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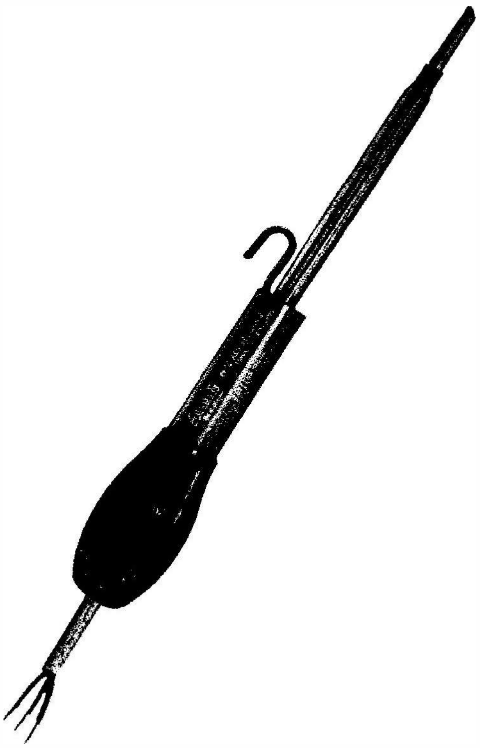

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ZT1700	17/9	ZR12	16/9	OAZ203	12/-

Mullard LA2300 9/5

All above transistors direct from manufacturer.
Unmarked silicon planar transistors suitable for use in divider circuits:—1/6 each or £5 per 100.

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Mains dropper type. Up to 30 watts. Some multi-tapped. Fraction of normal price! 10/- per dozen.

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RECORD PLAYER CARTRIDGES. COMPLETE WITH NEEDLES GP67/2 Mono 15/-, GP91/3 Compatible £1, GP93/1 Crystal Stereo 25/-, GP94/1 Ceramic 30/-.

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12 VOLT TRANSISTORISED FLUORESCENT LIGHTS. HALF NORMAL PRICE.
8 Watt 12" tube. Reflector type £2.19.6. 15 watt 18" Batten type £3.19.6.
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1μF	20 volt	4μF	25 volt	25μF	6 volt	320μF	4 volt
1·25μF	16 volt	5μF	6 volt	25μF	12 volt	320μF	10 volt
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Please include suitable amount to cover post and packing. Minimum order 10/-. Stamped addressed envelope must accompany any enquiries.

For customers in Birmingham area goods may be obtained from Rock Exchanges, 231 Alum Rock Road, Birmingham 8.

a complete stereo system for 28 gns!

The new Duo general purpose two way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally. **Type 1 SPECIFICATION:** Impedance 10 ohms. It incorporates Goodmans high flux 6 × 4in speaker and $2\frac{1}{2}$in tweeter. Teak finish 12 × $6\frac{3}{4}$ × $5\frac{3}{4}$in. 4 guineas each, P. & P. 7/6. Type 2 as Type 1. Size $17\frac{1}{2}$ × $10\frac{3}{4}$ × $6\frac{3}{4}$in., Incorporating Elac $10\frac{1}{2}$ × $6\frac{1}{2}$in., 10,000 lines and $2\frac{1}{2}$in. tweeter. 3 ohms impedance. $5\frac{1}{2}$ gns. + 7/6 P. & P. Garrard Changers from £7.19.6, P. & P. 7/6. Cover and Teak finish Plinth £4.15.0, P. & P. 7/6.

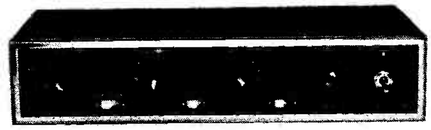
The Duetto

9 GNS + 7/6 P. & P.

Integrated Transistor Stereo Amplifier

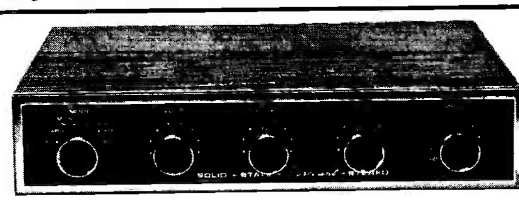
The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more. SPECIFICATION: R.M.S. power output: 3W per channel into 10 ohms speakers. **Input Sensitivity:** Suitable for medium or high output crystal cartridges and tuners. Crosstalk better than 30dB at 1Kc/s. **Controls:** 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control. **Tone Control:** Treble lift and cut. Separate on/off switch. A preset balance control.

The Classic



$8\frac{1}{2}$ GNS
P. & P. 7/6

Specification: Sensitivities for 10W output at 1KHz. *Tape head:* 3mV (at $3\frac{3}{4}$ i.p.s.). *Mag. P.U.:* 2mV. *Cer. P.U.:* 80mV. *Radio:* 100mV. *Aux.:* 100mV. *Tape/Rec. output:* 100mV. Equalisation for each input is correct to within ±2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone control range:* Bass ±13dB at 60Hz. Treble ±14dB at 15KHz. *Total distortion:* (for 10W output) <1·5%. *Signal noise:* <−60dB. A.C. mains 200–250V. Size $12\frac{1}{2}$in long, $4\frac{1}{4}$in deep, $2\frac{3}{4}$in high. Teak finished case.



The Viscount

$13\frac{1}{2}$ GNS + 7/6 P. & P.

Integrated High Fidelity Transistor Stereo Amplifier

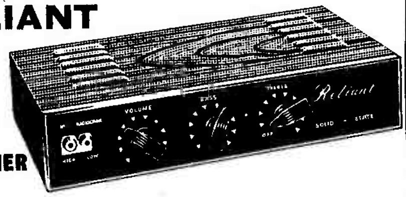
SPECIFICATIONS: Output: 10W per channel into 3 to 4 ohms speakers (20W monoral). **Input:** 6 position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U., Tuner, Tape and Tape Rec. out. **Sensitivities:** All Inputs 100mV into 1·8M ohm. **Frequency response:** 40Hz–20KHz ±2db. **Tone controls:** Separate bass and treble controls. TREBLE 13db lift and cut [at 15KHz]. BASS 15db lift and 25db cut [at 60Hz]. **Volume controls:** Separate for each channel. **A.C. mains input:** 200–240V. 50–60Hz. **Size:** $12\frac{1}{2}$ × 6 × $2\frac{3}{4}$in in teak finished case. Built and tested. P. & P. 7/6.

Viscount Mark II for use with magnetic pick-ups, specification as above. Fully equalised for magnetic pick-ups. Suitable for cartridges with minimum output of 4mV/cm/sec. at 1 kc. Input impedance 47k. **15 gns.** + 7/6 P. & P.

SPECIAL OFFER!

Complete stereo systems comprising BALFOUR 4 speed auto player with stereo head, 2 duo speaker systems, size 12" × $6\frac{3}{4}$" × $5\frac{3}{4}$", Plinth (less cover) and the DUETTO stereo amplifier. All above items 19 Gns + 20/- P. & P.

THE RELIANT

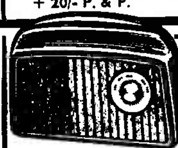


SOLID-STATE GENERAL PURPOSE AMPLIFIER

Specifications: *Output:* 10W R.M.S. *Output impedance:* 3 to 4 ohms. *Inputs:* 1. Xtal mic 10mV; 2. Gram/radio 250mV. *Tone controls:* Treble control range ±12dB at 10KHz; Bass control range ±13dB at 100Hz. *Frequency response* (with tone controls central): Minus 3dB points are 20Hz and 40KHz. *Signal to noise ratio:* better than −60dB. *Transistors:* 4 silicon Planar type and 3 Germanium type. *Mains input:* 220–250V a.c. *Size of chassis:* $10\frac{1}{2}$in long, $4\frac{3}{4}$in wide × $2\frac{1}{2}$in deep. A.c. Mains, 200–250V. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Separate bass and treble lift control. Two inputs with control for gram and mike. Built and tested. 8 × 5in speaker to suit: Price 14/6 plus 1/6 P. & P. Crystal mike to suit: 12/6 plus 1/6 P. & P. Mk. I as above, less teak case $5\frac{1}{2}$ gns. + 7/6 P. & P.

RELIANT Mk. II $6\frac{1}{2}$ GNS + 7/6 P. & P. In teak-finished case

THE DORSET (600mW Output)



7-transistor fully tunable M.W.–L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulised and pre-alignment techniques make this simple to build. Sizes: 12 × 8 × 3in. MAINS POWER PACK KIT: 9/6 extra.

Price £5.5.0

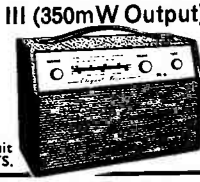
Plus 7/6 P. & P. Circuit 2/6 FREE WITH PARTS.

THE ELEGANT SEVEN Mk. III (350mW Output)

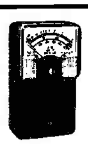
7-transistor fully tunable M.W.–L.W. portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction. MAINS POWER PACK KIT: 9/6 extra.

Price £4.9.6 + 7/6 P. & P.

Circuit 2/6 FREE WITH PARTS.

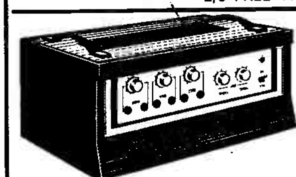


POCKET MULTI-METER



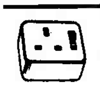
Size $3\frac{7}{8}$ × $2\frac{1}{8}$ × $1\frac{3}{8}$in. Meter size $2\frac{1}{8}$ × $1\frac{3}{8}$in. Sensitivity 1,000 O.P.V. on both a.c. and d.c. volts. 0–15, 0–150, 0–1,000 d.c. current 0–150mA. Resistance 0·100kohms. Complete with test prods, battery and full instructions, 42/6. P. & P. 3/6. **FREE GIFT** for limited period only. 30W Electric Soldering Iron Value 15/- to every purchaser of the Pocket Multi-Meter.

50 WATT AMPLIFIER
A.C. MAINS 200-250V



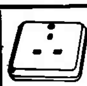
An extremely reliable general purpose amplifier—with six electronically mixed inputs. Suitable for use with: mics, guitars, gram, tuner, organs, etc. Separate bass and treble controls. Output impedance 3, 8 and 15 ohms.

Price 27 GNS +20/- P.&P.



OUR PRICE 12 for 30/-
Postage 4/6 extra

G.E.C. 13 amp surface mounting switched sockets in brown. Listed at 6/6.



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W. & D. 13 amp flush sockets in green.

CYLDON 2 TRANSISTOR U.H.F. TUNER. BRAND NEW. COMPLETE WITH CIRCUIT DIAGRAM

£2.10.0 + 1/- P. & P.

B.S.R. TD2 TAPE DECK

This tape deck takes $5\frac{3}{4}$in spools complete with two-track heads. Size $13\frac{1}{4}$in long by $8\frac{3}{4}$in wide.

£8.19.6 Plus 7/6 P. & P.

THREE-IN-ONE HI-FI 10 WATT SPEAKER

A complete Loud Speaker system on one frame, combining three matched ceramic magnet speakers with a low loss cross-over network. Peak handling power 10W. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40–60c/s. Frequency range 50c/s to 20kc/s. Size $13\frac{1}{2}$in × $8\frac{1}{16}$in × $4\frac{1}{2}$in. By famous manufacturer. List price £7. Our price 74/6 plus 5/– P. & P. Similar speaker to the above minus tweeters in 3 & 15 ohms 44/6 +5/– P. & P.

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21d High Street, Acton, London, W.3 also at 323 Edgware Road, London, W.2

the world's most advanced high-fidelity amplifier

This remarkable amplifier has been in production for some months, and now that we have caught up with the backlog of orders, we can supply the IC.10 promptly. We wish to apologise for the delay in reaching full production, which was due to circumstances beyond our control. We hope that now you can purchase the IC.10 without difficulty, you will enjoy to the full the great possibilities this unique Sinclair device offers.

The Sinclair IC.10 is the World's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, which has an output power of 10 watts, is a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick. This tiny chip contains 13 transistors (including two power types), 2 diodes, 1 zener diode and 18 resistors, all of which are formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins.

Monolithic I.C.'s were originally developed for use in computer and space applications where their extraordinary toughness and reliability were even more important than their minute size. These same advantages make them ideal for linear applications such as audio amplifiers, but hitherto they have been confined to low power applications. The IC.10 thus represents a very exciting advance. Not only is it far more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC.10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of the usual tone and volume controls and a battery or mains power supply. However, the IC.10 is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout), etc.

The photographic masks required for producing monolithic I.C.'s are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. So we are able to sell the IC.10 at a price far below that of the components for a conventional amplifier of comparable power. At the same time, we give a 5 year unconditional guarantee on each IC.10 knowing that every unit will work as perfectly as the original and do so for a lifetime.

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SINCLAIR RADIONICS LIMITED, 22 NEWMARKET ROAD, CAMBRIDGE. **Telephone 0223 52996**

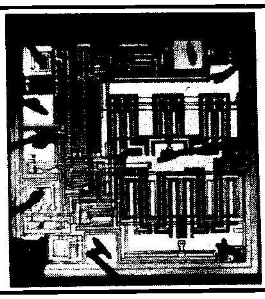
10 WATT MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER

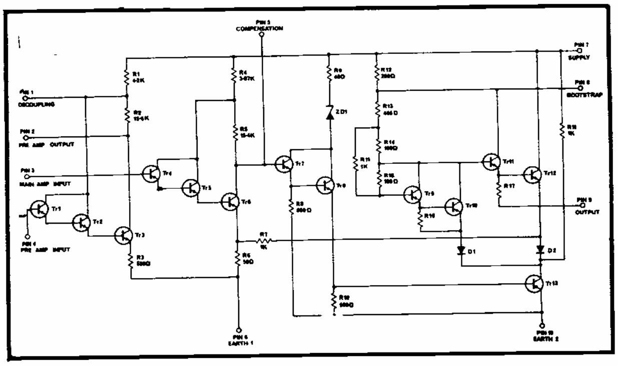
■ Specifications

Power Output	10 watts peak, 5 watts R.M.S. continuous.
Frequency response	5Hz to 100kHz $\pm$ 1dB.
Total harmonic distortion	Less than 1% at full output.
Load impedance	3 to 15 ohms.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	$1 \times 0{\cdot}4 \times 0{\cdot}2$ inches.
Sensitivity	5mV.
Input impedance	Adjustable externally up to 2·5M ohms for above sensitivity.

■

ABOVE SHOWS ACTUAL SIZE OF IC-10.
TO RIGHT, VIEW OF AMPLIFIER MAGNIFIED 625 TIMES





■ Circuit Description

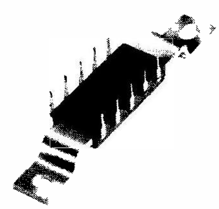
The circuit diagram of the IC.10 is shown on the right. The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. The output stage operates in class AB with closely controlled quiescent current which is independent of temperature. A high level of overall negative feedback is used round both sections and the amplifier is completely free from cross-over distortion at all supply voltages. Thus battery operation is eminently satisfactory.

