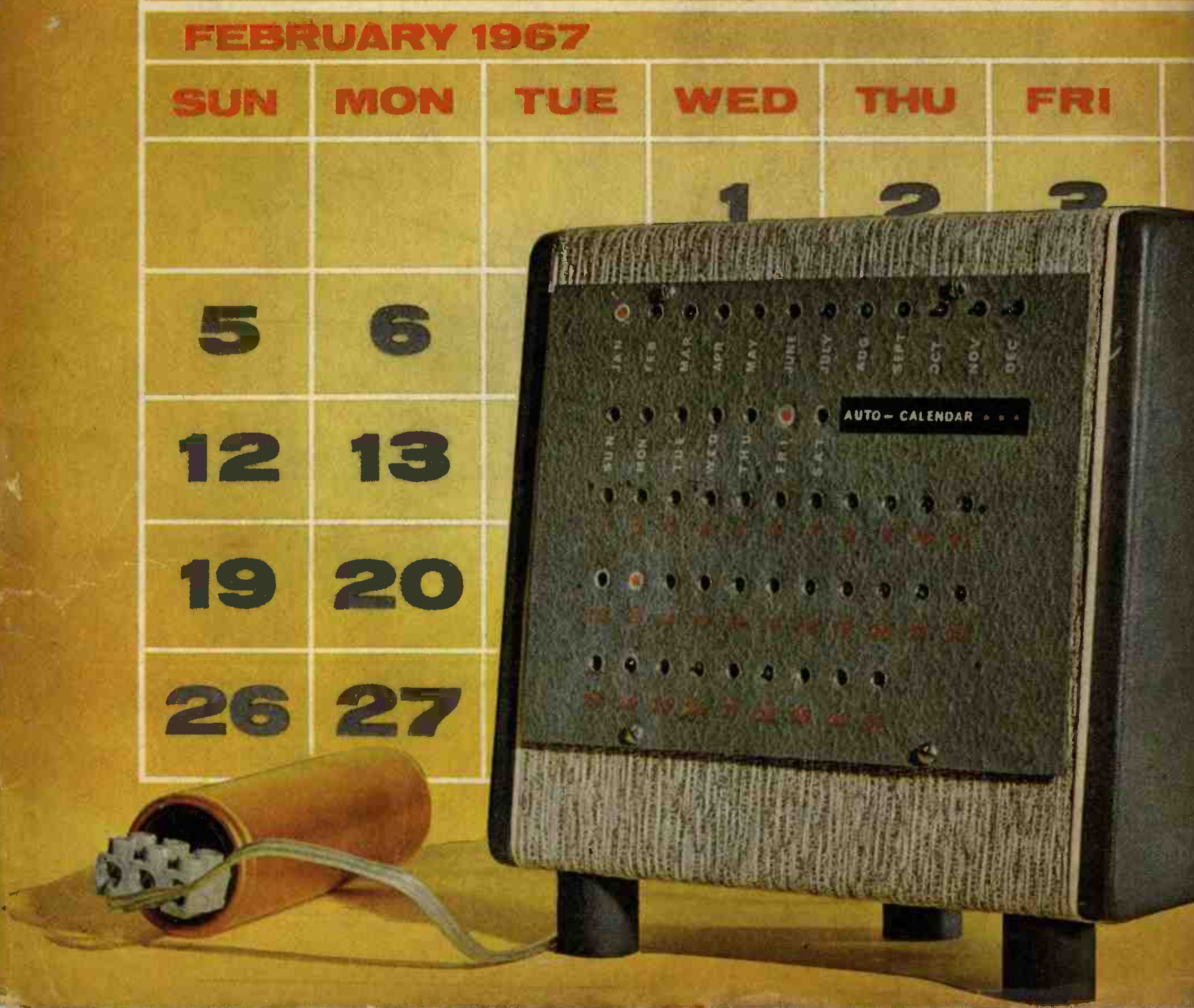
PRACTICAL ELECTRONICS

FEBRUARY 1967

PRICE 2/6

AUTO CALENDAR
WITH SUNRISE DATE CHANGE



ENORMOUS PURCHASE GUARANTEED. APPROX. HALF PRICE. WORLD FAMOUS MAKE

★ TAPE ★

We offer you fully tensilised polyester/mylar and P.V.C. tapes of identical quality hi-fi, wide range recording characteristics as top grade tapes. Quality control manufacture. They are truly worth a few more coppers than acetate, sub-standard, joined or cheap imports. TRY ONE AND PROVE IT YOURSELF.

Standard Play			Long Play		
3in.	150ft.	2/3	3in.	225ft.	2/9
4in.	300ft.	4/6	4in.	450ft.	5/6
5in.	600ft.	7/6	5in.	900ft.	10/6
5¾in.	900ft.	10/6	5¾in.	1,200ft.	13/-
7in.	1,200ft.	12/6	7in.	1,800ft.	18/6

Double Play			Triple Play		
3in.	300ft.	4/-	4in.	900ft.	13/-
4in.	600ft.	8/-	5in.	1,800ft.	25/-
5in.	1,200ft.	15/-	5¾in.	2,400ft.	34/-
5¾in.	1,800ft.	19/6	7in.	3,600ft.	44/-
7in.	2,400ft.	27/-			

Postage 1/- reel

Quadruple Play 3in. 600ft. 8/6

Post Free less 5% on three reels.
Quantity and Trade enquiries invited.
NOTE. *Large tape stocks at all branches.*

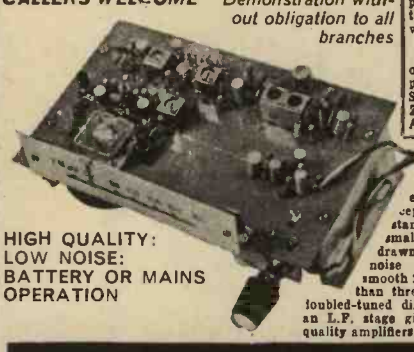
BARGAIN PARCELS

Including variable condensers, I.f. coils, loudspeaker plugs/sockets, knobs, pots, condensers, resistors, nuts, bolts, cabinet fittings, switches, transformer choke, rectifier, transistors at a small fraction of list value. Due to heavy demand we are now packing them in several sizes—TRY ONE.

3 lbs. (post 3/-) 9/-
7 lbs. (post 5/-) 17/6
14 lbs. (post 6/-) 29/-

Transistorised FM Tuner

CALLERS WELCOME *Demonstration without obligation to all branches*



HIGH QUALITY:
LOW NOISE:
BATTERY OR MAINS OPERATION

This beautifully compact 6 transistor machine (size 6 × 4 × 2½in.) will give quieter, more interference free reception. Months of use from a standard 9 volt battery or its small power requirements can be drawn from any amplifier. Low noise frequency changer with smooth 2 gang tuning feeding no less than three I.F. stages coupled to a doubled-tuned discriminator terminating in an L.F. stage giving ample output for all quality amplifiers.

avoid disappointment

ORDER NOW £8-10

15 Watt TUNER AMPLIFIER KIT

14 TRANSISTOR consisting of FMT41 tuner and the excellent Sinclair Z12 (built) together with complete integrated control. Kit consisting complete vol. on/off treble and bass, component sets with complete connecting instructions and circuits, battery version

£13.19.0

or complete with AC mains power pack £17.18.6
STEREO VERSION with 2 Z.12 amplifiers £18.10.0
A.C. STEREO £22.10.0

LATEST

GARRARD

All Factory Fresh. All with cartridge. EV26 Ceramic Stereo cartridge fitted to any deck for 15/- extra

SRP12 .... £4. 7.6
SP25 .... £9.19.0
AUTOSLIM £5.10.0
Model 1,000 .... £6. 5.0
Model 2,000 .... £6.10.0
Model 3,000 .... £8.10.0
AT60 .... £9.19.0
A70 .... £18.10.0
LAB80 .... £24.19.0
401 .... £29.19.0

B.S.R. BARGAINS

TU14 .... 59/-
GU7 .... 85/-
UA14 .... 89/-
UA16 .... 99/-
UA25 SUPERSLIM £5.10.0

CARTRIDGES

G.C.2 Garrard Mono 16/-
EV26 Garrard Stereo Ceramic 24/-
EUPHONIC SUPER Ceramic Stereo Diamond 100mV Output 29/-
DECCA DERAM Stereo 59/-

TRANS/CEIVERS

The very latest Silver/Black finish. They give an excellent performance with reliability, long telescopic aerial, crystal controlled. Note a licence is required to transmit. They compare with much dearer models 2/6 p. & p. **£6.19.0**
These cannot be operated in U.K.

STEREO FM HERE!

From Denmark's Largest Radio Factory

THE NEILSON 'ARENA' T1900H

All wave AF/FM stereo receiver amplifier, 5 wave bands. 2 sinus pressure-chamber speakers, 8 watts, four channel Fully transistorised, natural oiled teak cabinet, internal/external speaker, A.F.C., FM & AM tuning controls, internal or external aerials, tape recorder, gram inputs, 200/250 v. A.C. operation tuning indicator, bass, treble volume controls. Size 29½in. × 5¾in. × 8¼in. **65 Gns.**
Or complete with Stereo Multiplier, as stocked in all branches. **69 Gns.**

ARENA T1900F

As above, less speakers **59 Gns.**

Arena Hi-Fi speakers stocked at all branches.
CALLERS. *Wide range of Hi-Fi equipment available at all branches. WE OFFER PACKAGE DEAL DISCOUNTS.*

AM/FM 9 TRANSISTOR

Portable receivers. Due to enormous purchase we can offer these black/satin chrome receivers normally approx. 15 gns. covering full medium wave and F.M. bands. Built-in aerials, medium size, with batt. **9½ Gns.**
ALL BRANCHES *have a wide range of transistor sets from 55/- to £70.*

ELPICO MONO PRE-AMPS

DPA15. Latest black/satin chrome finish multiple input channels selector, bass and treble controls. Matches all pick-ups and mikes. Provision tape recording. Normally 10 gns. our price **4 Gns.**

TRANSISTORS GUARANTEED TOP QUALITY

Mullard Matched Output Kits OC81D and 2-OC81 .... 9/6
R.F. Kits OC44, OC45 (2) 3 transistors 9/6

HEAVY DUTY 14/20 WATT AMPLIFIER KITS

Famous make. Consisting integrated controls, high/low gain pre-amp stages feeding EL34 push-pull output, C core transformers complete with instructions down to the last bolt. Current model at fraction of list price. **8½ Gns.**

SILICON H.T. RECTIFIERS

Guaranteed performance. Top makes. Tested 250v. working.
120 ma. (3 for 6/6) **2/9** 500 ma. (3 for 19/6) **7/6**

SP25 ON PLINTH

Latest Garrard quality single player on Garrard matching plinth. Factory fresh. Unusual value at **11½ Gns.**

Value in VALVES

GUARANTEED 3 MONTHS BY RETURN OF POST

Satisfaction or Money Back Guarantee on goods if returned unused within 14 days. ALL VALVES ARE NEW UNLESS OTHERWISE INFORMED. FREE TRANSIT INSURANCE. POSTAGE 1 valve 9d. 2-11 6d. per valve. Free over 12.

1L4	2/3	6GSGT	9/6	20P4	17/9	ECC88	9/6	GZ34	10/6	SP61	2/9
IR5	4/9	6L1	9/6	25L6GT	7/-	ECF80	7/9	KT61	12/-	TDD4	7/-
184	4/9	6L6G	8/6	25Z4G	7/-	ECF82	7/6	KT63	5/9	U14/18	7/6
185	4/6	6L18	7/9	30F5	9/-	ECH21	10/-	KT66	19/6	U25	9/6
1T4	3/-	6LD20	8/6	30FL1	9/9	ECH35	11/-	KT88	27/6	U26	9/6
2D21	5/6	6P25	12/-	30L15	11/6	ECH42	10/6	KTW61	5/9	U35	12/6
3A5	6/-	6P28	9/6	30P4	11/6	ECH81	6/9	KTW63	5/-	U37	11/-
3Q4	5/3	6Q7G	7/-	30P12	9/-	ECH83	7/9	KTZ63	7/-	U107	12/6
5U4G	6/-	6Q7GT	8/9	30PL1	11/-	ECL80	5/9	MU14	7/-	U191	12/6
5Y3GT	6/6	6SL7GT	6/9	35A5	9/6	ECL82	7/6	N37	9/6	U281	9/6
5Z4G	6/9	6SN7GT	6/9	35L6GT	8/6	ECL83	10/6	N78	13/-	U282	15/-
5Z4GT	9/6	6U4GT	9/6	35W4	6/6	ECL86	9/6	N108	13/-	U329	8/6
6/30L2	9/6	6V6G	4/9	35Z4GT	5/9	EF36	4/9	PC86	9/6	U801	19/-
6A8G	7/6	6V6GT	6/9	30L6GT	8/6	EF39	7/-	PC97	7/6	UABC80	6/6
6AK5	4/9	6X4	4/6	80	7/6	EF40	10/-	PCC84	6/6	UAF42	7/9
6AQ5	5/-	6X5G	5/-	185BTA	19/6	EF41	9/-	PCC85	7/6	UB41	6/6
6AT6	5/-	6X5GT	6/9	807	9/6	EF50	3/3	PCC88	11/9	UBC41	8/9
6BA6	5/6	7B6	11/6	955	3/6	EF80	4/3	PCC89	11/-	UBC81	6/9
6BE6	5/6	7B7	7/6	956	3/-	EF85	6/3	PCC189	9/9	UBF80	7 6
6BH6	6/6	7C5	9/6	AZ31	8/6	EF86	7/6	PCF80	6/9	UBF89	7/6
6BJ6	7/-	7C6	7/6	CBL31	19/6	EF89	6/6	PCF82	6/9	UBL21	10/9
6BR7	9/6	7H7	7/6	DAF96	7/3	EF91	3/6	PCF86	8/3	UC92	6/9
6BW6	7/6	7S7	14/6	DF96	7/3	EF183	8/-	PCL82	7/9	UCC85	7/3
6BW7	5/-	7Y4	7/-	DK92	8/6	EF184	8/-	PCL83	9/6	UCF80	8/6
6C4	3/-	10C1	11/-	DL96	7/3	EL32	5/-	PCL84	9/-	UCH21	10/9
6C5	5/6	10C2	12/6	DL92	6/-	EL33	12/-	PCL85	9/6	UCH42	8/6
6C6	4/-	10F1	7/6	DL94	6/6	EL34	11/6	PCL86	9/6	UCH81	7/-
6C9	11/-	10LD11	14/6	DL96	7/3	EL35	8/-	PL33	8/6	UCL82	8/-
6CD6G	17/-	10P13	9/6	EABC80	6/9	EL38	15/-	PL36	11/-	UCL83	10/6
6D6	4/-	10P14	9/6	EAF42	8/-	EL41	9/9	PL38	12/6	UF41	9/-
6F1	6/6	12AT7	4/9	EB41	4/6	EL42	8/9	PL81	7/9	UF42	6/9
6F6G	5/-	12AU7	5/6	EB92	2/9	EL84	6/6	PL82	5/9	UF85	7/6
6F13	4/6	12AX7	6/-	EBC33	7/6	EM80	7/-	PL83	6/-	UF89	6/9
6F14	7/6	12J7GT	9/-	EBC41	9/6	EM81	7/6	PL84	7/-	UL41	10/-
6F15	9/6	12K7GT	5/-	EBC91	6/9	EM84	7/9	PY31	7/6	UL44	14/-
6F23	8/-	12K8GT	9/6	EBF80	7/9	EY51	7/6	PY32	9/6	UL46	10/6
6J5G	4/-	12Q7GT	6/6	EBF89	7/-	EY86	7/3	PY33	7/6	UL84	6/6
6J5GT	6/6	14S7	14/6	EBL21	11/-	EY88	8/6	PY80	5/9	UM80	9/6
6J6	3/3	19AQ5	5/6	ECC40	9/6	EZ40	7/6	PY81	5/9	UY21	8/9
6J7G	5/6	20D1	8/9	ECC81	4/9	EZ41	8/6	PY32	5/6	UY41	7/-
6J7GT	9/6	20F2	9/6	ECC82	5/6	EZ80	5/6	PY83	5/9	UY85	5/6
6K7G	2/8	20L1	16/-	ECC83	6/-	EZ81	6/-	PY88	8/6	VR105	5/-
6K7GT	5/9	20P1	9/6	ECC84	7/-	FC4	8/-	PY800	7/-	VR150	5/-
6K8G	5/9	20P3	9/6	ECC85	5/9	GZ32	9/6	PZ30	9/6	Z66	7/9

Stockists of Leak, Quad, Chapman, Goodman, Armstrong, Tripletone, Linear, Rogers, Truvox, Ferrograph, Wharfedale, etc.
Post: 1 lb. 1/5, 1½ lb. 2/6, 2 lb. 2/9, 4 lb. 3/3, 6 lb. 4/-, 14 lb. 5/6. All Mail Orders to Brighton please.

STEREO PORTABLE CABINETS

Latest black and silver metal finish. Consisting of centre cabinet size 16¼in. × 13in. × 8in. deep with lift up lid together with two 10 × 6 speaker cabinets which slip on ends of main cabinet size 4¾in × 13in. × 8in. making overall size of 25¾in. × 13in. × 8in. High quality chrome fittings. Will take almost any autochanger or tape deck. Approx. half price at **£3.19.0**
Ditto, but less chrome, takes 7 × 4 speaker **£2.19.9**

MONO PORTABLE CABINETS. B.S.R. tape deck or single record player, new attractive finish, half price. **19/6**

AUTOCHANGE PORTABLE CABINETS. As used on 18 gns. record player. Due to fortunate purchase we offer complete with motor board and all fittings at only **49/-**
PLEASE NOTE. *A wide range of cabinets to callers at all branches.*

100 HI-STABS 9/6
1% to 5% 100 Ω to 5 mΩ
CO-AX, low loss, 6d. yd. 25 yds. 11/6; 50 yds. 22/-; 100 yds. 42/6, Plugs 1/3.

100 RESISTORS 6/6
SIZES ¼-3 watt

MICROPHONE CABLE Highest quality, black, grey, white, 9d. per yard.

100 CONDENSERS 9/6
Miniature Ceramic, Silver, Mica, etc. 3pF to 5μF. LIST VALUE OVER £4.

25 ELECTROLYTICS
Assorted 2 to 500 mfd 6 to 400 volt. LIST VALUE OVER £5 **9/6**

50 TAG STRIPS 7/6
Mixed sizes 2 to 15 way

25 POTENTIOMETERS
Including with switch, long and short spindle, pre-sets, log and lin. unused, 1k-2m.Ω LIST VALUE APPROX. £4. **9/6**

CONNECTING WIRE
P.V.C. Bright Colours. Five 25ft. coils only. **4/-**

CALLERS. *A very wide range of electronic components await you at all branches. Your enquiries welcomed*

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POCKET MULTI-METER

Size 3⅛ × 2⅛ × 1⅛in. Meter size 2⅛ × 1⅛in. Sensitivity 1000 O.P.V. on both A.C. and D.C. volts. 0·15, 0·150, 0·1000. D.C. current 0·150mA. Resistance 0·100kΩ. Complete with test prods, battery and full instructions, 42/6. P. & P. 3/6. FREE GIFT for limited period only. 30 watt Electric Soldering Iron value 15/- to every purchaser of the Pocket Multi-Meter

CYLDON U.H.F. TUNER

complete with PC.88 and PC.86 Valves. Full variable tuning. New and unused. Size 4½" × 5½" × 1½". Complete with circuit diagram. 35/- plus 3/6 P. & P.

3 to 4 WATT AMPLIFIER

comprising chassis 8¾" × 2½" × 1". Double wound mains transformer, output transformer, volume and tone controls, resistors, condensers, etc. 6V6, ECC81 and metal / rectifier. Circuit 1/6 free with kit. 29/6 plus 5/6 P. & P. The above Amplifier built and tested 10/6 extra.

MULTIPLEX DECODER

Now is your chance to benefit in full from the new B.B.C. stereo transmissions with our Multiplex Decoder. Design features: Highly efficient Mullard vinkor pot cores. Two semiconductor diodes. Double purpose valve. Printed circuit type construction high input impedance. Specification: Cross talk minus 26 db at 1 kc/s. Input requirements 0.5 - 1.5 RMS. Stability plus or minus 0.1%. Voltage requirements H.T. 190 - 250 volts. D.C. at 5 ma. Heaters 6.3 volts A.C. at 300 ma. Self powered unit shortly available, price to be announced. Size 5½" × 3½" × 1". Fully built and tested, price £4.4.0 plus 3/- P. & P. charges.

"MUSETTE" 6-TRANSISTOR SUPERHET PORTABLE RADIO

39/6 Inc. carrying strap. Circuit Diagram 2/6—free with parts

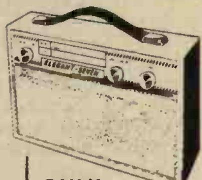
P. & P. 3/6

- ★ 2½" Speaker.
- ★ 6 Transistors Superhet Output 200 mw.
- ★ Plastic Cabinet in red, size 4¾" × 3" × 1⅞" and gold speaker louvre.
- ★ Horizontal Tuning Scale.
- ★ Ferrite Rod Internal Aerial.
- ★ IF 460 Kc/s.
- ★ All components Ferrite Rod and Tuning Assembly mount on printed board.
- ★ Operated from PP3 Battery.
- ★ Fully comprehensive instructions and point-to-point wiring diagram.
- ★ Printed Circuit Board.
- ★ Tunable over medium and long waveband.
- ★ Car aerial and earpiece socket.

TRANSISTORISED SIGNAL GENERATOR

Size 5½" × 3½" × 1½". For IF and RF alignment and AF output, 700 c/s frequency coverage 460 Kc/s to 2 Mc/s in switched frequencies. Ideal for alignment to our Elegant Seven and Musette. Built and tested. 39/6. P. & P. 3/6.

ELEGANT SEVEN Mk. II



ONLY £4.4.0
Plus 7/6 Post & Packing

SPECIAL OFFER. 7" × 4" P.M. Speaker at no extra charge. Power supply kit to purchasers of 'Elegant Seven' parts, incorporating mains transformer, rectifier and smoothing condenser, A.C. mains 200/250 volts. Output 9v. 100 mA. 7/6 extra.

Buy yourself an easy to build 7 transistor radio and save at least £10.0.0. Now you can build this superb 7 transistor superhet radio for under £4.10.0. No one else can offer such a fantastic radio with so many de luxe star features.

★ De luxe grey wooden cabinet size 12½" × 8½" × 3½". ★ Horizontal easy to read tuning scale printed grey with black letters, size 11½" × 2". ★ High 'Q' ferrite rod aerial. ★ I.F. neutralisation on each separate stage. ★ D.C. coupled push pull output stage with separate A.C. negative feedback. ★ Room filling output 350mW. ★ Ready etched and drilled printed circuit board back printed for foolproof construction. ★ Fully comprehensive instructions and point to point wiring diagrams. ★ Car aerial socket. ★ Fully tunable over medium and long wave, 168-535 metres and 1250-2000 metres. ★ All components, ferrite rod and tuning assembly mount on printed board. ★ Full after sales service. ★ Parts list and circuit diagram 2/6, free with parts.

Shop Hours 9 a.m. - 6 p.m.
Early Closing Wednesday

All orders by post must be sent to our Acton Address

Our new branch at
323 EDGWARE ROAD, LONDON, W.2
IS NOW OPEN
Personal shoppers only

All enquiries stamped addressed envelope

RADIO & T.V. COMPONENTS (ACTON) LTD.
21D, HIGH STREET, ACTON, LONDON, W.3

the Wyndsor Vanguard . . . the most versatile recorder at its price* offering so many outstanding features . . .

- 4 track-3 speeds —7 in. spools
- Separate Record and replay amplifiers
- Double play
- Sound-on-Sound
- Detachable lid fitted 8" speaker
- Tape Monitoring facility

- Push button controls
- Recording meter and Playback indicator
- Straight through amplifier facility
- Bass, treble, volume and record gain controls
- Many other features

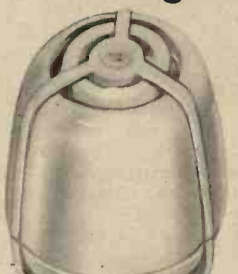
Before you buy an ordinary tape recorder write for full details of the Vanguard and other models.

* All British and full value for money at only 59 gns. inc. 1800 ft. LP tape and Tape manual. (less mike).

WYNDSOR RECORDING CO. LTD. (Dept. PEI)
Wyndsor Works, Bellevue Road, Friern Barnet, London, N.11. ENT. 2226

SPECIAL OFFER of GUARANTEED *NEW* LUSTRAPHONE

Moving-coil Microphones



Specification: Moving-coil Model LD61, medium impedance (nominal 600 Ohms at 1 k/cs) in cream plastic casing with a fabric blast guard, 9 ft. co-axial lead which can be extended to considerably greater lengths, fitted with a Belling-Lee co-axial plug—list price £3.7s.6d. **Yours for only 26/-.** This high quality mic. is omni-directional in the horizontal and approaches cardioid characteristic in the vertical planes. Frequency response approx. 70-12,000 cycles/sec. Sensitivity approx.—75 db (m).

The impedance of this microphone enables you to use it with a screened lead a hundred feet or more from your equipment without undue attenuation or hum pick-up.

A transistor adaptor can be easily made to use this mic. with practically any tape recorder or amplifier (circuit supplied).

26/- each Order NOW

Post Free in U.K. While Stocks last

Money Orders, Postal Orders or Cheques should be crossed and made payable to "Andrew Merryfield Ltd."

ANDREW MERRYFIELD LTD.
Dept. PL/804, 29 Wright's Lane, Kensington, London, W.8

NEW!

THE WORLD'S SMALLEST RADIO

Photograph shows actual size

- ★ ONLY ONE CONTROL
- ★ CALIBRATED DIAL
- ★ SIZE — $1\frac{4}{5}$" x $1\frac{3}{10}$" x $\frac{1}{2}$"
- ★ POLISHED ALUMINIUM FRONT PANEL WITH SPUN ALUMINIUM DIAL
- ★ AMAZING RANGE POWER & SENSITIVITY
- ★ NEW CIRCUITRY
- ★ BANDSPREAD FOR EASY RECEPTION OF 'POP' STATIONS
- ★ A.G.C.
- ★ IN KIT FORM OR READY BUILT
- ★ 5 YEAR GUARANTEE

SINCLAIR MICROMATIC

PROFESSIONALLY RIGHT IN EVERY DETAIL

THE SINCLAIR MICROMATIC is a brand new design from an organisation world-famous for its production of micro-electronic equipment for constructors. It has behind it the Sinclair tradition of specialisation in micro-radio circuitry which, in the MICROMATIC, reaches fantastically high levels of performance. We have combined new circuitry with new elegance to make the SINCLAIR MICROMATIC professionally right in every detail whether you build it yourself or buy it complete in presentation case.

This makes the perfect personal radio, ready to serve wherever and whenever required. Its minutely proportioned case houses transistors, ferrite rod aerial and batteries and yet is considerably smaller than an ordinary matchbox. The MICROMATIC has an elegantly designed aluminium front panel with matching calibrated slow motion dial. New circuitry assures reception from a wide range of stations over the medium waveband, with excellent selectivity and quality. Here is a new set you will be proud to be seen using; you will also find it an ideal gift to give anyone. YET THIS BRILLIANT NEW DESIGN IS THE EASIEST OF ALL SINCLAIR RADIO SETS TO BUILD—AND IT IS BRITISH!

TECHNICAL DESCRIPTION

The Sinclair Micromatic is housed in a neat plastic case with attractive aluminium front panel and aluminium tuning dial to match, calibrated in Kc/s and metres.

Three special Sinclair transistors are employed in a six stage circuit of exceptional power and sensitivity. Two stages of powerful R.F. amplification are followed by a double diode detector from which the signal tuned in is passed to a high gain three stage audio amplifier. Automatic Gain Control counteracts fading from distant stations and maintains signal strength. The set is powered by two Mallory Mercury Cells Type ZM.312 which are readily obtainable from radio shops, Boots Chemists, Stores, etc., and cost 1/7 each. The cells will give approximately 70 hrs. continuous working life. Inserting the earpiece plug switches the set on, withdrawing it switches off.

Complete kit of parts to build Sinclair Micromatic including lightweight earpiece, case and instructions **59/6**

Sinclair Micromatic ready built with lightweight earpiece, in presentation case. **79/6**

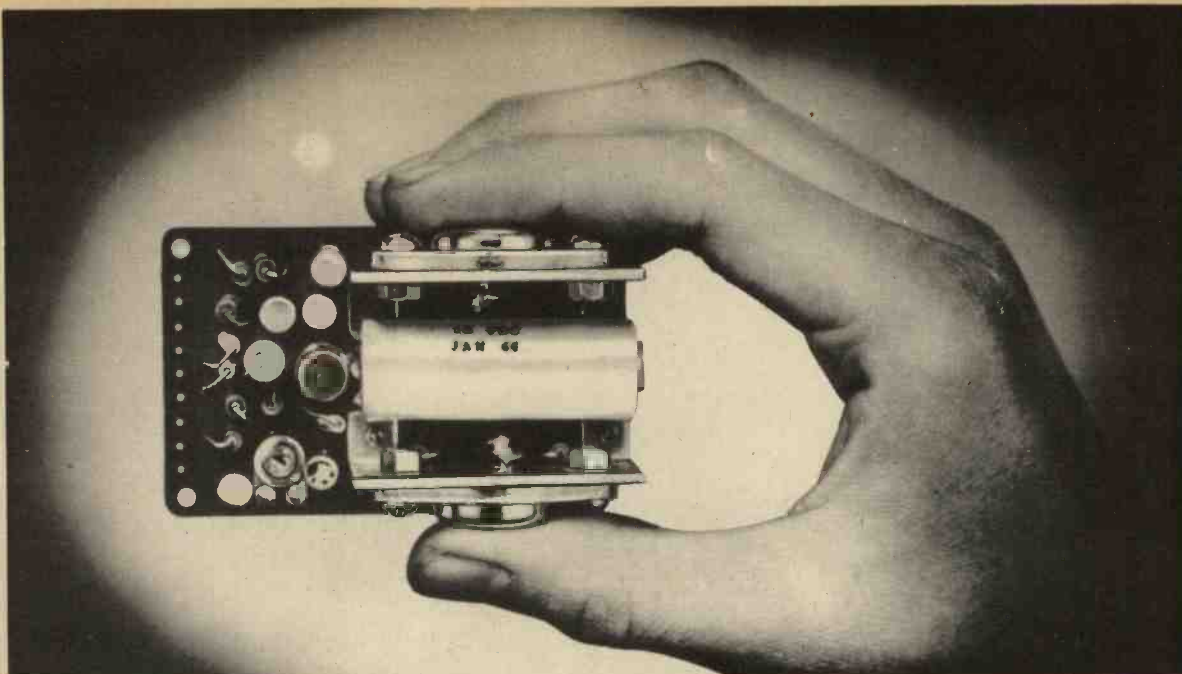
FULL SERVICE FACILITIES AVAILABLE TO ALL SINCLAIR CUSTOMERS

sinclair

SINCLAIR RADIONICS LTD., 22 Newmarket Rd., CAMBRIDGE

Telephone 52996 (STD Code OCA3)

Order form and more Sinclair designs on pages following



SINCLAIR Z.12

COMBINED 12 WATT HIGH-FIDELITY AMPLIFIER AND PRE-AMP

12 WATTS R.M.S. OUTPUT
CONTINUOUS SINE WAVE (24W. PEAK)

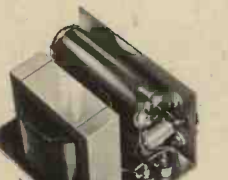
8 TRANSISTOR CIRCUIT WITH CLASS B ULTRALINEAR OUTPUT

IDEAL FOR HI-FI (STEREO OR MONO) CAR RADIO, ELECTRIC GUITAR, P.A., INTERCOM, ETC.

The amazing adaptability and rugged construction of this very powerful and exceptionally compact amplifier make it possible to use just one type of unit with outstanding success in an unusually wide variety of applications. Eight special H.F. transistors are used in a highly original circuit to achieve the characteristics demanded of any quality amplifier irrespective of price, yet this Sinclair unit costs well under £5, including its own integrated pre-amplifier. The Z.12 accepts radio, microphone and pick-up inputs. Detailed instructions for connecting these in mono and stereo are given in the manual supplied with every unit. A number of different control networks are also shown. The Z.12 will operate efficiently from any supply between 6 and 20 V. d.c, making it very convenient to run the amplifier from a car battery. Where it is required to run the Z.12 from mains supply, the PZ.3 is recommended. Those wishing to have a ready made pre-amp control unit can feed inputs via the Stereo 25, which, with two Z.12s will provide the finest stereophonic hi-fi possible—and the saving in cost is fantastic.

PZ.3 MAINS POWER SUPPLY UNIT

This special power supply unit uses advanced transistorised circuitry to achieve exceptionally good smoothing. Ripple is a barely measurable 0.05 v. The PZ.3 will power two Z.12s and a Stereo 25 with ease.



79/6

TECHNICAL SPECIFICATIONS

- Size 3 in. × 1¾ in. × 1¼ in.
- Class "B" ultralinear output
- **RESPONSE** 15-50,000 c/s ± 1 dB.
- Suitable for 3, 7·5 or 15Ω speakers. Two 3Ω speakers may be used in parallel
- **INPUT**—2mV into 2kΩ
- **OUTPUT**—12 watts R.M.S. continuous sine wave (24 w. peak); 15 watts music power (30 w. peak
- Signal to noise ratio better than 60dB.
- Quiescent current consumption—15mA.

Built, tested and guaranteed. Ready for immediate use. With Z.12 manual.

89/6

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If you are not completely satisfied when you receive your purchase from us, your money will be refunded at once in full and without question.

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A new Sinclair Set—see page 83

SINCLAIR RADIONICS LTD.
22 Newmarket Road, Cambridge 52996

To: SINCLAIR RADIONICS LTD., 22 NEWMARKET ROAD, CAMBRIDGE

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ADDRESS..........

For which I enclose cash/cheque, money order ....

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For the Finest Value and Service to HOME CONSTRUCTORS & ELECTRONICS ENTHUSIASTS

We consider our construction parcels to be the finest value on the home constructor market. If on receipt you feel not competent to build the set, you may return it as received within 7 days, when the sum paid will be refunded less postage.

TAPE RECORDERS

MAGNAVOX 363 DECKS

The very latest 3 speed model—1⅞, 3¾, 7½ i.p.s. available with either ½ track or ¼ track head. Features include: pause control; digital counter; fast forward and rewind; new 4 pole fully screened induction motor; interlocking keys. Size of top plate: 13¾ × 11 × 5¼in. deep below unit plate. For 200/250 v. A.C. mains, 50 c.p.s. operation. New unused and fully guaranteed.

LASKY'S PRICE ½ track model £10.10.0

LASKY'S PRICE ¼ track model £13.9.6

Carriage and Packing 7/6 extra.

SPECIAL FOR OVERSEAS CUSTOMERS — the new Magnavox-Collaro 363 Deck for 110/125 v. 50 or 60 c.p.s. mains now available, prices as above. Post to any part of the world 35/-.

MARTIN RECORD/REPLAY TAPE AMPS.

Latest models now available from stock—for use with the Magnavox 363 Tape Deck

½ track model .... LASKY'S PRICE £14.19.6

¼ track model .... LASKY'S PRICE £15.19.6

Carriage and Packing 4/6 extra

Optional extra: Control panel escutcheon to take deck and amplifier controls. LASKY'S PRICE 12/6. Post and Packing 2/6.

SPECIAL INTEREST ITEMS!

SPECIAL PURCHASE—UHF/VHF T.V. TUNERS

Well known British makers' surplus stocks. Now available for the first time to the Home Constructor. Add 2/6 Post and Packing on each.

VALVE UHF MODEL *(illustrated)*

In metal case size 4 × 6 × 1¾in. Fully tunable—complete with PCC86 and PCC88 valves. LASKY'S PRICE 29/6. Without valves 12/6

TRANSISTORISED UHF MINIATURE MODEL 1

Shielded metal case only 3½ × 1½ × 3in. Fully tunable—complete with two AF 139 transistors. LASKY'S PRICE 39/6

TRANSISTORISED UHF MODEL 2

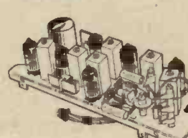
Metal case size 3¾ (plus spindle) × 2¾ × 1¾in. Fully tunable with slow motion drive. Comp. with two AF186 transistors and leads. LASKY'S PRICE 25/6

TRANSISTORISED VHF TUNER

Sub-miniature turret type fitted with 12 sets of coils and 3 Mullard AF102 transistors In metal case size 3 × 1½ × 2¼in. LASKY'S PRICE 37/6

Add 2/6 Post and Packing on each.

MAKERS' SURPLUS TELEVISION IF AMPLIFIERS



38 Mc/s. Contains a large number of components, IF transformers, resistors, capacitors, etc., and the following valves: 2xPCF80, 1xEB91, EF80, EF183 and EF184. Overall size 11½" × 3½" × 4" deep. Ideal for servicemen and experimenters. This IF amp. when used with the Valve model UHF Tuner (above) provides a suitable conversion for B.B.C.2. Circuit supplied.

LASKY'S PRICE 29/6 Post 2/6

SPECIAL PACKAGE OFFER

Free standing table cabinet, size 17½ × 9 × 5¼in., finished in medium Mahogany. Scale marked 21 to 68 (UHF band). Designed to accept the above IF Amplifier with space for a Valve UHF Tuner. Cabinet only 27/6 Post 3/6

Special Package Offer IF Amplifier, UHF Tuner with valves and Table Cabinet. PACKAGE PRICE 59/6 Post 6/-

WATER TEMP. THERMOSTATS

British made—orig. for use in high quality washing machine. range adjustable between 114°F and 230°F. Rating 200/250 V.A.C., 20 amps (also D.C. up to 125 V.A.). Size 2¾×1¾×1¼ with 18in. capillary tube and 6in. bulb. Single hole fixing—3/16in spindle.

