
7in. 3,600ft. T.P. mylar	£2·25

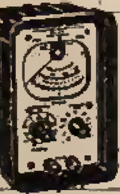
Postage 10p. Over £3 post paid.

ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Lightweight adjustable vinyl headband. 6ft. cable and stereo jack plug. 25–17,000 cps. 8 ohm imp. £3.37½ P. & P. 12½p.

RUSSIAN C1-16 DOUBLE BEAM OSCILLOSCOPES

5 MHz Pass Band. Separate Y1, Y2 amplifiers. Calibrated triggered sweep from ·2 sec to 100 milli sec/cm.
Supplied complete with all accessories and instructions £37. Carr. paid.



MARCONI T/44/TF956

AF Absorption Wattmeter

1 µ/watts to 6 watts.

£20. Carr. £1.

TE111 DECADE RESISTANCE ATTENUATOR

Variable range 0–111dB. Connections, Unbalanced T and Bridge T. Impedance 600 Ω range (0.1dB × 10) + (1dB × 10) + 10 + 20 + 30 + 40dB. Frequency: d.c. to 200kHz (−3dB). Accuracy: 0.05dB. + Indication dB × 0.01. Maximum input less than 4W (50V). Built in 600 Ω load resistance with internal/external switch. Brand new. £27·50. P. & P. 25p.

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.

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. £7·97½. P. & P. 20p.

BELCO DA-20 SOLID STATE DECADE AUDIO OSCILLATOR

New high quality portable instrument. Sine 1 Hz to 100 KHz. Square 20 Hz to 20 KHz. Output max + 10 dB (10 K ohms). Operation 220/240v. A.C. Size 215mm x 150mm x 120mm.
Price £27·50. Carr. 25p.

TE-40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input 10 ranges: 01/·003/·1/·3/1/3/10/30/100/300V. R.M.S. 4cps.-1·2 Mc/s. Decibels −40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V. A.C. £17·50. Carr. 25p.

TE-65 VALVE VOLTMETER

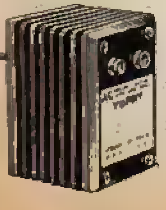
High quality instrument with 28 ranges. D.C. volts 1·5–1,500v. A.C. volts 1·5—1,500v. Resistance up to 1,000 megohms. 200/240v. A.C. operation. Complete with probe and instructions.
£17·50. P. & P. 30p. Additional probes available: R.F. £2·12½; H.V. £2·50.

AUTO TRANSFORMERS

0/115/230V. Step up or step down. Fully shrouded.

150 W.	£2·37½	P. & P. 17½p
300 W.	£3·25	P. & P. 22½p
500 W.	£4·97½	P. & P. 32½p
1000 W.	£7·25	P. & P. 37½p
1500 W.	£8·97½	P. & P. 42½p

SOLID STATE VARIABLE A.C VOLTAGE REGULATORS



Compact and panel mounting. Ideal for control of lamps, drills, electrical appliances etc. Input 230/240v. A.C. Output continuously variable from 20v—230v. Model MR 2305 5 amp 68 x 46 x 43mm £8·37½. Model MR 2310 10 amp 90 x 68 x 60mm £11·97½. Postage 12½p.

MULTIMETERS *for EVERY purpose!*

TECH PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000V. A.C. and D.C. 0/1/100/500mA. D.C. 0/100K. £1·97½. P. & P. 12½p.

HONOR TE.10A. 20k Ω/Volt 5/25/50/250/500/2,500 v. D.C. 10/50/100/500/1,000 v. A.C. 0/50uA/2.5mA/250mA D.C. 0/6K/6 meg. ohm. −20 to +22 dB. 10–0, 100 mfd. 0.100–0.1 mfd. £3·47½. P. & P. 15p.

MODEL TE-200 20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000 V.D.C. 0/10/50/250/1,000 V.A.C. 0/50 uA/250 mA. 0/60K/6 megΩ. −20 to +62 db. £3·75. P. & P. 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. 0/30uA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. ohm −20 to +63 db. £5·97½. 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. 1/2·5/10/25/100/250/500/1,000v. A.C. 0/50µA/5/50/500mA. 12 amp. D.C. 0/60K/6 Meg./60 MegΩ. £8·87½. Post paid.

MODEL TE-80. 20,000 O.P.V. 0/10/50/100/500/1,000v A.C. 0/5/25/50/250/500/1,000 v. D.C. 0—50uA. 5/50/500mA. 0/6K/60K/600K/6meg. £4·87½. P. &P. 15p.

MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200v. D.C. 0/6/30/120/600/1,200v. A.C. 0/30uA/3/30/300mA. 0/16K/160K/1.6M/16 MegΩ. £5·50. P. & P. 15p.

MODEL TE-90 50,000 O.P.V. Mirror scale, overload protection. 0/3/12/60/300/600/1,200 v. D.C. 0/6/30/120/300/1,200 v. D.C. .03/6/60/600mA. D.C. 16K/160K/1.6/16 MEGΩ. −20 to +63 db. £7·50. P. & P. 15p.

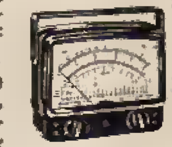
TMK MODEL TW-50K 46 ranges, mirror scale. 50K/Vol. D.C. 5K /Volt A.C. D.C.: Volts .125, .25, 1.25, 2.5, 5, 10. 25, 50. 125, 250, 500, 1000V. A.C. Volts: 1.5, 3, 5, 10, 25. 50, 125, 250, 500, 1000V. D.C. Current: 25, 50uA, 2.5, 5, 25. 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEGΩ. Decibels: −20 to +81·5 dB. £8·87½. P. & P. 17½p.

TMK MODEL TW-20CB FEATURES RESETTABLE OVERLOAD BUTTON. Sensitivity: 20KΩ/Volt D.C. 5KΩ/Volt A.C. D.C. Volts: 0–0.5, 2.5, 10, 50, 250, 1,000V. A.C. Volts: 0–2.5, 10, 50, 250, 1,000V. D.C. Currents: 0–0.05, 0.5, 5, 50, 500mA. Resistance: 0–5K. 50K. 0–500K. 5 MEGΩ. Decibels: −20 to +52 db. £11·50. P. & P. 17½p.

TE-900 20,000 Ω/VOLT GIANT MULTIMETER. Mirror scale and overload protection. 6in. full view meter. 2 colour scale. 0/2.5/10/250/1,000/5,000 v. A.C. 0/25/12.5/10/50/250/1,000/5,000 v. D.C. 0/50uA/110/100/500mA/10 amp. D.C. 02K/200K/20 MEG. OHM. £15. P. & P. 25p.

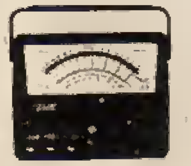
MODEL AS-100D. 100KΩ/Volt. 5in., mirror scale. Built-in meter protection 0/3/12/60/120/300/600/1,200 v. D.C. 0/6/30/120/300/600 v. A.C. 0/10uA/6/60/300MA/12 Amp. 0/2K/200K/2M/200MΩ. −20 to +17 bB. £12·50. P. & P. 17½p.

MODEL 5025. 57 Ranges, Giant 5½in. Meter, Polarity Reverse Switch. Sensitivity: 50K /Volt D.C. 5K /Volt A.C. D.C. Volts: .125, .25, 1.25, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.C. Volts: 1.5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.C. Current: 25, 50uA, 2.5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 2 K, 10K, 100K, 1MEG, 10 MEGΩ. Decibels: −20 to +85 db. £12·50. P. & P. 17½p.



TMK LAB TESTER. 100,000 O.P.V. 6½in. Scale Buzzer Short Circuit Check. Sensitivity: 100,000 O.P.V. D.C. 5K Ω/Volt A.C. D.C. Volts: .5, 2.5, 10, 50, 250, 1,000 V. A.C. Volts: 3, 10, 50, 50, 250, 500, 1,000V. D.C. Current: 10, 100uA, 10, 100, 500mA, 2.5, 10 amp. Resistance: 1K, 10K. 100K, 10MEG, 100 MEGΩ. Decibels: −10 to 49 db. Plastic Case with Carrying Handle. Size 7½in. x 6¾in. x 3¼in. £18·90. P. & P. 25p.

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. £5·97½. P. & P. 17½p.



SKYWOOD SW-500 50KΩ/Volt. Mirror scale DC Volts 0.6/3/12/30/300/600. DC Current 20uA/6/600mA Resistance 10K/100K/1 Meg/10 Meg. Decibels — 20 to +57 db. £7·50. P. & P. 15p.

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. £6·97½. P. & P. 15p.

270° WIDE ANGLE 1mA METERS

MW1-6 60mm square £3·97½
MW1-8 80mm square £4·97½
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"YAMABISHI" VARIABLE VOLTAGE TRANSFORMERS

Excellent quality . Low price . Immediate delivery

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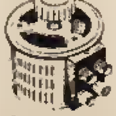
Bench Mounting

1 Amp	£5·50
2.5 Amp	£6·75
5 Amp	£9·75
8 Amp	£14·50
10 Amp	£18·50
12 Amp	£21·00
20 Amp	£37·00



MODEL S-260 B
Panel Mounting

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2.5 Amp	£6·62½

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INPUT 230 VOLTS,
50/60 CYCLES,
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0–260 VOLTS.
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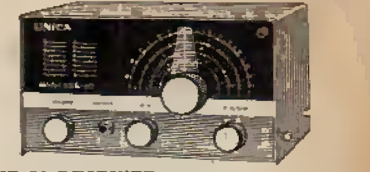


UNR-30 RECEIVER
4 Bands covering 550kc/s–30mc/s. B.F.O. Built-in Speaker 220/240v. A.C. Brand new with instructions. £15·75. Carr. 37½p.

WS62 TRANCEIVERS
Large quantity available for EXPORT! Excellent condition. Enquiries invited.

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. 12¾" x 4½" x 7". Brand new with instructions. £25. Carr. 37½p.

LAFAYETTE HA-600 SOLID STATE RECREIVE

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" x 9¼" x 8¼". 18 lbs. 220/240v. A.C. or 12v. D.C Brand new with instructions. £45. Carr. 50p.

LAFAYETTE HA-800 SOLID STATE AMATEUR COMMUNICATION RECEIVER

3.5–4, 7–7.3, 14–14.35, 21–21.45, 28–29.7 50–54 mc/s. Dual conversion, 2 mech. filters, product detector, variable BFO, S Meter, 100kc/s calibrator. 220/240v. A.C. or 12v. D.C. 15" x 9¼" x 8¼" 18 lbs. Brand new with instructions. £57·50. Carr. Paid. (100kc/s Crystal £1·97½ extra.)

FULL RANGE OF TRIO EQUIPMENT IN STOCK

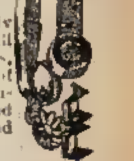
CLASS D WAVEMETERS

A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6 volts D.C. Ideal for amateur use. Available in good used condition. £5·97½. Carr. 37½p. Or brand new £7·97½. Carr. 37½p.

VOLTAGE STABILISER TRANSFORMERS
180—260v. input. Output 230v. Available 150w or 225w. £12·50. Carr. 25p.

EDDYSTONE VHF RECEIVERS Model 770R 19—165 Mc/s. Excellent condition. £150

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM



Operative over amazingly long distances. Separate call and press to talk buttons, 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets.
£6·97½. P. & P. 17½p.

INTERCOM/BABY SITTER

Transistorised Incoms, ideal for home / office / workshop, etc. 2-way buzzer call system. For desk or wall mounting. Supplied complete with connecting wire, batteries, instructions, 2 station £2·97½. P. & P 12½p. 4 station £6·62½. P. & P. 25p.

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PRACTICAL WIRELESS

VOL 46 NO 12
Issue 770

APRIL 1971

TOPIC OF THE MONTH

Servicemen all

THIS MONTH readers might feel that the issue is heavily weighted in favour of test instruments, for not only do we have a special 8-page supplement on the subject but two major supporting articles describe the construction of test instruments. Our excuse is that apart from readers who enjoy trying their luck at repairing the family radio set, many others get bitten harder by the servicing bug and relish the challenge of tracing faults and the satisfaction of a successful repair. No doubt about it, the acquisition of the ability to probe around inside a piece of equipment and come up with the right answers, works wonders for self esteem!

The idea behind the supplement this month is to provide a broad survey of the test instrument scene, examining the features of the various items of equipment and outlining their applications. This will be followed in the May issue by the first of a brand new series of articles on radio and audio servicing conducted by those two old PW favourites Gordon J. King and H. W. Hellyer, voted for previous efforts in this field as top of the work bench pops.

But servicing is really only one side of the coin, because everyone—from the absolute novice upwards—needs some test equipment, even if this consists solely of a cheap test meter, or a battery and bulb to make continuity checks! It is fairly safe to say, therefore, that constructors alike from novice to expert, experimenters as well as dabblers and professionals in servicing should have some knowledge of fault finding techniques. But in order to carry out logical fault finding it is necessary to have a reasonable theoretical grounding—somewhat of a vicious circle. The new series starting next month will, we hope, be helpful in providing a foothold for readers wanting to take a more active part in servicing activities.

W. N. STEVENS—*Editor*

P.W. COVER PRICE

Owing to the rising costs of production, it has been necessary to increase the cover price of Practical Wireless to 20p (4s. 0d) with effect from the next, May, issue. Much as we regret this increase, it has been made inevitable by the hard economic facts of publishing in these days of spiraling prices.
Existing subscriptions will, of course, continue to run out to their normal expiry date. The new subscription rate will be £2·65 per annum.

NEWS AND COMMENT

CONSTRUCTIONAL

OTHER FEATURES

SPECIAL FEATURE

MAY ISSUE WILL BE PUBLISHED ON APRIL 8th

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

1971 R.S.G.B. President

At a reception held at the Bonnington Hotel, London, on 15th January, F. C. Ward G2CVV, Secretary of Derby and District Amateur Radio Society, was installed as president of the Radio Society of Great Britain. Over 150 guests attended the function, including J. Swinnerton G2YS, J. Graham G3TR, V. Desmond G5VM, W. A. Scarr G2WS, A. O. Milne G2MI, P. Hawker G3VA, W. Corsham G2UV, A. Forsyth G6FO, T. Hughes G3GVV, and L. Newnham G6NZ. Also present were representatives of the Ministry of Posts and Telecommunications, and 20 visitors from Derby including Mr. A. G. G. Melville, president of Derby and District Amateur Radio Society, and his wife.

The Mayor of Derby, Alderman Miss M. E. Grimwood-Taylor (whose father was a founder member of the Derby society) sent Mr. Ward her congratulations and best wishes.

Mr. Ward is employed by the Post Office Engineering Department, and at present is in the Radio Investigation Service. He is keenly interested in the history of amateur radio, and mainly through his efforts, Derby and District Amateur Radio Society (the oldest such society in the country) has a comprehensive collection of documents and equipment from the early days of amateur radio.

In his speech at the reception, the new president expressed the hope that all members of the R.S.G.B. would endeavour to enrol at least one new member, the aim being to double the existing membership by the end of his year of office.

Mr. Ward's call-sign G2CVV was issued to him in 1937. He is active on all bands from 160m down to 2m, and, he says, would be interested in the higher frequencies if there were more hours in the day!

Rank and Dolby

Rank Wharfedale have released a small Hi-Fi cassette tape recorder. Based on the Dolby system, this recorder, the DC9, is a four-track stereo/mono machine with piano key controls. Price is £115.

It is felt by Wharfedale that the Dolby system together with other improvements have enabled the company to design a player with a performance as good or better than that of big and expensive machines.

North Devon A.R.C.

The above Club has recently been formed. Meetings are held the second and fourth Wednesday in every month at: Crinnis, High Wall, Sticklepath, Barnstable, North Devon. Meetings start at 7.30 but members wishing to study for the RAE should be there at 6.30. Further details may be obtained from *H. Hughes, G4LG, at the above address.*

Contestitus

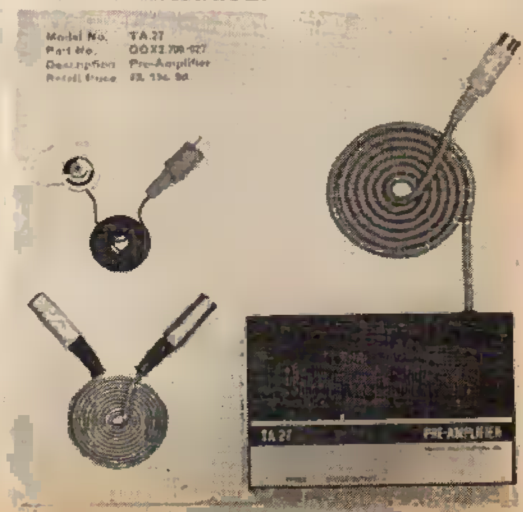
Those with "contestitus" will be pleased to note the following events for the mad month of March. March 6-7, ARRL DX contest (phone), 13-14 BERU contest, 20-21 ARRL contest (c.w.), 27-28 WPX s.s.b. contest. Don't forget to listen on April 4 in the low power 80 metre contest. It should bring out some transistor rigs who would appreciate a report.

Accessory guide

The British Radio Corporation has published a leaflet illustrating details of the wide range of accessories designed for use with BRC audio equipment.

There are nearly 30 different accessories in the range, including synchro-amps, pre-amps, slide synchronisers, mains adaptors for portable cassettes and radios, stethosets, footswitches, microphones, carrying cases and various connecting leads.

Each type of accessory is illustrated and a short description gives its applications. The picture shows a few of the accessories included.



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

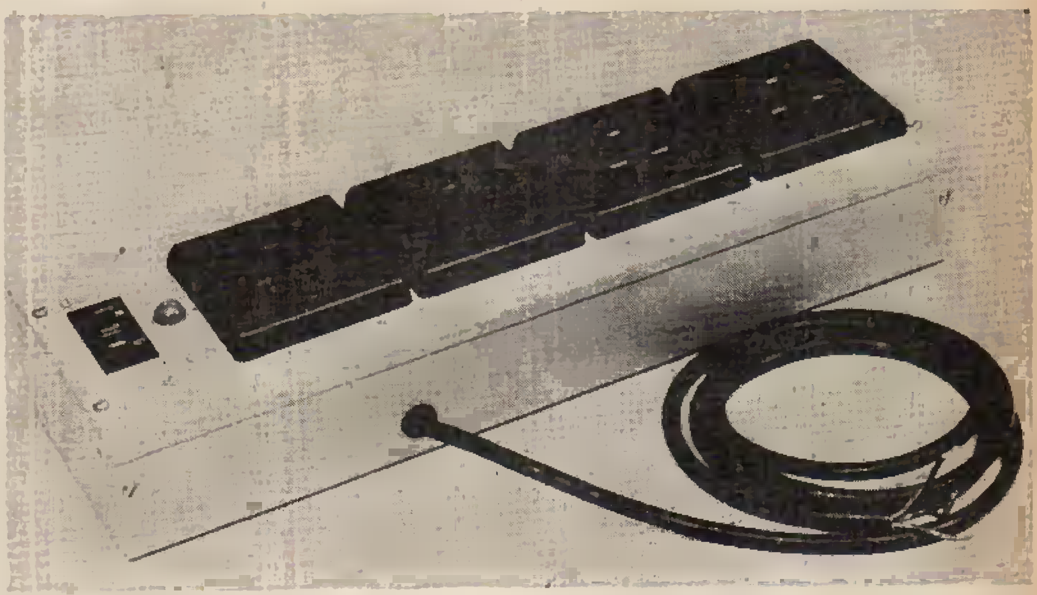
Price Drop

It certainly makes a change these days to hear of a reduction in prices, but this is exactly what Light Soldering Developments have done! Having recently relocated the production of their Litestat temperature-controlled soldering instruments in a new factory, they are now in a position to expand production and reduce costs.

They are therefore making reductions of 20% in the list price of both the Litestat 50 and Litestat 70 and spares including copper bits.

The Company are also introducing their new catalogue. In preparing this, they have taken the opportunity to incorporate details of all their products in one booklet using the A4 format (for our technical printing-type readers). Prices are shown in £sd and the new-fangled decimalised system and metric equivalents of all dimensions are given. Further gen from: *Light Soldering Developments Limited, 28 Sydenham Road, Croydon, CR9 2LL.*

Distribution Panel



A new, multi-socket mains distribution panel is now included in the Lektrokit range.

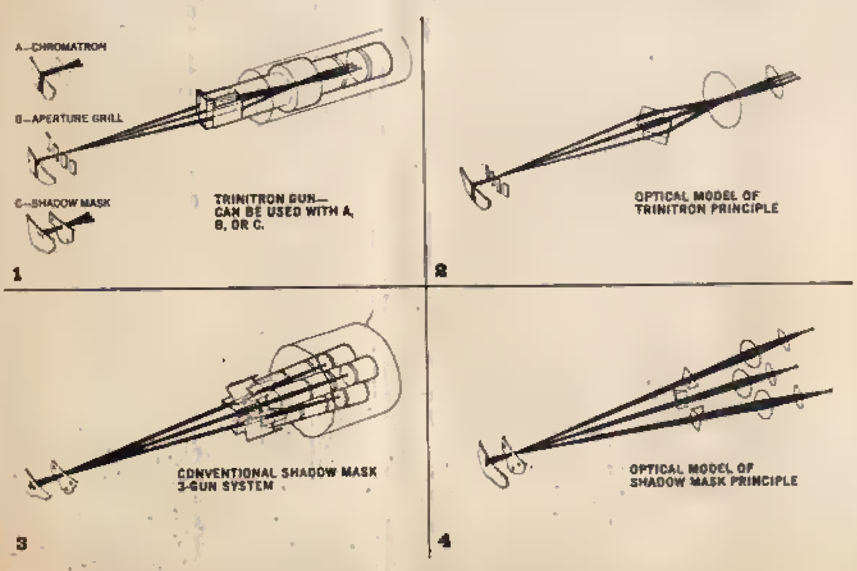
Designated the LKU-413, it consists of four, 3-pin, 13A shuttered outlet sockets, mounted side-by-side on the top of the unit, a combined on/off switch and magnetic circuit breaker, a red neon indicator and 6ft. of extension cable as standard.

Available direct from the manufacturers, the new unit is priced at £6.30 including purchase tax. If required, the panel can be supplied with 30ft. of cable (LKU-413L) at an inclusive price of £6·97½. *A.P.T. Electronic Industries Ltd., Chertsey Road, Byfleet, Surrey.*

Sony mini-colour TV.

The Sony Corporation of Japan are introducing a transportable colour TV set (Model KV-1320UB) using their Trinitron colour c.r.t. Price is £199.75 and screen size is 13in. The Trinitron tube has only one electron gun against three of a conventional Shadowmask tube. This gun emits three simultaneous in-line beams which are converged and focused through the Trinitron electro-optical system consisting of two large diameter lenses and a pair of electron prisms. An aperture-grill is mounted behind the screen and takes the place of the Shadowmask used in conventional tubes.

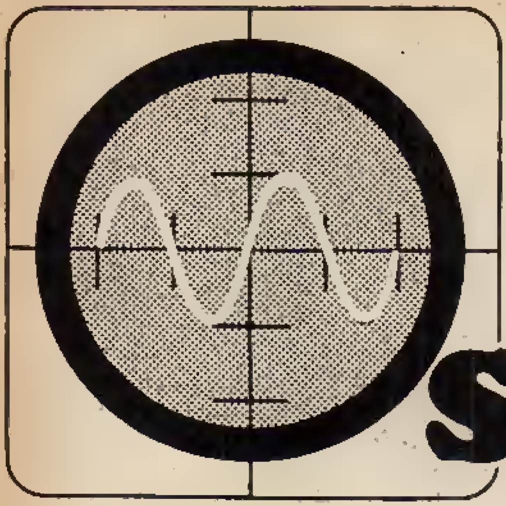
A description of the Trinitron tube appeared in the September 1970 issue of our sister magazine *Television*.



Diagrammatic representation of the Trinitron principle compared with that of the Shadowmask system.

Sony KV-1320UB Trinitron colour TV.

A. LESTER-RANDS



PW WORKSHOP Oscilloscope

PART 1

ON examining the circuit for the workshop oscilloscope, readers may wonder why valves have been used for the P.W. Workshop Oscilloscope. First of all, a cathode ray tube requires a heater voltage and high h.t. potentials for which a suitable mains transformer is necessary. It was found that as the requirements for the specified c.r.t. could be met with a fairly inexpensive standard 350-0-350v (plus heater windings) mains transformer, which would also provide potentials and heater supplies for a valve timebase and Y amplifier, there was little point in using transistors for a job which valves would do just as well and at no extra cost.

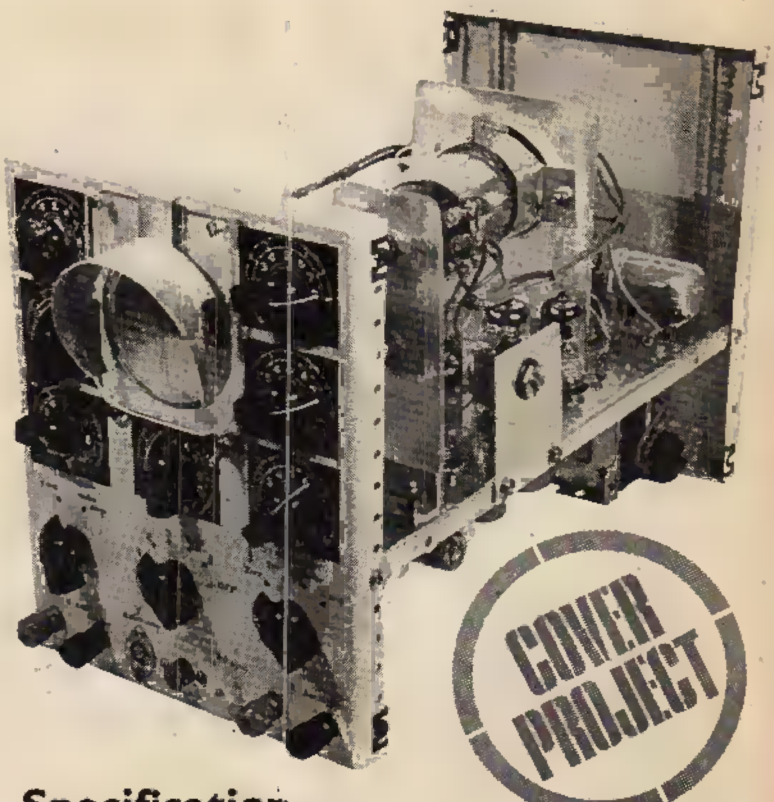
Most low cost general purpose oscilloscopes presently available use valves and as far as cost is concerned, the P.W. Workshop Oscilloscope can be built for much less than a commercially made equivalent.

CIRCUIT FUNCTION AND FACILITIES

The P.W. Oscilloscope is intended for general workshop use and is suitable for all audio work and many r.f. applications up to frequencies of at least 2MHz at which the main Y amplifier response is −3dB but extends up to nearly 5MHz. The fastest timebase speed allows the resolution and display of several complete cycles at frequencies around 1MHz and the slowest speed will allow the display of several complete cycles at frequencies as low as 10Hz.

The main Y amplifier has an input sensitivity of 250mV r.m.s. for a display of 4cm peak-to-peak (sine wave) and a nominal frequency response of 10Hz to 2MHz. The Y preamplifier has an input sensitivity of 10mV for a display of 4cm peak-to-peak (sine-wave) and a frequency response of 10Hz to 50kHz ±1dB. This additional stage to the Y amplifier chain is to provide adequate signal display from low level signal sources. The gain of the Y amplifier is continuously variable, regardless of which input is used, and each of the inputs have relatively large overload margins. The gain of the Y amplifier has been adjusted, in the relationship to the c.r.t. sensitivity, so that the final amplifier stage reaches clipping point after full Y plate deflection.

The timebase is a Miller-transitron circuit with its own sync amplifier that can be switched for internal or external signals. Each timebase range is continuously variable and each overlaps. The timebase can be switched off and the sync selector switch used to provide a small 50Hz sweep (internal signal source) or select a separate X plate amplifier with its own



Specification

Frequency Responses

Y amplifier	10Hz to 2MHz
Y preamplifier	10Hz to 50kHz
X amplifier	10Hz to 50kHz
Timebase frequency	10Hz to 24kHz

Input Sensitivities

Y amplifier	4cm deflection for 250mV
Y preamplifier	4cm deflection for 10mV
X amplifier	4cm deflection for 1·5V

(Deflection peak-to-peak, volts in r.m.s.)

Controls

1. Y amp. gain
2. Timebase Function
3. Y preamp. in/out
4. Timebase sweep
5. Timebase fine sweep
6. Timebase amplitude
7. Brilliance
8. Focus
9. Y shift
10. X shift

Timebase Ranges

1. 10–50Hz
2. 30–270Hz
3. 90–800Hz
4. 500–4,500Hz
5. 2,700–24,000Hz
6. Off.

Valve Lineup

C.R.T. CV1526 (3EG1), 3-off EF80's, ECC81, ECC83, ECF80.

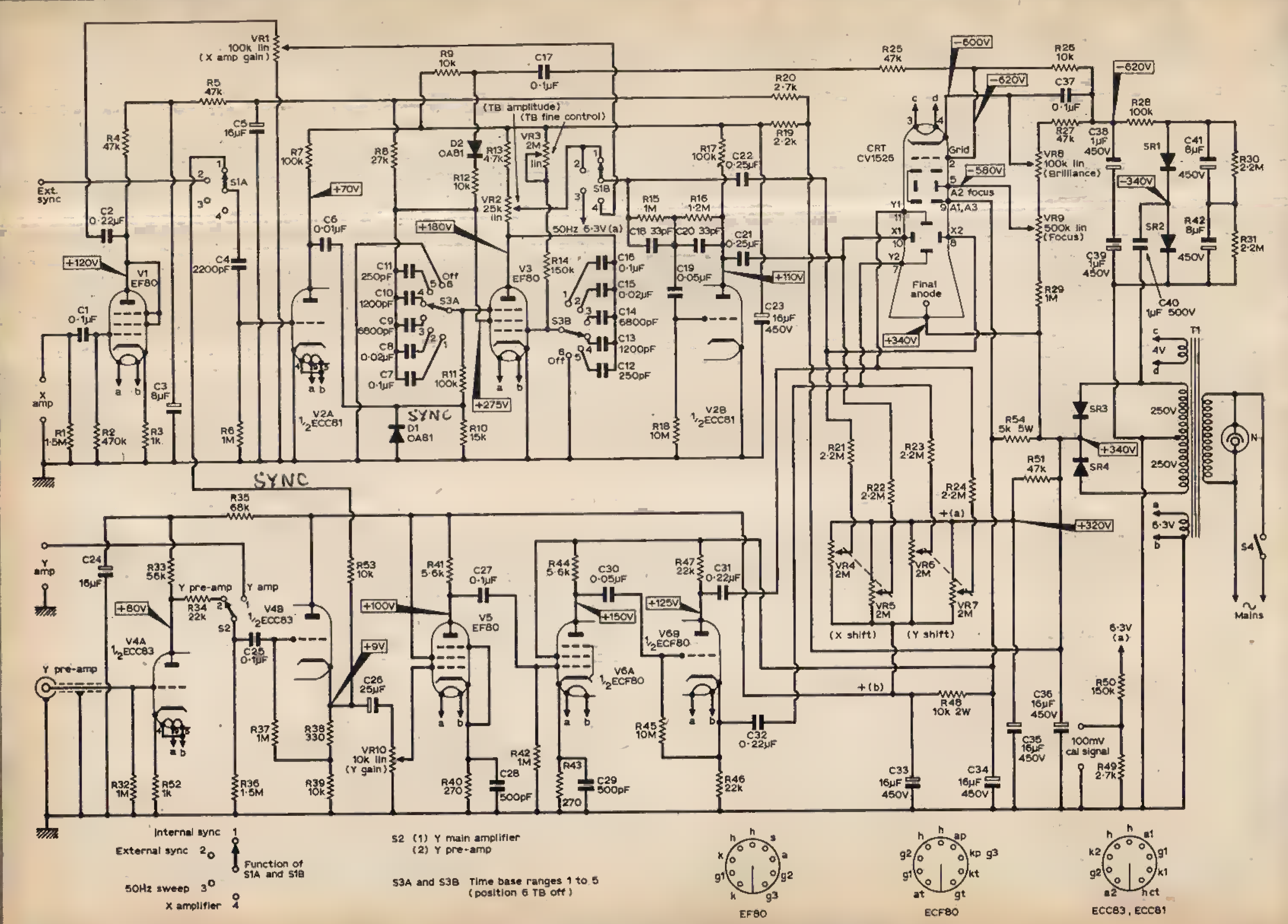


Fig. 1: The complete circuit of the P.W. Workshop Oscilloscope.

★ components list

Case as used for prototype
Contil type Q 13 x 9 x 7in. West Hyde Developments Limited

Cathode Ray Tube
Type CV1526 (3EG1) — Henry's Radio or
2½in. screen. Green trace — RST Valve Company
12-pin B12B Base — P.C. Radio Limited
(Price should be around £3·25)

CRT Base
12-pin B12B (suppliers as above)

Mains Transformer T1
230V pri-Sec. 350–0–350V 80mA
Heaters 6·3V and 4V Type MT2 Home Radio (Catalogue No. TM2)

Rectifiers (SR1, 2, 3 and 4)
SR1, 2, 3 and 4 Type 1N2374 Silicon Henry's Radio Limited

Valveholders
B9A 9-pin (6 off)

Valves

V1, V3, V5	EF80	Mullard
V2A-B	ECC81	Mullard
V4A-B	ECC83	Mullard
V6A-B	ECF80	Mullard

Diodes

D1, D2	OA81	Mullard

Switches

S1A-B	2-pole 4-way
S2	Single pole 2-way
S3A-B	2-pole 6-way
S4	Mains on/off toggle type

Potentiometers

VR1	100kΩ lin.	VR8	100kΩ lin.
VR2	25kΩ lin.	VR9	500kΩ lin.
VR3	2MΩ lin.	VR10	10kΩ lin.

VR4/5 } 2MΩ (Dual Potentiometers) Home Radio
VR6/VR7 } (Catalogue No. VR78/2M)

Resistors ¼W 10%

R1	1·5MΩ	R14	150kΩ	R27	47kΩ	R40	270Ω
R2	470kΩ	R15	1MΩ	R28	100kΩ	R41	5·6kΩ
R3	1kΩ	R16	1·2MΩ	R29	1MΩ	R42	1MΩ
R4	47kΩ	R17	100kΩ	R30	2·2MΩ	R43	270Ω
R5	47kΩ	R18	10MΩ	R31	2·2MΩ	R44	5·6kΩ
R6	1MΩ	R19	2·2kΩ	R32	1MΩ	R45	10MΩ
R7	100kΩ	R20	2·7kΩ	R33	56kΩ	R46	22kΩ
R8	27kΩ	R21	2·2MΩ	R34	22kΩ	R47	22kΩ
R9	10kΩ	R22	2·2MΩ	R35	68kΩ	R49	2·7kΩ
R10	15kΩ	R23	2·2MΩ	R36	1·5MΩ	R50	150kΩ
R11	100kΩ	R24	2·2MΩ	R37	1MΩ	R51	47kΩ
R12	10kΩ	R25	47kΩ	R38	330Ω	R52	1kΩ
R13	4·7kΩ	R26	10kΩ	R39	10kΩ	R53	10kΩ

All resistors 10% ¼Watt

Resistors (Special)

R54	5kΩ 5watt
R48	10kΩ 2watt

Capacitors (special)
C40 1μF paper type—500/600V working Home Radio

Capacitors

C1	0·1μF	C15	0·02μF	C29	500pF S.M.
C2	0·22μF	C16	0·1μF	C30	0·05μF
C3	8μF 350V	C17	0·1μF	C31	0·22μF
C4	2200pF	C18	33pF S.M.	C32	0·22μF
C5	16μF 350V	C19	0·05μF	C33	16μF 450V
C6	0·01μF	C20	33pF S.M.	C34	16μF 450V
C7	0·1μF	C21	0·25μF	C35	16μF 450V
C8	0·02μF	C22	0·25μF	C36	16μF 450V
C9	6800pF	C23	16μF 450V	C37	0·1μF
C10	1200pF S.M.	C24	16μF 350V	C38	1μF 450V
C11	250pF	C25	0·1μF	C39	1μF 450V
C12	250pF S.M.	C26	25μF 50V	C41	8μF 450V
C13	1200pF	C27	0·1μF	C42	8μF 450V
C14	6800pF	C28	500pF S.M.		

Note: C33/C34—may be dual type capacitors
C35/C36—may be dual type capacitors
All other electrolytics must be singles and all capacitors 350V working min.
S.M.—Silvered Mica

Miscellaneous items
- Terminals 2 red, 2 black (X and Y inputs) insulated type
- Sockets (insulated) 2 for sync and cal. voltage
- Socket Recessed co-axial type
- Pointer knobs 10 off
- Mains panel neon indicator 230V
- Insulated spindle couplers (focus and brilliance controls) 2 off
- 2–18 way and 4–10 way miniature tagboards 1½in. wide
- Aluminium 18 swg for screen etc.
- Aluminium angle ⅜ x ⅜in.
- Paxolin or perspex ⅛in. thick for brilliance and focus controls
- Sundry capacitor clips and chassis tag strips
- 1 6-way standard tagboard 2in. wide

(pre-set) gain control. This latter facility is extremely useful for Lissajous pattern work over a wide frequency range and with low signal levels. The X amplifier sensitivity is 1·5V rms for a 4cm peak-to-peak (sine-wave) display and the frequency response is 10Hz to 50kHz ±1dB.

CONTROLS

The timebase controls include a selector for the five timebase ranges plus a timebase 'off' position, a timebase fine frequency control and a timebase amplitude control. The 'sync' switch selects either internal or external synchronizing signals, a 50Hz X sweep of about 1·5cm, or the X plate amplifier. Brilliance and focus controls are provided, of course, and there are controls for X and Y shift with sufficient shift potential to move the trace vertically or horizontally to beyond the edge of the c.r.t. screen. The Y amplifier gain control is common to both Y inputs and is a front panel control but the X amplifier gain control is a pre-set mounted at the side. It can be easily adjusted with a screwdriver.

THE CATHODE RAY TUBE

Cathode ray tubes of currently available manufacture and type are quite expensive and are also difficult to buy because the demand is so low that few component dealers will keep them in stock. The tube chosen for the workshop oscilloscope is a type CV1526 (3EG1) which is readily available at low cost (see components list) and has a 2½in. diameter screen.

It operates with a final anode potential of approximately 1,000V and displays a green trace. *It should be emphasised that the workshop oscilloscope has been virtually designed around this c.r.t. and that the use of any other type is not recommended.*

THE CIRCUIT

The full circuit for the oscilloscope is shown in Fig. 1. E.H.T. for the tube final anode is derived from a voltage doubler arrangement (SR1-SR2) operated from one half of the secondary of T1, the 600V or so d.c. obtained from this being connected in series with the nominal 350V supply (SR3-SR4) to obtain the required total 1,000V or so. The 350V supply from SR3-SR4 provides the working potentials for the timebase, the X and Y amplifiers and the shift controls. The timebase generator, V3, is a conventional Miller-transitron arrangement and is followed by a paraphase amplifier, V2B, to provide balanced sweep voltages for the X plates. The timebase frequency ranges, each of which overlaps the other, are selected by S3A and B and the total frequency range is approximately 10 to 24,000Hz. Fine timebase frequency control is obtained by VR3 and amplitude by VR2. Synchronizing signals for the timebase can be supplied from either the Y amplifier at the cathode of V4B, or from an external source via the 'sync' switch S1A and B. This also selects the internal 50Hz X sweep voltage from the 6·3V heater supply or switches in the X plate amplifier V1.

The main Y amplifier is preceded by a cathode follower (V4B) which provides a high impedance input and low impedance output via the gain control VR10. The Y amplifier itself consists of V5 and V6A the output of which is terminated by the phase splitter V6B. This delivers symmetrical paraphased signals to the Y plates via the isolating capacitors C31 and C32. For low level signals the additional Y amplifier stage (V4A) is provided and this has an input sensitivity of 10mV for 4cm peak-to-peak deflection.

The c.r.t. operates at a potential of approximately 1,000V between cathode and the final anode. The potential dividing chain R27, VR8, VR9 and R29 provides the brilliance and focus control voltages. The grid of the c.r.t. is returned to the cathode via R26 but is also connected via C17 to obtain a negative going pulse for trace flyback suppression.

The X and Y plates are both connected to the shift potential networks VR4, VR5, VR6 and VR7, etc. via high value series resistors (R21, R22, R23, R24) so that no loading is imposed on either the X or Y plates or their respective amplifier outputs. The shift potential developed across VR4, VR5, VR6 and VR7 at the points marked +a and +b is approximately 200V and is sufficient to move the trace vertically or horizontally completely off the tube screen. A 100mV 50Hz calibration signal is derived from the 6·3V heater supply via the potential divider R49/R50.

PERFORMANCE

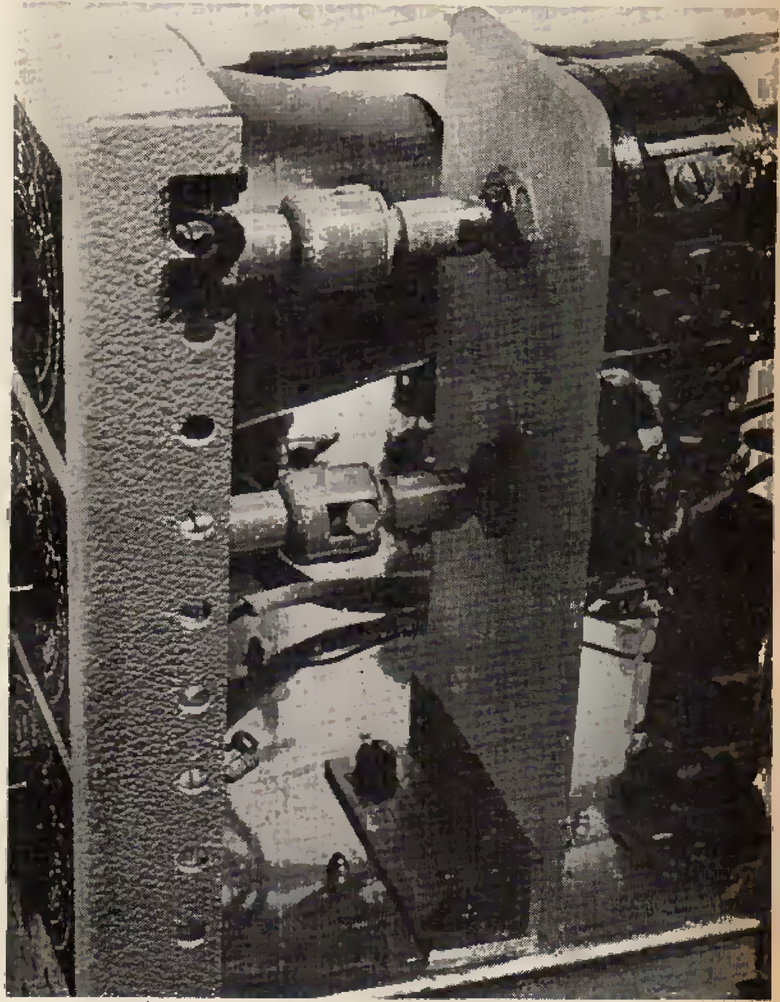
The workshop oscilloscope will cater for all normal audio tests including square-wave testing, frequency measurement by the Lissajous pattern method over a wide range of frequencies and signal levels and has many general "electronics" radio and video frequency applications. The Table gives details of the performance obtained with the prototype and which should be easily obtainable from the circuit shown in Fig. 1, providing the specified c.r.t. and other components are used.

X SWEEP

With the tube E.H.T. at 1,000V the brilliance is sufficient for photography and the trace focus is sharp. It is worth noting that no spurious spot deflection due to mains transformer field was discernible and providing the transformer specified is used and positioned below and to the rear of the c.r.t. as will be shown later, it should be quite unnecessary to provide mumetal shielding. With the timebase range control switched to 'off' and with the Y amplifier gain control at zero, the spot should appear completely round and sharp and not more than 1mm in diameter at normal brilliance. Note also that with the X and Y shift controls at exactly half way travel the spot should be at the centre of the screen.

CONSTRUCTION

The prototype was constructed exactly in accordance with the circuit given in Fig. 1 and as shown in the photographs, in a Contil case type Q (see components list). This has overall dimension of 13×

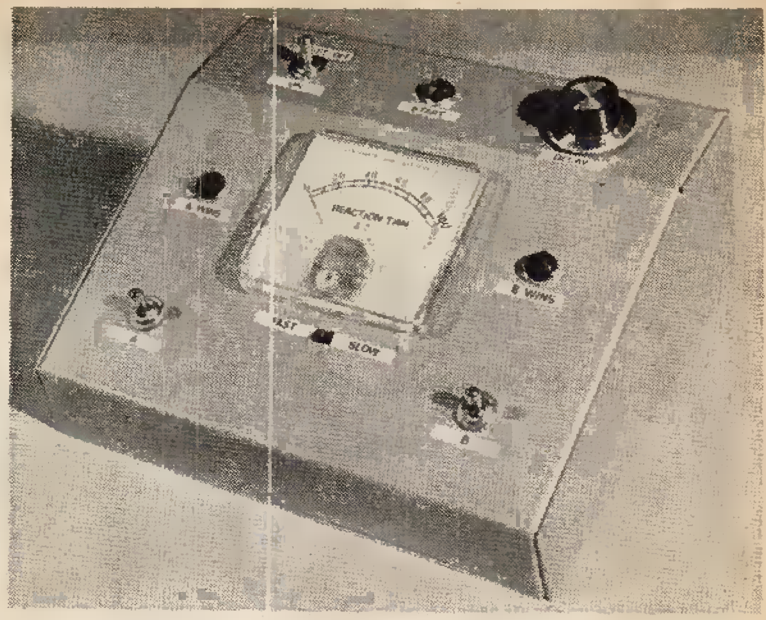


The insulated supporting bracket and insulated spindles for the focus and brilliance controls.

9×7in and is supplied with an internal chassis on which the c.r.t., the power supply and amplifier components and valves are mounted. A home constructed case of similar dimensions could of course be used. Construction also calls for an internal screen which supports the tagboards for the amplifier and timebase components, supporting brackets for the c.r.t. and the X amplifier gain control and a bracket of insulating material (paxolin or perspex) for mounting the brilliance and focus controls. Full details for construction and layout will be given in Part 2.

TO BE CONTINUED

RATE YOUR REFLEXES



HALVOR MOORSHEAD

THE project described here has several uses. It will do as the title says: "Rate Your Reflexes"—but it also enables you to test your reactions against those of other people. It can incorporate other tests including manual dexterity and it is a very effective "Drunkometer" which will prove to yourself—or to other people—just how much alcohol affects your reactions. There aren't many ways of arguing with the man who says "I'm perfectly safe on the road after eight pints, etc." but this device will show him just how much slower his reactions are *even after only a couple of pints*. The results will be there for him to see for himself.

It is often true that the simplest games and tests are the most fun and that certainly applies to the reaction tester described here. At parties it has proved a real winner. Rather like the fortune teller who is never short of customers because people always want to know something about themselves that only someone else can tell them, the reaction tester will tell people how their reactions or reflexes compare to the average. Unlike the fortune teller, however, this device is scientifically accurate to quite a high degree—you *yourself* determine the readings and they cannot be disputed. Once people have got the hang of it the reaction tester fascinates them.

The reaction tester has proved so popular that those who have tried it have devised all sorts of games and tests. Some of these are mentioned at the end of the article but no doubt many will occur to you.

Operation

There are two distinct ways of using the circuit. Firstly there is the competitive side—at a signal two "players" try to throw a switch as fast as possible, the one who is fastest is shown to be the winner by a second bulb lighting up above his switch. Even though the loser is a thousandth of a second behind the winner his bulb will fail to light and will not do so until the winner's switch is reset.

The competitive side can be built separately and will provide plenty of fun for very much less cost, but it does have limitations—it will only tell you who is the fastest of two players but no indication of the differences in their speeds and you cannot use it without another player.

The timer part of the circuit is additional and works as follows. As soon as the start signal bulb lights up, the needle of a meter starts to rise—and rise quickly—taking about a second to traverse the scale. As soon as the switches are thrown the needle stops and stays in the same position so that a reading can be taken of the time lapse between the "start signal" and the winner throwing the switch. It will of course only give the reading for the winner.

A considerable amount of thought was given to including a "cheat" device, that is one which would light up a bulb or sound a hooter if either switch was thrown prematurely but so much trouble was experienced with this that it was decided to leave it to the end. To the author's delight it was discovered that a "cheat" circuit is actually built into the existing circuitry and this will be explained later.

Although it may be rather pretentious, you could call the finished project a simple computer for it includes computer type circuits and this claim, made to non-electronic friends, should impress them!

The Circuit

There are three distinct sections to the circuit and these will be explained separately. They are the "start signal", the "winner" circuit and the "time indicator."

The "start" signal circuit should ideally be operated independently of either competitor and also ideally one would use some form of random circuit. However random circuits are very complex and it would be impractical to use one here.