■ Construction

The monolithic I.C. chip is bonded onto a gold plated area on the heat sink bar which runs through the package. Wires are then welded between the I.C. and the tops of the pins which are also gold plated in this region. Finally the complete assembly is encapsulated in solid plastic which completely protects the circuit. The final device is so rugged that it can be dropped thirty feet on to concrete without any effect on performance. The circuit will also work perfectly at all temperatures from well below zero to above the boiling point of water.

■ Applications

Each IC.10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity uses. These include public address, loud hailers, use in cars, inter-com., stabilised power supplies, electronic organs, oscillators, volt meters, tape recorders, solar cell amplifier, radio receivers.
The transistors in the IC.10 have cut off frequencies greater than 500MHz so the pre-amp section can be used as an R.F. and I.F. amplifier making it possible to build complete radio receivers without any additional transistors.



SINCLAIR IC-10

The complete IC-10 with the manual and 5 year guarantee costs just

59/6

Post free

SINCLAIR RADIONICS LIMITED,
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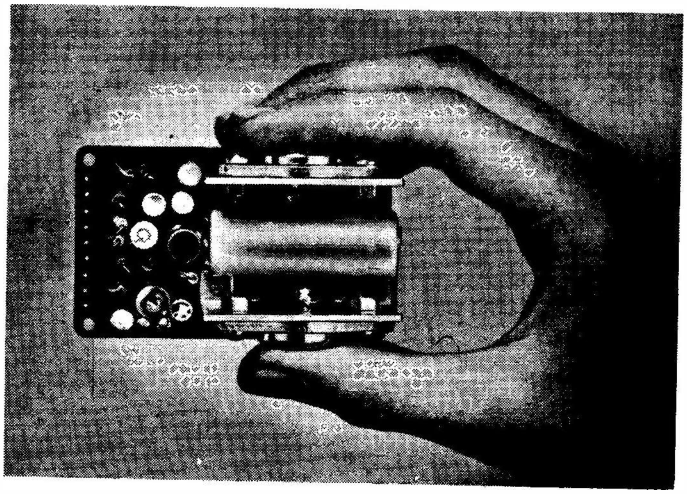
Telephone 0223 52996

ORDER FORM AND MORE SINCLAIR DESIGNS OVERLEAF

SINCLAIR Z.12 12 WATT INTEGRATED HI-FI AMPLIFIER & PRE AMP

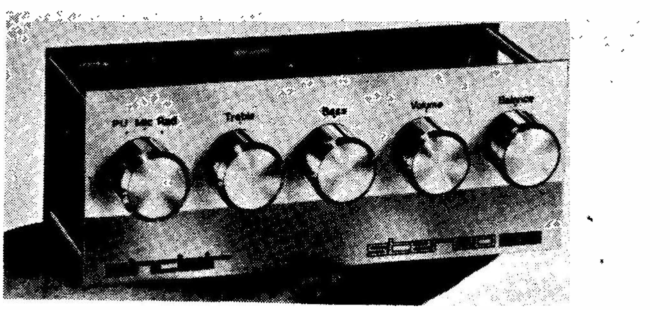


12 watts R.M.S. continuous sine wave output

This is the recommended amplifier for those requiring greater power than that provided by the IC.10. This eight transistor amplifier is the most successful of its kind ever designed. It has an excellent power to size ratio and is easily adapted to a wide variety of applications. The Z.12 performs satisfactorily from a wide range of voltages and it can easily be run from car batteries. This true 12 watt amplifier comes to you ready built, tested and guaranteed together with useful manual of circuits and instructions for matching the Z.12 to your precise requirements. Two may be used for stereo, when the Sinclair Stereo 25 will be found the ideal control unit for use with it.

Size—3in × 1¾in × 1¼in. Class B Ultralinear Output: Frequency response from 15 to 15,000Hz ±1dB: Output suitable for loudspeakers from 3 to 15 ohms impedance. Two 3 ohm speakers may be used in parallel: Input 2mV into 2K ohms: Output 12 watts R.M.S. continuous sine wave (24 watts peak); 15 watts music power (30 watts peak) Power requirements 6—20V d.c. from battery or PZ.4 Mains Supply Unit. Ready built, tested and guaranteed.

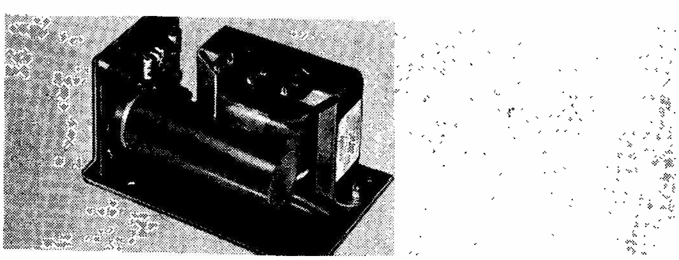
89/6



SINCLAIR STEREO 25

De Luxe Pre-amp and Control Unit to use with Z.12 Stereo assemblies. Switched inputs for PU (equalised to R.I.A.A. curve from 50 to 20,000Hz ±1dB), Radio and auxiliary. Supplied ready built with very attractive solid brushed and polished aluminium front panel. Control knobs for Bass/Treble/Volume/Balance/Input are solid aluminium. Size—6½ × 2½ × 2½in plus knobs. Built, tested and guaranteed.

£9.19.6



SINCLAIR PZ4

STABILISED MAINS POWER SUPPLY UNIT

Heavy duty transistorised power supply unit to deliver 18V d.c. at 1·5A. Designed specially for use with two Z.12 or IC.10 Amplifiers together with Stereo 25. Built, tested and guaranteed.

99/6

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SINCLAIR RADIONICS LIMITED, 22 NEWMARKET ROAD, CAMBRIDGE. Telephone 0223 52996

SINCLAIR MICROMATIC

Britain's smallest radio

This fantastic little British pocket receiver is available in kit form to build for yourself or ready built, tested and guaranteed. Its range and selectivity must be experienced to be believed; its power and quality everything you could want. The Micromatic tunes over the medium waveband and has A.G.C. to counteract fading from distant stations. Bandpass tuning makes reception of Radio 1 easier; in fact, you will find your Micromatic performing where other sets cannot be heard at all. The neat black case with aluminium front panel and tuning control give the Micromatic elegantly modern appearance.

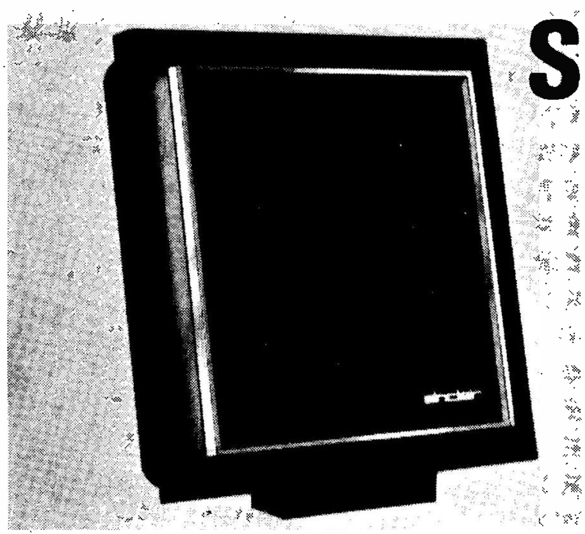
- **High quality magnetic earpiece**
- **Choice of many stations**
- **Plays anywhere**

Kit with earpiece, solder and instructions. **49/6** *+ 11d P.T. Surcharge*

Built, tested and guaranteed. **59/6** *+ 1/1 P.T. Surcharge*

Mallory Mercury Cells RM.675 (2 reqrd.) each 2/9.

SINCLAIR Q.14



the most challenging loudspeaker design in years

It is more than a matter of saving money when you choose the Q.14. This is the loudspeaker that delights experts and critics alike for its fine forward quality, its clarity and exceptional adaptability. Designed on original lines and from unusual materials, the Q.14 will easily carry up to 14 watts and has very smooth response from 60 to 16,000Hz. Size—9¾in square × 4¾in deep, with matt black finish and solid aluminium bar embellishment. Input impedance—8 ohms.

The Q.14 costs about a quarter of what you might expect to pay for a good stereo speaker system. A pair used with two Z.12s and the Stereo 25 will give you superb high fidelity to stand comparison with far costlier equipment.

Try the Q.14 in your own home without delay. If it does not delight you, send it back and your money including cost of postage will be refunded in full.

£7.19.6 *+ 2/11 P.T. Surcharge*

THE SINCLAIR Q.14 LOUDSPEAKER has a seamless sealed acoustic pressure chamber contoured to ensure forward sounding presence and wide dispersal of sound. The driver unit employs a massive ceramic magnet, special cone suspension and aluminium speech coil resulting in brilliant transient response. The input impedance of 8 ohms makes the Q.14 particularly suitable for use with transistor amplifiers. It can be used as a bookshelf speaker, a corner reflect or flush mounted on any appropriate flat surface, etc.

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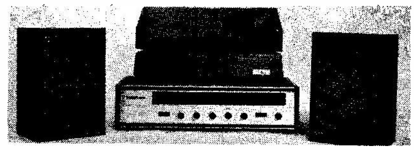

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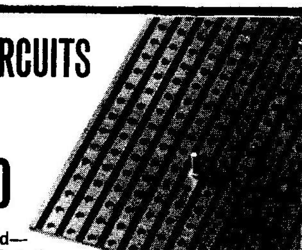

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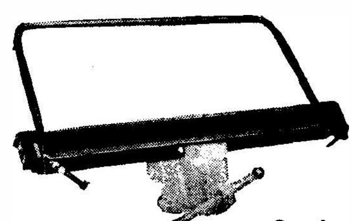

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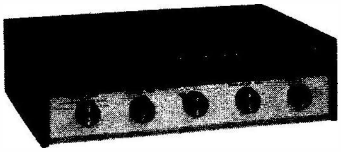

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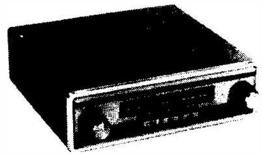

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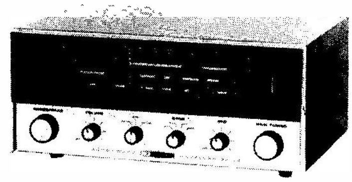

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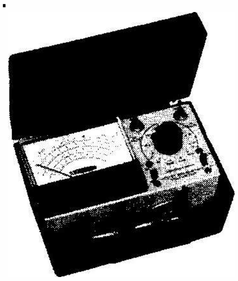

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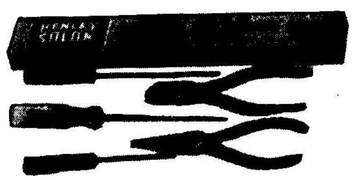

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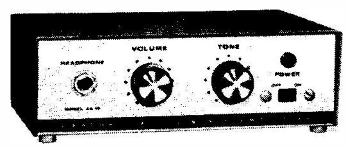

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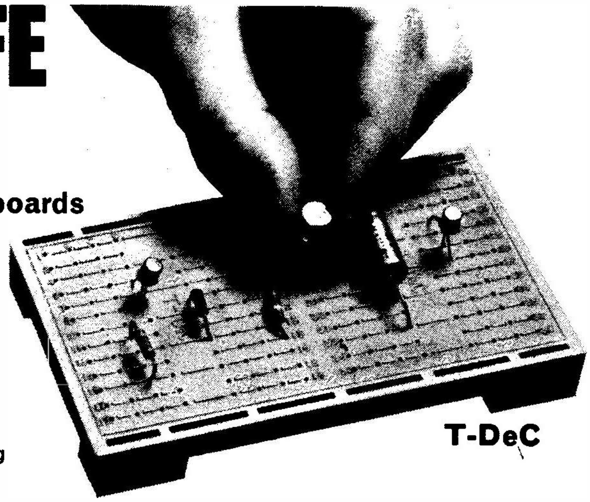

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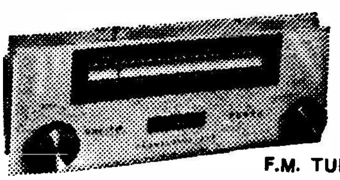

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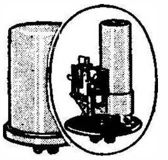

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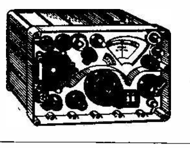

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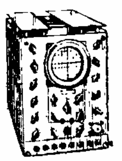

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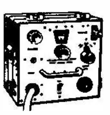

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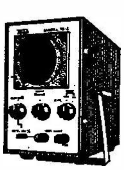

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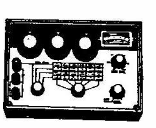

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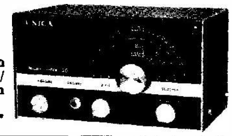

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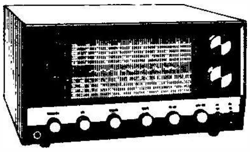

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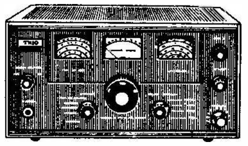

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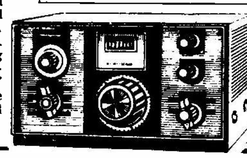

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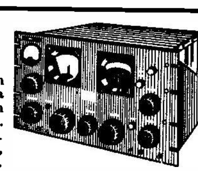
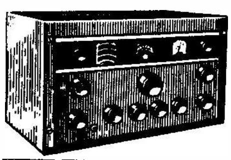


High quality professional dual conversion communication receivers. Few available again in this country at a reasonable price. Frequency range 540 Kc/s-54 Mc/s in 6 bands, variable tuning or 6 channel crystal controlled. 2·5 watt output into 600 ohms. Input 110/230V a.c. 20 valve circuit incorporating: Xtal filter, B.F.O., A.N.L., Xtal calibrator, S meter etc. Size 19 × 12 × 22in. (List £520.) Offered in excellent condition fully tested and checked. **£100** each.

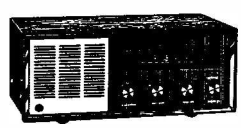


RCA COMMUNICATION RECEIVER AR88D

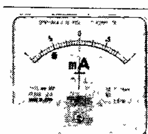
Latest release by ministry BRAND NEW in original cases. 110-250V a.c. operation. Frequency in 6 Bands. 535Kc/s-32Mc/s continuous. Output impedance 2·5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£87.10.0.** Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

A completely new transistorised receiver covering 152-174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75Ω aerial input. Headphone jack. Operation 230V. A.C./12V. D.C. Neg. earth. **£37.10.0.** Carr. 10/-.



CLEAR PLASTIC PANEL METERS



First grade quality Moving Coil panel meters. Type MR 38P. 1 21/32in square fronts.