LASKY'S PRICE 15/- Post 2/-

CONSTRUCTORS BARGAINS

The "Sixteen" Multirange METER KIT

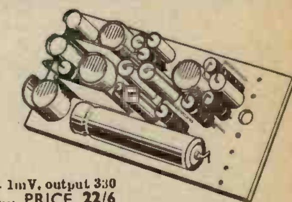
This outstanding meter was featured by *Practical Wireless* in the Jan. '64 issue. Lasky's are able to offer the complete kit of parts as specified by the designer.

RANGE SPECIFICATION: D.C. volts: 0-2.5-25-50-250-500 at 20,000Ω/V. A.C. volts: 0-25-50-250-500 at 1,000Ω/V. D.C.current: 0-50μA, 0-2.5-50-250mA. Resistance: 0-2,000Ω, 0-200kΩ, 0-20 MΩ. Basic movement: 40μA f.s.d. moving coil. With universal shunt full scale deflection current is 50μA. Black plastic case—3¾×5¾×1¾in. Controls: 12 position range switch; separate slide switch for A.C. volts—D.C. ohms; ohms zero adjustment pot, meter, meter zero. Power requirements: One 15v. and one 1.5v. batts. Complete with all parts and full construction details. H.P. Terms available.

LASKY'S PRICE £5.19.6. P. & P. 5/-

Data and circuit available separately, 2/6; refunded if all parts bought. Pair of batteries 2/- extra.

NEW—LASKY'S MINIATURE TRANSISTOR AMPLIFIER MODULES



Incorporating the very latest circuitry to provide high sensitivity and good quality in conjunction with extreme small size and compactness. High quality Newmarket transistors used throughout. All designed to operate on 9v. miniature battery. Add 1/-on each for post & packing

TYPE LRPC 1. 3 transistor. Input sens. 50 mV., output 150 mW, output imp. 40Ω, size 2×1×⅝in....... PRICE 27/6

TYPE LRPC 2. 5 transistor. Input sens. 1mV, output 330 mW, output imp. 15Ω, size 2¼×1½×⅝in.... PRICE 22/6

TYPE LRPC 3. 5 transistor. Input sens. 5 mV, output 400 mV, output imp. 15Ω, size 2¼ × 1½ × ⅝in. .... PRICE 25/-

TYPE LRPC 4. 5 transistor. Input sens. 150 mV, output 330 mV, output imp. 15Ω, size 2¼ × 1½ × ⅝in. .... PRICE 22/6

TYPE LRPC 5. 6 transistor. Input sens. 8mV, output 3W, output imp. 3Ω, size 5½ × 1¾ × 1in. .... PRICE 59/6

TYPE LRPC 6. Tape record/play back amp. (for use with self oscillating erase head). Output 750mW, output imp. 8Ω. Size 4¼ × 2 × 1in..... LASKY'S PRICE 39/6

FULLY ENCAPSULATED MODULES

Special function modules — all one size 1¾ × 1 × 1¼in. Complete with detailed function and installation instructions. Send S.A.E. for data.

TYPE PA-1. Public address amp. for use with carbon, crystal or Dynamic microphones. 3Ω output imp. .... PRICE 30/-

TYPE GR-1. Gramophone amplifier—provides sufficient power to fill average room. 3Ω output imp. .... PRICE 30/-

TYPE CO-1. Morse code practice oscillator — for use with morse key and 3Ω speaker. .... PRICE 20/-

TYPE MT-1. Metronome module—provides audible and visual beat from 30 to 240 beats per minute (for use with 3Ω speaker or ind. lamp).............. PRICE 22/6

SINCLAIR SUPER MINIATURE KITS

We stock the complete range. Write for details of package deals.

THE MICRO-6 miniature radio only 1⅘ × 1⁵⁄₁₆ × 1⅗in.	£2 19 6
THE MICRO-FM. (tuner/receiver)	£5 19 6
THE X-20 20 watt P.W.M. amplifier Kit £7.19.6. Fully built	£9 19 6
STEREO 25 pre-amp control unit fully built	£9 19 6
THE Z-12 12 watt amplifier and pre-amplifier. Fully built and tested	£4 9 6
PZ-3 power pack for Z-12	£3 19 6

VEROBOARD — High grade laminated board with copper strips bonded to it and pierced with holes.

Boards			Accessories	
42/1503	2½ × 5 in.	3/11	Terminal pins — pkt. of 50	3/-
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44/1505	3¾ × 17 in.	15/6	Orders of 10/- and over post free.	

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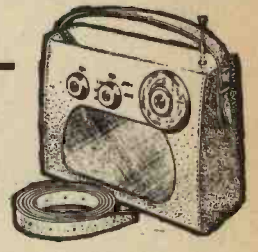
FIRST FOR PERFORMANCE, QUALITY AND PRICE!

BACKED BY OUR SUPER AFTER SALES SERVICE

"A wonderful range of transistor radios using first grade components for guaranteed results"



NEW ROAMER SEVEN Mk IV

7 WAVEBAND PORTABLE OR CAR RADIO

Amazing performance and specification ★ *Now with PHILCO MICRO-ALLOY R.F. TRANSISTORS*

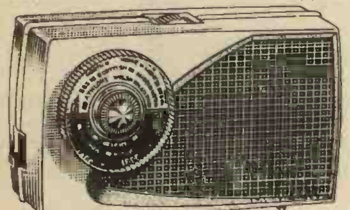
FULLY TUNABLE ON ALL WAVEBANDS ● 9 stages—7 transistors and 2 diodes

Covers Medium and Long Waves, Trawler Band and three Short Waves to approx. 15 metres. Push-pull output for room filling volume from rich toned 7" × 4" speaker. Air spaced ganged tuning condenser. Ferrite rod aerial for M & L Waves and telescopic aerial for S Waves. Real leather-look case with gilt trim and shoulder and hand straps. Size 9" × 7" × 4" approx. The perfect portable and the ideal car radio. (Uses PP7 batteries available anywhere.)

★ **EXTRA BAND FOR EASIER TUNING OF LUXEMBOURG, etc.**

Total cost of parts now only **£5.19.6** P. & P. 5/6

Parts Price List and easy build plans 3/- (Free with kit)



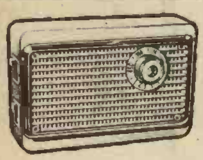
NEW MELODY MAKER SIX

3 WAVEBAND PORTABLE. ● 8 stages. Six transistors and two diodes.

Covers Medium and Long Waves and extra Band for easier tuning of Luxembourg, etc. Top quality 3" Loudspeaker for quality output. Two RF stages for extra boost. High 'Q' 6" Ferrite Rod Aerial. Approx. 350 Milliwatts push pull output. Handsome pocket size case with gilt fittings. Size 6½ × 3¾ × 1½ in. (Uses long-life PP6 battery). Carrying strap 1/6 extra.

This amazing receiver may be built for only **£3.9.6** P. & P. 3/6

Parts Price List and easy build plans 2/-. (Free with kit)



NEW TRANSONA FIVE

"Home, Light, A.F.N. Lux. all at good volume" G.P., *Durham*

● 7 stages—5 transistors and 2 diodes

Fully tunable over Medium and Long Waves and Trawler Band. Incorporates Ferrite rod aerial, tuning condenser, volume control, new type fine tone super dynamic 2¾ in. speaker, etc. Attractive case. Size 6½ × 4½ × 1½in. with red speaker grille. (Uses 1289 battery available anywhere.)

Total cost of all parts now only **42/6** P. & P. 3/6

Parts Price List and easy build plans 2/- (Free with kit)

POCKET FIVE

● 7 stages—5 transistors and 2 diodes.

Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and fine tone 2¾in. moving coil speaker, built into attractive black and gold case. Size 5½ × 1½ × 3¼in. (Uses 1289 battery, available anywhere.)

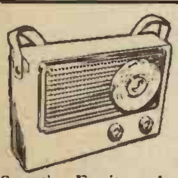
Total cost of all parts now only **42/6** P. & P. 3/6

Parts Price List and easy build plans 1/6 (FREE with Kit)

STOP PRESS!

Pocket 5 Med and Long wave version with miniature speaker

29/6 P. & P. 3/-



NEW ROAMER SIX

NOW WITH PHILCO MICRO-ALLOY R.F. TRANSISTORS

● **6 WAVEBAND!!**

● 8 stages—6 transistors and 2 diodes

Listen to stations half a world away with this 6 waveband portable. Tunable on Medium and Long Waves, Trawler Band and two Short Waves. Sensitive Ferrite rod aerial and telescopic aerial for short waves. Top grade transistors. 3-inch speaker, handsome case with gilt fittings. Size 7¼ × 5½ × 1½in. (Carrying Strap 1/6 extra.)

★ **EXTRA BAND FOR EASIER TUNING OF LUX, ETC.**

Total cost of all parts now only **£3.19.6** P. & P. 3/6

Parts Price List and easy build plans 2/- (Free with kit)

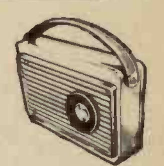
TRANSONA SIX

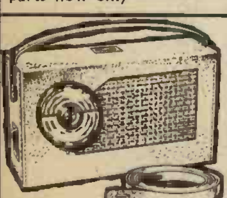
● 8 stages—6 transistors and 2 diodes

This is a top performance receiver covering full Medium and Long Waves and Trawler Band. High-grade 3in. speaker makes listening a pleasure. Push-pull output. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6½ × 4½ × 1½in. (Uses PP4 battery available anywhere.) Carrying Strap 1/- extra.

Total cost of all parts now only **59/6** P. & P 3/6

Parts Price List and easy build plans 1/6 (Free with kit)





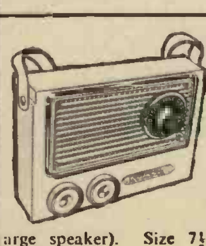
MELODY SIX

● 8 stages—6 transistors and 2 diodes

Our latest completely portable transistor radio covering Medium and Long Waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. Ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208 and many Continental stations. Handsome leather-look pocket size case, only 6¼ × 3¼ × 1⅞in. approx. with gilt speaker grille and supplied with hand and shoulder straps.

Total cost of all parts now only **£3.9.6** P. & P. 3/6

Parts Price List and easy build plans 2/- (Free with kit)



SUPER SEVEN

● 9 stages—7 transistors and 2 diodes

Covers Medium and Long Waves and Trawler Band. The ideal radio for home, car, or can be fitted with carrying strap for outdoor use. Completely portable—has built-in Ferrite rod aerial for wonderful reception. Special circuit incorporating 2 RF Stages, push-pull output. 3in. speaker (will drive large speaker). Size 7¼ × 5½ × 1½in. (Uses 9v battery, available anywhere.)

Total cost of all parts now only **£3.19.6** P. & P. 3/6

Parts Price List and easy build plans 2/- (Free with kit)

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RADIO EXCHANGE Ltd

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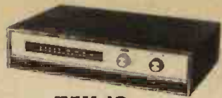
61a HIGH STREET, BEDFORD. Phone: 52367

HI-FI AMPLIFIERS —— TUNERS —— RECORD PLAYERS

FM TUNERS FM-4U



TFM-IS

HI-FI FM TUNER. Model FM-4U. Available in two units. R.F. tuning unit (£2.15.0 incl. P.T.) with I.F. output of 10·7 Mc/s and I.F. amplifier unit, with power supply and valves (£13.13.0). Total Price Kit **£16.8.0**

HI-FI AM/FM TUNER. Model AFM-1. Available in two units which, for your convenience, are sold separately. Tuning heart (AFM-T1—£4.13.6 incl. P.T.) and I.F. amplifier (AFM-A1—£22.11.6). Printed circuit board, 8 valves. Covers L.W., M.W., S.W., and F.M. Built-in power supply. Total Price Kit **£27.5.0** STEREO DECODER available, please see below.

Hear the BBC stereo FM programmes on the TRANSISTOR STEREO FM TUNER. Elegantly designed to match the stereo Amplifier, AA-22U. Available in two units, sold separately, can be built for a Total Price:
Kit (STEREO) **£24.18.0** incl. P.T.
Kit (MONO) **£20.19.0** incl. P.T.

10W POWER AMP. MA-12

9 + 9W STEREO AMP. S-99

HI-FI MONO AMPLIFIER. Model MA-12. 10W output, wide freq. range, low distortion. Use with control unit.
Kit **£12.18.0** Assembled **£16.18.0**

3 + 3W STEREO AMPLIFIER. Model S-33. An easy-to-build, low cost unit. 2 inputs per channel. Kit **£13.7.6** Assembled **£18.18.0**

DE LUXE STEREO AMPLIFIER. Model S-33H. De luxe version of the S-33 with two-tone grey perspex panel, and high sensitivity necessary to accept the Decca Deram pick-up. Kit **£15.17.6** Assembled **£21.7.6**

HI-FI STEREO AMPLIFIER. Model S-99. 9+9W output. Ganged controls. Stereo/Mono gram, radio and tape inputs. Push-button selection. Printed circuit construction. Kit **£28.9.6** Assembled **£38.9.6**

TRANSISTOR MIXER. Model TM-1. A must for the tape enthusiast. Four channels. Battery operated. Similar styling to Model AA-22U Amplifier. Kit **£11.16.6** Assembled **£16.17.6**

Heathkit DAYSTROM

Make the most of your leisure time . .

Here's the STEREO DECODER you have been looking for

Add Stereo RADIO to your listening pleasure at low cost. **FM DECODER SD-1.** This model will convert Heathkit valve (Mono) FM and AM/FM tuners to stereo. It can also be used with most other makes of FM tuner having facilities for multiplex output. Own buit-in power supply. Compact, 3¼″ x 3¼″ x 9″ deep. **Kit £8.10.0. Assembled £12.5.0.** Send for full specification details.

TRANSISTOR RECEIVERS

Oxford

UXR-1

GC-1U

"OXFORD" LUXURY PORTABLE Model UXR-2. Specially designed for use as a domestic or personal portable receiver. Many features, including solid leather case. Kit **£14.18.0** incl. P.T.

TRANSISTOR PORTABLE. Model UXR-1. Pre-aligned I.F. transformers, printed circuit. Covers L.W. and M.W. Has 7″ 4″ loudspeaker. Real hide case. Kit **£12.11.0** incl. P.T.

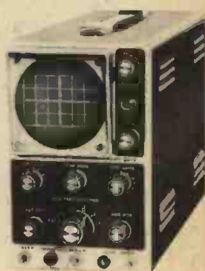
JUNIOR EXPERIMENTAL WORKSHOP. Model EW-1. More than a toy! Will make over 20 exciting electronic devices, incl.: Radios, Burglar Alarms, etc. 72 page Manual. The ideal present! Kit **£7.13.6** incl. P.T.

"MOHICAN" GENERAL COV. RECEIVER for Amateur or Short Wave listening. Send for leaflet.
Kit **£37.17.6** Assembled **£45.17.6**

WELCOME TO OUR LONDON HEATHKIT CENTRE
233 Tottenham Court Road, W.1
We open MONDAY-SATURDAY 9 a.m.-5.30 p.m.
THURSDAY ... ... 11 a.m.-2.30 p.m.
Telephone No.: MUSEUM 7349
WHEN YOU ARE IN TOWN, WE HOPE YOU WILL VISIT US THERE

TEST INSTRUMENTS

Our wide range includes:



OS-2

3″ LOW-PRICED SERVICE OSCILLOSCOPE. Model OS-2. Compact size 5″ × 7¾″ × 12″ deep. Wt. only 9¾lb. "Y" bandwidth 2 c/s–3 Mc/s ±3dB. Sensitivity 100mV/cm T/B 20 c/s–200 kc/s in four ranges, fitted mumetal CRT Shield. Modern functional styling.
Kit **£23.18.0** Assembled **£31.18.0**

5″ GEN.-PURPOSE OSCILLOSCOPE. Model 10-12U. An outstanding model with professional specification and styling. "Y" bandwidth 3 c/s–4·5 Mc/s ± 3dB. T/B 10 c/s–500 kc/s. Kit **£35.17.6** Assembled **£45.15.0**

VVM, IM-13U

DE LUXE LARGE-SCALE VALVE VOLTMETER. Model IM-13U. Circuit and specification based on the well-known model V-7A but with many worth-while refinements. 6″ Ernest Turner meter. Unique gimbal bracket allows operation of instrument in many positions. Modern styling.
Kit **£18.18.0** Assembled **£26.18.0**

V-7A

AUDIO SIGNAL GENERATOR. Model AG-9U. 10 c/s to 100 kc/s, switch selected. Distortion less than 0·1%, 10V sine wave output metered in volts and dB's.
Kit **£23.15.0** Assembled **£31.15.0**

VALVE VOLTMETER. Model V-7A. 7 voltage ranges d.c. volts to 1,500. A.C. to 1,500 r.m.s. and 4,000 peak to peak. Resistance 0·1 Ω to 1,000M Ω with internal battery. D.C. input resistance 11M Ω. dB measurement, has centre-zero scale. Complete with test prods, leads and standardising battery.
Kit **£13.18.6** Assembled **£19.18.6.**

RF-1U

MULTIMETER. Model MM-1U. Ranges 0–1·5V to 1,500V a.c. and d.c.; 150μA to 15A d.c.; 0·2 Ω to 20M Ω 4½″ 50μA meter. Kit **£12.18.0** Assembled **£18.11.6**

R.F. SIGNAL GENERATOR. Model RF-1U. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics. Up to 100mV output.
Kit **£13.18.0** Assembled **£20.8.0**

IG-82U

SINE/SQUARE GENERATOR. Model IG-82U. Freq. range 20 c/s–1 Mc/s in 5 bands less than 0·5% sine wave dist. less than 0·15μ sec. sq. wave rise time.
Kit **£25.15.0** Assembled **£37.15.0**

TRANSISTOR POWER SUPPLY. Model IP-20U. Up to 50V, 1·5A output. Ideal for Laboratory use. Compact size.
Kit **£35.8.0** Assembled **£47.8.0**

Prices and specifications subject to change without notice

TAPE AMPLIFIERS — TAPE DECKS — CONTROL UNITS

20 + 20W STEREO AMP. AA-22U

GARRARD PLAYER AT-60

20+20W TRANSISTOR STEREO AMPLIFIER. Model AA-22U. Outstanding performance and appearance. Kit **£39.10.0** (less cabinet). Attractive walnut veneered cabinet £2.5.0 extra. Assembled incl. cabinet, **£59.15.0**

GARRARD AUTO/RECORD PLAYER. Model AT-60, less cartridge **£13.1.7.** With Decca Deram pick-up **£17.16.1** incl. P.T.

Many other Garrard models available, ask for Lists.

HI-FI MONO AMPLIFIER. Model MA-5. A general purpose 5W Amplifier, with inputs for Gram., Radio. Modern functional appearance. Kit **£11.9.6** Assembled **£15.15.0**

WIDE RANGE OF HI-FI CABINETS, send for details. For example:
MALVERN Kit £18.1.0 incl. P.T.

TRUVOX DECK

AM/FM TUNER

TRUVOX D-93 TAPE DECKS. High quality stereo/mono tape decks. **D93/2,** ½ track, **£36.15.0** **D93/4,** ¼ track, **£36.15.0**

TRANSISTOR INTERCOM. Models XI-1U and XIR-1U. A time-saving device for office, shop or for the home. Master unit XI-1U will operate up to 5 remote stations. Master, XI-1U Kit **£11.9.6** Assembled **£17.9.6.** Remote, XIR-1U Kit **£4.9.6** Assembled **£5.18.0.** Send for full specification leaflet.

MONO CONTROL UNIT. Model UMC-1. Designed to work with the MA-12 or similar amplifier requiring 0·25V or less for full output. 5 inputs. Baxandall type controls. Kit **£9.2.6** Assembled **£14.2.6**

STEREO CONTROL UNIT. Model USC-1. Push-button selection, accurately matched ganged controls to ±1dB. Rumble and variable low pass filters. Printed circuit boards. Kit **£19.19.0** Assembled **£27.5.0**

Enjoy building a Heathkit model

Heathkit DAYSTROM

SPEAKER SYSTEMS

SSU-1

Berkeley

HI-FI SPEAKER SYSTEM. Model SSU-1. Ducted-port bass reflex cabinet "in the white". Two speakers. Vertical horizontal models with legs, Kit **£12.12.0,** without legs, Kit **£11.17.6** incl. P.T.

The BERKELEY SLIM-LINE SPEAKER SYSTEM, fully finished walnut veneered cabinet for faster construction. Special 12" bass unit and 4" mid/high frequency unit. Range 30-17,000 c/s. Size 26" × 17" only 7½" deep. Modern attractive styling. Excellent value. Kit **£19.10.0** Assembled **£24.0.0**

COTSWOLD SPEAKER SYSTEMS. Outstanding performance for price.
MFS: Size 36" × 16½" × 14" deep.
Kit **£25.12.0** Assembled **£33.17.0**

STANDARD: Size 26" × 23" × 14½" deep.
Kit **£25.12.0** Assembled **£33.17.0**

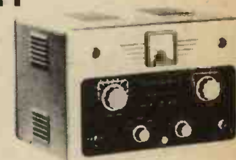
Complete your motoring pleasure with this outstanding car radio. Model CR-1.

Will give you superb LW and MW entertainment wherever you drive. Tastefully styled to harmonise with any car colour scheme. Available for your convenience in two parts. Can be built for a total price Kit (excl. L.S.) **£12.17.0** incl. P.T. Hi-Fi Loudspeaker **£1.8.6** extra. Send for full details.

SEND FOR THE LATEST FREE CATALOGUE

"AMATEUR" EQUIPMENT

80-10m TRANSMITTER, DX-40U. Power inputs 75W. C.W., 60W peak CC phone. Output 40W to aerial. Provision for VFO.
Kit **£29.19.0** Assembled **£41.8.0**



DX-40U

SSB ADAPTOR, SB-10U
Kit **£39.5.0** Assembled **£45.18.0**

AMATEUR BANDS RECEIVER. Model RA-1. To cover all the Amateur Bands from 160-10 metres. Many special features, including: half-lattice crystal filter; 8 valves; signal strength "S" meter; tuned R.F. Amp. stage.
Kit **£39.6.6** Assembled **£52.10.0**

RA-1

160-10M TRANSMITTER. Model DX-100U. Careful design has achieved high performance and stability. Completely self-contained.
Kit **£81.10.0** Assembled **£106.15.0**

COMMUNICATIONS TYPE RECEIVER. Model RG-1. A high performance, low cost receiver for the discriminating listener. Frequency coverage: 600 kc/s–1·5 Mc/s and 1·7 Mc/s–32 Mc/s.
Kit **£39.16.0** Assembled **£53.0.0**

REFLECTED POWER METER and SWR BRIDGE. Model HM-11U. Indicates reliability, but inexpensively, whether the RF power output of your TX is being transferred efficiently to radiating antenna. Kit **£8.10.0** Assembled **£10.15.0**

HM-11U

LOW COST ANALOGUE COMPUTER, EC-1U

Excellent for training engineering, physics and maths students in the principles and applications of analogue computers. 9 d.c. operational amplifiers in one compact unit. **Kit £97.8.0. Assembled £122.0.0.** Full specification sheet available.

Deferred terms available in U.K. over £10.

Prices quoted are Mail Order Prices

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FULL DETAILS OF MODEL(S)............................ ☐
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Please send FREE catalogue to my friend..
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R&A

The 700 Mark V Range

Specially designed to provide outstanding range, smoothness and uniformity of frequency response with freedom from self generated forms of distortion up to levels more than adequate for domestic listening. The speakers in this range all have a highly developed dual radiating system with optimum termination of both cones — voice coil impedence 15 ohms.

Power handling capacity in appropriate enclosures:—

780 Mk. V — **Price £3 . 19 . 7**
8 in. 6 watts r.m.s. 12 watts peak. (inc. 11/7 P.T. and P. & P.)

7100 Mk. V — **Price £4 . 14 . 3**
10 in. 8 watts r.m.s. 15 watts peak. (inc. 13/9 P.T. and P. & P.)

7120 Mk. V — **Price £4 . 18 . 6**
12 in. 10 watts r.m.s. 18 watts peak. (No P.T. but inc. P. & P.)

R&A

Send for full technical data sheet with suggestions for enclosures to:

REPRODUCERS AND AMPLIFIERS LTD.
Frederick Street, Wolverhampton England

LOUD SPEAKER MANUFACTURERS TO THE RADIO INDUSTRY SINCE 1930

Harmony in the home

RECORD HOUSING

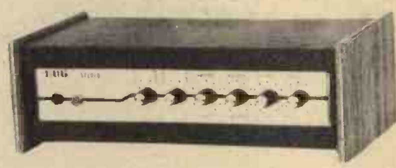
Does your hi-fi cause disharmony in the home? Does it clutter up the room? Does it irritate your wife? Why not bring harmony into the home with Record Housing? Our Scan Equipment Cabinet (£8.8.0) with matching Loudspeaker Enclosure (£8.8.0) and Storage Units (£6.17.6) will blend harmoniously into any setting.

Whatever your set-up there's a Record Housing cabinet to meet your needs. Amplifiers, tuners, turntables, loudspeakers, records, tapes, tape decks, — and even a complete tape recorder—you name it — we'll house it! Send for fully illustrated catalogue describing over twenty different cabinets and U.K. stockists' List.

FREE HI-FI HOUSING ADVISORY SERVICE

RECORD HOUSING (Dept. P.E.2)
Brook Road, London, N.22. *Tel.:* **BOWes Park 7487**

VIKING STEREO 4 + 4 HIGH QUALITY AMPLIFIER



A high quality stereo amplifier, built to meet the requirements of budget Hi-Fi. Elegant styled cabinet in black rexine and woodgrained ends. Brushed aluminium panel, black and silver knobs. Quality components throughout. Ganged Bass and Treble controls, separate volume controls for each channel. Valves (Standard Model) 2 × ECL86 (De-Luxe Model) 1 × ECC83 (2) × ECL86. Output 3 ohms matching, suitable A.C. mains 230-240 volt. Cabinet size, 16¾in. wide, 5¼in. high, 8¼in. depth. Full instructions and guarantee. Send for leaflet.

STANDARD MODEL (amplifier only) .... £11.11.0 plus 12/6 P. & P. and Ins.
DE-LUXE MODEL (amplifier only) ..... £12.12.0 plus 12/6 P. & P. and Ins.
CABINET extra if required £1. 5.0
CABINET separately .... £1.15.0 plus 7/6 P. & P. and Ins

VIKING 10-12. A twelve watt amplifier for use on 230-240 volt A.C. mains. Inputs suitable Microphone. Record Player, Tuner, Tape Recorder, etc. Printed circuitry. Five Mullard valves, reliable components. Front panel contains 2 Input Jacks, 2 Volume Controls, 1 Tone, Neon and On/Off switch. Designed to fit into same type and size cabinet as Stereo. Fully guaranteed. Send for leaflet.
Price (amplifier less case) £7.19.6 plus 12/6 P. & P. and Ins.

VIKING X.P.15. A frustrated order offered at a fraction of cost (original price 39 gns.). 15 watts output. Suitable for 210-240 Volt A.C. mains. Attractive Black chassis with slotted Chromed steel top cover, size 15 × 7½ × 7in. 4 Input Jacks, 2 volume controls, 2 tone. 5 Mullard valves. Fully guaranteed. Send for leaflet.
Price Complete £12.19.6 plus 12/6 P. & P. and Ins.

Famous **VIKING P.A. BASS AMPLIFIERS**, 15, 30, 40, 60 and 100 watts. *Send for leaflet.*

SPEAKER-ENCLOSURES — SPEAKERS — MICROPHONES — RECORD PLAYERS and TAPE DECKS. *Send for leaflets.*

Terms: C.W.O., C.O.D. Money back guarantee.

VIKING (ELECTRONICS) LTD. 37 HILLSIDE STONEBRIDGE LONDON, N.W.10
Telephone: ELG 3644

STUPENDOUS OFFER

£11 FOR £2

Only recently sold for £10.19.6. Note these features: Long and Medium Wave. Long dial. Push pull output. A.V.C. and feed back. Ferrite aerial. Six transistors. Cabinet size 4⅞in. × 3in. × 1½in. with carrying strap. You get everything you need and instructions. 39/6 plus 3/6 p. & p. Battery 1/9 extra. Data separately 2/6.

PP3 ELIMINATOR

Play your pocket radio from the mains! Save £'s. Complete component kit comprises 4 rectifiers, mains dropper resistances, smoothing condenser and instructions. Only 6/6 plus 1/- post.

HI-FI SPEAKER BARGAIN

12in. High fidelity loudspeaker. High flux permanent magnet type with either 3 or 15 ohm speech coil. Will handle up to 10 watts. Brand new by famous maker. Price 29/6 with built-in tweeter 35/-, plus 3/6 post and insurance.

2½kW FAN HEATER

3 heat positions to suit changes in weather: 1kW, 1½kW and 2½kW; also blows cold for summer, has thermostatic safety cut out. "Proper" price £5.17.6 **Yours for only £3.15.0.** Plus 7/6 post and insurance.

MAINS TRANSFORMER. Upright mounting with primary tapped 200, 220, 240 v. H.T. secondary is 250-0-250 v. at 100 mA. and it has two L.T. secondaries of 6·3 v. 1½ amp.—unused (removed from equipment), 15/- plus 3/6 post and insurance.

"C" CORE POTTED OUTPUT TRANSFORMER. Made by the famous "Parmeko" company these are the best money can buy—we can offer a bargain 15 watt rating, centre tapped primary with secondary for 3 ohm speaker. Potted and in black stove enamelled case for upright mounting these will make your amplifier or rig look perfect at only 12/6 plus 3/6 carriage and insurance—hurry for these.

½in. MEG. POTS. By Erie, standard ¼in. spindle, 1in. long, 7d. each in doz. lots, otherwise 10d.

½in. MEG. POTS WITH D.P. SWITCH. Again by Erie. Standard size spindle 1in. length. 10d. each in doz. lots, otherwise 1/3 each.

MINIATURE PICK-UP. For pop records—this is made by Cosmocord—has a crystal cartridge and long play sapphire stylus—offered for less than the wholesale price of the stylus only—namely 3/9 each or 36/- doz.

MINIATURE RELAYS with removable covers. Very sensitive (will close on only 20 mA). Coil resistance 10,000 ohms—contacts are three sets; triple set for change over pair to open circuit and the third pair to close circuit—perfect order unused (removed from equipment). 7/6 each.

CAR CHARGER OUTFIT. 3/4 amp transformer and selenium full wave rectifier only 27/6 plus 3/6 post.

FLUORESCENT LIGHT KITS. Comprising choke, lampholders, starter and two chrome tube clips. 20 watt 19/6. 40 watt 11/6. 80 watt 17/6. 65 watt 19/6. All 4/6 post.

SEMI-CONDUCTOR BARGAINS

Type No.	Price	Type No.	Price	Type No.	Price
2N1727	15/-	MAT101	8/6	OC71	4/-
2N1728	10/-	MAT120	7/9	OC72	5/-
2N1742	25/-	MAT121	8/6	OC75	6/-
2N1747	25/-	OA5	5/-	OC76	5/-
2N1748	10/-	OA10	6/-	OC77	7/-
AC107	9/-	OA47	3/-	OC78	5/-
AC127	9/-	OA70	2/-	OC78D	5/-
ACY17	8/6	OA79	2/6	OC81	5/-
ACY18	5/6	OA81	2/6	OC81D	5/-
ACY19	6/6	OA85	3/-	OC82	5/-
ACY20	5/6	OA90	2/6	OC83	5/-
ACY21	6/-	OA91	2/6	OC84	6/-
ACY22	4/6	OA200	3/3	OC139	8/6
AF114	7/-	OA202	4/3	OC140	12/6
AF115	6/6	OC22	10/-	OC170	5/-
AF116	7/-	OC23	17/6	OC171	6/-
AF117	5/-	OC24	22/6	OC200	9/-
AF118	12/6	OC26	7/6	OC201	12/6
AF139	17/6	OC28	15/-	OC202	13/6
AF186	19/6	OC29	17/6	OC203	12/6
AFZ12	15/-	OC35	12/6	OCP71	19/6
ASZ21	15/-	OC36	15/-	ORP12	8/6
BC107	14/6	OC42	6/6	ORP60	5/-
BY100	5/6	OC44	5/-	SB078	6/6
BYZ13	7/6	OC45	4/-	SB305	8/6
MAT100	7/9	OC70	4/-	SB251	10/-

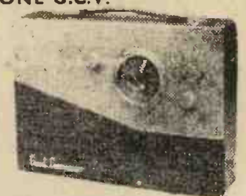
The above is a list of the more popular types in stock—we can also supply almost every semi-conductor made—please send 1/6 for comprehensive list and equivalent data.

HEAT & LIGHT UNIT

Bring luxury to your bathroom—have comforting heat where you now only have light—all the parts to build a full size (16" diameter) model are now available—you will build it in an hour—12" 750 watt circular silica glass encased element, opal bowl for up to 100 watt lamp—non-rust spun reflector, white enamelled base heat shield, pull switch. Magnificent unit as sold normally at £4.5.0 only 49/6 plus 7/6, post and insurance.

SUPERTONE G.C.V.

Saves you work—
It's partly built



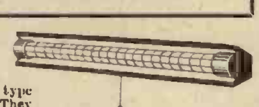
Like its predecessors this latest Companion has full fi performance—such as only a good wooden cabinet and biflux speaker can give, and due to its being partly built you will have it going in an evening. Note these features:

- All Mullard Transistors including 3 × AF117.
- Two-tone Cabinet, size 11 × 8 × 3in.
- All circuit requirements, Push-Pull output, A.V.C. and feedback, etc.
- Printed circuit board all wired only connections, e.g. to Volume control—W.C. Switch and Tuning Condenser.
- Pre-aligned IF stages complete with full instructions. Price only £3.19.6 plus 6/6 post and insurance.

THIS MONTH'S SNIP

This month's snip is the famous Garrard model 3000 complete with ceramic cartridge. The outstanding feature of this record player is its low mass arm which facilitates excellent tracking characteristics and reduces record wear to a minimum. Size 13 $\frac{5}{16}$" wide × 11¾" front to rear clearance 4 $\frac{5}{16}$" above and 2¾" below deck. Supplied complete with template if required and service sheet. Price £7.9.6 plus 7/6 carriage and insurance.

INFRA-RED HEATERS

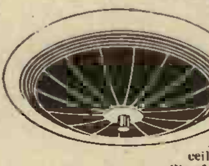


Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watts element, all parts, metal casing as illustrated, 21/6, plus 3/6 post and ins. Pull switch 3/- extra.

F.M. TUNER

of exceptional quality, giving really fantastic results with virtually no noise. Suitable for mains or battery operation. 6 transistors, three I.F. stages, double tuned discriminator. Complete, new and built up all ready to work on chassis. Size 6" × 4" × 2" with tuning scale and slow motion drive. A £12.12.0 tuner for only £8.10.0.

NOW INSTANT START CIRCULAR FLUORESCENT



Brings sunshine into your home. 150 watts of light but uses only 40 w. Beautiful fittings with glass, non-plastic centre, fluorescent tube and choke control. Made by Philips. Regular price £4.15.0. Special Bargain price 65/-, plus 8/6 c. and ins. Please state colour of glass centre, white, pink, blue, red, black, yellow or cream. Also whether plug into lamp holder or ceiling mounting model. 80 watt model 99/6. Plus 10/- carr. and ins.

3M SCOTCH TAPE

Brand new, unused and guaranteed perfect and not second in any way—a connoisseur's tape on normal spools.

Standard Play 5in.	600ft.	9/-	Long Play 5in.	900ft.	11/6
5¾in.	900ft.	11/6	5¾in.	1,200ft.	16/-
7in.	1,200ft.	16/-	7in.	1,800ft.	23/-

£3 post free, otherwise add 2/- post and insurance.

MAINS TRANSISTOR POWER PACK

designed to operate transistor sets and amplifiers. Adjustable output 6v.-9 to 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries, PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer-rectifier, smoothing and load resistor, 5,000 and 500 mfd. condensers, zener diode and instructions. Real snip at only 14/6, plus 3/6 post.

BATTERY CHARGER—FREE

9v. Nickel Cadmium Battery type PP3 (fits all popular pocket transistors). *Can be recharged 800 times.* Price with free battery charger, kit only 37/- p. & i. 3/-. Chargeable replacements also in stock for U7 12/6, U12 32/-.

SNIPERSCOPE

Famous war-time "cat's eye" used for seeing in the dark. This is an infra-red image converter cell with a silver caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. A golden opportunity for some interesting experiments. 5/- each, post 2/-. Date will be supplied with cells if requested.

FLUORESCENT SNIP

Your opportunity to instal non-flicker strip lighting at silly price—this month we offer the famous A.E.I. (Mazda) instant start lighting transformer suitable for one 4ft. 40 watt tube. This transformer is listed at over £7, but this month you can buy the complete kit comprising instant start choke/transformer, two tube ends and two Terry clips to hold tube. Special snip price only 14/6 plus 4/6 post and insurance—don't miss this tremendous bargain.

TUBULAR HEATERS

New and unused made by G.E.C.—rated at 60 watts per foot—these are ideal in airing cupboards, bedrooms, offices, stores, greenhouses, etc.—curtains or papers can touch them without fear of scorching or fire. Supplied complete with fixing brackets and available in the following sizes. Prices which are about quarter of list price includes carriage by B.R.S.