The next best thing—and perfectly satisfactory in

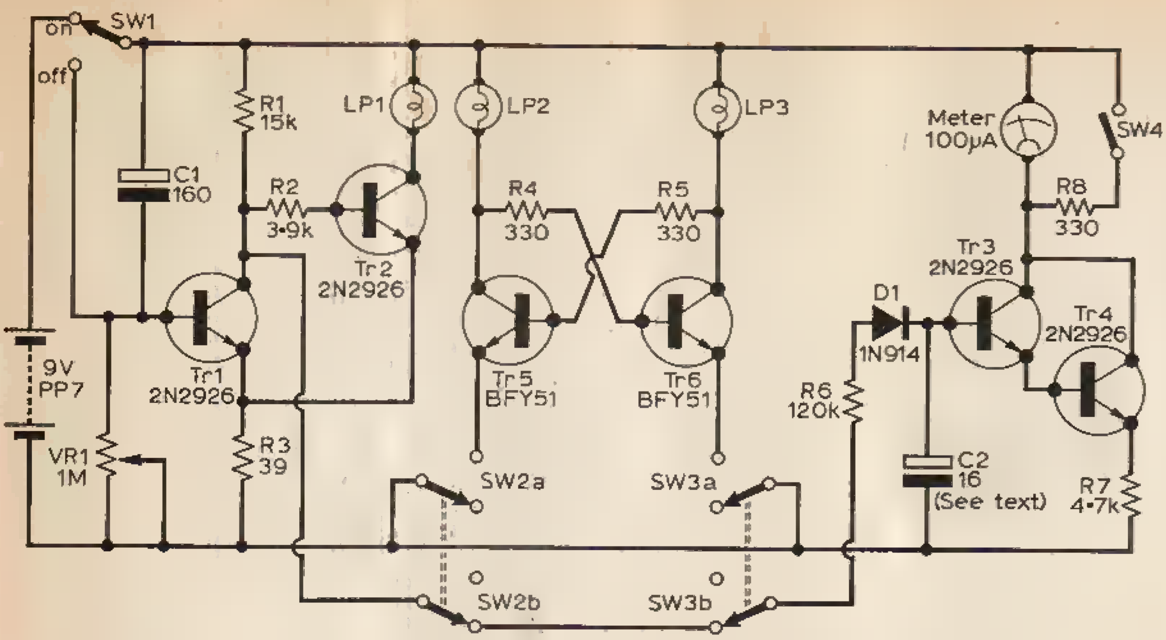


Fig. 1: The complete circuit of the Reaction Tester. Tr 1 and Tr 2 form the delay circuit which relies upon the charging of C1. Tr3 and TR4 are coupled as a Darlington pair to form the high input impedance timing circuit while Tr5 and Tr6 are part of the "winner" indicator circuit.

use—is to use a time delay circuit in which the delay is of sufficient length so that it is impossible to remember or estimate exactly when the "start" signal will trigger.

Tr1 and Tr2, together with the associated components, act as a time delay circuit, the delay varying between instant and about 12 seconds. A longer delay was originally included but it was found that delays of much more than about ten seconds served no real purpose and tests became boring. A period of 12 seconds when you are waiting for something to happen is a very long time indeed.

The "start" signal circuit makes use of a Schmitt Trigger—that is a circuit which can only be in two states, on or off, and the switching action is very fast indeed.

Referring to Fig. 1, when SW1 is thrown to "on", C1 begins to charge through VR1. To begin with the potential across it is small—as it is charging—and therefore the base of Tr1, which is coupled to the junction of C1 and VR1, is at nearly supply potential and is switched fully on. This means that it is passing considerable current and the potential between the collector and emitter is very small. The base of Tr2 is coupled to the collector of Tr1 via a resistor R2 and the emitter joins directly to the emitter of Tr1.

When Tr1 is "on" the potential across it is so small that Tr2 will not have nearly enough potential between the base and emitter to be in a conducting state and will be completely "off" and the bulb LP1 will be off.

However, as C1 charges the potential across it increases and the base of Tr1 is moved slowly towards chassis potential until a point is reached when Tr1 approaches cut-off; this means that the potential across it rises and this in turn means that Tr2 starts to turn on. There is a regenerative action because of R3 and the switching action, once it starts, is very rapid. When Tr2 is on, current is allowed to flow through it and the bulb LP1 lights up.

The time delay will depend on the setting of VR1 and as mentioned this can be adjusted for any setting up to 12 seconds.

The values of R1, R2 and R3 are not over-critical for the operation of the bulb but their choice does affect the operation of the timer circuit which comprises Tr3 and Tr4 with their associated components.

When the "start" circuit is triggered the potential at the junction of R1 and R2 rises and capacitor C2 begins to charge through R6 and D1 and this in turn starts to bias on the high impedance circuit (the Darlington Pair) comprising Tr3 and Tr4 in which the current increases with the rise in voltage at the base of Tr3. Even before the "start" circuit has triggered there is of course a small potential at junction R1 and R2 and the capacitor will be charged but it is not enough to bias the Darlington pair into conduction.

As soon as either of the competitive switches are thrown the charging line is broken and C2 is no longer being charged.

As the input impedance of the meter circuit is very high—in the order of 100MΩ—so little current will be drawn from the capacitor that it can be

★ components list

Resistors

R1 15kΩ	R5 330Ω
R2 3·9kΩ	R6 120kΩ
R3 39Ω	R7 4·7kΩ
R4 330Ω	R8 330Ω

All resistors ¼W, 10%
VR1 1MΩ linear track potentiometer.

Capacitors
C1 160µF 12V or higher.
C2 16µF—10V, Mullard—see text

Semiconductors

Tr1 2N2926G	Tr5 BFY51
Tr2 2N2926G	Tr6 BFY51
Tr3 2N2926G	D1 1N914
Tr4 2N2926G	

Switches
SW1 2-way, 1-pole toggle
SW2 2-way, 2-pole toggle
SW3 2-way, 2-pole toggle
SW4 On/off slide switch

Miscellaneous

Meter	100µA, 3½in face—see text
Case	See text
LP1, 2 and 3 ..	6V, 40mA MES bulbs
Bulbholders ..	3 MES types
Battery	PP9, 9V.
Component Board	0·15in matrix plain Veroboard

ignored and so the meter continues to register a nearly true reading of the charge on the capacitor. This is of course proportional to the time which has elapsed between the light coming on and either of the competitive switches thrown.

The needle will rise very fast but, once stopped, will stay there. In fact the needle will fall very slowly due to the leakage of C2 and to a far lesser degree due to the current taken for Tr3, but the fall on the prototype was only about one division on the meter in ten seconds, a division being one fiftieth of full scale deflection.

The quality of the component used for C2 is important. One of the Mullard "Blue" range was used as these appeared to be very much better than imported types at holding the charge. Some Japanese components hardly held any charge at all, the leakage was so high. It is certainly worthwhile choosing a good component for C2 by experiment.

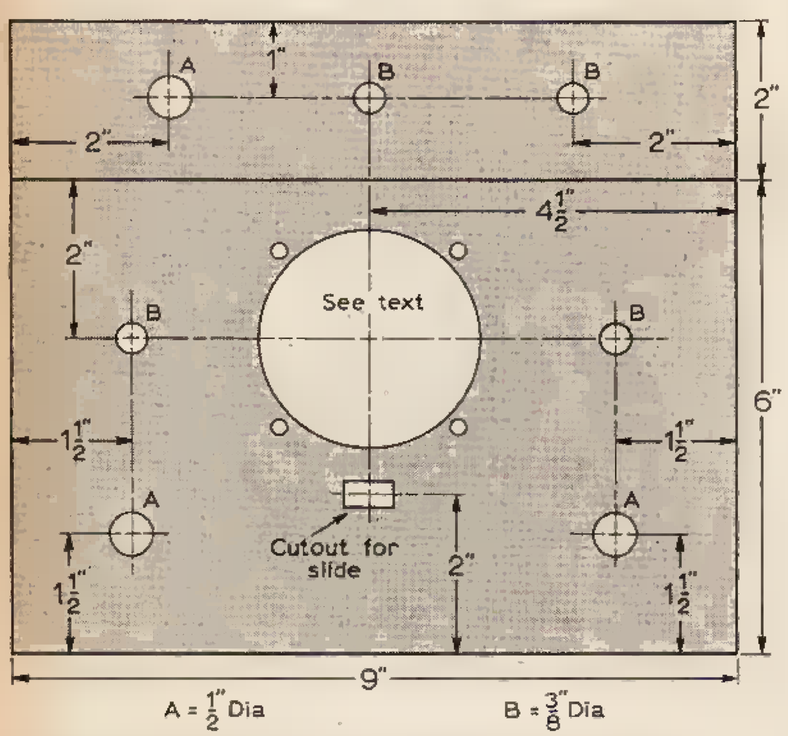


Fig. 2: The drilling of the face plate on the prototype. As can be seen from the heading photograph, this is angled.

R6 is included to set the rate of charge. A small slide switch and R8 are included to shunt the meter to give two scales of reading.

In the prototype the unshunted meter takes about a second to reach full scale deflection, the 330Ω shunt reduces the rise rates to 20% of the original. On the "slow" setting readings above 7 are far from linear but this does not really matter.

The slow rate is only needed for certain experiments since all the simple tests can be completed in under a second by most people.

The "winner" indicator circuit comprises Tr5 and Tr6 with associated components. Let us assume that the person with the most rapid reactions is on SW2. When this is thrown the emitter of Tr5 is connected to chassis and since the base circuit is biased via R5 and LP3, as soon as the circuit is completed by SW2 the transistor conducts and LP2 lights up. When the other person makes his switch, the emitter of Tr6 is connected to chassis but as Tr5 is in conduction and fully switched on the voltage across Tr5 is so small that there is not enough to bias the transistor on. It therefore remains off whatever the position of SW3. So it comes down to whoever completes the indicator circuit first messes it up for the other.

Since the circuit has already been broken between the Schmitt Trigger and the timing indicator, the additional break contributed by SW3b doesn't affect the operation and the timing indicator registers the winners time only.

Cheat Circuit

From the circuit it will be seen that LP2 and LP3 can be switched on regardless of whether LP1 is alight or not. However if this is done one of the bulbs LP2 or LP3 will light and will draw a fair amount of current and this is not only taken from the battery but also from the charging timing capacitor C1 to a small degree. This has the effect of triggering the Schmitt circuit and LP1 will light. But since the line connecting the junction of R1 and R2 to R6 has been broken, the timing circuit will show no reading.

It could be claimed that this would given the same reading as for an instant reaction and this is true but the fastest reactions possible (I have it on good authority) are in the order of 1/10th of a second. If you believe that they are faster just try it. Not only does the cheat circuit work but it also shows who has cheated because of course their light is on!

Reset

Once a test has been completed it is necessary to discharge both capacitors C1 and C2 and this is done by switching off for about a second. SW1 is arranged so that it directly shorts out C1 while C2 will discharge through the base emitter circuits of Tr3 and Tr4.

C2, unlike C1, does not discharge instantly—it takes about half a second. If SW1 is thrown off and on again too quickly a small reading will still be shown on the meter.

Construction

There is available a very suitable case which might have been built for this very project; this is one of the "U" range marketed by H. L. Smith & Co. Ltd., of 287/9 Edgware Road, London W.2. The case, sized $9\frac{1}{4} \times 7\frac{1}{2} \times 3\frac{1}{2}$in., is silver hammered finished and costs £1·20 plus postage and packing.

The meter is one of the Henelec or S.E.W. types with a $3\frac{1}{4}$in. face and a large hole has to be cut in the sloping panel to hold it.

These meters are supplied in a cardboard box with a piece of card that acts as a perfect template for marking the size of the hole and the positioning of the mounting screws. A series of holes are drilled just inside the area marked out to remove the main aluminium and a file removes the rest.

SW2 and SW3 are mounted at the bottom left and bottom right respectively of the sloping panel; these can be marked "A" and "B" and the associated light mounted above them.

The start bulb is sited on the top "flat" with the Off-Reset/On switch and VR1 the delay potentiometer.

The two terminal contacts on the back of the meter provide a very suitable mounting for the component board and two holes should be drilled in this to enable it to be screwed on.

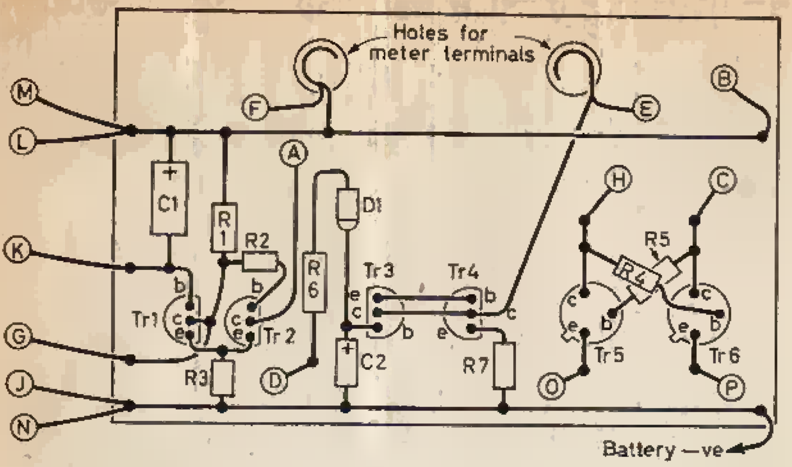


Fig. 3: The component layout on plain Veroboard. Note that Tr3 and Tr4 should read Tr5 and Tr6 and vice versa.

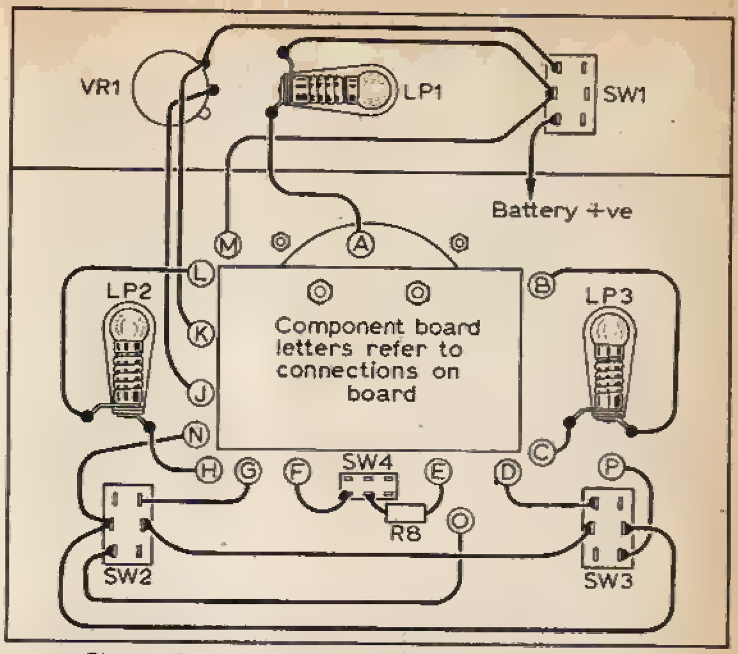
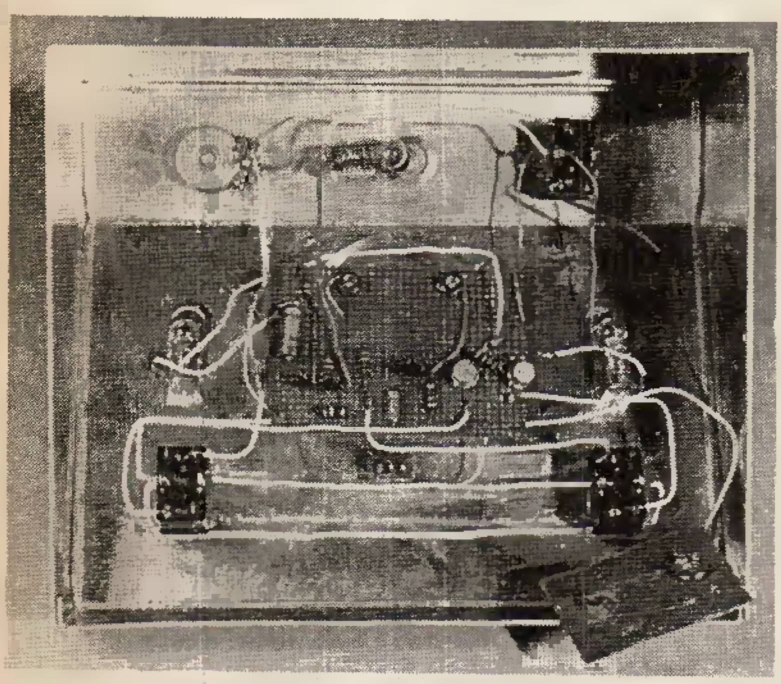
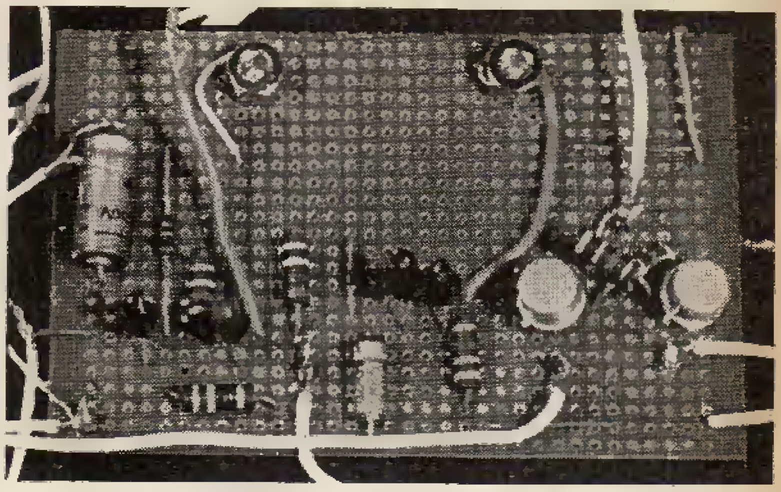


Fig. 4: The internal wiring of the reaction tester.



Compare this photograph with Fig. 4.



Closeup view of the component board. The meter terminals are visible at the top.

The component board is made from 0·15in matrix plain Veroboard and should be wired as shown in Fig. 3.

The wiring is shown in Fig. 4, the letters corresponding to the similar letter on the component board.

Using the Reaction Tester

It may be found on careful inspection that there is a very short delay between the bulb lighting and the needle starting to move. If this is so high that the fastest genuine reactions can be accomplished in the delay, the values of R1 and R2 should be experimented with. The delay is due to the voltage at the base of Tr3 having to reach a certain level before it begins to conduct.

The first tests can be done by yourself. With SW1 thrown to "on", switch either SW2 or SW3 as soon as the light comes on indicating "start". By the time you have thrown the switch a reading should have registered on the meter.

Try part-throwing the switch at the next test—that is, hold either SW2 or SW3 with such a pressure that the tumbler is just about to throw. This will remove as much of the mechanical delay (if one can call it that) as possible so that the time registered is only that of your reflexes. It will probably be found that this makes little difference. Then try having the hand that you are going to switch with flat on the table and only move it when the light comes on and note that reading.

One interesting point has been noticed on the prototype. If the unit has been off for a period of much over 20 minutes, the first reading will be much slower than subsequent ones. This is probably due to the electrolytics reforming. For this reason make sure that the first reading of a series is ignored.

If you leave the delay at one setting and try a series of tests you will find that both competitors get better as, even if the time delay is at maximum, they begin to estimate the starting signal and get ready for it.

Try to take a series of twenty readings, take the average and have a pint of beer. After ten minutes or so your reactions may show a slight improvement but after a second pint and a further series of tests the reactions will show a marked decline. During these original tests one player was so fascinated that he continued to take readings till he had drunk eight pints—at which point he was unable to find the switch!

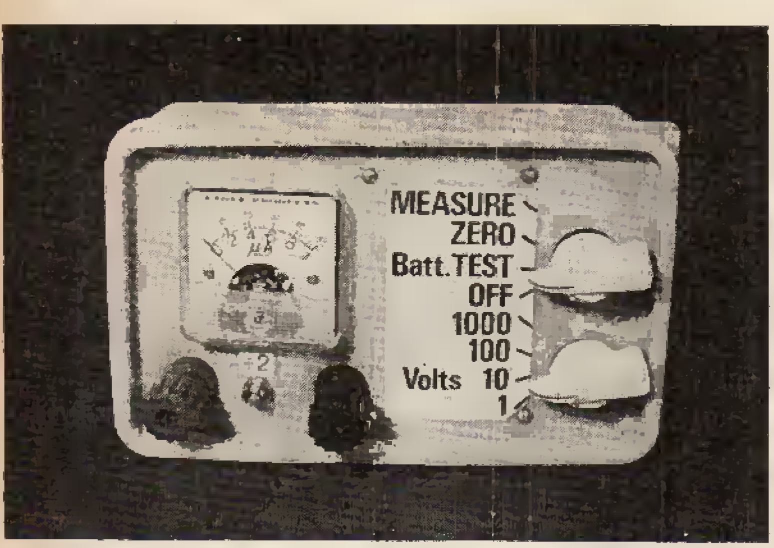
Averages must of course be used, as a single reading may be a fluke, either one way or the other.

A little ingenuity will enable you to make all kinds of tests and will provide hours of fun. ■

HI-Z VOLTMETER

PROJECT Autumn WINNER

C. R. BRADLEY B. Sc.



This article was the winner of the Project Autumn Silver Trophy Competition held last year. The judges considered it the best entry for several reasons including clear description and ingenuity. Although the likely popularity was not a major consideration in the judging, we believe that this project will be found to be very useful to the electronic experimenter.

RANGES (D.C. VOLTS)
0–0·5–1–5–10–50–100–500–1000

USEFUL MEASUREMENT RANGE
0·05–1000V. All readings above 0·25V in upper half of meter scale

CONTROLS
Range switch: 1–10–100–1000V d.c.
Function switch: Off–Battery Test–Short Circuit Input–Measure
Pushbutton to divide range by 2
Internal preset for meter calibration
Two internal presets for meter zero setting with terminals open and short circuited respectively.

FEATURES
Both forward and reverse overload protection for meter movement. Long battery life

INPUT IMPEDANCE

Range	Impedance
0–1V	>7MΩ
0–10V	>3MΩ
0–100V	>5MΩ
0–1000V	>5MΩ

THE improved noise performance, and only slightly diminished gain, provided by modern silicon planar transistors working at low collector current have encouraged the use of ever decreasing currents in small-signal circuits. The correctness of voltage measurements made using a conventional moving-coil multimeter therefore becomes increasingly doubtful, since the voltage conditions in the circuit may be seriously upset by the current 'stolen' by the meter. An example is illustrated in Fig. 1 where a voltmeter with a 50μA movement, which is about the highest sensitivity compatible with reasonable ruggedness and price, reads 50% low at the base of a typical transistor amplifier.

The only way to measure voltages with confidence is to use a voltmeter of much higher internal impedence than the point in the circuit tested. Excellent designs for high impedance voltmeters frequently appear and generally consist of a highly stable operational amplifier driving a moderately sensitive meter movement. However one must expect to invest several pounds in building such an instrument, or many more pounds to buy the cheapest commercial article. The author's aim was to design a high impedence voltmeter of adequate versatility for all likely experimental needs, which could be built for the absolute minimum cost. By careful shopping for components, the total cost of the prototype came to £4·25, which compares well with the cost of a moving coil multimeter. The latter, with its a.c. voltage, d.c. current and resistance ranges, remains the essential first purchase for the experimenter.

The specification of the high impedence voltmenter is shown in the table.

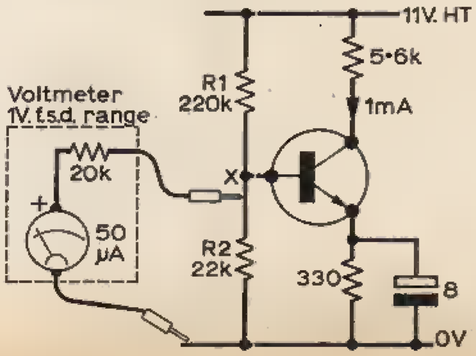


Fig. 1.

DESIGN

The very simplest circuit which has a high input impedence and can drive a meter is the emitter follower shown in Fig. 2. Here the voltage gain from base to emitter is unity. This is because if the base

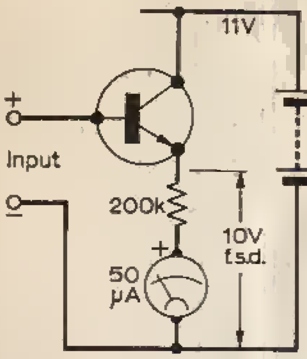


Fig. 2.

voltage is increased, base-emitter current and therefore collector current both increase, and the voltage drop across the emitter load rises until emitter and base voltages are similar. The 50μA meter in Fig. 2 has a 200kΩ series resistor so we should get full scale deflection for 10V at the input terminals. The input impedance of the circuit is *transistor gain*×200kΩ or typically 100×200kΩ=20MΩ. This suggests the circuit would form an ideal basis for a high impedance voltmeter. In practice two complicating factors arise, which are handled in the final circuit.

The first problem is that if any current at all flows from base to emitter, there is a voltage drop of about 0·7V across the junction. Thus the simple circuit would be useless for measuring a voltage around 0·5V, say. The second problem is that even with zero base-emitter current, the transistor passes a

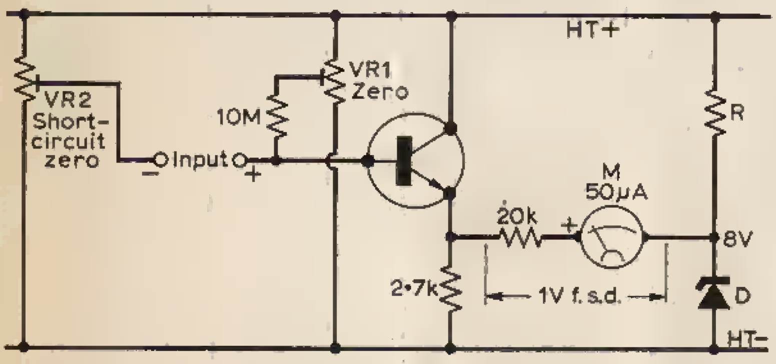


Fig. 3.

certain collector-emitter leakage current. Even with a silicon transistor, this leakage might be 5μA or more and this would show on the meter. In addition, these two values of 0·7V and 5μA vary with temperature.

The arrangement chosen to deal with this situation is shown in Fig. 3. Here the meter movement, with appropriate series resistor for the voltage range required, is connected between the transistor emitter and a constant supply of 8V provided by R and the zener diode D. Current is fed to the base by VR1 which is set up for zero meter deflection. This occurs when the emitter voltage equals the zener voltage. The transistor is then passing a collector-emitter current of 8V ÷ 2·7kΩ = 3mA which leaves its leakage current far behind. As the base current is tiny (i.e: 3mA ÷ transistor gain) a very large 10MΩ resistor can be put in series with VR1 slider to preserve the high input impedance of the emitter follower.

The positive input terminal is now at 8 + 0·7V. This voltage is also set at the negative input terminal by VR2, done by shorting the terminals together and setting VR2 for zero meter deflection. Now ready for measurements as low as 0·05V on the 1V f.s.d. range shown, the arrangement is simple and cheap, and the only drawback compared with a more sophisticated balance operational amplifier is a more frequent need to readjust the zero controls with changes in temperature.

FULL CIRCUIT

The full circuit of the instrument is shown in Fig. 4 and has been developed from that in Fig. 3 as follows. The single transistor is replaced by two transistors connected as a Darlington pair, which behaves like a single 'super' transistor whose gain is the product of the gains of the two separate transistors. Since the 2N2926 (green) has a specified gain (beta) of 235 to 470, the pair has a very high gain indeed. The emitter-base junction of another cheap silicon transistor is connected in reverse to serve as the zener diode in Fig. 3; this is cheaper than using the real thing and just as efficient. A batch of a dozen of this transistor all gave zener voltages in the range 6·5 to 9V which is acceptable for this use. The zero controls are combined with the zener diode to save one resistor (R in Fig. 3); this arrangement also allows finer adjustment of the two controls.

The total series resistance of VR1, R9 and the 50μA meter M is arranged to be 10kΩ; the meter therefore gives full scale deflection for (50μA × 10kΩ) = 0·5V across this chain. The potentiometer VR1 is included so that the circuit can be set up for a meter movement of any likely internal resistance,

✶ components list

Resistors

R1	3·3MΩ 2% ¼W	R6	10MΩ 5% ¼W
R2	TWO 10MΩ 2% ¼W	R7	2·7kΩ 5% ¼W
R3	TWO 10kΩ 2% ¼W	R8	10kΩ 1% ¼W
R4	TWO 100kΩ 2% ¼W	R9	4·7kΩ 5% ¼W
R5	390kΩ 2% ¼W	R10	2·7kΩ 5% ¼W

VR1, 2, 3 4·7kΩ (or 5kΩ) miniature skeleton preset potentiometers

All the above available from Electrovalue, 28 St. Judes Rd., Englefield Green, Egham, Surrey

Switches
S1 2-pole (or 3-pole) 4-way rotary
S2 3-pole 4-way rotary
S3 Push-to-close

Semiconductors
Tr1, 2 2N2926 (Green)
Tr3 2N2926 (Orange)
D1, D3 Any silicon diode e.g. 1N914
D2 Any germanium diode e.g. OA70

Meter
50μA f.s.d., 1·5in. square approx.
Eagle MR-2P or SEW MR.38P (latter from Barnet Factors Ltd., 147 Church St., London, W.2)

Miscellaneous
Veroboard 0·15in. matrix, 1⅞ (across tracks) x 3½in.
Insulated terminals, red and black
2 PP3 batteries and battery clips
4 8BA bolts, nuts, etc.
Scrap piece of polystyrene or foam rubber (see text)
2 pointer knobs
Polythene box (see text)
Letraset for labelling

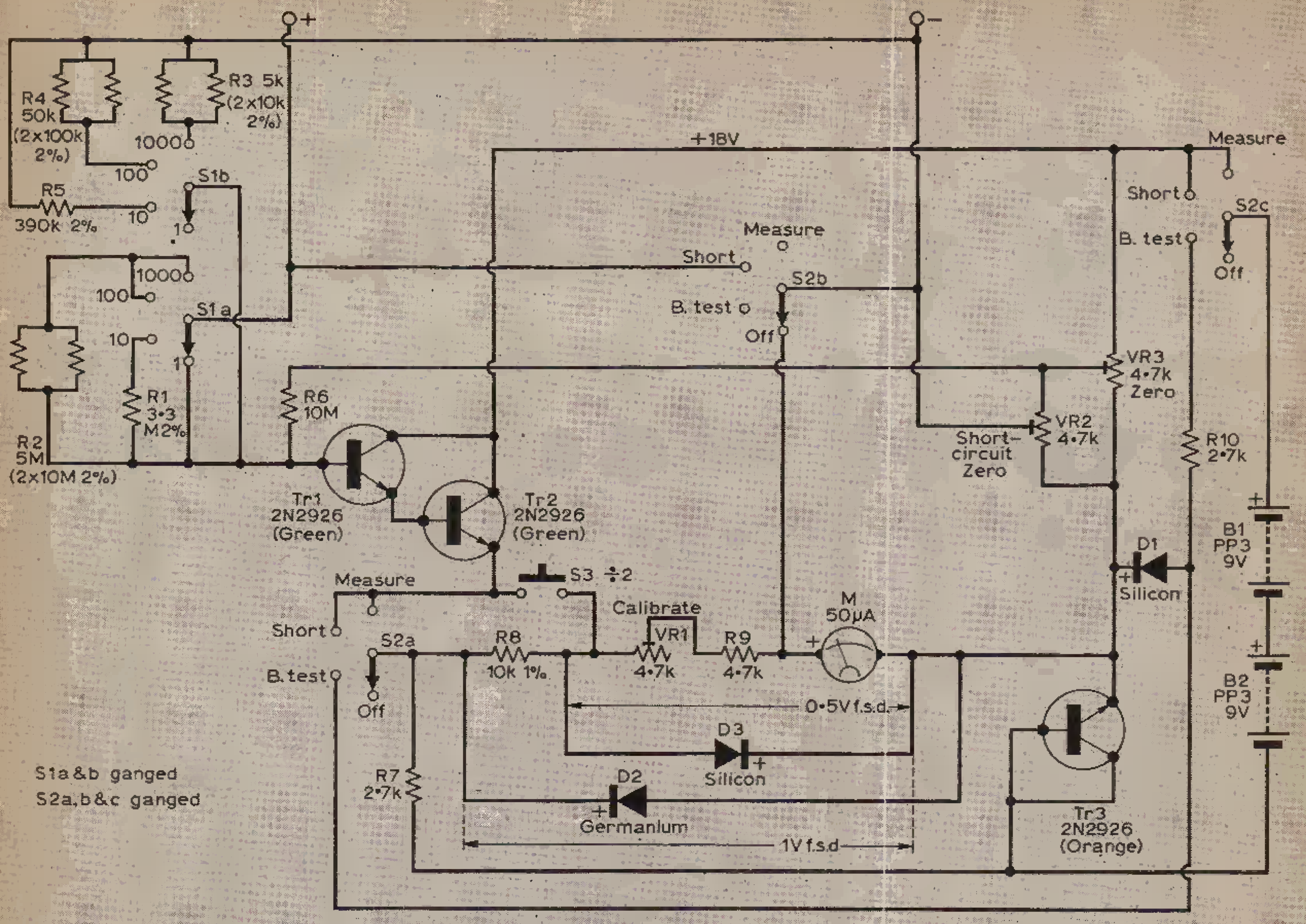


Fig. 4: The complete circuit of the high impedance voltmeter. Although seemingly complex, most of the circuitry is simply a refinement of that shown in Fig. 3. See the text for an explanation of the operation.

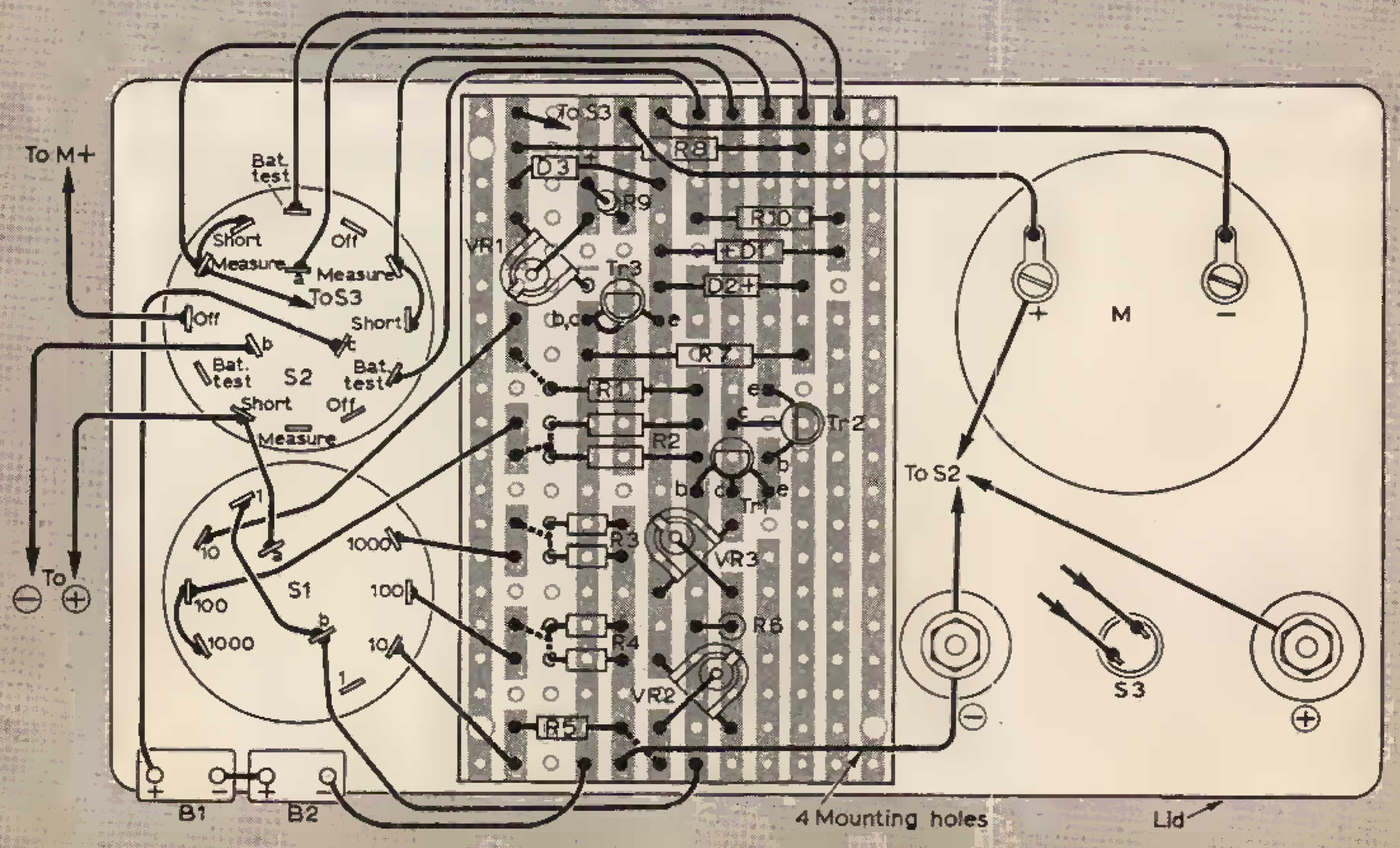


Fig. 5: The Veroboard layout of the components and the other connections.

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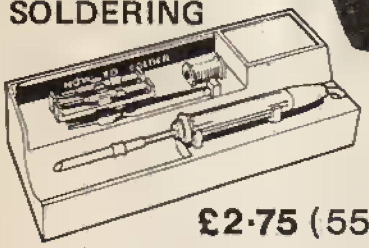

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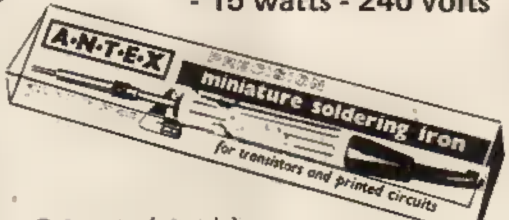
Model CN 240/2 - 15 watts - 240 volts



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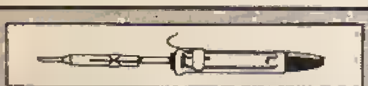

Model G - 18 watts. Fitted $\frac{3}{32}$" bit. Spare bits $\frac{1}{8}$", $\frac{3}{16}$" and $\frac{1}{4}$" available. For 240 or 220 volts. £0·87 (17/5).

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and it need only be set once and left. If the actual resistance of the meter is known (to 1% accuracy), then VR1 and R9 could be replaced by a single 1% resistor to bring the resistance up to 10kΩ. However the present arrangement might still be preferred for economy.

An additional resistor R8 brings the series resistance up to 20kΩ, giving 1V f.s.d. Division of any range by two (i.e: doubling the meter deflection) is achieved by pressing S3 which shorts out R8.

The 1V, 10V, 100V and 1000V ranges are selected by S1. On the 1V range (0·5V when S3 pressed) the base of Tr1 is connected directly to the positive measurement terminal. For the other ranges, appropriate divider resistors are selected by the two sections of S1. The input impedance of the instrument varies with the range selected, partly because the aim has been to use inexpensive preferred value resistors throughout, but it is never less that 3·5MΩ. Pairs of resistors in parallel are used to obtain non-preferred values in the case of R2, R3 and R4; this arrangement can incidentally be shown to give one a statistically better chance of getting a high tolerance. The divider values R1/R5 may at first sight seem wrong for dividing by 10, but this is because the shunting effect on R5 of R6 and the impedance of Tr1 base has to be taken into account.

The meter is protected from forward overloads by D3 which starts to conduct when the voltage across it is about 0·7V i.e: 140% of f.s.d. A germanium diode D2 is used for reverse overload protection since it will conduct at about 0·4V i.e: −40% of f.s.d. (1V). Note that the reverse overload protection is ineffective if the ÷2 button is pressed. In the event of an extreme input overload of either polarity, it is more likely that one of the Darlington pair transistors (cost 10p each) will burn out than the comparatively expensive meter movement.

The function switch is S2. The **battery test** position is a necessary stop between **off** and **measure**. The batteries are tested by halving their voltage (nominally 18V) with R10 and R7 and applying the resultant voltage via D1 to the zener diode Tr3. The meter measures the voltage drop across D1. Since this cannot be more than 0·7V and the meter is giving 1V f.s.d. (the ÷2 is inoperative) the meter will not be overloaded. In fact a meter reading of 0·6 - 0·7V indicates fresh batteries, while any meter indication at all above zero indicates useable batteries.

In the **short circuit zero** position of S2, the measurement terminals are connected together for adjustment of VR2. In the **off** position, the batteries are disconnected and S2b places a short (actually a small portion of VR2 to simplify switching) across the meter movement. This helps to damp down oscillations of the needle if the instrument is jolted in carrying.

CONSTRUCTION

The instrument can be constructed in any convenient insulated box; the author chose the heavier type of polythene food container (size $5\frac{3}{4}$in × $3\frac{1}{2}$in × 2in) sold by camping shops, since its flexibility and the shape of the removeable lid gave some physical protection for the meter. There is also spare space inside which in practice proves useful for storing the test prods.

The components are wired on a small piece of 0·15in matrix Veroboard. There should be no difficulty fitting them on if the miniature types specified are used; the complete layout is shown in Fig. 5. Note that one conductor track is removed completely from the Veroboard, using a razor blade, and 17 breaks are made in the remaining tracks. The board is secured by four 8BA bolts to the box lid, with a piece of scrap foam rubber or polystyrene as a spacer (see Fig. 6), together with the meter, switches and terminals as shown. Before mounting, check that all

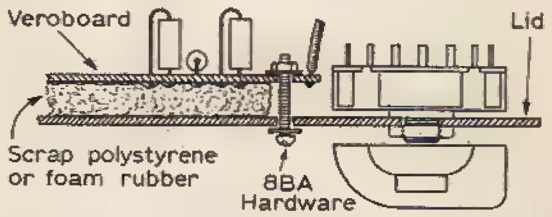
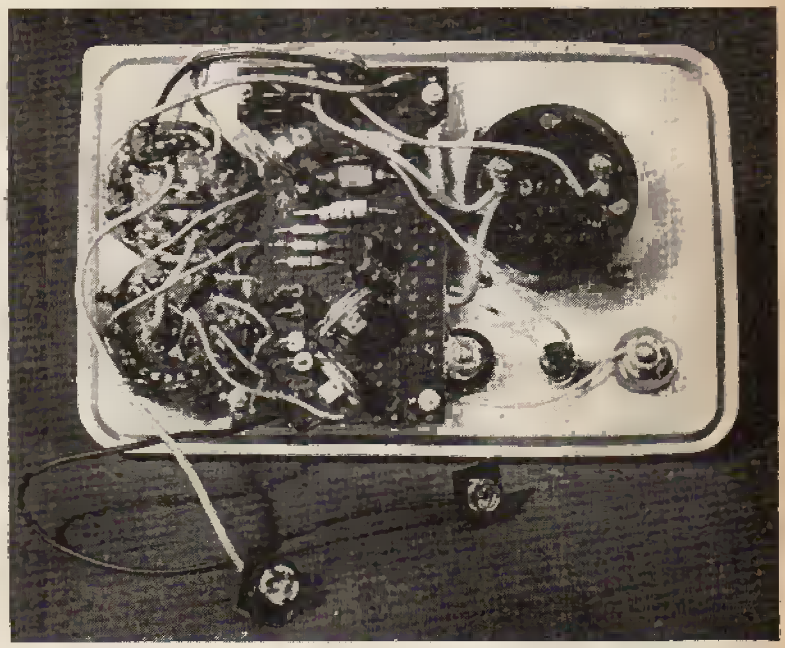


Fig. 6: The method used for mounting the component board.

these parts will fit together on the lid and allow the box to close; in the prototype it was necessary to trim the Veroboard slightly to clear the adjacent switches. The two batteries can be taped in any convenient position as they do not need frequent replacement. Two holes are made in appropriate positions on the box to allow adjustment of zero controls VR2 and VR3 from outside using a long screwdriver.

It is difficult to apply lettering direct to polythene. The panel labelling shown in the photograph was



An internal view of the completed high impedance voltmeter. Compare this with Fig. 5.

done by putting Letraset letters on white contact adhesive sheet (Woolworths) which sticks well to the box.

The meter scale is already labelled 0-50 which allows direct reading on ranges with the ÷ 2 button depressed, but is less appropriate for the 1V, 10V, 100V and 1000V ranges. For these a 0-1 scale can be added to the meter after removing the plastic face of the meter by gently pulling it away.

CALIBRATION

With the function switch at **off**, zero the meter by means of the screw on the meter front. This is purely a mechanical adjustment of the movement and must not be used instead of the electrical zero controls. Switch to **measure** and, with no input, adjust VR3 for zero meter deflection. Then switch to **short circuit zero** and adjust VR2 for zero. Initially it may be necessary to adjust VR3 and VR2 more than once. The calibration control VR1 can now be set. This is best done by connecting the voltmeter to any voltage in its range with a meter (any impedance) of known accuracy in parallel with it, and adjusting VR1 for corresponding readings. It is possible, though less easy, to set VR1 without any other meter. This is done by connecting the instrument to any voltage source that will give about 40 to 50% deflection on any range, and successively adjusting VR1 until pressing the ÷2 button exactly doubles the deflection.

USE

The function switch allows a quick check of the battery condition and the two zero settings every time the voltmeter is brought out for use. Once set accurately, VR1 should not be readjusted. It is necessary to readjust VR2 and VR3 occasionally, particularly with temperature changes. Allow a few seconds for the zero settings to stabilise when first switching on the meter.

The usual rule for meter usage should be followed, namely: select a higher range than the maximum voltage anticipated before connecting the meter to a circuit. In practice the ÷2 button proves extremely useful for doubling meter deflections of less than half scale. Remember that a meter measures most accurately over the upper 50% of its scale, where all measurements from 0·25 to 1000V can be made with this instrument. It is important that the Veroboard and switch wafers be kept clean and dry if measurements above about 500V are to be made as tracking problems could otherwise arise.

The impedance of the meter is high enough for confident voltage measurements in virtually all common circuits, except some high impedance valve grid and f.e.t. gate circuits. Unlike a moving coil multimeter, the impedance is virtually the same on all ranges.

It is possible to use the meter in a centre-zero mode for detecting d.c. nulls in bridges, etc. Set the function to **measure** and adjust VR3 for exactly half scale deflection, then switch to **short circuit zero** and adjust VR2 for the same deflection. The meter will now indicate voltages of either polarity at the terminals, the needle swinging to the right for a positive voltage at the positive terminal. The voltage swing over the whole meter scale is not changed, and the ÷2 button is still operative.

The batteries have a life of many months in normal use, or about a week if the meter is left on continuously. The instrument can in fact be operated on seriously run-down batteries, although the zero settings will drift badly. ■

TELEVISION

We are pleased to inform readers that our sister journal Television has now resumed publication following settlement of the recent printing dispute.

Issue dated **February 71** was published on February 12

Issue dated **March 71** will be published on March 8

Issue dated **April 71** will be published on March 29

We apologise to readers of Television for the loss of the December 70 issue and late appearance of subsequent issues.

Electronotes..

S. GINSBERG

COMPUTERS have been with us for some time but many people do not realise the degree of sophistication which is now being achieved. A fairly recent example is REDACAL. Basically a computer service, it enables any electronics customer to use a computer to solve problems. With REDACAL the design engineer has a powerful tool. He can, for example, ask this system to tell him of, say, an operational amplifier which has certain minimum and maximum gains. He might also specify that it must come within other limits, perhaps a 5V line. Within seconds, REDACAL will list all the currently available devices which will satisfy the conditions layed down and will also quote the current market prices, too.

But this system goes much further than providing such simple information. The designer can tell the computer what his newly designed electronic circuit is and seek its advice as to whether the circuit will work properly. For example, the designer can ask REDACAL in, say, the case of a square wave generator, what frequency the final output will be if all the capacitors and resistors were varied within a certain tolerance. Imagine if there were fifteen resistors in the circuit and they were all 5 per cent tolerance. They could all vary and this would affect the circuit. Once REDACAL has given a circuit the OK, the designer can literally put the design into production and know that the snags have been ironed out.

How does the designer tell the computer his problem? Easy, he simply telephones the computer and uses a thing called a modem (modulator/demodulator) which a standard telephone handset will sit in quite happily. He can also use a typewriter keyboard similar to the kind used in teleprinters. Thus any designer is no further away than the nearest telephone.

An interactive graphics terminal is available for circuit layout work. This is really a large cathode ray tube on which the designer can call up various shapes and pieces of circuit which he can then position very accurately with a light pen. He merely touches the portion he's working on with the light pen and points to the exact location he wants it and bingo—it's there immediately. Thus a designer can draw out a complex mask for an integrated circuit. When he has finished, he can ask the computer if there is a better way of drawing it, or if he has made any mistakes, etc. The system can then be used to provide masters for actually making the ICs. ■

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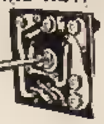

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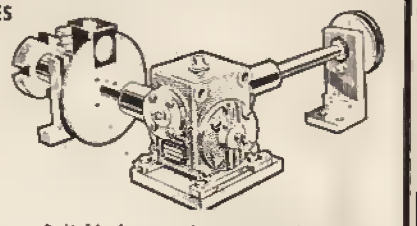

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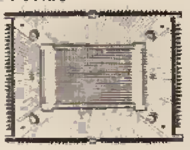

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Malcolm Connah

Frequencies in kHz • Times in GMT

THE first report for this month comes from new reporter **Steve A. Money** of Southsea. Steve has a Lafayette HE-30 receiver and a 50-foot long-wire antenna. He was lucky enough to be able to use a digital frequency meter to check the frequencies.

4110 *Urumchi, China* in Chinese at 2040.
4685 *Irkutsk, Siberia* in Russian at 2054.
4765 *RTV Congo,* Brazzaville in French at 1740.
4770 *ELWA, Liberia* in English at 0620.
4780 *Djibouti (RTF),* Afars & Issas, French, 1745.
4785 *Kunming, China* in Chinese at 0010.
4785 *Baku, Azerbaijan* in Russian at 1830.
4795 *Ulan Ude, USSR* in Russian at 0015.
4800 *YVMO, 'R. Lara',* in Spanish at 2330.
4815 *Ougadougou, Upper Volta* in French, 2220.
4823 *Hanoi, Vietnam* in Vietnamese at 2230.
4850 *Nouakchott, Mauritania,* in French at 2215.
4885 *Novosibirsk, USSR,* in Russian at 2350.
4890 *VLT4, P. Moresby,* Papua in English at 2030.
4900 *YVNK, 'R. Juventud'* in Spanish at 0005.
4907 *Phnom Penh, Cambodia,* Cambodian at 2300.
4940 *Abidjan, Ivory Coast* in French at 2225.
4945 *HJDH, 'R. Colosal'* in Spanish at 0715.
4955 *HJCQ, 'R. Nacional'* in Spanish at 0015.
4965 *HJAF, 'R. Santa Fe'* in Spanish at 0700.
4970 *YVLK, 'R. Rumbos'* in Spanish at 2350.
4975 *Yaounde, Cameroon,* vernacular at 2115.
4980 *YVOC, 'Ecos del Torbes'* in Spanish at 2310.
4980 *Ejura, Ghana* with African music at 2200.
4985 *R. Malaysia,* Penang in English at 2345.
4994 *Omdurman, Sudan* in Arabic at 2130.
5035 *Bangui, Cent. African Rep.* at 2140.
5042 *Bissau, Port. Guinea* in Portuguese at 0035.
5051 *R. Singapore* in English at 2330.
5055 *Chita, USSR,* unknown language at 0045.
5095 *HJGG, 'Accion Cultura'* in Spanish at 2320.