50μA	**37/6**	500-0-500μA	**25/-**	50mA	**25/-**
50-0-50μA	**35/-**	1mA	**25/-**	100mA	**25/-**
100μA	**35/-**	1-0-1mA	**25/-**	150mA	**25/-**
100-0-100μA	**32/6**	2mA	**25/-**	200mA	**25/-**
200μA	**32/6**	5mA	**25/-**	300mA	**25/-**
500μA	**37/6**	10mA	**25/-**	500mA	**25/-**
		750mA	**25/-**	3V. D.C.	**25/-**
		1 amp	**25/-**	10V. D.C.	**25/-**
		2 amp	**25/-**	20V. D.C.	**25/-**
		5 amp	**25/-**	100V. D.C.	**25/-**
		20mA	**25/-**		

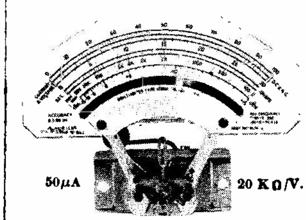
150V. D.C.	**25/-**
300V. D.C.	**25/-**
500V. D.C.	**25/-**
750V. D.C.	**25/-**
15V. A.C.	**25/-**
50V. A.C.	**25/-**
150V. A.C.	**25/-**
300V. A.C.	**25/-**
500V. A.C.	**25/-**
S meter 1mA.	**29/6**
VU meter	**39/6**

Full range of other sizes in stock. Send s.a.e. for leaflet.

Variable Voltage TRANSFORMERS

Brand new, guaranteed and carriage paid.
High quality construction. Input 230 V 50-60 cycles.
Output full variable from 0-260 V. Bulk quantities available.
1 amp.—**£5.10.0;** 2·5 amp.—**£6.15.0;** 5 amp.—**£9.15.0;**
8 amp.—**£14.10.0;** 10 amp.—**£18.10.0;** 12 amp.—**£21.0.0;**
20 amp.—**£37.0.0.**

AVOMETER MOVEMENTS



50μA 20 KΩ/V.

Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multimeter. Brand New and Boxed **69/6** P & P 3/6.

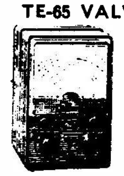
T.E.40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1.2Mc/s. Decibels—40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17.10.0.** Carr. 5/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0-20 Kc/s on 2 ranges. Output 500 Ω or 5kΩ. Operation 200/250V. A.C. Supplied in perfect order **£12/10/-.** Carr. 10/-.

TE-65 VALVE VOLTMETER



High quality instrument with 28 ranges. D.c. volts 1·5-1,500V. A.c. volts 1·5-1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. **£17.10.0.** P. & P. 6/-. Additional Probes available: R.F. **35/-.** H.V. **42/6.**

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

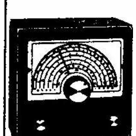
D.c. coupled. Band width 1kc/s. Perfect order. **£25.** Carr. 30/-.

AM/FM SIGNAL GENERATORS

Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20-80Mc/s. AM C.W./FM. Incorporates precision dial, level meter, precision attenuator 1μV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 × 8½ × 9in. Supplied in brand new condition complete with all connectors fully tested. **£45.** Carr. 20/-.

GEARED MAINS MOTORS

Paralux type SD19 230/250V a.c. Reversible. 30 RPM. 40 lb in. Complete with capacitor. Excellent condition. **99/6.** Carr 10/-.



TE-16A Transistorised Signal Generator. 5 ranges 400 kHz-30 mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 kHz modulation. 5¼ × 5¼ × 3½in. Complete with instructions and leads. **£7.19.6.** P.&P. 4/-.

FIELD TELEPHONES TYPE L
Generator ringing, metal cases. Operates from two 1·5v. batteries (not supplied). Excellent condition. **£4.10.0.** per pair. Carr. 10/-.

AUTO TRANSFORMERS

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

150 W.	**£1.12.6,**	P. & P. 3/6
300 W.	**£2.7.6,**	P. & P. 4/6
500 W.	**£3.10.0,**	P. & P. 6/6
1,000 W.	**£5.10.0,**	P. & P. 7/6
1,500 W.	**£7.19.6,**	P. & P. 8/6
7,500 W.	**£15.10.0,**	P. & P. 20/-

G. W. SMITH & CO (RADIO) LTD.
Also see oppos. page

ARF-100 COMBINED AF-RF SIGNAL GENERATOR

A.F. SINE WAVE 20-200,000 c/s. Square wave 20-30,000 c/s. O/P. **HIGH IMP. 21V.** P/P600Ω 3·8 V. P/P. TF 100 kc/s-300 Mc/s. Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF output and % mod. on R.F. 220/240 V a.c. **£30.0.0.** Carr. 7/6.

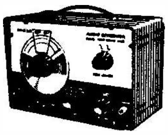
TE-20RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kc/s-260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instruction. **£15.0.0.** P. & P. 7/6. S.A.E. for details.

PEAK-SOUND PRODUCTS

Full range of Amplifiers, Kits, Speakers in stock.

TE22 SINE SQUARE WAVE AUDIO GENERATORS



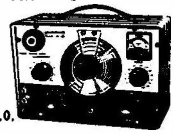
Sine: 20c/s to 200 Kc/s on 4 bands. Square: 20c/s to 30Kc/s. Output impedance 5,000 ohms. 200/250V. A.C. Supplied brand new and guaranteed with instruction manual and leads. **£16.10.0.** Carr. 7/6.

MARCONI TF142E DISTORTION FACTOR METERS

Excellent condition. Fully tested. **£20.** Carr. 15/-.

LAFAYETTE TE46 RESISTANCE-CAPACITY ANALYSER

2pF-2,000 mfd 2 ohms-200 megohms. Also checks impedance, turns ratio, insulation, 200/250V a.c.



Brand New £17.10.0. Carr. 7/6.

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.

VM.76 **VALVE VOLTMETER R.F. measurements in excess of 100Mc/s and d.c. measurements up to 100V with accuracy of ±2% d.c. range 300 MV to 1kV a.c. range 300MV to 300V RMS. Resistance ·02-500MΩ. Price £72.**

VM.78 **A.C. MILLIVOLT METER. Transistorised 1 MV-300V. Frequency 1c/s to 1 Mc/s. Price £55.**

VM.79 **UHF MILLIVOLT METER. Transistorised. A.c. range 10MV-3V.** D.c. current range 0·01μ/A-0·3MA. **Resistance 1 ohm-10 megohms. Price £125.**

H1B **AUDIO SIGNAL GENERATOR. 15c/s-50kc/s. sine or square wave. Price £30.**

J1B **AUDIO SIGNAL GENERATOR. 15c/s-50kc/s. Price £30.**

J2B **AUDIO SIGNAL GENERATOR. As per J1B except fitted with output meter. Price £35.**

TT1S **TRANSISTOR TESTER. £37.10.0**

Carriage 10/- per item.

MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0·7-0·9967. B: 5-200. Ico: 0-50 microamps 0-5 mA. Resistance for diode 200 Ω-1 MΩ. Supplied complete with instructions, battery and lead. **£5.19.6.** P. & P. 2/6.

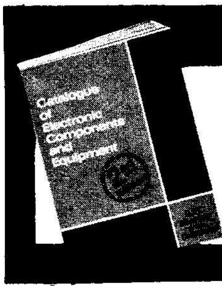
SONOTRONIC PORTABLE OSCILLOSCOPES

Ex-govt. scope, general purpose; 3in. c.r.t. Mains operated. Fully tested and checked. **£12.10.0.** Carr. 7/6.

SOLATRON MONITOR OSCILLOSCOPE TYPE 101

An extremely high quality oscilloscope with time base of 10μ/sec to 20m/sec. Internal Y amplifier. Separate mains power supply 200/250V. Supplied inexcellent condition with cables, probe, etc., as received from Ministry. **£8.19.6.** Carr. 30/-.

NEW CATALOGUE



Nearly 200 pages giving full details of a comprehensive range of COMPONENTS, TEST EQUIPMENT, COMMUNICATION EQUIPMENT AND HI-FI EQUIPMENT.
Each section greatly enlarged and fully illustrated. Thousands of items many at bargain prices.
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SRP22 Stereo	£5.19.6	*SL55	£11.19.6
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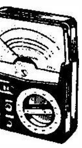
Carriage/insurance 7/6 extra any model. WB4 Bases **£3.19.6.** Perspex covers **£3.10.0.** *Special offer base and cover available for these models at **£4.15.0.** Carr. 5/-. Full range of Garrard accessories available.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER

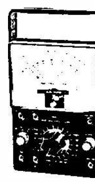
19 transistors, 8 diodes, IHF music power, 30W at 8Ω. Response 30-20,000 ± 2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3-16Ω. Separate L and R volume controls. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 10½ × 3 9/16 × 7 13/16in. Operation 115/230V. A.C. **£28.** Carriage 7/6.

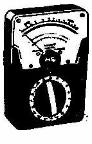
MULTIMETERS *for EVERY purpose!*



TE-51. NEW 20,000Ω/VOLT MULTIMETER with overload protection and mirror scale. 0/6/60/120/1,200V a.c. 0/3/30/60/300/600/3,000V d.c. 0-60μA/12/300mA d.c. 0/60K/6 meg. ohm. **92/6.** P. & P. 2/6.

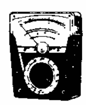
MODEL AS-100D. 100KΩ/VOLT. 5in., mirror scale. Built-in meter protection. 0 / 3 / 12 / 60 / 120 / 300 / 600 / 1,200V d.c. 0/6/30/120/300/600V a.c. 0/10μA/6/60/300MA/12 Amp. 0/2K / 200K / 2M / 200MΩ. −20 to +17dB. **£12.10.0.** P. & P. 3/6.

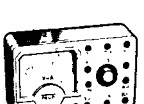




MODEL TE-90 50,000 O.P.V. MIRROR SCALE OVERLOAD PROTECTION 0/3/12/60 / 300 / 600 / 1,200V d.c. 0/6/30/120/300/1,200V d.c. 0·03/6/60/600MA d.c. 16kΩ / 160kΩ / 1·6/16MΩ. −20 to +63dB. **£7.10.0.** P. & P. 3/-.

MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200V. d.c. 0/6/30 / 120 / 600 / 1,200V. a.c. 0/30μA / 3/30 / 300mA. 0/16K/160K/1·6M / 16megohm. **£5.10.0.** P. & P. 3/-.



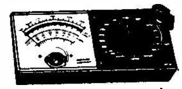


MODEL PT-34. 1,000 O.P.V.0/10/50 / 250 / 500 / 1,000V a.c. and d.c. 0/1/100/500 mA d.c. 0/100 KΩ **39/6.** P. & P. 1/6.

TE-900 20,000Ω VOLT GIANT MULTIMETER
6in. full view meter. 2 colour scale, overload protection. 0/2·5/10/250/1,000/5,000V a.c. 0 / 25 / 12·5 / 10 / 50 / 250 / 1,000 / 5,000V d.c. 0 / 50μA / 110 / 100 / 500mA 10A d.c. 20K / 200K / 20 MΩ. **£15.** P. & P. 5/-.

MODEL TE-10A. 20kΩ/Volt, 5/25/50/250/500/2,500 V, d.c. 10 / 50 / 100 / 500 / 1,000V. a.c. 0/50μA/2·5 mA./250mA. d.c. 0/6K/6 megohm. −20 to +22dB. 10-0, 100 mfd. t 0 0·100-0·1 mfd. **69/6.** P. & P. 2/6.

PROFESSIONAL 20,000 O.P.V. LAB. TESTER



Automatic overload protection, mirror scale. Ranges: 1/10/50 / 250 / 500/1,000 volts, d.c. and a.c 0-500μA, 10mA, 250mA. Current: 0/20K, 200K. 2 megohm. Decibels: −20 to +22dB, **£5.19.6.** P. & P. 2/6.

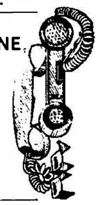
MODEL TE 80. 20,000 O.P.V.
0 / 10 / 50 / 100 / 500 / 1,000V. a.c. 0/5/25/50/250 / 500 / 1,000V d.c. 0·5μA. 5/50/500mA/0/6K/60K/6K/600K/6 Meg. **£4.17.6.** P. & P. 3/-.

MODEL TE12. 20,000 O.P.V. 0/0·6/30/120/600/1,200 / 3,000 / 6,000V d.c. 1/6/30/120/600/1,200V a.c. 0 / 60μA / 6 / 60 / 600MA. 0 / 6K / 600K / 6meg./60. Megohm 50PF. 2 MFD **£5.19.6.** P. & P. 3/6.

★ TRANSISTORISED FM TUNER ★

6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6×4×2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money. **£6.7.6.** P. & P. 2/6.
Stereo multiplex adaptors **99/6.**

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM



Operative over amazingly long distances. Separate call and press to talk buttons, 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets.
£6.19.6. P. & P. 3/6.

SINCLAIR EQUIPMENT

Z12 12 watt amplifier, **89/6**
PZ4 Power Supply Unit **89/6**
Stereo 25 Preamp., **£9.19.6**
Q14 Speakers, **£7.19.6**
Micromatic Radio Kit, 49/6. Built **59/6**
IC/10 59/6
ALL POST PAID

SPECIAL OFFER

Two **Z12** Amps., **PZ4** Power Supply, **Stereo 25** Preamplifier, **£22**, or with two **Q14** speakers, **£37.**

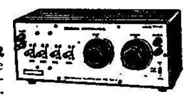
NEW SINCLAIR 2000 SYSTEM

35 watt Integrated Amplifier **£29.** Carr. 5/-
Self powered F.M. Tuner. **£25.** Carr. 5/-.

ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Lightweight adjustable vinyl headband. 6ft. cable and stereo jack plug. 25-17,000 cps. 8 ohm imp. **67/6** P. & P. 2/6.

TE111. DECADE RESISTANCE ATTENUATOR



Variable range 0-111dB. Connections. Unbalanced T and Bridge T. Impedance 600Ω range (0·1dB 10) + (1dB 10) +10 +20 +30 +40dB. Frequency: d.c. to 200kHz (−3dB). Accuracy: 0·05dB. +indication dB 0·01. Maximum input less than 4W (50V). Built in 600Ω load resistance with internal/external switch. Brand new **£27.10.0.** P. & P. 5/-.

RECORDING HEADS

Reuter ½-track. As fitted to Collaro Mk. IV and Studio Decks. High imp. record play back, low imp. erase. Brand new. **19/6** pair. **COSMOCORD ½-track heads.** High imp. record/playback **65/-**. Low imp. erase **20/-**. **MARRIOTT ¼-track heads.** High imp. record/playback **65/-**. Low imp. erase **20/-**. Post extra.

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

3in. 225ft. L.P. acetate	3/6
3¾in. 600ft. T.P. mylar	10/-
5in. 600ft. std. plastic	8/6
5in. 900ft. L.P. acetate	10/-
5in. 1,200ft. D.P. mylar	15/-
5in. 1,800ft. T.P. mylar	22/6
5¾in. 1,200ft. L.P. acetate	12/6
5¾in. 1,200ft. L.P. mylar	16/-
5¾in. 1,800ft. D.P. mylar	22/6
5¾in. 2,400ft. L.P. mylar	39/6
7in. 1,200ft. std. acetate	12/6
7in. 1,800ft. L.P. acetate	15/-
7in. 1,800ft. L.P. mylar	20/-
7in. 2,400ft. D.P. mylar	25/-
7in. 3,600ft. T.P. mylar	45/-

Postage 2/-. Over £3 post paid.