8ft. 30/-; 10ft. 36/-; 12ft. 42/-.

Also in twin assemblies (one pipe above the other): 4ft. 40/-; 5ft. 46/-; 6ft. 52/-.

THERMOSTATS

Type 'A' 15 amp. for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knob, quickly adjustable from 30°-80°F. 9/6 plus 1/- post. Suitable box for wall mounting, 5/-, P. & P. 1/-.

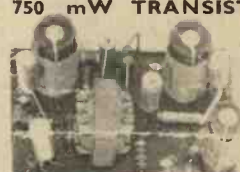
Type 'B' 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal screw alters the setting so this could be adjustable over 30° to 1,000°F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flamestat or fire alarm, 8/6 plus 2/9 post and insurance.

Type 'D'. We call this the Ice-stat as it cuts in and out at around freezing point. 2/3 amps. Has many uses, one of which would be to keep the loft pipes from freezing if a length of our blanket wire (16 yds. 10/-) is wound round the pipes. 7/6, P. & P. 1/1.

Type 'E'. This is a standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature, 7/6 plus 1/- P. & P.

Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50°F to 150°F. Price 18/- plus 2/- post and ins.

750 mW TRANSISTOR AMP.



4 transistors including two in push-pull input for crystal or magnetic microphone or pick-up—feed back loops—sensitivity 5 mV.

PRICE 19/6
Post and ins. 2/6.

Speakers 3in. 12/6; 5in. 13/6; 6in. × 4in. 14/6.

PHOTO ELECTRIC KIT

All parts to make light operated switch/burglar alarm/counter, etc. Kit comprises printed circuit, Laminated Boards and chemicals, Latching relay, Infra-red sensitive Photocell and Hood, 2 Transistors, cond., Terminal block. Plastic case. Essential data circuits and P.C. chassis plans of 10 photo electric devices including auto. car parking light, modulated light alarm. Simple invisible ray switch—counter—stray light alarm—warbling tone electronic alarm—projector lamp stabiliser, etc., etc. Only 39/6 plus 2/- post and insurance.

MULTI PURPOSE NEON TEST UNIT

Robust, useful and instructive—test insulation capacity — continuity — resistor — volume controls —also acts as signal injector and L.T. fault finder—kit comprises neon indicator, 4 way wafer switch, ebonite tubes, resistors, condensers, terminals, etc., with diag. only 9/6 plus 2/- post and insurance.

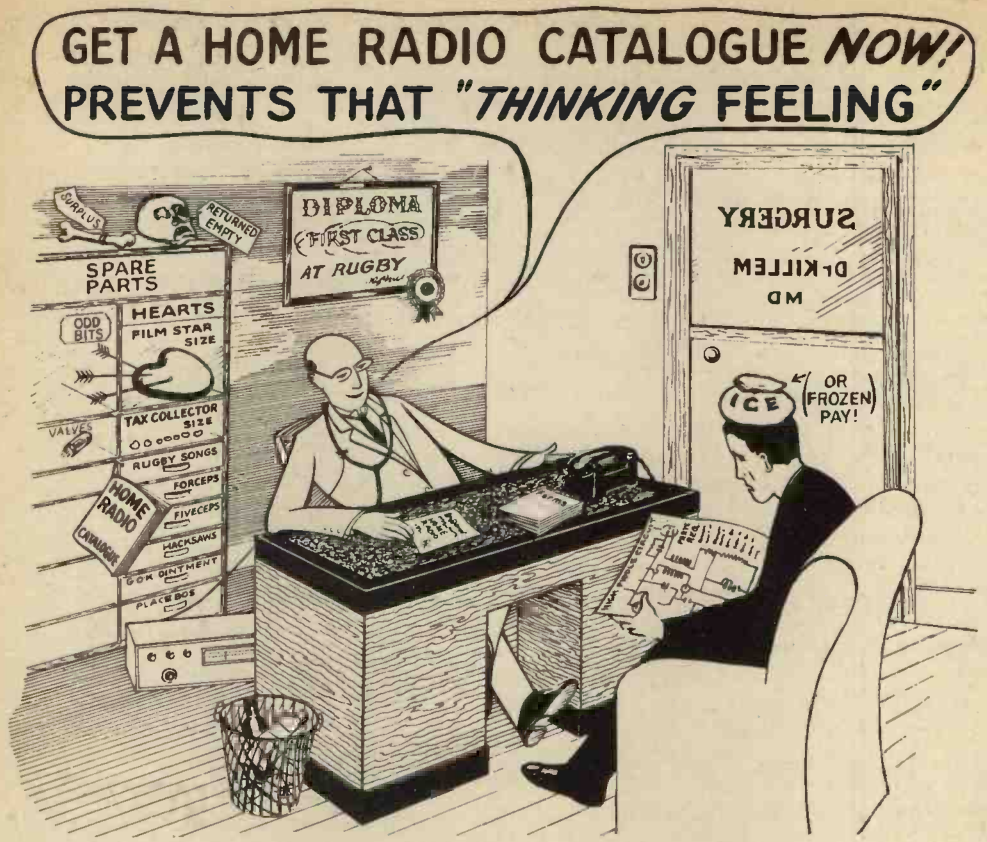
Where postage is not definitely stated as an extra then orders over £3 are post free. Below £3 add 2/9.

ELECTRONICS (CROYDON) LIMITED

(Dept. PE), 102/3 TAMWORTH ROAD, CROYDON, SURREY *(Opp. W. Croydon Stn)*

also at 266 LONDON ROAD, CROYDON, SURREY

HOME RADIO LTD., Dept. PE, 187 London Road, Mitcham, Surrey CR4 2YQ *Phone: MIT 3282*



Dr. Killem (smiles encouragingly) "Now then Mr. Sparks, what seems to be the trouble?"

Patient "I get these awful headaches doc!"

Dr. Killem "Oh yes! Well now let me see — have you a hobby?"

Patient "Yes . . . ham radio."

Dr. Killem "Does it give you any worries?"

Patient "Well, yes and no . . . as far as the actual construction goes NO —but where to get hold of all the components I need . . . YES."

Dr. Killem "Oh I see, this is obviously another case of catalogue starvation. Now just send this prescription along to Home Radio of Mitcham, and they'll soon get you perfectly in tune." (Exit patient jubilant).

The Prescription: Take one Home Radio Catalogue Annually.

Are you tired, listless, dispirited, headachy and unable to get all your components easily and quickly? Then follow Dr. K's advice and send today for the Home Radio Catalogue. (We regret it cannot be obtained on the National Health.) All the same you do get 218 pages, 6,000 items, 1,000 illustrations for 7/6 plus 1/6 P.& P. Every catalogue contains 5 vouchers each worth 1/- if used as directed, which makes it wonderful value. For a quick cure send the coupon today, enclosing your cheque or P.O. for 9/-.

Please write your Name and Address in block capitals

Name..

Address..

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Home Radio Ltd., Dept. PE, 187 London Road, Mitcham, Surrey

VOL. 3 No. 2
FEBRUARY 1967

PRACTICAL ELECTRONICS

CAREERS IN ENGINEERING

It may at first seem out of place for a hobby magazine to concern itself with the subject of careers. A hobby after all is supposed to be an activity pursued for pleasure and quite apart from one's normal occupation. It is also usually, but not necessarily, distinct in character from the daily job of work.

Since a considerable number of our readers are still at school, and since an even larger number are undoubtedly parents, we feel there are certain good reasons for focusing attention here on the opportunities that exist for a career in electronics.

Every day advertisements for electronic engineers in the National Press make abundantly clear the fact that demand exceeds supply. But if the shortage of qualified engineers is serious today how much more acute will this become in the vital years ahead as the horizons of technology—especially electronics—broaden out still further?

Now, at last, a determined effort has been made to contact those youngsters who will soon be making decisions concerning their future. The staging of the Engineers' Day Exhibition at the Science Museum in London during the last Christmas holiday period was an excellent idea. If attendance is any criterion, its success would seem assured.

This exhibition sponsored by the Ministry of Technology contained exhibits by some 20 national industries and Government departments. The school boy (and school girl) visitors for whom it was primarily intended had the opportunity of learning something about the day to day activities of the engineer—often from first hand as well as from the visual displays.

The electronics-minded found an amazing variety of doors open to them. They will be able to practice their skill or art in environments as diverse as medical research or coal mining; in rail transport or in the armed forces; or perhaps in the field of atomic and nuclear research or radio communications. When the vast variety of opportunities in the non-nationalised sector of our economy is also taken into account, the choice awaiting qualified engineers is truly staggering.

And finally, to those who may hesitate to mix business and pleasure, a word or two of reassurance: no need to fear that once one becomes a professional, the pleasures of amateur electronics will disappear. Electronics is a BIG subject, you know.

THIS MONTH

Our March issue will be published on Friday, February 17

All correspondence intended for the Editor should be addressed to: The Editor, PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Editorial and Advertisement Offices: PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: Temple Bar 4363. Telegrams: Newnes Rand London. Subscription Rates including postage for one year, to any part of the world, 36s.

STICK-ON WIRING

A RELATIVELY new proprietary brand of circuit wiring technique, which is versatile in experimental work, is now available to readers from Peak Sound (Harrow) Limited.

It has been given the name "Cir-kit" because it is quite a simple way of making a component layout match closely to its associated circuit diagram, therefore making checking, circuit reading, and fault location so much easier.

Cir-kit is generally obtained in sheet form and strip. The sheet can be cut to almost any required shape with a pair of scissors or metal shears. Curved, angular, and straight strips can be cut from the sheet. Both sheet and strip forms have an adhesive backing and protective paper. Hence the copper can be stuck to laminated plastics, cardboard, wood or similar insulating material.

It is possible to arrange crossed over-lapping strips, frequently seen on circuit diagrams, without short-circuit risks; not easily achieved with conventional printed circuit board without connecting link wires.

HOW TO USE

A series of photographs is shown here to illustrate how Cir-kit is actually applied to the s.r.b.p. board.

Cut one of the required lengths of copper strip (or cuttings from the sheet); stick down before proceeding to the next piece. Do not remove the paper backing until after cutting (1); maximum protection is still given to the adhesive until it is required to be stuck in position. No moistening of the adhesive is required.

It is not necessary to drill any holes until the whole layout is complete. This way the adhesive will have a better chance to settle. If a mistake is made the strip can still be lifted and adjusted without spoiling it or the board.

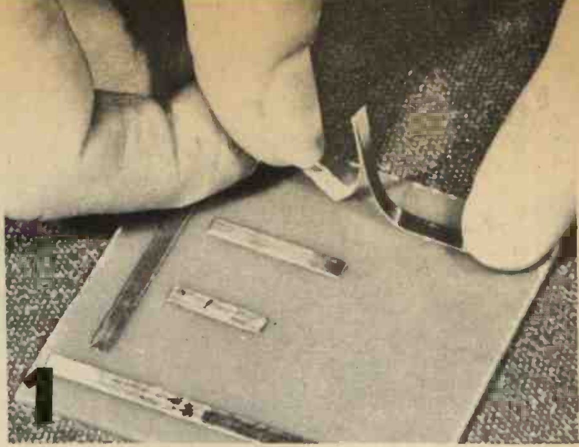
When satisfied that each piece is correctly laid, smooth down all the strips firmly, then mark the hole positions with a scriber on the copper (2).

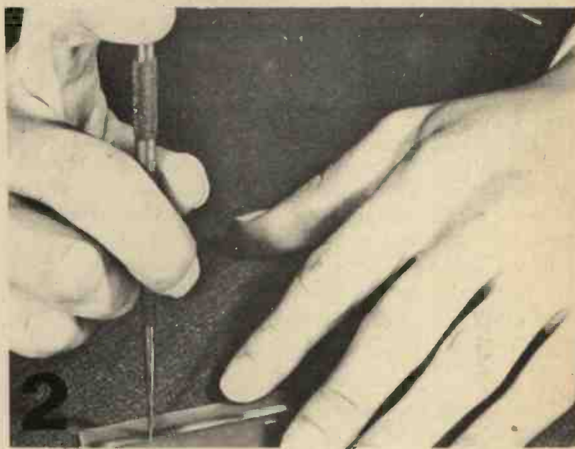
Use a small sharp drill (No. 60) to take the component wires (3). It is possible that a burr will form on the adhesive side of the copper during drilling and lift it slightly from the board. If this does happen, press down firmly again. Do not worry too much about this as the soldered wires will ultimately hold the copper quite firmly. The adhesive may become temporarily softened by heat and the copper again may lift slightly. Wait for it to cool and press down again firmly into position.

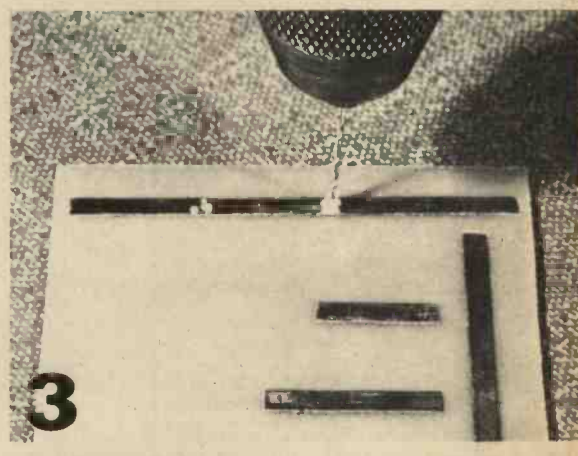
It is best to use the soldering iron in the same manner as with transistor leads, i.e. a hot iron applied quickly to avoid excessive overheating (4).

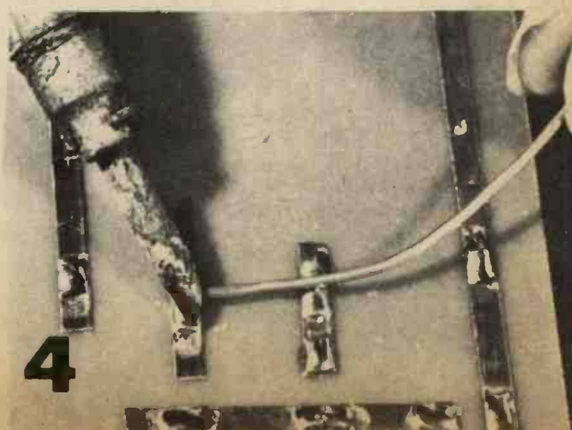
Crossovers can be effected by building up the circuit on both sides of the board or by placing one strip over another. The makers claim that the adhesive acts as an insulator, but to be quite sure it is better to leave the paper backing on where the top piece overlaps the underneath strip.

Where high component density is necessary the sheet material can be stuck on the laminate. Instead of etching the waste areas, cut them and peel them off, leaving a "printed circuit" appearance. ★



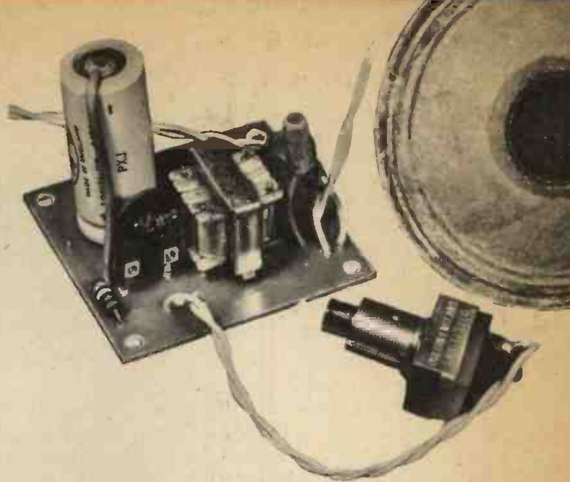






Versatile Blocking Oscillator

by G.M.HARVEY



FROM one simple basic circuit configuration three versions of a blocking oscillator can be built using Cir-kit stick-on wiring to provide a useful test signal injector, a morse practice oscillator, and an electronic siren.

BASIC CIRCUIT

The basic configuration is shown in Fig. 1. To this may be added a few components as described later to give the required function.

The heart of these three projects is an astable blocking oscillator; the transformer T1 provides regenerative feedback, by phase inversion, from the collector to the base of TR1. The pulse repetition frequency of this oscillator is a function of the product of the base resistor chain (R1, VR1, R2) and the capacitor C1 and, as such, a considerable degree of pitch variation is obtained through varying the potentiometer VR1.

The waveshape characteristics, in the process of blocking and relaxing, are ramp or sawtooth at the base and pulse at the collector with a negative pip on the trailing edge. See Fig. 2.

SIREN

In Fig. 3 is shown the siren circuit. Here, C2 is an electrolytic capacitor connected between the junction of R1 and VR1, and battery positive. The open primary terminal of T1 is connected via a small 3 ohm loudspeaker to battery negative. Switch S2 is used to disconnect the battery from the timing circuit. R1 and C2 in this configuration provide a time constant so that an increasing voltage to the base progressively raises the pitch of the note until charging is completed.

With the release of S1, capacitor C2 now replaces the battery and discharges through VR1, T1, R2, and the base/emitter diode of TR1 the whole action providing a slow pitch decay. The setting of VR1 will be a compromise between final pitch and decay rate and is therefore arbitrary. A possible application of this novelty would be to inject some realism into those toy electric motor car circuits that are proving so popular.

MORSE OSCILLATOR

In the morse practice oscillator (Fig. 4) C2 is omitted and C1 is changed to 100pF. This circuit runs at a frequency of about 1,000c/s with a range of pitch adjustment provided by VR1. S2 can be made a morse key to switch on the oscillatory action of the circuit.

SIGNAL INJECTOR

Finally, we come to the test signal injector which provides again an audio signal of about 1,000c/s. The

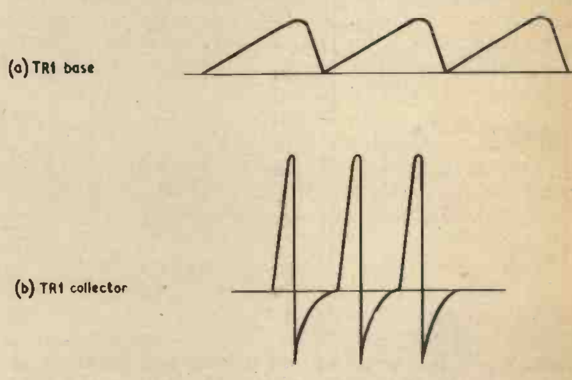


Fig. 2. Waveforms at base and collector of TR1

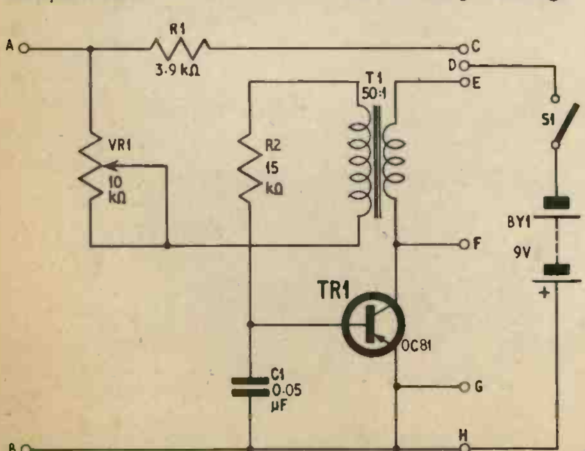


Fig. 1. Basic circuit to which must be added certain components as shown in Figs. 3, 4 and 5

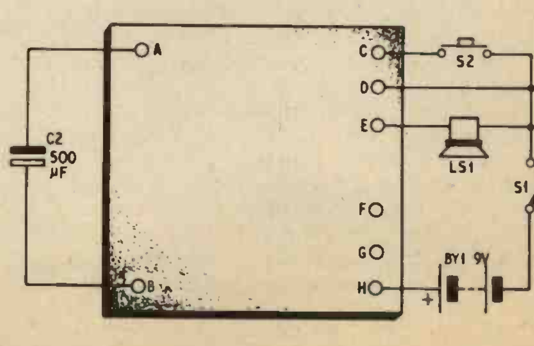


Fig. 3. Basic board plus components for making up the siren

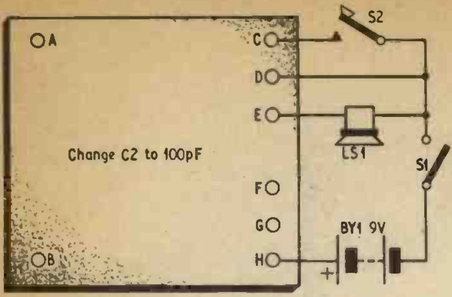
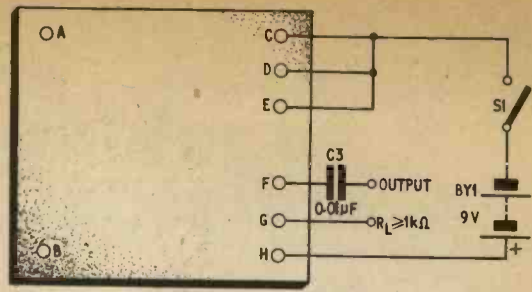


Fig. 4 (left). Morse oscillator set-up. S2 is a morse key

Fig. 5 (right). Signal injector. The output is taken from F and G, via C3



loudspeaker is shorted out, the output being taken via capacitor C3 from the collector. See Fig. 5.

The signal content is harmonically broad as the output pulse is sharp edged and of brief duration, a characteristic of the blocking oscillator, and as such could be used for fault finding in a.f. and r.f. stages.

When unloaded, the output voltage was 4 volts peak-to-peak with no substantial reduction at loads down to 1 kilohm. Below this value the output falls rapidly.

This demonstrates the excellent practicability of this injector as a valve and transistor circuit tester. To use it to test a radio or audio amplifier, a probe from C3 should be applied to the valve grid pin or transistor base. C3 should be rated at a high voltage (about 350V) to avoid accidental damage to TR1 from valve circuits. The test piece common line is connected to TR1 emitter.

The volume control of the unit under test should be turned to a maximum and signal injection should be applied to the output stage, then progressively to each preceding stage until the faulty or inoperative stage has been discovered; this of course becomes evident by the disappearance of the signal.

To check that this injector circuit is functioning, there should be an audible whistle coming from the transformer. If this is not working, the connections to one of the transformer windings should be reversed to correct the feedback phase.

CONSTRUCTION

Make up the basic circuit first as shown in Fig. 6 using the Cir-kit technique described on page 96. Then add the extra components required referring to the appropriate circuit diagram in Fig. 3, 4, or 5. ★

COMPONENTS . . .

Resistors
R1 3·9kΩ R2 15kΩ
Both 10% ½ watt carbon

Potentiometer
VR1 10kΩ linear carbon preset skeleton

Capacitors
C1 0·05μF disc ceramic 20V
or 100pF disc ceramic 20V (see text)
C2 500μF elect. 15V
C3 0·01μF ceramic 750V (Radiospares Hi-K)

Transformer
T1 50 : 1 "Miniature" output transformer (Radiospares)

Transistor
TR1 OC81 (Mullard)

Switches
S1 Single-pole on/off toggle
S2 Single-pole push button switch or Morse key (see text)

Miscellaneous
BY1 Battery 9V type PP9
LS1 3Ω 3in diameter loudspeaker (see text)
Cir-kit copper "wiring" kit (see page 96)
P.V.C. wire, tinned copper wire

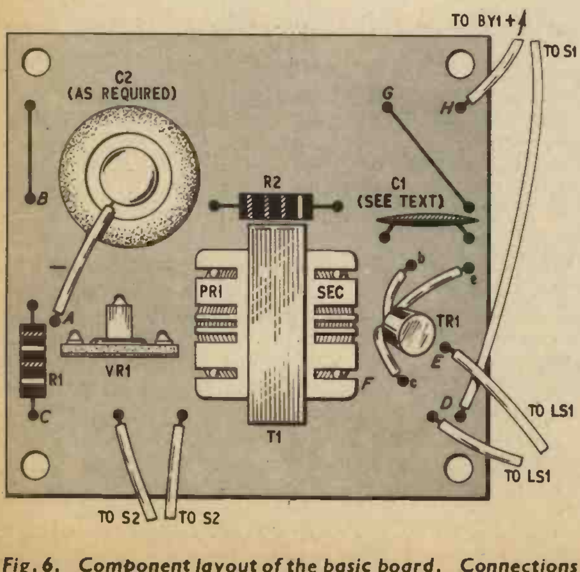


Fig. 6. Component layout of the basic board. Connections for C2, LS1, S1, S2 and BY1 as required are shown. C3 would be connected to F

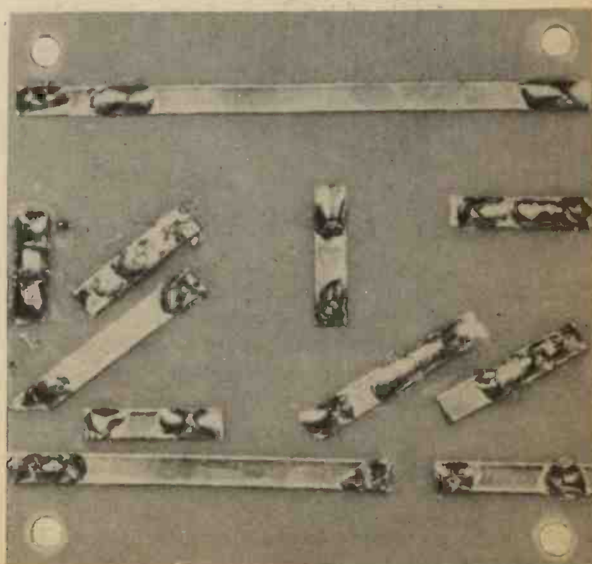


Fig. 7. Copper Cir-kit stuck on the underside and soldered

THE ELECTRONIC ORGAN

By ALAN DOUGLAS, Sen. Mem. I.E.E.E.

PART THREE

THE CONSOLE: MANUALS and PEDALBOARD

THE organ is the only keyboard instrument in which the feet are used to play notes as well as the hands. Therefore the feet cannot be used to help to balance the body. All organists know that some consoles are extremely comfortable to play, others never seem right. This is because the proportions of the different parts are not properly related.

GOOD CONSOLE DESIGN

Fig. 3.1 shows a section of a good three manual console design and you will notice several things. *Both* upper manuals are slightly inclined to the horizontal, the top one having a little more rake. The bottom one is parallel with the ground. All proper organ keys are the same size so far as the visible parts are concerned. But you can see that each manual overhangs the next to a definite extent and is also spaced away from its neighbour by a known amount. If an organ were to have four or five keyboards, some of these dimensions would change slightly, showing how critical it is to assure comfort.

One often sees statements claiming that a console is made to Royal College of Organist's (RCO) standards, but in fact there are no RCO standards except that an agreed design was reached for a pedalboard many years ago and we can certainly call this an RCO pedalboard. However there are many slight variants on this in existing pipe organs. The Incorporated Society of Organ Builders is now working on dimensions for a standard console.

It is obvious that, feet being larger than fingers, more space must be allowed between pedal keys than between manual keys. To prevent the reach for the furthest away keys becoming too great for comfort, these are inclined towards a point behind the centre of the bench. However, this would still make it uncomfortable if the keys were flat, as the knee would be bent up too much in the centre of the pedalboard. Therefore a position is found where middle D is comfortable, then each key to the left or right is progressively raised slightly so that, at the extreme ends, only a limited leg extension is required.

To relate these things, we go back to Fig. 3.1 and drop a plumb line from Mid D to the pedal key below. This should be D_{15}. The whole pedalboard is then moved fore or aft until the distances shown are reached. All

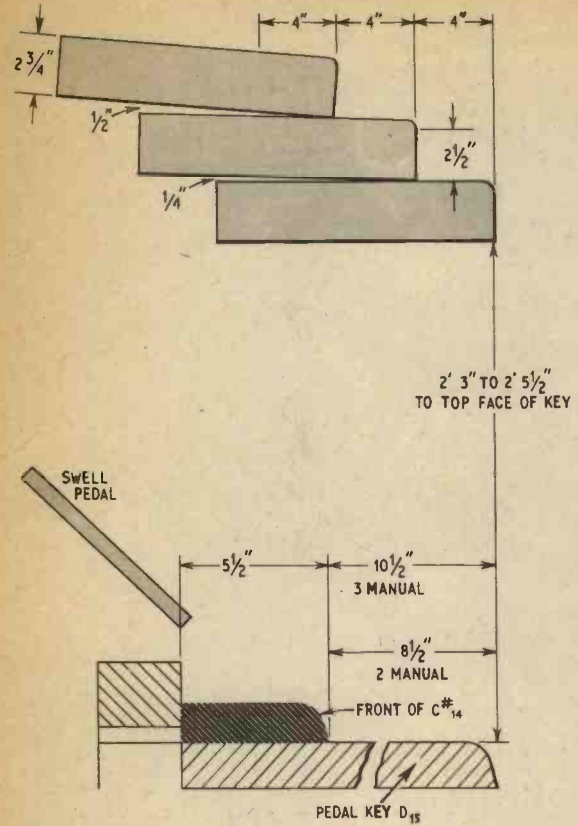


Fig. 3.1. This sectional drawing shows the critical dimensions in a three manual console

these measurements added together give an excellent playing balance, but of course there are shorter and taller people and they can generally accommodate themselves by means of an adjustable bench.

A great many small organs have short stub pedals of 13 notes compass and these include all the undesirable features of the flat pedalboard. No proper use can be made of published organ music with these elementary devices and this is indeed an example of spoiling the ship for a hap'orth of tar. But for the rhythmic fan they appear to be adequate.

CHURCH ORGAN DESIGNATIONS

Now, having assembled the parts which will control the organ, we begin to see the difference between the church and theatre approach. In our Fig. 3.1, we could call the manuals, from the top downwards: upper, middle, lower; or, swell, great, choir; or solo, main, accompaniment.

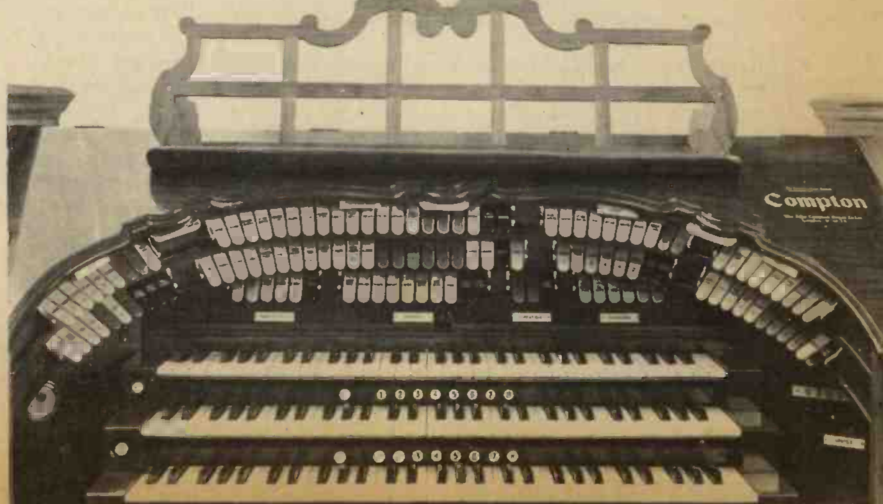
All these designations appear in the literature; why so? Well, the first example is certainly non-commital and quite logical; but it is little used. The second example can only refer to the church organ because these names have been so used for several hundred years. This is a good opportunity to explain these names. The swell manual is an expressive one, so called because the sound "swells out" when shutters regulating the volume of enclosed pipes associated with this manual *only* are operated. The middle keyboard, the great, was not always so called; but at all times it has been the main source of sound and to this end, no pipes on it are ever enclosed so none can be altered in volume. The lower keyboard is a later addition to the pipe organ and is called the choir because it contains a selection of quietly voiced stops to accompany singing (of a choir, not a full congregation). This manual is often enclosed, that is, has moveable shutters enclosing pipework to regulate the sound; but equally, it is often not enclosed.

You can see from the above that each keyboard is a complete organ, with its own independent pipes, though some of these can be interconnected by mechanical means.

THE MIGHTY WURLITZER

When we examine the last category, we find an entirely different conception of organ playing. When the late Robert Hope-Jones, with his usual prophetic imagination, saw that the silent film needed a new form of sound accompaniment, he met with a very chilly reception from the British organ builders—in spite of the fact that he was an accomplished organ builder and had many fine instruments to his credit, some of which are still in regular use. So he wasted no time but went to the Rudolph Wurlitzer company in New York, who welcomed him with open arms. This was the start of the "mighty Wurlitzer", the most successful and beautifully engineered of all theatre organs.

Now Hope-Jones started life as a telephone engineer, so he knew a great deal about relays and the idea of miles of wire did not daunt him at all. And this is the crux of the whole thing; the theatre pipe organ is an



The horseshoe type console of a modern Compton theatre organ electro-mechanical switching system capable of instantly connecting or cross-connecting almost any conceivable tonal arrangement by pressing buttons. Included in these tonal schemes were cymbals, drums, gongs, even full-sized pianos. Non-tonal adjuncts were train and boat whistles, sirens, motor horns, wind and wave noises, bird calls, rain, thunder and various other effects useful in the cinema. All had to work with precision, reliability and the correct loudness. Hope-Jones called this his "unit orchestra".

Therefore, whereas in a church organ each keyboard has its own pipes, Hope-Jones put his sets on unit chests, which merely means that anything which made contact with this chest could operate all the pipes thereon. So it was quite easy to make the chests "float", in other words, all the chests would appear on all manuals and pedal and be playable from all. So there was now no difference between the sounds possible on the various manuals, and they were called solo and accompaniment; the other manual (if used) being sometimes called "main", sometimes nothing at all.

So, with fully floating action there was no need for couplers except perhaps from manual to pedal, since this department alone had larger and more massive low pitched pipes which could not be played in chords.

COLOUR CODING FOR STOPS

Hope-Jones also at this time (55 years ago) introduced his colour-coding system for stops, which is still in use, and he also designed the large and comfortable stop key found on theatre consoles. This system uses white for flutes, tibias, and diapasons; red for reeds of all kinds; yellow or amber for string tones; black for non-tonal stops, e.g. tremulants, etc. Incidentally, why the name *stop?* Again, we go back nearly 400 years to find the "wooden shaft which, when pressed in, stopped the wind from entering that set of pipes".

The foregoing should help the reader to understand why the different parts of the organ are so named, and naturally with pipes we would expect a very different kind of sound from the two types; but with electronics, this is not so likely to be so, since only in the most elaborate and costly organs would we find separate generators for each rank, i.e. an exact correspondence with pipes. More than likely, we would find a worse state of affairs, where one set of generators has to be shared out amongst all the tonal requirements of the organ. So let us have a quick look at generating methods.

ELECTRONIC GENERATING METHODS

It is taken for granted that we are not interested in precision-made electro-mechanical systems and must concentrate on static electronic circuits. So, there are only two forms open to us; those having an *independently tuned oscillator for every note;* and those in which only the notes of the top octave are independently tuned, all other notes being obtained by *frequency division.* There is something to be said for both, and indeed organs by the most eminent makers use both systems.

All readers are aware that some organ voices are smooth and luscious; some are thin and keen; yet others are sonorous and reedy. Does this not suggest it is going to be rather hard to form all of these from one single kind of waveform, no matter what its shape? It is done, of course, but as a rule the circuitry is formidable and some restrictions are necessary. Or, alternatively, all the voices become degraded and lose fidelity. Then again, we have to be able to mix stops;

Modern Wurlitzer organ, fully transistorised

if all come from a common waveform there can be considerable losses.

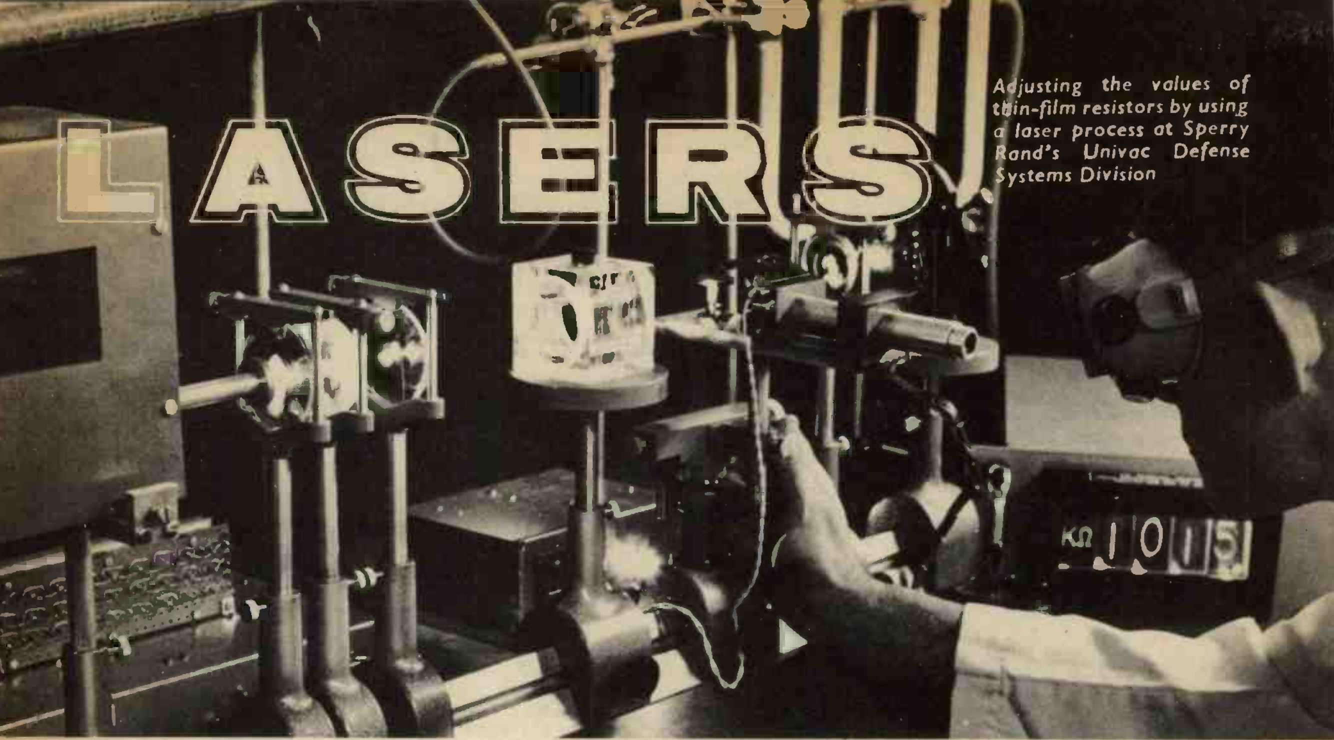
But these factors are not so important as the basic and inescapable fact that in a pipe organ—church or theatre—one does not hear all the sounds at the same instant and that, although perhaps in theory the harmonic content is equally regulated for each pipe in each stop, it is not so in fact and in any event the pipes do not stand in tune for more than a few hours. Thus we find innumerable small beats and phase differences which impart a great richness to the sound.