John H. Saunders of Paekakariki in New Zealand sent in an interesting report on what can be heard in that part of the world, his log included:

5054 *R. Singapore,* English news at 1130.
6035 *R. Monte Carlo* in Italian at 0700.
6085 *DMR24, Munich,* Germany, Home Sce. at 0600.
6090 *R. Luxembourg* heard at 1730.
6540 *Pyongyang, N. Korea* in English at 1900.
9640 *R. Kuwait* with news in English at 1839.
9680 *TWR, Monte Carlo* in German at 0905.
11680 *BBC, London* in Swahili at 0330.
11765 *SBC, Berne,* Switzerland at 0600.
11765 *ETLF, Ethiopia* in French at 0400.

Graham Close of Diss in Norfolk is a new reporter and his equipment consists of a GEC 5-valve domestic receiver, a 75-foot long-wire and a TV antenna. His log included the following:

3338 *Radio Mozambique* at 1200.
5058 *Radio Tirana,* Albania at 2130.
6125 *Voice of America* with news at 0245.
6230 *Radio Tirana,* Albania at 0500.
9525 *Polish Radio* in English at 1645.
9625 *CBC, Radio Canada* in English at 0740.
11620 *AIR, Delhi* in English at 0900.
11710 *ABC, Australia,* sign-off in English at 1000.
11720 *R. Trans Europe* in English at 1000.
11795 *WINB, Red Lion, USA* in English at 2130.
11815 *TWR, Bonaire* in English at 0900.
11865 *R. Trans Europe, Portugal* at 1400.
11950 *NHK, Japan* with sign-off at 2130.

Colin Blanchard of Sutton Coldfield used his 5-valve domestic receiver and 50-foot long-wire to hear the following:

6025 *Radio Portugal* noted at 0210.
9660 *Radio Kiev, Ukraine* in English at 0100.
9805 *Radio Cairo* in English until 2300.
11765 *ABC, Australia,* Sports News at 0830.
11955 *BBC, Far East Relay,* Tebrau at 1815.
15320 *Radio Nederland,* Bonaire at 2015.
17710 *Austrian B.S.* in German at 1400.
17720 *WINB, Red Lion, USA* in English at 1815.
17740 *BBC, Atlantic Relay,* Ascension Is. at 1815.

John Young of Oxted in Surrey has a Pye domestic receiver which is 18 years old and 5 feet of mains flex as an aerial, with this combination he was able to hear:

5990 *CBC, Radio Canada* in English, 0715-0745.
6020 *Radio Nederland,* Hilversum, English, 0930-1050.
6025 *R. Portugal* in English, 2100-2130.
6135 *HCJB, Quito, Ecuador* in English, 0730.
6165 *SBC, Switzerland* in English at 1430.
7240 *Voice of the Palestine Liberation* from *Baghdad, Iraq* in English, 1900-1920.
7250 *Vatican Radio* in English, close at 2055.
7275 *RAI, Italy* in English, 1935-1950.
9625 *Radio Sweden* in English, 1100-1130.
9635 *R. Baghdad, Iraq* in English at 2010.
9715 *R. Nederland,* Bonaire in English, 0800-0920.
11735 *Moroccan R. & TV,* in English, 1700-1800.
11740 *ABC, Radio Australia* in English.
11750 *BBC, Far East Relay,* Tebrau at 1815.
11810 *R. Berlin* International in English at 2000.
11965 *Deutsche Welle* in German with close at 1810.
15235 *BBC, Atlantic Relay,* Ascension Is. at 1700.

All reports, which should be in frequency order, must arrive by the 15th of the month. They should be addressed to the author at 5 Ranelagh Gardens, Cranbrook, Ilford, Essex.

ON THE SHORT WAVES

THE AMATEUR BANDS

David Gibson, G3JDG

Frequencies in kHz • Times in GMT

IT'S been a fantastic month for the l.f. types with DX romping in from most parts of the globe. The h.f. bands have provided some goodies but twenty has developed its habit of dying rather early in the evenings. Ten metres is doing well but appears to be mostly North America. One solitary log arrived for two metres but surprise, surprise, someone sent in a 70cm log.

Details received about the WAB contests for 1971. These are: 14/21/28MHz March 14 (phone), March 28 (c.w.); 1·8/3·5/7MHz April 4 (phone), April 11 (c.w.); v.h.f. phone contest, June 20, any frequency above 30MHz. More details from **C. J. Morris,** G3ABG, 24 Walhouse Street, Cannock, Staffs.

N. Richardson (Bucks.), tells stories of a 46-element beam at 32ft. feeding a Garex 70cm. converter with a 9R59DE providing the eventual audio. Nick says that the crystal he is using is a bit near Channel 1 TV frequency and the result is nasty happenings on next door's telly. Despite this he managed to log six counties in one session. Call signs heard were: G3GWL, G3KPB, G3LQR, G3VZV, G8ACN, G8AEX, G8APZ/P, G8ATS, G8AUE, G8BBE, G8BJA, G8BGQ.

G. Richards (Isle of Wight), 4-over-4 slot fed, JXK converter, Mohican, sends details of calls heard on 144MHz. On a.m. and within a range of 60-90 miles: G2JF, G3FSA, G3NGK, G3UNT, G3XFW, G6LL, G8CEI, G8CHO, G8ECK, and on s.s.b. G3AKF, G3OUV, G3MCS. From 125-150 miles: G3DY, G3BHT, G3SBF, G6CW all s.s.b.

"We had the house rewired recently which knocked the RX gain up a bit", says **John Moore** from his Leicester shack. John's all-band log includes: **160-** DL1FF, DL9KRA, GM3FSV, OK1AQW, OK1JAX, OK1JKA, OL4AMP, OL5ALY, OLØANU; **40-**EA8HA, OL9LV, UL7AA, VE2APL; **20-**CP6FG, CT3AS, FG7XT, FH8CY, FP8CS, FY7AE, M1I, OY3B, PY2PA, PY6HB, VE7IC, VP2AA, VP2VI, YV4TV, ZD7SD, ZL1AH, ZL4BO, ZM1ABO, ZS1EI, ZS2MI, ZS5EY, 4M1A, 4U1ITU, 8R1U, 9Y4AR (all s.s.b.); **15-**AX2AU, AX2AVT, VU2JM, W5ILR/TF, ZE2JA, 7X2ZHS, 9H1BP; **10-**AX5MF, AX6CT, KV4AD, MP4BRA, SVØWBB, UA9WO, YV1ACX, ZE2JA, 9K2AL. Gear in use is a CR100/2, a.t.u. and 130ft. long wire plus one pair of earholes Moore type Sharp Mk1.

How low can you get? Not much lower than 1·8MHz in Amateur terms. That's just what **J. Leaver** (Lancs.) did. Jim has a homebrew (good lad Jim) receiver, a.t.u., 100ft. of wire round the loft and an earth mat 20ft. square and 3ft. deep (he's the only man I know who uses a spade for spring cleaning). Topband c.w. log reads; DL1HS, DL9KRA, GD3DB, GM3OXX, GM3YCB, K8DBI, OK stations 1ARI, 1ATP, 1ATY, 1DJD, 1KRS, 1MLJ, 2BFN, 2SIX, 3KAS, 3KWO, 5VSZ, OL1AMR, OL4AMU, OL4AOK, OL7AOU, PAØPN, UR2CXY, W1HGT, W3ANO, W3GM, W8KFX, W9UCW.

"I know my writing is terrible", comments **P. Harris** (Lincs.). Deciphered Harris heiroglyphics inform of the following signals on 80; CT2BC, DU1FH, EA8MA, ELØK/5A1, EP2DX, ET3USA, FP8AP, MP4TDT, ON5DO/P/AP2, TA2BK/P/1, UAØADO, UF6DR, UI8LM, VE1AX, VE2WF, VE3PT, VP2VI, VS6DO, ZC4JW, 3V8AB, 7X2OA, 8P6DO, 9K2AL.

C. Henderson (Kent), B40, 120ft. end fed running NW/SE, went s.s.b'ing on 3·5MHz. Fruits of his labours include; EA3QW, EA6BN, K7HNJ, KX6BX, LU7AAC, LX1BJ, OD5BA, OX3WX, OY2R, OZ1LO, VE1IE, VO1FG, VO2DC, VS6DO, W2HCW, W3AZV, ZB2A, ZC4IK, ZM4KE, ZM4LM, 6W8DY, 9K2AZ.

T. Thornton (Berks.) says that 80 is providing nearly as much DX as any of the h.f. bands. He gives a list of times (GMT) when to listen as follows; 0800-1700 for Far East and Oceania, 0600 for North and South America and 2000 for South and East Africa and the Middle East. Tim's log for eighty reads; ON5DO/AP, CO2FA, CT2AK, DU1FH, EA6BN, EP2TW, ET3USA, FC2LG, FC8AP, HC1RF, HC2HM, HC2GG/1, HK3AVK, HK6BRK, HP1JC, HT1BW, IRØWX, IS1FIC, IT1ZGY, JX3MN, K5MU, LU7AAC, OD5BA, OX3WX, OY2R, PJ7JC, PY7ASQ, PZ1AK, TA2BK/1, K2LQQ/TF, TI2CF, VE7ZM, VO2JC, VP2MRK, VS6DO, VP2VI, XE1CE, YV5BQV, ZB2A, ZC4JW, ZL4NH, ZM2BCG, ZM2BHX, ZS1MH, 3V8AB, 3V8AL, 6W8DY, 9K2AL and 7X2OM on c.w.

R. Mortimore (S.Wales), has an H.A.C. one-valve receiver plus a three-transistor amplifier. A listen on 14MHz revealed; ET3USA, JA1KAV, KL7BK, KP4AST/M, VE1ASY, VE3FSV, VE7HP, VE9AT, 5H3MB, 7Q7LA, 8P6CC.

A. Crooks admits to lurking in Teeside but did a quick flit back to sunny Leicester. Stations heard on 21MHz while sunning himself in the warm winter sleet include; AX2XT, AX3ZJ, M1D, OA8I, PY4BO, VK2FU, VK5FM, W5RG, WB6NVW, YV5BPG, ZL4HE, ZS6QD, 3V8AL, 7X2HS, 7X2OM. Equipment used was an RA1, PR30 and 33ft. of wire draped round the room.

Enter **P. Beeson Esq.,** (Staffs.) complete with HA500 and 61ft. end fed. Fifteen metre squeaks from; CE3JY/P/WC, ET3USA, JA3DNL, KP4DCR, KR6EZ, KR6IL, PJ7JC, SV1CB, VE3XX, VE6AWC, VK2FU, VK6WV, VS6BE, VS6DO, WA9YGT/KG6, ZL2TA, ZL3FO, 3V8AL, 4Z4HF, 7X2OM.

D. Robbins has been looking through a general list of call-sign country locations and finds that the UK has a nice little bunch from 2AA to 2ZZ. He suggests things like GRO for Rockall and GDO for the Isle of Dogs but I think FIDO would be better. Fifteen metre log using a CR7OA and 70ft. end fed reads; CN8CS, CR6DB, CR7CH, EL2BA, G2MI/VP9, HC2HM, HR1KS, thirty seven JA's, KG4AM, KR6BD, M1B, VK2NN, PJØDX, PZ1DA, TG9MD, VP7DL, VP9GE, YN1CG, ZL3JC, ZL3SO, ZM3OH, ZP5FH, ZS6AXL, 3V8AL, 5U7AW, 5Z4KC, 7X2ON, 9Q5DL.

Logs for the Amateur Bands must arrive before the 15th. of each month. The address is: **12 Cross Way, Harpenden, Herts.**

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SPEAKERS

HI-FI AND AUDIO

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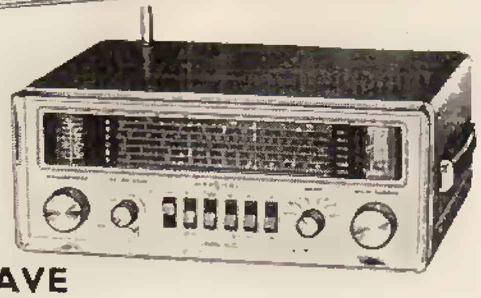

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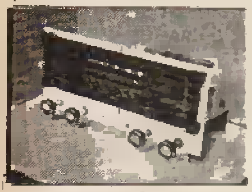

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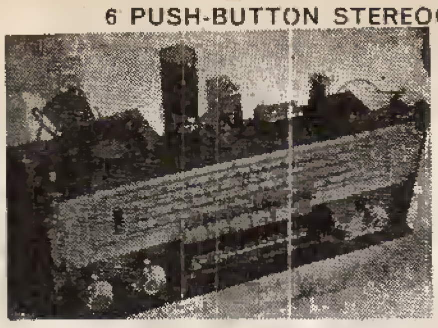

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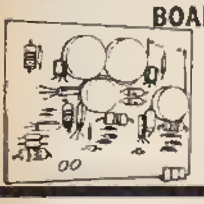

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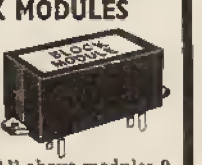

Phono pre-amp E1311 input 100k: gain 28dB max out 3 volt: max input 50mV. Tape pre-amp as above E1313. Power amp E1314 input 1,000 ohms gain 20dB 300mW. Organ tone osc E1315 tone freq. 200-1k. Hz output 80mW. All above modules 9 volt. Dual flasher E1318 flash time 1-4 secs power 6 volt. Lamp 6v 150mA. All at £1.25 P. & P. 10p

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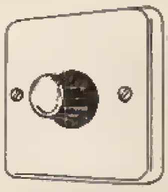

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These small units contain the following components: 700 ohm DPDT relay with base, 1μF 250v. paper, 0·01μF 400v. paper, 50μF 35v. electrolytic, 3 diodes OC200 transistor, a 2N2926 type transistor unmarked, a skeleton pre-set pot, 4 pin din plug & skt., 4 foot of 4 core screen. All housed in a small neat metal box. Can be made into many timing devices.
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4-pin transistor holders	2½p	each
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U2 battery holders (blue plastic) ..	5p	each
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TAKE 20

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A series of simple transistor projects, each using less than twenty components and costing less than twenty shillings to build.

No. 24 RAIN ALARM

HAVE you ever heard the ladies of the house let out a yell because the washing is out and it has been raining without anyone noticing?—or have you ever had to cope with soaking deck-chairs? Well, this month's project should put a stop to all that for it is a fairly simple rain alarm that will sound a "hooter" as soon as the first drop of rain reaches a sensor.

It is of course no good having such a device unless you can leave it on for long periods without the battery running down. The circuit used here draws so little current in the stand-by condition that the battery will suffer a natural death long before the circuit runs it down. An on/off switch has been included to enable the alarm to be turned off once it has been sounded otherwise you would have to put up with the "hooter" until the rain was stopped and the sensor dried out.

THE CIRCUIT

The key to the whole operation is the use of silicon transistors throughout with their almost negligible leakage currents—a germanium transistor version of the circuit would be operational all the time and obviously be useless.

Tr1 is the "switch" which is triggered by the rain. Rainwater, although very nearly distilled water and

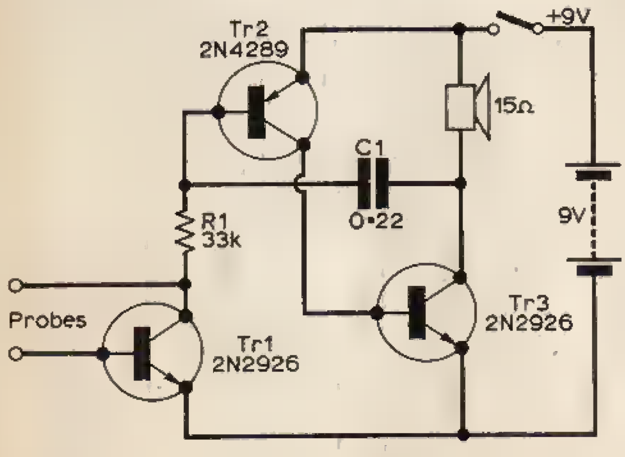


Fig. 1: The circuit of the Take 20 rain alarm

therefore not nearly such as good an electrical conductor as tap-water, has a definate resistance which is arranged to connect between the collector and base of Tr1. This will allow current to flow and allow Tr2, which is a low-cost p-n-p silicon type, to be biased into conduction. This in turn biases on Tr3 and a pulse of current is passed through the loudspeaker. The base of Tr2 and the collector of Tr3 are in phase and by connecting a capacitor, C1, between them we have an oscillator which will produce an audio note in the loudspeaker as long as Tr1 is turned on.

As we have seen, Tr1, when switched on, sets up a chain reaction turning the other two transistors on and into operation. R1 is included, for, if Tr1 was completely switched on, damage may occur to the other transistors. Its inclusion only means that the minimum resistance between the base of Tr2 and battery negative is limited to 33kΩ.

When Tr1 is off (that is with nothing between the probes) the only current drawn is the leakage of the three transistors which is so small that we can forget it.

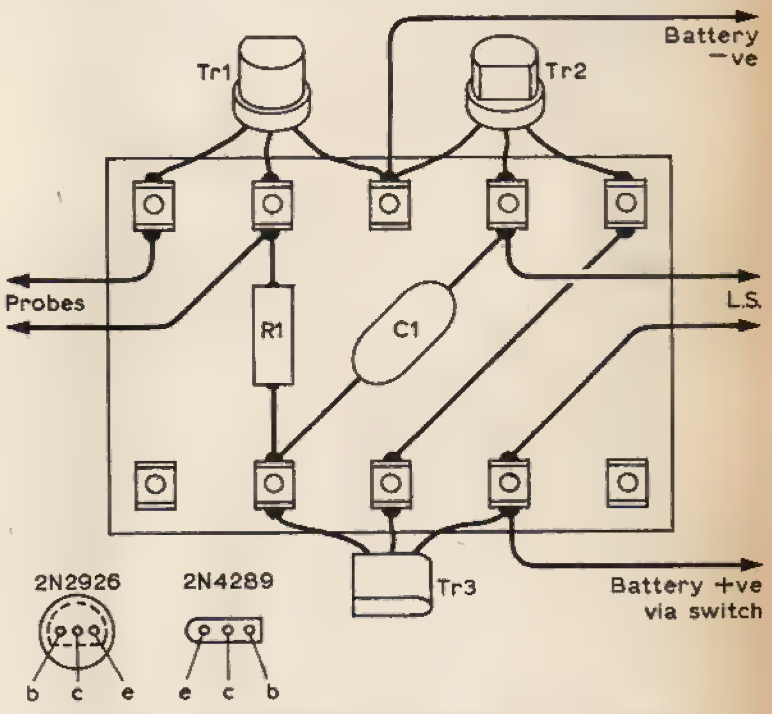


Fig. 2: A suggested component layout on a small tagboard.

CONSTRUCTION

A suggested layout for the components is shown in Fig. 2, the three transistors together with R1 and C1 are mounted on a tagboard. The probes can be made in a number of ways for it is only necessary to arrange for water to complete a conductive path between them. A sheet of plastic to which a piece of blotting paper has been glued with the probes pushed into the blotting paper works very well but will not last all that well. Alternatively a small piece of Veroboard can be used, one of the probe wires going to every second copper strip, the other probe connecting to the others. However, there are lots of ways for arranging for the rain-water to complete the circuit and with a little ingenuity you should be able to think up one of your own. ■

The COMMITTEE 'SUPER-FET'

UNDERCOVER PROJECT

SOMEONE, somewhere, remarked that PW ought to consider publishing an article on a piece of equipment designed as a joint venture by the leading regular contributors. It needed only malicious encouragement, coupled with a subtle admixture of coercion, bribery and blackmail, for Mr. Eeven Steeven to find himself forming a small committee for this purpose and as a result of a second-generation application of coercion, bribery and blackmail, to discover that the following running order of volunteers had agreed to join him in this formidable and noble undertaking.

THE EXPERTS ASSEMBLE

The following have arrived:

Eric Foulpest, (G4NBG), Julius Andyman (of "Take 40" and "You too can build a computer for six and tuppence" fame), L. A. J. ("Icky") Iceland, Downy Arthur and Rickey Colins (founders of the PW Darby and Joan Club), A. S. Bricklayer (G8 and Bar), Rave Glibson (author of "Tahiti on a Hat-pin or Bust"), Salvador Hogshead (of no fixed abode).

Starting prices: Foulpest 2/1 favourite, Andyman 5/2, 100-8 the field. Arthur and Colins wear blinkers.

The following declined to support the project for reasons too numerous and scandalous to mention: Mr. F. Greyer, Q. Cameron-Highlander, Randy Lester ("The Electronic Entrepreneur"), J. Thornton Lawrence of Arabia and Aberystwyth (henceforth referred to as J. T.), Malcolm Conman ("DX on a G-string"), R. F. Gravyboat (author of "Up the Spout"), F. C. Judder and M. Wallis-Collection ("The Testmaster in sickness and health").

A special sub-committee was also formed to liaise among themselves and with powers to mind their own business. This comprised: Henry (to make rude remarks), Pax (to do the doodling), Maxwell (to make the coffee) and the office boy (to sweep up spare committee members). Components were obtained from Steptoe's Surplus Stores. Gowns by Renta-Rag Ltd.

MOMENTOUS DECISION

At the first meeting Mr. Steeven appointed Mr. Steeven as Chairman of the Committee with sole discretionary rights to abandon the project at the slightest provocation. The Committee then adopted the motto *Nil Nijinsky* which, for the ignorant is an allusion to the ancient precept that a camel is a horse designed by a committee.

During several sessions, each followed by a "session", various proposals were put forward—and then pulled back. Messrs. Colins and Arthur suggested that if it was not going back too far the committee might consider resurrecting a classic receiver design of the early '20s. The Chairman asked if they meant the 1820s or 1920s.

Mr. Iceland was soon up in arms at the idea remarking that readers would probably take such a set to be an Ancient Monument. However he would agree to any other suggestion provided it was for a disintegrated digital clock using nine NAND/AND and four EITHER/OR TTLs with positive flip-flap readout, which he happened to have in his junk box. During questioning Mr. Iceland agreed that he had the copy ready for such a project but had hesitated to submit it to the Editor fearing it might be below the usual standard of material in the magazine.

The Chairman remarked that nothing could be lower than the present level. (Applause and cries of "Resign").

COST FACTOR

Mr. Andyman supported Mr. Iceland's project with the proviso that the total cost to the reader should not exceed 20p. Nor should it use more than 20 components. After allowing for the nine NAND/AND and four EITHER/OR TTL's it should be possible to complete the design with not more than seven other components. Mr. Iceland's remarks are not recorded but it is understood that he muttered something about £200 and 2000 somethings.

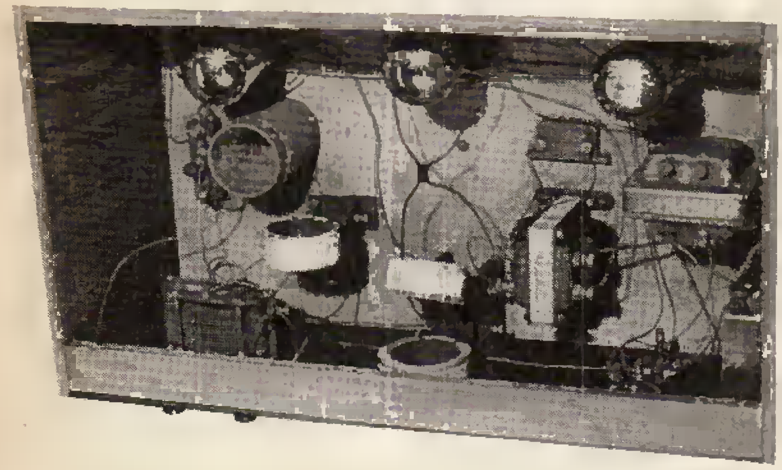
Mr. Hogshead also approved of the disintegrated clock concept provided he was allowed to design the peripheral hardware for the necessary testing of the clock. He was prepared to completely re-design and up-date his VCR97 oscilloscope, his ultra-linear wide-band total distortion amplifier (EF50-EF50-EF50-EF50-PX4-PX25-DA100) and his guitar amplifier which he had never got around to using anyway. Off the record, the walls of his flat had caved in and collapsed when he first turned up the wick on the 50W job but his wife had blamed it on the Concord/Concorde (this is for our French reading reader).

THE TENSION MOUNTS

At the 54th. session of the Committee it was reported that the Editor was getting a little nervous and impatient after waiting so long for the promised article and anyway he was constantly complaining of cramp in his fingers from the signing of the steady stream of allowance claim forms from a slightly unsteady Committee. The Art Director reported that so far he had not received any instructions on the artwork for the article.

Eric Foulpest thought that the clock idea was "all right" if the output of the clock could be used to drive a series of 10kW power amplifiers to radiate time signals at the bottom end of each amateur band from 1·8 to 2300MHz for 24 hours a day. It was also desirable, he said, to be able to direct the output of all the amplifiers onto the frequency of any pirate station in any amateur band.

He was willing to accommodate the entire equipment at his own QTH in return for which service he would expect to be allowed to use the equipment during contests with the power input reduced to 150W of course and to 10W on Top Band, naturally. (He's got to be joking! Ed.) Mr. Glibson commented that after listening around the bands recently it would be all contests and no time signals.



This excellent shot reveals the ingenious hybrid circuitry of the "Super-Fet". The familiar ST2-TD2-ZD2 line-up is followed by a DITTO2U2 audio gain-block located in the very centre of the layout. The plug-in power supply can be seen in the bottom righthand corner. The signal input attenuator is at the extreme left centre. (Photographs courtesy PW Space Centre).

THE BIG RE-THINK

At the 73rd. session Mr. Glibson submitted that all previous proposals should be forgotten and a fresh start made. The Committee agreed and went to lunch, then tea, then supper and so to bed.

Mr. Colins admitted that he had not really been paying attention at the previous meetings being mostly pre-occupied with his love life and his new house. He volunteered to write an article describing a bed, a vast bed, with a giant console from which he could control all the curtains, all the doors, all the radios and the TV's not to mention the tea-maker. Trouble was that he'd have to get out of bed to service the equipment but he was working on that problem.

The Chairman interrupted Mr. Colins to remark that if Mr. Colins cared to submit his plans . . . but Mr. Colins cut in to say that he was not going to submit his plans to anybody especially as he was getting married soon.

Mr. Bricklayer arrived in time for the 99th. session of the Committee and apologised for his absence from the previous meetings. Without any further ado he proceeded to outline briefly the circuitry for his 64-dollar (sorry-transistor) *Super-Fet All Band Receiver*. Four hours later the Committee approved the design for publication without further discussion.

Circuit

The circuit is the same as the physical layout which can be seen in the photograph of the *Super-Fet*.

CONSTRUCTION

The layout is the same as the circuit which can be seen in the photograph of the *Super-Fet*. The only component worthy of comment is the band switch which has the following positions:-

Band 1. Vienna Philharmonic.
Band 2. Foden's Motor Works.
Band 3. Plastic Ono.
Band 4. Carrol Gibbons and the Savoy Orpheans.

TESTING

Don't bother to check the wiring, it won't work anyway. Connect up a 9V non-polarised battery, stand well back and switch on. Go out and buy a kit set.

CONCLUSION

If you want to do an article for PW but can't think of a subject, dream of all the things you'd like to make for yourself and then pick on something else. Above all else, don't make the mistake of doing this on April the First. ■

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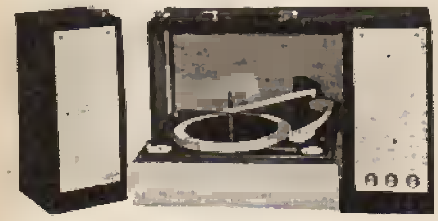

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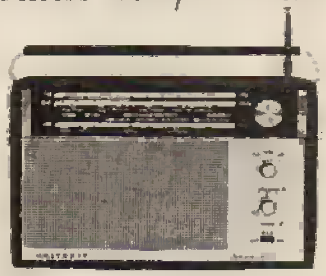

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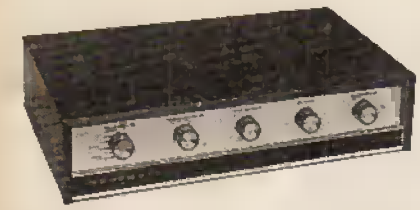

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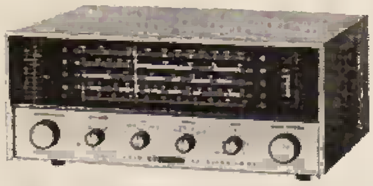

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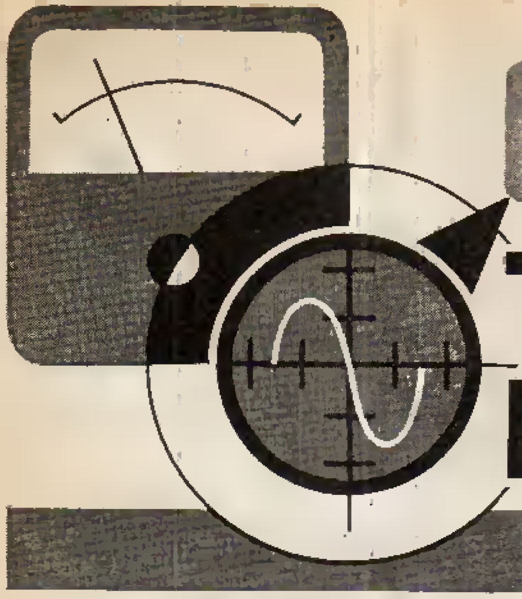


GUIDE TO TEST INSTRUMENTS

by GORDON J. KING

THIS supplement is designed to herald a new series of articles focussed on radio and audio servicing, starting next month. The servicing series will be handled by colleague H. W. Hellyer (Mac to his mates and the author of the recently acclaimed Tape Recorders book by *Fountain Press*) and yours truly, and between us we shall be exploring the theoretical and practical aspects of radio and audio equipment servicing, taking in the ordinary radio receiver as well as the more exotic hi-fi receiver (tuner-amplifier?) along with audio amplifiers and tape recorders, with Mac concluding the series on the latter note and reflecting his vast experience in the fields of tape recording theory and servicing.

We shall also be unweaving the enigmas of valve and transistor theory while introducing practical relationships. We shall demonstrate contemporary testing procedures, tell how to work out component values, delve into the mystery of multiplex f.m., introduce hi-fi specifications, have a look at pickup theory and practice; in fact we shall be embracing as widely as possible the entire area of 'servicing' and in order to do just that we might well find it necessary to split all or some of the five parts into two sections to yield a desirable balance between theory and practice.

Although the actual *using* of test instruments will be adequately highlighted in the series, such things as instrument basics, what instruments are available, what they do and how they do it, their salient features, respective importance and so forth will not be included. This is where I come in with this supplement, the plan being to set the instrument stage, so to speak.

There has been little intrinsic change in instruments over the decade. We still have meters for measuring voltage, current and resistance by means of a pointer; and we still have instruments for generating various types of signal, pure tone, pulsed or modulated. The versatile oscilloscope is still the same. There is still the cathode-ray tube with its pin-point of light which, under the control of a suitable timebase, traces out the signal waveform on its screen.

TEST METER SENSITIVITY

Nevertheless, there has been change, but of a detailed rather than intrinsic nature. Change has been necessary, of course, to enable servicing and testing to keep abreast of the rapidly developing state of the art. For example, some of the early multimeters are now singularly unsuitable for accurate fault diagnosis, testing and adjustments in some of today's solid state equipment. This applies both to the d.c. and a.c. aspects. Transistors and integrated circuits commonly run on smaller voltages than valves, and the currents in some of their circuits are remarkably small meaning the voltage dropped across resistive elements is also of a small magnitude. Thus our test-meters nowadays need to measure very small voltages over a substantial length of scale to maintain accuracy of readout. Moreover, as small voltage settings on such instruments reflect a reducing shunt resistance across the test circuit, the sensitivity of the movement itself must be higher than considered adequate in the valve heyday. Thus while we used to get by with a sensitivity of around 1,000 ohms/volt, we now require a sensitivity of at least ten times that value. Fortunately, development has been on our side, and we can now obtain quite a fair 10,000 ohms/volt species for a relatively modest outlay. Indeed, models are available up to 100,000 ohms/volt.

Current taken by a d.c. voltmeter merely follows Ohm's law. For example, the resistance of a movement giving a full-scale deflection of 1V when passing 1mA of current must be 1,000 ohms. The test circuit will then 'see' a shunt of 1,000 ohms; moreover, it will have to yield the corresponding power to cause the pointer to swing full-scale. If this meter current upsets the circuit conditions the measurement will be in error.

A voltmeter like that has a sensitivity of 1,000 ohms/volt for obvious reasons. If the full-scale deflection is geared, say, to 100V, then series resistance would be included to increase the total resistance as 'seen' by the circuit to 100,000 ohms. But the sensitivity would still be 1,000 ohms/volt. Sensitivity is enhanced only by a movement which gives full-scale deflection for a smaller current. A movement which requires, say, 0·1mA (100μA) yields a sensitivity of 10,000 ohms/volt, while a 10μA movement steps up the sensitivity to 100,000 ohms/volt.

TEST METER ACCURACY

Clearly, it pays to use the highest voltage setting consistent with a usable readout, for then the current drawn from the test circuit is reduced. However, working like that can impair the readout accuracy for two reasons. One because small voltages are not easy to determine on a highish voltage scale, and two because the inherent accuracy commonly tends to deteriorate at small deflections.

Meter accuracy is often geared to full-scale deflection.

GUIDE TO TEST INSTRUMENTS

Thus a specification of $\pm2\%$ of full-scale deflection means that on the 100V range, say, a true 100V could read as 98V or 102V (the latter just in advance of the final calibration mark). However, a true 50V on the same range could read as 48V or 52V, thereby corresponding to an error of $\pm4\%$ at *half-scale* deflection. In practice, therefore, it is best to select a range giving the greater pointer deflection for the applied voltage. In that way the readout error is minimised.

A common multimeter sensitivity is 20,000 ohms/volt, a value which satisfies the requirements for the vast majority of servicing tests in both valve and solid-state equipment. Even so, there are times when even greater sensitivity is demanded; when, for instance, voltage is measured from a high resistance circuit. Unless the current flowing from the test circuit into the meter is minimised, a substantial ratio of voltage will be dropped test circuit, the meter thus recording only a small ratio of the real voltage present without the meter connected.

ELECTRONIC TEST METER

When choosing a test meter, therefore, a major consideration should be the sensitivity voltage. From first principles, the greater the sensitivity the better; but since accurate meters of exceptionally high sensitivity (say, 100,000 ohms/volt) are more costly and possibly somewhat less robust than their lesser sensitivity counterparts, some technicians and enthusiasts prefer the electronic test meter alternative. Such an instrument commonly exploits the same sort of readout (moving-coil movement) as the 'directly applied' instrument just considered, though there are digital equivalents referred to anon. A major difference is that the movement is not operated directly from the power available in the test circuit, but instead from the power inherent in a valve or transistor circuit. In other words, the active (valve or transistor) circuit serves as a 'buffer' between the source and the meter movement, meaning that significantly less power is drawn from the source to work the meter.

Prior to the transistor era, instruments like this were often called valve voltmeters. Even today valves are sometimes employed, but many are now changing over to transistors with the advantage of battery powering and hence portability. A term which embraces both types is *electronic test meter*, but we might still talk of the valve voltmeter or transistor voltmeter.

Valves were particularly handy for the application since the power in the anode circuit is controlled by voltage of extremely low power in the grid circuit. Stemming from this was a very high input resistance, established essentially by the input attenuator, which remained relatively high even on the lowest voltage range. Transistors of the bipolar type are themselves current operated (like the meter movement) and are thus somewhat less matched to the requirement. Nevertheless, over the years circuit artifices have been adopted to secure the highest possible input resistance; the base input, in fact, monitoring the small current from the test source which is then reflected as a much higher collector current in the meter circuit. The field effect transistor, which is endowed with a very high input resistance, similar to that of a thermionic valve, is now extensively used in electronic test meter circuits.

The active circuit, of course, needs to be powered from the mains supply or batteries, and an arrangement is incorporated for setting the pointer of the movement to zero prior to the application of the test voltage.

MULTIRANGE METER

The bread-and-butter instrument is the multirange meter. This comes in both 'directly applied' and electronic form. The most common is the 'directly applied' version, without which it is impossible to perform even the most elementary of servicing operations requiring testing of some kind. The days of 'wet-finger' and neon bulb testing went out with the thermionic valve. Least complex of the species is for d.c. applications only; but the extra initial outlay for an instrument embracing a.c. ranges in addition to the d.c. ones is well warranted. Basic ranges are voltage, current and resistance.

RESISTANCE MEASUREMENT

Resistance is effectively measured in terms of current readout, the reading being directly in 'ohms'. An internal battery supplies the current and this is switched in series with the meter movement and an internal resistive arrangement, a part of which comes out to a 'zero set' control on the front. When the test leads are shorted the meter is caused to read full-scale by control adjustment, corresponding to zero 'ohms'. When the leads are connected across an external resistance the meter current is reduced and the deflection is less, the pointer then indicating the approximate value of the resistance.

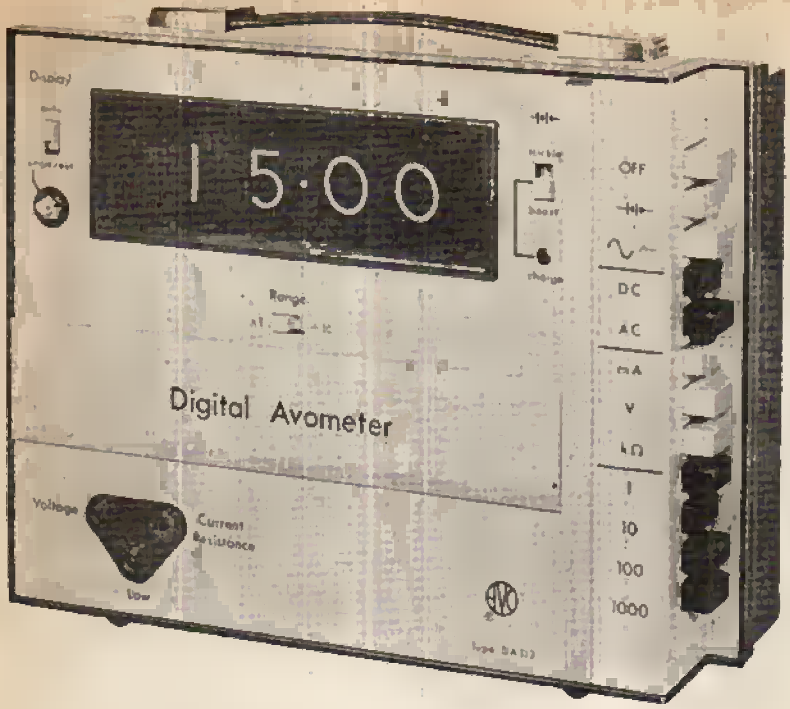
This is the simplest means of resistance measurement. Greater accuracy calls for a special 'bridge' or a more sophisticated direct-reading meter. Most multimeters provide for at least two resistance ranges, but it is not unduly difficult to measure higher values than allowed for by the internal battery by adopting an external battery to give a full-scale deflection on the highest practical voltage range, then introducing the resistance for measurement in series with the battery. This, though, might involve some sort of scale recalibration or mere scale multiplication, depending on the nature of the instrument and the battery voltage.

The greater the voltage sensitivity of the instrument, the higher the resistance value measureable. Very low values of resistance are not so easily measured in the manner expounded; again, a special kind of resistance meter is required for this.

DIRECT CURRENT MEASUREMENT

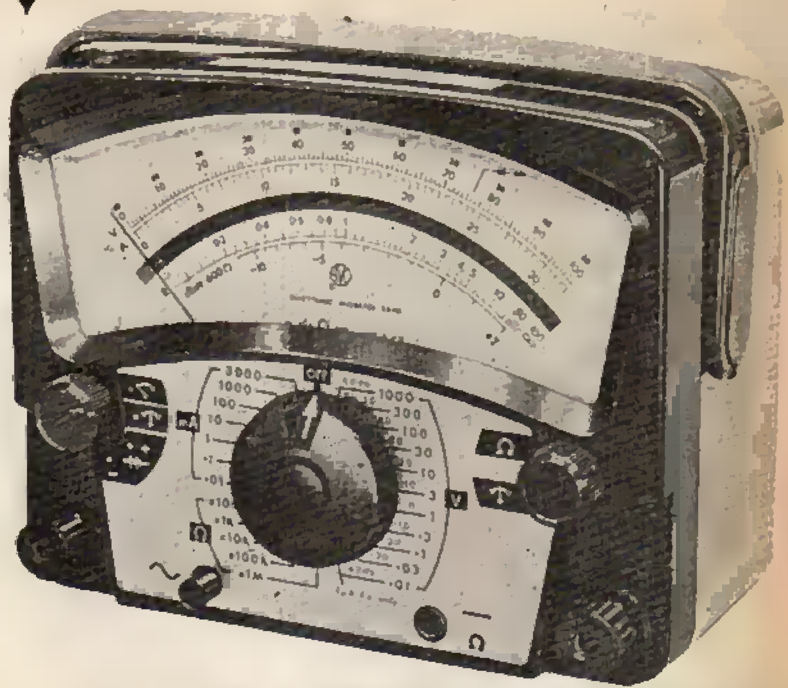
The voltage sensitivity reflects the lowest d.c. measureable. For example, a meter with a d.c. sensitivity of 20,000 ohms/volt would probably have a d.c. current range down to $50\mu A$ (0·05mA), while a 10,000 ohms/volt meter would be unlikely to measure d.c. below $100\mu A$ (all full-scale of course). However, it is noteworthy that this basic relationship is sometimes affected by meter movement 'padding', which may be adopted partly for calibration purposes and partly for temperature compensation, with meter overload protection probably having some influence.

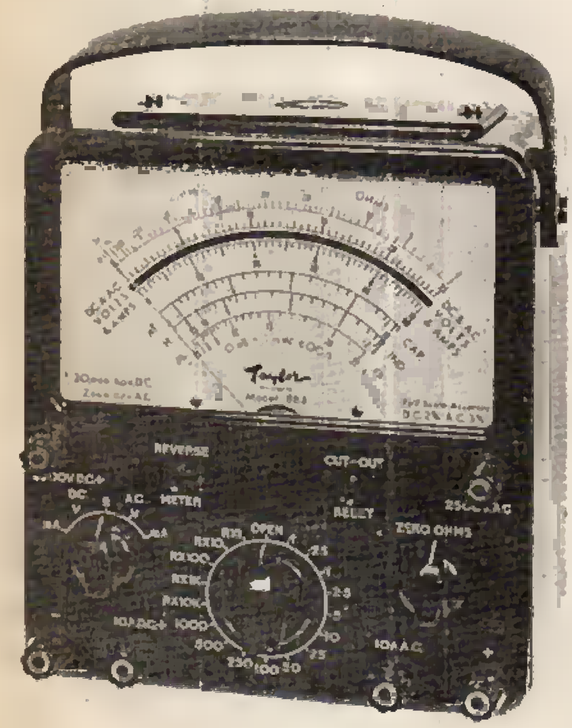
For testing in transistor circuits a meter of 20,000 ohms/volt sensitivity reading full-scale down to about 0·1V



▲ Fig. 1: The multimeter of the future—the Digital Avometer.

Fig. 2: The latest Electronic Avometer which operates from 4 mercury cells. Extensive multimeter range coverage is provided (see text). ▼

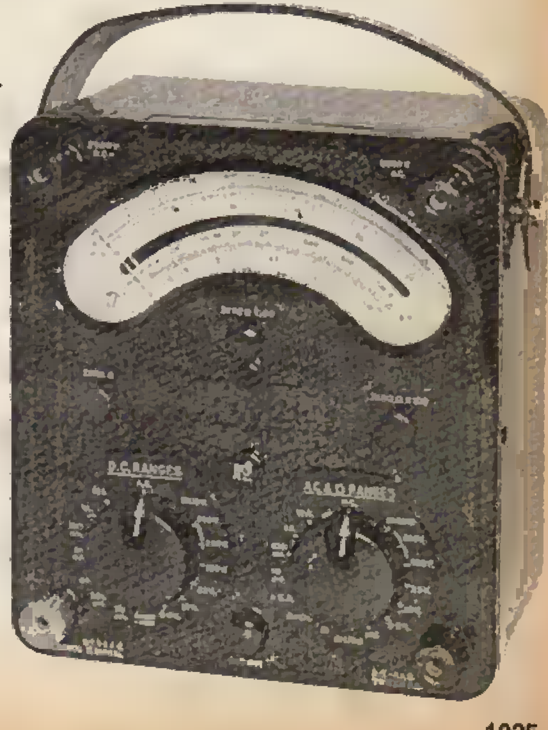


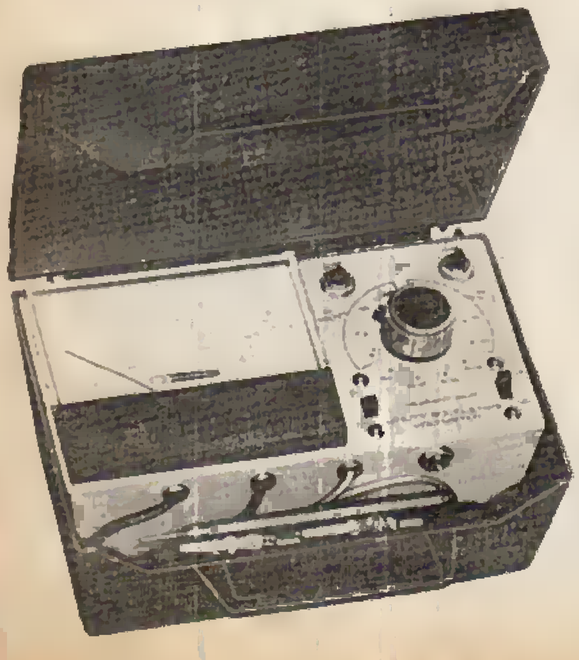


◀ Fig. 3: The popular Taylor multimeter, Model 88B with a sensitivity of 20,000 ohms/volt d.c. and 2,000 ohms/volt a.c. Some idea of the scope range can be gleaned from the picture. Also see text.

Fig. 4: Eagle K-1400 volt/ohm/milliammeter in action. This has a sensitivity of 20,000 ohms/volt d.c. and 5,000 ohms/volt a.c. and measures d.c. voltage 0–5kV in 8 ranges at accuracy better than ±3% f.s.d., a.c. voltage also 0–5kV but in 6 ranges, d.c. current 0–10A in 6 ranges, a.c. current 0–10A in 4 ranges and resistance in three ranges, to 20MΩ. Frequency response 10Hz to 100kHz (for 2·5V, 10V and 50V a.c. ranges), and a dB scale is fitted. ▲

Fig. 5: An old favourite updated. The Avometer Model 8 MkIV. Meter movement sensitivity 50μA full-scale, providing a sensitivity of 20,000 ohms/volt on d.c. and 2,000 ohms/volt on a.c. Features include movement reverse control and overload protection. A.C. voltage accuracy maintained up to 15kHz on 250V range, suitable for audio frequency measurements. A dB scale is included. ▶





◀ Fig. 6: Heathkit Utility Solid-State Voltmeter, Model IM-17. This employs 4 silicon transistors, 1 field effect transistor and 1 silicon diode and has 4 d.c. voltage ranges from 1V to 1kV (full-scale) and 4 a.c. voltage ranges from 1·2V to 1kV (full-scale).

GUIDE TO TEST INSTRUMENTS

(100mV) would be useful. Complementary ranges might than be 0·25V, 1V, 2·5V, 5V, 10V, 25V, 50V, 100V, 250V, 500V, 1kV and, perhaps, 2·5kV. Remember that we often need to measure with fair accuracy down to 0·25V or less in transistor stages, so it is essential for the meter to feature well proportioned ranges down to at least 0·25V full-scale.

D.C. current ranges are also important, but possibly marginally less so than voltage ranges. This is because when testing in printed circuit equipment we endeavour to calculate the current by measuring the voltage dropped across a known value resistor in the circuit carrying the current, simple Ohm's law then giving the answer without the need to break the circuit to introduce a current meter.

Well proportioned voltage ranges are generally reflected in the d.c. current ranges, from the lowest full-scale value allowed by the meter movement to several amperes without external shunts. For example, a 20,000 ohms/volt multimeter might have full-scale ranges of 50µA, 100µA, 250µA, 500µA, 1mA, 2·5mA, 5mA, 10mA, 25mA, 50mA, 100mA, 500mA, 1A and 10A. These, it will be noticed complement the voltage ranges just mentioned.

A.C. MEASUREMENTS

A multimeter designed to measure a.c. *voltage* might not be equipped to measure a.c. current. There are two versions, the less costly one that measures a.c. voltage and the more costly one that measures a.c. current as well as voltage. In the valve days a.c. current measurements were more important than they are today, for valve heater current was an important parameter.