MAXELL TAPE CASSETTES

C60. **10/3**; C90. **14/3**; C120. **19/6.** Post extra

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AC176	5/-	2G301	2/6
ACY17	3/-	2G303	2/6
AF114	4/-	2N711	10/-
AF115	3/6	2N1302-3	4/-
AF116	3/6	2N1304-5	5/-
AF117	3/6	2N1306-7	6/-
AF239	12/6	2N1308-9	8/-
AF186	10/-	2N3844A	5/-
AF139	10/-	Power Transistors	
BFY50	4/-		
BSY25	7/6	OC20	10/-
BSY26	3/-	OC23	10/-
BSY27	3/-	OC25	8/-
BSY28	3/-	OC26	5/-
BSY29	3/-	OC28	7/6
BSY95A	3/-	OC35	5/-
OC41	2/6	OC36	7/6
OC44	2/6	AD149	10/-
OC45	2/6	AUY10	30/-
OC71	2/6	2N3055	15/-
OC72	2/6	Diodes	
OC73	3/6	AAY42	2/-
OC81	2/6	OA95	2/-
OC81D	2/6	OA70	1/9
OC83	4/-	OA79	1/9
OC139	2/6	OA81	1/9
OC140	3/6	IN914	1/6

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Germanium PNP type transistors, equivalents to a large part of the OC range, i.e. 44, 45, 71, 72, 81, etc.

PRICE £5 PER 1000

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VOL. 5 No. 9
September 1969

PRACTICAL ELECTRONICS

FEELING THE PULSE

An obsession with facts and figures threatens to become a national malaise. Like, for instance, those monthly balance of payments figures. Yet we are witnessing just the beginning of the deluge of data of all kinds we will have to contend with as the computer population continues its rapid rate of growth. For the computer, above all, has created a statistician's dream world.

In contrast to this perpetual "feeling of the pulse" is the occasional examination which, covering a longer period of time, is more meaningful in its revelations. Like the Annual Statistical Survey of the Electronic Industry published in July by the Electronics Economic Development Committee.

This survey shows that the gross output of the industry was valued at over £1,000 million, nineteen per cent above the 1967 level.

In the capital equipment sector, we read, the major growth was in the U.K. computer market. (From £98 million in 1967 to £136 million in 1968.) Unfortunately, the home based computer manufacturers could not keep pace with this demand, and a greater proportion of the market had to be supplied by imported equipment.

The survey suggests that the defence market, although of major importance, will decline in future years. Outstanding achievements have been made by firms producing and marketing radar and navigational aids, particularly in exports, which have increased 42 per cent in this group.

In other sectors of the industry the balance of trade is not always so good. In the case of consumer goods, imports have actually *increased*. This tendency is likely to continue, especially in view of the coming colour television on 625 lines.

Active components also show, on balance, a trade deficit. In spite of greatly expanded home production, imports rose by over 30 per cent. On the other hand, U.K. firms did export 32 per cent more than in the previous year.

Finally, in reading through the survey, it is satisfying to see the inclusion of amateur electronics in a chart showing the structure of the U.K. electronics industry.

Amateur electronics is indicated as one of the consumers ("domestic final demand") for (1) home produced components and (2) imported components. No values, it is stated, can be assigned to any of these different sections of the market. Perhaps this deficiency will be rectified on a later occasion. The figures should be interesting and instructive, for though relatively very small, the amateur share of the market is going to increase steadily in the future. At least that is *our* prediction—and made without the aid of a computer!

F. E. Bennett—*Editor*

THIS MONTH

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Our October issue will be published on Monday, September 15

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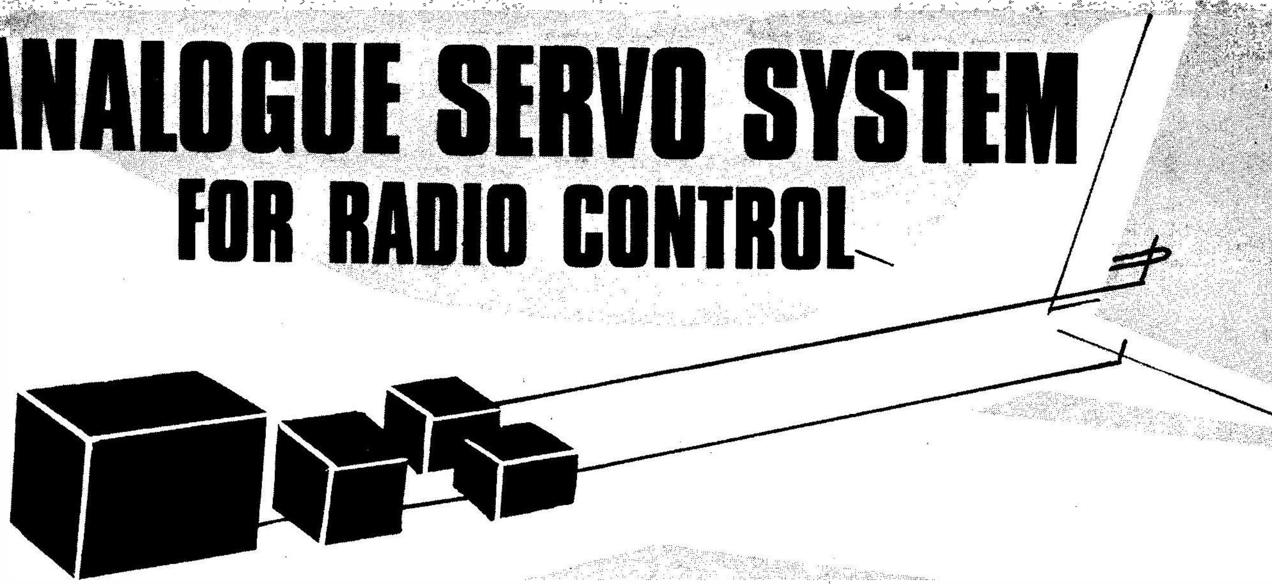
ANALOGUE SERVO SYSTEM FOR RADIO CONTROL



By A.R.Miller

Most modellers who own single channel radio control equipment often require a unit to add to their existing system to make it more comprehensive. Simple units, consisting of a transmitter, receiver and an actuator are particularly popular because of their versatility and low price compared with complete proportional units. Various units have already been described in the past in this magazine, giving details of equipment for model control.

Model control receivers are often very critical in operation because of the high radio frequency used. This is the point at which most would-be constructors get into difficulties, and in the end it is often cheaper to purchase ready-made equipment. Such equipment can be obtained for as little as ten pounds, compared with digital systems costing over one hundred pounds.

This article describes a cheap addition for a single channel system providing a function that compares favourably with far more complex systems. It utilises two servo amplifiers described in an article by Mr J. Tennant in the December 1967 issue of P.E. (unfortunately this issue is now unobtainable).

BASIC OPERATION OF THE SYSTEM

The only necessary modification to existing equipment is the addition of a pulser to the transmitter modulation system. The pulse frequency must be continuously variable between 3 and 10 pulses per second, with a centre frequency of 6 pulses per second. The mark to space ratio of these pulses must also be controllable.

A simple pulser suitable for this application may be constructed using an astable multivibrator as the pulse generating device, followed by an amplifying stage. However a far better pulser can be made using a unijunction transistor sawtooth generator, followed by two stages to square off the waveform, and vary the mark to space ratio. The advantages of this type is that it is more stable in operation, and there is practically no interaction between controls.

The receiver used in the construction of this article must incorporate a relay—this is common in ready-made receivers—for this reason the pulse rate use in this design is very low.

Conventional practice with this type of pulse system is to use a "Galloping Ghost" actuator, employing an electric motor driving a spring loaded gear system providing mechanical control. Although this method sounds good in theory, this type of actuator has a marked disadvantage; the power supplied by the electric motor is quite low, and therefore it can only be used for small models. The system described here uses feed-back servos and thus overcomes the low power problem.

DECODER

Variation of the mark to space ratio causes the relay (RLA1 in Fig. 1) to vary the brightness of the bulb LP1. This variation in brightness is received by the photocell X1 the resistance of which is correspondingly varied, thus controlling the bias applied to the base of TR6. The mark to space ratio servo amplifier consists of transistors TR6 to 10, which differentiate this bias and feed it to motor MO1. This motor is ganged to VR4 which varies the feed back to the amplifier, and hence the motor drives the servo to a position dictated by the bias.

The purpose of the lamps and photocells (LP1, 2 and X1, 2) might not seem obvious. However, as stated,

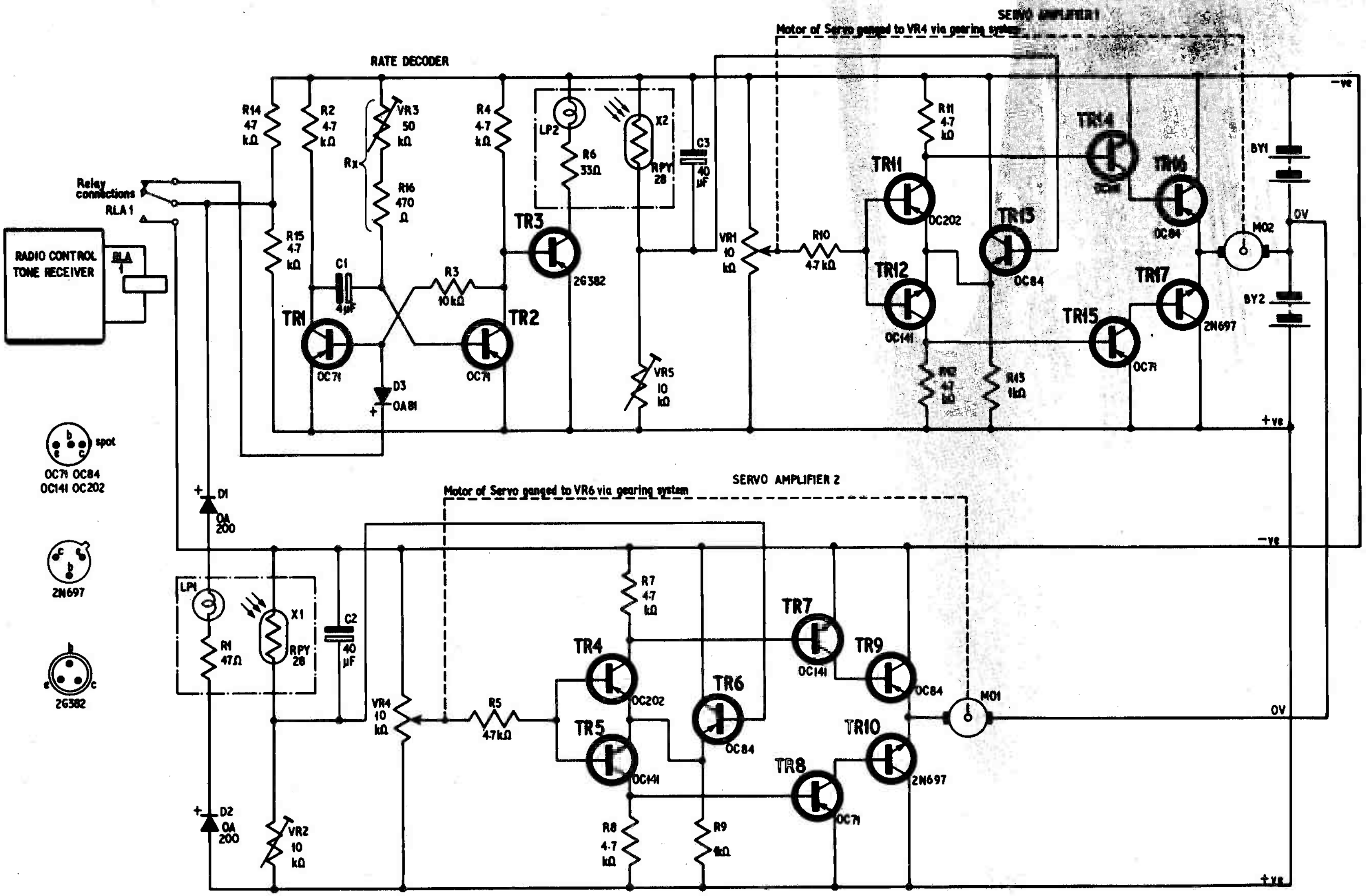
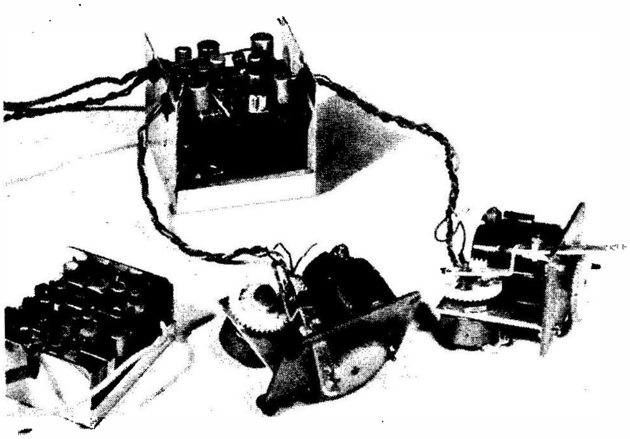


Fig. 1. ***The complete circuit diagram of the analogue servo system***

this system does not use high frequency pulsing techniques. Consequently considerable smoothing of the input signal is necessary. Capacitance and resistance junctions were tried, but damped the movement of the servos to such an extent that they were practically inoperative. Eventually a system using lamps and bulbs was evolved and this is described here. It is surprisingly accurate, sensitive and reliable and, in comparison with other analogue circuits, it is also less complex. The two electrolytic capacitors C2 and C3 provide further smoothing of the input signal.

Bulbs do tend to consume a large amount of power, and this can be a problem when the supply is in the form of dry batteries; however, the bulbs used in the system are low wattage types so the power consumed is not too great. A resistor is incorporated in series with each bulb, to reduce the current so that the bulb glows dimly. At this point the power consumed is about 60mA at 4 volts. The mark to space ratio is nominally 50–50, therefore the bulb is only on for half the time period; consequently power consumption is roughly halved. The system is therefore quite economical on power.



This shows all the modules necessary for a complete installation. They are : the receiver, the electronic servo control and the two servos

The purpose of D1 and D2 in series with LP1 is to prevent unwanted current flowing back through D3 and interfering with the operation of the rate decoder when the polarity of the relay is reversed. Diodes used for D1 and D2 in the prototype were subminiature silicon types; almost any good small silicon diodes can be used.

RATE SERVO FUNCTION

The rate decoder provides the second servo function; this consists of a monostable multivibrator which provides a pulse independent of the mark to space ratio of RLA1. The time constant of this circuit is given by the equation 0·7.C1.Rx seconds. Now the centre pulse rate frequency of the transmitter is 6 pulses per second, therefore if we time the monostable circuit to give a $\frac{1}{12}$ of a second pulse when the relay is connected, this will mean that TR3 is switched on for $\frac{1}{12}$ second, and switched off for $\frac{1}{12}$ of a second. This means that the output from TR3 collector will have a mark to space ratio of 50–50.