Now in a system having independently tuned oscillators we get just this, if these oscillators use inductances. Small differences in the iron/air ratio, stacking factor, grain orientation, etc. provide differences in harmonic amplitudes which can be used to great effect. Naturally these oscillators cannot be sinusoidal, but it is possible to retain a sinusoidal tank circuit, which is good for stability, and obtain some 40 harmonics elsewhere in the circuit. Of course, one could be very clever and use grain-oriented laminations or powdered iron cores; and at once these advantages disappear. There is an economic limit to the number of these so-called free-phase oscillators one can use, but we can profitably form the main core of the organ with this circuitry.

FREQUENCY DIVIDER SYSTEM

The divider arrangement is very economical in cost and space, but is phase-locked and limited to (usually) a square wave output. This would be available at many pitches, and since one must key the signal directly with constantly-running dividers, the problem of click suppression becomes very serious at high frequencies. A square wave of this kind is devoid of even harmonics, but we must have these for some voices so when we come to discuss this divider system for actual use, we will show how even harmonics can be introduced when required.

LASERS



Adjusting the values of thin-film resistors by using a laser process at Sperry Rand's Univac Defense Systems Division

PART 2

By J. B. Dance M.Sc.

RUBY LASERS

The ruby laser was the first type of laser to be developed; it first appeared about 1960. It provides an intermittent output in the form of light flashes of high intensity, whereas the output of the gas laser is continuous.

The ruby crystal itself used in this type of laser consists of aluminium oxide containing about 0·05 per cent of chromium oxide. The crystal is in the form of a cylindrical rod, perhaps 10cm in length by 1cm in diameter.

The two ends of the crystal are carefully polished and made parallel to each other before a reflective coating is deposited on them. The ruby crystal is placed at one of the foci of an elliptical mirror (see Fig. 5), a flash tube being placed at the other focus. The mirror is polished on its inner surface. Almost the whole of the light emitted by the flash tube is focused by the mirror onto the ruby crystal. Some ruby lasers employ simpler systems without an elliptical mirror.

The flash tube used is similar to the type of flash tube used in photography, but may be much more powerful. The energy emitted by the flash tube raises the energy level of many of the atoms in the ruby crystal, but almost immediately the excited atoms lose some of their energy to the crystal lattice, which is thus raised in temperature.

The atoms are left in an excited metastable state. Photons emitted by some of these atoms travel through the crystal and are amplified as they move by normal laser action. The amount of light builds up very quickly and escapes through one of the end mirrors.

The output flash from both the flash tube and from the ruby crystal has a duration of about one millisecond. The laser action stops when the number of atoms in the excited state is too small for photon amplification to continue.

The power output of a ruby laser can be very large. Power levels of over one megawatt can be obtained for a period of about one millisecond. If a suitable lens is used to focus this light, the energy is adequate to punch small holes through a steel plate of considerable thickness as shown in Fig. 6.

Such lasers can obviously cause severe burning of the skin and suitable precautions must be taken when they are being used. They are finding medical applications, especially in the treatment of detached retinas, but are also being used against certain types of cancer. It has been suggested that they might be used for drilling minute holes in teeth. They are not likely to be used for communications work, since their light output is intermittent.

The cost of a ruby laser varies with the power output which it is designed to provide. The ruby crystal used in a fairly small laser will cost about £100, but the price increases rapidly with increasing crystal size. The flash tube and its power supply are quite expensive items, whilst the elliptical mirror is not by any means cheap. Thus it seems unlikely that ruby lasers will be used by many amateurs.

The ruby laser is one example of a class of lasers known as doped crystal lasers. The crystal used in these types of laser contains impurity atoms dispersed in a crystal of another material. It is one of the inner orbits of the impurity atoms which give rise to the laser action. The electrons in these inner orbits are essentially isolated from the effects of the neighbouring atoms. Another example of a doped crystal laser is the neodymium doped glass type, but this can operate only in the infra-red region.

Q-SWITCHING

The ruby laser can provide a much higher power output than a gas laser, but a technique known as "*Q*-switching" can be used to increase the output power

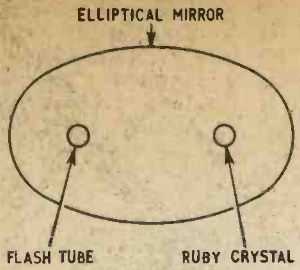


Fig. 5. Section through a ruby laser

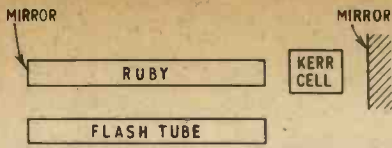


Fig. 7. A ruby laser with a Kerr Cell for Q-switching. The output beam is taken through one of the end mirrors which is only partially silvered. The elliptical mirror has been omitted for clarity

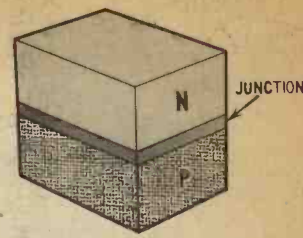


Fig. 8. A semiconductor laser

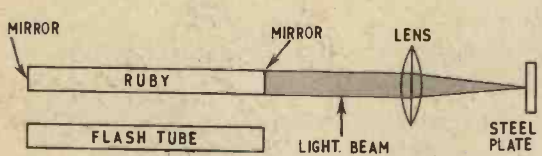


Fig. 6 (left). The use of a ruby laser to punch a hole through a steel plate. The elliptical mirror around the ruby crystal and the flash tube has been omitted for clarity

considerably. It is not possible to feed an unlimited amount of power from a flash tube into a ruby crystal, since the crystal would be damaged.

An upper frequency limit (typically two flashes per minute) is imposed on ruby lasers, since the crystal would overheat at higher rates unless the energy per flash is reduced. In the Q-switching technique the total output energy of the flash is not much increased, but the energy is delivered in a very much shorter time, perhaps in one hundredth of a microsecond.

In a Q-switched laser an absorber is introduced so that laser action cannot take place whilst the number of excited atoms is increasing. When the number of excited atoms has reached a maximum, the absorber is removed and the whole of the stored energy is released in a minute fraction of a second.

In practice an electronic absorber (such as a Kerr Cell) is used, since it can be made transparent to the radiation in a minute fraction of a second by the application of an electrical pulse (See Fig. 7). A laser has a Q factor very similar to the Q of a tuned circuit. The introduction of an absorber lowers this Q factor. Thus the operation of the laser occurs when the Q is switched from a low value to a high value.

SEMICONDUCTOR LASERS

A completely different form of laser has been made using gallium arsenide *pn* junctions. It has been known for some time that a gallium arsenide junction diode will emit infra-red light when suitably biased. However, if two opposite edges of a gallium arsenide crystal are polished (Fig. 8) so that they form parallel faces, and the current per unit area passing through the junction is great enough, a kind of laser action occurs which results in the emission of coherent light from the junction region.

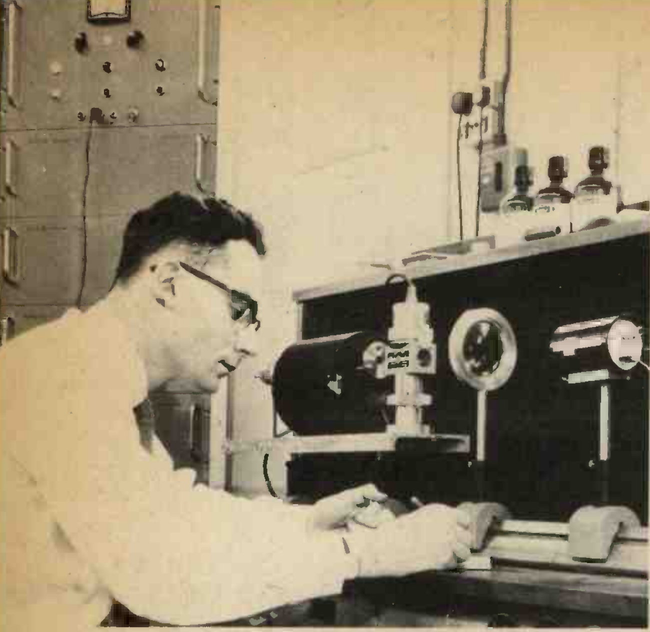
Although gallium arsenide is the most commonly used material in semiconductor lasers, various other semiconductor materials can be employed. Gallium arsenide emits infra-red light, but other wavelengths in the infra-red region can be obtained by the use of other semiconductor materials.

In a semiconductor laser the electrons injected into the junction region lose some of their energy when photons are formed. These photons can cause other electrons to lose energy and form photons by stimulated emission. The laser action can take place only at high current densities where the number of electrons in the conduction band exceeds that in the valency band of the semiconductor material.

The semiconductor laser is a small and rugged device which has an appearance somewhat similar to that of a transistor to which a suitable window has been fitted. At room temperature a semiconductor laser should be operated only by pulses, since if a continuous current high enough to produce laser action is used, the heat developed will damage the semiconductor junction.

These lasers are much more commonly used at liquid air temperatures where a very high efficiency can be obtained. An applied potential of the order of 1 volt at some tens of milliamps will produce a light output power of the order of ten milliwatts.

Barr and Stroud laser rangefinder for objects up to 10 kilometres distant. The transmitter uses a Q-switching ruby laser with a peak output of 1 megawatt



The G. & E. Bradley ruby laser. The ruby crystal and flash tube are contained in the elliptical box to the right of the mouth of the operator

The main limitation of the gallium arsenide laser is its low output power. Nevertheless the brightness (light emitted per square centimetre) of the junction region is very great, although the junction is very small. Owing to this small junction area, the light beam will have a divergence of a few degrees due to diffraction effects.

Semiconductor laser light is easily modulated by altering the current flowing through the junction region. However, the frequency is not very stable and therefore the use of semiconductor lasers in communication systems would tend to provide a noisy output.

OTHER TYPES

Various other types of laser have been developed, but at the moment they are seldom found outside laser research laboratories.

Much research is being carried out on new methods of introducing the pumping energy in an attempt to raise the efficiency of the system. In one type of laser the pumping energy is provided by a chemical reaction in the material surrounding the active laser material, whilst the use of nuclear fuel inside a laser to provide the required energy has been suggested.

THE SAFE USE OF LASERS

There being as yet no statutory regulations governing the safe operation of lasers, there is published, by the Ministry of Aviation, a document "Laser Systems—Code of Practice". The notes given here were compiled from this document and extracted from "A General Guide to the Safe Use of Lasers" published by the Electronic Engineering Association.

Attention is concentrated on the hazard to vision, but it should not be forgotten that laser devices often use high voltages and that normal precautions must be taken against electric shock and the explosive failure of ancillary equipment.

Danger to the Eyes in Direct Viewing

The focusing action of the lens in the eye may concentrate the light on to a small spot on the retina for a considerable range of visible and infra-red wavelengths. If the energy in the beam is sufficient, tissue will be heated and killed, resulting in blindness at that spot. Higher energies will cause damage to the cornea, iris, lens and eyeball itself. Complete blindness may result, while the subject may be unaware that damage is taking place. This is particularly so with lasers working outside the visible region.

Other Effects on the Eye

Infra-red radiation is known to cause corneal cataract (so-called "glass blowers cataract") with excessive exposure. Many laser wavelengths are now in use experimentally which might cause this effect. The common helium-neon laser, for example, often works at $1 \cdot 15\mu$ and at $3 \cdot 39\mu$ wavelengths as well as in the visible region.

Effect on the Skin

At sufficiently high levels energy will produce burning of skin; other damage, such as rupture of the cell walls, is also to be expected. Investigation of these effects is at an early stage.

Note that some gas lasers, for instance those using argon, produce considerable amounts of ultra-violet radiation from the sides of the tube which can cause burns also.

A laser should not be used in the open without great caution. The effective "range for safe viewing" and polar diagram for the laser should be known accurately, taking account of possible reflections and off-axis lobes.

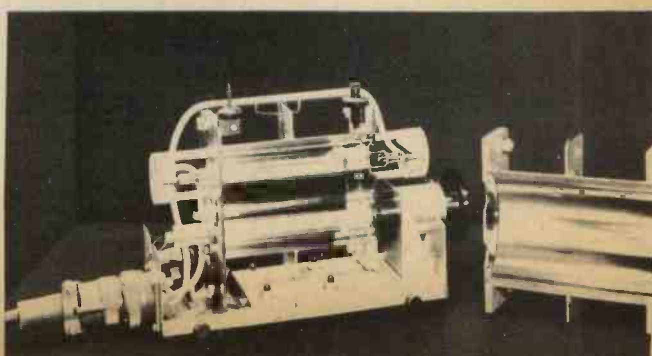
Safety Spectacles

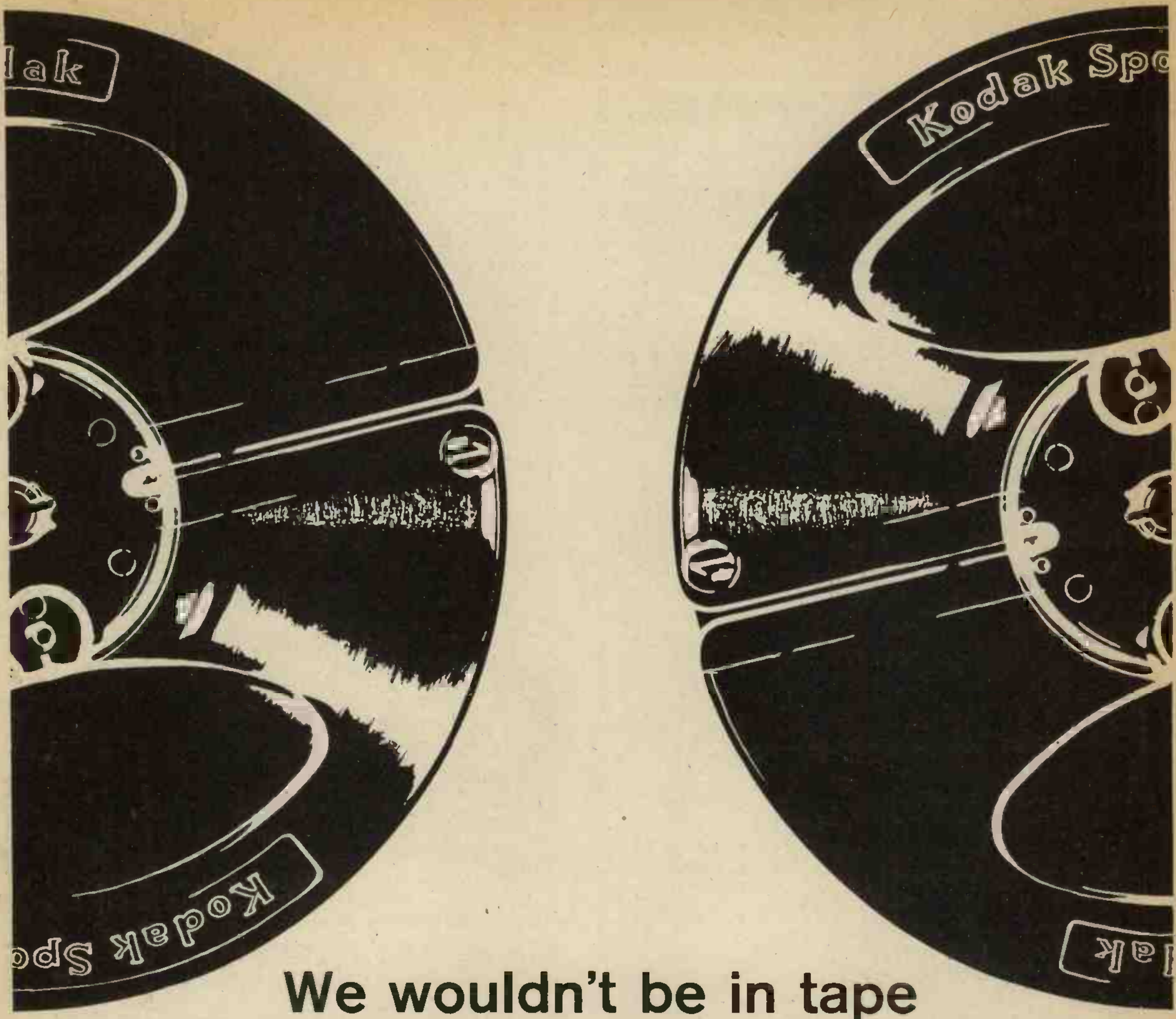
There are a number of commercial spectacles available which give some protection to the eyes from laser radiation. They may be either of wideband absorption or narrowband reflection type. Neither type should be relied on to give a major part of the protection between a laser beam and the eye. Before use they should be tested to ensure that they do not shatter or become transparent during exposure. They should be chosen carefully for the wavelength required and marked distinctively to prevent accidental use of the wrong type.

When using protective glasses the pupil is likely to be enlarged because of the reduced ambient light reaching the eye, and this should be taken into account.

In the present state of medical knowledge, it is clearly desirable to exclude from further risk those who already possess obvious retinal defects. It is, therefore, recommended that those about to undertake work with lasers should have a retinal examination, and that a photographic record should be taken. ★

The head of the M.E.L. laser is in the form of an elliptical reflecting cavity in which the flashtube is mounted along one foci and the laser rod along the other. In this photograph the two halves of the cavity have been separated to show the construction





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Please send me literature on Kodak Sound Recording Tapes.

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Address...

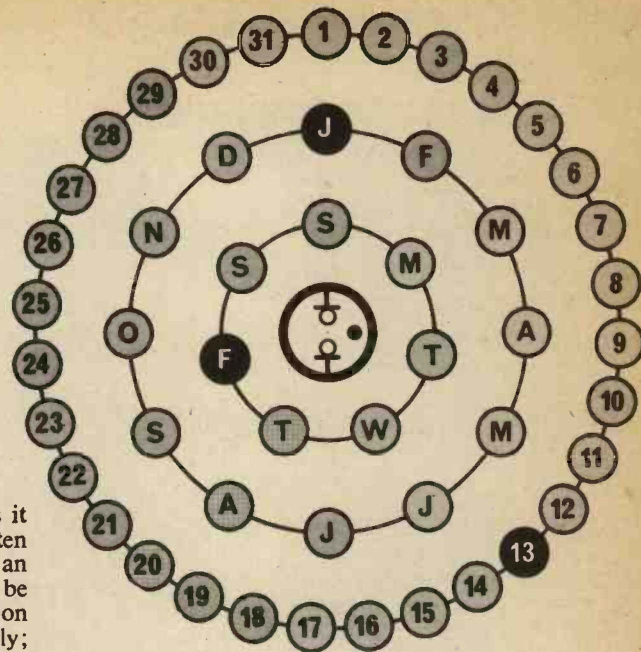
....

....

P.E.

AUTO CALENDAR

by D.F. Moody B.Sc.



THE DESIGN of this auto-calendar is interesting as it attempts to combine factors which, as usual, often conflict with one another, and so compromise is an essential ingredient. For example, long life must be attained as a prime requisite; low power consumption is desirable as the apparatus is left on continually; moderate cost; insensitivity to mains voltage fluctuations, small overall physical size and so on.

It is hoped that the design presented is a reasonable compromise and that, even if the reader is not prepared to put his hand a bit deeper into his pocket and construct this equipment, he will obtain some useful information from the article and appreciate the tremendous variety of uses of the host of modern components.

RING COUNTERS

The circuit is essentially a counting circuit using cold cathode tubes as elements, chosen as they are relatively cheap and are self-indicating with a pleasing orange glow.

The day name and day number rings are stepped in parallel, and the month ring is driven in series from the day number ring. Feedback is applied to the day number ring to control the number of elements in this ring in accordance with the number of days in each month. See Fig. 1.

The calendar is told when to change date in the most appropriate way, i.e. by the coming of dawn, detected by an externally mounted cadmium sulphide cell. When not illuminated this cell has a very high resistance, and so the voltage at the junction of VR1 and R2 is high. R3 is chosen such that there is sufficient base current in TR1 to ensure saturation. Hence the collector voltage on TR1 is very small, with all the voltage dropped across R4.

With light now falling on the cell, its resistance decreases and so the voltage across C2 falls. This large capacitance ensures that no transient fluctuations (such as lightning at night) will affect the calendar.

As the voltage falls so does the base current into TR1. Hence when the base current has fallen sufficiently TR1 will leave saturation and the collector voltage will rise. When it reaches the striking voltage of V1, V1 will ignite. Due to C3, V1 thinks that it is striking from a low impedance source and so gives a good pulse into the base of TR2.

By choosing the ratio of R4 and R5 correctly, V1 cannot oscillate but will settle down to a stable condition. As the base current into TR1 is further reduced, it is effectively cut off. The collector voltage of TR1 is held at a safe level by the voltage drop across R4 due to the current flow through V1.

The current pulse into the base of TR2 is amplified by TR2 and is then fed into the gates of SCR1 and SCR2. Hence these thyristors will fire and as explained later will step the day name and number counters by one.

The feedback system from the month ring to the day number ring is a bit too complex to describe in the space available, but it can be seen that when day number 1 tube strikes it feeds a current pulse into the base of TR3 which amplifies it and feeds it into the gate of SCR3 which then steps the month ring.

The push to make switches S1, S3 and S4 are provided to enable the correct date to be set up initially. S2 is the leap year/ordinary year switch to correct for the 29th day in February. In the position shown it is an ordinary year. It should be changed (if necessary) at the beginning of a new year so that it is not forgotten. Switching it at any time other than the 28 or 29 February will obviously not affect any other date.

The construction of the device has been divided conveniently into three parts:

(a) *Board one*. This holds the three ring counters.

(b) *Board two*. This holds the remainder of the circuit with the exception of the relays, the large smoothing capacitor C1, the manual controls and the cadmium sulphide cell.

(c) *Unit construction and installation*.

BOARD ONE—FUNCTION

The operation of the ring counter can be seen by considering one of the cold cathode tubes conducting. The common rail voltage will then be the sum of the maintaining voltage of the tube and the voltage developed across the cathode resistor. This is arranged to be less than the striking voltage of any other tube and so the condition is stable.

If the common rail voltage is reduced, i.e. by closing the shunt switch S1, S3 or S4, or by firing the shunt

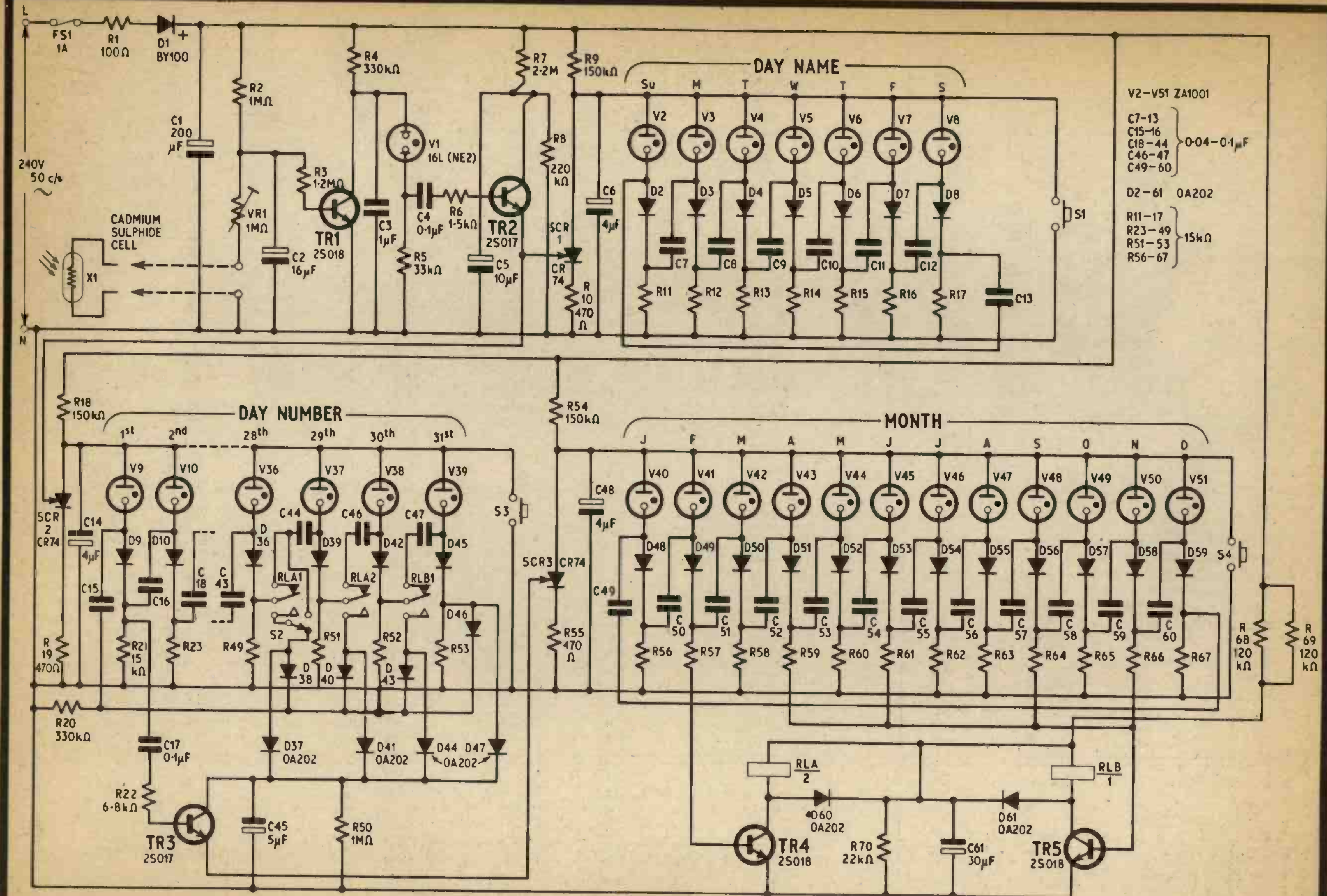


Fig. 1. Complete circuit diagram of the autocalendar. Stages V11 to V35 inclusive are omitted for clarity but are identical to stage V10

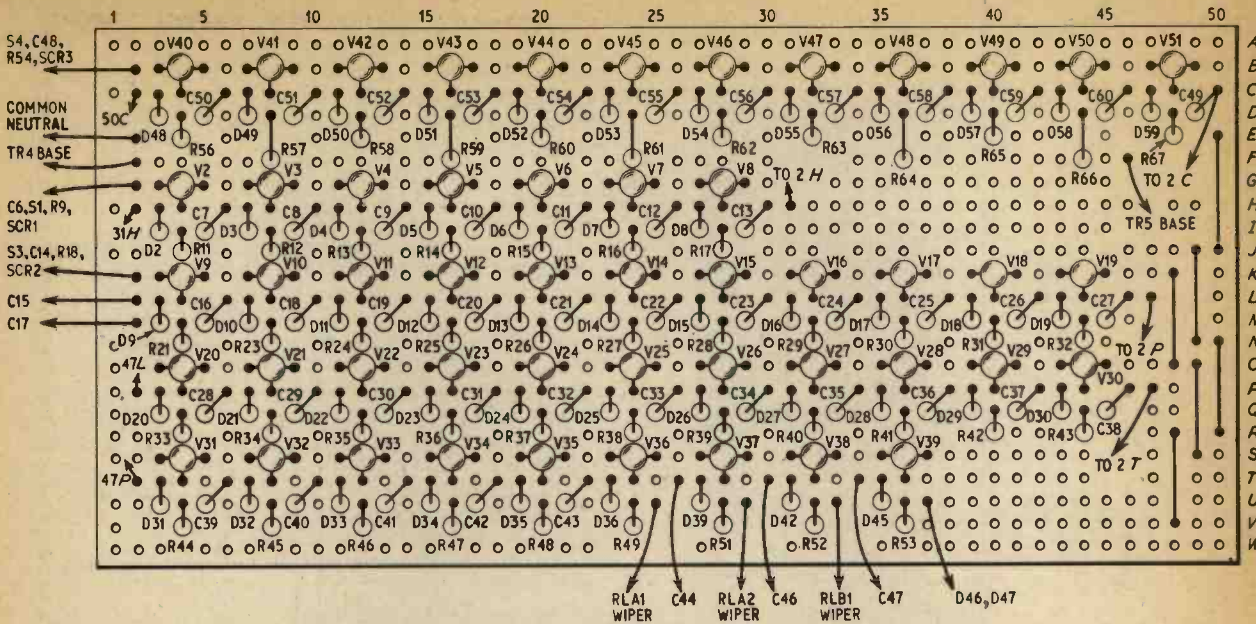


Fig. 2a. Component layout of Board I. All components are viewed end on. Pins are inserted as in text

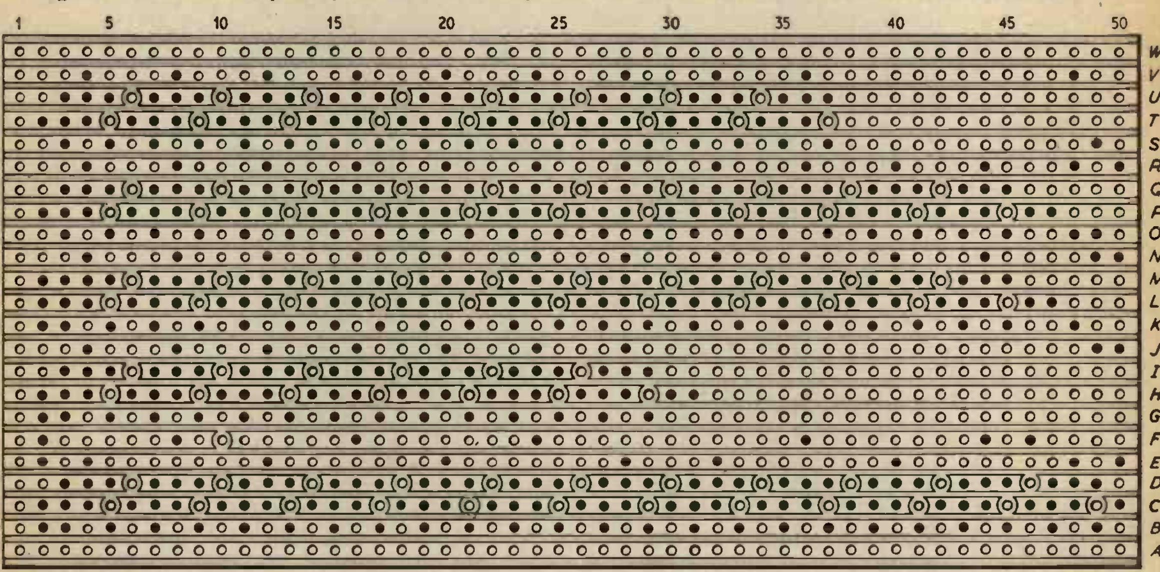


Fig. 2b. Underside view of Board I showing copper strip breaks and connections

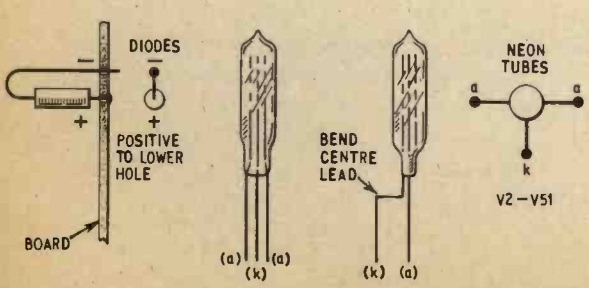


Fig. 3. Mounting details of diodes and cold cathode tubes on Board I. Resistors and capacitors are mounted similarly to the diodes

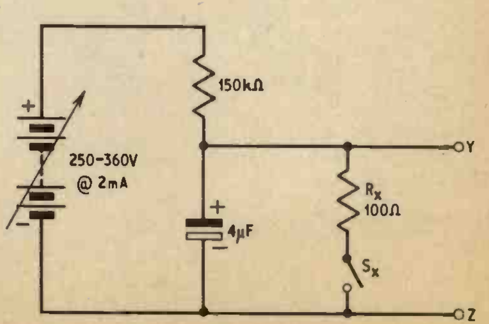
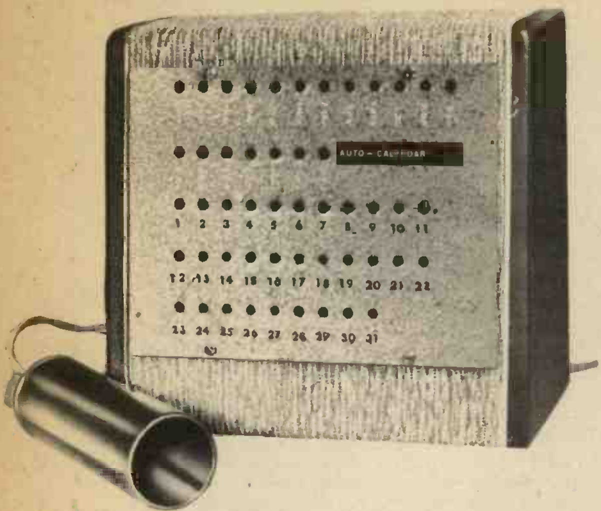


Fig. 4. Test circuit for Board I. The battery can be a variable d.c. supply unit



thyristor, then the tube which was conducting extinguishes. The capacitor joining the cathode resistor of the extinguished tube to the cathode of the next tube is charged to a voltage equal to the voltage across the cathode resistor. Due to the diode this capacitor cannot lose its charge, and so the cathode of the next tube is made negative.

If the switch is opened (or the thyristor extinguished) the common rail voltage starts to rise with a time constant determined by the shunt capacitor and the common feed resistor. This time it is made sufficiently long to ensure that the tube which was conducting is completely de-ionised. Hence the next tube with its cathode negative has a greater voltage across it than any other and will strike first.

In this way the glow is transferred round the ring. In the case of the day name and month rings the loops contain a fixed number of elements (seven and twelve respectively). In the case of the day number ring the number of elements is controlled by feedback system from the month loop so that the number of elements is varied from 28 to 31 to cater for the different number of days in different months. The 29th day of February in a leap year is taken care of by a manually operated slider switch, S2.

Board one holds the day name, day number and month ring counters, and will measure about 8in × 4in and about 1in in depth. These figures will depend on the pitch of the Veroboard used.

The layout is such that the cold cathode tubes (being self-indicating) are viewed end on as indicated in Fig. 2.

Board 1 will be attached to a face plate which is drilled such that the holes correspond to the positions of the cold cathode tubes. Hence at any one time there will be three cold cathode tubes glowing, one indicating the month, one the day name and the other the day number.

COMPONENT LAYOUT

With the high density grouping of components required to keep the overall dimensions of the unit within reasonable limits, construction on Veroboard is essential. Design of layout is considerably eased by the repetitive nature of the ring counters, which also helps to reduce assembly errors.

The pitch of the Veroboard has been given although this will depend on the size of the components used, especially the capacitors; it would be best therefore to buy the Veroboard after the components, choosing the smallest pitch that enables you to site the components without too much difficulty.

ASSEMBLY

Assembly of board one, although time consuming, is relatively simple if approached in a methodical manner.

First cut the board to the right size, giving 23 copper strips each with 50 holes. Then place the board in front of you, plain side up and insert a piece of wire through hole *C5*; turn the board over and remove the copper from around this hole; proceed like this until all the holes similarly shown in Fig. 2b have been done.

The resistors should be mounted first and they will take heat better than other components. Bend one lead of the resistor alongside the body of the resistor and then cut the leads as shown similarly for the diodes in Fig. 3. Do this to all resistors.

A useful technique when assembling components vertically is to cover one of the holes on the copper side with solder. Then, holding the board in the left hand, keeping the component in the desired holes with pressure from your left-hand index finger, touch the solder blob lightly with the iron when the lead will slip through the hole and be held in place by the solder. The board can then be laid flat and the leads soldered normally.

When all the resistors have been fitted, the capacitors and diodes should be assembled. Observe the correct polarity connections. The utmost care should be taken when the cold cathode tubes are being fitted as the glass around the lead-outs will break if the wires are strained too much. Bend the centre lead as shown (Fig. 3.), so that the three leads fit neatly into the three holes. Again, cut the leads before soldering the tube in.

Mount the tubes vertically to the board so that when the face plate has been drilled the glass pips at the top of the tubes coincide with the holes.

It will be noticed that there is some variation in tube length. As it is desirable to keep the distance from the top of each tube to the board the same, it will be necessary to mount the shorter tubes a little further out from the board, but keep leads as short as possible as this will give the tubes greater rigidity.