It is still desirable to be able to measure a.c. voltage, however, for some audio equipment, in particular, is sensitive to main voltage. We also commonly need to know the a.c. voltage across the secondary windings of the mains transformer feeding the rectifier or the a.c. voltage applied, say, to the motor of a tape recorder or turntable unit. To some extent, depending on instrument design, we can also use the a.c. voltage ranges to measure audio signal provided the level is sufficiently high. This is said with some qualification, however, since the meter loading on the signal source and the frequency response shortcomings of the meter circuit can seriously affect the readout accuracy.

A moving-coil movement responds correctly only to direct-current. This means that for a.c. measurements the instrument uses a rectifier, often of the bridge type. The nature of the a.c. circuit reduces the instrument's sensitivity on the a.c. ranges, and it is not uncommon to find that the a.c. sensitivity of a meter with a d.c. sensitivity of 20,000 ohms/volt is around the 2,000 ohms/volt mark. The a.c. volts ranges are thus generally fewer than the d.c. volts ranges, starting at about 1V full-scale instead of, perhaps, 100mV.

A meter which also measures a.c. current is similarly restricted, the first full-scale range being, perhaps, 1mA instead of 50µA or 100µA, as on d.c.

Knowing the mains loading (e.g., W=VA) of a radio receiver or item of audio equipment—even if solid state—sometimes provides a clue as to a possible fault condition, and as this can be obtained only by measuring the a.c. input current the meter can usefully possess at least a fairly high current range.

The a.c. ranges are scaled in root mean square (r.m.s.) values based on sinewave input. Thus a signal which deviates from pure sinewave form will fail to provide an accurate r.m.s. indication.

OTHER MULTIMETER MEASUREMENTS

More advanced multimeters incorporate additional features which are sometimes useful for servicing applications. For example, a decibel scale (or scales) can be used in conjunction with the a.c. voltage ranges to measure the power response, say, of an audio amplifier, provided that the frequency response of the meter is reasonably 'flat' over the audio spectrum and that the voltage ranges match the audio voltage across the load ($W=E^2/R$). It is common for 0dB to correspond to 1mW into 600 ohms, and the scale or scales may extend from −10dB to +60dB or more.

Some models also provide for the measurement of capacitance and inductance with an external adaptor (the Taylormeter, Model 38B, for example).

MULTIMETER FEATURES

More costly versions are equipped with either mechanical or electronic overload protection, which is certainly very useful in the service workshop!

Another handy fitment is a switch for reversing the polarity of the test leads. Thus if the meter deflects against the stop, the switch can be operated to give a normal forward reading.

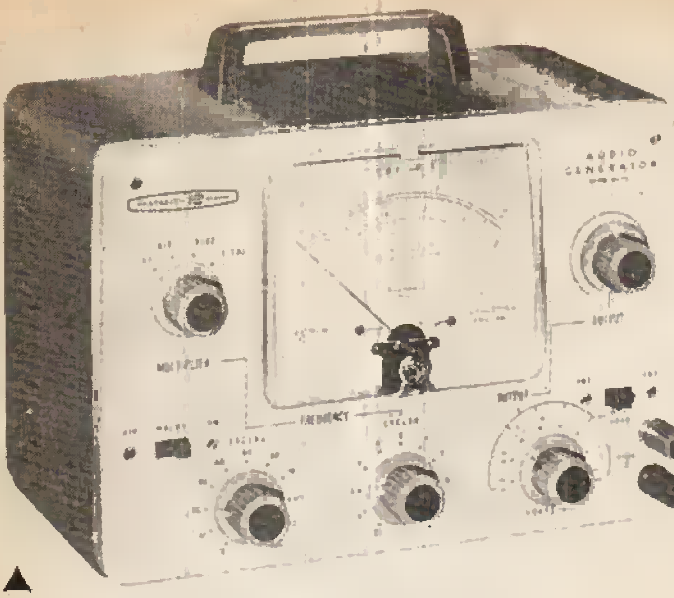
Maximum readout accuracy is given by the models with large scales (5in. or so), and to avoid reading error due to parallax effects, a section of the scale may carry a mirror (called anti-parallax mirror) so that the pointer can be aligned with its reflection when the reading is taken.

Number of ranges and facilities provided by a multimeter, of course, reflect its price. The small 'pocket' instruments are useful for field activities, but for workshop applications a more valuable investment is desirable.

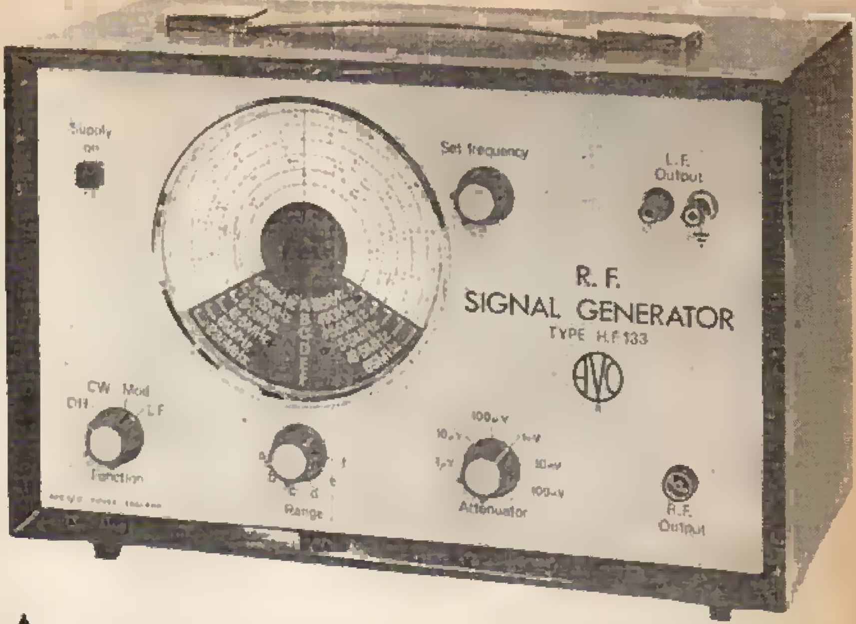
ELECTRONIC MULTIMETER

The electronic multimeter generally boasts features in advance of those already described. The high input impedance is a useful attribute for certain tests, this sometimes being around 11M on d.c. and 1M or so on a.c.

A.C. frequency response, too, is significantly enhanced, sometimes by an external diode probe. The Heathkit 'Utility Solid-State Voltmeter', for example, has a ±1dB response from 10Hz to 1MHz. If the voltage sensitivity is in the order of millivolts full-scale, then such an instrument can almost be employed as an audio milli-voltmeter. The Avo Electronic Avometer Type EA113 goes down to 10mV on its lowest range with an accuracy of ±1·25% from 20Hz to 25kHz which makes it quite suitable for audio applications. The Grundig 'Universal Voltmeter', Model UV30 is another model suitable for audio work, in addition to the measurement of voltage and current, a.c. and d.c. This goes down to 100mV full-scale on the a.c. range with an accuracy of ±3% from 10Hz to 100kHz ±0·5dB. The instrument is battery powered and adopts field effect transistors.

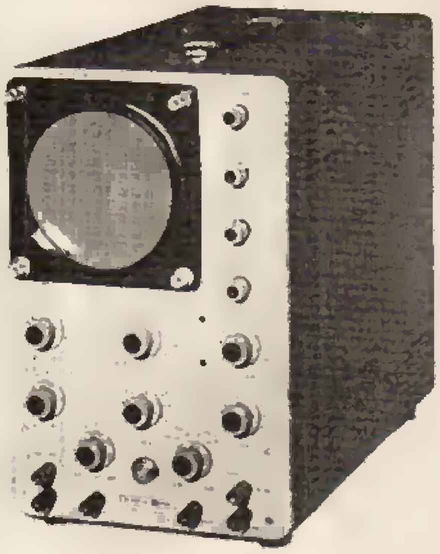


▲
Fig. 7: Heathkit Audio Generator, Model AG-9U. Frequency range is from 10Hz to 100kHz with less than 0·1% distortion from 20Hz to 10kHz. Output voltage is indicated on a 4½in. meter with three scales of 1 and 3 volts and −10 to +2dB.



▲
Fig. 8: An a.m. signal generator by Avo, Model HF133. The picture shows the facilities provided.

Fig. 9: The Heathkit (Heath, Gloucester Ltd.) Model I0-18U oscilloscope. This general purpose model has a 5in. tube, 4·5MHz bandwidth and 30mV (p-p)/cm. sensitivity. Sweep goes from 10Hz to 500kHz. ▶



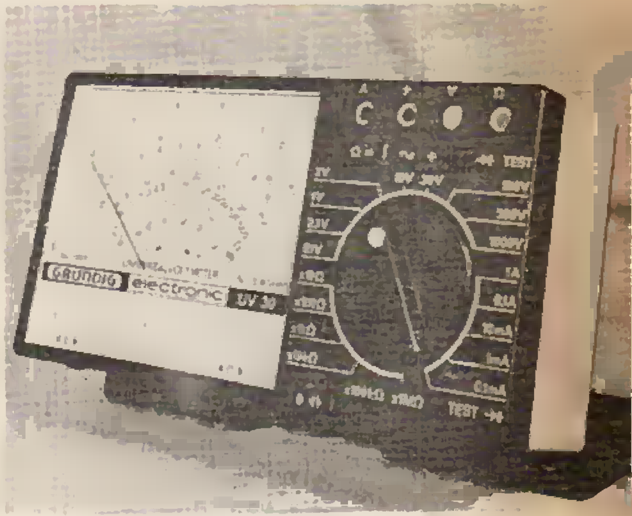
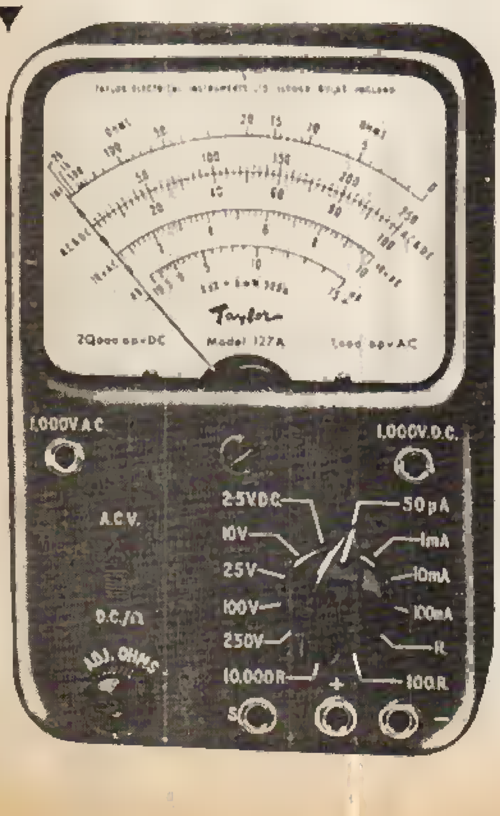
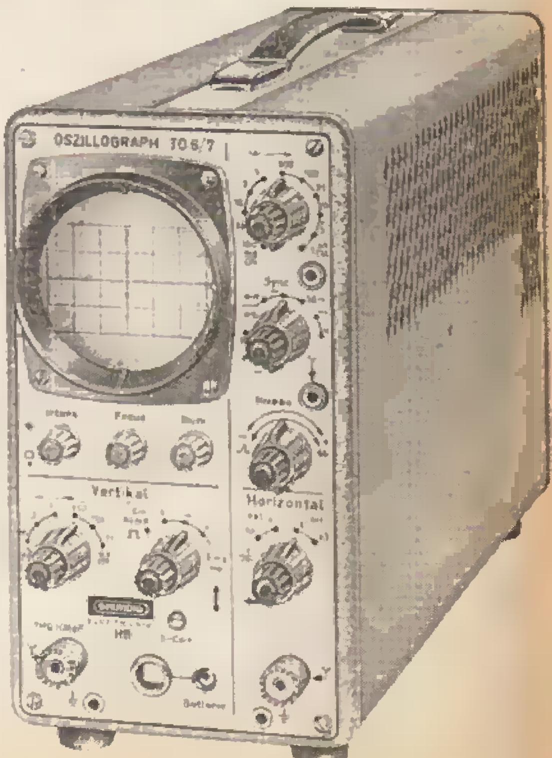


Fig. 10: A Universal Voltmeter by Grundig. Model UV30. This uses field effect transistors, is battery powered and pocket size. Impedance as high as 30M and resistance measurement from 1Ω to 500MΩ. ▲

Fig .11: A pocket-sized multimeter by Taylor, Model 127A. This is suitable for bench and field work in industry and for the student and amateur radio enthusiast. Sensitivity is 20,000 ohms/volt d.c. and 1,000 ohms/volt a.c.
▼



▶
Fig. 12: Grundig Oscilloscope Model TO 6/7. This is an example from the very wide range of test instruments by Grundig. Using solid-state devices, it is suitable for mains and battery powering, with facilities for powering from external vehicle battery. Y bandwidth 0-6MHz −3dB and sensitivity 30mV/cm.



GUIDE TO TEST INSTRUMENTS

For checking the gain of r.f. and i.f. stages one needs to measure r.f. and i.f. input and output signals, and this mode of measurement is sometimes catered for by a diode probe designed for use with an electronic multimeter or similar instrument. Signals up to 100MHz (sometimes higher) can be measured by this method.

AUDIO MILLIVOLTMETER

This instrument differs from the multirange electronic meter in that it is designed to measure a.c. voltage only from low audio-frequency up to 30kHz or more. Some models, in fact, measure up to 1MHz or beyond this into the video-frequency spectrum.

Design is based on high response accuracy over the intended frequency range and also very high sensitivity on the low ranges. Indeed, some ultra-sensitive models give full-scale deflection from a signal as low as 100μV (sometimes less!). With such sensitivity it is possible to measure very low-level audio signals, such as those delivered by a magnetic pickup cartridge or microphone.

A multiplicity of ranges, based on a calibrated input attenuator, often extends the full-scale readout to several volts or tens of volts. Readings are commonly scaled in r.m.s. values, though there may also be peak voltage scales or a switch or control to change the readout from r.m.s. to peak.

As this sort of instrument is designed for audio and video applications it is almost certain to feature a decibel scale. The moving-coil meter is operated from rectified signal obtained from the output of an amplifier, the various ranges being catered for by switched attenuators.

Mains and battery powered versions are available and quite a few models are equipped with an amplifier output socket, prior to the meter rectifier, so that the measured signal can be viewed on the screen of an oscilloscope. This is useful when the instrument is reading audio distortion via a distortion analyser, for the 'scope display then reveals the nature of the harmonics of which the distortion is composed. Battery-powering leads to portability and reduces hum-loop problems when tests are being made in low-level circuits.

DIGITAL READOUT

Although digital instruments are fast becoming popular in laboratories, it will be some time before we can afford them specifically for servicing and experimental applications. At the time of writing a digital multimeter costs about three times more than an equivalent analogue instrument.

For lab. work the appeal lies in the accuracy, ease of readout and high sensitivity. For example, the Digital Avometer, Model DA112 features voltage ranges from 100μV to 1·5kV (with a 50% over-range facility) at an accuracy to 0·1%. Readout is from a 3½ digit display with automatic decimal pointing, and the design covers both mains and battery powering.

Cost lies essentially in circuit complexity, but with the advancement of integrated circuits (of which many already employ) and mass demand, the cost is almost certain to decline eventually, though this may not be in the very near future!

SIGNAL GENERATORS

For radio servicing the signal generator must yield a modulated carrier-wave and operate over the bands corresponding to those tuned by the receiver. Modulation, too, must match the design of the receiver. Thus a.m. receivers require amplitude-modulation and f.m. ones frequency-modulation. The generator should also tune over the i.f. spectrum, commonly 10·7MHz f.m. and 470kHz a.m.

An important part of the design is the output attenuator. This should be reasonably accurate so that a fair approximation of the strength of the signal fed to the receiver is known. This is necessary for determining the sensitivity of the receiver. Calibration is either in decibels below the maximum signal output (sometimes referred to 0dB) or direct in μV and mV. A switched attenuator generally sets the output range, which is then controlled by a 'fine' attenuator.

Some models have facilities for varying the modulation depth and a meter for setting the signal level prior to the attenuator, but for general servicing applications such refinements are not essential.

For range extension harmonic working is sometimes adopted. This is not generally a desirable scheme, although it tends to reduce cost. Fundamental working even into the higher frequency bands makes life less complicated and reduces errors which can sometimes result from harmonic working.

Models designed for radio and television servicing commonly incorporate a fixed-frequency audio oscillator, at 400Hz or 1kHz, for modulating the carrier-wave, and the signal from this is often brought out to a front socket, either at 'full force' or via a variable attenuator. This signal is useful for making tests in audio sections of receivers and in amplifiers. Modulation depth is fixed at approximately 30%, though it can vary slightly over the frequency ranges.

Even though the instrument might produce only amplitude-modulation, provided the modulation can be switched off and the r.f. range embraces Band II (from about 87 to 108 MHz), it can be used for f.m. receiver servicing to some extent (this will be explained in the forthcoming series).

F.M. generators are usually more costly than a.m. counterparts, but models are made which switch over a.m. and f.m., covering the range from about 130kHz to 250MHz over various bands.

For the visual alignment of radio receivers (using an oscilloscope to display the response characteristic), a special kind of signal generator is required, commonly referred to as a 'wobbulator'. The r.f. output from this swings either side of the nominal carrier frequency in synchronism with the X sweep of the oscilloscope, sufficient to embrace the full width of the response. A reponse display is then obtained by feeding the detector output of the receiver to the oscilloscope Y input.

AUDIO GENERATOR

For audio testing the generator should tune from at least 20Hz to 20kHz; but many go above this frequency. Signal output is a sinewave, but many instruments can be switched to change the sinewave to a square-wave,

Fig. 13: For more advanced measurements and tests, this Universal Bridge by Avo, Model B.150, caters for a wide range of inductance, capacitance and resistance measurements. Balanced null point is indicated by a meter, while the value of the component under test is automatically presented in digital form.

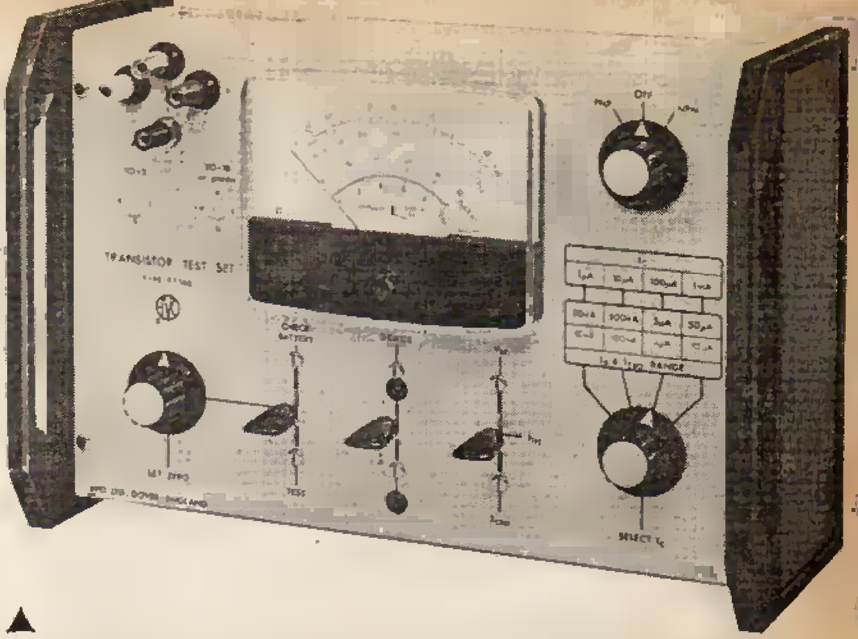


Fig. 14: Avo Transistor Test Set, Model TT.166. Design is for the measurement of bipolar transistor d.c. parameters. Tests can be made at very low collector currents appropriate to modern devices (1μA to 1mA), p-n-p and n-p-n. Operation is from two internal 9V batteries.

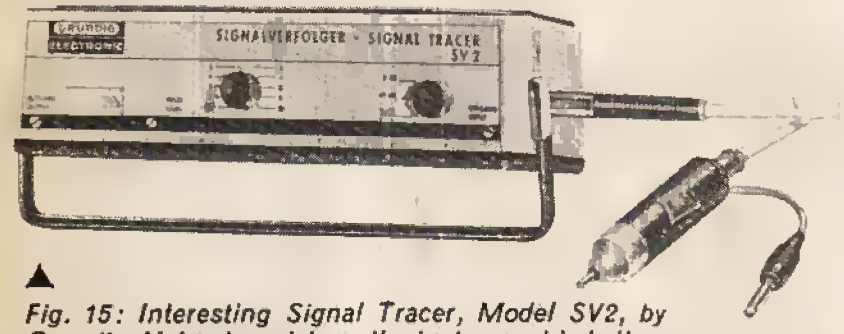


Fig. 15: Interesting Signal Tracer, Model SV2, by Grundig. Using transistors, the instrument is battery powered and of handy size. Signal is traced via a test prod which, after amplification, is indicated by meter or loudspeaker.

Fig. 16: The still popular Taylor Model 68A/M signal generator. Frequency range is from 100kHz to 240MHz (all on fundamentals) over 8 ranges. Although a.m. only, the instrument is suitable for the alignment of ratio detectors and f.m. r.f. and i.f. stages. A variable 400Hz audio output is available and an r.f. monitoring meter allows accurate setting of the signal applied to the attenuators.

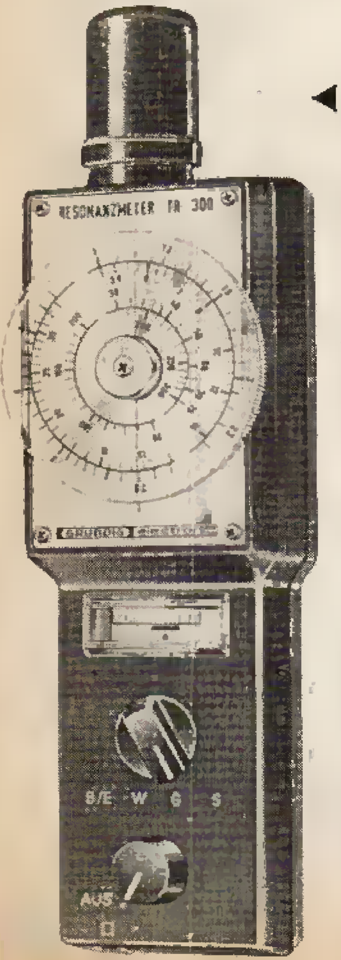
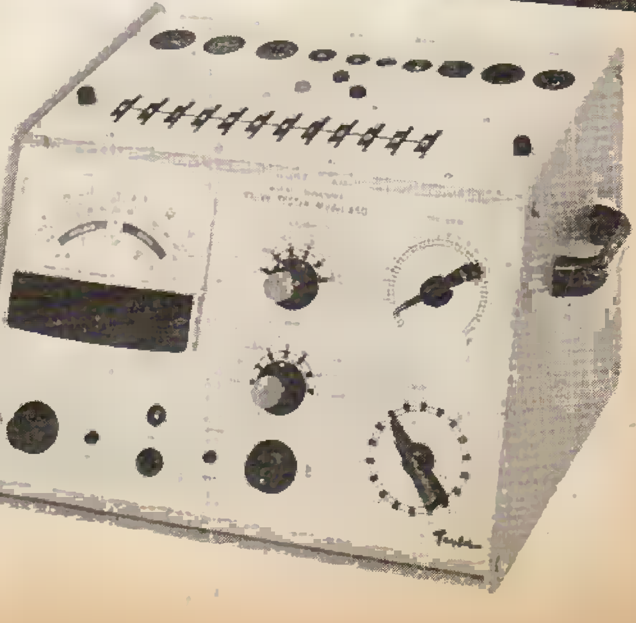


Fig. 17: Grundig Grid Dip Resonance Meter, Model TR300. This model covers 0·95MHz to 300MHz in 8 ranges (Model TR30 95kHz to 30MHz) and is battery powered. A very useful instrument for experimenters since not only is the frequency of an external tuned circuit indicated by a change in current, but switching changes the mode to absorption wavemeter and receiver, operated through a headphone set.

Fig. 18: Taylor Valve Tester, Model 45D. This general purpose instrument is capable of testing almost all thermionic valves with the exception of the larger transmitting type. There are ten valve bases, including the more recent B10B and B9D, and a special B14E base accepts a range of plug-in adaptors available; to cover new and old valves. Mutual conductance is measured (emission of diodes), and there is also a "replace —?— good" scale for speedy appraisal.



GUIDE TO TEST INSTRUMENTS

useful for 'transient' testing audio amplifiers.

The sinewave must be as pure as possible, especially when the signal is to be used for distortion measurements, and for this application the total harmonic distortion on the signal should be significantly less than 1%. However, it is possible to 'filter' the signal from a generator of relatively high distortion to delete the harmonics, thereby making it more suitable for t.h.d. measurements (this, too, will be explained in the forthcoming series).

Maximum output should be a volt or two (r.m.s.), and the attenuator should reduce this in decrements of 20dB, with a 'fine' attenuator varying the 'set output' down to zero. It is also important for the audio signal output to remain substantially constant over the entire frequency range.

OSCILLOSCOPE

For many radio and audio applications an oscilloscope with a Y bandwidth up to 3MHz can be very useful. Cost can be cut by building one's own from a kit of parts, such as the excellent Heathkits. The General Purpose Service Oscilloscope, Model OS-2 is a good illustration. This, by Heathkit, sells at £29·20 (carriage 60np) as a kit and for £44·20 (same carriage) in ready-to-use form.

For more specialised circuit investigations, however, a Y bandwidth to −3dB points) up to 10MHz and beyond is demanded; this applies to the study of very fast pulse signals and transients, etc.

X bandwidth is less critical for most normal applications (that of the Heathkit being 2Hz to 300kHz ±3dB, and the Y bandwidth 2Hz to 3MHz ±3dB). Y sensitivity (e.g., vertical deflection of the spot) is also important, and this should be at least 250mV p-p per cm. A useful feature is a 'voltage calibrator' which switches an a.c. voltage of known amplitude to the Y input.

For use with a wobbulator an X (timebase) output terminal should be available, this then being coupled to the X or sweep input of the wobbulator for securing a response display as already mentioned.

X sweeps should match the Y bandwidth in terms of waveform time. These are sometimes given as time (μS, mS or S) per cm. of horizontal sweep.

It is also useful to be able to switch off the timebase so that external signals can then be applied to both the Y and X amplifiers. Certain tests of phasing require the use of these two circuits without the influence of the timebase.

The display is locked on the screen by a synchronising signal from the source, and most recent 'scopes embody an automatic circuit for this, the sync signal being extracted internally from the test signal.

Most instruments designed for general servicing still run on valves, particularly the less costly ones, but there is a trend towards the use of solid-state devices, giving a choice of mains or battery powering and the bonus of portability.

Screen diameter is not all that important for radio and audio servicing, though obviously the larger, the better; but some sort of calibration is desirable, and this commonly takes the form of a graticule scribed in cm. squares.

Another useful feature is X expansion. This merely consists of an amplifier through which the timebase signal passes to the X plates of the cathode-ray tube. With the X expansion control—a variable attenuator—fully clockwise horizontal deflection just fills the screen. As the control is advanced so the deflection increases. It is thus possible to expand a waveform display horizontally (as well as vertically by the Y attenuator) to allow otherwise hidden artifacts to be examined. Turning on X expansion is tantamount to increasing the timebase sweep velocity, so the expansion control complements the sweep control.

It is sometimes required to examine two signals simultaneously and to compare one with the other. For this a dual beam 'scope is needed, with duplicated Y amplifiers, etc. Such instruments cost more than the single beam variety and are found mostly in laboratories. However, it is possible to secure two displays from a single beam model electronically, using a special switch. A good example is the Heathkit Electronic Switch, Model S-3U, which costs £16·30 as a kit or £28·30 in ready-to-use form.

DISTORTION ANALYSER

For audio amplifier servicing of a serious nature an important instrument is the distortion analyser. Basically, this consists of a tunable notch filter through which a sinewave signal after passing through the amplifier is fed to a sensitive audio millivoltmeter. The sinewave signal fed to the input of the amplifier under test is obtained from a low distortion audio generator, and the idea is that the 'notch' deletes the fundamental leaving only the harmonics. These are measure by the audio millivoltmeter and their total voltage is then compared with that of the sinewave signal proper across the same output load in terms of percentage total harmonic distortion.

A laboratory instrument at reasonable cost—Model Si452—is made by J. E. Sugden & Co. Ltd. of Cleckheaton, Yorkshire. When complemented with a millivoltmeter and generator t.h.d. readouts to less than 0·1% are possible.

Integrated instruments (e.g., embodying the audio generator and readout) are also available. These are generally very costly instruments, but for less exacting work inexpensive Heathkit models are available, one for t.h.d. measurement (Model M-58U) and another for intermodulation distortion analysis (Model IM-48).

It is obviously impossible to survey the whole field of servicing test instruments in a supplement of limited space, but it is hoped that the foregoing, and the accompanying illustrations, will give a fair impression of the type of instruments currently on offer.

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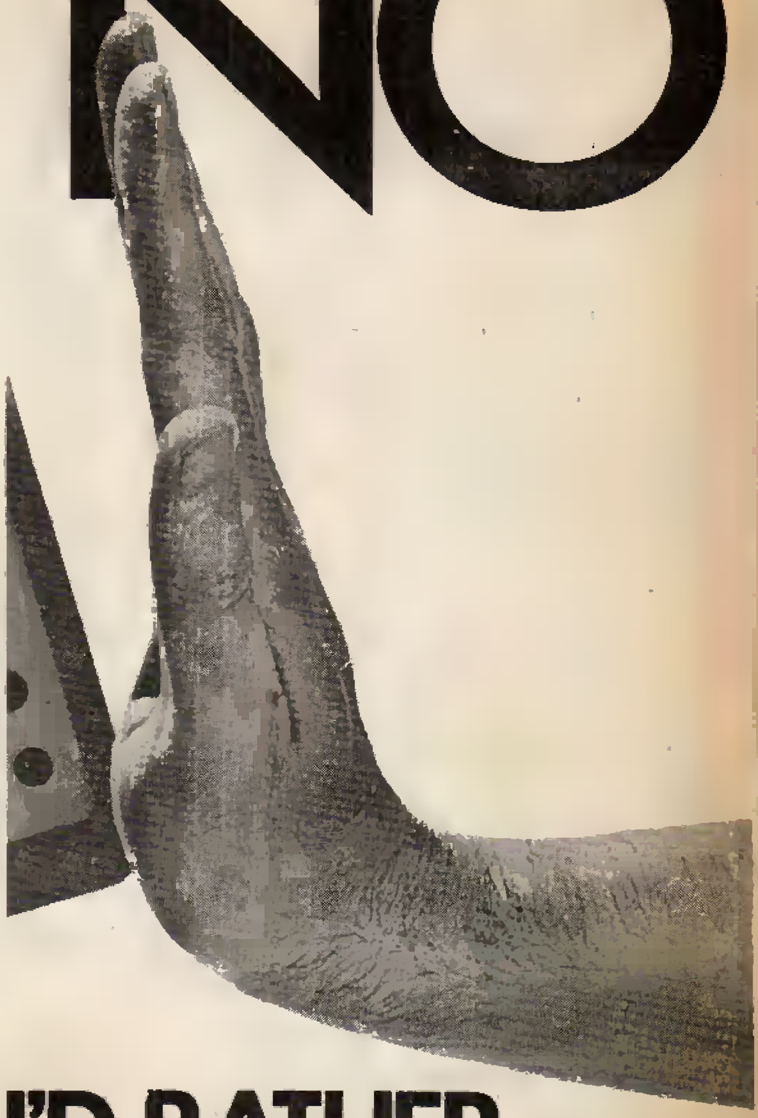

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2N5458	37p
2N5459	50p
2S301	50p
2S302	50p
2S303	60p
2S304	75p
40250	50p
40361	55p
40362	60p
AAY30	10p
AAY42	15p
AAZ13	12p
AAZ17	10p
AC107	37p
AC126	25p
AC127	25p
AC128	25p
AC176	25p
AC187	30p
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AF178	47p
AF179	47p
AF180	52p
AF181	42p
AF186	40p
AF239	42p
ASY26	25p
ASY27	32p
ASY28	25p
ASY29	30p
ASY67	47p
ASZ21	42p
BA115	7p
BA164	10p
BAX13	6p
BAX16	7p

BAY31	7p
BAY38	17p
BC107	12p
BC108	12p
BC109	12p
BC113	25p
BC114	35p
BC115	32p
BC116	40p
BC116A	45p
BC118	37p
BC119	50p
BC134	37p
BC135	30p
BC136	35p
BC137	40p
BC138	40p
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BD132	85p
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BDY17	£1·50
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BDY19	£1·97
BDY61	£1·25
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BF197	15p
BF200	37p
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BFW90	22p
BFW91	20p
BFX13	25p
BFX29	30p
BFX30	32p
BFX37	32p
BFX84	30p
BFX85	40p
BFX86	32p
BFX87	32p
BFX88	30p
BFY18	30p
BFY50	22p
BFY51	20p
BFY52	22p

BFY53	17p
BFY64	42p
BFY90	65p
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BSX21	37p
BSX76	15p
BSY95	15p
BSY95A	15p
BY100	15p
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SC40B	200	6 amps	£1·20	£1·00	85p	80p
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SC45D	400	10 amps	£1·50	£1·35	£1·20	£1·10
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IN4002	100	9p	8p	7p	5½p	4½p
IN4003	200	10p	9p	7½p	6p	5p
IN4004	400	10p	9p	8p	7p	6p
IN4005	600	12p	10p	9p	7p	7p
IN4006	800	15p	14p	12p	11p	9p
IN4007	1000	20p	16p	13p	12p	10p

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Type	P.I.V.	1-49	50+	100+	500+	1000+
PL4001	50	10p	9p	8p	7p	6p
PL4002	100	11p	10p	9p	8p	7p
PL4003	200	12p	11p	10p	9p	8p
PL4004	400	12p	11p	10p	9p	8p
PL4005	600	15p	13p	11p	10p	9p
PL4006	800	17p	15p	13p	12p	10p
PL4007	1000	20p	17p	15p	13p	11p

3 AMP PLASTIC WIRE ENDED RECTIFIERS

Type	P.I.V.	1-49	50+	100+	500+	1000+
PL7001	50	20p	18p	17p	16p	14p
PL7002	100	20p	19p	18p	17p	15p
PL7003	200	22p	20p	19p	18p	16p
PL7004	400	25p	23p	21p	20p	18p
PL7005	600	26p	24p	23p	22p	20p
PL7006	800	27p	25p	24p	23p	21p
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1002	100	2 amps	60p	55p	50p	45p
2002	200	2 amps	70p	65p	60p	55p
4002	400	2 amps	80p	75p	70p	65p
504	50	4 amps	60p	55p	50p	45p
1004	100	4 amps	70p	60p	55p	50p
2004	200	4 amps	75p	70p	65p	60p
4004	400	4 amps	80p	75p	70p	65p
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BYZ12	400	30p	25p	20p
BYZ13	200	25p	20p	17p

10AMP RECTIFIERS

	P.I.V.	1-49	50+	100+
SK103	100	45p	40p	37p
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SK403	400	55p	50p	45p
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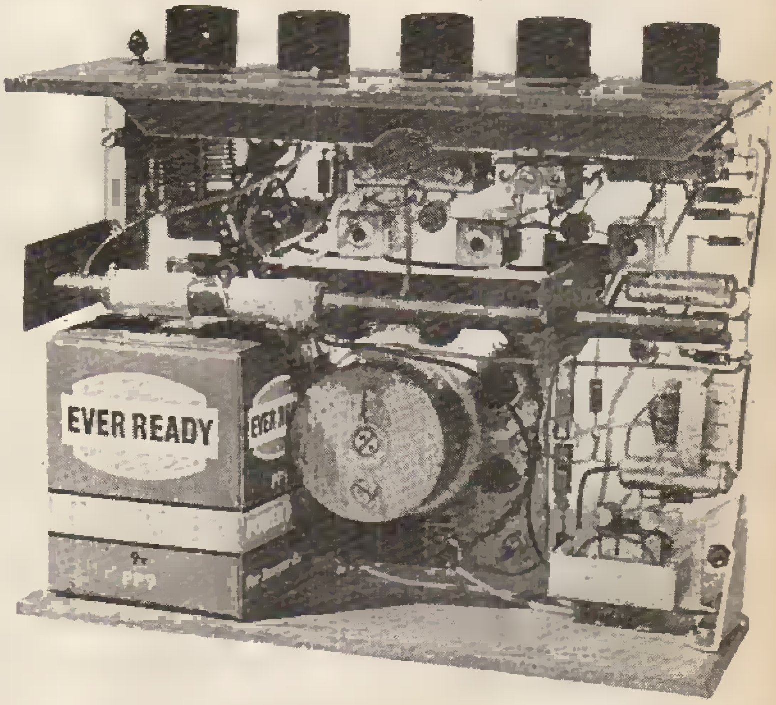
'STATION FOCUS' SIX

At best the performance of the average superhet receiver depends largely upon the proper alignment of the various tuned circuits. In this 'no-compromise' medium and long wave receiver, the "Station Focus" Six, separate panel controls are included for the correct alignment of the critical circuits.

The prototype has been built on a clear perspex panel, as shown on the right, and the photographs included in the article will greatly assist the construction and later checking of the circuit.

An attractive but simple wooden cabinet completes the receiver which, because of its simplicity is ideal for the beginner but because of its performance is also suited to the more advanced constructor.



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It is written by G. J. King and H. W. Hellyer, authors of previous popular series on servicing. Be certain not to miss the start of this new series.

AUDIO FANS ARE NOT FORGOTTEN IN THE NEXT ISSUE AND A 10W TRANSISTORISED AMPLIFIER INCLUDING PREAMP. IS DESCRIBED.

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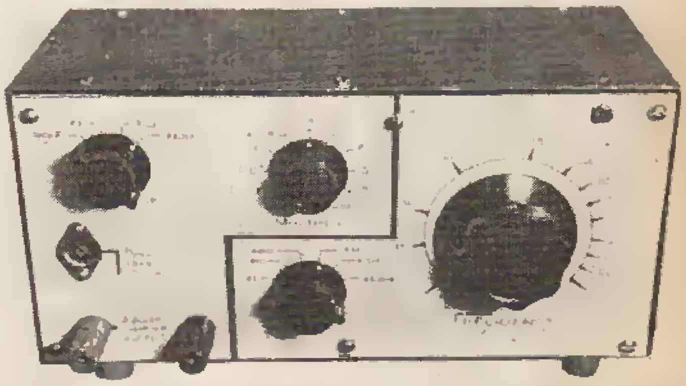
hi-fi

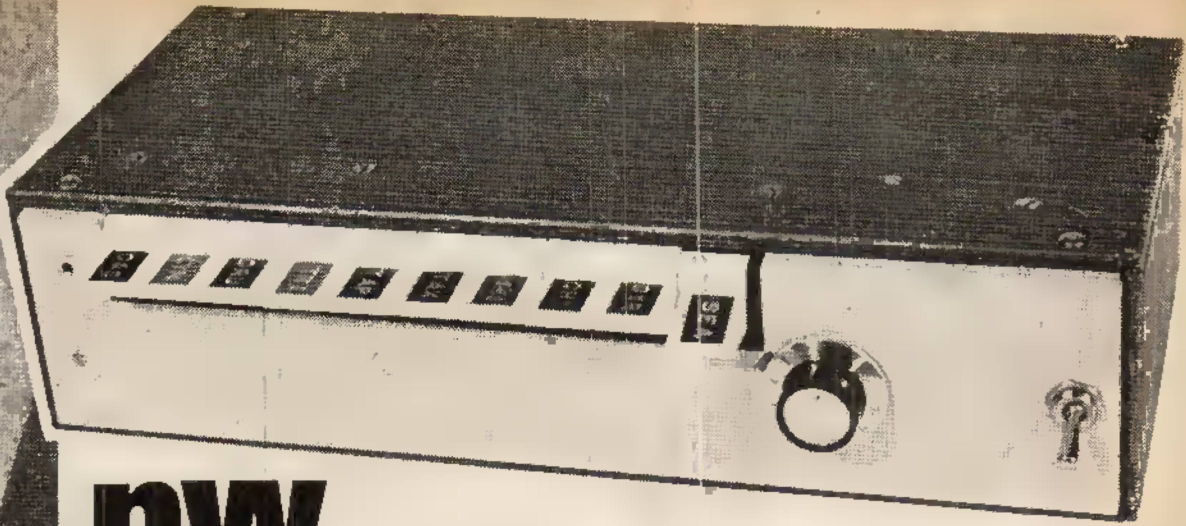
SIGNAL GENERATOR



The high standards of modern audio amplifiers have made many older audio signal generators obsolete; it is obviously a waste of time trying to trace 0.1% distortion if the inherent distortion of the source is comparable.

Confidence in test gear is important and for this reason, starting in the May issue, the circuit and complete building instructions are given for a laboratory quality signal generator. Distortion at 1kHz is a mere 0.01% and output ranges run from 15Hz to 150kHz ± 1dB though an additional range goes up to 1.5MHz.

Output can be up to 12V peak-to-peak and either sine or square wave outputs can be selected.



pw sound effects SYNTHESISER

PART 2

F.C.JUDD

THE general layout of the complete unit and the circuits for castanets, cymbal and snare drum were dealt with in Part 1. With the exception of the Bell Chime circuit, all the others can be constructed and operated individually as each has a fairly large signal output. If all the generators are to be used together i.e., as in the original unit, they must be finally connected together via a mixing output pre-amplifier which will be dealt with later.

The next circuits include the Triangle No. 4, Wood Block No. 5, Taxi horn No. 6, Train Whistle No. 7 and Bell Chime No. 8 and each is assembled on an s.r.b.p. board as those in part 1. As will be seen from the board layout diagrams given in this article, some boards are pretty full with components. For this reason the components used should be as physically small as possible.

Circuit for Triangle—No. 4

The sound of a triangle is clear and high pitched and the waveform almost sinusoidal. The circuit as in Fig. 11 therefore, employs a phase shift oscillator adjusted for a frequency of approximately 4500Hz. The output from the oscillator Tr1 is first attenuated via R21 and then taken to the control amplifier Tr3. This amplifier is triggered by Tr2 which generates a control voltage waveform as shown in the Triangle Circuit waveform B Fig. 21. When the key No. 4 is closed a pulse (Triangle Circuit waveform A) is generated which causes Tr2 to conduct. This brings the emitter of Tr2 almost up to the supply voltage and C9 becomes charged. Tr3 takes it's h.t. from C9 which then slowly discharges and produces the required decay effect. The sine-wave output from Tr1, although considerably attenuated, does slightly overdrive Tr3 and this helps to provide the characteristic metallic sound of a triangle. Note that the key click filter C7/R9 must be included. The resistor R14 in series with C9 reduces the otherwise very hard attack and C9 itself determines the decay time. If C9 is made larger the decay time will be larger and vice versa. The pitch should be adjusted as close as possible to 4500Hz and this can be done by either reducing the value of R1 slightly or by connecting another resistor in parallel as R1A. The circuit board layout is shown in Fig. 12.

Circuit for Wood Block—No. 5

This is a little less complicated than the other circuits and employs only two transistors. The circuit is shown in Fig. 13 and in this Tr1 is a phase shift oscillator biased to cut off and is turned on only when Tr2 conducts i.e., when the key (No. 5) is closed. The pitch and decay time are both very important if a realistic sound is to be produced. For instance, if the

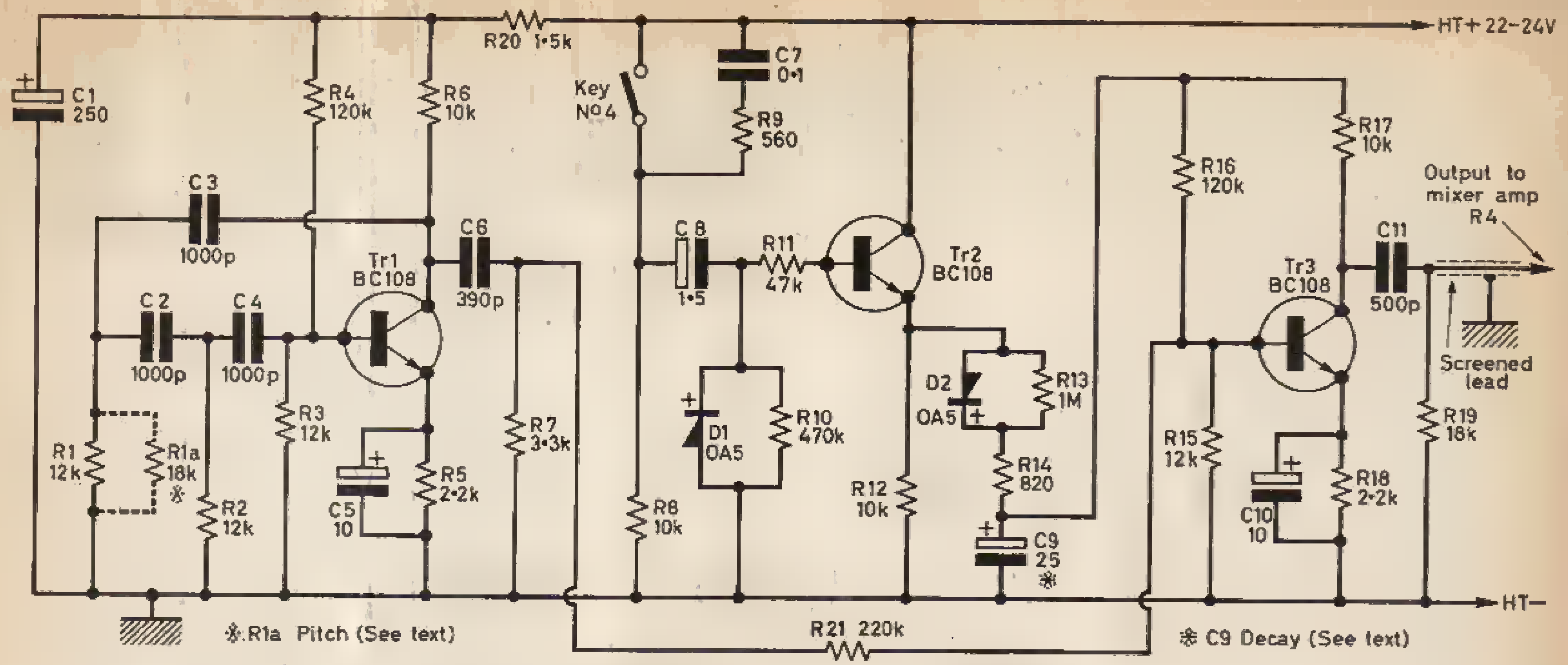


Fig. 11: The circuit of the triangle sound synthesiser.

decay time is too long the sound will be too much like a bell and if too short will sound like a click. Some adjustment of R9 may be necessary to achieve the right period of decay. Pitch can be altered by slight variation of R1 which is nominally 8·2kΩ. Adjustment of both decay time and pitch rather depends on aural estimation of the sound. The strike and decay control voltage and output waveforms are shown in Fig. 21. (Wood-block Circuit waveforms A and B respectively.) The circuit board layout is shown in Fig. 14.

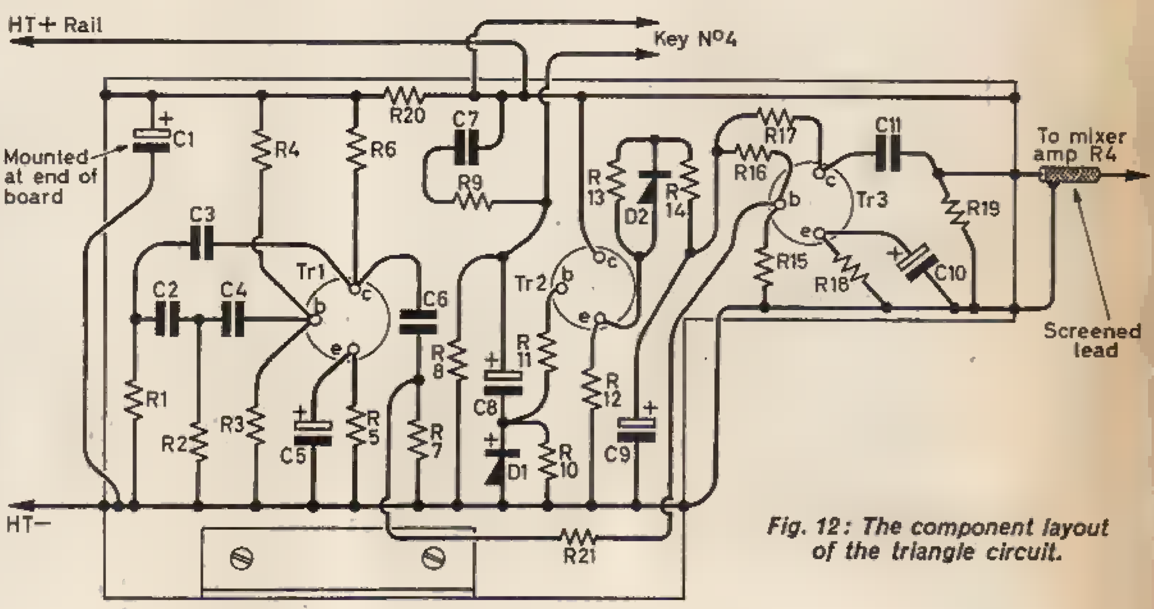


Fig. 12: The component layout of the triangle circuit.