It is a characteristic of a monostable circuit that the pulse output time is independent of the pulse input time, consequently the rate decoder will not respond to variations in mark to space ratio from the receiver relay (RLA1). If the pulse frequency of the transmitter is increased, then TR3 is switched on for a longer period than it is switched off. This will mean that the bulb LP2 will glow more brightly, and vice-versa if the pulse rate is decreased. Hence, variations in the light intensity of LP2 control the rate servo motor via X2 in a similar manner as that with the mark to space servo.

SERVOS

A useful start when constructing the electronics of the system is to have the servo motors already made up; this is because most of the decoder circuitry is set up using the servos as the standard. The servos used in the prototype were constructed from "Mighty Midget" electric motors coupled through Ripmax 40/1 reduction worm gears to the feedback potentiometer and the final output drive, see Fig. 2. This motor which can be obtained from most model shops strikes a happy medium between reliability and cost—it could, at the time of writing be purchased for about £1.

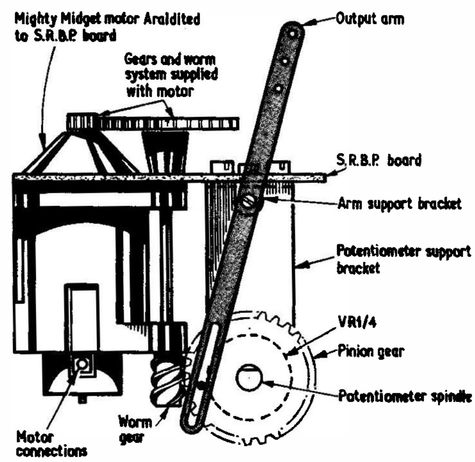


Fig. 2. Basic construction of the servo using a Mighty Midget motor

The current drawn by the motor is quite small, and it will operate from a low voltage supply. Typical current ratings are 150mA running, and 250mA stalled; it is therefore within the capabilities of the amplifier output transistors. When purchased, the motor is complete with a 6/1 nylon reduction gear already fixed. This gear has a countershaft speed of between 600 and 800 r.p.m., consequently, after the wormgear drive, the servo takes about 2 seconds to complete the full travel of 180 degrees.

CONSTRUCTIONAL DETAILS

Once the servos have been constructed and are running smoothly, construction of the electronics can begin. Details of the printed circuit boards for the unit are given in Figs. 3 and 4.

Two different wiring boards are used in the system, and when each has been etched and drilled, using a $\frac{1}{16}$ inch drill, soldering work can begin. Due to the size of the lands on the board a soldering iron with a small bit is necessary. Multicore 22 gauge solder is preferable as this is much more convenient to work with. The printed wiring board for the servo amplifiers should be wired up first; this has two amplifiers on it side by side. Four resistors are used for each amplifier, and these should be soldered in first.

One channel should be selected, and the transistors for this channel soldered in. It may be necessary, before inserting the input transistor (TR6 or TR13) to solder in the signal input lead, this is made 6in long. When the transistors for one of the amplifiers have been inserted, then all the remaining leads for the amplifier are soldered to the board. A 50 kilohm potentiometer should now have its wiper connected to the signal input lead, and the two outside connections soldered to the positive and negative output leads.

The servo motor is then connected to the drive transistors and to the centre tap of two 4·5V batteries or a 7·2V Deac pack. Next connect the positive and negative terminals of the battery pack to the appropriate points. When this has been done the servo should move to some point on its travel and stop in that position. If this happens, turning the 50 kilohm potentiometer should cause the servo motor to move to another position and stop again. If this does not happen disconnect the battery and try reversing the motor contacts.

Assuming the amplifier circuit is working correctly the potentiometer, motor and battery can be removed, and construction of the other channel can be carried out in a similar manner, testing the circuit by the same method. If it is noticed that either servo motor travels more quickly in one direction than in the other, then it may be that the output transistors are incorrectly matched. Transistors TR9, 10, 16 and 17 must be fitted with finned heat sinks.

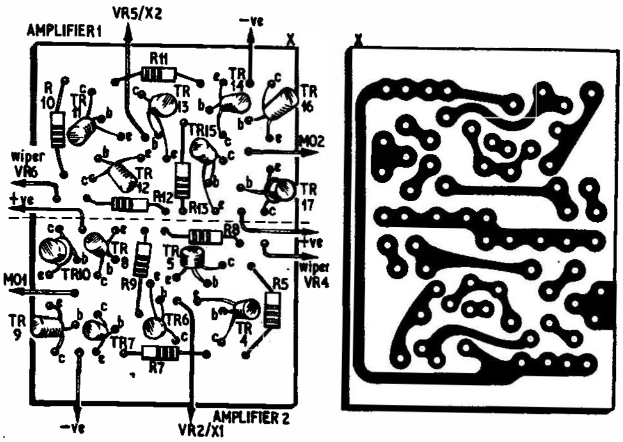


Fig. 3. Layout and wiring of the servo amplifier board. The board is shown full size

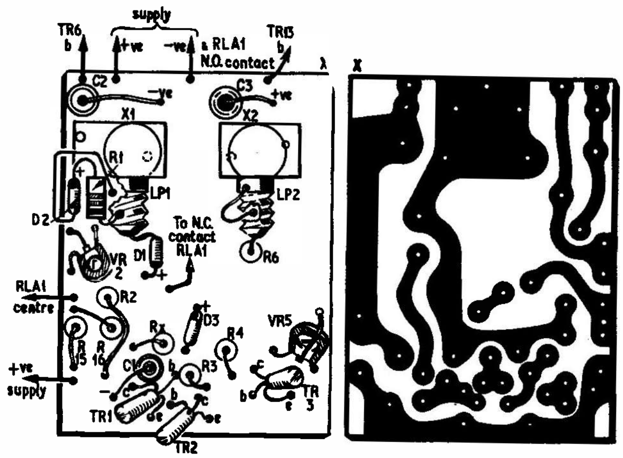


Fig. 4. Layout and wiring of the decoder board. The board is shown full size

COMPONENTS . . . .

Resistors

R1	47Ω $\frac{1}{4}$W (see text)	R8	4·7kΩ	R13	1kΩ
R2	4·7kΩ	R9	1kΩ	R14	4·7kΩ
R3	10kΩ	R10	4·7kΩ	R15	4·7kΩ
R4	4·7kΩ $\frac{1}{4}$W	R11	4·7kΩ	R16	470Ω $\frac{1}{4}$W
R5	4·7kΩ $\frac{1}{4}$W	R12	4·7kΩ		
R6	33Ω $\frac{1}{4}$W (see text)				
R7	4·7kΩ				

All 10%, $\frac{1}{8}$ watt carbon (except where stated)

Potentiometers

VR1 10kΩ carbon lin.
VR2 10kΩ skeleton preset
VR3 50kΩ (any linear potentiometer to find value of Rx)
VR4 10kΩ carbon lin.
VR5 10kΩ skeleton preset

Capacitors

C1 4μF elect. 6V

Semiconductors

D1, 2 OA200 (2 off, see text)
D3 OA81
X1, 2 RPY28 light dependent resistor (2 off, Mullard)
TR1, 2, 8, 15 OC71 (4 off)
TR3 2G382
TR4, 11 OC202 (2 off)
TR5, 7, 12, 14 OC141 (4 off)
TR6, 9, 13, 16 OC84 (4 off)
TR10, 17 2N697 (2 off)

Miscellaneous

MO1, 2 "Mighty Midget" motors and gears (two off—see text)
LP1, 2 6V, 0·1A bulbs (two off)
BY1, 2 Centre tapped 7·2V 500DKZ Deac. battery pack *or* two 4·5V batteries (see text)
Copper clad s.r.b.p. board ($1\frac{3}{8}$in × $1\frac{7}{8}$in, 2 off)
22 s.w.g. aluminium for case ($5\frac{3}{4}$in × $5\frac{1}{2}$in)
Finned heat sinks (4 off)

DECODER CONSTRUCTION

Having established the operation of the servos; construction of the decoder can begin. After making sure that the printed circuit board is clean, solder in VR5, then transistor TR3 and so on proceeding down the side of the board to Rx. At the holes for this resistor two wires should be soldered in and connected to R16 and the 50 kilohm potentiometer which was used for setting up the servos (VR3).

After this has been done and all parts of the decoder are in place, the bulbs and photocells can be positioned. Start with LP2 and the photocell X2. The RPY28 is flat in structure, and the leadout wires protrude from the underside; these wires should be positioned in the appropriate holes at the end of the board, so that the centre of the photocell stands about half a centimetre above the board.

A piece of thin stout connecting wire is soldered to the body of the bulb LP2 and inserted through a hole in the board as shown. The glass part of the bulb should be vertically above the photocell, with the element above the centre of the photocell. A 33 ohm ¼ watt resistor is soldered to the bulb, and to the circuit board (see Fig. 4). Do not insert LP1, D1, D2, VR5 or X1 yet. The necessary connecting wires can now be soldered in. Connect the relay of the receiver to VR1 wiper and to the positive end of the diode D3. Switch on the transmitter and start the receiver relay pulsing.

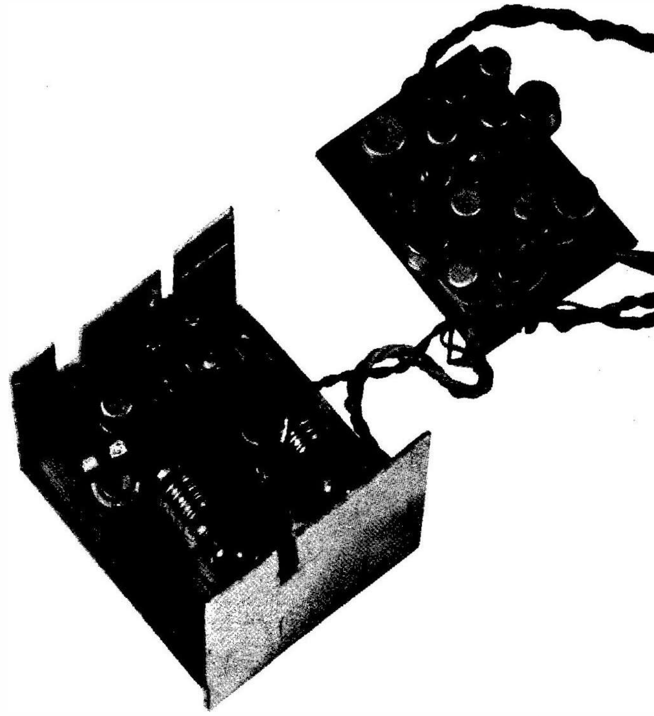
Connect a 7·2 volt Deac supply or two 4·5 volt dry batteries in series (whichever supply is to be used) to the respective supply rails of the decoder, noting the current that is flowing; it should be in the region of 50mA, pulsing in time with the relay. If LP2 does not flash try adjusting the 50 kilohm potentiometer (VR3). If it still does not work, it may be that the load resistor in series with the bulb is too great in value. Remove the bulb and put a milliameter across the bulb connections; it should register about 40mA at 4 volts. If there is no current, check over the circuit for faults—check that the diode and supply polarity is correct.

As a last resort remove TR3, connect a voltmeter across the positions occupied by TR3 base and emitter, and check that there is a series of pulses of about 3 to 4 volts at this point. If this is happening then it may be that TR3 is defunct. If these pulses are not coming through then the monostable circuit is not working—check TR1 and 2. No trouble should in fact be encountered with this circuit as it is a simple one.

SETTING UP PROCEDURE

Assuming now that the decoder circuit is working correctly, set the transmitter control stick to its neutral position, then adjust the 50 kilohm potentiometer (VR3) until lamp LP2 appears to be on and off for equal periods; a more accurate value of this resistance (Rx) can be found by moving the mark to space control on the transmitter. Any variation of the mark to space control should not produce a perceptible variation in brightness of the bulb, however variation in pulse rate will have a marked effect in the brightness of the bulb.

If everything is operating correctly, potentiometer VR2 and photocell X1 may be soldered in. Another ¼ watt resistor is positioned in the hole next to VR5; the value in the prototype was found to be 47 ohms, although this may vary according to the characteristics of diodes D1 and D2. Diode D2 has its negative end connected to the board, and its positive end connected to R1. The leads of the diode and resistor are clipped



The electronics for the control system partially installed in the case

short, care being taken not to overheat the components during soldering. This done, diode D1 can be connected to the bulb at its negative end, and into the appropriate hole at its positive end. Connect the centre tap of the relay to the positive end of D1 and the normally open contact of the relay to the negative supply rail; the normally closed contact is connected to diode D3.

Switch on the transmitter and receiver and both bulbs should start flashing. If LP1 does not flash, check that the diodes are connected correctly and also that there are no other wiring faults. If LP1 still does not flash, try decreasing the load resistor (R1); if this has no effect remove the bulb and check for voltage and current as before.

It may be that the forward resistance of the diodes is too high and there is not quite sufficient current to light the lamp, in which case the diodes will have to be substituted. If LP2 stops flashing when LP1 starts, this is due to the back resistance of the diodes D1 and 3 being too low. Again the diodes will have to be substituted.

Once the decoder circuit is working correctly it can be linked to the amplifiers constructed previously. Connect up the amplifier 1 input to the junction between VR5 and X2 and amplifier 2 input to the junction between VR2 and X1.

Adjust VR2 and VR5 to their centre positions but do not turn on the transmitter yet. Switch on the supply to the amplifiers and decoder; the lamps should not flash but the servo motors should both travel to a point and stop. If this happens, cover one of the photocells; this should cause the appropriate servo to move to a new position; when the covering is removed the servo should return to its original position. Repeat the procedure for the other unit.

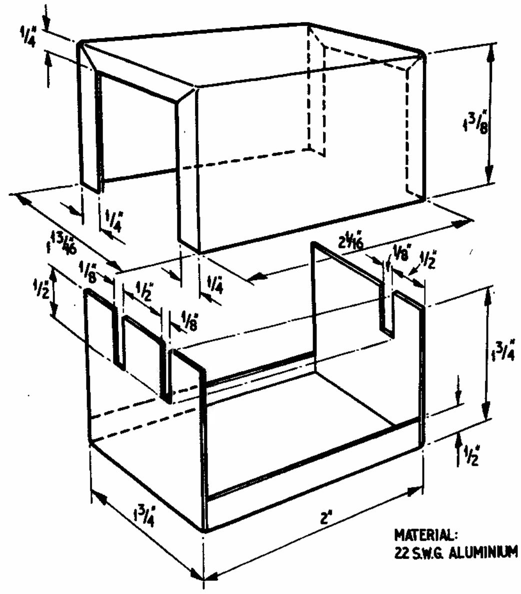


***Fig. 5.** The case used to house the prototype unit. Servo output wires are led out of the two slots at the left hand side. The opposite single slot carries the supply leads and relay connections. All external connections should be protected from the case by suitable grommets*

The transmitter can now be switched on. Once this is done the bulbs should flash as before. Cover both photocells and lights, so that the light from one bulb does not interfere with that from the other. Moving the mark to space control on the transmitter should produce a corresponding movement in the mark to space servo; if the movement is biased to one side, then the servo can be centred by VR2. (The load resistor in series with the bulb is varied until the bulb just glows.)