When this has been done solder the wire links, and then check carefully all the soldered joints. The board is now ready for testing.

Connecting pins are inserted in holes *B2*, *E2*, *F2*, *F46*, *G2*, *K2*, *L2*, *M2*, *T26*, *T30*, *T34*, *U25*, *U29*, *U33*, and *U37* for easy accessibility during testing and inter-unit connection.

TESTING BOARD ONE

For adequate testing of Board 1, a variable stabilised power supply, giving 250 to 360 volts 2mA d.c. will be required with two resistors: 150 kilohms, 1 per cent, 1 watt; 100 ohms, 20 per cent, ½ watt. See Fig. 4.

One press-to-make switch and a capacitor 4μF 250V are also required. The purpose of testing Board 1 by itself is first to check that the connections are correct and that faulty components are located while it is still relatively easy to change them. If testing is omitted before the complete unit is built then, due to the closeness of components, fault finding will be made very much more difficult.

COMPONENTS . . .

Resistors
R1 100Ω 6W
R2 1MΩ
R3 1·2MΩ
R4 330kΩ ½W
R5 33kΩ
R6 1·5kΩ
R7 2·2MΩ
R8 220kΩ
R9 150kΩ 1W, 1%, high stab.
R10 470Ω ½W
R11–R17 15kΩ ¼W, 5%, high stab. (7 off)
R18 150kΩ 1W, 1%, high stab.
R19 470Ω ½W
R20 330kΩ
R21 15kΩ ¼W, 5%, high stab.
R22 6·8kΩ
R23–R49 15kΩ ¼W, 5%, high stab. (27 off)
R50 1MΩ
R51–R53 15kΩ ¼W, 5%, high stab. (3 off)
R54 150kΩ 1W, 1%, high stab.
R55 470Ω ½W
R56–R67 15kΩ ¼W, 5%, high stab. (12 off)
R68 120kΩ 1W, 5%
R69 120kΩ 1W, 5%
R70 22kΩ 1W, 5%
All 10%, ¼ watt except where otherwise stated

Potentiometer
VR1 1MΩ linear carbon preset miniature

Capacitors
C1 200μF elect. 350V
C2 16μF elect. 350V
C3 1μF paper 150V
C4 0·1μF paper 150V
C5 10μF elect. 50V
C6 4μF elect. 300V (T.C.C. Elkomold)
C7–C13 0·04μF *or* 0·1μF paper 150V (T.C.C. type CP113G/4G) (7 off)
C14 4μF elect. 300V (T.C.C. Elkomold)
C15 0·04μF *or* 0·1μF paper 150V (T.C.C. type CP113G/4G)
C16 0·04μF *or* 0·1μF paper 150V (T.C.C. type CP113G/4G)
C17 0·1μF paper 150V
C18–C44 0·04μF *or* 0·1μF paper 150V (T.C.C. type CP113G/4G) (27 off)
C45 5μF elect. 50V
C46 0·04μF *or* 0·1μF paper 150V (T.C.C. type CP113G/4G)
C47 0·04μF *or* 0·1μF paper 150V (T.C.C. type CP113G/4G)
C48 4μF elect. 300V (T.C.C. Elkomold)
C49–C60 0·04μF *or* 0·1μF paper 150V (T.C.C. type CP113G/4G) (12 off)
C61 30μF elect. 150V (Hunts)

Cold Cathode Tubes
V1 16L (NE2) (Hivac)
V2–V51 ZA1001 (Philips) (50 off) (Henry's Radio)

Transistors (Texas)
TR1 2S018
TR2 2S017 *or* 2S018
TR3 2S017 *or* 2S018
TR4 2S018
TR5 2S018

Thyristors
SCR1, 2, 3 CR74 *or* CRS140 (S.T.C.) (3 off)

Diodes
D1 BY100
D2–59 OA202 *or* OA200 (Mullard) (58 off)
D60, D61 OA202 (Mullard) (2 off)

Cadmium Sulphide Cell
X1 1 watt, type 2 (Proops Bros.) *or* ORP15 (Mullard)

Relays
RLA, RLB 14kΩ, 2 sets of changeover contacts (2 off) (Magnetic Devices Ltd. series 2400)

Switches
S1 Single pole, on/off, push to make
S2 Single pole, changeover, slide switch
S3 Single pole, on/off, push to make
S4 Single pole, on/off, push to make
S5 Double pole, on/off, slide or toggle switch for the mains (optional)

Fuse
FS1 1A anti-surge cartridge fuse with holder

Miscellaneous
Veroboard 0·15in hole matrix, 3·75in × 17in, 24 strips
Perforated board same size to match above
Aluminium sheet 18 s.w.g. 5in × 17½in
Wood for case required later
Tube for mounting X1 required later
Tinned copper wire 20 s.w.g.

Month Ring

Connect pin *B2* to point Y on the test circuit.

Connect pins *E2*, *F2*, *F46* to point Z on the test circuit.

Switch the power supply on. It is likely that more than one tube may ignite as there is no preferential priming of any one tube. Adjust the d.c. supply to about 280V and then press the switches and release. Continue doing this until one tube is glowing and then leave the circuit alone for about two minutes. This is to allow time for any priming of any other tube to disappear.

Adjust the supply to 300V and by pressing the switch step the glow around the ring. If the glow steps around correctly then the components and joints appear satisfactory.

This test should then be carried out with supply voltages in the range 270V to 360V. The circuits should still perform properly. If the glow jumps about, then check carefully for dry joints. If one tube refuses to ignite the likely cause will be that the diode in its cathode circuit is faulty. Check this with an ohmmeter after switching off the h.t. If this appears to be all right then it is possible that the cold cathode tube is faulty, in which case it should be replaced.

Day Name Ring

Connect pin *G2* to point Y on the test circuit.

Connect pin *E2* to point Z on the test circuit.

Carry out tests as above.

Day number ring

Connect pin *K2* to point Y on the test circuit.

Connect pin *E2* to point Z on the test circuit.

Connect capacitors (the ones which you have used on the board) between pins *U25–T26*, *U29–T30*, *U33–T34*, *U37–L2*.

Carry out tests as above.

Next month: Board 2 construction and assembly

the 73 page by Jack Hum G5UM

"No Royal Road", part two

"There is no royal road to obtaining an amateur radio transmitting licence". Thus had said Mr Smith of Herne Bay to the young hopeful of whom we wrote here last time . . . hopeful of becoming a transmitting amateur, less hopeful when he discovered the definition of "royal road" to be "a means of attaining without trouble".

Mr Smith by the use of this phrase had made it clear that, like most of the worthwhile things in life, the transmitting permit was not to be had for the asking: it would need to be worked for.

All this was in the mid-Nineteen Twenties. Yet what was said then is true today; and although, still, no royal road exists, aspirants to the transmitting licence in the mid-Nineteen Sixties enjoy the considerable advantage of knowing much more accurately than was formerly the case exactly what they must do to get it.

They can obtain from the Post Office a useful pamphlet (and it is free) called *How to become a radio amateur*.

They can buy a variety of books to help them to pass the Radio Amateurs' Examination.

They can sit this examination very conveniently at the local "tech".

And as for morse code, today's "young hopeful" (and the old hopefuls too) can work up his speed to the obligatory "twelve per" by following one of the slow morse broadcasts which are organised by the R.S.G.B. in many urban areas. For a final polish up of his code speed he can seek the co-operation of one of his local transmitting men—and there are 13,000 of *them* the length and breadth of the land.

Self Taught

Forty years ago there were a bare 2,000 of them—and none of the facilities described above. Morse was very largely self taught. And even though there was no Radio Amateurs' Examination to measure the strength of a person's claim to be granted a transmitting licence, it was still necessary to show oneself to be versed in "wireless lore" if one harboured any hope at all of persuading authority to part up with the coveted permit.

This was done by means of a rather curious device called "the line of experiment". In the 'Twenties the British amateur transmitting fraternity were licensed to operate their stations "for experimental purposes", *not* for general communication as is the case today. Forbidden to transmit the CQ general call to all stations, they became the only group of amateur transmitters in the world to use the word TEST as a synonym for the "general call". They were "testing" in the interest of their "lines of experiment". At least this characteristic was a distinguishing feature of the U.K. radio man!

Said the Post Office to the mid-Twenties applicant for a transmitting permit (the term "licence" is a post-war one): "Convince us that you are engaged on a particular line of experiment that justifies the need to transmit and we will consider your case".

Many and varied were the "experiments" dreamed up by young hopefuls like our correspondent-with-Mr Smith, but what can be said with some truth is that if you had a good "line" the Post Office would swallow it!

One one side of them were "the military", keen to hold on at all costs to the wavelengths ("frequency" was not yet in use) which they had occupied during World War One and the years following. On the other side sound broadcasting's claim for space could be heard with increasing amplitude. Somewhere in the middle were the poor amateurs—the "licensed experimental stations". (For a time even the nation's quarter-million *receiving* stations were considered to be "experimental"!)

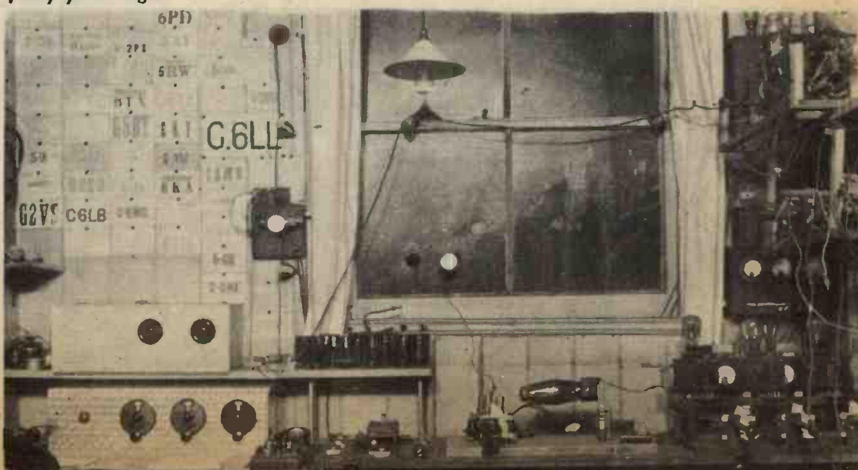
Climate of Caution

All in all, a climate of caution prevailed, created by the difficulty of seeing where the future of "wireless", developed immensely by war, truly lay. This caution was exhibited in a special degree as a phobia against "interference". Even the tranmitters of the British Broadcasting *Company* were under an obligation to close down at certain intervals lest they should jam "official" stations!

It was within this climate that young men in increasing numbers, fascinated by this quite new scientific thing, "the wireless", felt the desire to use it as a means to communicate with one another. It must be said to the credit of the Post Office of the time—and turbulent times they were, politically—that any young man who could show them that he took "wireless" seriously—that he had a convincing "line of experiment", generally with aerials, that justified permission to transmit—would be able to travel that far from royal road with a reasonable degree of hope.

Upon that confident note we could well leave the story of the young hopeful and Mr. Smith, were it not for the fact that one further phenomenon peculiar to the amateur radio world of the 'Twenties has not yet been described, and that is the "artificial aerial" transmitting permit. But this, and the overtones which it has produced in the amateur radio scene of today, must wait until next time.

Mr James W. Mathews is one of the band of amateur radio pioneers who, though not professionally engaged in electronic engineering, made a considerable contribution towards the art of communication. Licensed in the Twenties, "G Six Double Ell", as he is generally known, opened up the 10 metre band at a time when its potentialities for world wide contacts were virtually unknown. In later years he was one of the first operators to use the 2 metre band when it was allocated to British amateurs after the war. Today in retirement in a Hertfordshire village, Mr Mathews continues to operate actively on several v.h.f. bands, with equipment very different in appearance from that shown in this picture taken of station 6LL when it was in Clapton, London, forty years ago.



JOYSTICK

VFA Only 7' 6" Long

"DRAGS IN STATIONS I NEVER KNEW EXISTED"

Says SWL G. WHYTE — ABERDEEN

The Joystick System is based on an entirely new " Variable Frequency Aerial " principle. The aerial rod and the associated tuning unit together possess the unique quality of extremely high sensitivity and efficiency at any desired frequency from 1.8 M/cs to 30 Mc/s.

The Short Wave listener can cover all the ham bands from 160 meters to 10 meters, trawlers, distress wavelengths and the international short wave broadcasting stations. Transistor receivers in particular respond very well to the highly selective property of this system.

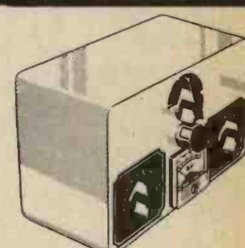
Tuning units are available to allow the system to be used for Medium Wave reception. Licensed amateurs all over the world are radiating excellent signals using the transmitting Joystick Systems and are also enjoying a considerable improvement in reception quality. In fact, the latest figures show that over 10,000 systems are now in use.

Hundreds and hundreds of enthusiastic testimonials are flowing into the Joystick office. These show that in particular users who have difficult locations, live in flats or EVEN IN A BASEMENT have experienced a remarkable increase in sensitivity and reception volume—many say they now hear signals that they did not know existed before they rigged up their Joystick System.

Patents have been applied for all over the world — and we recommend you to send for a brochure and full information immediately.

SWL John D. Thompson, 13 Old Park Road, Dover, Kent. Says: " Yesterday evening I was tuning in YV's on 15m. band with the HF tuner and later on switched round to the 160m. band and a couple of GM stations rolled in like the home service. Frankly, I am astonished by the ability of the Joystick—surrounded as I am in a built up area—well within a town and in a valley with considerable hills around me." (JOYSTICK INDOORS)!

WA2WOR/W4WFL, New York 23 says: 'Not only does the Joystick make it possible for me to operate on 160m. from my location in the centre of New York City, its performance on the higher frequencies is excellent; the Joystick is certainly the answer to the Antenna problem for apartment dwellers."



Above : One of the new JOY-MATCH/'EASY-TO-USE' units with the built-in RF indicator for transmission.

U.S. Patent No. 3274600
S. Africa Patent No. 63/4389
U.K. and World Patents Applied for

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MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

SAFETY FIRST

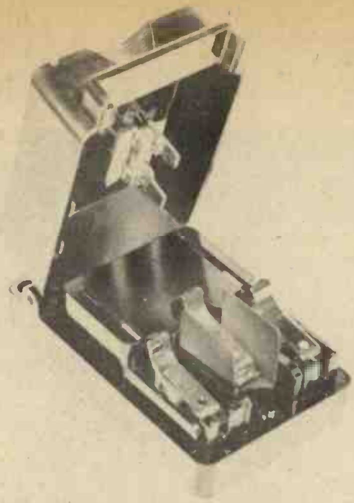
The first item this month is the Bulgin Security Alarm from **A. F. Bulgin & Co. Ltd.**, Bye-pass Road, Barking, Essex, which provides protection to the average household at a reasonable cost of £12 17s 6d. The basic system, once installed as instructed, is very efficient and consists of six units: Latching Door Switch, having special one way operation; Keyswitch Control Box,

Security Alarm by Bulgin

which is the nerve centre of the system and keeps the bell ringing once activated; Battery Magazine; 4 in Underdome bell; Pressure Switch; and the system is completed by twin plastic coated wire, screws, tacks, keys and protective Door Striker Plates. There are many accessories available and seems well worth investigating.

A safety device of particular interest to the experimenter is the **Rendar** Safebloc available from DTV Group, 126, Hamilton Road, West Norwood, London, S.E.27 or by post from Guildford Mail Order, 6, Leapdale Road, Guildford, Surrey. This device provides a quick and safe method of securing 2-core or 3-core bare ended connecting wires to the mains.

Another item which should be considered a must in the workshop or house is a fire extinguisher. The usual excuse for not having one is either that they are too expensive or too heavy, consequently not suitable



Rendar Safebloc mains connector

for the lady of the house. With the introduction of a new range of extinguishers from **Firemaster Extinguishers Ltd.**, these arguments are no longer valid. Of the dry powder type, they are light, 2·2lb, powerful and easy to use and range from £2 19s 6d to £4 9s 6d. They are covered by a three year guarantee and there is a low cost replacement service for used extinguishers.

CONSTRUCTORS AIDS

A fairly new "electronic breadboard" that will appeal to the hobbyist is being marketed exclusively in the U.K. by **Livingston Components Ltd.**, called the Develoboard it consists of a breadboard chassis assembly which employs solderless connectors, enabling transistor circuits to be made up rapidly and any circuit modifications can be made instantly—well almost.

Some time ago we used "Masterboxes" from **Cockrobin Controls**, in a series of constructional articles (issues now entirely out of print and unobtainable). These proved very successful in obtaining a good presentable finish. Now this firm is producing a series of four design sheets to help layout circuits and aid in choosing the best type of boxes to be used. Our photograph shows a model railway control panel which is a typical example of the type of unit that can be first laid out on these sheets.

Develoboard marketed by Livingston

COMPONENTS

The basis of portable flash equipment for photography is the use of rechargeable low voltage batteries as a primary source of power with an electronic circuit charging a capacitor to a much higher voltage. Electrolytic capacitors are used because of their large capacitance for a given size coupled with low leakage currents, and to ensure proper charging after extended idling periods.

A specially designed capacitor for this application is the "Lectroflash" manufactured by TCC Division of **Plessey** and available from most good retailers. The capacitor is available with ratings from 200μF to 1,750μF. The discharge energy varies between 16 and 92 joules.

Whilst still on electronic flash guns we have in the past recommended **Deac** batteries. These batteries are now available direct from **Deac (Great Britain) Ltd.**, Hermitage Street, Crewkerne. Somerset.

Major 750 Firemaster extinguisher

A problem that seems to always confront us when building battery powered equipment is how best to mount the batteries? A spring clip mounted on one side of a cabinet is usually possible, but with equipment that is likely to be subjected to some form of vibration there is a tendency for the batteries to become dislodged. However, Bulgin are now producing a complete range of battery holders in various styles, base mounting, panel mounting, and types for fixing to chassis lugs. All have highly insulating moulded bodies, corrosion resisting metal tags and springs and reversed polarity prevention.

TOOLS

Three aids to wiring and soldering are the next components of interest. The first is a tool kit containing 18 tools in a neat zip fastened wallet.

The selection of tools include a 14mm magnifying mirror, a 30 watt soldering iron, a flexible screwdriver and a variety of miniature screwdrivers and tweezers. This kit is intended mainly for transistor circuits and is priced at 10 guineas from **Henri Picard & Frère Ltd.,** 34/35, Furnival Street, London, E.C.4.

The second is a tweezer shaped in such a manner that it enables much steadier and positive use as indicated in the photograph. Available from **J. A. C. Wilkinson Co.,** 5, Beeches Avenue, Carshalton, Surrey, this tweezer is known as the Rubis No. 5A, is Swiss made, and sells at 12s 9d for a standard carbon steel model and 14s 3d for a stainless steel version.

The third item is the well-known Model 8 wire-stripper from **Multicore Solders Ltd.,** which cuts and strips most standard wires accurately. It

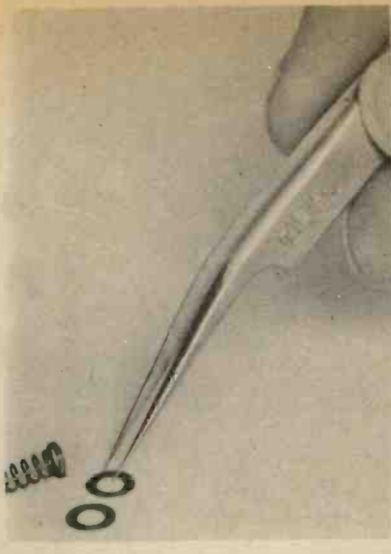
Henri Picard & Frère tool kit

can be adjusted quickly to the wire thickness required by the special pre-set selector gauge, which is now conveniently marked at each setting with a letter for simple identification. At 8s 6d this seems to be a worthy addition for the tool box.

LITERATURE

Two of the most treasured items in our workshop have been the catalogues issued by **Home Radio (Mitcham) Ltd.,** and **Henry's Radio Ltd.** The only trouble is that they keep disappearing and a frantic search follows until a voice casually mentions "Oh! I've got that, I borrowed it and took it home to do some research on a job I'm doing".

There are quite a number of new items in the Home Radio Catalogue, price 7s 6d, which arrived in the office and has already disappeared into the Editor's office.

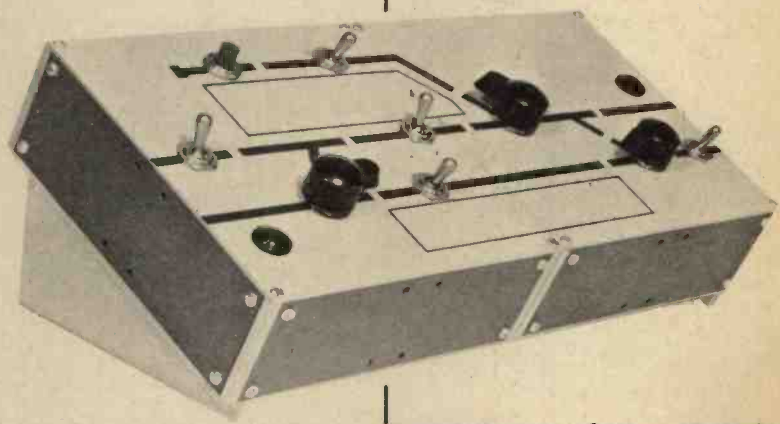


Rubis No. 5A tweezer

Model 8 wire-stripper from Multicore Solders

A third catalogue has just been added to the above list and we strongly recommend readers to obtain a copy for reference. It is part of a new service just started by **Electroniques (Prop. STC Ltd.),** Edinburgh Way, Harlow, Essex, specially for the home constructor and the smaller companies. The catalogue is called Electroniques Hobbies Manual and lists components and equipment from over 85 leading manufacturers. Priced 10s 6d it contains details of complete designs and kits, technical data, practical tips and formulae as well as the vast amount of stock parts required to construct electronic apparatus.

A new **Brimar,** Data List No. 33, valve booklet covering 542 valves and cathode ray tubes is available from Brimar Publicity Department, Thorn-AEI Radio Valves & Tubes Ltd., 7, Soho Square, London, W.1. No price given.



Masterboxes from Cockrobin Controls

FINISHING TOUCH

How to finish off one's final project has always been a problem, particularly the front panel which either makes the equipment look professional or amateurish. With so many decorative plastics self-adhesive papers available (and not forgetting the well-known technique of rubbing an aluminium front panel with glass-wool) the panel itself presents no real problem until you come to lettering the facia. This is where the trouble really starts, hand painting and labels are all right but do not really fulfil the requirements.

We have recently started using Letraset (**Letraset Ltd.,** 195, Waterloo Road, London, S.E.1) instant lettering and find this is one of the best methods so far. The only drawback is that you have to lay the lettering on the panel before mounting any components. But provided the lettering is sprayed with Letracote protective coating it will withstand rough handling and abrasion.

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PROXIMITY DETECTOR

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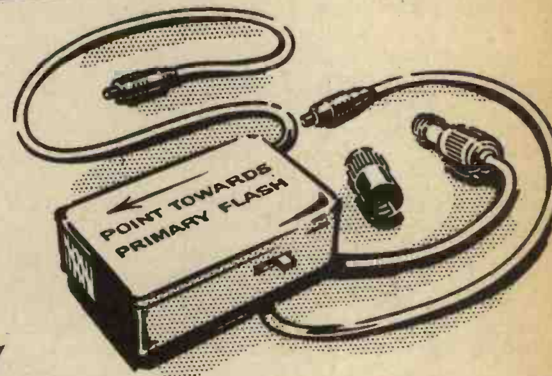
Variety of applications in house, garage, garden, etc.

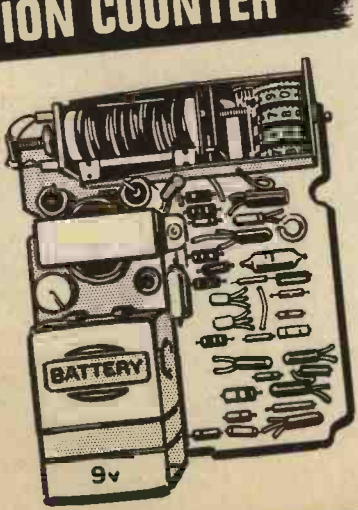
PHOTOFLASH SLAVE UNIT



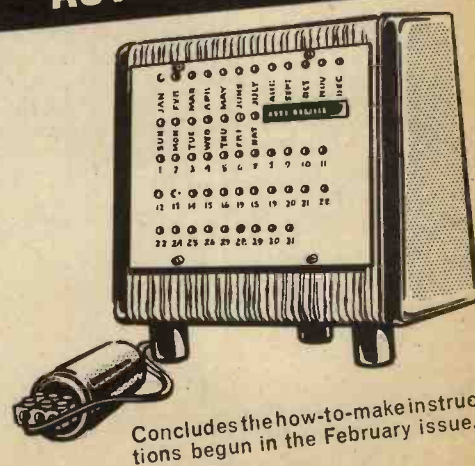
A small synchroniser for remote operation of more than one flash gun. Does away with the need for inter-connecting wires.

RADIATION COUNTER

Transistorised circuit drives a digital relay which displays the count from a halogen-quenched Geiger Muller tube. Suitable for determining the day-to-day change in cosmic radiation or for the accurate quantitative analysis of liquid samples.



AUTO CALENDAR



Concludes the how-to-make instructions begun in the February issue.

MARCH ISSUE ON SALE FEB. 17—2/6

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DOORBELL REPEATER

by G.E. COUCHER

IT WILL probably seem obvious to the reader that, although the unit featured in this article was originally designed for the hard of hearing, it will find a use in most households with an inadequate bell system or while television is on.

The problem could be tackled in a variety of ways. A louder bell is the obvious solution, but this is often disturbing to the neighbours. The existing bell could be moved to the living room, but since this normally leads to confusion with bells included in the televised programme, it is not effective.

The alternative is a visual indicator displayed in a prominent position, but the practical difficulties are rather more formidable than would at first be expected.

Firstly, if a bulb is used, the illumination period is restricted to the time that the bell is ringing, and if the bulb is not noticed at once its effect is lost, so that the illumination must be sustained.

Secondly, many bell systems are powered by a.c. mains via a suitable transformer, which is unsuitable for any form of standard timing circuit.

TIME DELAY

Both these problems are overcome by the circuit described. Only the transistor circuit of the unit need be operated on d.c. The bulbs may be run off the low voltage a.c. used to supply the bell.

The whole idea of using a transformer to power the bell is to save the frequent purchase of batteries, and to use batteries in this particular application seems at first to defeat the purpose of the transformer. Any rectifying circuit would have to be on continuously and include electrolytic capacitors, which have a habit of breaking down after a few months continuous use.

To offset the disadvantage of using batteries, both the quiescent and running currents have been kept to a minimum, being 25–60μA (depending on ambient temperature) and 45mA respectively at 9 volts.

The timing factor uses a slightly modified version of the better known type of delay circuit. Potential dividers have been eliminated in the quiescent state, and the time constant is derived from the charge time of a capacitor rather than its discharge, thus there are no capacitors across the battery supply.

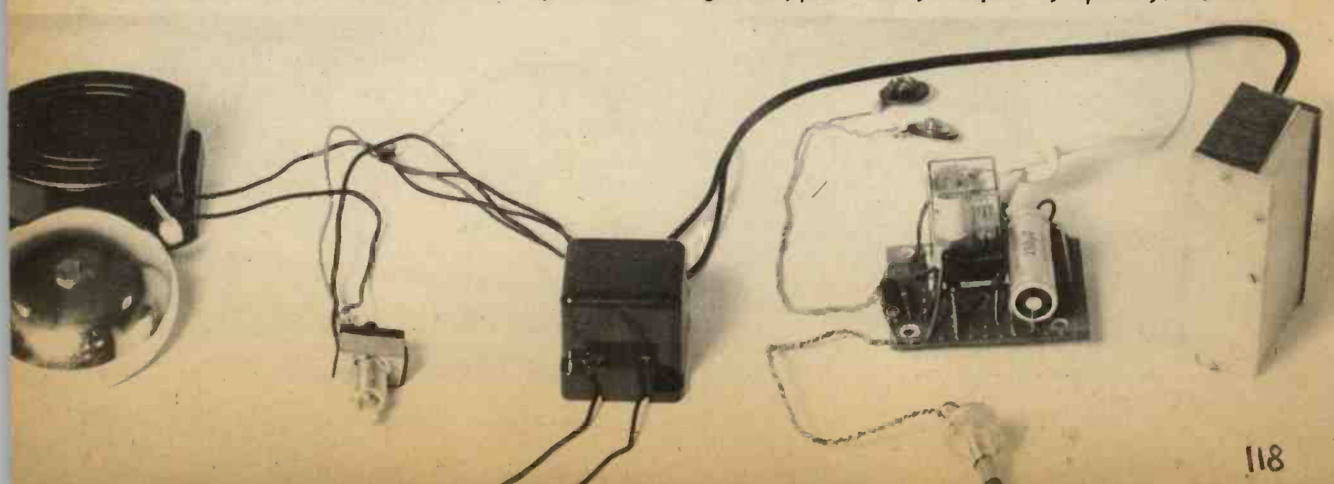
As can be seen in Fig. 1, a.c. is fed from the bell through D1; the consequent d.c. is smoothed by C2. This produces a few volts bias at the base of TR2, and switches it on operating the relay. The relay in the off position serves to "ground" the base of TR2 through R4, and TR1 through R3, thus keeping the quiescent current low. At the same time, it keeps C1 fully discharged. When the relay is operated RLA2 connects the indicator bulb across T1 secondary.

Contacts RLA1 connect C1 to the base of TR1 via R2. C1 charges through R2, VR1, and R3, and biases TR1 negative. TR1 conducts via the bell and D1 supplies a continuous negative bias to TR2, which sustains the relay. This condition continues until the charge of C1 approaches a maximum when the bias at TR1 drops to a point where TR1 can no longer sustain TR2, and the relay drops out. C1 is then discharged by R1, and the transistors once more are "grounded".

The speed at which C1 charges is dependent on the setting of VR1, which may be adjusted to vary the time delay. If a short delay is required, a smaller value potentiometer should be used.

It is expected that one Ever Ready PP7 battery will operate this unit 1,800 times for a period of 2 minutes

Group photograph of the various units wired together. Left to right: bell, push button, transformer, repeater, indicator



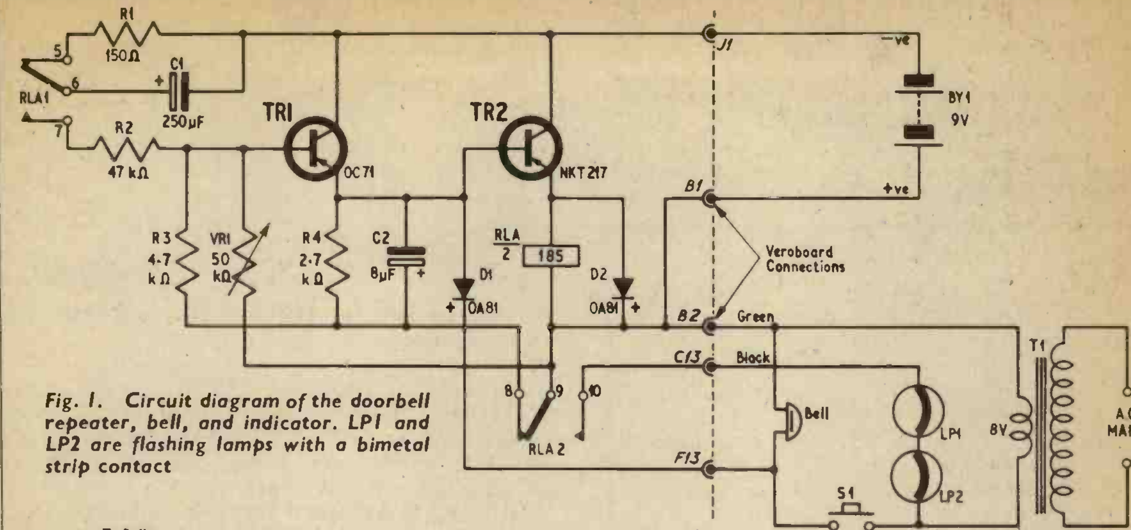


Fig. 1. Circuit diagram of the doorbell repeater, bell, and indicator. LP1 and LP2 are flashing lamps with a bimetal strip contact

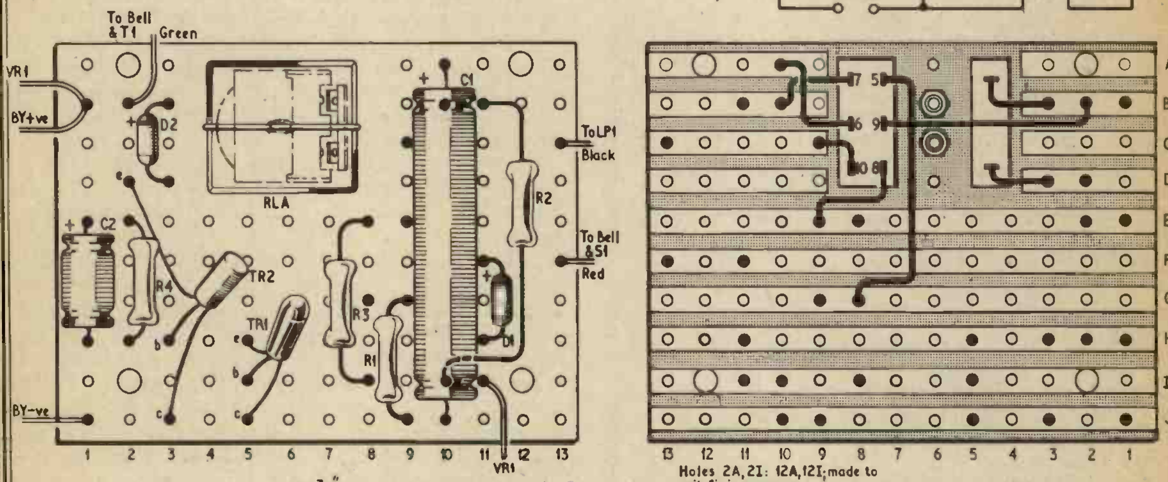


Fig. 2. Component layout and wiring of the Veroboard unit

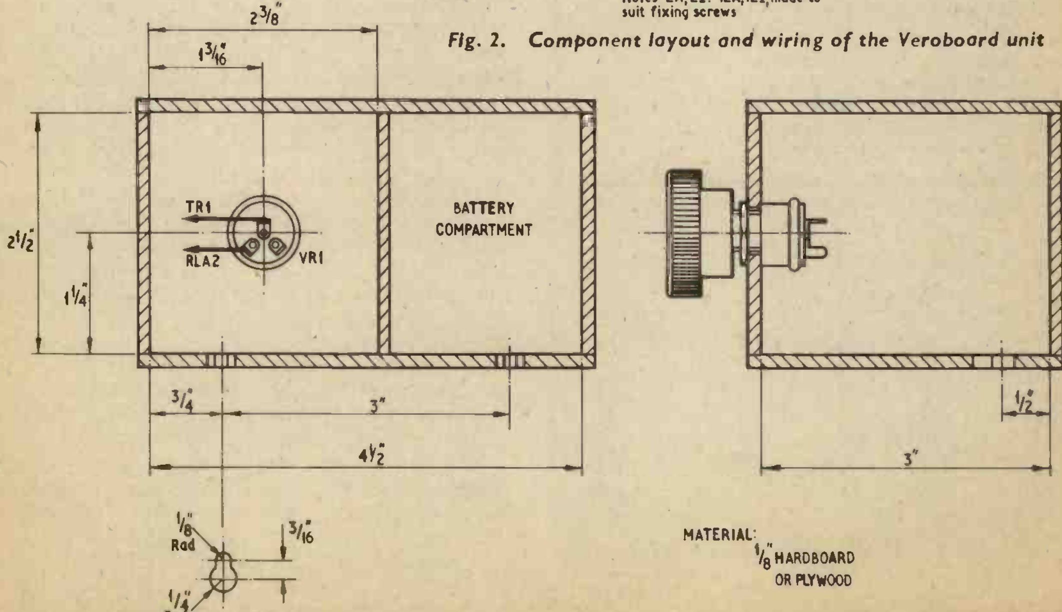


Fig. 3. Dimensions of the repeater housing showing the position of VR1 and the details of the keyhole slots to be cut in the back plate

per operation at 10 operations per day, or 3,600 operations using a PP9. It follows that this figure would be doubled at 1 minute periods.

Although the initial current is about 45mA at switch-on, this drops steadily to 4·5mA during illumination, at which point the relay drops out.

COMPONENTS . . .