Circuit for Taxi Horn—No. 6

This is another of the more complex circuits and employs four transistors as shown in Fig. 15. First however, note that the signal from the multi-vibrator

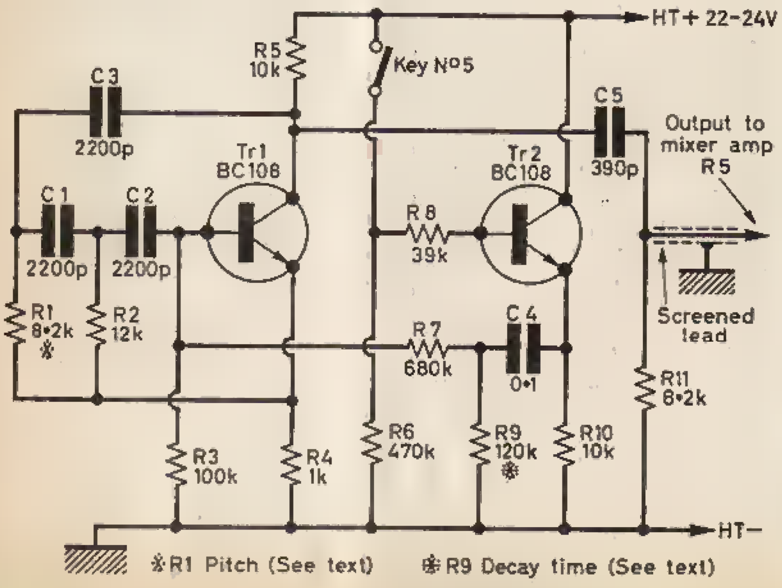


Fig. 13: The wood block sound circuit.


An internal view of the completed project. The board shown is for the castanets circuit.

Tr1-Tr2 is also used for the bell chime circuit No. 8. If the taxi horn circuit is to be used by itself the lead out to R16 on the bell chime circuit will not be necessary. The signal from Tr1-Tr2 is a typical multi-vib. waveform which is modified and attenuated by the network R6, R7, C5 and R12. The pitch should be adjusted to between 200 and 250Hz by slight variation of R2 and the attack/decay characteristic by R15 and R16. Depression and instant release of the key No. 6 should produce a short but typical 'honk' sound characteristic of old bulb type car horns. If the key is depressed

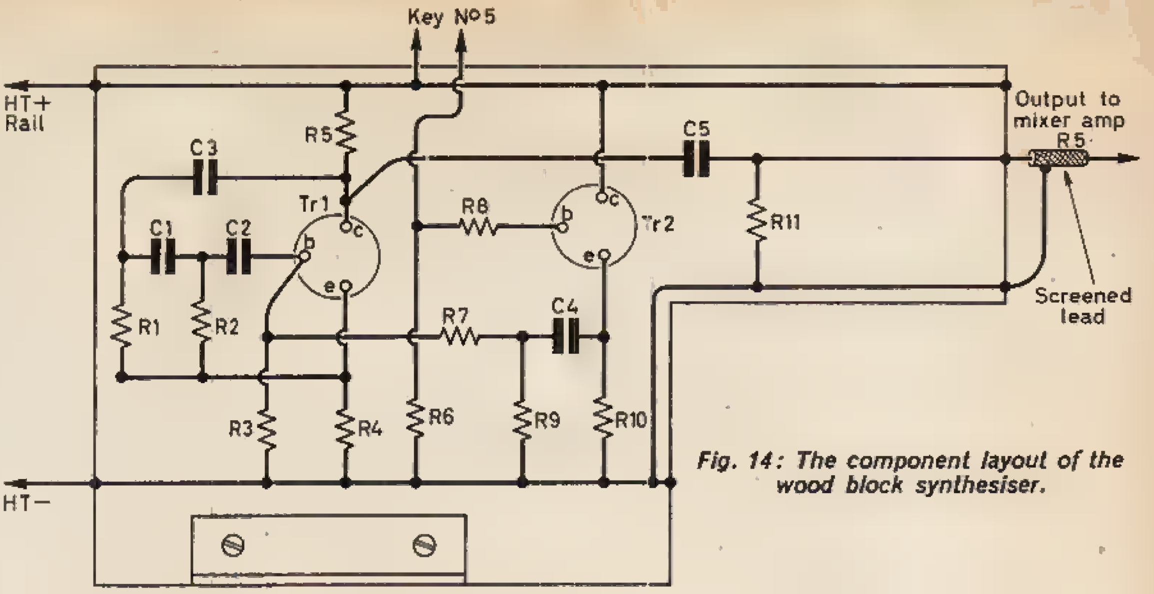


Fig. 14: The component layout of the wood block synthesiser.

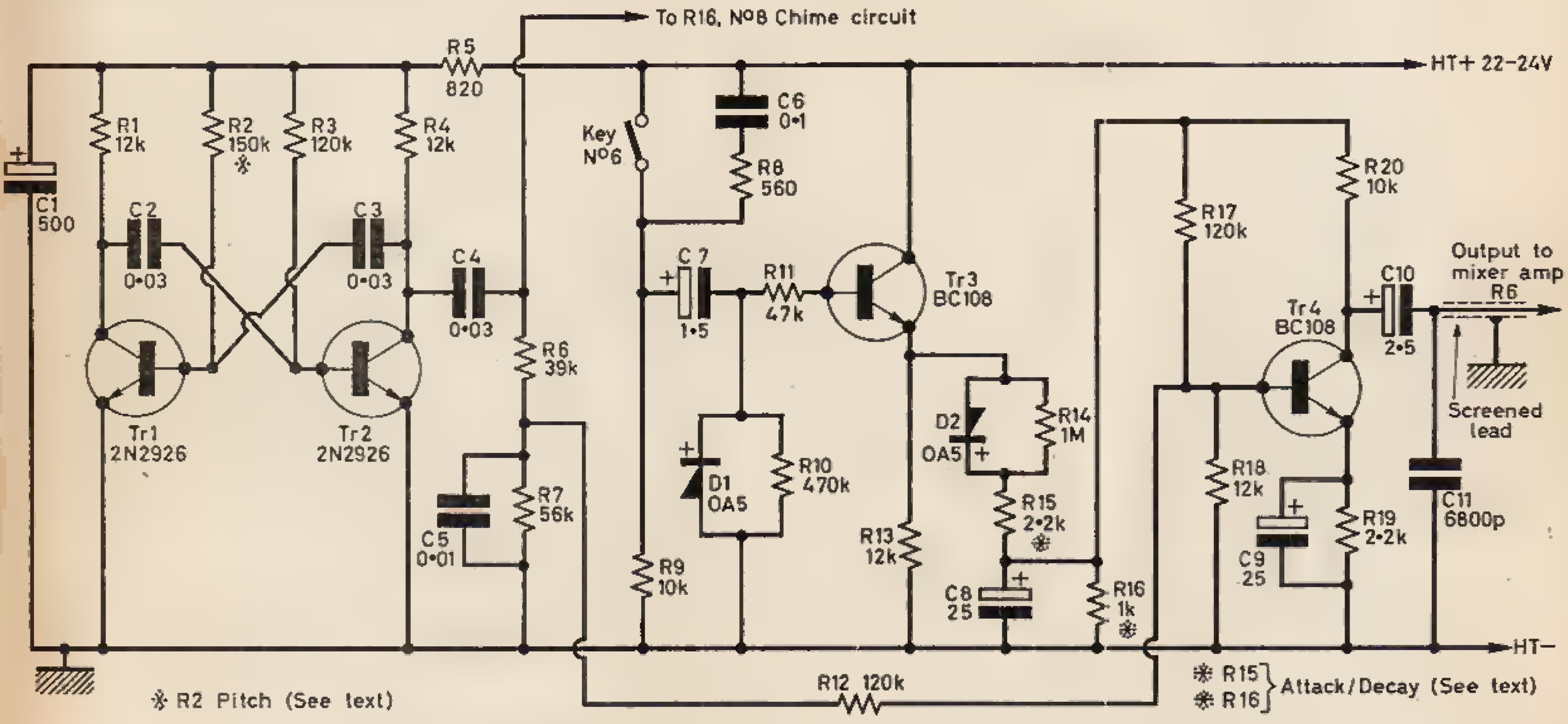


Fig. 15: The taxi horn sound synthesiser circuit. The various waveforms produced are shown in Fig. 21.

and held down the decay will be very slightly longer but the sound will die away completely. The circuit is triggered by Tr3 and the function of this transistor and it's triggering voltages are the same as those (except for the decay time) for the triangle and cymbal circuits. The triggering voltage waveforms are shown in Fig. 21 (Taxi Horn Circuit waveforms A, B and C). The circuit board layout is shown in Fig. 16.

Circuit for Train Whistle—No. 7

Two transistors and a noise diode type Z1J are required for this circuit as shown in Fig. 17 and which produces a typical steam train whistle complete with noise content and pitch

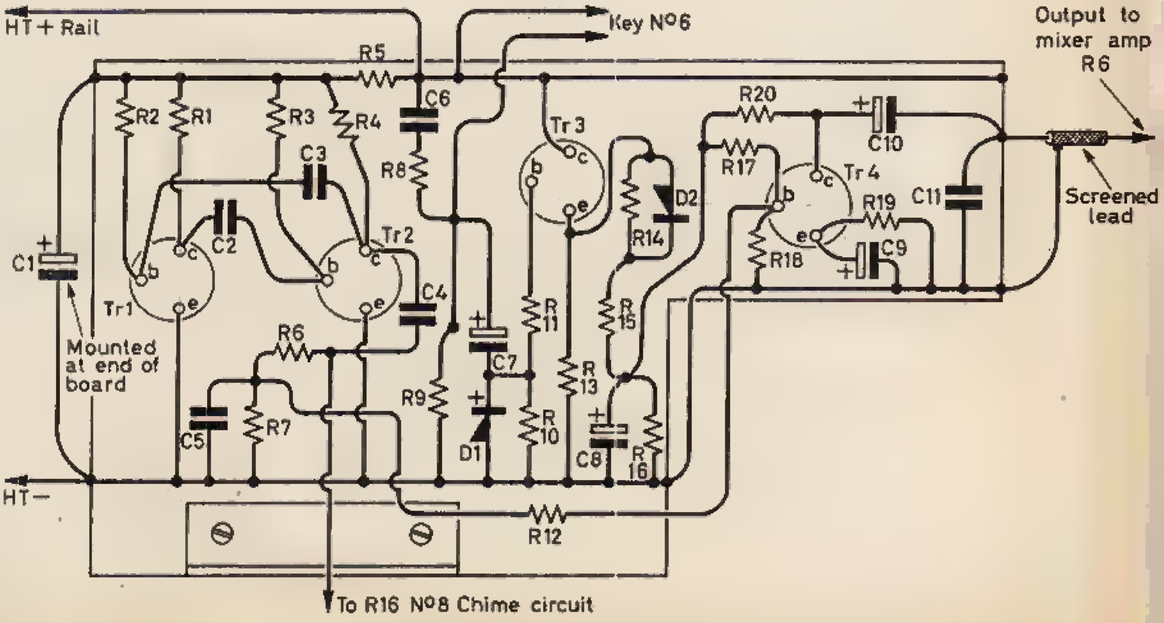


Fig. 16: The component layout of the taxi horn sound synthesiser.

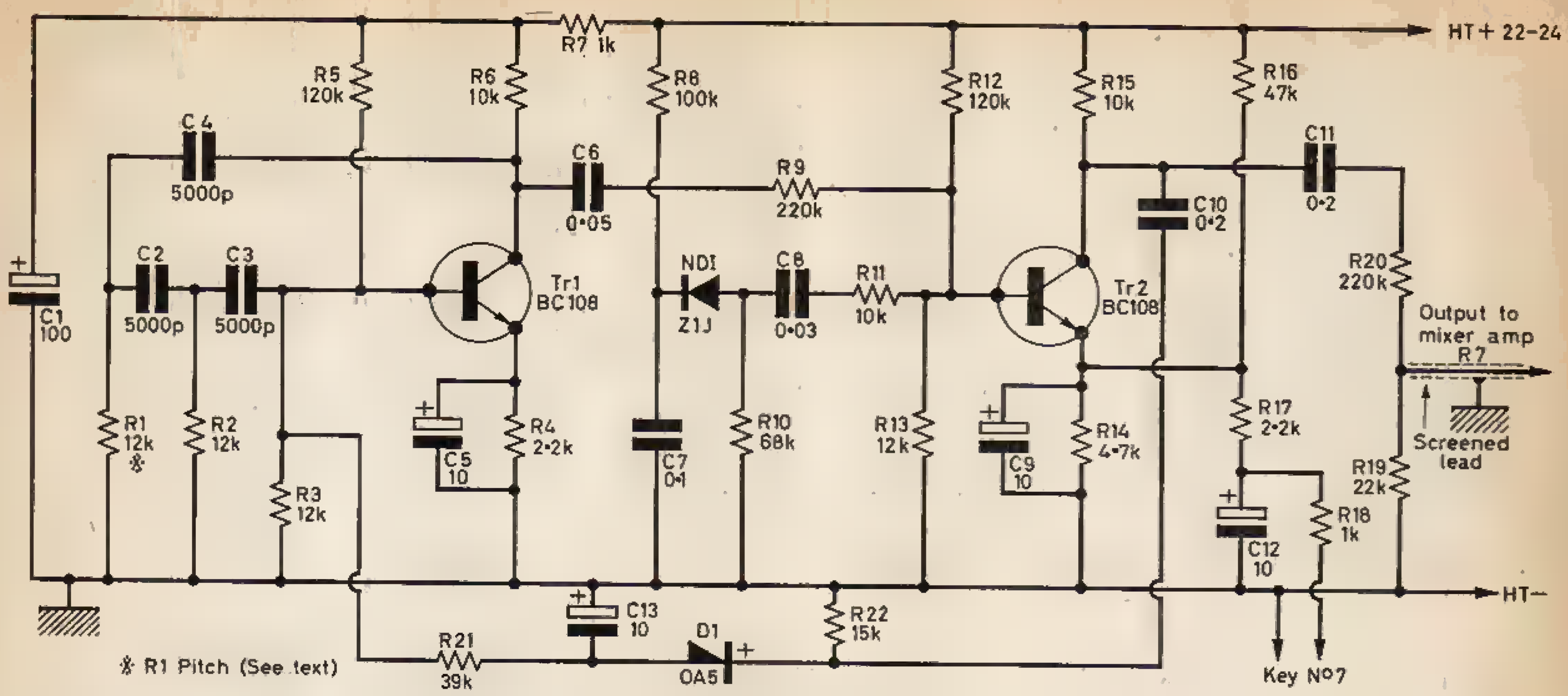


Fig. 17: The circuit used for simulating the train whistle sound.

variation. The transistor Tr1 is a phase shift oscillator, the output of which is attenuated via R9. The pitch should be approximately 1000Hz and adjustment to attain this can be made by slight variation of R1. The noise generator ND1 is the same as used for the cymbal and snare drum circuits and it's output is slightly attenuated by R11. The transistor Tr2 takes the signal from Tr1 and ND1 simultaneously but is normally biased to cut off by R14/R16. When key No. 7 is depressed Tr2 conducts and passes the combined sinewave and noise signals. However the signal output from Tr2 is also directed via C10 to the diode rectifier circuit R22, D1

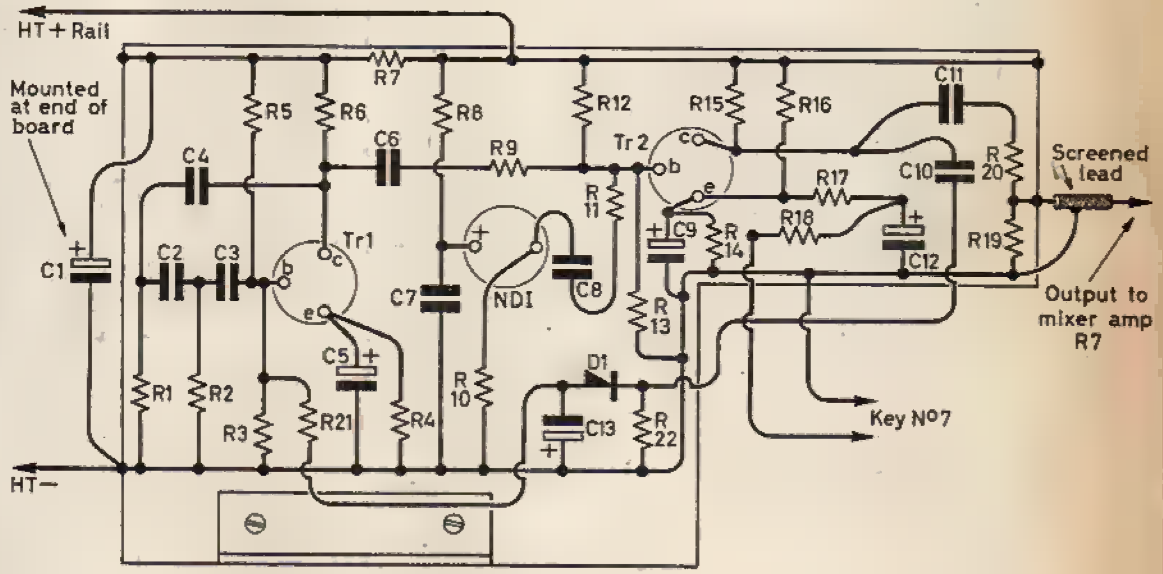


Fig. 18: The component layout for the circuit in Fig. 17, the train whistle synthesiser.

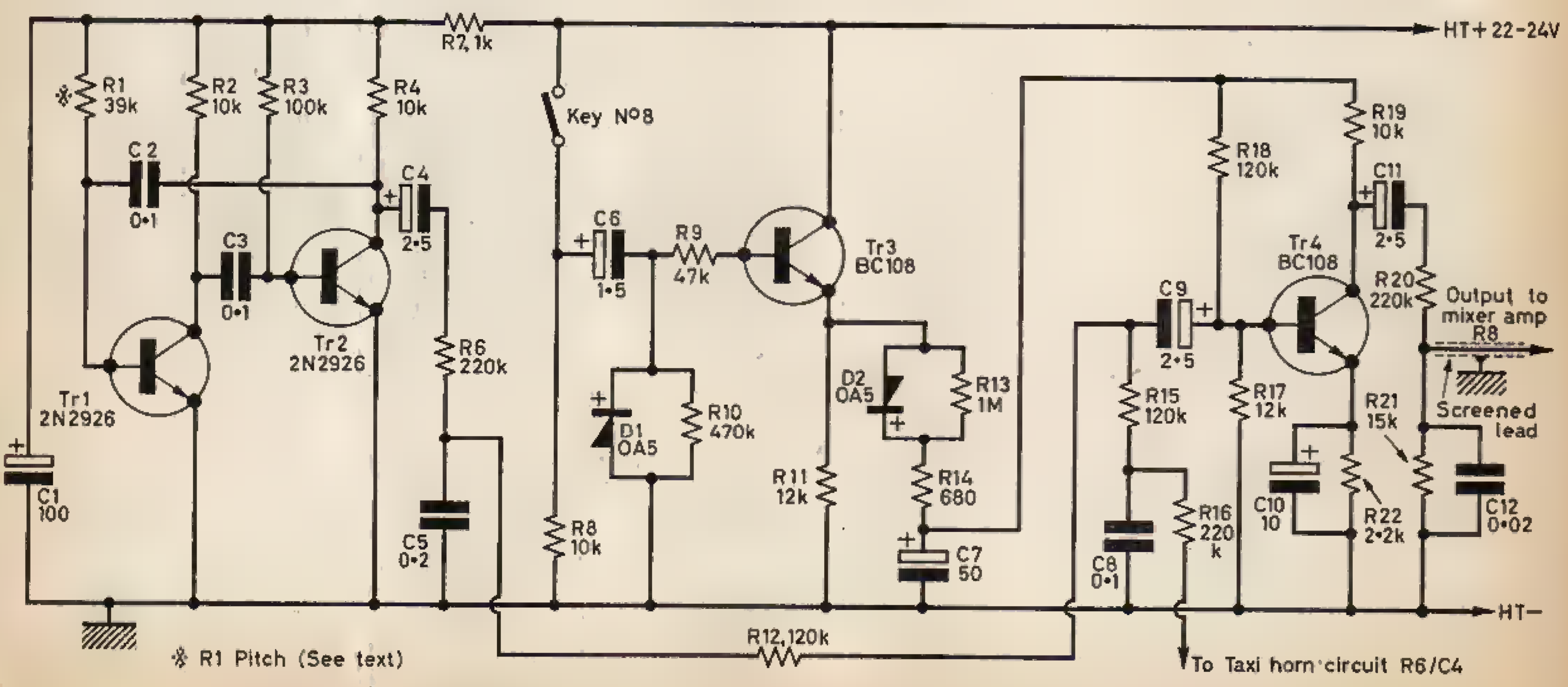


Fig. 19: The bell chime synthesiser. The waveforms of the various stages are shown in Fig. 21.

and C13. The negative voltage derived from this via R21 is applied to the base of Tr1 and produces a slight change in the pitch of the whistle frequency a fraction of a second after its initial sound. It is however, important that the white noise content of the whistle is not too great. The effect, which is that of hissing steam, should be only just apparent and should appear on the output waveform as shown in Fig. 21. (Train Whistle waveform B.) The output waveform should also appear slightly clipped at the top. Adjustment to the level of the white noise content can be made by altering the value of R1 slightly i.e., increase R11 for a decrease in noise content and vice versa. The circuit board layout is given in Fig. 18.

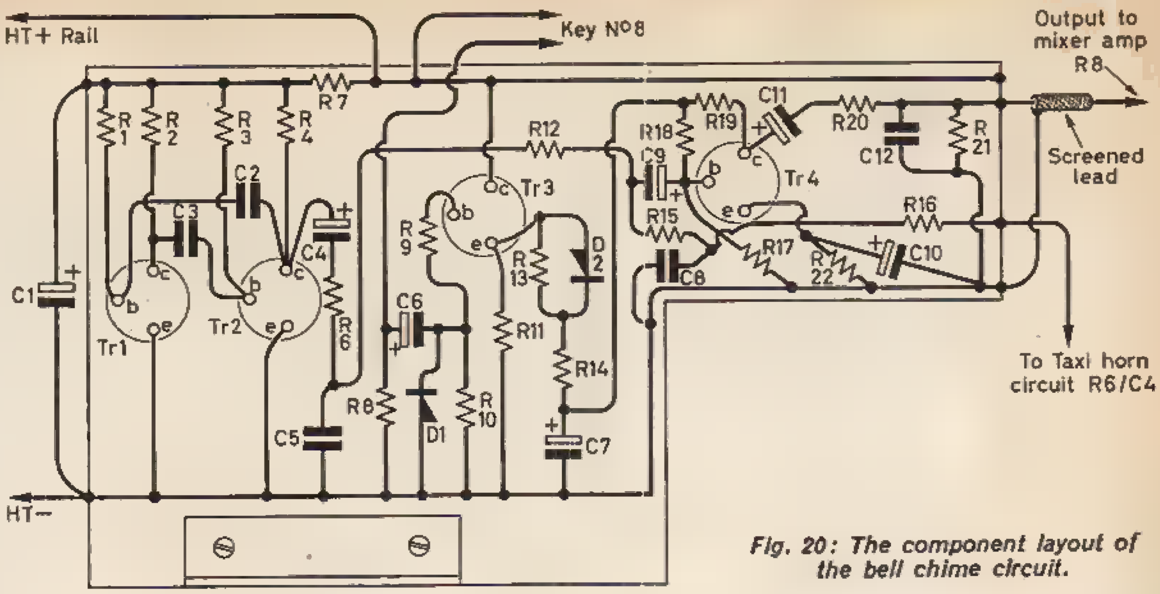
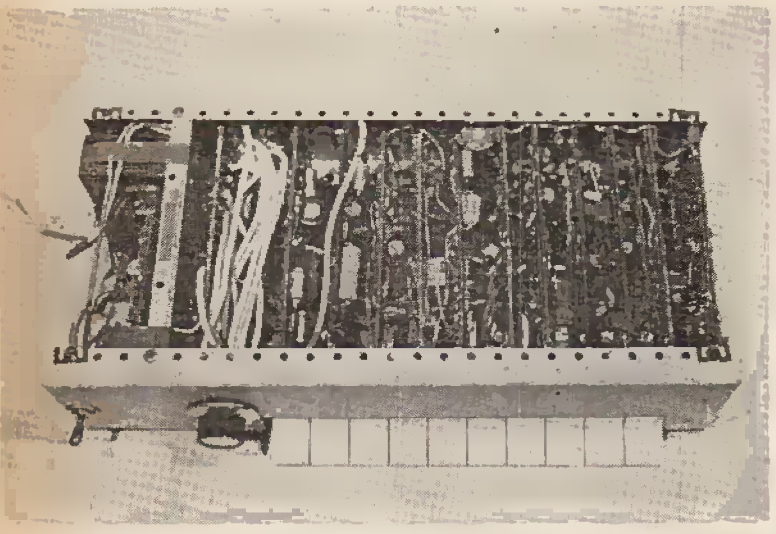


Fig. 20: The component layout of the bell chime circuit.



The various boards are shown at the centre and right, the power supply on the left.

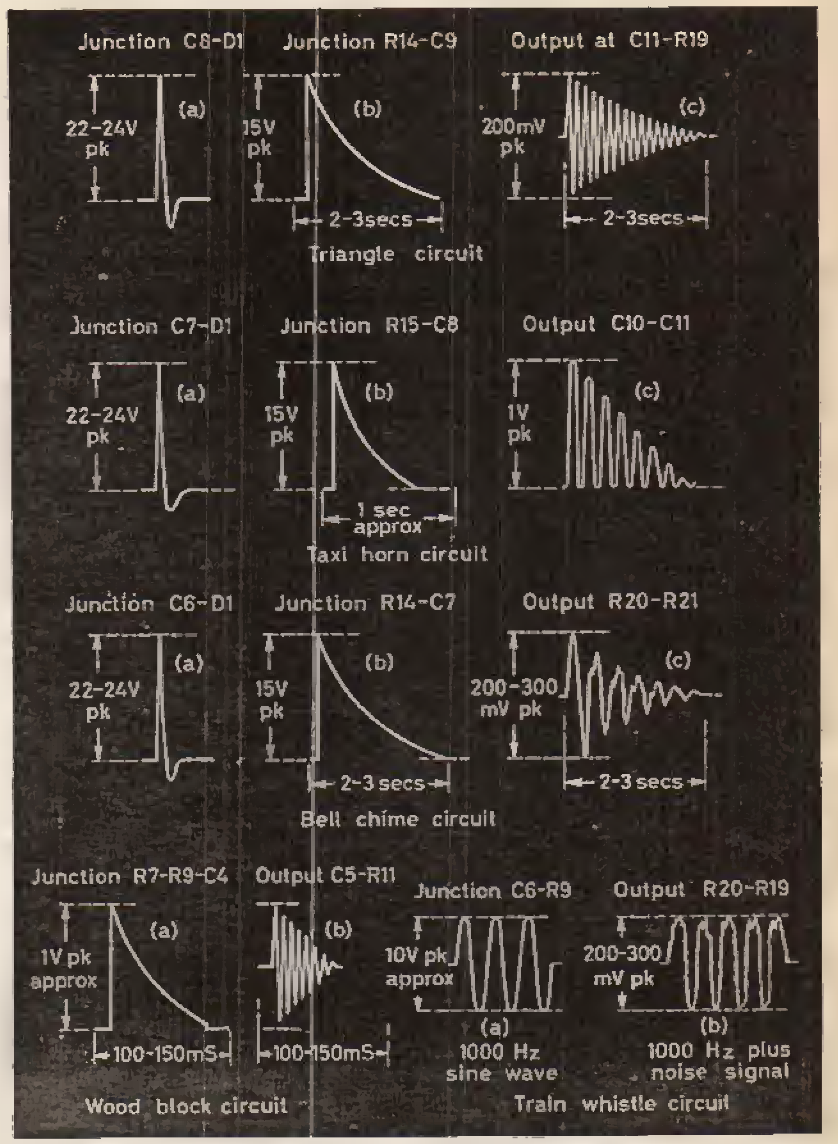


Fig. 21: The waveforms produced by the circuits described in Part 2. If possible these should be checked on an oscilloscope.

Bell Chime Circuit—No. 8

A deep bell chime, similar to that produced by a large clock for instance, is a complex sound made up of an undulating fundamental and many overtones. To achieve a close approximation of this without having to resort to the use of filters and/or a number of tone generators, a multivibrator has been used for the fundamental pitch and overtones. A strong beating or undulating effect is produced by adding another signal at almost the same frequency as the fundamental. This extra signal is obtained from the taxi horn oscillator. The harmonics of this also add considerably to those produced by the bell chime oscillator and the result, after suitable attentuation and 'voicing,' is a deep undulating but strident clock chime. The triggering circuit for the bell chime is produced by Tr3 which is switched on by key No. 8. The action of the circuit is the same as that used for the cymbal and triangle circuits and the decay time about the same i.e., two to three seconds. The output from the bell chime oscillator Tr1-Tr2 is voiced by R6/C5 and attenuated by R12. The signal from the taxi horn oscillator is treated in much the same way by R16, C8 and R15. Both signals are fed to the base of Tr4. Further attenuation and voicing is introduced at the output from Tr4. The frequency of the signal produced by Tr1 and Tr2 should be adjusted by slight variation of R1 so that a slow audible beating effect is obtained when the sound is keyed. Do not alter the pitch of

✗ components list–part two

Triangle Circuit No. 4

Transistors

Tr1, Tr2, Tr3 — BC108 Mullard

Diodes

D1, D2 — OA5 Mullard

Resistors

R1	12kΩ	R8	10kΩ	R15	12kΩ
R1A	18kΩ	R9	560Ω	R16	120kΩ
R2	12kΩ	R10	470kΩ	R17	10kΩ
R3	12kΩ	R11	47kΩ	R18	2·2kΩ
R4	120kΩ	R12	10kΩ	R19	18kΩ
R5	2·2kΩ	R13	1MΩ	R20	1·5kΩ
R6	10kΩ	R14	820Ω	R21	220kΩ
R7	3·3kΩ				

All ¼W, 10% tolerance

Capacitors

C1	250μF	C7	0·1μF
C2	1000pF	C8	1·5μF
C3	1000pF	C9	25μF
C4	1000pF	C10	10μF
C5	10μF	C11	500pF
C6	390pF		

Circuit for Woodblock No. 3

Transistors

Tr1, Tr2 — BC108 Mullard

Resistors

R1	8·2kΩ	R6	470kΩ
R2	12kΩ	R7	680kΩ
R3	100kΩ	R8	39kΩ
R4	1kΩ	R9	120kΩ
R5	10kΩ	R10	10kΩ

All ¼W, 10% tolerance

Capacitors

C1	2200pF	C4	0·1μF
C2	2200pF	C5	390pF
C3	2200pF		

Circuit for Taxi Horn No. 6

Transistors

Tr1, Tr2 — 2N2926

Tr3, Tr4 — BC108 Mullard

Diodes

D1, D2 — OA5 Mullard

Resistors

R1	12kΩ	R8	560Ω	R15	2·2kΩ
R2	150kΩ	R9	10kΩ	R16	1kΩ
R3	120kΩ	R10	470kΩ	R17	120kΩ
R4	12kΩ	R11	47kΩ	R18	12kΩ
R5	820Ω	R12	120kΩ	R19	2·2kΩ
R6	39kΩ	R13	12kΩ	R20	10kΩ
R7	56kΩ	R14	1MΩ		

All ¼W, 10% tolerance

Capacitors

C1	500μF	C7	1·5μF
C2	0·03μF	C8	25μF
C3	0·03μF	C9	25μF
C4	0·03μF	C10	2·5μF
C5	0·01μF	C11	6800pF
C6	0·1μF		

Circuit for Train Whistle No. 7

Transistors

Tr1, Tr2 — BC108 Mullard

ND1 Noise diode — Z1J Semitron (see part 1)

D1 — OA5 Mullard

Resistors

R1	12kΩ	R9	220kΩ	R16	47kΩ
R2	12kΩ	R10	68kΩ	R17	2·2kΩ
R3	12kΩ	R11	10kΩ	R18	1kΩ
R4	2·2kΩ	R12	120kΩ	R19	22kΩ
R5	120kΩ	R13	12kΩ	R20	220kΩ
R6	10kΩ	R14	4·7kΩ	R21	39kΩ
R7	1kΩ	R15	10kΩ	R22	15kΩ
R8	100kΩ				

All ¼W, 10% tolerance

Capacitors

C1	100μF	C7	0·1μF	C13	10μF
C2	5000pF	C8	0·03μF		
C3	5000pF	C9	10μF		
C4	5000pF	C10	0·2μF		
C5	10μF	C11	0·2μF		
C6	0·05μF	C12	10μF		

Bell Chime Circuit No. 8

Transistors

Tr1, Tr2 — 2N2926

Tr3, Tr4 — BC108 Mullard

Diodes

D1, D2 — OA5 Mullard

Resistors ¼watt 10%

R1	39kΩ (see text)	R9	47kΩ	R16	220kΩ
R2	10kΩ	R10	470kΩ	R17	12Ω
R3	100kΩ	R11	12kΩ	R18	120kΩ
R4	10kΩ	R12	120kΩ	R19	10kΩ
R5	omitted	R13	1MΩ	R20	220kΩ
R6	220kΩ	R14	680Ω	R21	15kΩ
R7	1kΩ	R15	120kΩ	R22	2·2kΩ
R8	10kΩ				

(Note: R5 omitted due to circuit modification)

All ¼W, 10% tolerance

Capacitors

C1	100μF	C7	50μF
C2	0·1μF	C8	0·1μF
C3	0·1μF	C9	2·5μF
C4	2·5μF	C10	10μF
C5	0·2μF	C11	2·5μF
C6	0·5μF	C12	0·02μF

the taxi horn circuit which should have been adjusted to between 200 and 250Hz. The pitch of the bell chime oscillator is best adjusted by substituting R1 with a variable of say 100kΩ in series with a fixed resistor of not less than 18kΩ, to prevent the base of Tr1 being taken straight to h.t.+. Pitch should then be adjusted until it is very close to that of the taxi horn oscillator frequency i.e., until a slow beat becomes audible. Check the amount of resistance in circuit and replace with an appropriate value fixed resistor. It might be better to replace R1 completely with a small pre-set of say 50kΩ in series with a fixed resistor of 18kΩ. Again the effectiveness of the sound is best judged aurally but the output waveform, if displayed on an oscilloscope, should appear complex and with considerable fluctuation in the amplitude of the harmonics. The triggering and output waveforms are shown in Fig. 21 (Bell Chime circuit waveforms A, B and C.) The circuit board layout is shown in Fig. 20.

TO BE CONTINUED

practically wireless commentary by HENRY

No. 78

Tribology

NOT the study of rustic man, not a thesis on triple-ended anchorites, nor even a discourse on moonrock. Tribology is a word coined by the ball and roller bearing people, to mean the study of inter-acting surfaces in motion.

Passing lightly over the thought that some tribal rites, like "Top of the Pops," and the "Rolf Harris Show," would give Tribologists something to study, we nod sagely in the direction of the scientists and hark back to a reference we made when talking about headphones—computer-aided-design.

The thought is inspired by the news that the Science Research Council has given a grant of £9,730 to Bath University to further Dr. A. W. Keen's "Computer-Graphics-Aided Synthesis of Electronic Signal Processing Circuits. C.A.D. for short.

Down there in rural Bath, they argue that circuit design has "grown to the point where engineers tend to collect standard circuits from which they can draw when they are designing." Doctors Whipp and Martin, two lecturers on Dr. Keen's team, nod towards the increasing number of devices such as transistors used in instrument circuits and the growing need for some method which will allow not only the selection and assembly of standard circuits but also the automatic generation of new electronic circuit systems for a desired application.

Some tribal rites

Now that's a thought! Toss into the system for /50 computer—no, I am wrong, with the aid of this grant these lads hope to further their researches with a PDP 8 E complete with graphic display, early this year—well, toss an idea in SOMEWHERE, and what comes out? A completely packaged, plastic-clad, printed circuit, ergonomically engineered, probably deep-frozen to lock in the flavour of the multi-million bits.

Beautiful, shiny, perfectly concocted—but as neutral as a consciencious umpire. Bring in the tribological ergonomists and individuality flies out of the window! However, gone will be the kinky boards that could only be the dream-children of the Superstar factory, the panels from Messrs. Busbox with more lines to the inch than a miniature orchestral score; vanished those flexible, flimsy, finnicky efforts that come from the Yoshi-Toshi Company. Disappeared like yesteryear's wiring harnesses, all dull colours and knotted string and bent as precise as the kink in a drill sergeants moustache. Declining like those dinky glass bottles with their warm and friendly glow . . .

Forgive an old engineer. Allow me to wipe away a nostalgic tear. The thought of some of our lost specialities makes me sad. The evocative whiff of burning transformers brings back memories and the pungency of toasted selenium is a haunting signpost to the days when apprentices listened when spoken to, customers put us on a par with the rent collector and a crossover was some form of token.

But although the keen Dr. Whipp or the whippy Dr. Keen would have us banish even more of the character that remains in radio, even though they would have "wireless" mean what it says, Henry suspects that the immutable obtuseness of the average computer will defeat them. To judge by our electricity bills, demands of the telephone company and the current computerised

Disappeared like yesteryear's wiring harnesses.

identity by which our friendly neighbourhood bank manager knows us, all that CAD will cough up for the boys of Bath is a row of inscrutable dots. Rationalising of circuitry is all very well, the aim to restrict the prolific growth of semiconductor devices is very commendable, but we suspect that the ultimate result will be to add a number of new integrated circuits to an already bewildering list. Take a look at some of those tuner amplifiers which already feature i.c.'s. Their overall circuitry is as complicated as before, their designer has taken advantage of a new device to extend his ideas within a certain budget. He could do even more with building brick circuits. Imagine the complexity that Bodgit & Co could produce from a handful of i.c.'s and some of the Bath-bricks, a bunch of wires and some presets. The trouble is that for every beautiful computerised block that condenses the Bath team's ideas there will have to be twenty modified versions to suit individual requirements or circuit designers.

And that's the trouble—there will have to be a bit off here and a bit off there until the poor old computer won't know what to disgorge. Computers are notoriously single minded. Those whip-keen laddies at Bath have been talking to computers so long that they think all designs can be divided into logical boxes. They should take a look at some of the articles for *Practical Wireless* that the Editor dares not publish.

I.C. OF THE MONTH

L.A.J. IRELAND

Number 18 — Digital Counting and Display Devices

THIS month's article deals with a rather unusual topic in that we confine ourselves to the digital i.c. field which so far has not been considered in the present series. Yet the greatest advance in i.c. technology is being made in this field so that today relatively cheap m.s.i. (medium scale integration) circuits are on offer by many manufacturers making it possible for the amateur to construct low cost digital readout and counting circuits with a wide variety of uses.

It may appear at first approach that there are few possibilities of interest in this field. Indeed due to the inherent cost of constructing equipment using discrete components it was well beyond the range of the average constructor but once again mass production coupled with the mastering of m.s.i. technology has completely changed the picture.

Very compact decade counters can be built for less than £5 per decade which compares very favourably with the old dekatron units which proved very popular for any pulse counting requirements. In fact a maximum counting speed of around 20kHz was usually associated with such tubes whereas today there is little difficulty producing counting speeds in excess of 20MHz with t.t.l. logic circuits.

Within the SN74 series of i.c.'s are decade counters and decoder drivers. Two approaches are possible here depending on the type of display output required. One incorporates a cold cathode neon type tube using a common anode with ten separate cathodes formed in the shape of the 0-9 numerals and stacked behind one another.

An input pin is required for each cathode which in turn is usually connected to a decimal decoder circuit. Even though the gas filled readout tube may require around 200 volts for satisfactory operation, it is not necessary that the driver transistors be capable of withstanding this potential as the anode resistor will automatically reduce the voltage and limit the current through the driver transistors. Thus any transistor with a collector to emitter breakdown voltage around 60 volts will work quite well.

A complete decade counter using the new Bi-Pak SN series is shown in Fig. 1. Due to the complexity of the decoder and driver circuits only the logic symbols for the various units are illustrated and the amateur will have to get used to the black box approach to complex i.c. circuits as it would be virtually impossible to follow literally the hundreds of transistors and associated passive components in the present design.

One drawback of the above system is the high voltage required for the readout tube which necessitates the use of some form of inverter if the unit is to be put to portable use. A more modern approach therefore to digital readout is the low voltage filament type of segmented tube consisting of seven independent strip filaments arranged in a figure eight pattern.

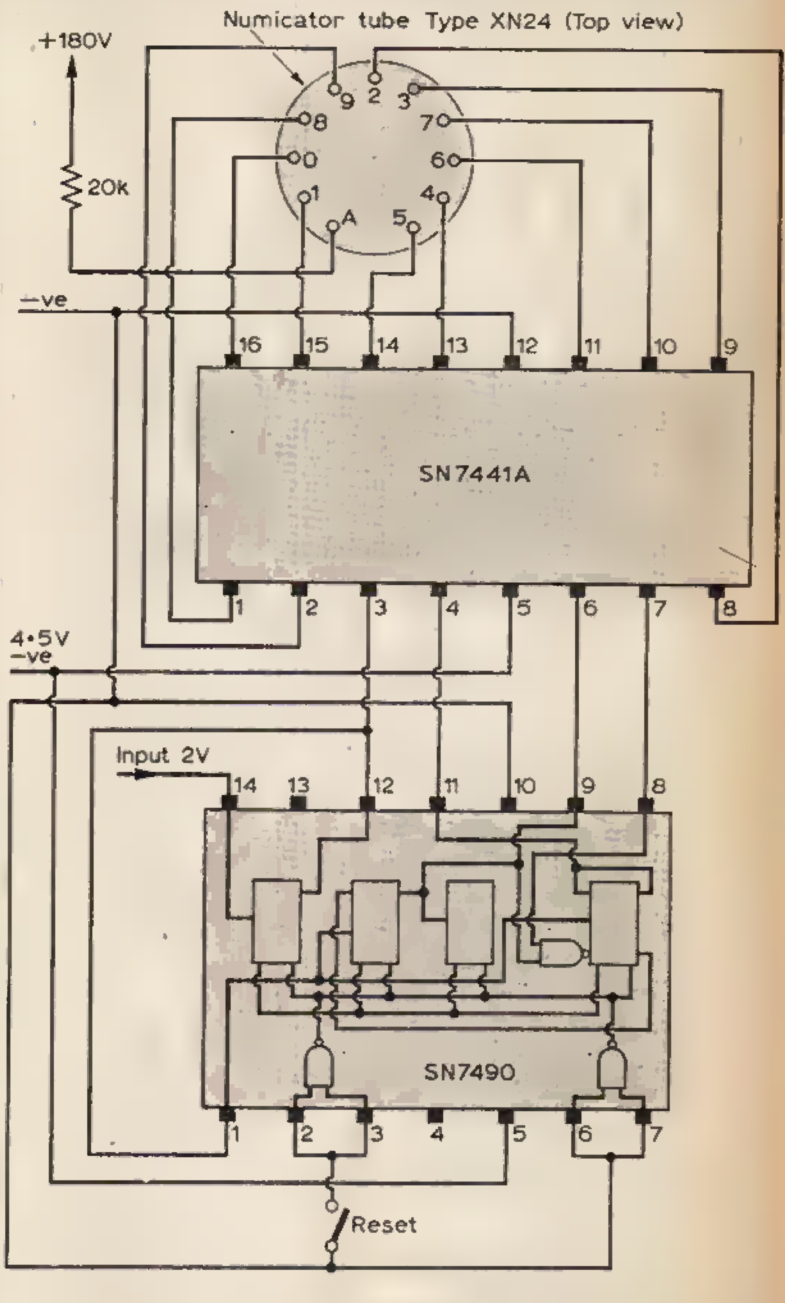


Fig. 1: A complete decade counter using the new Bi-Pak SN series.

Any numeral between 0-9 can be found by illuminating the required segments. In fact eleven alphabet letters can also be created so to an extent the tube can be made to function as a limited alpha-numeric display device with suitable decoding circuits. In the present design consideration will be given to the RCA numitron type DR2000.

The same decade counter with b.c.d. (Binary Coded Decimal) outputs as used in the first design will function here but a different decoding circuit is required. Whereas in the previous design a separate pin was needed for each numeral, here only seven are required and a b.c.d. to seven segment decoder is used—RCA type CD2500E.

Once again the complexity of the internal circuitry of this i.c. makes it impractical to draw so Fig. 2 shows the interconnections of the complete unit. A suitable printed circuit board pattern should not prove too difficult for the competent constructor and use could profitably be made of the new dual-in-line mounts advertised by some firms in this magazine. In addition to providing easy insertion and removal of the i.c.'s they also prevent damage to the i.c.'s from excessive heat in the soldering process.

Needless to say, numerous uses can be visualised for these counters. The 50Hz mains can be used as a frequency standard to make an accurate interval timer when coupled through an AND gate to the counter. Also interruptions in a beam of light or pulses from a geiger tube to determine the activity of a radioactive sample can be counted.

A very welcome development related to this field is the drop in prices of the new Gallium Arsenide solid state light emitting diodes. Single devices of this type can now be purchased for around £1.50. With no filament to worry about they are exceptionally robust and have an exceedingly long life span. Arrays using upwards of fifty of these arrayed in a 5 x 10 rectangular matrix are used in many alpha numeric readout systems and recently the first all electronic solid state wrist watch with digital readout has been released in the U.S. using four of these arrays. If the present trend continues they will certainly offer fascinating possibilities for the home constructor in the not too distant future.

IC type SN7441A and SN7490 are available from Bi-Pak Semiconductors.

IC type CD2500E and numitron DR2000 are available from:—Roberts Electronics Ltd., Hermitage Road, Hitchin, Herts.

Hivac Numicator type XN24 available from:—Hivac Ltd., Ruislip, Middlesex.

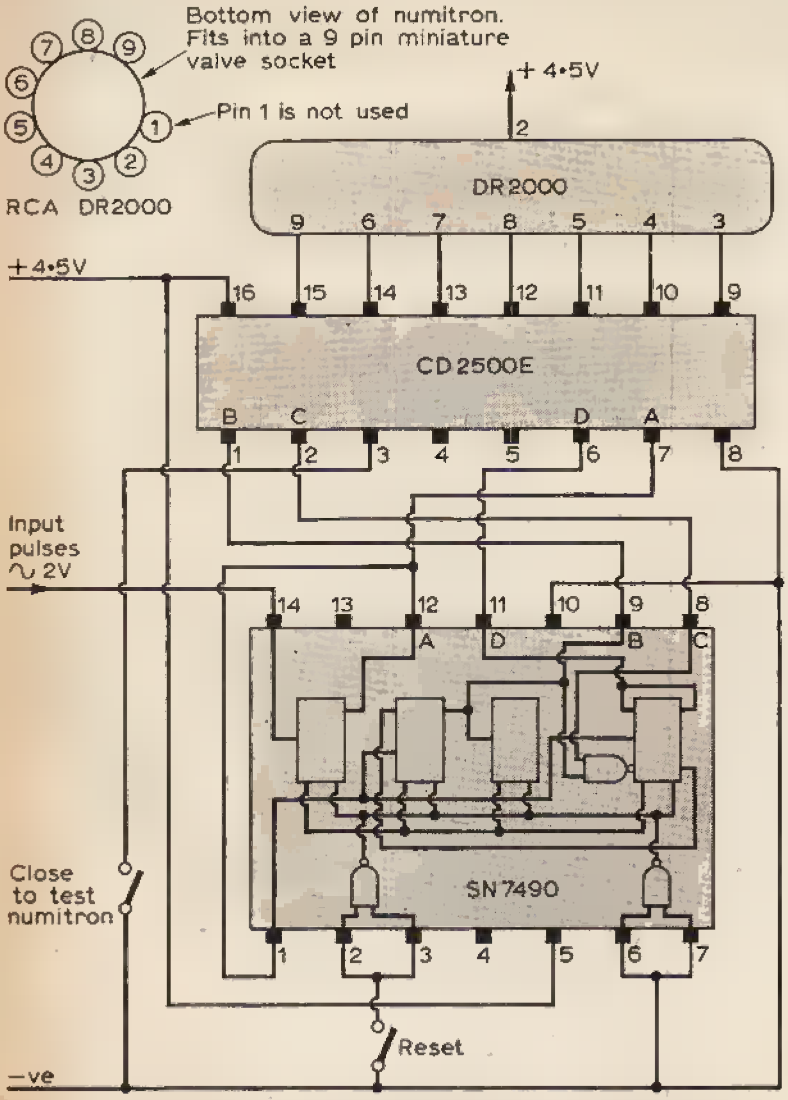


Fig. 2: Shows the interconnections of the units using the CD2500E decoder.

DECCA 3000 HI-FI SYSTEM WON BY BRISTOL READER OF 25 YEARS STANDING

A reader of Practical Wireless for 25 years has won the Decca Hi-Fi System Competition which was featured in our November Issue. He is Mr. Dyke of Bristol. At a recent lunch held by I.P.C. Magazines to congratulate Mr. Dyke, it was revealed that he had taken to reading the magazine after the excellent results he had found with a home-built 2-valve radio designed by F. J. Camm, an earlier Editor of P.W.—and he has hardly missed an issue since.

Mr. Dyke is a great fan of "Practically Wireless" by Henry and rates F. G. Rayer amongst his most popular authors. Being an 'old-timer' in the construction game he is also a keen follower of "Going Back".

The entry which secured the Hi-Fi System for Mr. Dyke was: 1-J, 2-K, 3-L, 4-E, 5-A, 6-D, 7-B and 8-C. The entry was the only correct one out of several thousands.

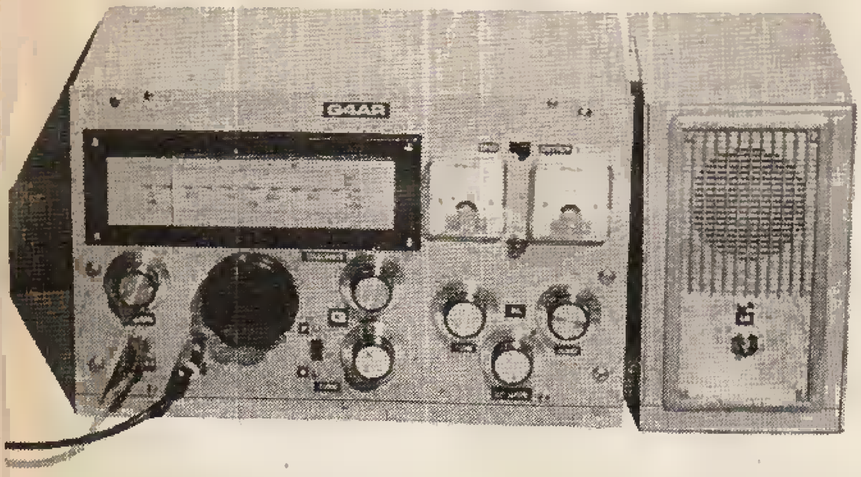
The Hi-Fi System was something Mr. Dyke had wanted for a very long time and it is the first prize of any value that he has ever won!