When the mark to space servo has been set up, the frequency servo can be aligned. VR5 should be used to centre the servo so that there is equal travel on either side of the centre frequency position. The 50 kilohm potentiometer (VR3), which is still in the circuit, is now adjusted more finely until there is no interference from the mark to space ratio control. This done, the potentiometer and R16 can be removed from the circuit, and their resistance value which gave this balance point measured; this can be done with an ordinary ohmmeter. A $\frac{1}{8}$ watt resistor (Rx) of this value is then inserted in place of potentiometer VR3 and R16.

All that remains is for the circuit to be tidied up, and a case, and cover for the bulbs and photocells made. Details of a case are given in Fig. 5; this should be made from 22 gauge aluminium insulated on the inside with a plastics covering material to protect against short circuits.

The lamp housing used in the prototype was made from celluloid. This was formed into a suitable shape, and glued with balsa cement. Two coats of black polystyrene paint were applied on the outside, and a coat of silver on the inside to provide a better reflective surface.

The weight of the complete system including the cases was found to be approximately 15 ounces.

★

NEWS BRIEFS

Laser Light Strikes Moon

SHORTLY after the Apollo 11 astronauts landed on the Moon, giant "pancakes" of laser light, two and a half miles across and ten feet thick, were arranged to strike their landing area and bounce off a special reflector in a scientific experiment designed to provide precise answers to age-old questions about the Moon.

The "pancakes" represent pulses of high-power laser light, one one-hundred-millionth (ten billionths) of a second in duration, fired from a rangefinder telescope on an Arizona mountain top—a rangefinder so precise it is able to measure the relative Earth to moon distance to within one and a half metres.

Dr. Renne S. Julian, senior scientist at Hughes Aircraft Company, California, which built the rangefinder system for the U.S. Air Force Cambridge Research Laboratories, said the ability to measure the range with such precision will provide valuable information about the lunar orbit, the moon's size, its true shape and its libration (rocking). It will also provide information about the mass distribution of the Earth and the movement of Earth land masses, or "continental drift".

The NASA retro-reflector placed on the Moon can be used by any country that wishes to use the device. It has been reported that Russia has a lunar rangefinder operating, and France and other countries are at work on similar devices.

Protected Instrument Landing

AIRFIELDS in the United Kingdom will be the first to use the new CPILS (correlation protected instrument landing system) as a result of a development contract awarded to Plessey Radar by the Ministry of Technology. The new system—being developed from an idea originating at RAE—will greatly improve the operational reliability of aircraft instrument landing systems.

The equipment being developed is the ground and airborne equipment for a microwave glide-path system. This combines all the advantages of conventional ILS currently in use at airports throughout the world, with greater accuracy and complete freedom from interference and site effects.

Unlike other proposed instrument landing systems from the U.S.A., U.K. and France, this system is fully compatible with existing ILS and therefore more likely to succeed in world-wide exploitation. Existing flight-deck instrumentation can be used, the only changes necessary in the aircraft being the addition of a smaller antenna and a minor modification to the receiver.

CPILS will meet the needs of airports where full autoland facilities are required as well as those of less well-endowed airports where expense and siting difficulties preclude conventional ILS.

Degrees and the Practising Engineer

WILL a university degree become the only accepted qualification for professional engineers? Already there are ominous signs that this is so; for example there are efforts to hold the Higher National Diploma and Certificate to the "technician" level.

A determined fight against this tendency is being conducted by The Society of Engineers, as was announced by their President W. G. Taylor at a recent meeting. Other members of the Society also voiced their fears that many practising engineers would be excluded from any Register of Engineers that may be compiled in the future.

One industrialist has stated that students who have attained a good HNC turn out to be better than many graduates after they have received one or two years' training in the laboratory. This view is believed to be fairly widely held in industry.

COMMENTARY ON SOUND REPRODUCING EQUIPMENT

audio trends

By F. C. Judd

DURING the few months prior to the Annual Audio Festival (this year in October and now called the International Audio and Photocine Fairs) news of anything really new or of special technical interest is usually pretty scarce.

It appears at the moment however, that unit hi fi systems will be very much in evidence at the forthcoming fair, but one wonders whether this idea is not really degenerating into a trend toward "glorified" radiograms. Already some unit systems comprising a radio tuner, an amplifier and a record player are being made available all in one box. The small bookshelf type loudspeakers classified as hi fi might just as well be included.

NEW AUDIO EXHIBITION ANNOUNCED

News has been released that a second hi fi exhibition is now to be staged and run by the Federation of British Audio Promotions Limited, at which only "top performance" hi fi audio equipment that performs to, or better than, a minimum acceptable standard will be displayed and demonstrated.

The exhibition is to be held in the Skyways Hotel near the London Heathrow Airport from April 23 to 26, 1970, with the 23rd strictly reserved for the trade and technical press only. Each exhibitor, who may be a British or foreign manufacturer or U.K. distributor of equipment made outside the U.K., will have an identical and completely sound-proofed room for demonstration purposes, with separate rooms for static displays of their products. Tickets will be made available to the public via hi fi dealers and various other sources.

An exhibition of hi fi equipment with an agreed minimum performance standard ("only the best in audio" quote the organisers) is a very good idea, but who is going to draw that very thin line between "acceptable" and "unacceptable"?

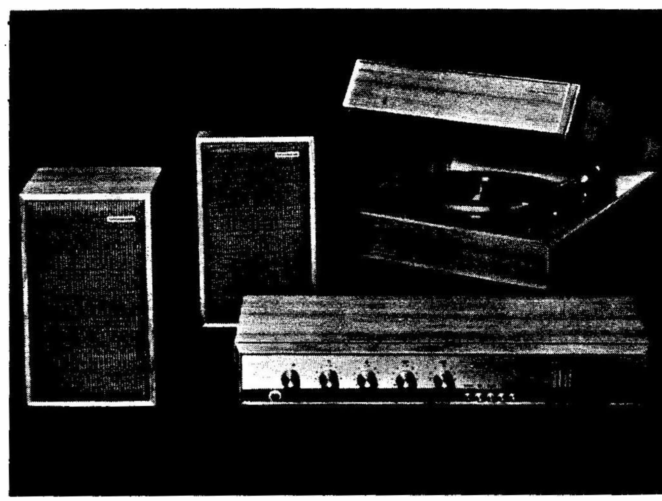
We have no performance standard in this country like the German DIN 45-500 for domestic audio equipment which could be adopted. The German standard is generally regarded in this country as not quite good enough for strictly hi fi and is perhaps one good reason why a British standard should be established anyway.

Another and equally good reason is because the term "hi fi", which at one time really did mean high fidelity, is now freely used to describe the sound reproduction qualities of anything ranging from a cheap transistor radio to genuine top performance audio equipment. Meanwhile, the full range of fidelity audio equipment by British and foreign manufacturers will be displayed and demonstrated at the combined International Audio and Photocine Fairs at Olympia from October 16 to 22.

LOW NOISE TUNERS AND AMPLIFIERS

Audio manufacturers and particularly the Japanese are now using field effect transistors with (pardon the pun) considerable effect, especially in a.m./f.m. tuners.

A tuner of Japanese origin, which I had the opportunity of testing recently, featured f.e.t.'s in the r.f. stages with a very great reduction in noise level and increased sensitivity. Completely noise free stereo could be obtained with an indoor aerial some 20 miles from the London (Wrotham) transmitter. This is something I have not found possible with other tuners not using f.e.t.'s.



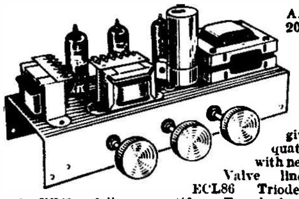
Goodmans "Music Suite" complete stereo system

With the help of modern low noise transistors, a signal-to-noise ratio of 60dB or better is now fairly commonplace in top quality amplifiers and is the sort of figure that should be looked for, even with inputs for low sensitivity pick-up cartridges and tape heads which have a high degree of bass lift for equalisation.

One amplifier which performs quite well in this respect is the Nikko TRM 120 which has a rated output power of some 42 watts r.m.s. per channel or a combined music power from both channels of 120 watts. Not only is the output power genuine, but the amplifier also has a signal-to-noise ratio of around 60dB for all inputs.

For those who want "life size" sound and really high fidelity performance, this is the amplifier. It retails at £95 (equivalent to about 16/- per watt music power).

DE LUXE STEREO AMPLIFIER



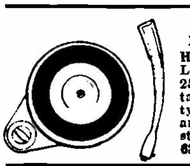
A.c. mains 200–240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as full wave rectifier. Two dual potentiometers are provided for bass and treble control, giving bass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

TRANSISTOR STEREO 8 + 8 MK II

Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Freq. response ± 3dB. 20–20,000c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at 0·6 amp.

PRICES: AMPLIFIER KIT £10.10.0; POWER PACK KIT £3.0.0; CABINET £3.0.0. All Post Free.

Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).



SPECIAL PURCHASE! E.M.I. 4-SPEED PLAYER

Heavy 8½in. metal turntable. Low flutter performance 200/250 V shaded motor (90 V tap). Complete with latest type lightweight pick-up arm and mono cartridge with t/o stylii for LP/78. ONLY 63/-. P. & P. 6/6.

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PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, AT60, SP25. With Transparent Plastic cover. OUR PRICE 5 gns. complete. P. & P. 8/6.

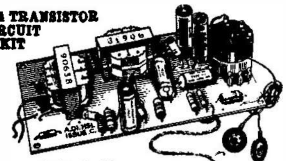
SONOTONE 9TAHC compatible Stereo Cartridge with diamond stylus 50/-. P. & P. 2/-.

LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **32/6.** P. & P. 2/-.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **30/-.** P. & P. 2/-.

FEW ONLY! ACOS HIGH-G Mono Cartridge for EP and LP. Only **10/-.** P. & P. 2/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1

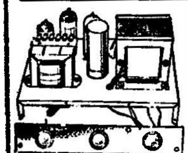


● Peak output in excess of 1½ watts.
● All standard British components.
● Built on printed circuit panel size 6 × 3in.
● Generous size Driver and Output Transformers.
● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET114 or 81 Mullard AC128D and matched pair of AC128 o/p). ● 9 volt operation.
● Everything supplied, wire, battery clips, solder, etc.
● Comprehensive easy to follow instructions and circuit diagram **2/6** (Free with Kit). All parts sold separately.

SPECIAL PRICE 45/-. P. & P. 3/-.

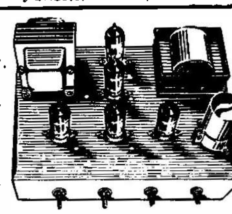
Also ready built and tested, **52/6.** P. & P. 3/-.

3-VALVE AUDIO AMPLIFIER HA34 MK II



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved **wide range tone controls giving bass and treble lift and cut.** Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4.15.0.** P. & P. 6/-.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier, with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **2/6** (Free with parts). **All parts sold separately.** ONLY **£7.9.6.** P. & P. 8/6. Also available ready built and tested complete with std. input sockets, **£9.5.0.** P. & P. 8/6.

LOUDSPEAKER BARGAINS

5in. 3 ohm. **16/-.** P. & P. 3/-. 7 × 4in. 3 ohm. **21/.** P & P 4/-. 10 × 6in. 3 ohm. **27/6.** P. & P. 6/-. E.M.I. 8 × 5in. 3 ohm. with high flux magnet **21/-.** P. & P. 4/-. **E.M.I.** 13½ × 8in. 3 ohm. with high flux ceramic magnet **42/-** (15 ohm **45/-**). P. & P. 6/-. E.M.I. 13 × 8in. 3 or 15 ohm. with two inbuilt tweeters and crossover network **4 gns.** P. & P. 6/-.

BRAND NEW. 12in. 15W H/D Speakers. 3 or 15 ohms. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5.10.0.** P. & P. 7/6. Guitar models: 25w. **£6;** 35w. **£8.8.0.**

E.M.I. 3½in. HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohms **15/-** each; 15 ohms **18/6 each.** P. & P. 2/6.

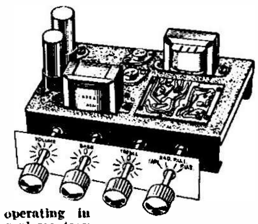
12in. "RA" TWIN CONE LOUDSPEAKER. 10 watts peak handling. 3 or 15 ohm. **37/6** P. & P. 6/-.

35 OHM SPEAKERS

3½in. 14/-. P. & P. **2/6;** 7 × 4in. **21/-.** P. & P. 4/-.

VYNAIR AND REXINE SPEAKERS AND CABINET FABRICS app. 54in. wide. Usually 35/- yd., our price **13/6** yd. length. P. & P. 2/6 (min. 1 yd.). S.A.E. for samples.

NEW! HSL.700 MONO TRANSISTOR AMPLIFIER



A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated preamplifier assembled on special printed sub panel. AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for a.c. mains 200–240v. **Controls:** bass, treble, volume/on/off. **Function** selector for PU1, PU2, tape, radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9½ × 5 × 4½in. high.

Performance figures:
Sensitivity—PU1—50m/v, 56K input impedance.
PU2—110m/v, 1 meg input impedance.
Tape—110m/v, 1 meg input impedance.
Radio—110m/v, 1 meg input impedance.

Output power measured at 1Kc—6·2 watts RMS into 3 ohms, 5·8 watts RMS into 15 ohm. Overall frequency response 30c/s–18Kc/s: Continuously variable tone controls: Bass. +8db to −12db at 100c/s. Treble, +10db to −10db at 10Kc/s.

The HSL.700 has been designed for true high fidelity reproduction from radio tuner, gramophone deck and tape recorder pre amp but is also capable of being used in conjunction with a guitar by connecting to PU1 socket and the peak output power will then be in the region of 15 watts.

Supplied ready built and tested, complete with knobs, attractive anodised aluminium front escutcheon panel, long spindles (can be cut to suit your housing requirements) full circuit diagram and operating instructions.

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QUALITY RECORD PLAYER AMPLIFIER MK II

A top-quality record player amplifier employing 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. × 3 d. × 6 h. Ready built and tested. PRICE **75/-.** P. & P. 6/-. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. **PRICE 97/6.** P. & P. 7/6.

DE LUXE QUALITY PORTABLE R/P CABINET MK II

Uncut motor board size 14½ × 12in., clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 × 15 × 8in. **PRICE 79/6.** P. & P. 9/6.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS Giving 13 alternatives. Primary: 0–210–240v. Secondary combinations: 0–5–10–15–20–25–30–35–40–60v. half wave at 1 amp. or 10–0–10, 20–0–20, 30–0–30v. at 2 amps full wave. Size 3"h. × 3½w × 3"d. Price **32/6** P. & P. 6/-.