Resistors
R1 150Ω, R2 47kΩ, R3 4·7kΩ, R4 2·7kΩ — All 10% ¼ watt carbon

Potentiometer
VR1 50kΩ linear carbon

Capacitors
C1 250μF elect. 25V
C2 8μF elect. 15V

Transistors
TR1 OC71 (Mullard)
TR2 NKT217 (Newmarket)

Diodes
D1 and D2 OA81 (Mullard)

Relay
RLA 185Ω with two sets of changeover contacts. Type MH2P with socket or type MH2 without socket (Keyswitch Relays)

Transformer
T1 Primary 200–250V a.c.; Secondary 8V (Bell transformer)

Battery
BY1 9V (type PP7)

Lamps
LP1 and LP2 6V 0·4A flashing bulbs (Pifco)

Switch
S1 Single-pole on/off push button

Miscellaneous
Veroboard 2⅝in × 2in, 0·15in hole matrix
Electric bell 8V
Battery connectors, screws, wire
Plywood for boxes (see diagrams)
M.E.S. batten lampholders (2 off)

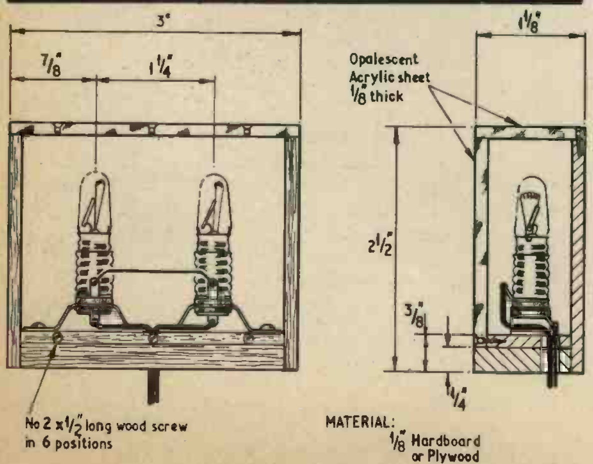
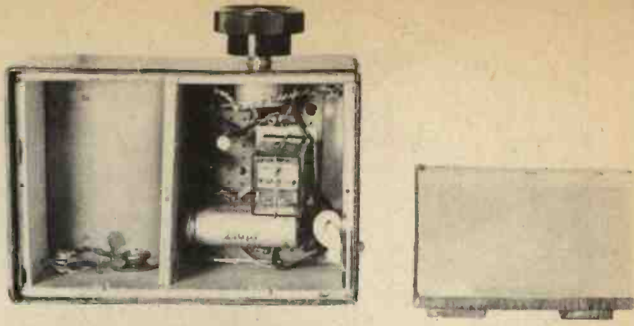


Fig. 4. Indicator lamps are housed in a small box with opalescent Perspex on two sides



The repeater unit and flashing indicator box. The battery has been removed

COMPONENTS

Veroboard construction is used for simplicity, and the device kept as small as possible. Layouts are shown in Figs. 2 and 3.

The relay is a plug-in type chosen for its high performance, clean action, and ease of replacement. If economy is important, an MH2 type may be used and directly mounted without a socket. If the socket is used, however, this should be ordered with the relay, and suitable holes should be cut in the Veroboard to accommodate it.

Supply voltage to the unit may be varied between 5–25V without serious deterioration of performance, but a high voltage is rather impractical in view of battery size.

None of the resistance values are critical, nor the capacitance of C2, as long as this is about 8μF or more. Diodes D1 and D2 have a maximum current capacity of 150mA. This is important, as D1 has to supply about 40mA to the relay via the base-emitter junction of TR2 when the battery runs down. This switches the relay on and off twenty times per second, even without the battery supply and illuminates the bulb at half power. This automatically throws suspicion on the battery, and nothing else.

The indicators chosen were Pifco 6V flashing bulbs, which flash at a rate governed by a bimetal strip, situated near the filament. Because of their voltage rating, two must be used in series, but they are relatively inexpensive to run. The two may be displayed in the same room or in different parts of the house.

HOUSING

Size and appearance were borne in mind, since the unit will probably be mounted on a wall. Overall sizes of the two units are 3¼in × 4¾in × 2¾in and 3in × 2½in × 1⅛in. Two inverted "keyholes" were cut in the back of the large box for mounting on screws in the wall.

A partition 2⅝in wide made of plywood is used to separate the battery from the main assembly. A small gap is left between the base and partition to allow the battery leads access to the battery.

The Veroboard is secured to the base by four round-headed ⅜in screws, and pieces of plastics cable sleeving are used to space the board from the base. This prevents damage to the underneath wiring.

A hole should be cut in the side of the box to accommodate VR1 and another in the left-hand side for the connecting cable to pass through to the lamp unit. Blocks are eliminated, saving a great deal of space.

The whole unit is covered in decorative plastics laminate to give a pleasing appearance. ★

audio trends

COMMENTARY ON SOUND REPRODUCING EQUIPMENT BY CLEMENT BROWN

HI FI UNITS

Redesigned tuners and other transistorised units have been introduced by the Chapman Division of Derritron. Tuner model FM1000A, for f.m. only, is fitted with a stereo decoder and sells at £39 11s 3d when prepared for cabinet mounting. A shelf mounting version is obtainable and there is also an a.m./f.m. tuner type FM1005A for which outstanding signal-to-noise ratio and sensitivity are claimed. This latter model has entirely separate sections for a.m. and f.m.

Also new from Chapman is model 310 integrated stereo amplifier which, at £50, is supplied as a free standing unit in a wood case. Output rating is 10 watts per channel and there are the usual inputs for pick-ups (magnetic and crystal), radio tuners and tape recorders. The amplifier and control unit sections can be removed from the case if cabinet mounting is preferred.

Eagle products marketed by Adler (see *Audio Trends*, November) include a transistor stereo pre-amplifier which provides the extra stage of voltage amplification needed when a magnetic pick-up is used with an insufficiently sensitive amplifier. This little mains powered unit, type PRE302, costs £5 16s 6d. There is a mono version. Bookshelf speakers from this firm have a rosewood finish and are available in several sizes, the smallest of which is the MS40 (£8 10s 6d).

NEW SPEAKERS

A new bookshelf speaker by LNB of Loughborough is known as the Charnwood and sells at £21 16s 0d. The drive units are a Celestion h.f. radiator and an E.M.I. 13in by 8in elliptical for bass. This firm, well known for its small labyrinth enclosures has now restyled its Lab 8 model in a Mk3 version, which is priced at 14 guineas.

Nichols Acoustical Fitments, of Church Street, Bubwith, Yorks, offer a range of robust enclosures and supply drive units by leading makers. Advice is available on suitable combinations to meet individual needs. The Derwent Minster (£19) and Major (£15), the largest models, have characteristics which suit the Celestion 12in units. The Minor, at £11 10s, has a volume of 1·66cu ft and the Bookshelf (£5 5s) encloses 0·41cu ft.

Next a note for those who like to make a practical contribution to their speaker system. The Decca Kardioid, until now a ready-made speaker, has been introduced in kit form at 40 guineas. This is the system which incorporates the Kelly ribbon h.f. unit and an acoustical lens device. Also of interest is the revised Heathkit catalogue, now obtainable from Daystrom Ltd., Gloucester.

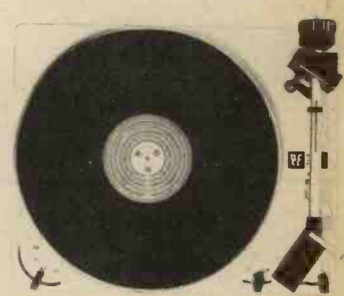
The Triaxiom 212c, a triple-element drive unit for high fidelity use, has been added to the Goodmans range. The basically similar 1220c, with a 20 watt rating, is already well established; the new version, rated at 15 watts and again of 12in diameter, costs £15 10s. This type of unit is essentially a twin-cone speaker with a horn loaded pressure tweeter mounted in the centre.

AUDIO FURNITURE

Model S33 speaker enclosure by Design Furniture Ltd. measures 27in by 16in by 12in and is intended for use with various well known drive units. It is available in walnut, teak or mahogany finishes. A new equipment cabinet, model EQC18, has features which were determined to some extent by the results of a design competition held some time ago. For details write to the firm at Calthorpe Manor, Banbury, Oxfordshire.

There are two additions to the already extensive catalogue of Scandinavian audio furniture, a speciality of Howland-West. The "Viking Standard", 39in by 19¼in by 12in, is an equipment cabinet finished in teak with matt black contrasting sections. The Perspex turntable cover runs in grooves and can be pulled to one side. This model costs 20 guineas and the solid teak plinth is an extra 6 guineas.

A similar "Major" model, 51in long, is priced at 24 guineas (plinth extra). The mounting board for the pick-up and turntable measures 19in by 18in. Model PE34 four-speed transcription turntable and arm, distributed in the U.K. by Howland-West, now retails at £30—considerably below the original price.



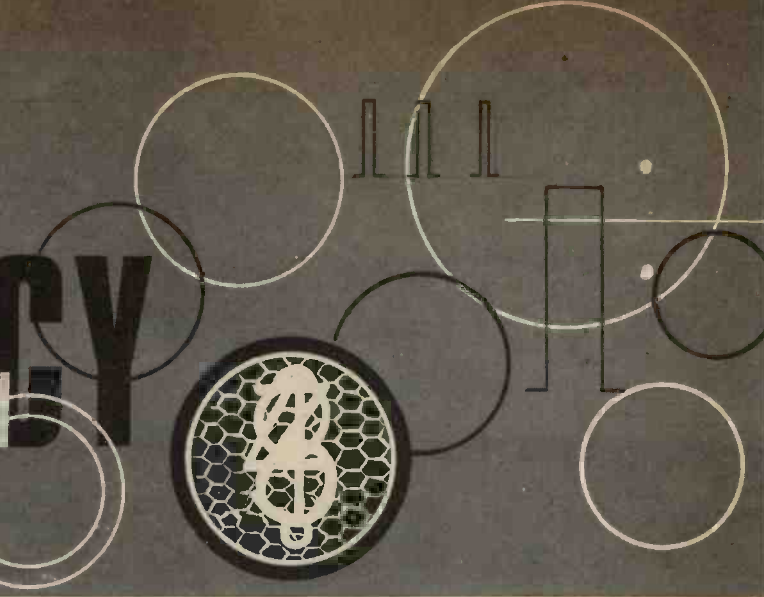
Model PE34 four-speed turntable unit.

This firm is also importing Barzilay cabinet kits from the U.S.A. The imposing equipment consoles, substantial and built to luxury standards, are mostly expensive, but there are large (6cu ft) loudspeaker enclosures which sell at a little over £70 a pair. Hand finished, oiled walnut is standard for these cabinets.

A British firm making high class furniture of specialised type is Balmforth and Battye, The Forge, Marland, Rochdale. Elegant cabinets, made in two sizes, are supplied for practically any combination of hi fi units. A new venture is an efficient horn enclosure for Lowther PM6 or PM7 drive units. Priced at £22 the enclosure contains a folded horn of 9ft total length, but the external dimensions of the cabinet are quite moderate. The weight of this model, 56 pounds, gives an idea of the robust construction.

J.D. LOCKE A.M.I.E.R.E.

FREQUENCY DIVISION



LAST month, various pulse circuits for driving Dekatron clock counters were described. Here we go on to see how the divider circuits can be matched to a display.

NUMERICAL DISPLAY

There are two main types of numerical display: high voltage discharge tubes and low voltage incandescent lamp displays. In general, it is simpler to use the first group with decade counters and the second group with transistor counters and we will proceed on this assumption.

Now let us see what the display circuits of the clock have to do. We want a count of 0 to 9 and 0 to 5 to display the minutes and 1 to 12 to display the hours (or 0 to 23 on a 24-hour clock). Once again this means using frequency divider circuits. The only difference is that we want to know the state of the count at any instant.

Using binary circuits (the flip-flops already considered) there are two ways of doing this:

Method 1 (divide by 10 as an example)

The binary divider shown in Fig. 15 divides by 10. A "truth table" is shown giving the output conditions of each divide by 2 circuit for each input pulse. A "0" signifies no output and a "1" signifies an output. One has to be careful here; "0" output means that the output transistor is off, therefore the output voltage is highly negative; "1" output means that the output transistor is on therefore the output voltage is a very low negative voltage.

The conditions shown in this table must then be interpreted to light the appropriate number lamp; to light lamp 4 "A" must be on, "B" must be off, "C" must be on, and "D" must be off. This is expressed as $A\,\overline{B}\,C\,\overline{D}$. The bar over the B and D means "not B" and "not D". The "not" output is taken from the opposite transistor to that giving the normal output in the flip-flop. This is shown in Fig. 16.

Table 1

Input Pulse Number	Output from D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	1
5	0	1	1	0
6	0	1	1	1
7	1	1	0	1
8	1	1	1	0
9	1	1	1	1

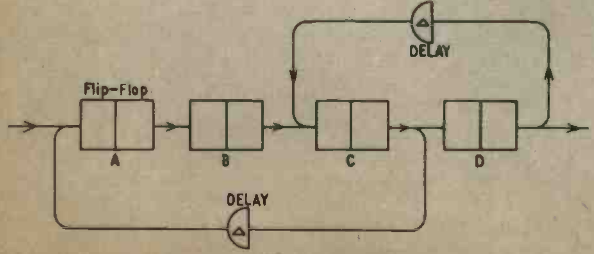


Fig. 15. Binary divide by 10 circuit

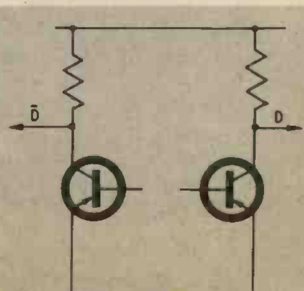


Fig. 16. The NOT output D and normal output D from a flip-flop

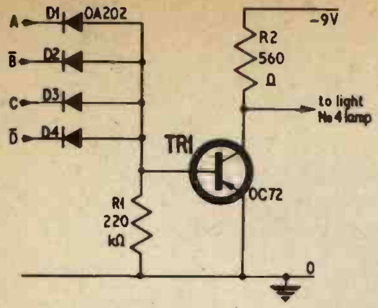


Fig. 17. Transistor AND circuit

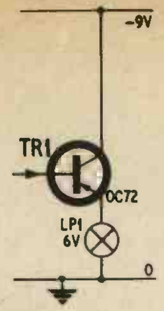
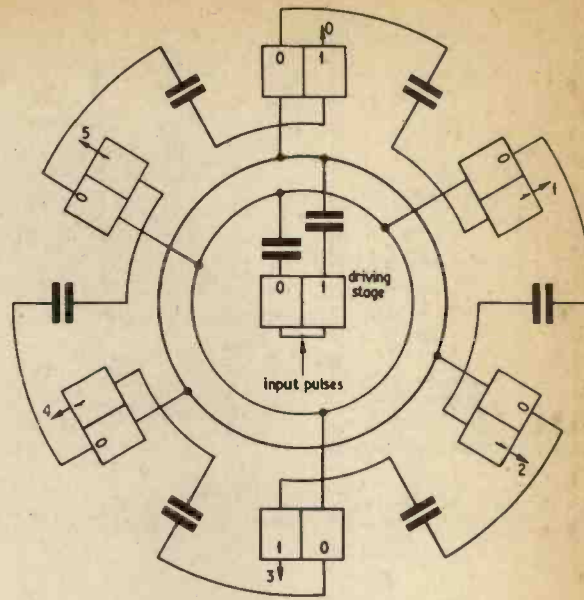


Fig. 18. Emitter follower for a 100 mA bulb



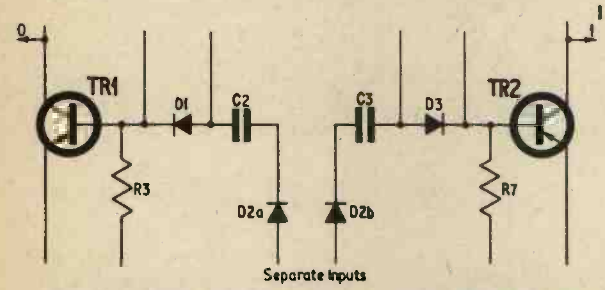


Fig. 20. Modified inputs (see Fig. 1) for the ring counter

Fig. 19. Ring counter for driving six lamps

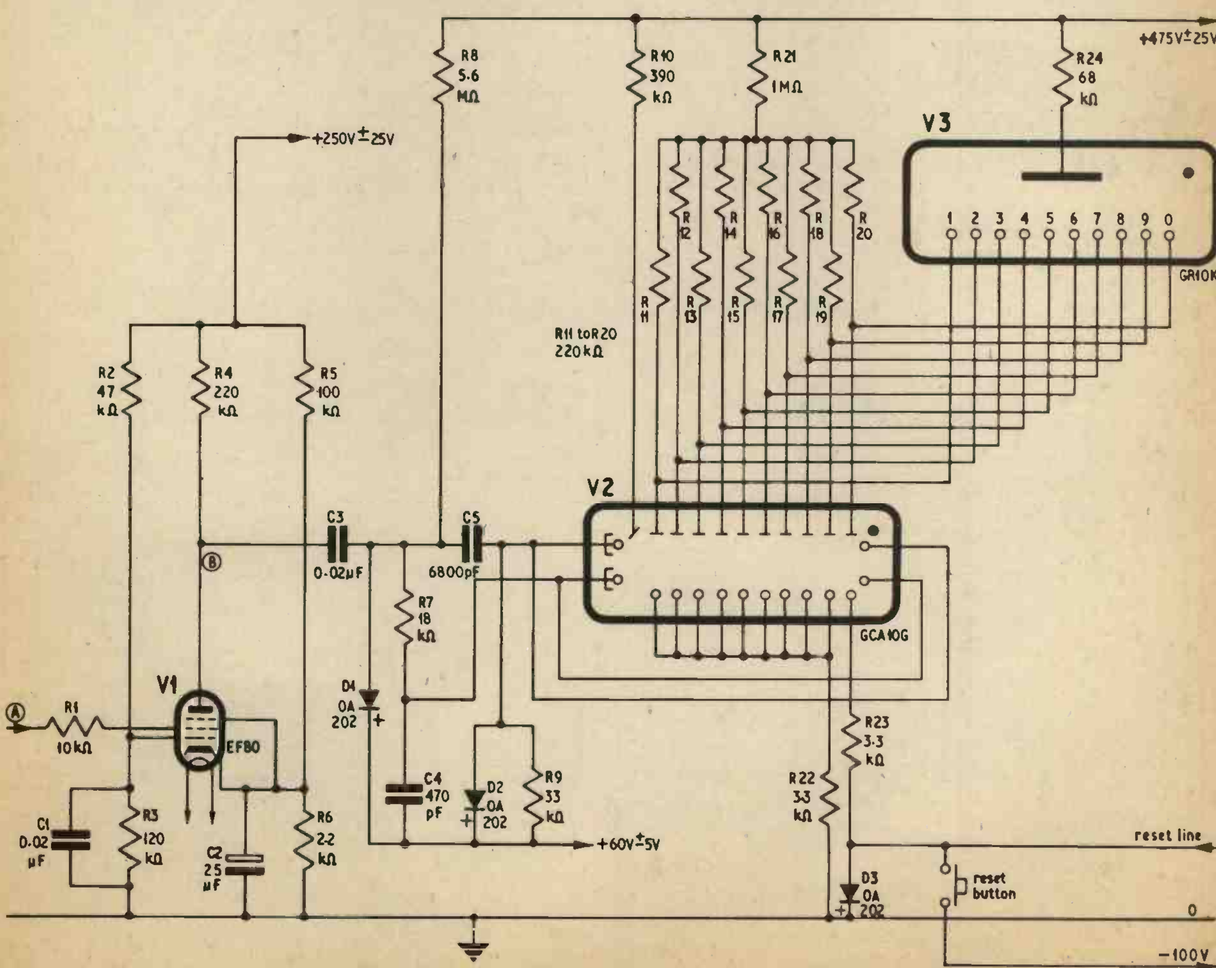


Fig. 21. Indicator drive stage using a Dekatron and Digitron

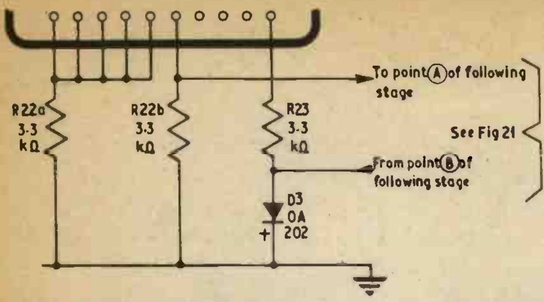


Fig. 22. Output taken from cathode 6, inverted and fed back into the reset line

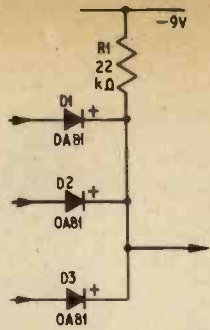


Fig. 25. OR circuit for three inputs

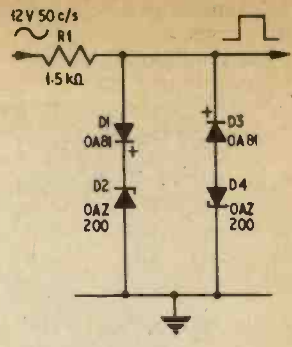


Fig. 26. Squarer for flip-flop drive

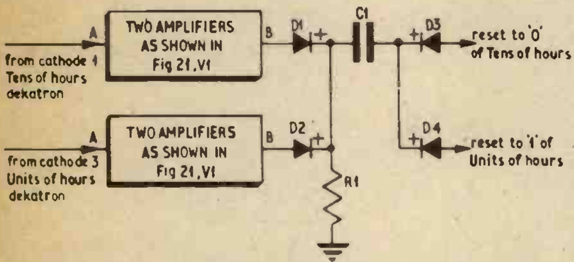


Fig. 23. Inversion of the hours output

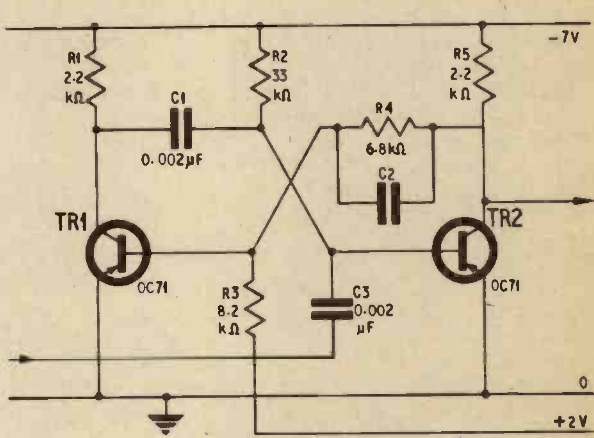


Fig. 27. Delay circuit

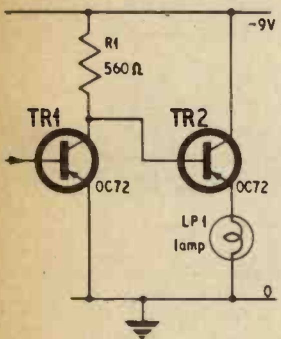
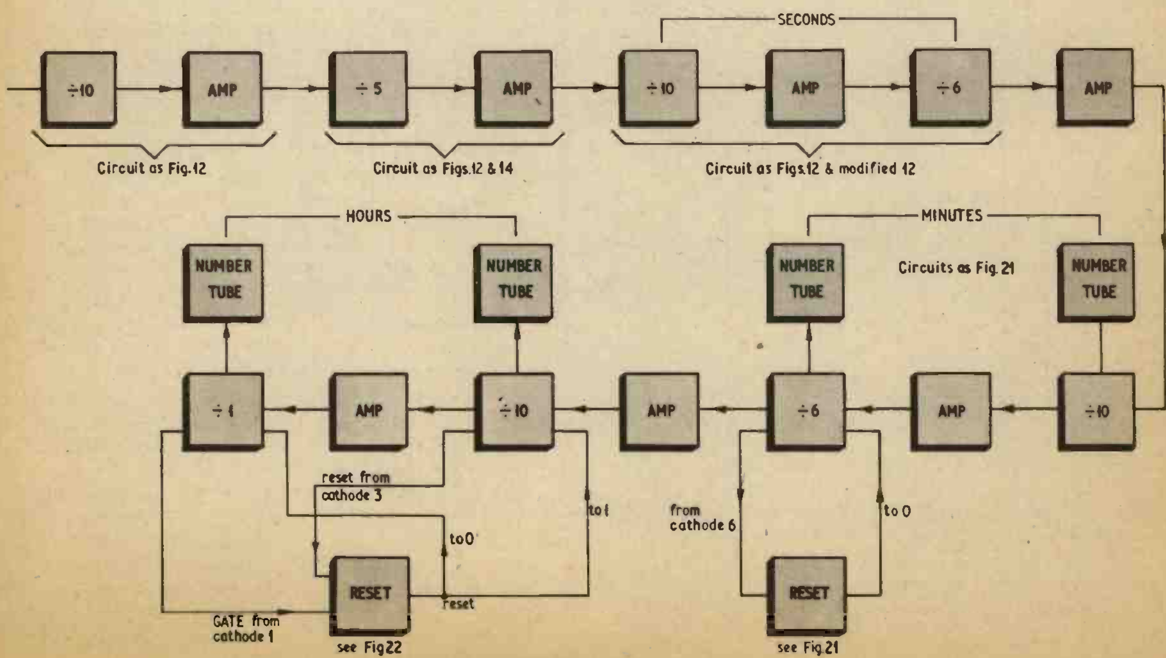


Fig. 24. Lamp driver for ring counters

Fig. 28. Block diagram of an electronic clock using Dekatrons



Having found which circuit conditions have to light the lamps, we have to find a circuit which will satisfy these conditions and also provide enough power to light the lamps. An AND circuit will do the first and an emitter follower will do the second. The AND circuit is shown in Fig. 17.

The transistor will be nearly cut off and its collector voltage will be high only if all the inputs are in the "1" condition. The output of the transistor is then fed to an emitter follower to give current amplification sufficient to drive a lamp (in this example 6V, 0·1A) (Fig. 18).

RING COUNTER

The arrangement described above requires a large number of diodes, 112 for the AND circuits, but only 15 flip-flops for the display. There is an alternative method which uses more flip-flops but no extra diodes. This method is basically a ring counter made up of flip-flops, only one of which will be on for each lamp lit.

An example of a ring counter, one for driving 6 lamps (0 to 5 for tens of minutes) is shown in Fig. 19. Notice that the inputs to all the outer flip-flops are split, i.e. separate inputs to each transistor. Thus the input to the circuit shown in Fig. 1 has to be modified as shown in the redrawn section, Fig. 20. The two outputs labelled "0" and "1" are the outputs from TR1 and TR2 respectively.

The operation of the ring counter is as follows: assume that stage 2 is on and all other stages are off, i.e. TR2 is in the "1" state and all the other stages are in the "0" state, including the driving stage.

The next input pulse switches the driving stage to "1". This feeds a pulse to the outer ring to drive all those connected to it to "0". The only stage to be affected is stage 2. This then produces an output from its "0" terminal which will switch on stage 3. The next input pulse switches the driving stage from "1" to "0", producing a pulse on the inner ring, which switches off stage 3 and in turn switches on stage 4. Once again, a current amplifier is required to drive the lamps.

The final method of indicator drive is by using a Dekatron to drive a Digitron. This is shown in Fig. 21. This circuit is only suitable for counts from 0–9 and not for 0–5 and 1–12 as are also required for the clock display. For a count of 6, an output must be taken from cathode 6, inverted and fed on to the reset line, as shown in Fig. 22.

In order to obtain a count of 12, a further stage is required. An output from cathode 1 of this extra stage is used to "gate" an input which is obtained from cathode 3 of the previous stage. The output of the gating circuit provides a reset pulse to reset the additional stage to "0" and the previous stage to "1". Thus as soon as the indicators try to go to 13 they are reset to read 01.

Figs. 23 to 27 are supplementary circuits used in building up a complete clock such as shown in Fig. 28.

The circuits given will form a good basis for a clock but may need adjustments to get the best out of them.

Power supplies are not shown but are conventional and will be well within the compass of anyone attempting a project of this kind. It is stressed that the circuits given are only intended for guidance for the experimenter.

The estimated cost of the transistor version would be about £75, for the Dekatron version £25, excluding hardware. ★

Book reviews

RAPID SERVICING OF TRANSISTOR EQUIPMENT
By Gordon J. King
Published by George Newnes Ltd.
151 pages, 8¾in × 5½in. Price 30s

ALTHOUGH this book is aimed primarily at first year students, service technicians, and enthusiastic amateurs, the author avoids the usual lengthy comparisons between valve and transistor circuits, thereby saving valuable space for a more direct treatment of up-to-date equipment. The emphasis, as the title suggests, is on fault finding, but there is a great deal of general information in the text to interest the casual reader.

The contents are as follows; transistor fundamentals, d.c. tests, signal condition testing, audio amplifiers with a disappointingly short section on video amplifiers, a good chapter on r.f. testing which includes u.h.f. tuners and boosters, tape bias/erase and other lowish frequency oscillators, radios, and a brief look at hi-fi amplifiers. Some of the circuit examples have component values and five fault diagnosis charts are provided. The concluding chapter, after a discussion of test equipment, becomes severely practical with printed circuit and soldering advice, and a list of "don'ts" for the unwary.

The index does little to help the reader, but clear paragraph headings will make a search for information more rapid than the time it takes to cure a fault. The book is well produced on semi-glossy paper with a durable cover, and it contains photographs.

D.B.

COMPUTER BASICS—INTRODUCTION TO ANALOGUE COMPUTERS
Published by Foulsham-Sams
288 pages, 8¾in × 5½in. Price 30s

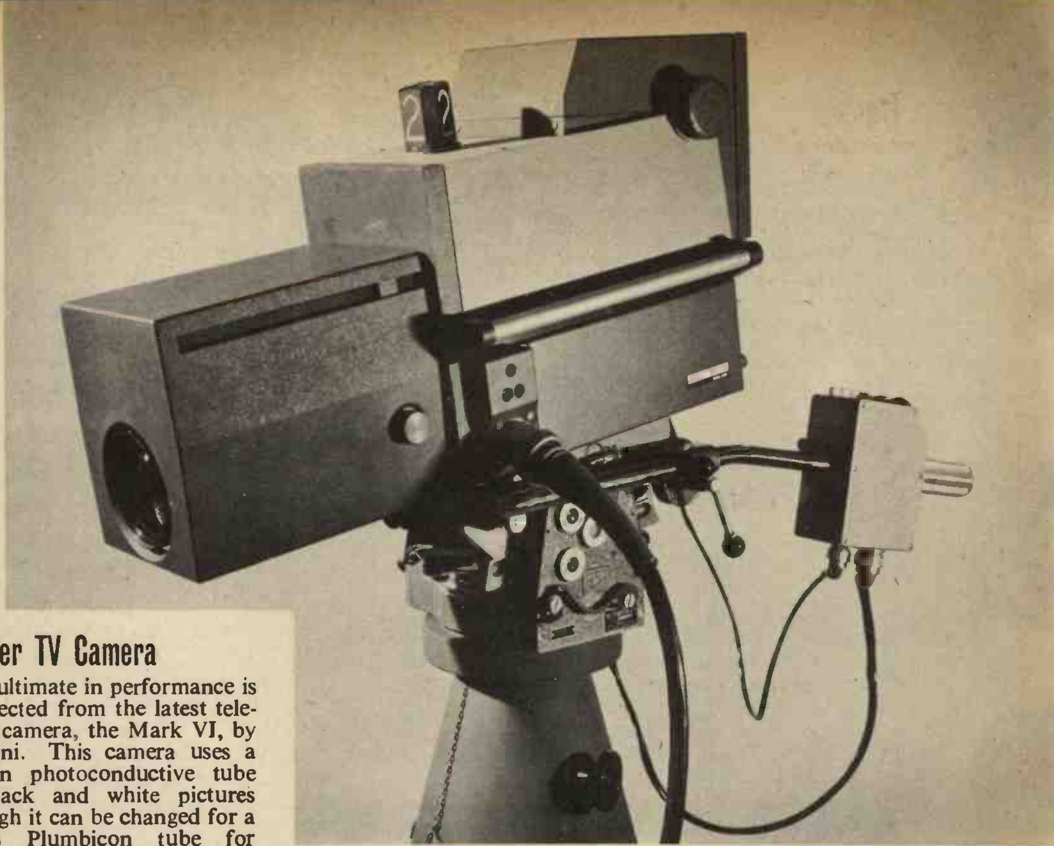
THIS VOLUME, which is of U.S. Navy origin, is only the first of a series of five books and this may explain some otherwise inexplicable peculiarities. Certainly, it came as a slight shock to find a book, supposedly on computer design, which did not contain a single circuit diagram of any sort. Throughout the book the emphasis is almost exclusively on mechanical means of calculation with lengthy discussions on the wheel-and-disc integrator, differential gear systems, the cam, and related devices. Apart from the occasional mention of electrical-mechanical analogies the subject of electronic calculation is left untouched. In fairness, though, it would seem that this deficiency is at least partly corrected in Book 2, the contents of which include a chapter on electronic calculating devices.

In addition to the descriptions of purely mechanical calculators there are chapters on basic and advanced computer mathematics which in some places become very advanced indeed.

By itself this book is of little value to those wishing to learn about the principles of electronic analogue computers, although coupled with Book 2 it would probably be appreciably better. On the other hand for anyone wishing to investigate the properties and capabilities of mechanical analogue devices it should be of considerable use and can be recommended.

S.T.A.

ELECTRORAMA



Cheaper TV Camera

The ultimate in performance is expected from the latest television camera, the Mark VI, by Marconi. This camera uses a Vidicon photoconductive tube for black and white pictures although it can be changed for a Philips Plumbicon tube for special applications. The use of photoconductive tubes simplifies the associated circuitry, reducing both capital and operating costs.

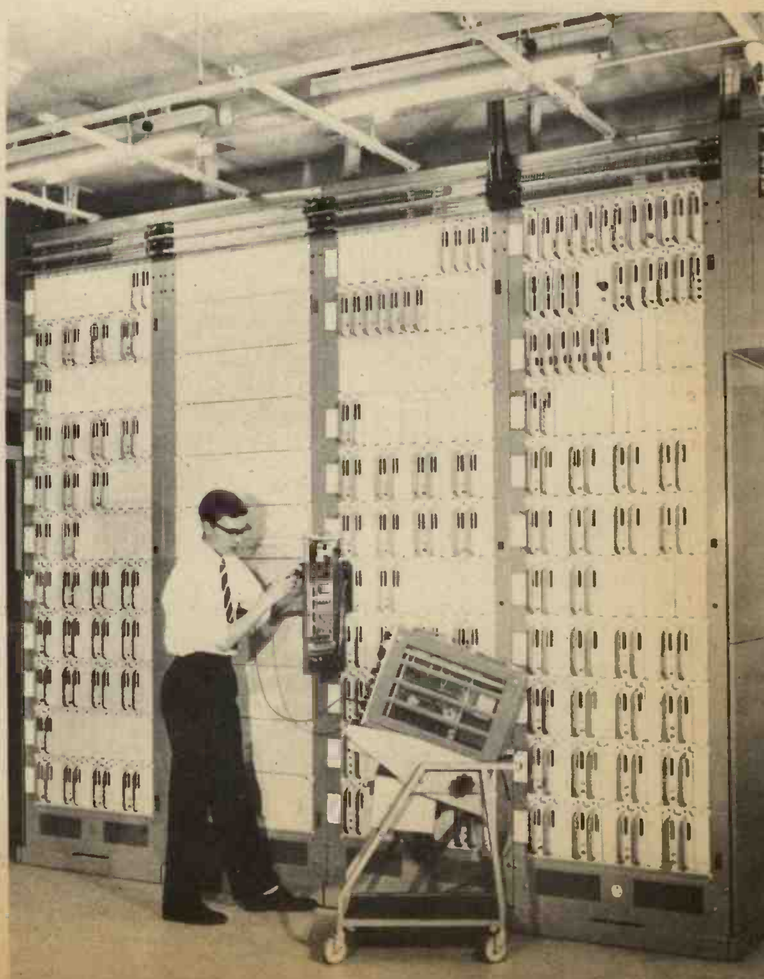
Electronic Exchange in Service

The first production electronic telephone exchange, Pentex TXE 2, was brought into public service on December 15 at Ambergate, Derbyshire, by the Postmaster-General. This new system relies on reed relay switches instead of the conventional types. It vastly cheapens relay production and improves reliability. However, this lower cost is offset by using sophisticated pulse circuitry which gives higher speed line location.

Dialled digits are stored until the final digit is registered, then the complete code finds the required line in 50 milliseconds. Faults are detected automatically and the exchange finds another path and prints out the fault on paper tape for servicing engineers.

It is possible in electronic PABX installations that the caller can dial direct into the required extension. Although Ambergate carries only about 900 lines at present, a "large" exchange version (more than 2,000 lines) is expected to be ready later this year.

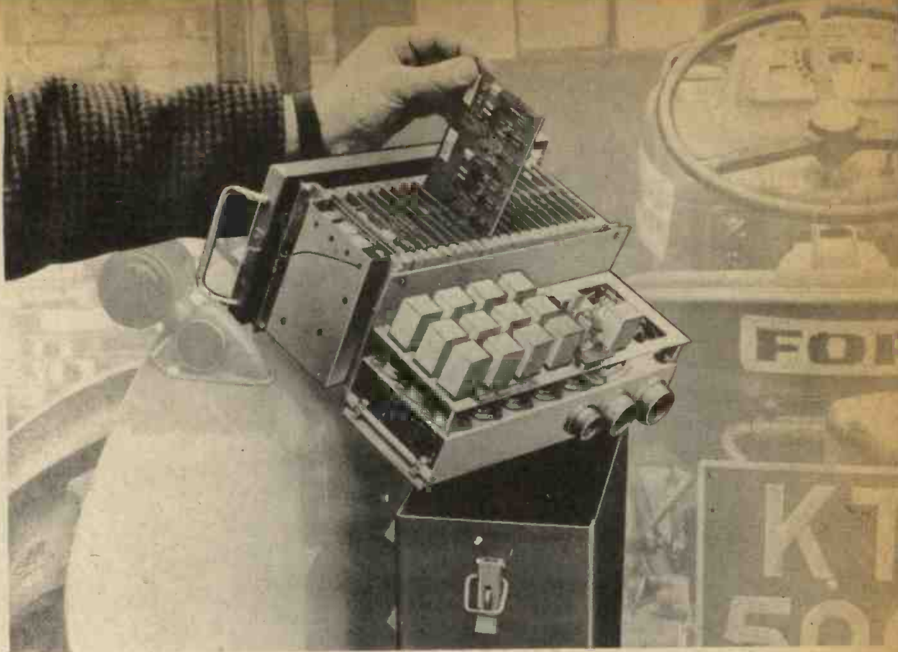
The equipment is built by Ericsson Telephones, one of the Plessey Group of Companies, to Post Office specification.