Norman Stevens on the left, Editor of Practical Wireless, congratulates Mr. and Mrs. Dyke on winning the Decca 3000 Hi-Fi System.

'Trojan' Top band Transceiver

ERIC DOWDESWELL
G4AR

PART TWO



Final Assembly When the two circuit boards and the panel are completed as far as is possible they can be fitted to the aluminium framework, shown in Fig. 7, forming the sides and back of the chassis. The back has a hole for the outlet of the power supply cable form and another to allow adjustment of the transmitter mixer anode coil L4. The co-axial aerial socket is the only fitting on the back member.

In practice only the side members were fitted initially the back not being fitted until the transceiver was completed and aligned, the co-axial socket being allowed to float in the meantime. This allowed full access to the chassis, another advantage of this method of construction.

headphone and key jacks. The four switching diodes D3-6 are mounted on a piece of Veroboard and fitted close to the key jack.

The main tuning capacitor VC2 is mounted on a small aluminium bracket across the cutout in the left hand board and a certain amount of "packing" with washers may be found necessary to ensure that the spindle lines up with the tuning drive coupler.

The wiring between the panel components and the boards may now be completed and a general check-over of all the wiring made for short circuits or errors.

Power Supply Unit The circuit of the supply unit, Fig. 3, shows that the transformer T1 provides the h.t., the negative bias for the transmitter and the relay operating voltage as well as the heater supply. On the h.t. side choke input is used in order to improve the regulation and to keep the voltage down to around 270V so avoiding the use of wasteful dropping resistors.

Switch S2 is mounted on the back of the unit and is essential during the alignment procedure for cutting the h.t. to the p.a. The speaker is a 4in. one with a matching transformer T2 and slide switch S3 cuts out the speaker when headphones are being used.

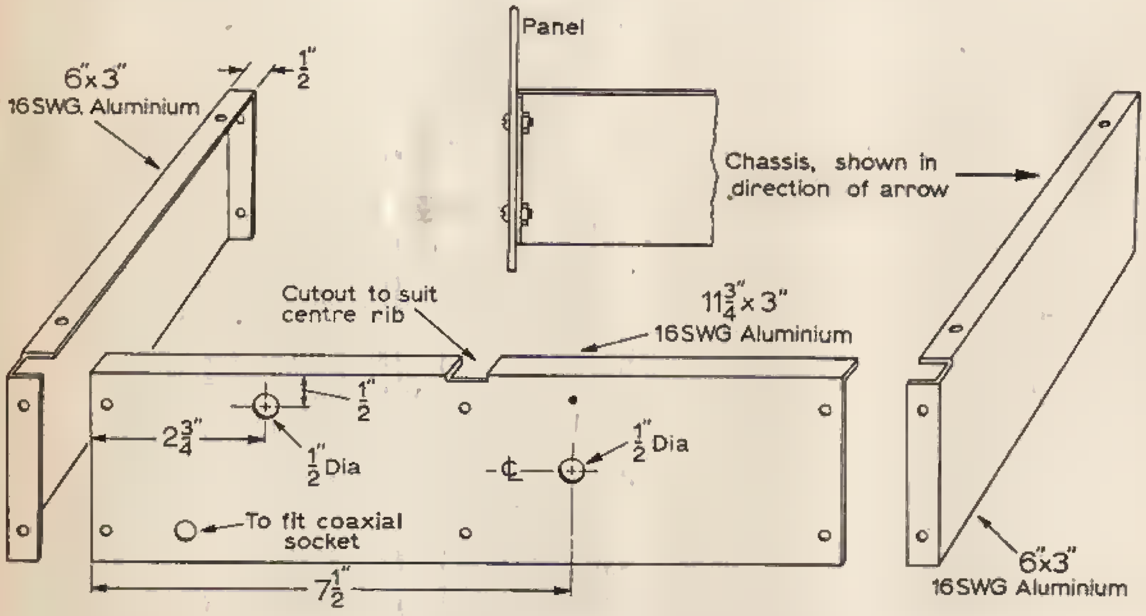


Fig. 7. Exploded view of chassis members. Note that panel extends below the bottom of the chassis, see Fig. 6. Part One. Since the rear member carries only the coaxial socket it can be left off until all wiring and constructional work is completed.

The boards are attached to the chassis with self-tapping screws, two along each edge except at the front. An aluminium bracket supports the two boards at the centre of the chassis and is bolted to the front panel and the back member. This can be seen clearly in the photograph of the underside of the completed transceiver.

The remaining components can now be fitted to the panel, namely the r.f gain control VR1, Q multiplier tuning capacitor VC4, i.f. gain control VR2 and the

In wiring the two low voltage windings in series regard must be taken of their relative phase to ensure that the voltages are additive and reversing one winding if the relay operating voltage is low. The diodes and resistors are mounted on the bottom of the unit on a piece of Veroboard as can be seen in the photograph of the unit.

The eight leads from the transceiver are taped together and fitted to an octal plug, the leads being about twelve inches long. The receptacle on the power unit is an ordinary octal valveholder. Note that the earth lead is duplicated to reduce the resistance of this lead.

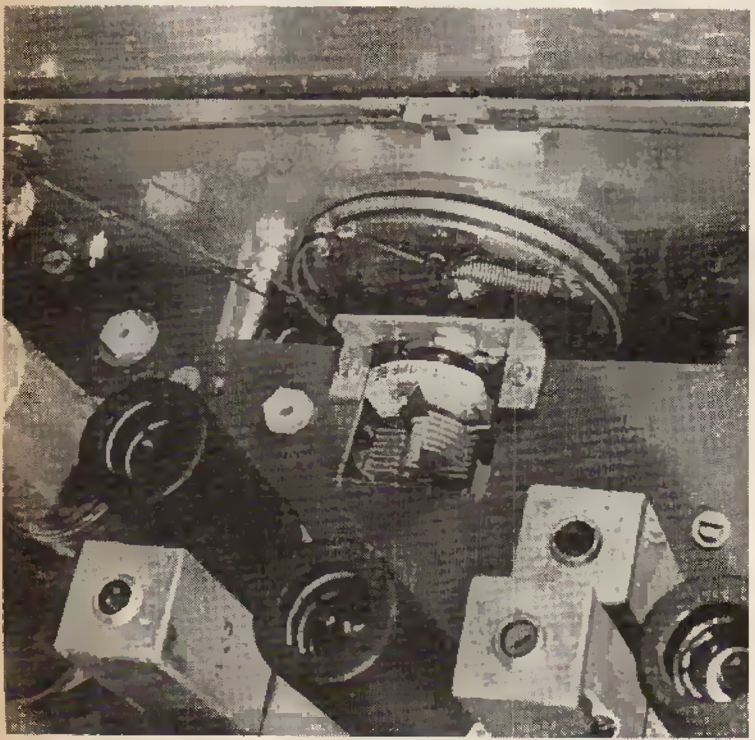
A speaker fret $6\frac{3}{4}$ x $3\frac{1}{2}$in. in grey plastic (G. W. Smith Ltd.) was bolted to the panel of the power unit, part of the fret being cut away as shown in the heading photograph in Part One of this article. The cabinet was finally sprayed with a grey enamel to match the transceiver cabinet and panel.

ALIGNMENT

Before alignment, checks should be made to ensure that the various h.t., bias and heater voltages are approximately correct. Initially the transmitter valves V5, V6 and V7 can be removed. The i.f. gain control is set at half way and the b.f.o. and first oscillator coils L2 and L3 shorted out, as is the diode D2 in the product detector. The Q multiplier valve V8 can also be removed temporarily.

Connect a low reading a.c. voltmeter across the primary of the output transformer via a blocking capacitor of about $0 \cdot 1\mu$F. Feed a modulated signal at 465kHz from a signal generator to the grid of the second i.f. amplifier V4 and adjust the cores of i.f.t.3 for maximum output, at all times keeping the signal input as low as possible consistent with a reasonable output meter reading.

Transfer signal to grid of V3 and repeat tuning procedure with i.f.t.2 finally feeding the signal to V2 and peaking i.f.t.1. Without changing the frequency of the input signal on 465kHz switch off its modulation, remove the short circuit from the b.f.o. coil L3 and the diode D2 and tune the core of the b.f.o. coil until a beat note is heard which should be adjusted to zero-beat with the input signal.



A close-up of the main tuning mechanism. Note cut-away dial plate to clear potentiometers and mounting bracket for VC2.

The next step is to adjust the first oscillator for full coverage of the Top Band, i.e. 1·8 to 2·0MHz. Remove the short circuit from the coil L2 and feed in a modulated signal of 1·8MHz to the grid of the mixer valve V2 again shorting out the b.f.o. coil and the diode D2. With the main tuning capacitor VC2 near to maximum capacity adjust the core of L2 until the signal at 1·8MHz is heard. The oscillator itself should now be on 2265kHz which must be checked with a dip oscillator.

Turn the dial so that the capacitor is near minimum and feed in a signal at 2·0MHz and adjust trimmer TC1 until the signal is heard. These last two steps must be repeated until the required coverage is obtained.

RF Stage With the r.f. gain control about half way feed in a signal to the aerial socket at 1·9MHz and swing the p.a. tuning capacitor VC1a-b remembering that this peaks both the p.a. circuit and the receiver mixer grid circuit. It will be found to peak the 1·9MHz signal at two points on the dial corresponding to these two circuits. Adjust the core of L1 until the two peaks coincide when VC1 will be found to be near maximum capacity.

Q Multiplier The Q multiplier valve V8 can now be replaced. With the receiver working normally choose a quiet spot on the band with no signals and with the Q multiplier tuning control VC4 at mid point and switch S2 in the "peak" position tune the core of L7 until the background noise is at its lowest pitch. The selectivity control VR3 should be set at minimum.

If VR3 is now rotated a point will be reached when the stage will go into oscillation. On tuning in a signal the Q multiplier tuning control can be adjusted to peak the beat note at the same time increasing the selectivity control to just below the point of oscillation.

Without altering the main tuning dial any signal in the passband can be peaked, the maximum selectivity being just about all that any c.w. operator could desire.

With S2 in the "null" position interfering signals can be severely attenuated with the Q multiplier controls.

Transmitter Mixer Valves V5, V6 and V7 may now be replaced. Since the b.f.o. and first oscillator are now on their correct frequencies it is very likely that an indication of grid current will be shown on pressing the key. Switch S1 must be set to read grid current and the h.t. to the p.a. switched off.

The cores of the transmitter mixer and buffer amplifier coils L4 and L5 can now be adjusted to peak the grid current at the centre of the band and should reach around 3mA. Check and double check that the output is on Top Band using an absorption wavemeter.

A dummy load carbon resistor of between 50 and 70 ohms should now be connected to the aerial socket. This resistor should have a power rating of at least 5 watts and may be made up of several higher value resistors in parallel but they must be of carbon and can be mounted on a coaxial plug for convenience.

Turn the p.a. loading capacitor VC3 to maximum and peak signals with the p.a. tuning control. On pressing the key the anode current will be about 45mA and the p.a. tuning should be quickly tuned for a dip in anode current to about 20mA. Decrease the value of the loading capacitor and re-dip the tuning. Repeat this until the dipped value of the anode current is about 35mA. This represents an input of about 10W, the legal maximum on Top Band. Check again that the output is on the correct frequency using the absorption wavemeter.

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Total building costs £6.98 (£6.19.7)

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Parts Price List and Easy Build Plans 25p (5/-) (FREE with parts).

Overseas P. & P. 85p (17/-)

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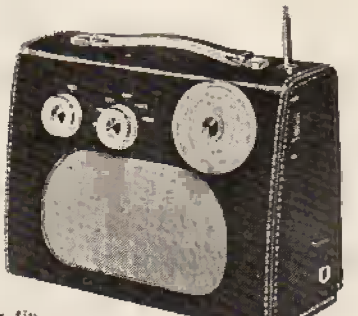

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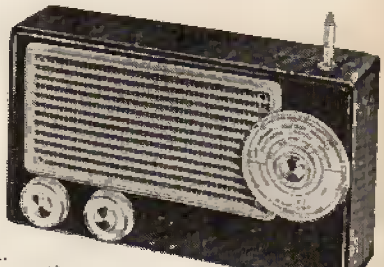
SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

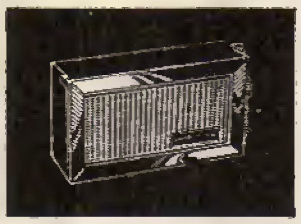


Attractive case in black with red grille and black knobs and dial with spun brass inserts. Size 9 x 5¼ x 2¾in. approx. Tunable on Medium and Long Waves, three Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. Eight improved type transistors plus 3 diodes. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (5/-) (FREE with parts). Earpiece with switched socket for private listening 25p (5/-) extra.

Total building costs £4.48 (£4.9.7) P. & P. 28p (5/7)

Overseas P. & P. 65p (13/-)

pocket five
MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER

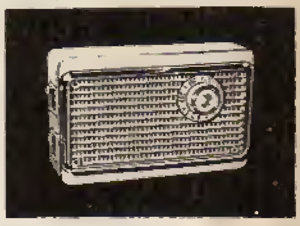


Attractive black and gold case. Size 5¼ x 1½ x 3¼in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Easy build plans and parts price list 8p (1/7) (FREE with parts).

Total building costs £2.23 (£2.4.7) P. & P. 18p (3/7)

Overseas P. & P. 50p (10/-)

transona five
MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER

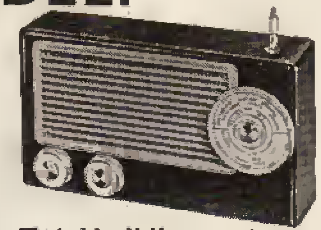


Attractive case with red speaker grille. Size 6¼ x 4¼ x 1¼in. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Easy build plans and parts price list 8p (1/7) (FREE with parts).

Total building costs £2.38 (£2.7.7) P. & P. 19p (3/9)

Overseas P. & P. 50p (10/-)

IMPROVED MODEL!
roamer six
SIX WAVEBAND PORTABLE WITH 3in. SPEAKER



Attractive black case with red grille and black knobs and dial with spun brass inserts. Size 9 + 5¼ + 2¾in. approx. Tunable on Medium and Long Waves, two Short Waves, Trawler Band plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and latest telescopic aerial for Short Waves. Improved circuit. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. Easy build plans and parts price list 10p (2/-) (FREE with parts).

Total building costs £3.98 (£3.19.7) P. & P. 23p (4/7)

Overseas P. & P. 65p (13/-)

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★ *Open 10–1, 2.30–4.30 Mon.–Fri. 9–12 Sat.*

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TRANSONA FIVE	☐	TRANS EIGHT	☐
POCKET FIVE	☐	ROAMER SIX	☐

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Name ....

Address ....

.... PW.28

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2N4286	17½p
2N4287	17½p
2N4288	17½p
2N4289	17½p
2N4290	17½p
2N4291	17½p
2N4292	12½p
2N4303	47½p
2N5027	52½p
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40326	37½p
40329	30p
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40347	57½p
40348	52½p
40360	42½p
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40362	57½p
40370	32½p
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BCY33	20p
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BF178	52½p
BF179	72½p
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BSY56	90p
BSY78	47½p
BSY79	45p
BSY82	52½p
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NKT128	27½p
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NKT243	62½p
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NKT245	20p
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OC71	12½p
OC72	12½p
OC74	32½p
OC75	22½p
OC76	22½p
OC77	30p
OC81	20p
OC81D	22½p
OC83	25p
OC84	25p
OC139	32½p
OC140	32½p
OC170	30p
OC171	30p
OC200	37½p
OC201	47½p
OC202	62½p
OC203	42½p
OC204	42½p
OC205	62½p
OC207	75p
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ORP61	50p
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TI843	40p
TI844	12½p
TI845	12½p
TI846	12½p
TI847	12½p
TI848	12½p
TI849	12½p
TI850	17½p
TI851	12½p
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38 Series—FACE SIZE 42 × 42mm. All prices for 1-9 pieces. All meters D.C.

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200	,,	£1·62½	500	,,	£1·25
500	,,	£1·37½	1	Amp	£1·25
50-0-50	,,	£1·75	5	,,	£1·25
100-0-100	,,	£1·62½	10	Volts	£1·25
500-0-500	,,	£1·25	20	,,	£1·25
1	Milliamp	£1·25	50	,,	£1·25
5	,,	£1·25	300	,,	£1·25
10	,,	£1·25	500	,,	£1·25

SILICON RECTIFIERS

PIV	50	100	200	400	600	800	1000	1200
1A	10p	12½p	15p	16p	17½p	19p	20p	—
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6A	—	—	25p	30p	32½p	35p	50p	—
10A	—	52½p	57½p	65p	77½p	86½p	97½p	£1·25
17A	—	57½p	62½p	77½p	90p	97½p	£1·20	£1·57½

*5 amp only. 1 amp are plastic encapsulation.

DIODES & RECTIFIERS

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IN916	07½p	BA100	15p	BY103	22½p	OA47	07½p
IN4007	22½p	BA102	22½p	BY122	37½p	OA70	07½p
IS44	10p	BA110	32½p	BY124	15p	OA73	10p
IS113	15p	BA115	07½p	BY126	15p	OA79	09p
IS120	15p	BA141	32½p	BY127	17½p	OA81	07½p
IS121	17½p	BA142	32½p	BY164	57½p	OA85	07½p
IS130	12½p	BA144	12½p	BYX10	22½p	OA90	07½p
IS131	12½p	BA145	20p	BYZ10	35p	OA91	07½p
IS132	15p	BA154	12½p	BYZ11	32½p	OA95	07½p
IS940	07½p	BAX13	12½p	BYZ12	30p	OA200	10p
AA119	10p	BAX16	12½p	BYZ13	25p	OA202	10p
AA129	10p	BAY18	17½p	FST3/4	22½p		
AAZ13	10p	BAY31	07½p	OA5	17½p		
AAZ15	12½p	BAY38	12½p	OA10	22½p		

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1 amp Charger. Sec. 0–3·5–9–18V 97½p
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2 amp (Douglas) MT 104 Sec. tappings from 6V to 50V .. .. £2·12½
Post and packing 22½p on all Transformers.
5 amp (Douglas) MT107 Sec. tappings from 6V to 50V .. .. £5·50
Post and packing 37½p
Various other Douglas Transformers ranging from ½A to 5A in stock.

TRIACS

SC41A 6 amp 100V £1
SC41B 6 amp 200V .. .. £1·10
SC41D 6 amp 400V .. .. £1·20
SC50D 15 amp 400V .. .. £2·05
40512 TO-5 mod. 6 amp 400V .. .. £1·45
40430 TO-66 6 amp 400V 97½p
40486 TO-5 mod. 6 amp 400V 95p

Economy Range Triacs
TC4/10 (Pressfit) 4 amp 100 PIV 75p
TC4/20 (Pressfit) 4 amp 200 PIV 85p
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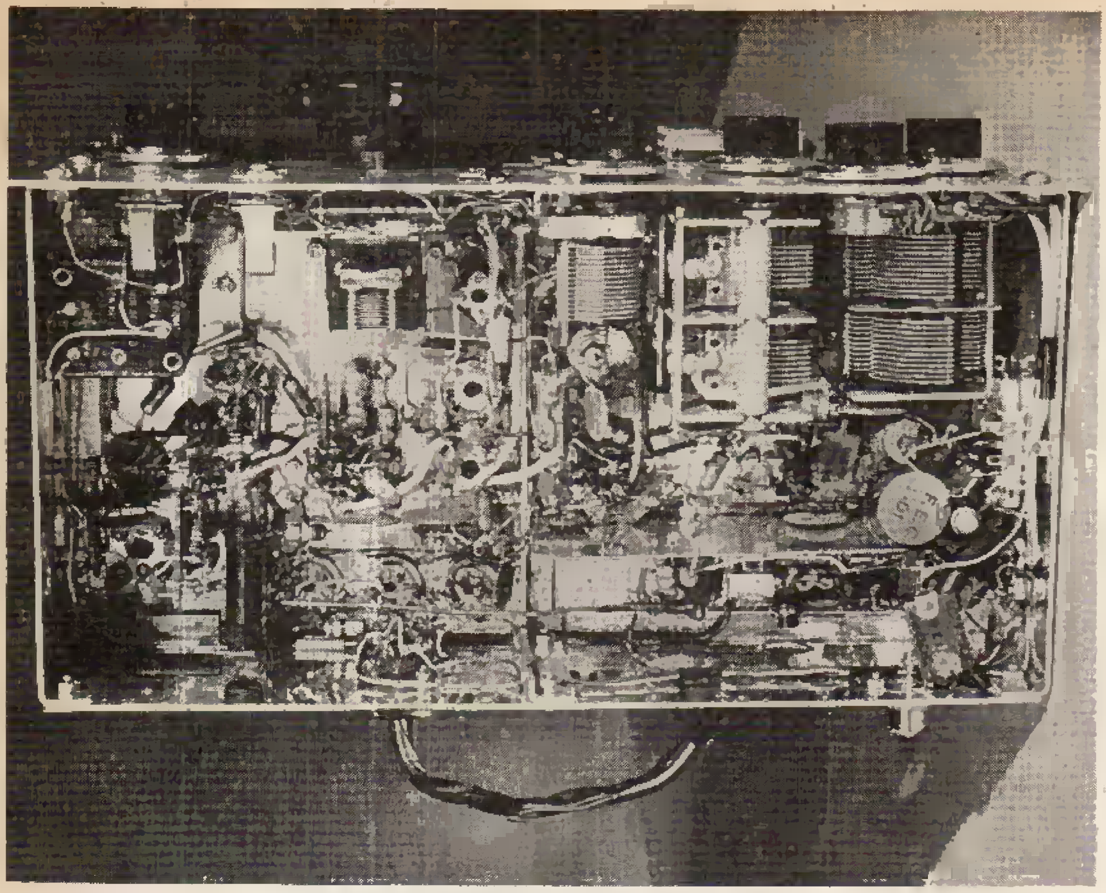


Below-chassis view of transceiver. The main components may be identified by referring to Fig. 5. Part One. The inner edges of the boards are supported by the aluminium bracket running vertically downwards in the centre of the chassis.

If the receiver only is required there is no reason why this part of the transceiver should not form a project on its own. In this case the cathode returns of the r.f. stages should be returned to earth and the p.a. coil L6 replaced by a Denco Range 3 aerial coil.

The transmitter portion of the transceiver can be utilised on its own by feeding outputs from the first oscillator and the b.f.o. of a Top Band receiver into the transmitter mixer valve V5. Remember that any interference with these oscillators will affect their calibration. Other arrangements would have to be made for the changeover from receiver to transmit.

Although a higher voltage on the p.a. would be desirable from the point of view of efficiency by using a capacity input filter in the power supply it was decided to stick to choke input for the better voltage regulation that it provides.

The importance of using a calibrated absorption wavemeter for checking the transmitter output cannot be too highly stressed. It must be remembered that the r.f output indicator will respond to any r.f. output including any spurii which may occur during alignment.

If it is found that the dip in the anode current on transmit does not quite coincide with the position of the p.a. tuning for maximum signals on receive, the transmitter should be carefully tuned and signals then peaked by adjusting the core of the receiver mixer coil L1. This should be done around 1·9MHz when it will be found that the alignment will hold over the whole band.

Once the transceiver has been aligned and the output frequency checked and found correct the r.f. output indicator can be used for tuning up the transmitter.

Final Alignment When the transceiver is working properly in all respects the whole alignment procedure should be repeated and although this may sound quite formidable in fact it takes only a few minutes.

In particular the tuning of i.f.t.1 will have been upset by the addition of the Q multiplier stage.

NOTES

As the finished chassis is a close fit in the cabinet the flanges on the sides of the cabinet must be cut away to provide clearance.

Holes are cut in the back of the cabinet, one to clear the power lead octal plug and the other for the co-axial aerial socket. Chassis cutters of 1½in. and ¾in. respectively were used for this purpose.

Aluminium angle trim was glued to the bottom front edge of the transceiver cabinet and the power supply cabinet, as a finishing touch, as well as to lift up the fronts of the units from the table. Conventional rubber or plastic feet can also be used to achieve the same effect.

Letraset was used to make up labels for identifying the various panel controls, switches etc.

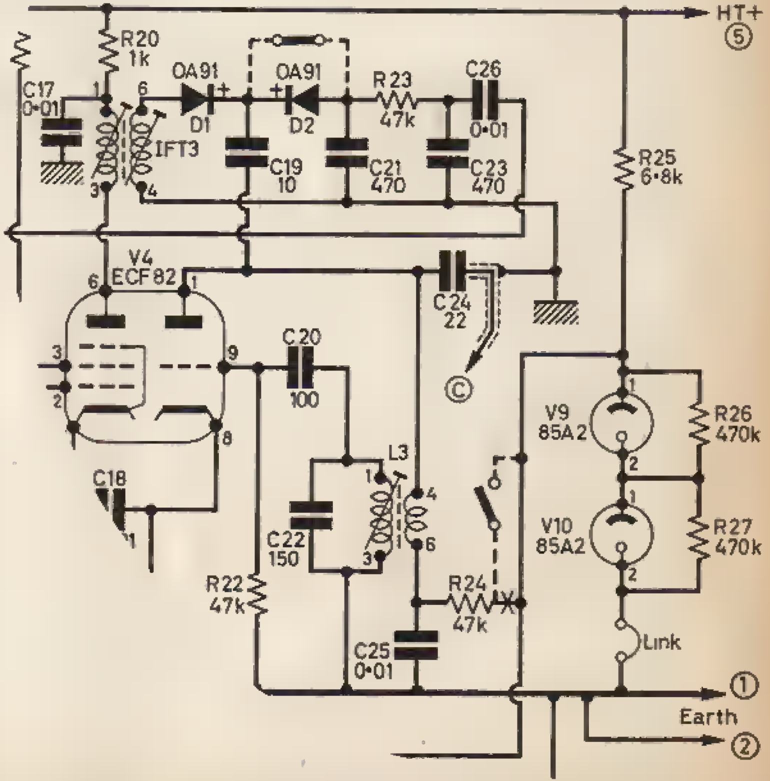


Fig. 8. Modification for reception of a.m. signals. One pole of a slide switch shorts out diode D2, the other pole opens the h.t. feed to the b.f.o., V4. Existing feed to b.f.o. must be broken at point X.

MODIFICATIONS

Since completing the transceiver the following modifications have been made to improve its versatility.

AM Reception As it stands the transceiver can be used to receive a.m. signals by tuning the carrier to zero-beat. This is not entirely satisfactory so a double-pole changeover slide switch was fitted to the panel. One pole is wired in series with the h.t. line to the b.f.o. and the other is wired across the product detector diode D2 which is shorted out on a.m. Thus on a.m. the b.f.o. is off and D1 becomes a normal diode detector, Fig. 8.

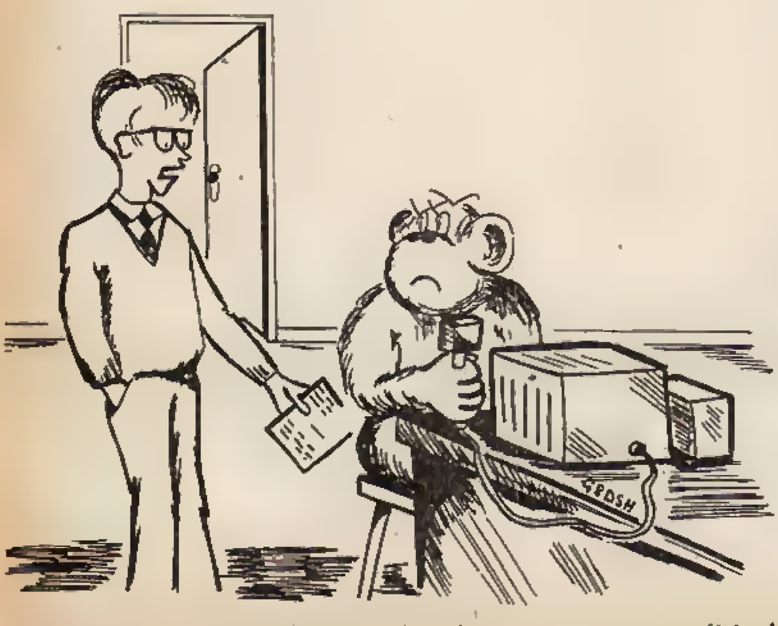
AM Transmission In order to be able to use a.m. telephony an open circuit jack socket was fitted to the back panel of the power supply unit and connected in parallel with the transmitter h.t. supply switch S2.

With the switch open the output of a small modulator can be plugged into the socket and the transmitter adjusted for proper modulation in the usual way.

When receiving a.m. signals the Q multiplier selectivity control may need backing off to obtain adequate bandwidth for reasonable speech quality.

It is important to note that when transmitting in the a.m. mode the b.f.o. must be on. The slide switch, mentioned above, must be moved to the "on" or "c.w." position before pressing the key to transmit. ■

MAXWELL



"It's the man from the G.P.O. about your party-political broadcast"

THE MW COLUMN

CENTRAL USSR and its Asiatic Republics to the south are usually neglected by the medium wave enthusiast. Local broadcasting in this area is on European frequencies and since the time zones are ahead of GMT, the majority of stations will have signed off before interference from Western Europe subsides for the night. Although there are a few all-nighters to be heard the best time for DX is at sign on, which occurs between 0100hrs and 0300hrs GMT. Saturday night is unfavourable owing to the extended schedules of many Europeans. **Harold Emblem** of Mirfield, Yorkshire, has been DXing this region and reports reception of Gorki on 827kHz; Simferpol Crimea 1313kHz (which was heard behind Stavanger at 1800hrs); Kharkov 1322kHz at 0240hrs; Saransk 1061kHz. DX logged recently by the writer includes Murmansk Lapland 656kHz at 2330hrs GMT; Ufa Bashkir 692kHz at 0106hrs; Kuybyshev 809kHz at 0140hrs; Garm Tadzhikistan 980kHz at 0050hrs; Baku Azerbaijan 1016kHz at 0130hrs. Those heard signing on at 0200hrs GMT were Yerevan Armenia 863kHz; Stavropol Caucuses 881kHz and Tbilisi Georgia 1043kHz. Others logged later in the night are Astrakhan 791kHz at 0206hrs; Markhagkala Dagestan 917kHz at 0205hrs; Tashkent Uzbekistan 1025kHz at 0230hrs. From nearby Iran, Tabriz 645kHz is often strong when it signs on at 0228hrs with a haunting Iranian melody played on a vibraphone, followed by a 3-pip time signal and the call 'Radio Iran.'

Identification can sometimes be a problem with USSR stations. Those that do identify locally use the word *Govarit* if in Russian, *Geplevar* in Turkmenian, *Danishir* in Azerbaijanian, *Khosum* in Armenian followed in each case by the place name. Radio Tashkent identifies in Uzbek with *Tashkentdan Gapiramis*. Harold points out that the BBC transmissions in Russian on 809kHz might be mistaken for Kuybyshev, but USSR stations usually transmit the 'Midnight in Moscow' interval signal two minutes before the hour or half hour, followed by a 6-pip time signal, while many carry the '*Programma Mayak*' which is mentioned in the identification. Sometimes a station broadcasts on one of the Tropical Bands as well as on the MWs. The writer has checked Ashkhabad 200kHz on the long waves against Ashkhabad 4825kHz on the 60 metre band and found the same local programme on each frequency.

Medium wave stations in the Caribbean are often prominent at this time of year. Listen between midnight and 0100hrs GMT for JBC 750kHz Point Galina, Jamaica; ZFY 760kHz Georgetown, Guyana; 4VEC 830kHz Cap Haitien, Haiti, in French; Radio Belize 834kHz in British Honduras; Radio Caribbean 840kHz in St. Lucia in French; WBMJ 1190kHz San Juan, Puerto Rico in English, ZBM1 1235kHz Hamilton, Bermuda; PJD2 1295kHz St. Martin in Dutch and English; Martinique 1310kHz in French.

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ECC81	20p	EL42	52p	PCL83	65p
EBF80	37p	EL84	23p	PCL84	42p
EBF83	30p	EL85	36p	PCL85	42p
EBF89	30p	EL86	40p	PCL86	42p
ECC81	20p	EL90	30p	PFL200	57p
ECC82	28p	EL95	35p	PL36	53p
ECC83	27p	EL500	85p	PL81	50p
ECC84	20p	EM31	25p	PL82	40p
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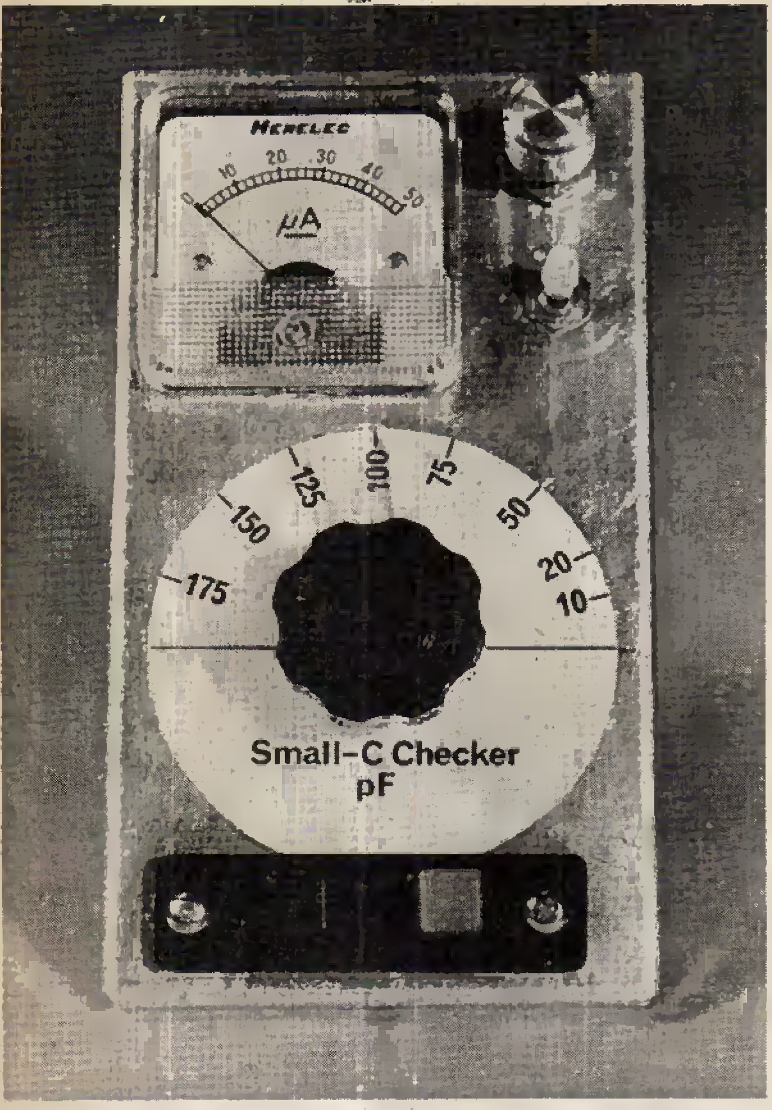


IN the course of time the average constructor accumulates quite a lot of odd small-value capacitors which eventually lose their markings and identity either by constant handling or by just being jostled around in the junk box. In any case they are then virtually useless and a positive menace and might just as well be thrown away. A 10pF capacitor used inadvertently with a tuned circuit instead of 100pF can cause an awful lot of trouble.

However by using this simple checker these capacitors can be rescued and re-marked and an hour spent in this way can be very rewarding.

The usual method of measuring capacity is with a bridge using an integral a.f. or r.f. oscillator to power the bridge. It occurred to the writer that since most constructors have a seldom used 1MHz crystal calibrator sitting on the workbench this could be put to good use as a signal source for a capacity checker.

In the event the checker proved so useful and was used so often that it was decided to integrate the oscillator and capacity measuring circuitry. This second unit is also described below.

METHOD

The usual bridge circuit has not been used. Instead a tuned circuit is resonated with the signal source at 1MHz, the unknown capacitor connected in parallel with the circuit and the tuning capacitor reduced in value until resonance is restored.

If the tuning capacity is calibrated (in pF) the decrease in its capacity to maintain resonance is equal to the value of the unknown capacitor.

The range of capacity that can be checked is approximately equal to the value of the calibrated capacitor, in this case up to about 200pF.

CIRCUIT MK I

The signal source at 1MHz is fed via a short coaxial lead to the input socket Sk1, Fig. 1, across which is connected the tuned circuit L1, VC1. With VC1 at maximum capacity the slug of L1 can be adjusted until the circuit resonates with the 1MHz source.

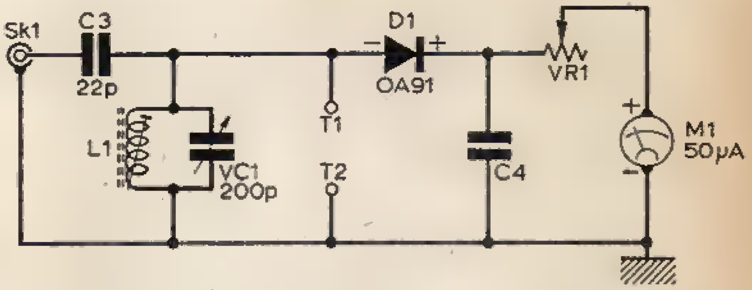


Fig. 1: Circuit of the Mk I capacitor checker.

Resonance is indicated by maximum deflection on the 50μA f.s.d. meter M1 fed from the rectifier circuit D1 and C4 connected across the tuned circuit. The f.s.d. of the meter can be adjusted over a wide range by the potentiometer VR1 to cater for differing input signal levels.

The capacitor to be measured is connected to the terminals T1 and T2. The range can be extended by increasing the value of VC1 but the accuracy of the read-out will be less.

SIGNAL SOURCE

The author had a 1MHz-100kHz-10kHz crystal calibrator available so this was used originally as a signal source for the checker, at 1MHz. There is no reason why an ordinary signal generator tuned to 1MHz should not be used but it should be stable in frequency and be fitted with an attenuator or other output level control.

CONSTRUCTION

All the components are mounted on the lid of a small aluminium box $5\frac{1}{4}$ x $2\frac{3}{4}$in. and 2in. deep. A suggested layout is shown in Fig. 2 (the circuit-board and switch S1 being ignored), but there is nothing critical in the placement of the few components. Care must be taken to ensure that terminal T1 is properly insulated from the lid, the two-terminal strip specified being fixed to the lid with 6BA bolts with a spacing nut between the strip and the lid, the wire from T1 being taken through a clearing hole in the lid.

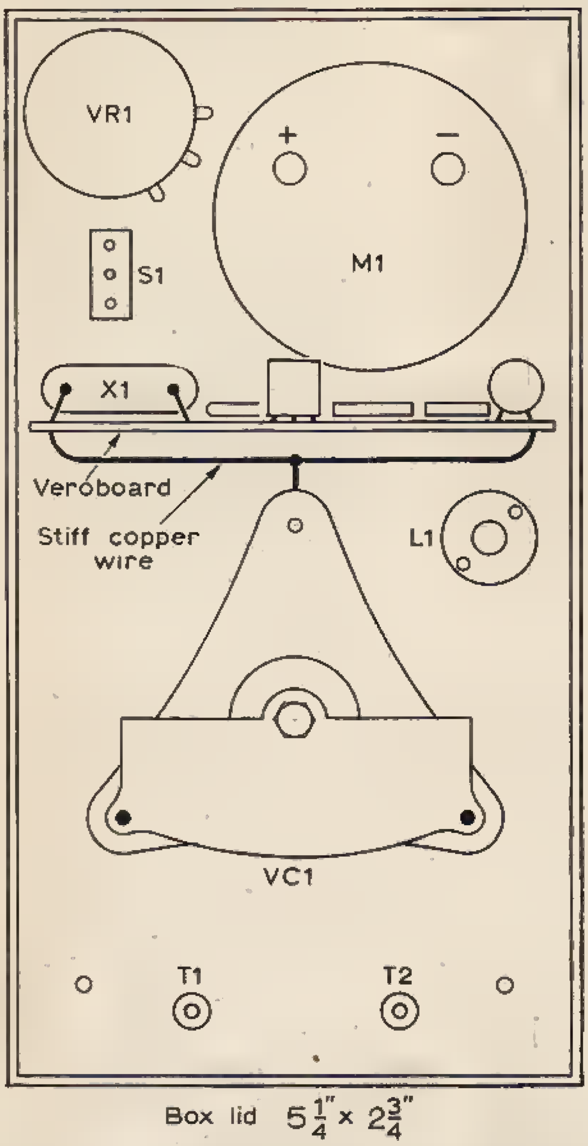


Fig. 2: Layout of the checker Mk II. In the Mk I version the circuit board and switch S1 are omitted and an input socket fitted.

These terminals are spring loaded which considerably facilitates the gripping of the wire ends of small capacitors.

The inductor L1 has its own fixing nut through which the slug can be adjusted with a conventional hexagonal trimming tool or it may be fixed in position with Araldite. Diode D1 and capacitor C4 are wired directly between components.

A stiff white cardboard dial, $2\frac{1}{2}$in. diameter, is clamped underneath the retaining nut of VC1. A thin perspex pointer with a hairline scribed on it is stuck to the underside of the knob on VC1.

CALIBRATION

After checking the wiring, such as it is, set VC1 to maximum capacity and adjust the pointer to the zero line on the dial. Feed in a signal at 1MHz from the crystal calibrator and adjust VR1 for a reasonable deflection on the meter.

Adjust the slug in L1 for a peak on the meter reducing the signal input or increasing VR1 until the peak deflection coincides with the f.s.d.

Using a series of capacitors of known value, preferably of 1% tolerance, connect each in turn across the terminals. When this is done the meter reading will drop as the tuned circuit is no longer resonant at 1MHz but it may be peaked again by reducing VC1 at which point the scale should be marked with the value of the known capacitor. Some constructors may wish to use the preferred range of values such as 22, 47, 68pF etc., when calibrating the dial.

In use VC1 is set to zero on the dial and VR1 adjusted for full scale deflection. The unknown capacitor is connected to the terminals and VC1 rotated to restore full scale deflection on the meter. The dial reading at this point being the value of the capacitor under test.

If, with the unknown capacitor in circuit, it is found that it is not possible to regain f.s.d. it is likely that the capacitor insulation is down although it may still be of the order of megohms.

★ components list

Resistors:
R1 220kΩ $\frac{1}{8}$W   R2 1kΩ $\frac{1}{8}$W   VR1 470k pot. (miniature)

Capacitors:
C1 1000pF SM   C3 22pF SM
C2 820pF SM   C4 0.01μF disc
VC1 200pF variable (Jackson Type 87/057)

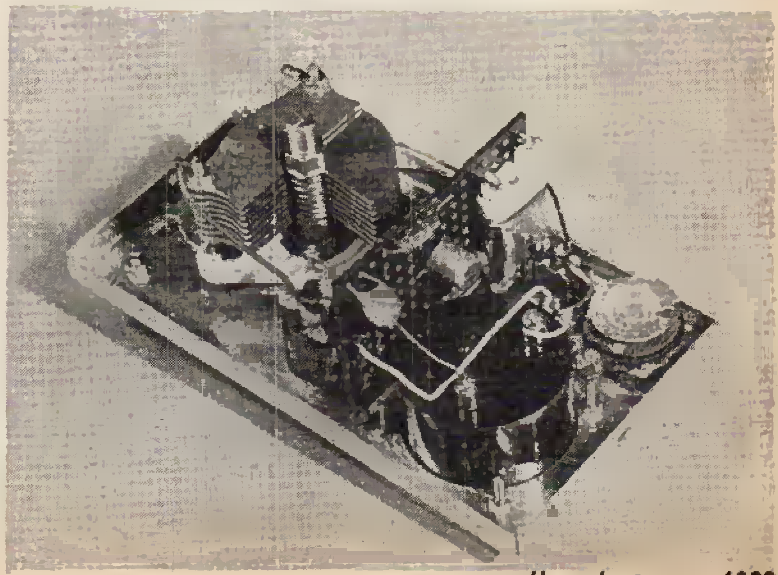
Semiconductors:
Tr1 AF117 D1 OA91

Miscellaneous:
X1 1MHz crystal, type HC6U and holder (Henrys)
L1 Inductor, HQ4 (Electronic Techniques (Anglia) Ltd., Viking Works, Kirton, Ipswich, Suffolk.
M1 Meter, 50μA f.s.d. (Henrys Type MRA38)
Battery 9V, (PP3) and connectors
Terminals, black and red (Henrys SLT2)
Piece of Veroboard. Knobs. Miniature on/off switch
Aluminium box $5\frac{1}{4} \times 2\frac{3}{4} \times 2$in. (H.L. Smith) or similar

CIRCUIT MK II

In view of the great use to which the checker was put it was decided to integrate the 1MHz oscillator and the capacity measuring circuitry to obviate the necessity of connecting the two units together every time a capacitor was to be checked.

The original crystal calibrator was a valved job so



—continued on page 1066

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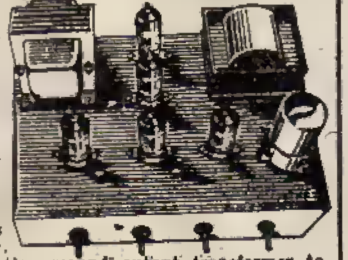

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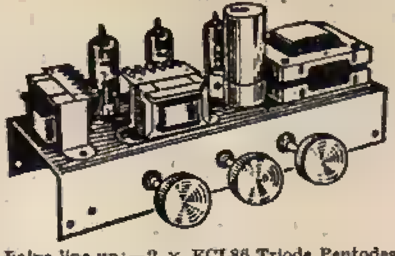

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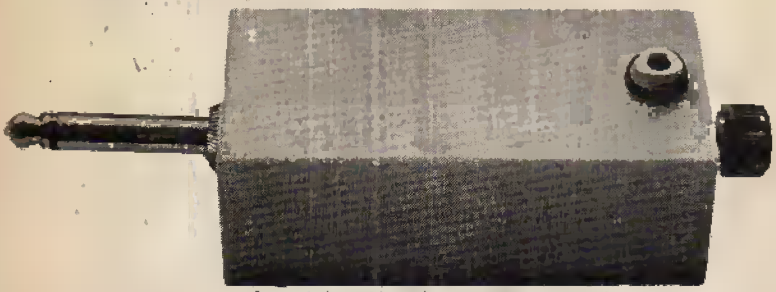
PLUG-IN TUNER

RICHARD COLLINS



THIS simply constructed crystal tuner has many advantages to offer. It is easy to construct, compact and does not require any power source.

In this article the construction of a crystal diode tuner is described. It can be used to provide a signal that can be fed into a tape recorder, amplifier, or just a pair of high impedance headphones, so becoming a simple crystal receiver. Full constructional details are given so that a complete beginner may build the project.

The layout of the tuner is by no means critical and constructors can position the components to suit the box in which the unit is to be built.

The prototype was constructed in a small plastic case obtained from one of the advertisers in this magazine but any small box of similar size, be it made from plastic, metal, wood, etc., is suitable.

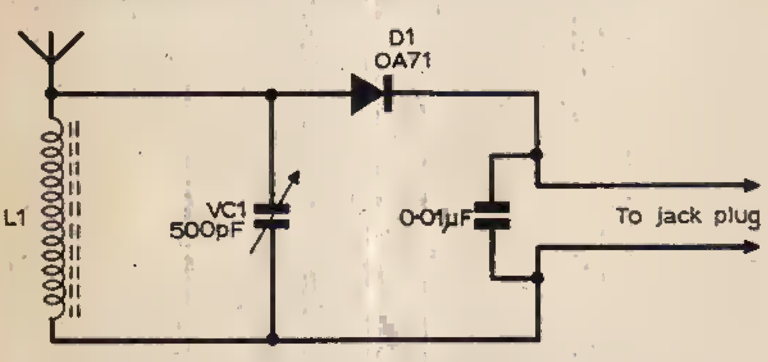


Fig. 1: Circuit of the crystal tuner. A resistor R1, 10kΩ, should be shown across the 0·01μF capacitor, but see text.

The complete circuit is shown in Fig.1 and from this it can be seen that very few components are employed; a coil, trimmer capacitor slightly modified, diode and resistor together with an aerial socket and the "business" end of a jack plug. The use of a jack plug helps to eliminate any losses of signal strength and reduces any hum that may occur.

There are only three holes to make in the case and the sizes of these are determined by the particular types and makes of components employed. One of these is for the aerial socket, one for the tuning capacitor and the third for the jack plug. The coil may be either glued to the casing or held in its position by employing fairly thick wire for connecting (bell wire from Woolworths will be ideal for this).

Before construction begins, the tuning capacitor or trimmer VC1 must be modified somewhat so that it can be used with a knob.

As can be seen from Fig. 2b, the original bolt has been removed and a longer bolt inserted, (a 1in. 6BA round-headed bolt will do). This should be screwed through the trimmer from the back. The trimmer should then be set in the "open" position and the end of the bolt snipped off so that about ¼in. is left for fixing the "knob." This knob shown in the prototype was a small perfume bottle cap with a nut glued inside it. When the glue had set, a small amount of glue was spread onto the thread of the nut. After a while, the knob was screwed onto the thread and a good solid fixture was made. This knob can be fabricated from the lid of an old toothpaste tube or anything of similar size.

When the trimmer capacitor has been modified, a hole of suitable size should be drilled in one end of the case as shown in Fig. 3. Should constructors wish, they can use a small 500pF variable capacitor—the size being dependent on the size of case employed. Another hole to fit the aerial socket through should be drilled in a suitable position (if the case is made of metal, this socket should be of the insulated lead-through type).