MAINS TRANSFORMER. Primary 200-240V two separate ½ wave secondaries giving approx. 16V at 1 amp and 20V at 1·2 amp; secs. can be connected in series for 36V at 1·5 amp. Ideal for transistor power supplies. Drop through mounting. Stack size 2¾ × 3½ × ¾in. 15/-. P. & P. 6/-.

MAINS TRANSFORMER. For transistor power supplies.
Pri. 200/240V. Sec. 9–0–9 at 500mA. **11/-.** P. & P. 2/6.
Pri. 200/240V. Sec. 12–0–12 at 1 amp. **14/6.** P. & P. 2/6.
Pri. 200/240V. Sec. 10–0–10 at 2 amp. **27/6.** P. & P. 3/6.

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ACY20	4/9	2N388H	8/6	NKT216	10/–	NKT405	14/9
ACY21	5/–	2N404	5/–	NKT217	10/6	NKT406	13/6
ACY22	5/–	2N696	5/–	NKT219	5/6	NKT674F	6/–
AF116	2/9	2N697	5/–	NKT229	5/3	NKT713	5/3
AF117	2/9	2N706	5/3	NKT237	8/3	NKT717	8/3
AF139	7/6	2N706A	3/3	NKT240	5/3	NKT773	4/9
AF259	7/6	2N708	3/9	NKT241	5/–	NKT791	5/9
BC107	4/–	2N709	11/9	NKT242	3/–	NKT10339	6/6
BC108	3/9	2N914	5/9	NKT243	13/6	NKT10419	5/–
BC109	4/–	2N916	7/6	NKT244	3/3	NKT12389	10/6
OC44	2/6	2N918	11/–	NKT245	4/–	NKT13329	5/–
OC45	1/8	2N929	7/–	NKT261	4/3	CARBON	
OC70	4/6	2N930	8/–	NKT262	4/3	RESISTORS	¼Watt
OC71	2/3	2N1131	10/–	NKT264	4/3	VALVE	3d each
OC72	2/6	2N1132	12/9	NKT271	4/–	HOLDERS	6d and 9d
OC74	3/9	2N3391	6/–	NKT272	4/–		each
OC75	3/9	2N3391A	6/9				

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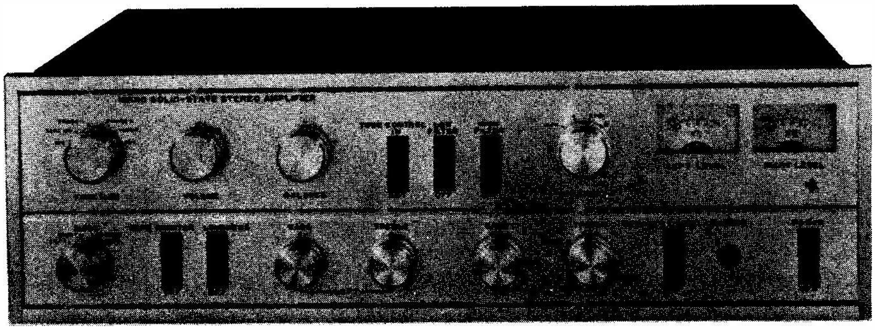


Japanese Nikko TRM120 stereo amplifier

Its U.K. distributors are Howland West Limited, 2 Park End, South Hill Park, London, N.W.3.

MUSIC SUITE

Those who are looking for something less powerful and much more compact may find the new Goodmans "Music Suite" more to their liking. This comprises three matching items which include the latest Goodmans 3000 integrated stereo tuner amplifier, their 3025 record player complete with pick-up arm and cartridge and a pair of 3005 loudspeakers all for £140 9s 4d.

This hi fi system will be in the shops by the time this article appears in print and will be featured at the forthcoming "Audio and Photocine Fairs".

The tuner amplifier features include preset tuning and push button station selection, automatic frequency control, a built-in stereo decoder, 12 watts r.m.s. output power per channel, inputs for pick-up and tape, and a socket for stereo headphones with automatic speaker muting.

LOW DISTORTION POWER AMPLIFIER MODULES

Home constructors will be interested in the transistor power amplifier modules available from Welbrook Engineering and Electronics Limited. The makers claim a distortion level of not greater than 0·1 per cent at all output levels, which is achieved by a special Welbrook circuit design.

These power stage modules which are used in the Welbrook integrated stereo amplifiers, are rated for 15 watts r.m.s. into 8 ohms or 10 watts r.m.s. into 15 ohms and require an input signal of 100mV for full output. Power requirements are 45V at 0·7A per module. The Modules cost £8 each or two modules (for stereo) £15. Details from Welbrook Engineering and Electronics Limited, Brooks Street, Stockport, Cheshire.

RECORD PLAYER KIT

A kit of parts for building a record transcription unit should also prove attractive to construction minded hi fi enthusiasts. This is the Sugden kit for building their well-known Connoiseur BD1 record turntable which caters for 33⅓ and 45 r.p.m. discs and costs £11 13s 5d.

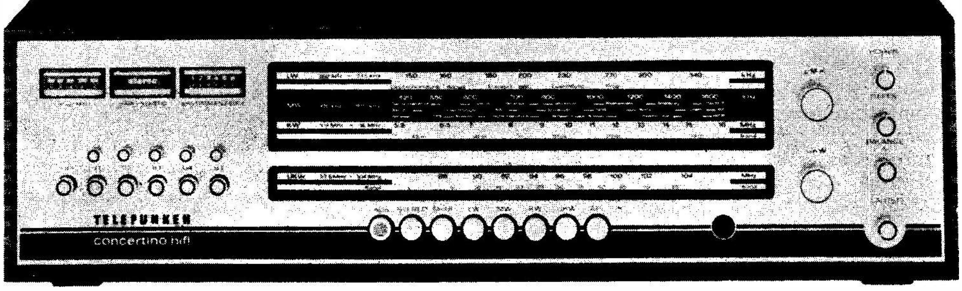
It will accommodate any of the popular pick-up arms and the only tools required for assembly are a screwdriver and pliers. Further details can be obtained from A. R. Sugden and Co. Ltd., Market Street, Brighouse, Yorks.

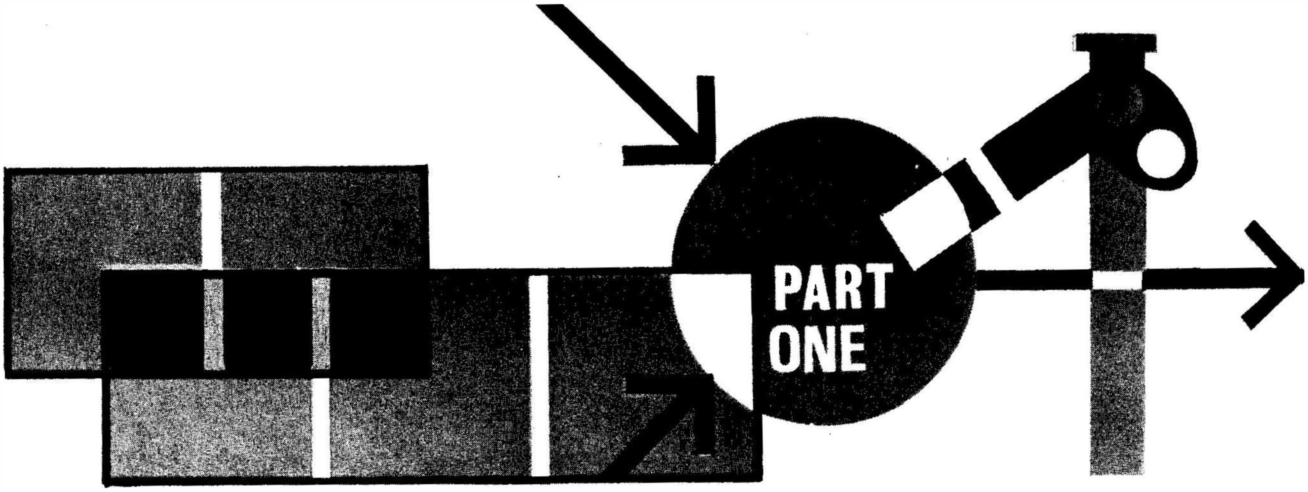
NEW TUNER AMPLIFIER

One final item is a new hi fi stereo tuner amplifier from Telefunken called the "Concertino". The tuner section covers the v.h.f./f.m. and short, medium and long wave bands and features a pre-tuned station selection system, an electronic tuning indicator and stereo decoder.

The makers claim 22 watts music power (15 watts r.m.s.) per channel and an overall performance to the German DIN 45–500 standard. The amplifier caters for pick-up and tape inputs, and has a conventional active tone control system for bass and treble. Price £103 19s 0d. Distributed in the U.K. by A.E.G. (Great Britain) Limited, 27 Chancery Lane, London, W.C.2.

Telefunken "Concertino" stereo tuner amplifier





By P. GOODES

Model railway is just one of several examples in which logic switching circuits can be fully exploited. This is the first of a short series describing these circuits and how they can be usefully employed to take over much of the complex operations of a large scale model railway system

A MODEL railway layout can eventually reach a size and complexity where it is more than a full time job to keep all trains and ancillaries running smoothly. Naturally, an excess of automation *can* take all the fun out of the hobby from the modelling angle, so it is the intention of this series to present a system which would be acceptable to the model enthusiast and electronics gadgeteer alike.

All the ideas to be described make use of simple standard switching circuits. These circuits comprise the bistable, the monostable, a relay buffer, the inverter, the AND gate, the OR gate, the divider, the shift register, and a motor control amplifier. The circuits have been designed to be straightforward and reliable and to use the minimum variety of components in an attempt to keep the cost within reasonable limits.

Constructional details are deliberately omitted because the final form of construction will depend on the complexity of the system to be used. It is expected that anyone contemplating the making of a logic system will be able to use established methods (to choice) of modular construction.

LOGIC SWITCHING

A logic sequence in electronics may be considered as a series of switching functions to give a particular result for a particular set of input conditions and a predetermined set of operating instructions which are incorporated by the designer. Consider the circuit shown in Fig. 1.1a. The voltage across R may be either 12V when S1 is closed or zero when S1 is open. Thus we have two definite states whereby we can answer the statement "S1 is open" by "true" or "false". It is normal in logic circuitry to represent these two states by 1 and 0 on paper, and electronically they may be represented by "voltage" and "no voltage", positive or negative. This is purely arbitrary but in this discussion it has been decided that −12V should be represented by 1 and zero represented by 0. A transistor may be considered to have two definite states, first when it is fully conducting, i.e. the collector voltage is approximately zero, and the transistor is thus effectively a short circuit. The second state is when the transistor is cut off so that no current flows through the transistor and the collector voltage to all intents and purposes is equal to the supply voltage (see Fig. 1.1b).

This then forms the basic electronic switch and various operations may be performed by interconnecting these switches in different ways. Pulses are transmitted throughout the control circuit and the different elements prepared according to their characteristics, i.e. 1 or 0.

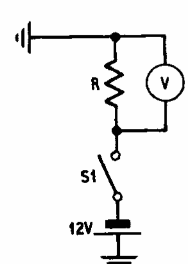


Fig. 1.1a. Simple electrical switching circuit

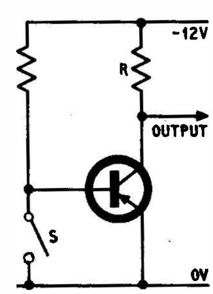
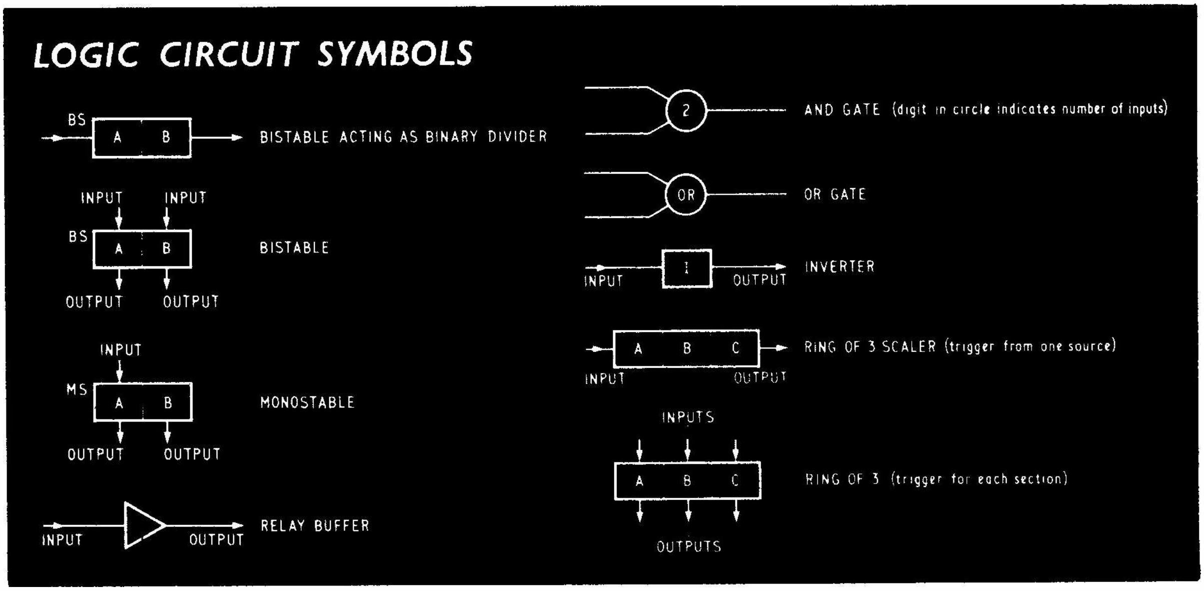


Fig. 1.1b. Simple transistor switching circuit



A number of standard circuits are employed. A brief description of these circuits is given here.

BISTABLE CIRCUIT

The circuit in Fig. 1.2 comprises two switches with their inputs and outputs cross-connected. Assume TR1 is conducting (state 0) and TR2 is cut off (state 1) due to TR1 collector voltage being at 0V (base-emitter junction is reverse biased). A negative trigger pulse applied to the base of TR2 causes it to start conducting and its collector voltage to rise. This rise is amplified and inverted by TR1 and fed back via C2 and R3 to assist the trigger in driving TR2 on. This regenerative effect finally results in the state where TR1 is cut off (state 1) and TR2 is conducting hard (state 0). Thus on receipt of a trigger pulse the output at TR2 collector has changed from 1 to 0 and the output from TR1 collector has changed from 0 to 1. The circuit will remain in this condition until a negative pulse is applied to the base of TR1 when the circuit will revert back to its original condition.

BINARY DIVIDER

The binary divider performs in a similar manner to the bistable described above, except that it may be triggered back and forth from a common pulse input. See Fig. 1.3. Diodes D1 and D2 perform the function of steering the positive spike of the differentiated input pulse to the transistor which is hard on, thereby cutting it off. Thus for every two pulses coming in, one comes out, i.e. the circuit has divided the incoming pulse train frequency by two.