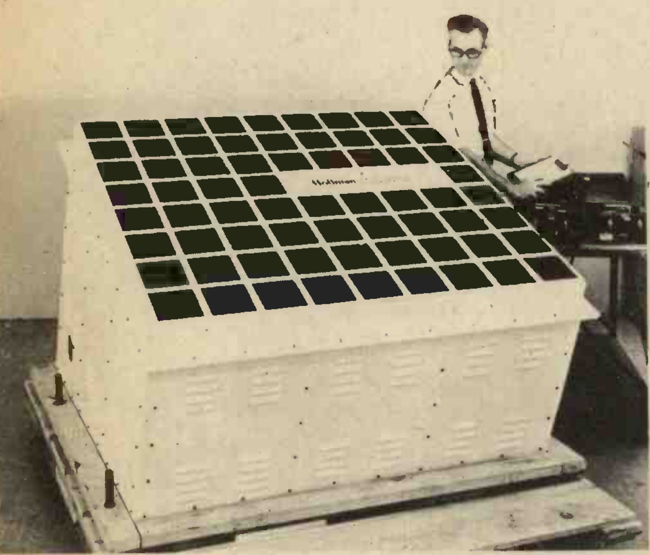


Ghost Tractor

A NEW development in farming in this country is this remote control farm tractor. The unit here has been lifted out of its housing on the back of a tractor to show a 28-channel digital receiver built up on plug-in Veroboards.

Information is transmitted in binary code by on/off bursts of carrier. A memory store retains any required operation in the "on" or "off" state until a "change" signal is received. The electronic control system is the work of C. & L. Developments of Weybridge in conjunction with the Ford Motor Company.





Solar Cell Television

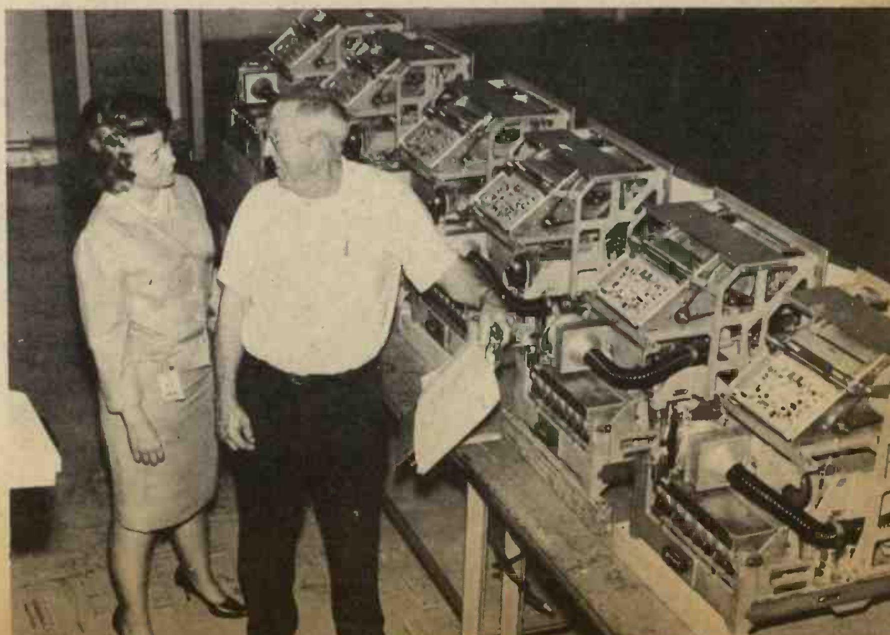
THE FIRST sun powered television translator to cover areas where a signal is weak or non-existent is being installed in Jamaica. It is designed by T.I.E. (Communications) Limited using components manufactured by Hoffman Electronics Corporation, Marconi Company Limited, and Nife Limited.

The first installation has been deliberately located in an accessible area so that data from its operation can be easily received and evaluated. Subsequent installations will tend to be in remote areas, where mains electricity does not exist and where the provision of fuel and maintenance for engines is both difficult and expensive.

The Jamaica installation, opened in December, demonstrated for the first time that a television picture can be made available for some eight hours a day, or more, relying on sunlight as the only source of power.

Missile Use Teleprinters

A ROW of advanced communications equipment bearing a resemblance to a line of slot machines are seen here at the Aerojet-General plant in California. The devices are actually teleprinters awaiting assembly into flight communication systems for installation at U.S. Air Force Minuteman ballistic missile launch sites.



THE R1155 Classic

Origin

When in 1940 the new R1155 receiver (with its companion T1154 transmitter) was released in small numbers to units of the R.A.F., its advent was greeted with surprise delight by signals personnel, for nothing quite like this had been seen (or heard) before. Offering one-knob operation allied to high performance, it brought about a revolution in the technique of air to ground communication, hitherto performed largely with the TR1082/1083 combination that used a t.r.f. receiver with adjustable reaction and 2 volt battery valves!

In later years the R1155 came under the shadow of receivers more recently developed and offering such improved facilities as greater audio output and a crystal filter. This situation, although depressing the post war selling price of the R1155, has added to the attractiveness of the receiver to persons desiring to embark on short wave reception at minimum cost.

Like most classic communication receivers the R1155 went through many "marks" of which the most important from the private listener's point of view is the R1155N, a variety introduced for air to surface vessel communication. Because this version covers the 160 metre amateur band it generally fetches a pound or two more than other varieties. On the "N" version the four most populated amateur bands occur, namely, 1·8Mc/s, 3·5Mc/s, 7Mc/s and 14Mc/s. For the 21 and 28Mc/s bands an external converter(s) would be needed, as also for the v.h.f. bands (see important note under "Modifications" below).

Basic Circuit

One r.f. amplifier	VR100 (KTW63)
Mixer	VR99 (X65)
Two i.f. amplifiers, both	VR100 (KTW63)
Beat oscillator and a.g.c. diode	VR101 (DL63)
Demodulator and audio amplifier	VR101 (DL63)
Tuning indicator	V1103 (Y61)

COMMENT: If the R1155 is purchased unmodified three valves additional to the above will be found on the chassis. These are associated with the direction finding facility and have little or no value for amateur band reception. Their removal provides enough space for a small transistorised v.h.f. converter to be installed, or a 100kc/s calibration oscillator. Although all valves are conveniently 6·3 volt types it is well to check through all heater lines to ensure that none are in series-parallel modes.

Waveranges Covered

(Standard version)
75kc/s to 200kc/s.
200kc/s to 500kc/s.
600kc/s to 1,500kc/s.
3,000kc/s to 7,500kc/s.
7,500kc/s to 18,500kc/s.

Intermediate Frequency

560kc/s (It will be noted that a gap has been left for the i.f. in the above tuning ranges).

Power Requirements

A small power unit delivering 60mA at 220 volts and 2·5A at 6·3 volts will be adequate if the receiver is used "as is" but with the three D/F valves removed. If an output stage is added for loudspeaker operation the power requirements will rise to about 3A l.t. and 100mA h.t.

SPECIAL NOTE: The h.t. negative rail of the R1155 is *not* at chassis level, a biasing resistor being interposed. A separate h.t. negative point is on the 8-way power input plug on the front panel and any power unit used externally should be connected to this.

Controls

It is the big crescent shaped tuning scale that gives the R1155 its immediate recognizability. All bands are visible at a glance, and the big pointer may be set at once with a direct drive knob to the area it is desired to tune. A second concentric knob gives slow motion tuning of that area. For quick frequency setting this receiver has advantages over certain other subsequent sets in which laborious winding of the tuning knob is necessary to reach a desired frequency area.

In this, the fifth article in our short series dealing with classic communication receivers, we come to a well known British model, popularly called the *Marconi Eleven Fifty Five*. Being obtainable more cheaply than many other receivers of similar age and performance, the R1155 is particularly attractive to younger purchasers wishing to embark on short wave listening for the first time.

Readers acquiring this model are recommended once again, as in previous articles in this series, to obtain at the time of purchase at least a circuit diagram together with as much other technical literature about the receiver which the vendor is able to provide.

It should be noted that handbooks for receivers featured in this series are often available from advertisers.

COMMUNICATION RECEIVERS

COMMENT: Unfortunately, the amateur bands, which will be the main preoccupation of most users of the R1155, are rather cramped and can be passed over with only a few turns of the slow motion drive. There is certainly a case for utilising external converters for all bands except "160" and "80", and using the set solely as an i.f. strip to give improved bandspreading. And because "160" occurs only on the R1155N an external converter for that band, too, may be worth considering.

Apart from the tuning control and wavechange switch, the only other controls requiring attention are the volume control, the b.f.o. pitch control (a trimmer just above the main scale), the master switch bottom right, which selects a number of functional operations, of which only the "AGC ON" and "AGC OFF" are of importance to the amateur user, and the audio filter, bottom left.

Recommended Basic Modifications

Additional Audio: In its airborne applications the R1155 was required only to feed aircrews' headphones. If a 6V6 output stage is built into the case to furnish high level audio it can conveniently occupy one of the redundant D/F valve sockets, suitably rewired.

Aerial Input: In Service applications pin 2 received a long wave aerial, and may be ignored. For short wave reception pin 1 of the front panel 8-way socket is the correct one to use. If external converters are to be employed it will be desirable to trace back the lead from pin 1 to its tapping on the r.f. stage grid input coil, and to substitute for it a length of 80 ohm coaxial cable brought to a panel mounting coaxial socket on the front. Only by this means will it be possible to minimise i.f. breakthrough caused by reception on the receiver's main tuning range.

Mute Switch: It is desirable to fit a toggle switch on the front panel to cut the h.t. positive line; or if the set is to be used alongside a transmitter a small relay can be fitted inside the case, arranged for the contacts to be closed to apply h.t. during receive periods.

Separating the Gain Controls: Many users like to do this in order to facilitate reception of single sideband signals. The existing ganged r.f. and a.f. controls can be readily separated; or one of them put out of commission, its leads wired to a new gain control of like value mounted on the front panel.

Redundant D/F Valves: If these and their associated components are removed the heater connections to socket pins 2 and 7 may conveniently remain to facilitate subsequent adaptation of these valve sockets to such purposes as audio output stage or crystal calibrator.

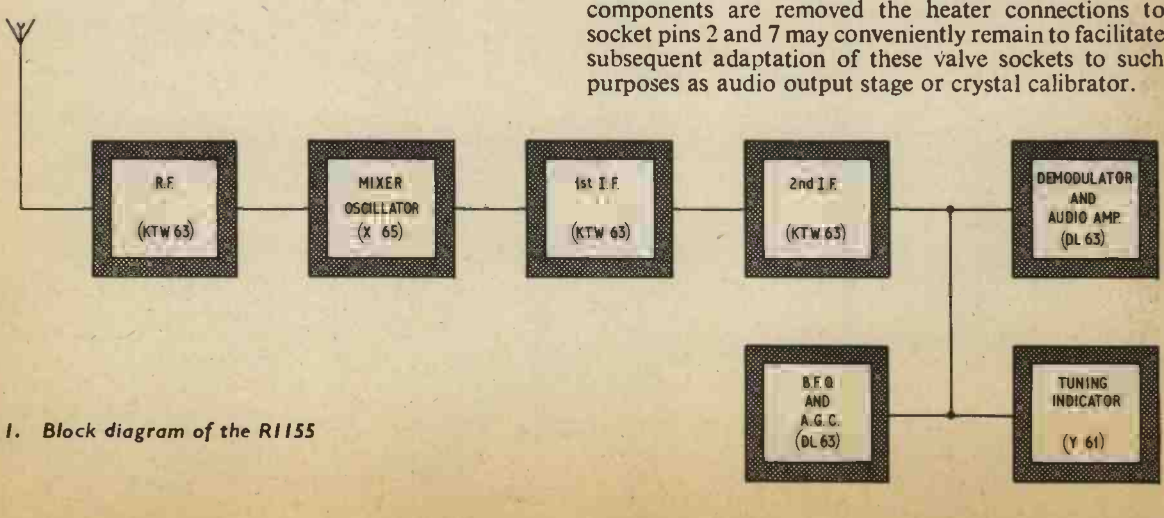
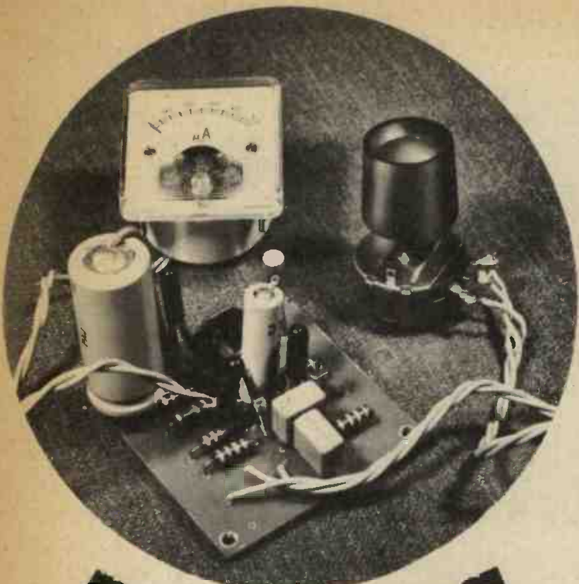


Fig. 1. Block diagram of the R1155



recording LEVEL indicator

by A. M. GRUNDY

ALTHOUGH recording level meters are standard equipment on some of the more expensive tape recorders, many cheaper, and older recorders still use the magic eye to perform this function. It is true with some older machines that after long periods of use, the "eye" suffers from low emission and becomes dull.

Peering at the small segments of, for example, an EM34 can be rather trying and one longs for the clear indication of a meter. A meter is useful for giving reference levels of the matter to be recorded. The unit described here is a simple circuit for fitting in any tape recorder.

CIRCUIT

The circuit diagram is shown in Fig. 1. The first stage is an emitter follower, to give the unit a high input impedance so that it will not in any way affect the recorder circuit with which it is used.

The second stage is, at first sight, an ordinary common emitter amplifier. Closer inspection reveals that R3, the base bias resistor, is of a high value, 1 megohm. This means that TR2 is only just conducting; the base-emitter junction is acting as a diode, rectifying the a.c. input from TR1 and giving a d.c. output at TR2 collector.

Zero drift is slight, and may only be caused by changes in ambient temperature, as the voltage is stabilised by the Zener diode D1. However, a "set-zero" control, VR2, is supplied to make any adjustment to the zero calibration if this becomes necessary.

The time constant of the meter is the time t taken for the meter to fall to 0·37 of its initial value, as shown in Fig. 2, and is dependent on the value of the internal resistance of the meter R_m and C_4. The relationship is given by the formula $t = C_4R_m/10^6$ seconds, where R_m is in ohms, and C_4 is in microfarads.

Using a typical 500μA movement, with an internal resistance of 500 ohms, and C_4 at 250μF, the time constant is 0·125 seconds (nominal). The tolerance of the meter and the capacitor will modify this slightly.

It was found that this value was the most satisfactory, as it gave indication of sharp music transients, without flicker at low frequencies. Other designs investigated

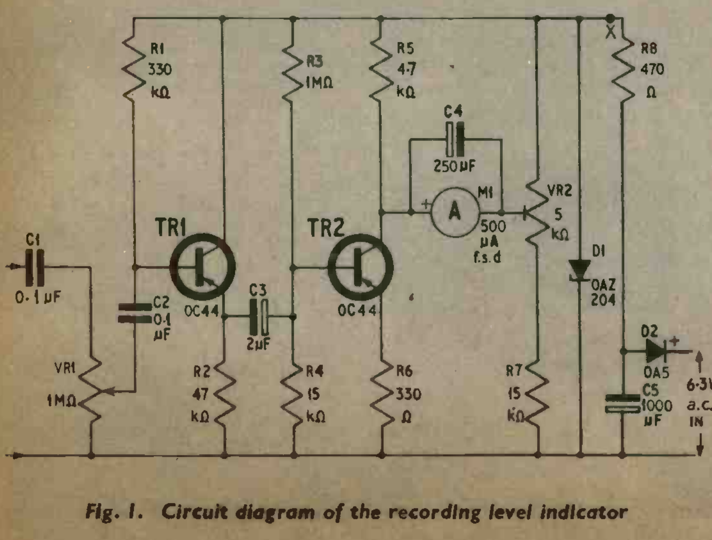


Fig. 1. Circuit diagram of the recording level indicator

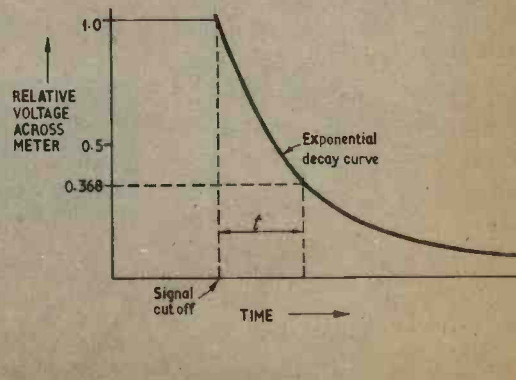


Fig. 2. Time constant characteristic of the meter

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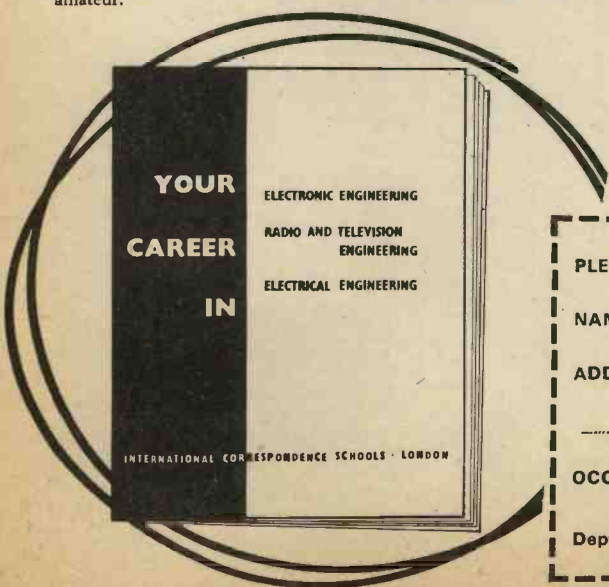

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I.F.P50/2CC 470 kc/s	5/7	Printed Circuit, PCA1.	9/6
3rd I.F. P50/3CC	6/-	J.B. Tuning Gang	10/6
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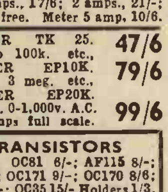

For PHILIPS 19TG111A, 121A, 125A, 142A, 23TG111A, 113A, 121A. 131A,S TELLA ST1033A 39A, 43A, 53A. COSSOR CT1910A, 21A, CT2310A, 21A, 31A
PHILIPS Price 3 gns.
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4 watt. 2 stage. 3 to 7 ohm. Neg. feed back. UCL82. UY85. 200-250v. A.C. tapped input. Chassis size 8 x 2½ x 4in. high. Gold/Walnut knobs. Volume and Tone controls on separate Polished Wood Panel 6 x 2in. Brand new with makers' guarantee. BARGAIN PRICE P. & P. 1/6. **78/6**

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4/350 v.	2/3	250/25 v.	2/6	16/600 v.	12/6
8/450 v.	2/3	500/15 v.	3/-	16+16/500 v.	7/6
16/450 v.	3/-	8+8/450 v.	3/6	32+32/450 v.	6/-
32/450 v.	3/9	8+16/450 v.	3/9	50+50/350 v.	7/-
25/25 v.	1/9	16+16/450 v.	4/3	60+100/350 v.	11/6
50/50 v.	2/-	32+32/350 v.	4/6	100+200/275 v.	12/6

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HEATER TRANS. 6.3 v. 1½ a., 7/6; 6.3 v. 4 a. 10/6
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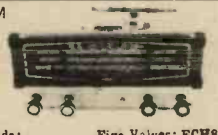

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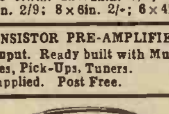

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Bass Res.	40/50 cps.
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Chassis Solid Aluminium	
Overall dia.	12½ in
Overall depth	6 in

PRICE **£8** POST FREE

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Practical Radio Inside Out	4/6
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5 watt, 10 watt, 15 watt — 0.5 to 8.2 ohm 3 w. WIRE-WOUND RESISTORS 10 ohms to 6,800 ohms — 1/6, 1/9, 2/-
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WIRE-WOUND 4-WATT STANDARD SIZE POTS. LONG SPINDLE VALUES 50 OHMS to 100 K., 7/6.

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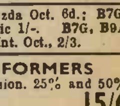

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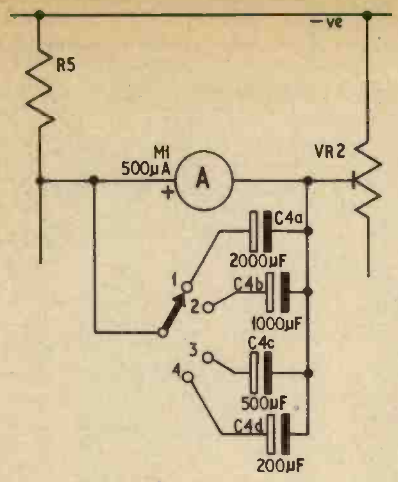

Fig. 3. A pre-selected switching arrangement providing four different time constants. Table I

by the author had much larger time constants. If this is found desirable the value of C_4 can be modified to suit. Table I gives values of C4 for some different values of t, for a 500 ohm meter.

Table I. R_m = 500 ohms

t (sec.)	0·1	0·25	0·5	0·75	1·0	2·5
C_4 (μF)	200	500	1000	1500	2000	5000

If a meter of different resistance is to be used, or if t is not covered by Table I, the value of C4 may be calculated by the formula,

$$C_4 = \frac{10^6 t}{R_m} \mu F$$

where t is in seconds and R_m is in ohms.

Fig. 3 shows a method of wiring in a selection of values for C4 using a rotary switch.

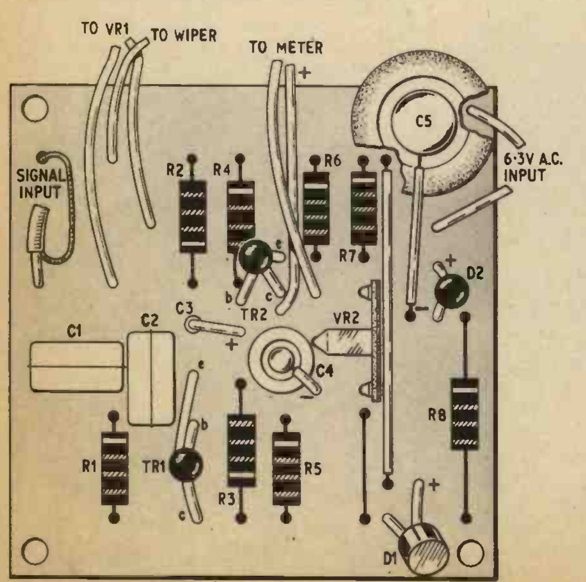

Fig. 4a. Component layout on s.r.b.p with connections to the input, VR1, and 6·3V a.c. supply

Components . . .

Resistors
R1 330kΩ
R2 47kΩ
R3 1MΩ
R4 15kΩ
R5 4·7kΩ
R6 330Ω
R7 15kΩ
R8 470Ω
All 10%, ¼ watt carbon

Potentiometer
VR1 1MΩ log. carbon
VR2 5kΩ linear, preset carbon skeleton

Capacitors
C1 0·1μF polyester 250V
C2 0·1μF polyester 250V
C3 2μF elect. 15V
C4 250μF elect. 6V (see text)
C5 1000μF elect. 15V

Transistors
TR1, TR2 OC44 (2 off) (Mullard)

Diodes
D1 OAZ204 (6·2V Zener) (Mullard)
D2 OA5 or OA10 (see text)

Meter
M1 500μA moving coil

Miscellaneous
Cir-kit adhesive copper kit (see page 96)
Screened cable for input
P.V.C. wire

CONNECTING TO THE RECORDER

The take-off point from the recorder to the unit can be the grid tag of the magic eye valveholder but, if preferred, it can be the anode or grid of the output valve which feeds the recording head. Screened wire is recommended to avoid misleading readings due to hum. Connect the screen to chassis.

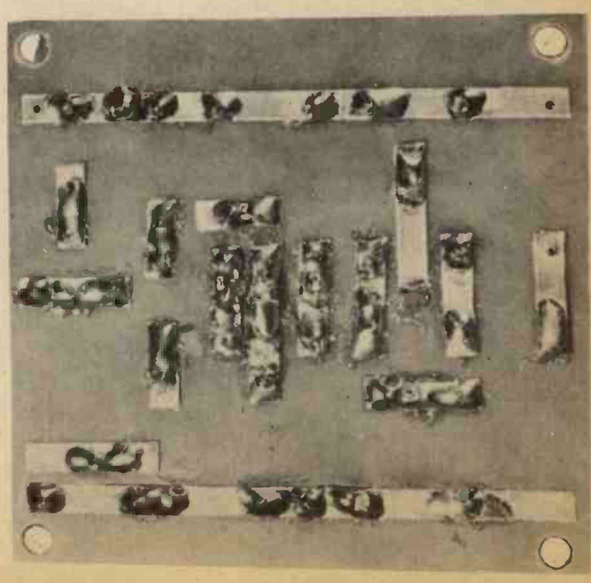

Fig. 4b. Cir-kit is stuck to the underside in strips to give the required connections between components

The unit has a high input impedance and plenty of sensitivity (0·6V minimum for f.s.d.). If the signal is taken from the anode, a setting of only a quarter of f.s.d. is needed. The frequency response is substantially flat from 10c/s to above 50kc/s.

Power for the meter circuit can be obtained from a simple half-wave rectifier, which is run off the 6·3V a.c. heater line. The voltage is stabilised by D1, a Zener, to avoid mains voltage variations affecting the sensitivity. Alternatively, the unit may be powered from a 6V battery, such as PP1 or four-pen cells. The life of a battery will almost equal its shelf life, since the current drain is only about 2mA.

Diode D2 is given in the components list as an OA5 or OA10; however, the base-emitter or the base-collector junctions of a transistor such as an OC72 may be used, the base being the cathode.

CONSTRUCTION

Having located suitable signal, earth and heater take-off points (a circuit diagram of the recorder is useful here), if a continental D.I.N. pattern 3 or 5 way socket can be added to the recorder, then the level meter may be connected via twin screened microphone cable. The prototype was finally fitted into the recorder, but any suitable case will suffice.

The circuit was built up using the Cir-kit technique (see page 96); the layout diagrams are shown in Fig. 4.

SETTING UP

Having connected up the unit to the recorder, set VR1 to the *earthy* end of its track, and VR2 to the *negative* end of its track. Switch on the recorder and check the voltage on the negative line (point X on Fig. 1). This should read about 6V. The meter M1 should read around 100 to 150, providing VR2 is set in the above condition.

Adjust the set zero control VR2 to bring the pointer to zero and then set the recorder controls to "record". Inject, at the recorder input, an audio tone of about 400c/s from a signal generator, being careful not to overload the pre-amplifier stage, and adjust the recording level control, so that the vanes on the magic eye indicate maximum signal level. Then adjust VR1, so that M1 reads 400.

On normal recordings of speech and music the needle should not rise above this. If desired, a red line may be painted on the meter scale at 400, to indicate the maximum.

The instrument could be used as the basis of an a.c. millivoltmeter. ★

INDEX

An index for Practical Electronics volume two (January 1966 to December 1966) is now available price 1s 6d inclusive of postage.

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Meetings . . .

INSTITUTION OF ELECTRICAL AND ELECTRONICS TECHNICIAN ENGINEERS

LONDON

Date: January 16
Title: Semiconductors for Power
K. G. King, D.F.H., C.Eng., M.I.E.E.
Time: 6 p.m.
Address: I.E.E. Lecture Theatre, Savoy Place, London, W.C.2.

BRISTOL

Date: January 31
Title: The Future of Telecommunications
D. A. Barron, C.B.E., M.Sc., C.Eng., F.I.E.E.
Time: 7.45 p.m.
Address: Large Conference Room, Council House, Bristol.

SOCIETY OF ELECTRONIC AND RADIO TECHNICIANS

BIRMINGHAM

Date: January 17
Title: Post Office Tower, London
K. J. Lonnon
Time: 7.15 p.m.
Address: University of Aston in Birmingham, Gosta Green, Birmingham, 4.

INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS

LONDON

Date: January 17
Title: Symposium on "Radio Microphones"
M. L. Gayford, G. R. Pontzen and R. W. Swain
Time: 6 p.m.
Address: London School of Hygiene & Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.

HORNCHURCH

Date: January 26
Title: Some Applications of Electronics to Oceanography
A. M. East
Time: 6.30 p.m.
Address: College of Further Education, Ardleigh Green Road, Hornchurch.

SOUTHAMPTON

Date: January 17
Title: Colour Television, S. M. Edwardson
Time: 6.30 p.m.
Address: Lanchester Theatre, University of Southampton.

(Sponsored by the I.E.R.E. and I.E.E.)

STAFFORD

Date: January 17
Title: Electronic Exchanges, E. S. Grundy
Time: 7.15 p.m.
Address: Stafford College of Further Education, Tenterbanks.

JOINT MEETING

Date: January 31
Title: Colloquium on "Adaptive Control For Aircraft"
Time: 2.30 p.m.
Address: I.E.E., Savoy Place, London, W.C.2.

This is a joint conference sponsored by I.E.R.E., R.Ae.S. and I.E.E. Tickets are available from I.E.E., Savoy Place, London, W.C.2.

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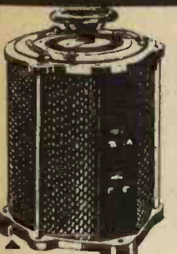

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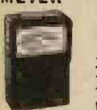

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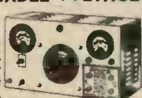

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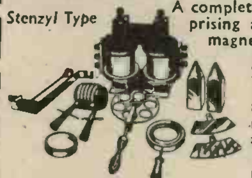

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Car BURGLAR ALARM System

By M. J. BUNCE

SEVERAL types of anti-theft devices for cars have appeared commercially, but these have two main disadvantages. Either they are relatively expensive or they give inadequate protection. Investigation shows that a simple ignition immobilising switch does not afford enough protection, as a skilled thief can easily overcome the action of such a device. What is required is a cheap device protecting two or more points of entry to the car in addition to an ignition immobilising switch. Such a device is described in this article.

PRINCIPLES OF OPERATION

The alarm sounding device used in this system, as in most conventional systems, is the car horn. When the driver leaves his car he actuates a concealed switch *outside* the car, which engages the alarm system. The alarm can be set off in several ways, as detailed below:

(a) If the thief forces open a window this tilts the car sufficiently to actuate one of several critically-placed mercury switches.

(b) If a skeleton key is used to open any door, the interior light switch closes and sets off the alarm.

(c) If the car is disturbed in any way (i.e. in a hit-and-run accident) the alarm is set off.

Any attempts to stop the alarm by getting out of the car or closing the door will be foiled by the action of a set of hold-on relay contacts in the system. The only disadvantage of this system may appear to occur if the car is parked on a hill. In practice, however, this does not arise, as the mercury switches are arranged in such a way that they are actuated only by sideways movement, as a car is rarely parked broadside on to a slope.

CIRCUIT DESCRIPTION

The only components used in the system are two or three mercury switches as required, a two-pole change-over relay, and a concealed switch of suitable type.

The circuit diagram is shown in Fig. 1, and the system operates as follows. When the car is left and the concealed switch S3 is actuated, the coil of the relay RLA is effectively connected, in series with the interior light (door) switch, across the car battery. The mercury switches S2, S3 etc. shunt the interior light switch, and to make the system completely foolproof a normally open relay contact (RLA2) is also connected in parallel with these switches. The mercury switches are normally "open", as is the interior light switch when the door is closed.

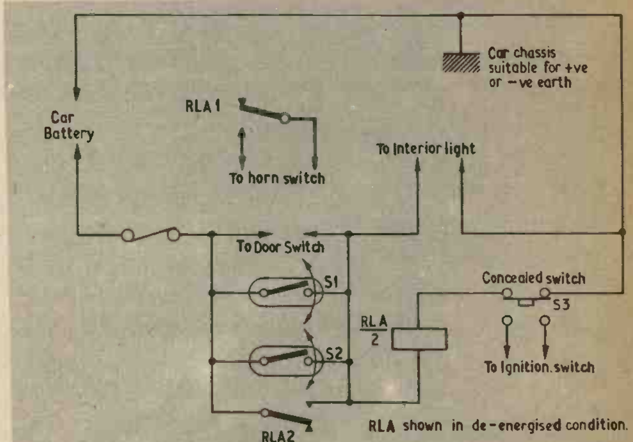

Fig. 1. Complete circuit diagram of the mercury switch (S1 and S2) alarm system

If the concealed switch S3 has a double-throw change-over contact, the open contacts can be connected in series with the ignition lead to the key switch on the dashboard. This effectively immobilises the vehicle when the alarm system is engaged, and makes the system even more satisfactory in operation.

One advantage of this system is that it uses no current whatsoever unless the alarm is actually operating.

When the alarm has been set off, the only way it can be silenced is by operation of the concealed switch S3, due to the action of the hold-on relay contact RLA2.

CONSTRUCTION

It is recommended that the alarm unit is built in a reasonably sturdy metal box secured in the engine compartment of the car. The box will house the relay and one mercury switch. Most electrical connections can be made here, with the possible exception of the horn switch contacts and, of course, the interior light lead. The connections to and from the unit can be made via an octal plug and socket with a suitable cable harness. If several mercury switches are required, these can be fitted outside the box and connected via the cable harness. The box will then function more or less as a convenient junction box for all the leads.

SETTING-UP PROCEDURE

The mercury switches (which can be obtained quite cheaply on the surplus market) are best mounted in Terry clips. The switches should be fitted *across* the car so that they are *almost* making contact under normal conditions. When the car is rolled, they will then operate. If, however, roads with a steep camber cause problems, the mercury switches may be mounted longitudinally at the expense of being unable to use the alarm when parked on steep hills.

An alternative system is to attach the mercury switch to the inside of the boot lid, to protect this in the event of a break-in. In this case there is less likelihood of a slight disturbance setting off the alarm accidentally. This setting-up is rather critical and may take a few minutes to achieve the optimum setting.

THE CONCEALED SWITCH

Any form of switch can be used for S4, but it is advisable to use a type in which the on and off positions cannot be confused. A very ingenious type of switch will now be described, based upon a car radio aerial.

Certain types of fully-retractable car radio aerials have non-metallic tubes into which the aerial collapses. As the car radio (if fitted) will not be used with the aerial retracted, it is a simple matter to arrange a pair of contacts which close when the aerial is fully retracted. A number of systems of this type are shown in Fig. 2.

With such a system, the driver, when he leaves his car, simply retracts the aerial, thus engaging the system. Before re-entering the vehicle he raises the aerial with the special key which is supplied with such aerials. There is no reason why an aerial should not be used as a switch even if a car radio is not used, as few car thieves would suspect an aerial (especially retracted) of concealing the master switch of a highly efficient burglar alarm system.

This "aerial type" of switch is of course a simple single pole on/off device, and no provision can be made for connecting up to the ignition circuit in this case. ★

COMPONENTS . . .

Switches
S1, S2 (etc.) Miniature mercury switches
S3 Double-pole, changeover switch, or as described in text

Relay
RLA Relay, 12V coil; 2 pole changeover contacts

Miscellaneous
Suitable metal box, e.g. 6in × 4in × 2½in aluminium chassis with top plate. Octal plug and socket. Terry clips.

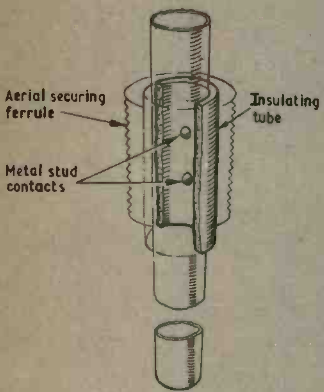

Fig. 2a. Two metal studs in an insulated tube are short-circuited when the aerial is retracted

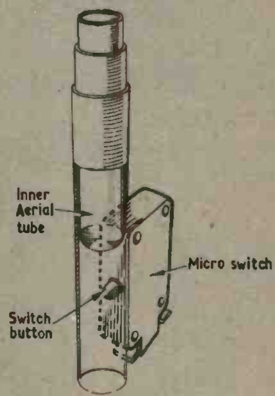

Fig. 2b. A microswitch button is depressed when the aerial is retracted

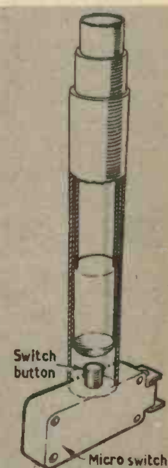

Fig. 2c. A microswitch is operated when mounted underneath the aerial

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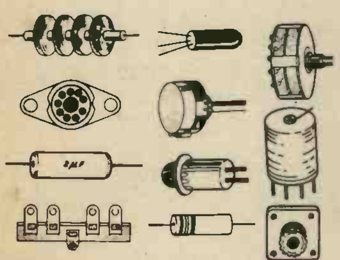

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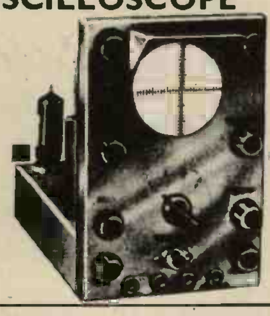

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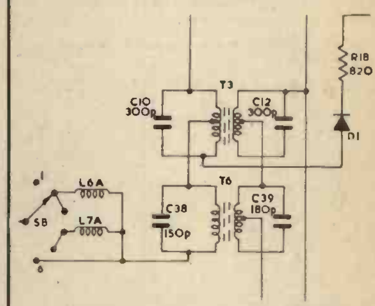

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Silicon Planar TRANSISTORS

by G. Wareham

SILICON planar transistors are now becoming almost as cheap as germanium transistors. They are extremely versatile. The same type is often useful for both audio and radio frequency applications. But these new maids-of-all-work do differ in certain respects from the more familiar germanium transistors, and to get the best out of them these differences must be taken into account. This article is a brief guide to practical applications.