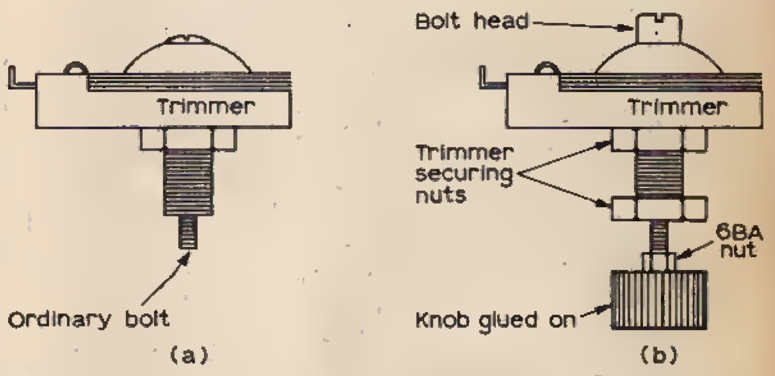


Fig. 2: Tuning capacitor modification.

The third hole, for the jack plug, should then be made. This, being the largest is best started off with a hot soldering iron in the case of plastic or wood (a drill and file are best used to make a neat job in a metal box).

If this hole is made slightly smaller than the thread on the shank of the jack plug, it can be screwed into the actual case for a tight fit rather than have a securing nut fitted. This is a preferred way of mounting as a securing nut may foul the jack connecting tags.

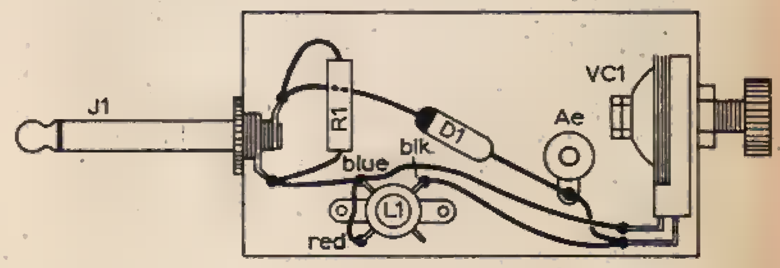


Fig. 3: Component layout and wiring diagram.

The three items may then be fitted in their respective positions (see Fig. 3) and the wiring commenced.

The coil, a Repanco DRX1 employed in the prototype was a medium/long wave component but only the medium wave winding was connected. A piece of wire should be taken and connected to the blue and red tags on the coil L1. This wire should then be taken to one of the tags on the trimmer capacitor VC1. Another wire should be taken from the other tag of VC1 to the black tag on the coil. From the blue and red connections on the coil, a wire should be taken to the centre connection on the jack plug. Resistor, R1 should be connected across the centre tag and the other tag and the black end of the crystal diode should be connected also. The positive or red end of the diode should then be connected to the aerial socket. A wire should then be taken from this to the tag on the capacitor VC1 that goes to the black tag on the coil. Some constructors may wish to employ the long-wave winding on this coil and if this is so, a suitable on/off type switch may be mounted in any convenient position in the case. The tuner may now be tested and an aerial should be plugged into the socket and the jack plug connected to an amplifier input. Wires may be secured with Sellotape while testing takes place. When the tuning capacitor VC1 is rotated, a station should be heard. If two stations are heard simultaneously, a capacitor about 100 pF value should be inserted between the aerial and the aerial socket—this should help separation.

It has always been the author's policy that the best aerial is one that has as much wire up as high as possible and this is certainly the case as far as crystal receivers go. A length of wire between 50-100ft. should suffice.

If it is wished to build up this circuit just for use as a crystal set, the 10kΩ resistor may be omitted. ■

PLUG-IN TUNER—*contined from page 1062*

it was thought better this time to employ a transistor oscillator and to put it and the battery supply in the orginal box with the tuned circuit etc.

This version of the checker is therefore ready for instant use.

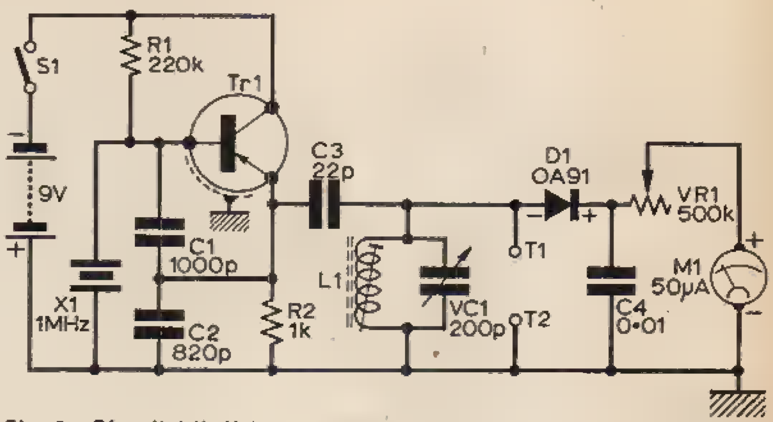


Fig. 3: Circuit Mk II incorporating a 1MHz oscillator signal source

The oscillator is straightforward and uses an AF117 p.n.p. germanium transistor and an HC6U style 1MHz crystal unit, Fig. 3, and is constructed on a small piece of Veroboard, Fig. 4. The board is mounted between the meter and the tuning capacitor VC1 by a stiff copper wire soldered to the earth side of VC1, as can be seen in the photograph.

The output of the oscillator is connected to the original tuned circuit by C3.

The method of measuring the value of an unknown capacitor is the same as before except that initially the step of adjusting the core of L1 should be repeated since the permanent capacity across the tuned circuit will now be different.

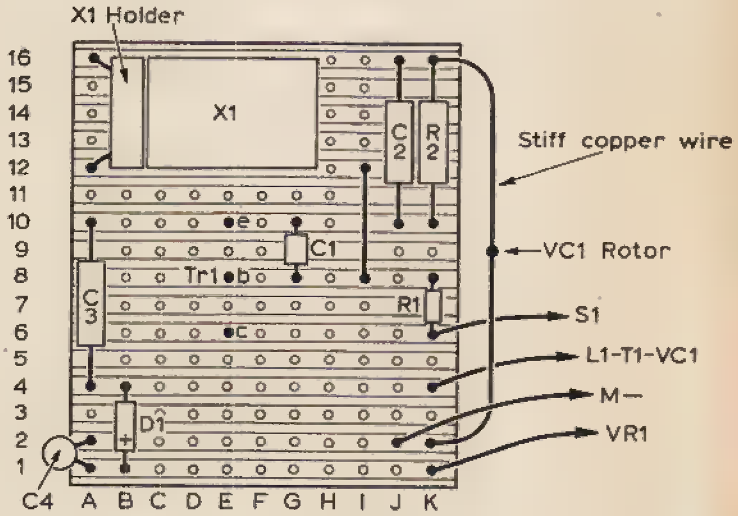


Fig. 4: Circuit board of the 1MHz oscillator built on Veroboard, 0·15 x 0·15in. matrix.

The miniature switch S1 could very well be part of the potentiometer VR1 which would save some space. If this is done make sure that the pot. is wired so that clockwise rotation of the pot. decreases its resistance.

The checker will be found very useful indeed in matching small values of capacitance where precise values are not important. In practice changes of less than 1pF can be detected.

Don't forget that the Small-C Checker can still be used as a frequency spotter with its internal 1MHz oscillator. Connect a short stiff wire to the live terminal and harmonics can be found up to at least 30MHz. ■

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Post Free less 5% on three reels. Quantity and Trade enquiries invited

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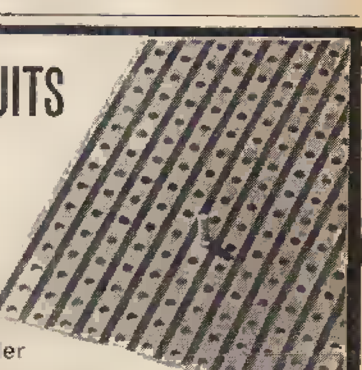

—the Universal Wiring Board—
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Trade enquiries to:
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GOING BACK...

1970 60 50 40 30 20

COLIN RICHES
ARTHUR DOW

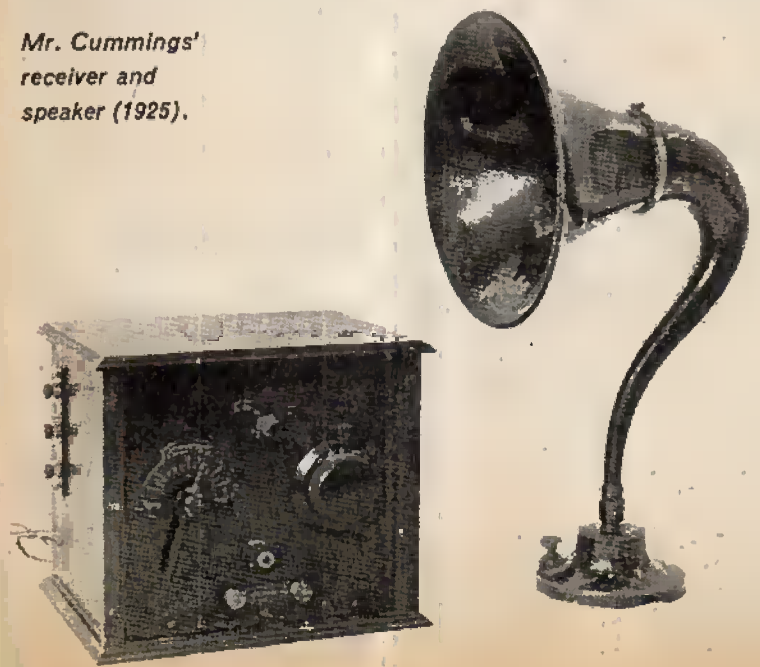
EVERY day of the week, except when there is a postal strike, we receive letters from readers interested in the Going Back article. The **Reverand R. J. Mantle,** M.A., from Aberdeen writes that he has a B.T.H. crystal wireless dated 1924 and another B.T.H. valve/crystal set with two crystals and one valve dated about 1927. He says that amongst his books on wireless, his most precious is a book entitled "A Beginner in Wireless" by E. Alexander, published in 1923. It has many interesting photographs like Marconi's Timed Spark c.w. Generator, the Brown Microphone Amplifier and Fleming's thermionic valves.

One suggestion that Reverand Mantle makes is that wireless of the 1920's should be known as "Veteran Radio" and that of the 1930's should be known as "Vintage Radio".—Any comments?

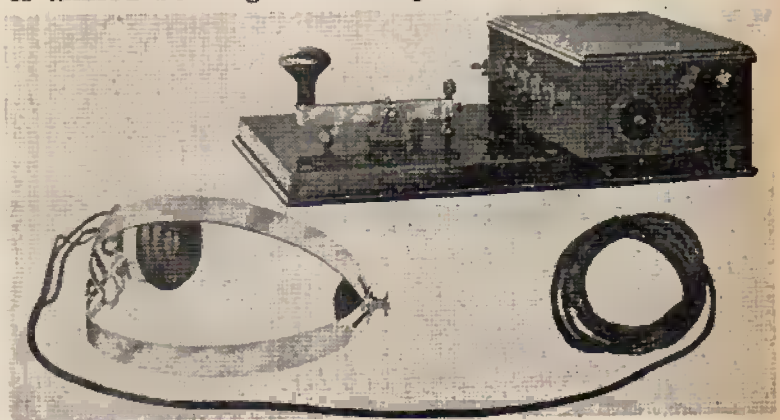
C. Langton Kirk writes to say that he has seen the name of N. Gilbertson mentioned in our August 1970 issue and wonders if this is the same one that he knew as a very good friend back in 1925-26. Both were interested in wireless as a hobby in those days. So, Mr. Gilbertson, if you worked in a cinema in Leicestershire in 1925, you are the correct man and Mr. C. Langton Kirk, 137 Hubert Road, Bournbrook, Birmingham, 29 6ET would like to hear from you.

Mr. W. G. Rumbold, M.I.E.E., tells us how he used to listen to the "shipping bands" on 600m where there was a constant stream of traffic in readable Morse always on tap. A little higher up in wavelength (frequency was not spoken of then) were Croydon Airport, Castle Bromwich and Le Bourget with R/T on 900m.

Mr. Cummings' receiver and speaker (1925).



Mr. F. C. Burgess, 58 Beaconhurst Drive, Beacon Bay, East London, C.P., South Africa, writes to say that he has in his possession an old Marconiphone two-valve set. He estimates its year of manufacture at approximately 1923. The set is still in good condition with its two plug-in coils and a small name-plate is affixed bearing the inscription "Marconiphone V2.



Marconi Morse practice buzzer.

Type R.B.I.A., A.S.206B Inst. No. C-A-7618." If any readers have any idea of the exact date of manufacture, will they drop a line to Mr. Burgess please?

A photograph we received the other week is of a Marconi Morse Practice Buzzer. Vintage is 1912. Slightly different from a modern transistor Morse oscillator, this one boasts a highly finished teak board on which is mounted an operating key and other parts. Enclosed in a case on the same board is a battery, high note buzzer and induction coils, one of which is provided with a convenient handle, by means of which the strength of signals in the telephone can be varied. The buzzer is arranged in a practically sound-proofed box, but can be removed for easy adjustment. A single head piece telephone was provided with the instrument, but a double head piece could be supplied if required at slightly increased cost.

Keith Cummins—better known to our sister magazine "Television" readers for his 625-line TV Receiver articles, sends us a photograph (left) of a receiver he has recently put in working order. It employs two valves and a 4·5V battery has been used for the l.t. supply giving each valve 2·25V in a series circuit. Keith says this helps since they are so ancient —and he is highly delighted by the performance. Date is approximately 1925.

Wireless Experiments on an Aeroplane

Flanders' monoplane on which experiments with wireless were carried out in 1912.

One of our vintage radio enthusiasts, Mr. Leonard Adlard of Essex recently loaned us some copies of an old magazine called *The Marconigraph*—the official organ of the Marconi Co. All dated 1912, these magazines have some real gems of information in them and below we publish an extract which tells the story of an early exploit with an airborne transmitter.

"One of the applications of wireless is telegraphing from aeroplanes, airships and balloons. The advantage of being able to communicate with land or other stations whilst in the air has been well exemplified on many occasions.

On March 16th, 1912 when some wireless experiments were being carried out on Mr. Howard Flanders' monoplane at Brooklands Aviation Grounds near Weybridge, a curious incident occured. On the previous evening a trial flight was made after the wireless apparatus had been fitted to the machine and everything seemed in perfect working order. On the Saturday morning, as the weather was exceedingly favourable for flying, the machine was taken out again, but it was then that the mishap occured. The aviator was flying very low at the time, and on landing his first skid apparently struck the ground owing to a too sudden descent and to the speed at which the aeroplane was moving at the time—approximately 60 miles per hour—the machine turning completely over. The aviator was thrown out of his seat, and when picked up was unconscious. The fuselage of the machine was smashed to two places and the propellor was also damaged. The wings had apparently escaped unhurt, but had to be stripped of their fabric and thoroughly overhauled. The exhaust pipes, radiators, and lubricating pipes on the engine were also damaged and the front skid of the aeroplane was broken in two. Amidst the debris, it would not have been surprising if the wireless apparatus had been smashed, especially as the oil tank beside which the wireless apparatus was fitted had been severely battered and was leaking badly. After removing the sand and dirt with which everything was covered, it was found, however, that the wireless apparatus had escaped quite undamaged and was in working order; even the aerial wire, which was attached to the broken fuselage remained intact!"
—Amazing!

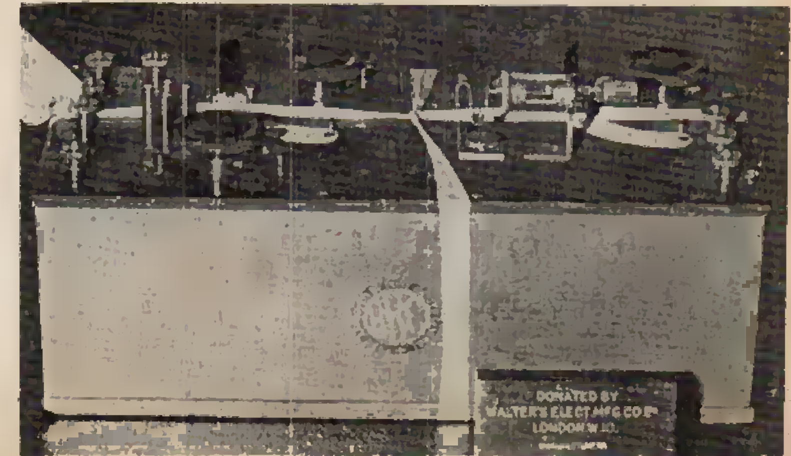
CQ! CQ! CQ! CQ! CQ!

If you have a Vintage CQ you would like included in Practical Wireless, drop a line to Colin Riches and Arthur Dow who will include it in the earliest available issue.

APPARATUS REQUIRED

. . . ex-Cable and Wireless Morse Operator (now alas teletype) wishes to acquire two early Morse keys (brass) to cherish and use on the amateur bands.—J. A. Van Walwyk, G3YRW, 321 Parkside Avenue, Barnehurst, Kent.

. . . I am interested in knowing if anyone has any Telsen baseboard components which were produced in 1933. They include the dual-range coil, the combined dual-range short wave coil unit, the h.f. coil, screened tuning coils (pair or singles) and the twin tuning condenser with the built-in trimmer to match the coils. Also the 4, 5 and 7 pin valve holders.—G. Beasley, 31 York Avenue, Bedworth, Nr Nuneaton, Warks.



For those readers who have asked to see a close-up of the Walters Receiver (News . . . Jan. 1971).

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BARGAINS IN NEW SEMICONDUCTORS all power types supplied with free insulating sets

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2N697	22p	2N2926	11p	AC126	20p	BC154	20p	BFY51	20p
2N706	12p	2N3053	27p	AC127	20p	BC157	19p	BFY52	23p
2N930	29p	2N3055	75p	AC128	20p	BC158	17p	BSX20	16p
2N1131	36p	2N3702	13p	AC153K	25p	BC159	18p	C407	17p
2N1132	40p	2N3703	13p	AC176	27p	BC167	13p	MC140	25p
2N1302	19p	2N3704	13p	ACY20	20p	BC168	11p	MPS6531	35p
2N1303	19p	2N3705	13p	ACY22	16p	BC169	13p	MPS6534	30p
2N1304	23p	2N3706	13p	AD140	58p	BC177	17p	NKT211	25p
2N1305	33p	2N3707	13p	AD142	50p	BC178	19p	NKT212	25p
2N1306	33p	2N3708	13p	AD149	60p	BC179	17p	NKT214	23p
2N1307	36p	2N3709	13p	AD161	40p	BC182L	13p	NKT274	18p
2N1308	36p	2N3710	13p	AD162	40p	BC183L	11p	NKT403	65p
2N1309	36p	2N3711	13p	AF114	30p	BC184L	13p	NKT405	79p
2N1613	23p	2N3794	15p	AF115	30p	BC212L	25p	OC71	29p
2N1711	26p	2N3819	35p	AF117	28p	BC213L	25p	OC81	25p
2N1893	54p	2N3906	35p	AF124	30p	BC214L	25p	OC81D	25p
2N2147	95p	2N4058	20p	AF127	28p	BCY70	19p	ZTX300	17p
2N2218	33p	2N4059	20p	AF139	48p	BCY71	33p	ZTX301	17p
2N2218A	43p	2N4060	20p	AF239	49p	BCY72	16p	ZTX302	22p
2N2219	38p	2N4061	20p	ASY26	27p	BF115	23p	ZTX303	22p
2N2219A	53p	2N4062	20p	ASY28	27p	BF167	27p	ZTX304	33p
2N2270	62p	2N4124	18p	BC107	14p	BF173	31p	ZTX500	25p
2N2369A	19p	2N4126	27p	BC108	12p	BF194	17p	ZTX501	25p
2N2483	35p	2N4284	15p	BC109	14p	BF195	18p	ZTX502	30p
2N2484	42p	2N4286	15p	BC125	15p	BFX29	31p	ZTX503	25p
2N2646	54p	2N4289	15p	BC126	22p	BFX84	25p	ZTX504	60p
2N2904A	42p	2N4291	15p	BC147	15p	BFX85	34p		
2N2905	44p	2N4292	15p						

RESISTORS

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99 (see note below)	100 up
C	1/20W	5%	82 Ω–220K Ω	E12	7	6·5	6
C	1/8W	5%	4·7 Ω–330K Ω	E24	1	0·8	0·7
C	1/4W	10%	4·7 Ω–10M Ω	E12	1	0·6	0·7
C	1/2W	5%	4·7 Ω–10M Ω	E24	1·2	1	0·9
C	1W	10%	4·7 Ω–10M Ω	E12	2·5	2	1·8
MO	1/2W	2%	10 Ω–1M Ω	E24	4	3·5	3
WW	1W	10% ± 1/20 Ω	0·22 Ω–3·9 Ω	E12	7	7	6
WW	3W	5%	12 Ω–10K Ω	E12	7	7	6
WW	7W	5%	12 Ω–10K Ω	E12	9	9	8

Codes: C = carbon film high stability low noise
MO = metal oxide Electrosil TR5 ultra low noise
WW = wire wound Plessey.

Prices are in pence each for same ohmic value and power rating, NOT mixed values. (Ignore fractions of 1p. on total value of resistor order)

Values:
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

INTEGRATED CIRCUIT AMPLIFIERS

SINCLAIR IC10 complete with instruction book giving amplifier circuit details and range of applications. **£2·95** nett.

Components pack for stereo inc. mains transformer, controls etc. **£4·75** nett.

PLESSEY SL403A Now only **£2·10** nett 3W into 7·5 Ω for 18V supply. Application data sent with two more.

WAVECHANGE SWITCHES LONG SPINDLES

1P 12W; 2P 6W; 3P 4W; 4P 3W — **24p each**

SLIDER SWITCHES D.P.D.T. — **15p each**

NEON INDICATOR LAMPS

all 200/250V. Square bezel, red only — **19p**
Round chrome bezel red, amber, clear — **24p each**

Toggle switches, 250V a.c. 1·5A.
chrome dolly and chrome milled nut S.P.S.T. **19p**, S.P.D.T. **22p** D.P.D.T. **29p**; S.P.D.T. centre off **20p**

S-DeC's put an end to "birdsnesting". Components just plug in Saves valuable time. Use components again and again. S-DeC (70 points) only **£1**. Compact T-DeC, increased capacity, may be temperature-cycled. T-DeC (208 points) only **£2·50**. Full range stocked.

MULLARD polyester C280 series

250V 20% 0·01; 0·022; 0·033, 0·047 **3p** ea. 0·068; 0·1, 0·15 **4p**, 0·22 **5p**, 10%: 0·33 **7p**, 0·47 **8p**, 0·68 **11p**, 1μF **14p**, 1·5μF **21p**, 2·2μF **24p**.

MULLARD SUB-MIN ELECTROLYTIC

C426 range axial lead — **6p each**

Values (μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 2·5/64; 4/10; 4/40; 5/64; 6·4/6·4; 6·4/25; 8/4; 8/40; 10/2·5; 10/16; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/4; 32/10; 32/40; 32/64; 40/16; 40/2·5; 50/6·4; 50/25; 50/40; 64/4; 64/10; 80/2·5; 80/16; 80/25; 100/6·4; 125/4; 125/10; 125/16; 160/2·5; 200/6·4; 200/10; 250/4; 320/2·5; 320/6·4; 400/4; 500/2·5.

LARGE CAPACITORS

High ripple current types: 1000/25 **23p**; 1000/50 **41p**; 1000/100 **82p**; 2000/25 **37p**; 2000/50 **57p**; 2000/100 **£1·44**; 2500/64 **77p**; 2500/70 **98p**; 5000/25 **62p**; 5000/50 **£1·20**; 5000/100 **£2·91**; 10000/15 **85p**; 10000/25 **£1·22**; 10000/50 **£2·20**.

MEDIUM RANGE ELECTROLYTICS

Axial leads: 50/50 **9p**; 100/25 **9p**; 100/50 **13p**; 250/25 **13p**; 330/25 **13p**; 250/50 **19p**; 500/25 **19p**; 500/50 **21p**; 1000/25 **20p**; 1000/50 **30p**; 2000/25 **30p**; 2000/50 **48p**.

SMALL ELECTROLYTICS

Axial leads: 4·7/10: 4·7/25; 5/50 **5p** ea. 10/10; 10/25; 10/50; 33/10; 50/10 **5p** ea. 22/25; 25/50; 47/25; 100/10; 220/10 **6p** ea.

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Stereo amplifier in modular kit form 12 watts per channel **£38·45**; Cabinet kit only **£6**. These prices nett.
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Designed by Peter Baxandall. Superb reproduction for its size. Handles 10 watts with ease. Uses ELAC 15 Ω 59RM109 speaker Unit Kit **£13·90** nett; built **£19·40** nett.

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RCA/SGS designed main amplifier kits.
Input sensitivity 500–700mV for full output into 8 Ω.

Power	Kit price including components	Suitable unreg. power supply kit
12W	£8·40 nett	£4·60
25W	£9·50 nett	N/A
40W	£10·50 nett	£5·75
70W	£12·60 nett	£6·94

30 WATT BAILEY AMP. PARTS

Sensitivity 1.2V for full output into 8 Ω
Transistors and PCB for one channel **£6·40**
Transistors and PCB for two channels **£12·80**
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5% full range E24 values; 400mW: 2·7V to 30V **15p** each 1W: 6·8V to 82V **33p** each 1·5W: 4·7V to 75V **60p** each
Clip to increase 1·5W rating to 3 watts (type 266F) **4p**.

CARBON TRACK POTENTIOMETERS, long spindles

Double wiper ensures minimum noise level.

Single gang linear	220 Ω, to 2·2M Ω	12p
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Log/antilog	10K, 47K, 1M Ω only	42p
Any type with ½A D.P. mains switch, extra		12p

Please note: only decades of 10, 22 and 47 are available within ranges quoted.

CARBON SKELETON PRE-SETS

Small high quality, type PR, linear only 100 Ω, 220 Ω 470 Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M2, 5M, 10M Ω Vertical or horizontal mounting **5p** each.

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10% on orders for components for £5 or more. 15% on orders for components for £15 or more (No discount on nett items).

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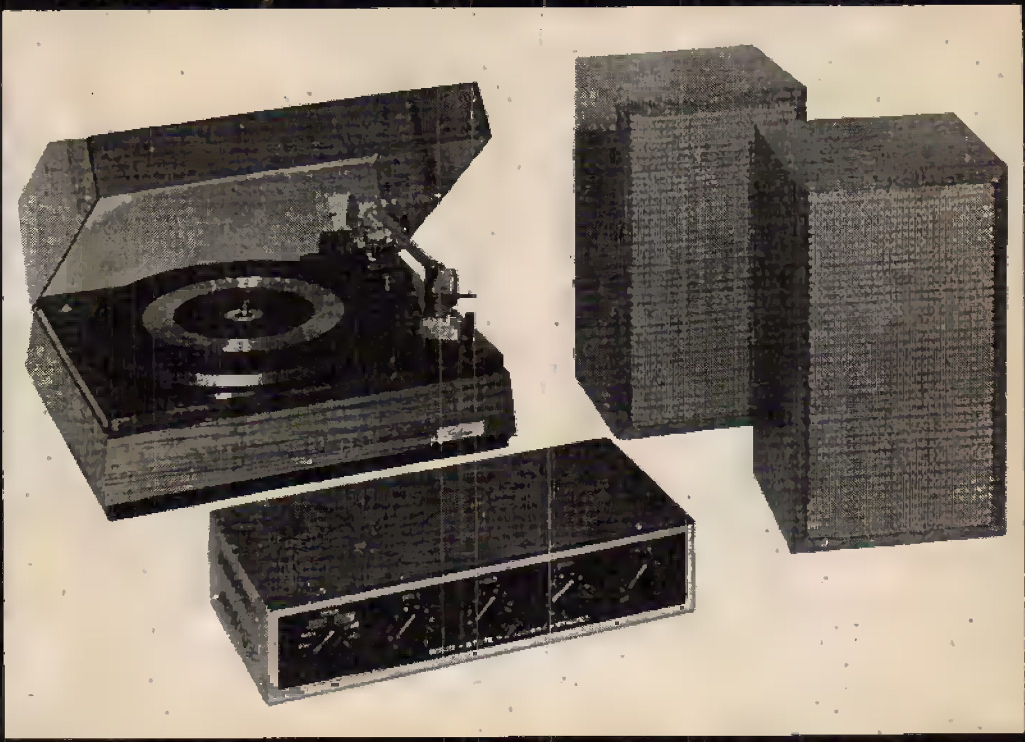
Complete Stereo System £43

WITH VISCOUNT F.E.T. FIELD EFFECT TRANSISTORS AMPLIFIER



This superb stereo system is a real price break through. It comprises the VISCOUNT F.E.T. Mk I amplifier on which full details are given below, the famous Garrard SP 25 Mk III (including teak veneer base and transparent cover) with diamond cartridge or 2025 TC and the very successful DUO type 2 speakers. Measuring 17½in x 10¾in x 6¾in, the Duo type 2 speakers are teak finished with matching Vynair grills. They incorporate a 3 ohm. 13in x 8in drive unit and Parasitic tweeter. Max. power handling 10 watts. Price £13·50 per pair plus p. & p. £1·50.

Complete stereo system £43 plus £2·50 p. & p. or with Mk II Amplifier and Magnetic Cartridge £48 & £2·50 p. & p.

The Viscount F.E.T. MkI **£14.25** + 50p. p. & p. High fidelity transistor stereo amplifier employing field effect transistors. With this feature and accompanying guaranteed specifications below, the Viscount F.E.T. vastly surpasses amplifiers costing far more.

Specification—Output per channel 10 watts r.m.s. into 3 ohms Frequency bandwidth 20 Hz to 20 kHz + 1db at 1 watt. Total distortion at 1 kHz at 9 watts 0.5% Input sensitivities CER. P.U. 100mV into 3 meg ohms. Tuner 100mV into 100K ohms. Tape 100mV into 100K ohms. Overload Factor Better than 26db.

Signal to noise ratio—70db on all inputs (with vol. max). Controls—6 position selector switch (3 pos. stereo and 3 pos. mono). Separate volume controls for left and right channels. Bass ± 14db at 60 Hz. Treble (with D.P.S. on off) ± 12 db at 10 KHz. Tape recording output sockets on each channel. Size 12¼in. 6in. 2¾in. in simulated teak case. **BUILT & TESTED.**

MkII (MAG P.U.) **£15.75** plus 50p. p. & p.

Specification same as Mk. 1, but with the following inputs. Mag. P.U. CER. P.U. Tuner. Spec. on Mag. P.U. 3mV at 1 kHz input impedance 47K. Fully equalised to within ±1db RIAA. Signal to noise ratio—65db (vol. max).

The £25 Stereo system

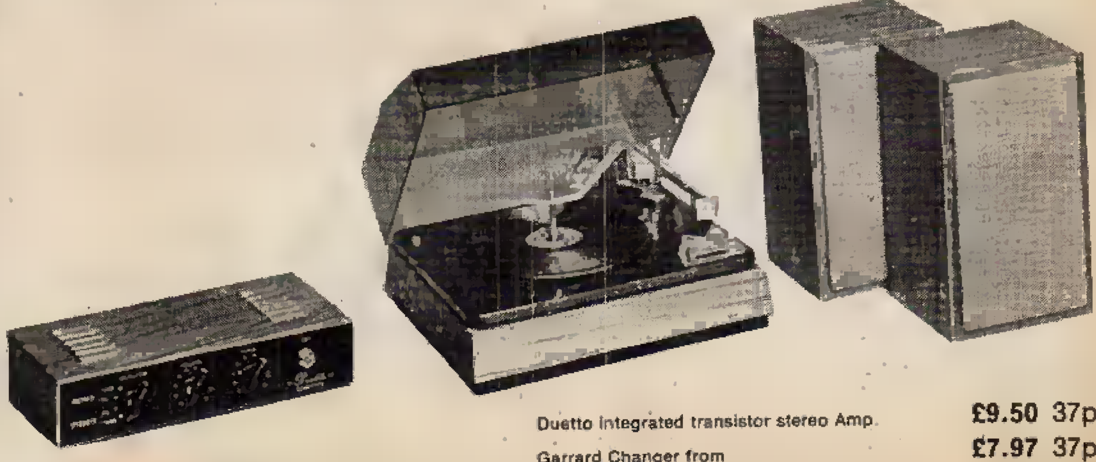
The Duetto is a good quality stereo amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.

SPECIFICATION—
R.M.S. power output 3 watts per channel into 10 ohms speakers.

INPUT SENSITIVITY. Suitable for medium or high output crystal cartridges and tuners. Cross-talk better than 30dB at 1Kc/s.

CONTROLS: 4-position selector switch (2 pos. mono and 2 pos stereo) dual ganged volume control.

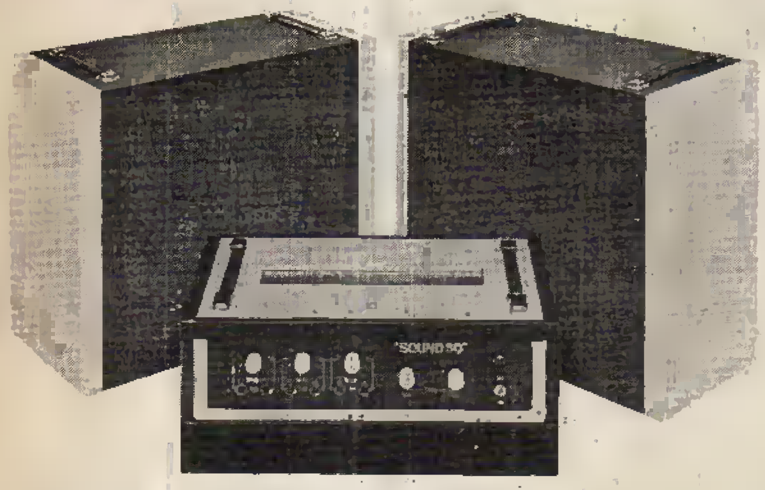
TONE CONTROL Treble lift and cut Separate on off switch. A preset balance control.



Duetto Integrated transistor stereo Amp.	£9.50	37p
Garrard Changer from	£7.97	37p
Cover and teak finish plinth	£4.75	37p
Duo Type I speakers (see opp. page)	£4.20	37p
The above items purchased together	**£25**	£1.50

SOUND 50

50 WATT AMPLIFIER & SPEAKER SYSTEM



The Sound Fifty valve amplifier and speakers are sturdily constructed with smart housings and thoroughly tested electronics. They are designed to last—to withstand the knocks and bumps of life on the road. Built for the small and medium sized gig, they are easy to handle and quick to set up and can be relied upon to come over with all the quality and power you need.

Output Power: 45 watts R.M.S. (Sine wave drive). **Frequency response:** —3dB points 30Hz at 18KHz. **Total distortion:** less than 2% at rated output. **Signal to noise ratio:** better than 60dB. **Speaker Impedance:** 3, 8 or 15 ohms. **Bass Control Range:** ± 13dB at 60Hz. **Treble Control Range:** ± 12dB at 10 KHz. **Inputs:** 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470K.
To protect the output valves, the incorporated fail safe circuit will enable the amplifier to be used at half power.
SPEAKERS! Size 20″ × 20″ × 10″ incorporating Baker's 12″ heavy duty 25 watt high flux, quality loudspeaker with cast frame. Cabinets attractively finished in two tone colour scheme—Black and grey.

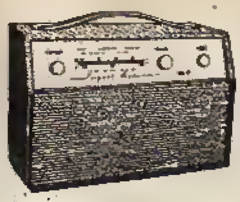
COMPLETE SYSTEM Sound 50 amp and 2 speakers **£50** Plus £4 P. & P.

or available separately.

Amplifier **£28.50** plus £1.50 P. & P.

Speakers **£12.50** each plus £1.75 P. & P.

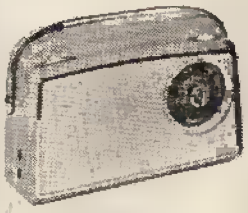
The ELEGANT SEVEN Mk. III (350mW Output)



7 transistor fully-tunable M.W.—L.W. superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.
MAINS POWER PACK KIT: 47p extra.

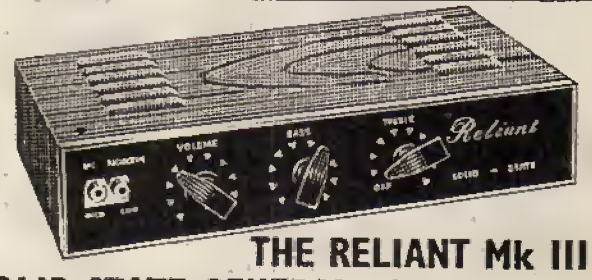
Price **£5.25** plus 37p. P. & P.
Circuit 13p FREE WITH PARTS.

The DORSET (600mW Output)



Price **£5.25** plus 37p P. & P.
Circuit 13p FREE WITH PARTS

7-transistor fully tunable M.W.—L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulised and pre-alignment techniques makes this simple to build. Sizes: 12 x 8 x 3in.
MAINS POWER PACK KIT: 47p extra.



THE RELIANT Mk III SOLID-STATE GENERAL PURPOSE AMPLIFIER

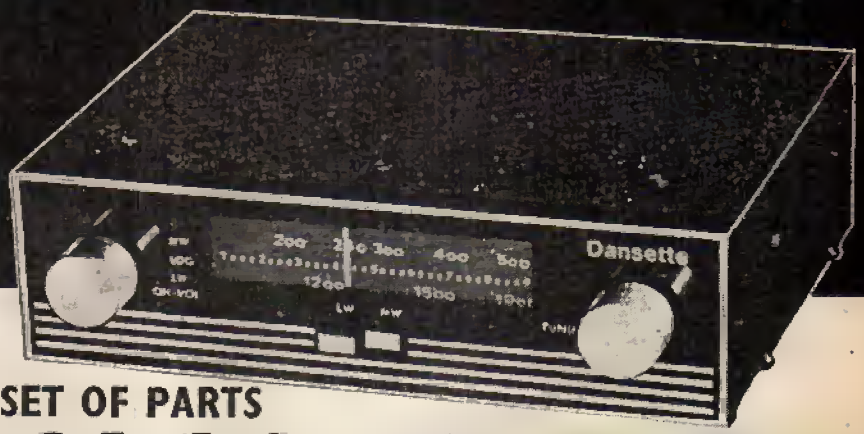
in simulated teak case **£7.25** plus P. & P. 37p

SPECIFICATIONS
Output ± 10 watts. Output impedance—3 to 4 ohms.
Inputs 1. -xtal mic 10mV Tone Controls—Treble control range ± 12dB at 10KHz. 2. -gram/radio 250mV. Bass control range ± 13dB at 100Hz.
Frequency Response—(with tone controls central) Minus 3dB points at 20Hz and 40KHz. Signal to Noise Ratio—better than −60dB. Transistors—4 silicon Planar type and 3 Germanium type. Mains input—220/250V. A.C. Size of chassis—10¾in. x 4¾in. x 2¾in. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Built and tested.

THE DUO SPEAKER SYSTEM

Similar in design to those on the previous page the 2-way speaker system is beautifully finished in polished teak veneer. It is ideal for wall or shelf mounting either upright or horizontally.
Type 1 SPECIFICATION :—
Impedance 8 or 10 ohms (please state requirement). It incorporates high flux 7in. x 3¾in. speaker and 2½in. speaker. Teak finish 11½in. x 6in. x 5¾in. £4.20 each. 37p P. & P.

LIQUIDATED STOCK
DANSETTE
TOURISTE MK3 CAR RADIO



ALL TRANSISTOR

Beautifully designed to blend with the interiors of all cars. Permeability tuning and long wave loading coils ensure excellent tracking, sensitivity and selectivity on both wave bands. R.F. sensitivity at 1 MHz is better than 8 micro volts. Power output into 3 ohm speaker is 3 watts.

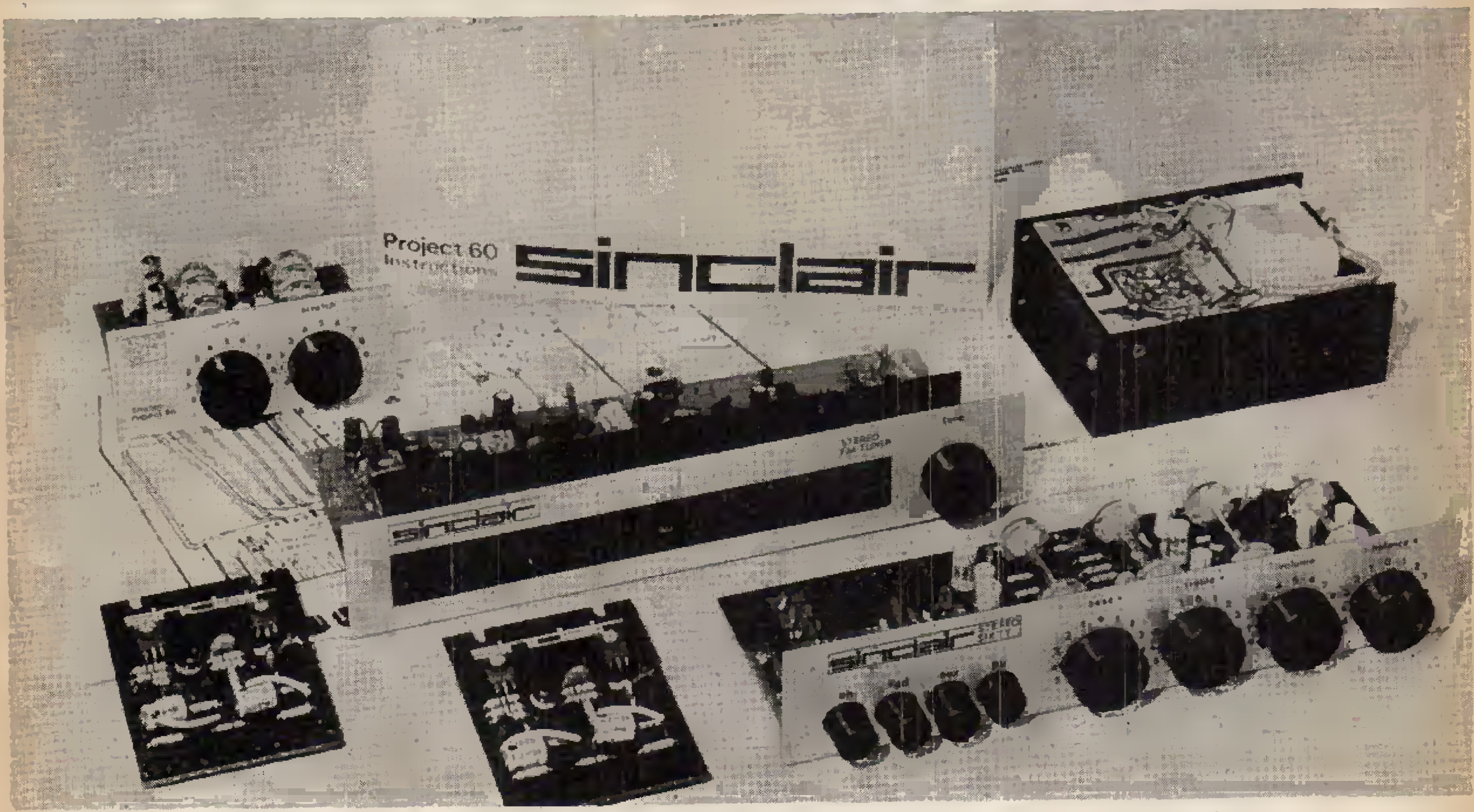
Originally sold completely built for £15.4.6 (£15.23) Pre-aligned I.F. module and tuner together with comprehensive instructions guarantees success first time. 12 volts negative or positive earth. Size 7in x 2in x 4¼in deep.

See top of previous page for address

SET OF PARTS £6.30
plus P. & P. 37p.
Circuit diagram 13p. Free with parts
Speaker, baffle and fixing kit **£1.25** extra plus 20p. p. & p. Postage free when ordered with parts.

RADIO & TV COMPONENTS
R+TV
(ACTON) LIMITED

Sinclair Project 60



the world's most advanced high fidelity modules

Sinclair Project 60 presents high fidelity in such a way that it meets every requirement of performance, design, quality and value and now that the remarkable phase lock loop stereo FM tuner is available, it becomes the most versatile of high fidelity systems. With Project 60, it is possible to start with a modest mono record reproducer and expand it to a sophisticated stereophonic radio and record reproducing system of fantastically good quality to hold its own with any other equipment, no matter how expensive. Project 60 is a unique high fidelity module system where compactness and ease of assembly are combined with circuitry that is far in advance of any other manufacturer in the world. Thus it is extraordinarily easy to assemble any combination of modules using nothing more complicated than the simplest of tools, and you certainly do not have to be experienced to build with complete confidence. The 48 page manual free with Project 60 equipment makes everything easy and you can house your assembly in an existing cabinet, motor plinth, free standing cabinet or virtually any arrangement you wish. Once you have completed your assembly you will have superlatively good equipment to give you years of service and enjoyment. You will have obtained superb value for money because Project 60 is the best selling modular system in Europe and can therefore be produced at extremely competitive prices and with excellent quality control.

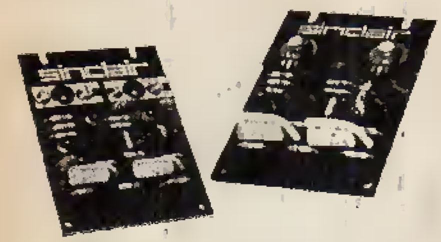
	System	The Units to use	together with	Cost of Units
A	Simple battery record player	**Z.30**	Crystal P.U., 12V battery volume control	**89/6** (£4.47½)
B	Mains powered record player	**Z.30, PZ.5**	Crystal or ceramic P.U. volume control etc.	**£9.9.0** (£9.45)
C	20+20 W. R.M.S. stereo amplifier for most needs	**2 x Z.30s, Stereo 60, PZ.5**	Crystal, ceramic or mag. P.U., most dynamic speakers, F.M. tuner etc.	**£23.18.0** (£23.90)
D	20+20 W. R.M.S. stereo amplifier with high performance spkrs.	**2 x Z.30s, Stereo 60, PZ.6**	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	**£26.18.0** (£26.90)
E	40+40 W. R.M.S. de-luxe stereo amplifier	**2 x Z.50s, Stereo 60 PZ.8, mains trsfrmr**	As for D	**£32.17.6** (£32.87½)
F	Outdoor P.A. system	**Z.50**	Mic., up to 4 P.A. speakers controls, etc.	**£5.9.6** (£5.47½)
G	Indoor P.A.	**Z.50, PZ.8, mains transformer**	Mic., guitar, speakers, etc., controls	**£17.8.6** (£17.42½)
H	High pass and low pass filters	**A.F.U.**	C, D or E	**£5.19.6** (£5.97½)
J	Radio	**Stereo F.M. Tuner**	C, D or E	**£25.0.0**

Sinclair Radionics Ltd., London Road, St. Ives, Huntingdonshire PE17 4HJ.
Tel: St. Ives (048 06) 4311

sinclair

Sinclair Project 60

Z.30 & Z.50 power amplifiers



The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at full output and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and may be used with other units in the Project 60 range equally well.

SPECIFICATIONS ***(Z.50 units are interchangeable with Z.30s in all applications).***

Power Outputs

Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.

Z.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms, using 50 volts.

Frequency response: 30 to 300,000 Hz±1dB

Distortion: 0.02% into 8 ohms

Signal to noise ratio: better than 70dB unweighted.

Input sensitivity: 250mV into 100 Kohms.

For speakers from 3 to 15 ohms impedance.

Size $3\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{1}{2}$ in.

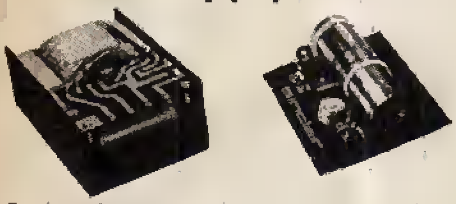
Z.30

Built, tested and guaranteed with circuits and instructions manual **89/6** (£$4.47\frac{1}{2}$)

Z.50

Built, tested and guaranteed with circuits and instructions manual **109/6** (£$5.47\frac{1}{2}$)

Power Supply Units



Designed specially for use with the Project 60 system of your choice.

Illustration shows PZ.5 to left and PZ.8 (for use with Z.50s) to the right. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stablised supply is essential.

PZ-5 *30 volts unstabilised* **£4.19.6** (£$4.97\frac{1}{2}$)

PZ-6 *35 volts stabilised* **£7.19.6** (£$7.97\frac{1}{2}$)

PZ-8 *45 volts stabilised (less mains transformer)* **£5.19.6** (£$5.97\frac{1}{2}$)

PZ-8 *mains transformer* **£5.19.6** (£$5.97\frac{1}{2}$)

Guarantee

If within 3 months of purchasing Project 60 modules directly from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost

Stereo 60 pre-amp/control unit

Designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs.

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 + 15 to —15dB at 10KHz; BASS + 15 to—15dB at 100Hz.

Front panel: brushed aluminium with black knobs and controls.

Size: $8\frac{1}{4}$ x $1\frac{1}{2}$ x 4 ins.

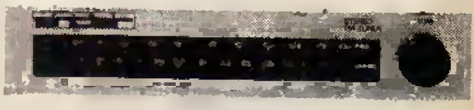
Built, tested and guaranteed. **£9.19.6** (£$9.97\frac{1}{2}$)

Active Filter Unit

For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. Two stages of filtering are incorporated – rumble (high pass) and scratch (low pass). Supply voltage – 15 to 35V. Current – 3mA. H.F. cut-off (–3dB) variable from 28kHz to 5kHz. L.F cut-off (–3dB) variable from 25Hz to 100Hz. Distortion at 1kHz (35V. supply) 0.02% at rated output.

Built, tested and guaranteed **£5.19.6** (£$5.97\frac{1}{2}$)

Stereo FM Tuner



first in the world to use the phase lock loop principle

Before production of this tuner, the phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio over other systems. Now, for the first time, the principle has been applied to an FM tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and squelch circuit for silent tuning between stations. Sensitivity is such that good reception becomes possible in difficult areas. Foreign stations can be tuned in suitable conditions and often a few inches of wire are enough for an aerial. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with any other high fidelity system.

SPECIFICATIONS:

Number of transistors: 16 plus 20 in I.C.

Tuning range: 87.5 to 108 MHz.

Capture ratio: 1.5dB

Sensitivity: 2μV for 30dB quieting: 7μV for full limiting.

Squelch level: 20μV.

A.F.C. range: ±200 KHz

Signal to noise ratio: >65dB

Audio frequency response: 10Hz—15KHz (±1dB)

Total harmonic distortion: 0.15% for 30% modulation

Stereo decoder operating level: 2μV

Pilot tone suppression: 30dB

Cross talk: 40dB

I.F. frequency: 10.7 MHz

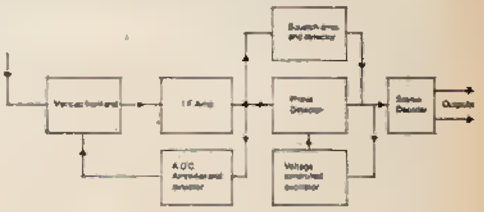
Output voltage: 2 x 150mV R.M.S.

Aerial Impedance: 75 Ohms

Indicators: Mains on: Stereo on; tuning indicator

Operating voltage: 25-30 VDC

Size: 3.6 x 1.6 x 8.15 inches: 91.5 x 40 x 207 mm



Price: £25 built and tested. Post free

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVES HUNTINGDONSHIRE PE17 4HJ

Please send ________________

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for which I enclose cash/cheque/money order.

Name ________________

Address ________________

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PW.471

Sinclair IC10/Q16/Micromatic

IC10

The world's most advanced high fidelity amplifier

This is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself is a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick, having 5 watts RMS output (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 zener diode and 18 resistors, and is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is more rugged and has considerable performance advantages, including complete freedom from thermal runaway and a very low level of distortion. The IC10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of such components as tone and volume controls and a battery or mains power supply. It may also be used in other applications including car radios, electronic organs, servo amplifiers (it is dc coupled throughout) etc.

Circuit Description

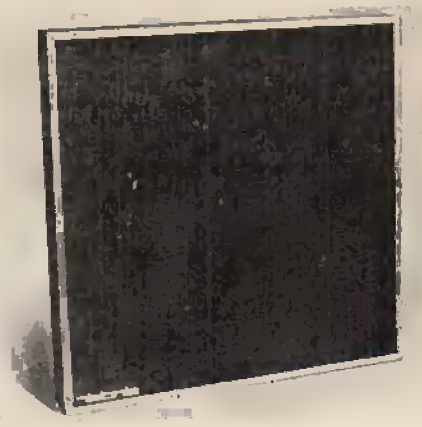
The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. There is generous negative feedback round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satisfactory.

Each IC10 is sold with a comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include oscillators, etc. The pre-amp section can be used as an RF or IF, amplifier without any additional transistors.

Specifications:

Output: 10 watts peak, 5 watts RMS continuous.
Frequency response: 5Hz to 100kHz 1 ± dB.
Total harmonic distortion: Less than 1% at full output.
Load impedance: 3 to 15 ohms.
Power gain: 110 dB (100,000,000,000 times) total.
Supply voltage: 8 to 18 volts. (A Sinclair power unit, PZ.7 is available for mains operation).
Size: 1 x 0.4 x 0.2 in. plus heat sink and tags.
Sensitivity 5 mV.
Input impedance: Adjustable externally up to 2.5 Mohms.
Price (with manual): **59/6** (£2.97½) post free.

Q16



High fidelity loudspeaker

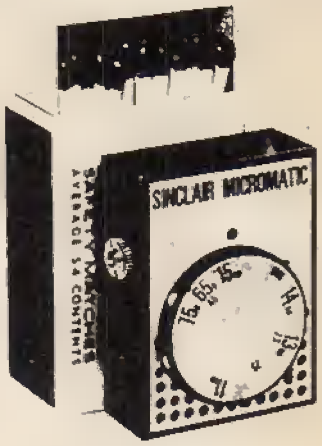
The Q16 employs the well proven acoustic principles specially developed by Sinclair in which a special driver assembly is meticulously matched to the characteristics of the uniquely designed cabinet. In reviewing this exclusive Sinclair design, technical journals have justly compared the Q16 with much more expensive loudspeakers. Its shape enables the Q16 to be positioned and matched to its environment to much better effect than is the case with conventionally styled enclosures. A solid teak surround with a special all-over cellular foam front is used as much for appearance as its ability to pass all audio frequencies.

This elegantly designed shelf mounting speaker brings genuine high fidelity within reach of every music lover.

Specifications:

Construction: Special sealed seamless sound or pressure chamber with internal baffle.
Loading: up to 14 watts TMS.
Input impedance: 8 ohms.
Frequency response: From 60 to 16,000 Hz, confirmed by independently plotted B and K curve.
Driver unit: Special high compliance unit having massive ceramic magnet of 11,000 gauss, aluminium speech coil and a special cone suspension for excellent transient response.
Size and styling: 9¾ in square on face x 4¾ in. deep with neat pedestal base. Black all-over cellular foam front with natural solid teak surround.
Price **£8.19.6.** (£8.97½).

Micromatic



Britain's smallest radio

Considerably smaller than an ordinary box of matches, this is a multi-stage AM receiver brilliantly designed to provide remarkable standards of selectivity, power and quality for its size. Powerful AGC counteracts fading from distant stations; bandspread at higher frequencies makes reception of Radio 1 easy. The plug-in magnetic earpiece provided matches the Micromatic's output to give wonderful standards of reproduction. Everything including the special ferrite rod aerial and batteries is contained within the minute and attractively designed case. Whether you build a Micromatic kit or buy this amazing receiver ready built and tested, you will find it as easy to take with you as your wrist watch, and dependable under the severest listening conditions.

Specifications:

Size: 36 x 33 x 13 mm (1 4/5 x 1 3/10 x ½ in.)
Weight: including batteries, 28.4 gm (1 oz.).
Case: Black plastic with anodised aluminium front panel and spun aluminium dial.
Tuning: medium wave band with bandspread at higher frequencies. (550 to 1,600 Hz).
Earpiece: Magnetic type.
On/off switching: By inserting and withdrawing earpiece plug.
Kit in pack with earpiece, case, instructions and solder **49/6** (£2.47½).
Ready built, tested and guaranteed, with earpiece **59/6** (£2.97½).
Two Mallory Mercury batteries type RM675 required. From radio shops, chemists, etc.

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVES HUNTINGDONSHIRE PE17 4HJ

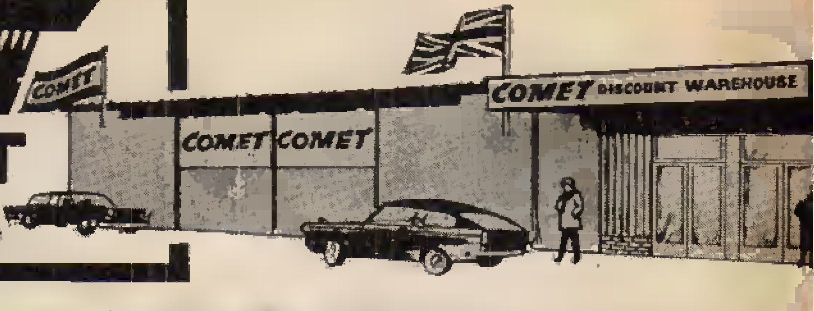
Please send	Name
	Address
for which I enclose cash/cheque/money order.	PW.471

Sinclair Radionics Ltd., London Road, St. Ives, Huntingdonshire PE17 4HJ.
Tel: St. Ives (048 06) 4311

sinclair

DRIVE-IN CAR PARK

COMET HI-FI DISCOUNT WAREHOUSES



STEREO AMPLIFIERS	Rec. Retail Price	Comet Price
ARMSTRONG 521	56·00	44·50
DULCI 207	25·00	17·00
*DULCI 207M	30·00	21·00
FERROGRAPH F307	59·00	48·00
GOODMANS Maxamp	54·00	38·00
LEAK Stereo 30 Plus	56·50	44·75
LEAK Stereo 30 Plus, in teak case	62·50	49·50
LEAK Stereo 70	69·00	55·00
LEAK Stereo 70, in teak case	75·00	59·50
*LINEAR LT 66	21·00	17·00
METROSOUND ST20	36·00	28·00
PHILIPS RH 591	76·75	59·00
PHILIPS RH 590	51·75	39·50
PHILIPS RH 580	28·00	22·00
PIONEER SA500	62·10	43·00
PIONEER SA700	98·00	70·00
PIONEER SA900	134·10	97·00
PIONEER Reverberation	45·50	33·00
ROGERS Ravensbourne	59·50	47·00
ROGERS Ravensbourne (cased)	64·00	50·00
ROGERS Ravensbrook Mk. II	47·50	38·00
ROGERS Ravensbrook (cased) Mk. II	52·50	42·00
*SINCLAIR 2000	30·45	23·00
SINCLAIR PROJECT 60/2 X Z30/ PZ5	23·90	17·00
SINCLAIR PROJECT 60/2 X Z50/ PZ8/trans	32·88	23·50
SINCLAIR Neoteric	61·95	46·00
SINCLAIR 3000	45·00	36·00
TELETON 203E	28·75	20·00
TELETON GA 101 30w RMS	37·50	28·50
VOLTEX 100w. Stereo Discotheque, 8 electronically mixed inputs	185·00	139·00

Starred items above take ceramic cartridges only. All others take both ceramic and magnetic cartridges.

TUNERS	Rec. Retail Price	Comet Price
*ARMSTRONG 523 AM/FM	53·76	45·00
*ARMSTRONG 524 FM	41·89	35·00
ARMSTRONG M8 Decoder	9·50	8·00
*DULCI FMT.7 FM	22·05	18·00
DULCI FMT.7S Stereo	31·00	25·25
GOODMANS Stereomax	82·52	49·95
LEAK Stereofetic Chassis	66·50	52·00
LEAK Stereofetic in teak case	72·50	59·00
PHILIPS RH 690	44·50	35·50
PHILIPS RH 691	89·00	75·50
PIONEER TX500 AM/FM	77·94	64·00
PIONEER TX900 AM/FM	153·69	125·00
ROGERS Ravensbourne	61·89	50·00
ROGERS Ravensbrook	45·01	40·00
ROGERS Ravensbrook (cased)	51·26	43·00
*SINCLAIR 2000	26·73	19·25
SINCLAIR Project 60	25·00	21·00
TELETON GT 101	45·50	34·00
TELETON 201X FM	36·00	30·00

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

TUNER/AMPLIFIERS	Rec. Retail Price	Comet Price
AKAI 6600	142·53	112·00
ARENA R500	82·00	67·00
ARENA 2400	90·30	72·00
ARENA 2600 Stereo AM/FM	111·30	94·00
ARENA 2700	105·00	85·00
ARENA T1500F	72·45	60·00
ARENA T9000	303·45	258·00
ARMSTRONG M8 Decoder	9·50	8·00
ARMSTRONG 525	91·89	77·00
ARMSTRONG 526	104·71	87·00
GOODMANS 3000	77·73	53·00
*PHILIPS RH 781	74·98	55·00
PHILIPS RH 790	135·00	109·00
PIONEER KX330 AM/FM/SW	78·62	63·00
PIONEER SX770 AM/FM	160·43	126·00
PIONEER SX990 AM/FM	194·74	150·00
*TELETON F2000	51·50	32·00
TELETON 7 AT 20	105·00	80·00
TELETON 10AT1 150w. RMS	160·00	109·00
TELETON TFS50	75·50	56·00
*TELETON R.8000 with Speakers	63·25	50·00
TELETON CR55	120·00	95·00
WHARFEDALE 100.1	131·25	105·00

Starred items above take ceramic cartridges only. All others take both ceramic and magnetic cartridges.

All the above Tuners and Tuner/Amplifiers include MPX Stereo Decoder with the exception of Armstrong where decoder is extra as listed.

COMET for after-sales service

THROUGHOUT THE U.K.

Pictured, Service Dept at Clough Rd, Hull also at Leeds, Goole, Wakefield, Doncaster, and Bridlington

PICKUP ARMS	Rec. Retail Price	Comet Price
GOLDRING Lenco L75	12·33	10·50
GOLDRING Lenco L69	9·29	7·00
SME 3009 with S2 Shell	31·31	26·00
SME 3012 with S2 Shell	33·36	29·00

CARTRIDGES	Rec. Retail Price	Comet Price
GOLDRING 800	13·00	7·50
GOLDRING 800H	10·69	8·00
GOLDRING 800E	18·86	12·25
GOLDRING 800 Super E	26·01	20·00
*GOLDRING CS90 Stereo	5·20	4·25
*GOLDRING CS91/E	7·81	6·25
GOLDRING G850	6·50	5·25
EMPIRE 100ZE/X	63·00	52·50
EMPIRE 999VE/X	44·50	36·00
EMPIRE 999TE/X	27·60	22·50
EMPIRE 999SE/X	21·00	17·50
EMPIRE 999E/X	16·50	13·00
EMPIRE 999/X	11·50	9·25
EMPIRE 909E/X	12·85	10·25
EMPIRE 909X	9·00	7·50
EMPIRE 90EE/X	9·75	8·00
ORBIT Magnetic NM 22	Special Price	2·90
PICKERING V15 AC2	8·40	7·00
ORTOFON SL15E	29·65	23·75
ORTOFON 2X15K Transformer	7·00	5·25
SHURE M3DM	7·41	5·25
SHURE M31E	12·05	9·50
SHURE M32E	11·10	8·75
SHURE M32-3	10·20	8·00
SHURE M44-5	11·10	8·50
SHURE M44-7	10·20	8·00
SHURE M-44C	10·20	8·00
SHURE M44E	12·05	9·50
SHURE M55E	12·95	10·25
SHURE M75G	17·60	14·00
SHURE M75-6	16·70	13·00
SHURE M75EJ	19·45	16·00
SHURE M75E-95G	23·15	18·00
SHURE M75E	21·30	16·00
SHURE M75E/D19	23·15	19·00
SHURE V15-11	40·76	30·00
SHURE V15-11-7	38·90	29·00

Starred cartridges above are ceramic. All others are magnetic.

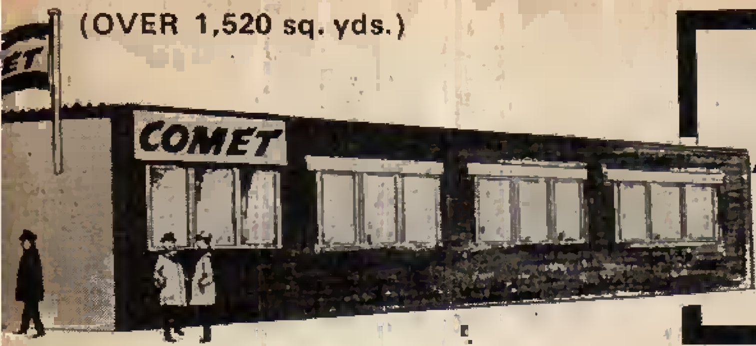
TURNTABLES

GARRARD SP25, fully wired with Goldring G800 Magnetic Cartridge. Complete with base, plinth and cover—Special Price 20·98

	Rec. Retail Price	Comet Price
DUAL 1219 transcription	60·40	50·00
DUAL 1209 transcription	42·62	35·00
GARRARD SP25 Mk III	16·45	11·90
GARRARD SL65 B	21·25	15·90
GARRARD SL75 B	38·95	28·50
GARRARD SL95 B	53·27	38·50
GARRARD 401	38·07	29·50
GARRARD SL72 B	32·77	26·90
GARRARD 3500, with GKS Cartridge	17·23	12·90
Base and Cover to fit GARRARD SP25, SL55, SL65B and 3500	Special Price	4·00
GARRARD 40B	13·84	10·97
GARRARD AP 76	28·88	21·50
GOLDRING 705/P with 850 Cartridge and Cover	26·00	23·90
GOLDRING GL69 Mk. II	26·63	22·50
GOLDRING GL69 P Mk. II	35·14	29·50
GOLDRING GL75	36·41	33·90
GOLDRING GL75 P	45·94	41·90
GOLDRING Covers for 69P and 75P	4·21	3·50
GOLDRING C99—plinth and cover for G99	11·45	9·90
GOLDRING G99	26·00	23·90
GOODMANS 3025	37·74	26·90
McDONALD MP 60	15·75	12·25
McDONALD 610	20·00	15·90
Base and Cover for McDONALD MP 60 and 610	Special Price	4·50
PHILIPS 228	20·00	17·00
PHILIPS GA 146	31·50	25·00
PHILIPS 217	33·00	28·00
PHILIPS 202 Electronic	69·00	57·50
PIONEER PL 12A	50·90	39·95
PIONEER PL11	57·90	39·00
THORENS TX 25 cover	8·22	6·53
THORENS TD125	75·89	62·00
THORENS TD150A Mk. II	43·63	33·00
THORENS TD125AB	120·20	100·00
THORENS TD150AB Mk. II	47·43	41·00
THORENS TX11 Cover	4·11	3·75

SPEAKERS	Rec. Retail Price	Comet Price
ARENA HT 16	13·00	10·95
B & W Model 70	139·50	115·00
B & W DM3	63·00	53·00
B & W DM1	32·00	25·50
CELESTION Ditton 120	24·00	18·00
CELESTION Ditton 15	29·00	23·00
CELESTION Ditton 25	59·85	47·00
GOODMANS Minister	22·45	19·00
GOODMANS Magister	57·00	45·00
GOODMANS Maxim	20·39	16·75
GOODMANS Mezzo 3	30·90	23·90
GOODMANS Magnum K2	40·10	29·90
KEF Celeste	29·00	21·50
KEF Concord	43·50	33·00
KEF Concerto	53·50	42·00
KEF Cresta	22·17	18·00
KELETRON KN 654/3 3 speaker system (pair)	19·00	14·97
KELETRON KN 824/3 3 speaker system (pair)	23·00	18·97
KELETRON KN 104/3 3 speaker system	16·75	12·97
KELETRON KN 123/3 3 speaker system	18·75	15·97
KELETRON KN 120/4 4 speaker system	24·50	18·97
LEAK 200	24·95	17·90
LEAK 300	32·50	23·50
LEAK 600	49·50	36·90
LOWTHER Acousta (with PM6)	45·50	38·50
LOWTHER Acousta (with PM7)	53·00	46·00
LOWTHER Ideal Baffle	35·50	30·00
METROSOUND HFS 20	18·50	13·50
PHILIPS RH481	11·00	9·25
PHILIPS RH482	18·00	15·00
SINCLAIR Q16	8·98	8·00
STE-MA 275 3 speaker system	23·10	15·00
WHARFEDALE Speakers		
Airedale	69·50	56·00
Denton	19·95	15·90
Super Linton	24·95	20·50
Melton	32·50	25·50
Dovedale 3	42·50	32·50
Rosedale	65·00	52·50
Triton (pair)	59·90	46·90
Unit 3 Speaker Kit	13·00	10·50
Unit 4 Speaker Kit	18·00	14·25
Unit 5 Speaker Kit	26·00	20·50

CHASSIS SPEAKERS	Rec. Retail Price	Comet Price
GOODMANS Axiette 8	7·48	6·00
GOODMANS Twinaxiette 8	8·44	7·00
GOODMANS Axiom 10	8·84	7·00
GOODMANS Axiom 80	26·07	21·75
GOODMANS Axiom 201	13·45	10·00
GOODMANS Axiom 301	19·25	14·50
GOODMANS Audiom 8P	5·50	4·25
GOODMANS Audiom 10P	6·00	3·58
GOODMANS Audiom 51	12·15	9·50
GOODMANS Audiom 61	17·60	13·00
GOODMANS 12P	12·87	10·00



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GOODMANS ARU 172	3·89	3·00
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GOODMANS Trebax 5K/20XL	8·40	6·50
GOODMANS Midax	11·20	8·50
GOODMANS Attenuator	3·07	2·25
GOODMANS Crossover Networks XO/950/5000	8·43	6·25
GOODMANS Crossover Networks XO/950	6·39	4·75
GOODMANS Crossover Networks XO/5000	2·30	1·75
WHARFEDALE 8 in. Bronze/RS/DD	5·00	4·00
WHARFEDALE Super 8/RS/DD	8·50	7·00
WHARFEDALE Super 10/RS/DD	14·00	11·50
WHARFEDALE WMT 1 Matching Transformer	0·84	0·75
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ALBA UA552	47·50	35·98
ALBA UA652	62·99	47·98
ARENA MR 15	145·00	115·98
BUSH System 749/746/764	102·65	82·75
DECCA Sound 603	72·50	60·00
DECCA Sound 604	72·50	61·00
DECCA Sound 1203	97·50	80·00
DECCALIAN 5 complete with stand	65·50	53·00
EKCO S.R.G. 609	88·50	70·00
FERGUSON 2065	117·00	80·00
FERGUSON 3422	84·70	69·00
GOODMANS 3000 Suite	140·45	96·00
HMV 2416	129·70	105·00
HMV 2404/5/6	202·85	170·00
KB KA1250	72·00	56·00
KB KA1250/651	83·00	63·98
MARCONI Unit 4	77·45	67·00
MARCONI Unit 3	86·00	70·00
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PHILIPS GP 824	67·50	55·98
PHILIPS RF 833	67·50	55·98
PHILIPS RF 834	88·00	73·98
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TELETON CRIOT/2025/1003 with stereo radio	62·10	45·98
TELETON CMS400	102·50	70·00
TELETON 2S60F	75·00	56·00
TOSHIBA SP8507	248·00	181·00
ULTRA 6405	79·75	67·00
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ALBA R22 Twin Track Battery/Mains	50·25	24·98
AKAI M10L	245·05	189·99
AKAI X200D	190·00	160·00
AKAI X5000 W/L	177·98	140·00
AKAI X330	342·57	269·00
AKAI X-330D	312·56	245·00
AKAI X-360	380·08	284·00
AKAI X-360 D-deck	318·92	243·00
AKAI 1800SD	199·42	167·00
AKAI 1710L	89·85	68·90
AKAI CR80 8-track stereo recorder	115·03	99·98
AKAI CR80D 8-track stereo tape deck	95·00	79·98
AKAI 4000 4-track Stereo	124·90	100·00
AKAI 4000 D 4-track Stereo deck	89·96	70·00
BUSH TP 60 Cassette Tape Recorder	29·40	25·00
BUSH TP 70 Cassette Battery/Mains Tape Recorder	29·95	24·00
BUSH discassette DC70	19·95	14·98
FERGUSON 3244 Stereo 4-track	97·90	80·00
FERGUSON 3245 Twin track	37·05	30·00

	Rec. Retail Price	Comet Price
FERGUSON 3246 4-track	43·00	34·00
FERGUSON 3247 4-track	48·45	39·00
FERGUSON 3248 4-track	54·30	42·00
FERGUSON 3249 4-track	64·30	50·00
FERROGRAPH 722	242·54	199·00
FERROGRAPH 724	242·54	199·00
FERROGRAPH 702/W 2 track tape deck	207·35	175·00
FERROGRAPH 704/W 4 track tape deck	207·35	175·00
GRUNDIG C200L Cassette	39·90	30·00
GRUNDIG TK 141 (4-track)	61·85	50·00
GRUNDIG TK 121 (Twin-track)	56·85	44·00
GRUNDIG TK 146 (4-track Auto)	68·14	53·98
GRUNDIG TK 124 Twin-track	44·90	35·00
GRUNDIG TK 149 4-track	57·64	48·00
PHILIPS 2202	29·90	24·00
PHILIPS 2205 Cassette Tape Recorder	43·15	34·98
PHILIPS 4404 4-track stereo recorder	95·00	73·98
PHILIPS 4407 4-track stereo recorder	110·00	89·98
PHILIPS 4302 Twin Track Auto	39·00	32·00
PHILIPS 4307 4-track	49·50	39·00
PHILIPS 4500 4-Track Stereo Tape Deck	126·00	99·00
PHILIPS 4408 4-Track Stereo	139·00	109·00
PHILIPS N4404 4-Track Stereo	83·00	70·00
PHILIPS N4308	60·50	50·00
PYE Cassette Recorder/Radio (Batt./Mains)	45·50	37·00
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TELETON 5L40 Twin Track Battery/Mains	38·50	25·00
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TELETON TC110 cassette battery/mains	27·50	19·98
TOSHIBA GT 840 S	110·00	80·00
TOSHIBA GT 601v Twin Track	45·15	30·00
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GARRARD WB4 Base	5·69	4·75
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GOLDRING Covers for 69P and 75P	4·21	3·50
THORENS TX25 (for TD125AB)	8·22	6·50
THORENS TX11 Cover	4·11	3·75
Base and Cover for TD 125	15·18	12·50
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MOTORBOARDS only	4·95	3·00
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KOSS ESP-9 Electrostatic	69·00	53·50
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KOSS PRO-4AA	28·00	22·50
KOSS PRO-4A	23·00	18·50
KOSS KO-727B	16·50	13·50
KOSS K-6	12·50	9·95
KOSS SP-3XC	9·50	7·50
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Leak Tuner case	7·17	6·25
Leak Double case for amp. & tuner	9·93	8·50

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GOLDRING GL 75P mounted in teak base with hinged perspex cover complete with GOLDRING G800E Cartridge. Leak Stereo 30 Plus Amplifier in Teak case. 2 GOODMANS Mezzo 3 Speakers	194·30	149·00
THORENS TD 150AB Mk. II with TX11 dust cover, SHURE M55E Cartridge, LEAK Stereo 70 Amplifier in Teak case. 2 Wharfedale Dovedale 3 Speakers	224·50	175·00
THORENS TD 125AB Electronic Turntable complete with cover. SHURE V15-11 Cartridge, GOODMANS Maxamp, GOODMANS Stereomax AM/FM Tuner. 2 GOODMANS Magister Speakers	419·65	319·00

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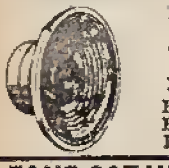
Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **£5.75** Carr. 30p

OR SENIOR 15 WATT INC. HF126 15,000 LINE SPEAKER carr. 35p **£6.75**

AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS



Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround. "D" indicates Tweeter Cone providing extended frequency range up to 15,000 c.p.s. Impedance 3 or 8-15 ohms. Please state choice. Exceptional performance at low cost.

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A full range 8in. 10 watt unit for excellent sound quality, in suitable enclosure. Cast chassis Roll P.V.C. cone surround and long throw voice coil to achieve very low fundamental resonance of 30 c.p.s. Tweeter cone is fitted to extend high note response. Frequency range 25-15 KHz. Impedance 3 or 8-15 Ω. Gauss 10,000. Remarkable value. **£3.50**

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SE8 For optimum performance with any 8in. Hi-Fi speaker. Size 22 x 15 x 9in. Ported **£5.75**

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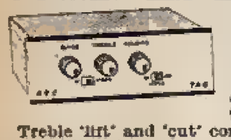
R.S.C. TA6 6 Watt HI-FI SOLID STATE AMPLIFIER



200-250v. AC mains operated. Frequency Response 30-20,000 c.p.s. —2dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble 'lift' and 'cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3-15 ohm spkrs. Max. sensitivity 5mV. Output rating I.H.F.M. Fully enclosed enamelled case, 9½ × 2½ × 5½in. Attractive brushed silver finish facia plate 10½ × 3½in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **£7.50** Carr. 40p

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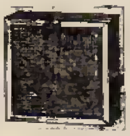

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★ Two extra heavy duty 12in. Loudspeakers.

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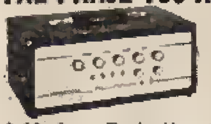

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FOR BASS GUITAR, ELECT. ORGAN, ETC.

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12in. 25 WATT

Dual Cone 15 Ω (for uses other than Bass Guitar or Electronic Organ). **£6.75** Carr. free

or Dep. £1 and 9 mthly payments 75p (Total £7.75).

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Highly sensitive. Push-Pull high output, Hum level—70dB. Response ±3dB 30-20,000 c/s. All high grade components. Valves EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls. Sensitivity 36 millivolts. For High Impedance microphones. For Clubs, Schools, Theatres. Dance Halls Outdoor Functions, etc. For Electronic Organ, Guitar, String Bass, etc. Gram, Radio or Tape. Two separate inputs with vol. controls permit such as "mike" and Pick-up etc. to be used for mixing purposes, 200-250 v. 50 c/s A.C mains. For 3 and 15 ohm speakers. Complete Kit of parts with wiring diagram and instructions. Twin-handled perforated cover £1.75 Or factory built with EL34 output valves and 12 months' guarantee for £19.75 **£15.75** Carr. 65p

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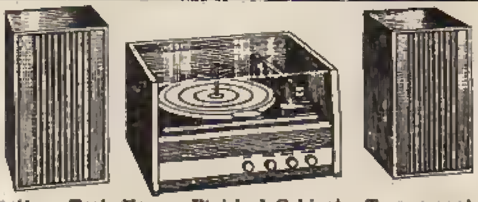

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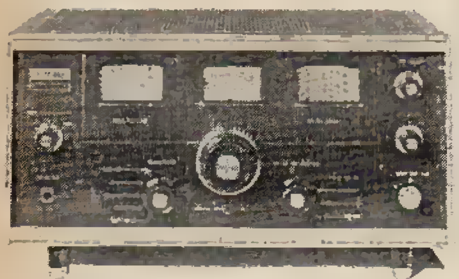
MARCH ISSUE



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8¼"	6⅞"	1	5	0	1	11	9	1	17	0
10¼"	7⅞"	1	14	6	2	2	6	2	6	0
12¼"	3⅞"	1	5	0	1	11	9	1	17	6
12¼"	5⅞"	1	14	0	2	2	0	2	5	6
12¼"	8⅞"	2	3	0	2	11	6	2	15	6
14¼"	3⅞"	1	10	0	1	17	6	2	2	0
14¼"	9⅞"	2	11	6	3	7	0	3	10	0
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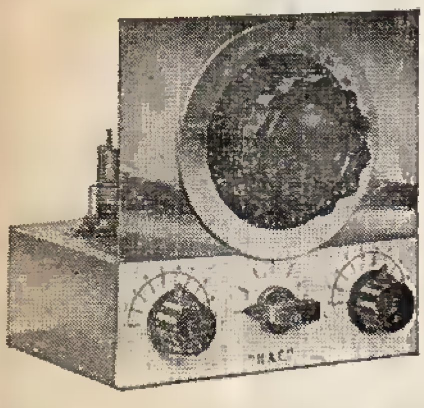

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Uses denco plug in coils 500 KHZ to 30 KHZ in 4 ranges. Normally supplied with kit 1.5 MHZ to 5MHZ extra ranges 12/- (60np) each. Slow motion tuning. Push pull audio output to your 8 OHM speaker black perspex predrilled front panel. In kit form at **£9.12.6 (£9.62½)** ready built calibrated and guaranteed at **£15.5.0 (£15.25).**

Power Controller.
Full wave control using branded triac rated 15amp 3kw. Single control zero to full power. In strong metal box with 13 amp main socket outlet ideal for fires, drills, floodlights, motors etc. Ready built at **£9.15.0 (£9.75).** post paid. In kit form with full instructions **£7.5.0. (£7.25)** post paid.

Vox Switch.
Make a noise, it switches, high imp. L/P for XTL mike. Drives your 12 volt relay. Ready built **£3.10.0 (£3.50).** or in kit form **£2.7.6. (£2.37½).**
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Reverberation Amplifier.
Self contained transistorised. Batt operated. Entirely different approach to sound reproduction. With this unit proper sound delay through reverberation, tones are created truly third dimension for concert hall originality. Two controls adjust volume and reverberation. Simply plug in microphone, guitar etc and O/P into your amplifier encased in beautiful walnut cabinet 7½" × 3" × 4½" at only **£10.15.0 (£10.75)** post paid.

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Variable beat. Drives your speaker or earpiece provided uses pp3. In attractive plastic case at **£1.17.6 (£1.87½)** or as a kit at **£1.7.6. (£1.37½)** both post paid.

Morse Oscillator.
Just attach your key. Drives your speaker or earpiece provided. Works on pen cells. Ready built in case as above **£1.5.0 (£1.25)** as a kit 17/6 (87½)np both post paid.
Latest Mullard manual on audio amps etc. **32/6 (£1.62½)** post paid.

Texas Transistors. Driver NPN and PNP complimentary symmetry. Pack of three 7/- (35np) post paid.

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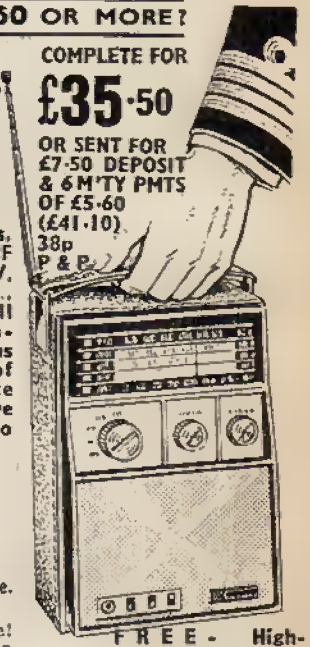

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OB3	0.60	6AS5	0.35	6F6G	0.30	10F1	0.90
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IR4	0.35	6BA6	0.25	6F23	0.80	10P14	1.10
IR5	0.35	6BE6	0.30	6F24	0.75	12AB5	0.60
IS4	0.27	6BF5	0.80	6F25	0.75	12AC6	0.40
IS5	0.25	6BF6	0.50	6F26	0.35	12AL5	0.45
IT4	0.25	6BH6	0.45	6F28	0.60	12AQ5	0.43
IU4	0.27	6BJ6	0.45	6J4	0.50	12AT6	0.30
IU5	0.50	6BK7A	0.55	6J5GT	0.30	12AT7	0.33
IV2	0.45	6BN5	0.43	6J7	0.45	12AU6	0.30
IX2B	0.40	6BN6	0.40	6K6GT	0.55	12AU7	0.30
2D21	0.35	6BQ5	0.25	6K7	0.35	12AV6	0.33
3A4	0.35	6BR8	0.65	6K8G	0.35	12AV7	0.50
3B28	2.15	6BS7	1.30	6K25	0.75	12AX7	0.30
3BP1	2.75	6BW6	0.85	6L6GT	0.45	12AY7	0.70
3Q4	0.40	6BW7	0.70	6L7	0.40	12B44 A	0.55
3S4	0.35	6BX6	0.25	6L18	0.45	12BA6	0.35
3V4	0.45	6BZ6	0.35	6LD20	0.40	12BA7	0.35
5R4GY	0.60	6C4	0.33	6N7GT	0.40	12BE6	0.35
5U4G	0.33	6C5GT	0.40	6P1	0.60	12BH7	0.40
5U4GB	0.42	6CA4	0.28	6P28	0.65	12BY7	0.55
5Y4G	0.42	6CA7	0.50	6Q7	0.40	12K5	0.55
5Y3GT	0.32	6CB6	0.30	6SA7	0.40	12K7GT	0.35
5Z3	0.50	6CD6GA	1.15	6SG7	0.35	12Q7G	0.30
5Z4G	0.40	6CG7	0.50	6SK7	0.35	12SR7	0.35
6/30L2	0.75	6CH6	0.55	6SL7GT	0.35	14S7	0.80
6AB4	0.35	6CL6	0.50	6SN7GT	0.35	20D1	0.45
6AF4A	0.50	6CW4	0.63	6SQ7	0.40	20L1	1.10
6AG7	0.40	6CY5	0.43	6SR7	0.40	20P1	0.50
6AH6	0.50	6CY7	0.65	6T8	0.35	20P4	1.10
6AJ8	0.30	6D3	0.45	6U4GT	0.60	20P5	1.20
6AK5	0.30	6DC6	0.75	6U8A	0.40	25C5	0.50
6AK6	0.57	6DK6	0.48	6X4	0.30	25L6GT	0.45
6AL3	0.43	6DQ6B	0.63	6X5GT	0.35	25Z4G	0.30
6AL5	0.20	6DS4	0.75	6X8	0.55	25Z6GT	0.65
6AM5	0.32	6EA8	0.58	6Y6G	0.65	30A5	0.45
6AM6	0.33	6EH7	0.30	7Y4	0.60	30AE3	0.40
6AQ5	0.35	6EJ7	0.35	9BW6	0.50	30C1	0.30

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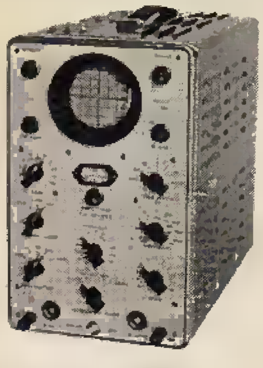
30C15	0.80	85A2	0.40	DK96	0.42	ECC84	0.30
30C17	0.85	90AG	2.40	DL96	0.42	ECC85	0.60
30C18	0.75	90AV	2.50	DM160	0.65	ECC88	0.40
30F5	0.85	90C1	0.60	DY86	0.33	ECC89	0.50
30FL1	0.70	90CV	1.25	DY87	0.35	ECC91	0.20
30FL12	0.93	807	0.50	DY802	0.50	ECC189	0.60
30FL14	0.75	812A	3.50	E88CC	0.65	ECF80	0.35
30L1	0.40	813	3.75	E130L	5.00	ECF82	0.35
30L15	0.85	866A	0.75	E180F	0.95	ECF86	0.65
30L17	0.80	5642	0.65	EABC80	0.35	ECF804	1.50
30P12	0.80	6080	1.50	EAF42	0.55	ECH42	0.70
30P19	0.80	6146	1.50	EBC33	0.50	ECH81	0.30
30PL1	0.70	6146B	2.50	EBC41	0.55	ECH83	0.40
30PL13	0.93	6360	1.25	EBC81	0.30	ECH84	0.45
30PL14	0.90	6939	2.15	EBF80	0.40	ECL80	0.40
35A3	0.55	7199	0.75	EBF83	0.40	ECL81	0.45
35A5	0.75	7360	1.80	EBF89	0.30	ECL82	0.35
35B5	0.65	7586	1.25	EC53	0.50	ECL83	0.65
35C5	0.40	7895	1.25	EC86	0.60	ECL84	0.55
35D5	0.70	9002	0.35	EC88	0.60	ECL85	0.55
35L6GT	0.50	9003	0.50	EC90	0.33	ECL86	0.40
35W4	0.30	AZ1	0.48	EC91	0.50	ECLL800	1.50
35Z3	0.60	AZ31	0.55	EC92	0.35	EF37A	0.60
35Z4G	0.30	CBL1	0.80	EC93	0.50	EF39	0.40
35Z5GT	0.40	CBL31	0.90	EC8010	2.25	EF40	0.50
50A5	0.70	CY31	0.35	ECC40	0.60	EF41	0.65
50B5	0.45	DAF96	0.42	ECC81	0.33	EF42	0.70
50C5	0.40	DF96	0.42	ECC82	0.30	EF80	0.25
50CD6G	1.65	DK40	0.55	ECC83	0.30	EF83	0.55
50L6GT	0.50	DK92	0.50				

EF85	0.35	EY88	0.43	PCL88	0.90	U78	0.30
EF86	0.30	EZ40	0.45	PCL800	0.93	U191	0.75
EF89	0.28	EZ41	0.45	PCL801	0.70	U201	0.35
EF91	0.33	EZ80	0.25	PD500	1.50	U281	0.40
EF92	0.40	EZ81	0.28	PF86	0.60	U282	0.40
EF95	0.30	GY501	0.80	PF818	0.85	U301	0.40
EF97	0.65	GZ30	0.40	PFL200	0.70	U403	0.50
EF98	0.65	GZ31	0.33	PL33	0.35	U404	0.40
EF183	0.30	GZ32	0.48	PL36	0.55	U801	1.00
EF184	0.35	GZ33	0.70	PL81	0.50	UABC80	0.35
EF800	1.00	GZ34	0.60	PL82	0.45	UAF41	0.50
EF804	1.25	HABC80	0.45	PL83	0.45	UAF42	0.55
EK90	0.30	HK90	0.35	PL84	0.40	UBC41	0.50
EL33	1.25	KT66	1.70	PL302	0.80	UBC81	0.40
EL34	0.50	KT88	1.75	PL504	0.80	UBF80	0.40
EL36	0.50	N78	1.15	PL508	0.90	UBF89	0.35
EL37	1.25	PABC80	0.40	PL509	1.80	UBL1	0.50
EL41	0.55	PC86	0.60	PL509	1.30	UBL21	0.60
EL42	0.58	PC88	0.60	PL801	0.80	UC92	0.35
EL81	0.55	PC97	0.50	PM84	0.50	UCC85	0.40
EL83	0.42	PC900	0.48	PY31	0.30	UCF80	0.55
EL84	0.25	PCC84	0.40	PY33	0.63	UCH21	0.60
EL85	0.43	PCC85	0.40	PY80	0.35	UCH42	0.70
EL86	0.40	PCC88	0.55	PY81	0.30	UCH43	0.75
EL90	0.35	PCC89	0.50	PY82	0.30	UCH81	0.35
EL95	0.35	PCC189	0.55	PY83	0.38	UCL81	0.60
EL360	1.15	PCC805	0.85	PY88	0.40	UCL82	0.35
EL803	1.00	PCC806	0.80	PY500	1.00	UCL83	0.60
EL821	0.55	PCF80	0.30	PY800	0.50	UF41	0.60
EL822	0.90	PCF82	0.35	PY801	0.50	UF42	0.60
ELL80	0.75	PCF84	0.50	PZ30	0.35	UF43	0.60
EM34	0.90	PCF86	0.60	QQV2-6	2.15	UF80	0.35
EM71	0.75	PCF87	0.85	QQVO3-10	1.25	UF85	0.40
EM80	0.40	PCF801	0.50	QQV03-20A	5.25	UF89	0.35
EM81	0.60	PCF802	0.50	TT21	2.65	UL41	0.55
EM84	0.35	PCF805	0.75	TT22	2.80	UL84	0.30
EM85	1.00	PCF806	0.70	U18/20	0.75	UM84	0.20
EM87	0.55	PCF808	0.75	U25	0.75	UY1N	0.50
EN91	0.35	PCH200	0.70	U26	0.75	UY11	0.65
EY51	0.40	PCL81	0.50	U31	0.45	UY41	0.45
EY80	0.45	PCL82	0.35	U37	1.50	UY82	0.50
EY81	0.40	PCL83	0.65	U52	0.33	UY85	0.30
EY83	0.55	PCL84	0.45	U76	0.30	W729	0.60
EY86	0.40	PCL85	0.40			Z803U	0.90
EY87	0.43	PCL86	0.45				

TRANSISTORS

2N404	0.17	2S034	1.00	BC152	0.15
2N444A	0.25	2S102	0.40	BC175	0.25
2N696	0.20	2S104	0.50	BCY30	0.35
2N697	0.23	2S701	0.50	BCY33	0.25
2N698	0.40	2S702	0.50	BCY34	0.30
2N706	0.70	2S746	0.30	BCY72	0.20
2N706	0.15	AC113	0.15	BCZ11	0.40
2N708	0.20	AC125	0.30	BD121	0.80
2N753	0.25	AC126	0.25	BD123	0.95
2N929	0.30	AC127	0.20	BF115	0.20
2N930	0.35	AC132	0.35	BF167	0.25
2N987	0.35	AC153	0.25	BF173	0.30
2N1131	0.40	AC154	0.15	BF181	0.25
2N1132	0.45	AC156	0.23	BF184	0.25
2N1184	1.25	AC157	0.20	BF185	0.20
2N1301	0.40	AC169	0.10	BF194	0.20
2N1302	0.25	AC176	0.25	BF195	0.15
2N1304	0.25	AC187	0.30	BF196	0.20
2N1305	0.25	AC188	0.30	BF197	0.20
2N1306	0.25	ACY17	0.30	BFW87	0.30
2N1307	0.30	ACY18	0.20	BFW88	0.25
2N1308	0.40	ACY19	0.25	BFW89	0.23
2N1309	0.35	ACY20	0.20	BFW91	0.20
2N1613	0.25	ACY21	0.20	BFX88	0.25
2N1711	0.30	ACY22	0.15	BFY17	0.40
2N1756	0.75	AD140	0.80	BFY19	0.60
2N2147	0.75	AD149	0.50	BFY50	0.25
2N2160	1.25	AD161	0.35	BFY51	0.20
2N2217	0.30	AD162	0.35	BFY52	0.25
2N2218	0.40	AF114	0.25	BSY26	0.25
2N2219	0.45	AF115	0.30	BSY27	0.30
2N2369A	0.25	AF116	0.25	BSY28	0.30
2N2477	0.65	AF117	0.20	BSY65	0.20
2N2646	0.60	AF118	0.45	BSY95A	0.20
2N2905	0.50	AF125	0.25	OC16	0.75
2N2923	0.15	AF127	0.25	OC22	0.65
2N2924	0.15	AF178	0.40	OC23	0.60
2N2926	0.15	AF180	0.35	OC24	0.60
2N3053	0.30	AF181	0.35	OC25	0.40
2N3055	0.75	AF186	0.50	OC26	0.30
2N3133	0.25	AF239	0.40	OC28	0.60
2N3134	0.50	AFZ11	0.45	OC29	0.65
2N3391	0.20	ASY26	0.25	OC30	0.75
2N3392	0.15	ASY27	0.30	OC35	0.50
2N3393	0.15	ASY28	0.30	OC36	0.60
2N3394	0.15	ASY29	0.30	OC42	0.30
2N3395	0.20	ASY54	0.25	OC44	0.20
2N3402	0.15	ASY74	0.50	OC45	0.20
2N3403	0.15	ASY77	0.35	OC70	0.20
2N3404	0.35	ASY82	0.20	OC71	0.15
2N3414	0.20	ASY86	0.20	OC72	0.25
2N3415	0.15	ASZ16	0.70	OC73	0.40
2N3416	0.25	ASZ17	0.75	OC75	0.25
2N3417	0.25	ASZ18	0.75	OC76	0.25
2N3702	0.15	ASZ21	0.50	OC78	0.25
2N3703	0.15	BC107	0.15	OC78D	0.20
2N3704	0.20	BC108	0.15	OC81	0.25
2N3707	0.20	BC109	0.20	OC81D	0.15
2N3709	0.15	BC113	0.40	OC83	0.20
2N3710	0.15	BC118	0.30	OC139	0.35
2N3819	0.35	BC134	0.30	OC140	0.40
2N3906	0.30	BC147	0.20	OC141	0.60
2S002	1.00	BC148	0.15	OC170	0.25
2S004	1.00	BC149	0.15	OC171	0.25

SYNCHROSCOPE TYPE C1-5



3-in tube fitted with telescopic viewing hood, giving bright display in full daylight.
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 2000kc/s with built-in crystal calibrator providing timing marks at .05-.2-1-5-20-100 μ sec + 5%.
Amplitude calibrator directly calibrated in volts.
Input attenuator 1-10-100.
Power supplies 127/230v AC.

PRICE £39.00. Packing and carriage 1.50

MINIATURE 1-IN CATHODE RAY TUBE TYPE DH3-91—1CP1—1CP31

63v heater. Anode voltage 500v. Sensitivity Y plates 45v/cm; X plates 52v/cm (typical) Y plates suitable for assymmetrical deflection. Green face, medium persistence.

PRICE £6.0.0 p.p. 0.25

SOLID STATE LIGHT EMITTING DIODES MV10B

T018 outline. Brightness 500 FT-L at 50mA. Forward voltage 1·65 to 2V. Diode gives bright red pinpoint of light when supplied from a 2V source. Lens diameter 0·170in. PRICE £1.05

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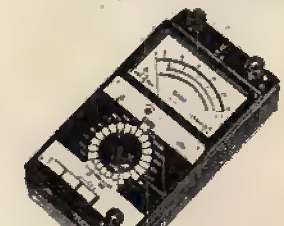

Type U4312
U4313
with AC current ranges

Type U4312—Low sensitivity instrument (667 o.p.v.) 1% accuracy on DC and 1·5% on AC. 9 current ranges on DC (300μA to 6A) and 8 current ranges on AC (1·5mA to 6A). 9 voltage ranges 0·3 to 900V AC/DC. Resistance 0·2 to 30k Ω. Mirror scale.

PRICE, complete with leads and steel carrying case £9.75

Type U4313—20,000 o.p.v. DC and 2,000 o.p.v. on AC. 8 DC current ranges 60μA to 1·5A. 6 AC current ranges 0·6 to 1·5A. 9 DC and AC voltage ranges 1·5–500V. Resistance ranges 0·5–500k Ω. Accuracy 1·5% DC and 2·5% AC. Mirror scale.
PRICE, complete with test leads and steel carrying case £10.50

MINIATURE CERAMIC CAPACITORS 25V WORKING

5% tolerance 22–27–33–39–47–56–68–82–100–120–150–180–220–270–330–390–470–560–680–820–1000pF
All at 12np per dozen.
+50%–20% tolerance 1500–2200–3300–4700–6800–10,000–15,000 pF—All at 15np per dozen.
+80%–20% tolerance 0.022–0.033–0.047 μF.
All at 20np per dozen.
Minimum orders 12 of one size.

HALF WAVE SILICON WIRE ENDED RECTIFIERS

BY101	50 p.i.v.	1 Amp	10np
IN4002	100 p.i.v.	1 Amp	10np
BY125	200 p.i.v.	425mA	13np
IN4004	400 p.i.v.	1 Amp	12np
BY130	450 p.i.v.	800 mA	10np
BY127	600 p.i.v.	1 Amp	15np
IN4006	800 p.i.v.	1 Amp	15np
BY105	800 p.i.v.	1·1 Amp	20np

INTEGRATED MONOLITHIC DUAL OPERATIONAL AMPLIFIER MC1435P

Two identical amplifiers in 14-pin dual-in-line epoxy package. 400mW dissipation. Typical open loop voltage gain 7000. Max. differential input ± 5V. Power supplies 6 to 9V. Max. frequency 1 mc/s. £2.00.

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