MANUFACTURING TECHNIQUES

Silicon planar transistors are made by techniques in which the flat, polished surface of a silicon "chip" is treated so that selected areas are modified to produce the base, emitter, and collector. In the transistor factory, the percentage of "good" transistors (the *yield*) is high, partly because the fabrication techniques are more precise than the old fashioned alloying process, and partly because the surface of the silicon is protected, during and after manufacture, by a layer of silicon oxide.

This layer gives the transistor such good protection against chemical attack that it is possible for most purposes to dispense with the usual vacuum-tight hermetically sealed encapsulation and simply embed the transistor in synthetic resin. This, again, makes for cheapness, and so we find that, despite the fact that transistor-grade silicon is extremely expensive, these "epoxy transistors" can still be sold for a few shillings each.

WORKING CONDITIONS

A glance at the collector characteristics (see Fig. 1) of a typical silicon planar transistor shows nothing which differs substantially from the familiar germanium transistor characteristics. A closer look shows that one curve is apparently absent: the curve for $I_B = 0$. The reason is simple: a *germanium* transistor with no base current still passes enough collector current to show up on the curves, because of internal leakage. But in *silicon* transistors the leakage is so small that the curve for $I_B = 0$ virtually coincides with the X axis, until a certain critical collector voltage is reached. Then, as the curves show, the collector current tends to rise indefinitely. A sharp rise of collector current takes place for other values of I_B. This tendency to pass large collector currents at large collector voltages is obviously not healthy for the transistor and the only thing to do is avoid high collector voltages.

A good rule of thumb is: do not work the transistor at more than half the absolute maximum voltage quoted in the manufacturer's data. Thus a transistor with V_{CE} max = 18V will generally be all right at a battery voltage of 9V. The important exception is when the load is inductive. In this case, if the transistor is cut off abruptly, the collector voltage may rise far above the battery voltage. The situation is familiar to people who use transistors to operate relays, and the usual remedy is to connect a diode across the relay, so that it conducts and short-circuits the high-voltage "spike" which occurs on switch-off.

(There is nothing peculiar to silicon transistors here. Germanium transistors behave in the same way. But it is worth making the point again.)

EMITTER-BASE VOLTAGE

The curves of Fig. 1 do not show the one circuit voltage which is quite different from the corresponding one in germanium transistors. This is the base-emitter voltage V_{BE} which exists when the transistor is passing a given collector current. It is much bigger (0·5–1V) in silicon than in germanium transistors (0·1–0·3V).

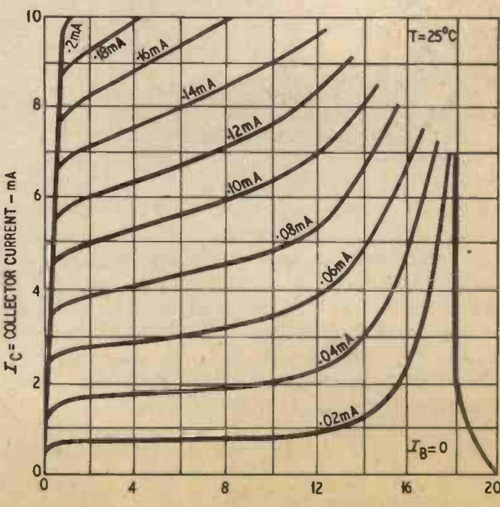

Fig. 1. Characteristic curves of typical silicon planar transistor

This has two practical results. One, not usually important, is that silicon transistors will not work from quite such low voltages as germanium ones, since there must always be enough voltage to provide the working V_{BE}, and this means, say, 0·6V minimum, whereas many germanium transistors will work with lower voltages than this.

However, the high V_{BE} can be turned to good advantage, and this is the second and more important result. A particularly simple and effective biasing system is possible with silicon transistors. This is shown in Fig. 2. Two resistors R_f and R_b form a potential divider across the collector-emitter circuit. Their values are selected so that the required V_{BE} is set up across R_b. A method of calculating the required values is shown on the diagram, but readers might be interested to know the reasoning behind it.

The important thing is that the bias resistors should not shunt the base input impedance of the transistor too heavily, and so cause a loss of input-signal current, but, on the other hand, they should stabilise the working conditions against variations in temperature and transistors. The first condition—not to shunt the input—calls for high values of R_b and R_f and the second—good stabilisation—for low values. These conditions are incompatible, and the system seems a bad one, until one takes some actual examples.

The *d.c.* or *large-signal* input resistance of the transistor is simply $V_{BE}/I_B = R_{IN}$. The *a.c.* or *small-signal* input resistance is $25\ h_{fe}/I_E = r_{in}$. Now, $I_B = I_C/h_{FE}$, where h_{FE} is the *large signal* current amplification factor, so $R_{IN} = V_{BE} \cdot h_{FE}/I_C$. Taking the ratio of small-signal to large-signal input resistances we have:

$$\frac{r_{in}}{R_{IN}} = \frac{25h_{fe}}{I_E} \times \frac{I_C}{V_{BE} \cdot h_{FE}} \text{ (mA, mV)}$$

Now, if h_{FE} is large, I_C is very nearly equal to I_E. Also, under typical operating conditions, h_{fe} and h_{FE} are about equal. In this case,

$$\frac{r_{in}}{R_{IN}} \approx \frac{25}{V_{BE}}$$

In a typical planar transistor used in the type of circuit in question, V_{BE} is not likely to be very different from 625mV, and so

$$\frac{r_{in}}{R_{IN}} \approx \frac{1}{25}$$

The a.c. input resistance is only 4 per cent of the d.c. resistance. Thus a bias network which shunts the d.c. input resistance heavily does not necessarily shunt the a.c. input signal heavily. This is precisely what we want for good stabilisation combined with small signal-loss. A satisfactory compromise is to make R_B five times the a.c. input resistance. It is then typically one-fifth of the d.c. input resistance. In a germanium transistor, with V_{BE} = 150mV, the ratio r_{in}/R_{IN} would have been 1/6 and the best compromise factor $\sqrt{6} = 2{\cdot}5$.

Bias circuits designed by this technique have the effect of compensating for the effects of differences in the gains of transistors on the working point. By calculating R_C, R_F and R_B for an average transistor we arrive at values which can be used for *any* transistor. It is necessary, if the system is to work really well, for the current gain to be high. Fortunately, the general-purpose planar transistors now coming on the market do usually have high gains (h_{fe} = 50–300) so this condition is easily met.

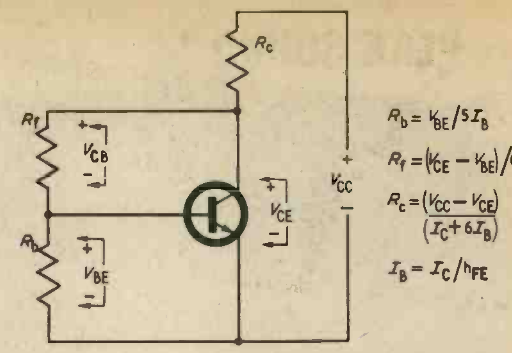

Fig. 2. The two-resistance bias circuit for RC amplifiers using high-gain silicon transistors. This compensates for both temperature and transistor variations and uses no electrolytic capacitors

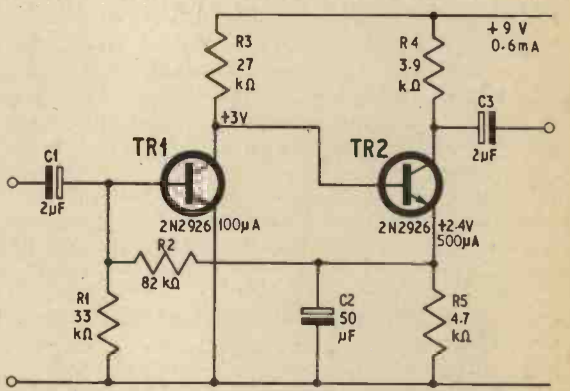

Fig. 3. General-purpose audio pre-amplifier. Both transistors may be high-gain 2N2926 (h_{fe} over 50)

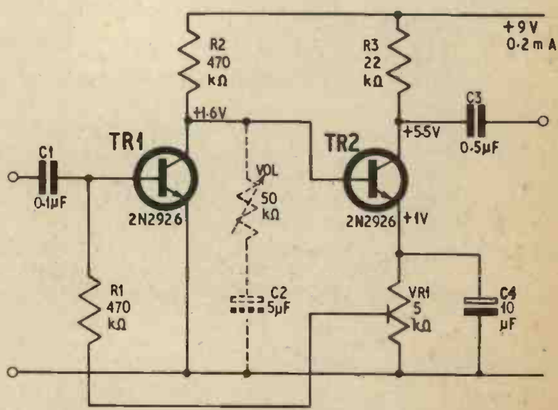

Fig. 4. In this "starved" amplifier TR1 passes only about 10 micro amps, and therefore generates very little noise. Amplifiers like this can often be incorporated into existing valve amplifiers, since they require very little current and the polarity of the supply voltage is the same as that of the existing high tension supply

LOW-NOISE AUDIO CIRCUITS

Silicon planar transistors are often noisier than their germanium counterparts at audio frequencies, yet they make excellent low-level audio amplifiers. The explanation of this paradox lies in the behaviour of the transistors at low collector currents. In general, reducing the collector current reduces the noise. But it also reduces the gain, so there is a limit below which reducing current serves no useful purpose.

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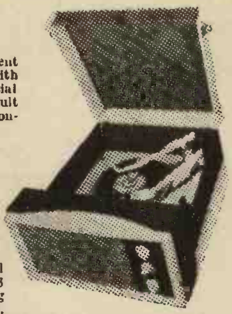

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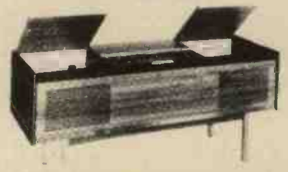

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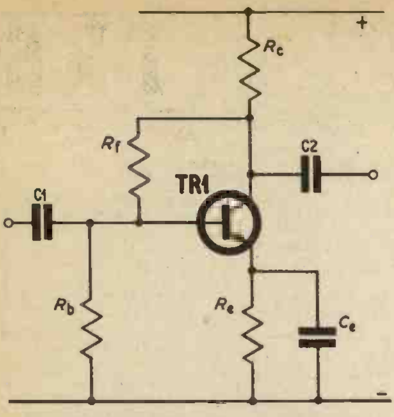


Fig. 5. *In wide-band RC amplifiers an emitter resistor and capacitor provide high-frequency compensation*

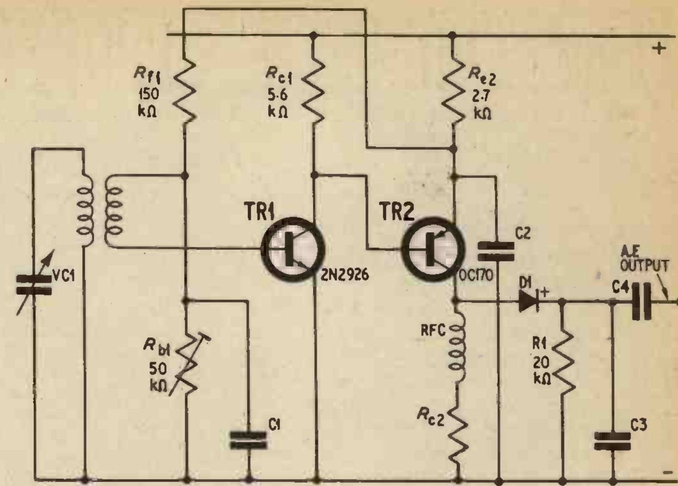


Fig. 6. *Silicon npn transistors can readily be used in conjunction with germanium pnp transistors. In this circuit TR1 and TR2 form an untuned r.f. amplifier feeding a detector*

In the case of a germanium transistor, the gain usually falls off rapidly below about 0·5mA. But comparable silicon planar transistors usually work quite happily down to 0·1mA, and a high proportion still have useful gains (h_{fe} over 10) at 0·01mA (10 microamps). By taking advantage of this good low-current performance we can achieve lower noise with silicon than with germanium. The input resistance goes up as I_C goes down, and this can be useful for matching the impedance of the signal source.

Using cheap epoxy transistors such as the 2N2926 series, amplifier circuits are "designable" with $I_C = 100\mu A$, in the sense that fixed values of resistance are adequate. At lower currents, it is advisable to include one adjustable resistance to provide for variations from transistor to transistor. Two typical amplifier circuits are shown in Figs. 3 and 4.

RADIO FREQUENCY CIRCUITS

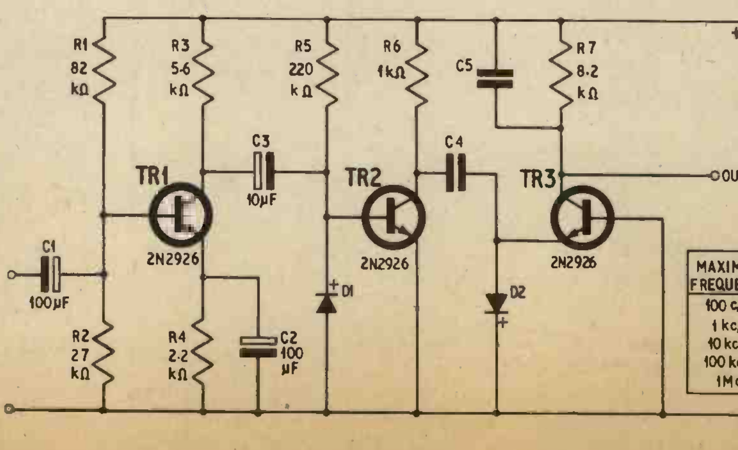
Radio frequency circuits are no different in principle from germanium transistor circuits. The cut-off frequency of a typical small planar transistor, particularly if it is of the epitaxial type, is likely to be high—a few hundred Mc/s. Special u.h.f. types go to 1,000Mc/s or higher. Ideally, one would like to operate well below cut-off, e.g. one-tenth of the cut-off frequency. In practice, transistors must often be used at frequencies close to cut-off. In this case the gain is inevitably low, but may still be useful.

Whether neutralisation is necessary in a tuned amplifier depends partly on the stage gain and partly on the size of the collector-base capacitance C_{OB}. In the cheaper transistors, with C_{OB} around 10pF, neutralisation is probably required. Special r.f. types, with C_{OB} less than 1pF, are just coming on the market, and are suitable for use without neutralisation.

The cut-off frequency is generally reduced if the transistor is operated at lower or higher collector currents than those for which the value of f_T is specified. Collector voltage should be reasonably large (5V) for high-frequency working.

WIDE-BAND AMPLIFIERS

There is no difficulty in making amplifiers with useful gains at frequencies of several megacycles. The main problem is keeping the gain reasonably constant over the full bandwidth—there is a natural tendency to get more gain at the lower frequencies. One simple technique is to include some resistance in the emitter circuit, and to bypass this at h.f. with a capacitance (Fig. 5). The required values are best found by trial and error, but are often in the range 100–1,000 ohms and 100–1,000pF.



MAXIMUM FREQUENCY	VALUE OF C4	VALUE OF C5
100 c/s	1μF	100μF
1 kc/s	0·1μF	10μF
10 kc/s	0·01μF	1μF
100 kc/s	0·001μF	0·1μF
1Mc/s	100pF	0·01μF

Fig. 7. *Frequency to voltage converter. Here TR2 squares the waveform, and C4 differentiates it. The result is to make TR3 pass a current proportional to the input frequency. The voltage across R7 is likewise proportional to frequency. Capacitor C4 sets the range and C5 smoothes the output. If the circuit is used as a frequency meter C5 should be large, while for use as a discriminator it should bypass the carrier frequency but not the audio output*

Assuming a low-impedance signal-source ("voltage drive") the *mutual conductance* of the transistor with emitter resistance R_e is roughly $1/R_e$, and this holds good for R_e of 100 ohms or more at collector currents of 1mA or more. As with all wide-band circuits, the stage gain must be reduced (by using smaller R_C) as the bandwidth is increased. The bandwidth is always less than f_T, since at this frequency the "gain" is unity.

MIXED *NPN* AND *PNP* CIRCUITS

Constructors who are accustomed only to *pnp* circuits are often worried about the prospect of mixing *pnp* and *npn* transistors. In practice this is no problem, and often results in cheaper circuitry.

A typical case is shown in Fig. 6. Here the two transistors form a wide-band amplifier feeding a detector diode. The input is from a ferrite rod aerial, and the whole circuit is a simple t.r.f. receiver "front end". Note that R_{E2} is bypassed to the negative line. (If it were bypassed to positive this would create a low-impedance path for h.f. disturbances on the positive line to R_{F1} and enough might get back to the base of V1 to cause instability. Resistor R_{C2} is included to provide d.c. bias to the detector. (In practice, the resistance of the choke is often adequate). Essentially the same *pnp–npn* technique can be used in the audio stages.

NON-LINEAR CIRCUITS

Planar transistors may be used in the usual switching and waveform-shaping circuits, but one or two special features should be borne in mind. Unlike alloy transistors, planar transistors have practically no gain in the "inverted" condition, i.e. with collector and emitter connections reversed. This is because the base is small. For the same reason, the base will not pass large currents.

The reverse base-emitter breakdown voltage for a planar transistor is usually about 6V. If there is danger of exceeding this, a diode must be connected in the base lead so that, when the base voltage is such that the transistor is cut-off, the diode is reverse biased. In this condition the diode absorbs most of the reverse voltage and the transistor is protected.

A typical wave-shaping circuit, due to Marconi Instruments, is shown in Fig. 7. This is a frequency-to-voltage converter, and it could be used as a frequency meter or pulse-counting f.m. discriminator up to about 1Mc/s. ★

NEWS BRIEFS

Solid State Physics on TV

A NEW BBC1 television series on modern solid state electronic devices called "The New Electronics" started on January 8. Integrated circuits, Gunn oscillators, silicon-controlled rectifiers, field effect transistors—these are some of the newest devices in a technology which was almost unknown ten years ago. They are all semiconducting devices. They all depend on the production of very pure solids in very exact crystalline forms. Impurities are added to these in amazingly small concentrations to make the *p*-type and the *n*-type materials which are the basis of the devices themselves.

These ten programmes which are intended for electrical engineers, teachers in schools and colleges, undergraduates and sixth forms explain how the devices are made, how they work and some of their uses.

GBR Returns to the Air

THE historic call sign GBR can once again be heard on the very low frequency of 16kc/s (18,750 metres) after an absence of 12 months.

Originally designed and built in the early 1920's by G.P.O. engineers, the Rugby Radio Station made history as the world's most powerful transmitter using valves. Now the old transmitter has been completely re-designed. The most striking changes are in the main amplifier stages where 54 water-cooled valves have been replaced by nine vapour-cooled amplifier valves; and in the modulator which can generate precision frequency-shift signals as well as the original c.w. signals at speeds up to 72 bauds. Transistors are employed in the driver stages.

At an opening ceremony on November 30, GBR was switched on by Capt. C. B. H. Wake-Walker R.N., Director of Naval Signals. The new transmitter is now in regular use for naval traffic and time signal emissions. It can be received by warships and submarines in all parts of the world.

The output power is 450–500kW and the radiated power from the large aerial array (a prominent landmark in the midlands) exceeds 60kW.

Mr. E. K. Cole

NEWS OF the death of Mr. E. K. Cole last November will have brought back memories of the early days of broadcasting to many readers.

A pioneer of the mains operated radio set and founder of a large radio and electrical firm, Ekco, Mr. Cole made his first mains set in 1925. He was then working as an electrical engineer at Southend. His company, which grew to become one of the foremost in the industry, was merged into Pye of Cambridge a few years ago. Mr. Cole was 65.

New IEE Grading Structure

TO CONFORM to an agreed scale of membership grades, on which constituent institutions of the Council of Engineering Institutions are collaborating, the Institution of Electrical Engineers has changed its membership structure.

Full members are now designated *Fellows;* associate members are now *members;* graduates and associates are now *associate members.*

Applications to the old class of associate have now been abolished. A new grade of *associates* is open to those applicants in other professions who are interested in or associated with the activities of the I.E.E. These may include doctors concerned with medical electronics, architects, teachers, and technicians who do not qualify for other grades of membership.

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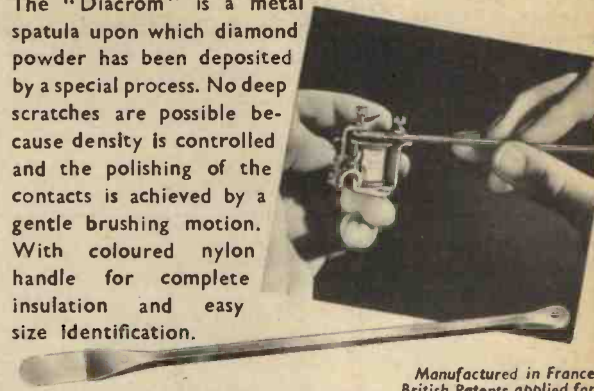

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200–250 v.. 20 lb. pull. Spindle length 1¾in.. Base size 2¾ × 2¼in. Intermittent rating. Brand new 25/-, p.p. 2/6.

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No. 2 950–0 959 v. 30 M/A and 575–0-575 v. 50 mA, 5v., 2 A. completely sealed chassis mounting. Brand new. 49/6. carr. 7/6.
Parmeko Chokes. 4 Henries, 550 mA D.C. res. 40 Ω 25/-, p.p. 6/-.

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JOHN VALENCE

FOG CONQUERED

Down at London airport great strides are being made in overcoming the fog problem. The Autoland system came through the latest tests earlier this winter with flying colours. A BEA Trident airliner made a number of landings in thick fog and the aircraft touched down within 3ft of the runway centre line, on each occasion.

This is an achievement of distinction, a credit to the designers and manufacturers of this equipment and also to the airline authorities for pursuing this idea so fervently. Conquest of the fog menace is one of the biggest challenges presented by nature. It is nice to know that in this field, Britain is well to the fore, if not way out ahead of other countries. Certainly London airport is at present unique in that it is equipped for blind landings.

Technically proved, the system has yet to receive official blessing so permitting its use for normal passenger flights. But the latest tests under extremely limited visibility must have hastened the day when automatic landing becomes fully operational.

BUT HERE . . . FOG PERSISTS

While the technocrats are winning the battle against fog at London airport, we find the bureaucrats at Westminster resolved on maintaining the "fog" which engulfs their proceedings so far as the public is concerned.

Rejection of the proposal to have trial sound and vision recordings made in the House during sessions seems to me most regrettable. Quotations I read from time to time in newspaper reports of Parliamentary debates do of course go some way to explaining the reluctance of our elected representatives to allowing a wider audience to listen or look in!

One of the greatest attributes of electronic science is surely the power to enable man to communicate with his fellow. To spurn modern innovations without good reason suggests an unawareness of the realities of present times.

THE SAX IS BACK

Are our ears about to be assailed by yet another "new sound" from the jazz and popular music world?

I learn that the electronic saxophone has just been launched on the American market. Probably by now this latest creation is on its way to these shores, and soon the air will be filled with soft cooing sounds reminiscent of the mid '20's.

With this "Varitone" electronic unit, the characteristic tone of the saxophone can be modified with tremolo and reverberation effects. Those who do not like playing alone can produce an accompaniment by the flick of a switch—a frequency dividing circuit does the rest.

So this is the long awaited American reply to the Beatles!

ANOTHER DEPENDENT RELATIVE

When I refer to AUNTIE, you probably think I am alluding to that much maligned old soul who resides in Portland Place. But you would be wrong. The Auntie in question is another computer. (What fun it must be devising these names).

If the suggestions made by the Conservative Political Centre ever come to fruition, this particular machine (Automatic Unit for National Taxation and Insurance) will know all facts about our incomes and any social benefits we may be entitled to receive and would produce a single statement showing the balance due to (or from) the State.

The logic of having this kind of system is hard to deny. In fact I feel sure that this is inevitable in time, and the facilities of the computer will be extended to cover other personal particulars.

Yes, even dog, car, and *television* licences! And what a boon the latter would be to our other Auntie in her present straitened circumstances.

NO LOGIC AT ALL

One can dwell on the subject of computers, imagining all kinds of applications to exercise their nimble brains. As servant of the Government the computer might be thought as hastening the arrival of the Brave New World.

Perhaps this is rather frightening.

Turning to private enterprise, one application that seems to have quite a future is the "match-making" business. There have been many accounts of computers being used to match up compatible couples, but these were usually light hearted exercises conducted for the amusement of the operators between more serious stints.

However, the professional match makers have not been slow to appreciate the possibilities of this electronic tool, as a recent court case revealed.

Multifarious and marvellous are the tasks performed by the electron. It can guide a satellite-carrying rocket far out in space, it can solve a quadratic equation in a minute fraction of a second; but is it not *rushing in where angels fear to tread* when it tries to couple up for life two of nature's most imponderable creatures? There's really no logic in it at all. . . .

"I had a nice little number before the shakeout"

Readout—

A SELECTION FROM OUR POSTBAG

Stereo amplifier

Sir—With reference to your article in PRACTICAL ELECTRONICS on the *Integrated Stereo Amplifier*. Having had great difficulty in trying to obtain the OA99 diodes as specified, I have been informed that these diodes are not in production and therefore unobtainable. Would you therefore inform me if any alterations to the circuit are required.

I also note that in the same article no switches are given in the components list.

Although I know that this amplifier is of top quality design and up to your usual very high standard, is it not pointless to specify something which is unobtainable from normal suppliers and which can cause the amateur a great deal of trouble when he finds he cannot obtain components?

P. G. Dunstan,
Mill Hill,
London,
N.W.7.

Our apologies for the omission of the switches. S1 is 4-pole 3-way; S2 single-pole on/off or changeover; S3 double-pole on/off. As stated in last month's issue the diodes should be OA95. TR3a and b can alternatively be NKT0003

Alpha-radioactivity

Sir—Comments from many leading research scientists indicate that my suggestion of alpha-radioactivity influencing generation of thunderstorm electricity (P.E. October 1966) are considered probably correct and very important.

Of all the processes *previously* proposed to explain thunderstorm electricity, the one put forward by Mason has long been the favourite. It is based on the fact that defect protons (analogous to defect electrons in conventional semiconductors) drift towards the colder regions of ice crystals, charging them positively there.

Most of the precipitation of thunderstorms is produced via soft hailstones which grow by accretion of supercooled water droplets and then melt in the cloudbase to produce the heavy raindrops. Each water droplet thus captured by a growing hailstone first forms a thin skin of ice which bursts and releases numerous ice splinters during further freezing of the drop. Originating from the coldest parts, the ice splinters will be carrying the drifted protons and are thus positively charged. They are rapidly blown to the crown of the thundercloud, whereas the much larger hailstone continues to fall.

This convincing process *definitely* takes place in all thunderstorms, but was so far not recognised as the final explanation of thunderstorm electricity because it is too weak by a factor of 5 to 25 compared to the requirements of numerous intense storms. It is easy to see that its electric yield will be proportional to the number of defect protons available in the ice.

I already showed in my thunderstorm article, that the ionisation current yield of the total alpha-radioactivity in a thundercloud is quite adequate to supply the currents involved in all thunderstorms. It now seems evident that this ionisation current will actually appear as copious *additional* defect protons for the Mason process. Thus it will be coupled efficiently to the turbulence, for large-scale electric charge separation in the manner described.

Turning to a related question, I would like to reply to Mr C. B. Sibley regarding possible thunderstorms on Jupiter which he commented in his *Radio Astronomy* feature (P.E. August 1966). Thunderstorms of the required ferocity to account for radio signals received from Jupiter are indeed possible if a Mason-Michaelis process operates on liquid and solid ammonia instead of water and ice.

The jovian atmosphere is believed to contain ammonia and also possesses suitable daytime temperatures around −100°C which would be necessary for an ammonia thunderstorm. Radioactive emanations would doubtless be present just as on earth, and the chemical properties of liquid and solid ammonia would suggest much greater proton semiconductivity in response to alpha-radiation, than that obtainable with ice under terrestrial conditions.

M. L. Michaelis, M.A.

Dr B. J. Mason will be giving a talk on "The Generation of Cloud Electricity" at the I.E.E., Savoy Place, London, W.C.2 on January 18, 6.30 p.m.

Forthcoming . . .

Sir—I am interested in building a trace doubler.

I would like to know if you could perhaps send me a circuit or let me know if you will be printing one in any later issues.

Any information you can give me on this equipment will be a great help to me.

G. G. Redding,
Rogerstone,
Mon.

A trace doubler will be appearing in the near future.

. . . attractions

Sir—I would appreciate information of any kind, concerning the construction of a radio telescope.

We have a group of members interested in electronics, and would like to purchase blueprints, and equipment.

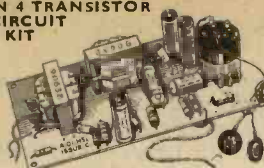
I trust you will be able to assist us, or at least direct us to a supplier.

J. W. Norton,
Immingham Youth Centre,
Immingham.

Although we have not so far published any constructional information in this field, we are sure you will be interested to learn that very shortly we will be commencing a short series on this subject by a well-known authority on radio astronomy. This series will include details of a simple station that can be set up for observation of the sun.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT

Type TA1



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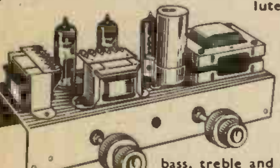

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SPECIAL PURCHASE! TURRET TUNERS

By famous maker. Brand new and unused. Complete with PCC84 and PCF80 valves 34-38 Mc/s IF. Biscuits for Channel 1 to 5 and 8 and 9. Circuit diagram supplied. ONLY 25/- each. P. & P. 3/9.

GÖRLER F.M. TUNER HEAD

88-100 Mc/s 10.7 Mc/s. I.F., 15/-, plus 2/- P. & P. (ECC85 valve, 8/6 extra).

TAPE DECKS

B.S.R. MONARDECK (Single speed) 3¾in. per sec., simple control, uses 5¾in. spools, £6/15/-.

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A top-quality record player amplifier. This amplifier was used in a 29 gn. record player. employs heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 2½in. d. x 5½in. h. Ready built and tested. **PRICE 69/6.** P. & P. 4/9.

ALSO AVAILABLE mounted on board with output transformer and 6in. speaker ready to fit into cabinet below. **PRICE 89/6.** P. & P. 5/9.

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Uncut motor board. Will take above amplifier and B.S.R. or GARRARD Autochanger or Single Record Player Unit. Size 18 x 14 x 8½ in. **PRICE £3/9/6.** Carr. 7/6.

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All brand new in maker's original packing.

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B.S.R. TU/12 .... £3/9/6. Carr. 5/6.
GARRARD SP25 De Luxe... £12/10/6. Carr. 5/6.
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Latest B.S.R. UA25 Super slim £6 2 6
GARRARD 1000 with special Hi-Fi cartridge £6 19 6
GARRARD AT6 £9.10.0. Carr. 6/6 on each.

All the above units are complete with t/o mono head and sapphire styli or can be supplied with compatible stereo head for 12/6 extra.

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ACOS GP67-1. Mono complete. List price 21/-. **Our price 13/6.** P. & P. 1/-.

BRAND NEW. 12" 15w. H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Offered below list price at 89/6. P. & P. 5/-. Guitar models: 25w. £5.5.0; 35w. £8.8.0.

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5 in., 12/6; 6½ in., 15/-; 8 in., 21/-; 10 in., 25/-; 7 in. x 4 in., 15/-; 10 in. x 6 in., 26/-.
E.M.I. 8 in. x 5 in. with high flux ceramic magnet 3 ohm 23/6.
E.M.I. 13½ x 8 in. with high flux ceramic magnet, 42/-. (15 ohm, 45/-). P. & P. 4" & 5" 2/-, 6½" & 8" 2/6, 10" & 12" 3/6 per speaker.

E.M.I. PLASTIC CONED TWEETER. 2½". 3 ohm. Limited number: 12/6 each, P. & P. 1/6.

SPECIAL OFFER! Limited number of 12 in. 10 watt "R.A." Speakers: 3 ohm 25/-; 15 ohm, 27/6. P. & P. 3/6.

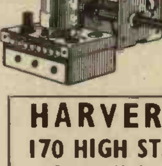
7-10 watt OUTPUT TRANSFORMERS to match pair of ECL 86's in push-pull to 3 ohm output. ONLY 11/-. P. & P. 2/6.

MAINS TRANSFORMER for transistor power supplies. Tapped prl 200-250v. Sec. 40-0-40 at 1 amp (with electrostatic screen) and 6·3v. at ·5 amp for dial lamps etc. Drop thro mounting. Stack size 1¼" x 3¾" x 3¼" 27/6. P. & P. 4/6.

SMOOTHING CONDENSER. 2800 mfd. 25v. 1¼" dia. × 3" high 3/-. P. & P. 1/-.

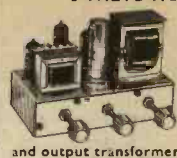
MATCHED PAIR OF 2½ WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stack size 1½ x 1¼ x ¾ in. Output trans. tapped for 3 ohm and 15 ohm output. 10/- pair plus 2/- P. & P.

SPECIAL OFFER! FM/AM TUNER HEAD



Beautifully designed and precision engineered by Dormer and Wadsworth Ltd. Supplied ready fitted with twin .0005 tuning condenser for AM connection. Prealigned FM section covers 86—102 Mc/s. I.F. output 10.7 Mc/s. Complete with ECC85 (6L12) valve and full circuit diagram of tuner head. Another special bulk purchase enables us to offer these at 27/6 each. P. & P. 3/-. Order quickly! Limited number also available with precision geared 3: 1 reduction drive. 30/-. P. & P. 3/-.

3-VALVE AUDIO AMPLIFIER MODEL HA34



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in. w. x 4in. d. x 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls.

The HA34 has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc., wired and tested for only **£4.5.0** P. & P. 6/-.

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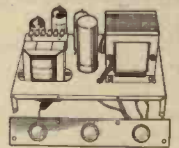
A.C. Mains 200/250v., 4 watt, using ECC83, EL84, EZ80 valves



★ Heavy duty double-wound mains transformer with electrostatic screen. ★ Separate Bass, Treble and volume controls, giving fully variable boost and cut with minimum insertion loss. ★ Heavy negative feedback loop over 2 stages ensures high output at excellent quality with very low distortion factor. ★ Suitable for use with guitar, microphone or record player. ★ Provision for remote mounting of controls or direct on chassis. ★ Chassis size only 7¼ in. wide x 4 in. deep. Overall height 4¾ in. ★ All components and valves are brand new. ★ Very clear and concise instructions enable even the inexperienced amateur to construct with 100% success. ★ Supplied complete with valves, output transformer (3 ohms only), screened lead, wire, nuts, bolts, solder. etc. (No extras to buy.) PRICE 79/6. P. & P. 6/-.

Comprehensive circuit diagram, practical layout and parts lists 2/6 (free with kit).

This kit although similar in appearance to HA34 employs entirely different and advanced circuitry.

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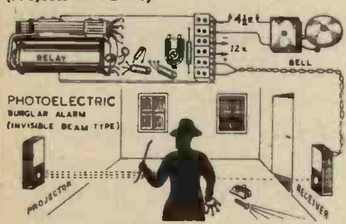

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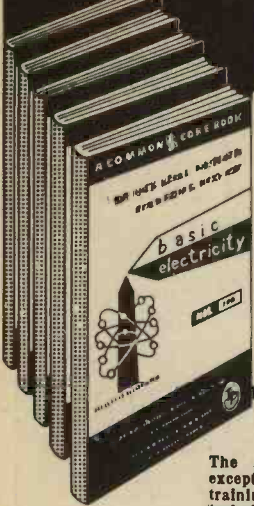

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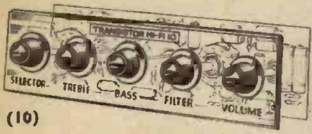

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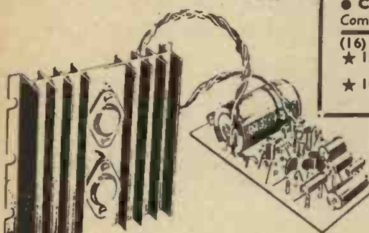
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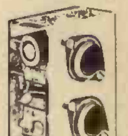
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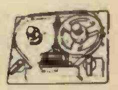
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OA70	1/6
OA79	1/6
OA81	1/6
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SX781	1/8
GJ5D	1/9
CG6E	1/3
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1S100	2/6
1S101	3/3
1S105	4/6
1S402	4/6
1S404	8/-
1S410	4/-
1S415	9/6
1S423	14/9
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3·3v	3/6
4·3v	3/6
5·1v	3/6
6·2v	6/-
6·8v	6/-
7·5v	3/6
8·2v	3/6
10v	3/6
11v	3/6
1 watt 5%	
3·9v	8/6
8 watt 5%	
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