MONOSTABLE CIRCUIT

The circuit in Fig. 1.4 may be used for generating a fairly accurate time delay or a pulse of a particular width. As can be seen the circuit is similar to the bistable, but one of the resistor coupling networks is replaced by a capacitor resistor network. Initially TR2 is conducting due to the base bias via R3, its collector voltage holding TR1 base sufficiently close to 0V for TR1 to be cut off. A negative trigger pulse (1) applied to TR1 base causes a rise in voltage at its

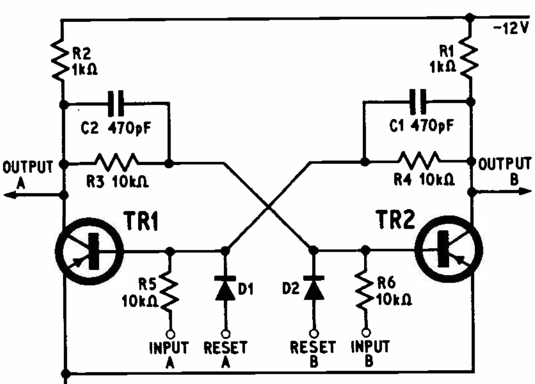


Fig. 1.2. Bistable switch with two inputs and two outputs

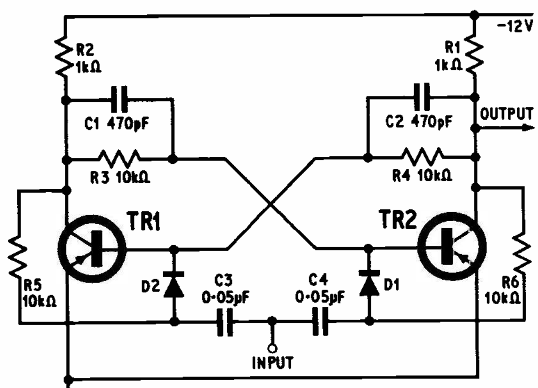


Fig. 1.3. Binary divider (divide by two)

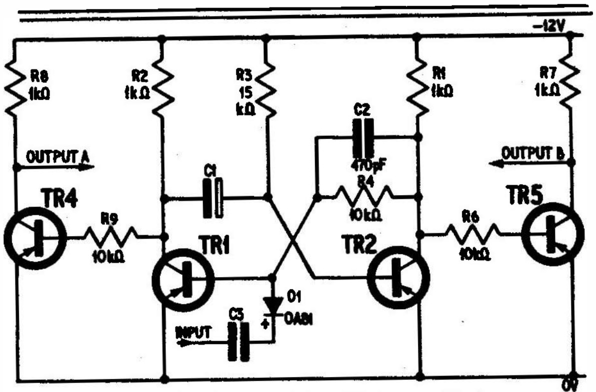
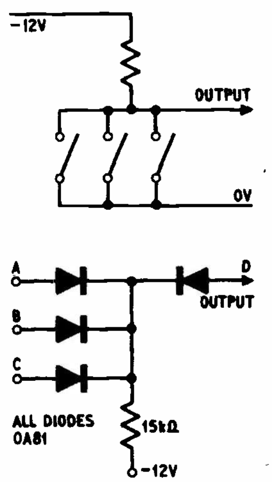
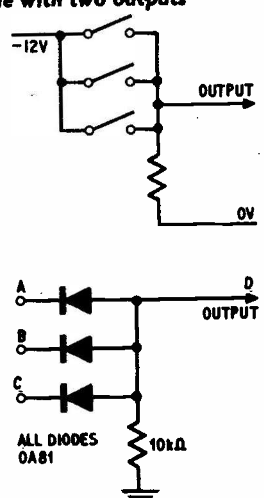


Fig. 1.4. Monostable with two outputs



3-INPUT "AND" GATE



3-INPUT "OR" GATE

A	B	C	D
0	0	1	0
0	1	0	0
1	0	0	0
1	1	0	0
1	0	1	0
0	1	1	0
1	1	1	1
0	0	0	0

Fig. 1.5. Three-input AND gate and logic table

A	B	C	D
0	0	1	1
0	1	0	1
1	0	0	1
1	1	0	1
1	0	1	1
0	1	1	1
1	1	1	1
0	0	0	0

Fig. 1.6. Three-input OR gate and logic table

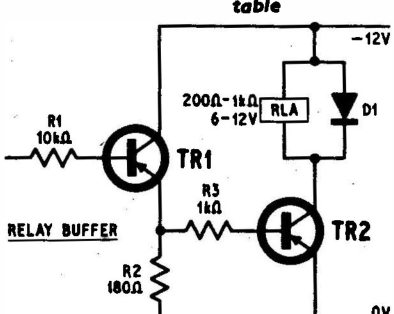


Fig. 1.7. Relay buffer stage. R1 may be replaced by a 1µF capacitor, for single shot buffer, R1 to be short circuit when used with AND gate

collector. This is coupled via C1 to TR2 base which amplifies and inverts, assisting in driving TR1 hard on; hence TR2 cuts off. Capacitor C1 then discharges at a time constant C_1R_3, and TR2 base voltage falls until it starts conducting. The collector of TR2 rises, cutting off TR1; the initial state is reached once more and remains so until another trigger pulse is received.

AND GATE

The AND gate for negative pulses is shown in Fig. 1.5. If any one input (A), (B) or (C) is at 0V then its associated diode is forward biased (i.e. an effective short circuit) and output (D) assumes this potential of 0V. However, if all three inputs are at a voltage of $-V$ volts, then each diode is reversed biased, representing a resistance of approximately 100 kilohms, and the output is approximately $-V$. An analogy may be drawn here to the simple circuit also shown in Fig. 1.5, where the output is negative only if all three switches are open. If any one is closed the output adopts 0V. This may be represented by the 1–0 notation bearing in mind that negative is represented by 1, and 0V is represented by 0.

OR GATE

The OR gate is shown in Fig. 1.6. If any one input (A), (B) or (C) goes negative, then the output at (D) is negative. The output is at 0V only if all inputs are at 0V. Here again an analogy may be drawn to a simple switching circuit as shown and the results are drawn up in the associated table.

RELAY BUFFER

This is a simple amplifier (Fig. 1.7) with an emitter follower at the input to offer a fairly high input resistance to the rest of the circuit. The output is used to operate a 230Ω relay when the input is 1. It may be turned into a single shot buffer by replacing R1 by a 0·33µF capacitor, in which case the relay operates and then falls out even if the 1 is maintained at the input.

The single shot unit is used in many cases where the relay is employed to operate a "points" motor coil. "Points" motor coils tend to get rather hot when permanently connected to the supply.

The diode across the relay coil acts as a transient suppressor to protect the transistor.

RING OF THREE SCALER

The ring of three scaler (or shift register) shown in Fig. 1.8 performs a similar function to a bistable except that it has three stable states whereas the bistable has only two.

Any one transistor (say TR1) can be off, i.e. in state 1 and this holds the other two transistors hard on. Since TR1 collector is at about -12V this means that diode D1 is forward biased via R10. When a 0 trigger is applied to the input line, D1 passes this to the capacitor C2. Diodes D2 and D3 do not conduct this pulse since they are reverse biased. Thus the 0 trigger is passed only to the base of TR2, cutting off TR2, causing TR1 and TR3 to conduct hard and biasing diode D2 ready for the next 0 pulse which will cut off TR3. Thus the impulses at the input cause each transistor in turn to adopt a 1 state.

The circuit may be used as a sequence counter or alternatively as a straightforward "divide-by-three" circuit.

The principle may be extended for use as a ring of five scaler by adding on transistors and inserting resistors to ensure that each base is connected to any collector via a resistor.

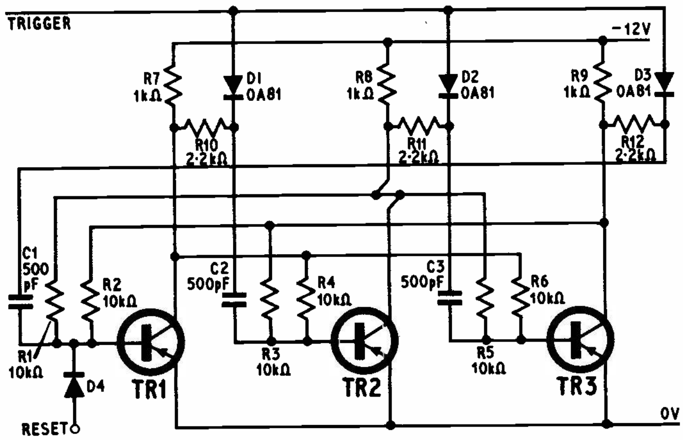


Fig. 1.8. Ring of three scaler

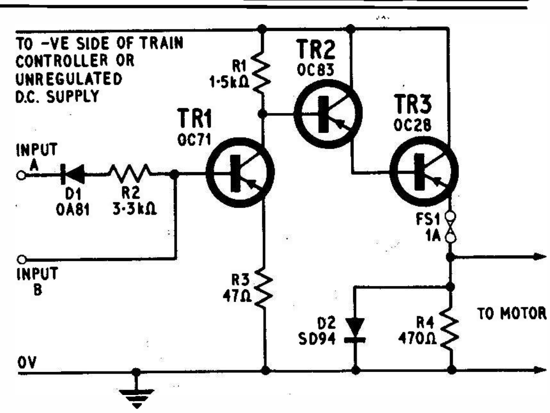


Fig. 1.9. Motor control amplifier

The circuit may be triggered from independent sources. In this case the triggering circuitry, D1 to D3, R10 to R12, C1 to C3 may be omitted and each transistor is triggered via diodes connected in a similar manner to the rest.

MOTOR CONTROL AMPLIFIER

In the circuit shown in Fig. 1.9 when input (A) is at zero, TR1 is cut off with approximately −12V on its collector. This causes TR2 and TR3 to be conducting hard and power to be applied to the motor. When a 1 input is applied to input (A), TR1 starts conducting hard causing TR2 and TR3 to cut off; thus the motor stops. Diode D2 is included in the motor circuit and acts as a quench on the back end of the motor when it stops. Resistor R4 acts as a dummy load, when there is no motor to be run.

When a straightforward stop or start action is required, input (A) is used. When used in conjunction with a slow down circuit, input (B) is used.

The speed of the motor may be adjusted by varying the supply to the amplifier by means of the rheostat on the ordinary train controller. If a separate unregulated d.c. supply is used, a base biasing arrangement on TR1 will control the motor speed.

Transistor TR3 should be mounted on a small heat-sink, and in the author's model a piece of aluminium $\frac{1}{16}$in × $2\frac{1}{2}$in × $1\frac{1}{4}$in was found to suffice.

SLOW DOWN/SPEED UP

This circuit (Fig. 1.10) is basically a very simple version of the Miller integrator. It is controlled by some other circuit (e.g. monostable or bistable) and generates a rather poor ramp voltage. Normally there is a 1 at the input which means that the collector is at 0 volts. When a 0 is applied at the input the transistor tries to cut off, but is slowed down by the feedback via C1. This causes the collector voltage to fall with a relationship to time. As the transistor cuts off, C2 charges via D1.

When the input returns to 1, C1 discharges quickly and the collector of TR1 returns to 0V. D1 is now reversed biased and C2 has to discharge via R3 in series with the input resistance of the motor control amplifier. Capacitors C1 and C2 are selected values depending on external circumstances, for example, length of train, length of isolated sections in the signalling system and so on. Remember that C1 will basically determine the slowing down rate of the train and C2 the speed-up time. The author used 25μF for C1 and C2 and a fairly realistic effect was obtained.

The circuit may be used also to stop a train in a station for a given length of time by triggering from a monostable with a time constant equivalent to the time required to stop in the station.

INVERTER

This is a very simple one transistor amplifier (Fig. 1.11). When the input is 1, TR1 conducts hard causing a 0 in the output. When the input goes to 0, TR1 cuts off and a 1 output results. Thus where we did have a 1 we now have a 0 and vice versa. R1 may alternatively be connected from the base to −12V as in Fig. 1.12. A switch connected between base and 0V will give a 0 output when open and a 1 output when closed.

Next month: Interlocking Signalling Systems

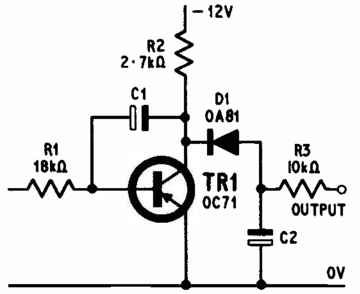


Fig. 1.10. Miller integrator used to slow down or speed up a motor

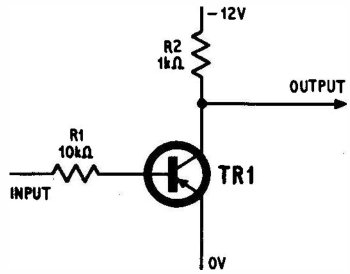


Fig. 1.11. Simple one transistor amplifier used as an inverter

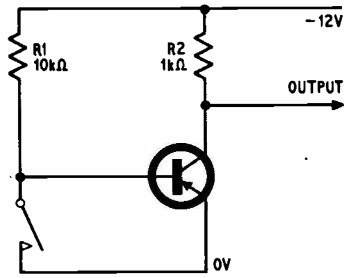
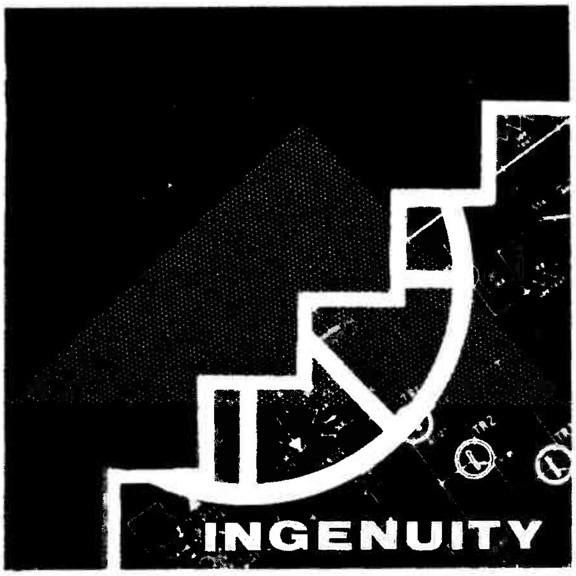


Fig. 1.12. Alternative bias and switching arrangement of the inverter



UNLIMITED!

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment according to its merit.

STOCKS AND SHARES

I ENCLOSE two ideas for giving an added interest to your recent article on an Electronic Stockmarket game published in the December 1968 issue.

Bank Raid Insurance

The first addition to the game is a simple timing circuit which is used as a bank raid insurance.

The time delay of the circuit shown in Fig. 1 is approximately 2 minutes, but this can be varied according to the value of capacitor C1 which can be any value from 500μF to 5,000μF depending on how long the games usually last. The relay RLA can be any sensitive 8–9V type with one set of make contacts.

The extra capacitor C2 and switch S3 shown dotted in the circuit diagram can be included to double the length of the insurance period if over three people are playing.

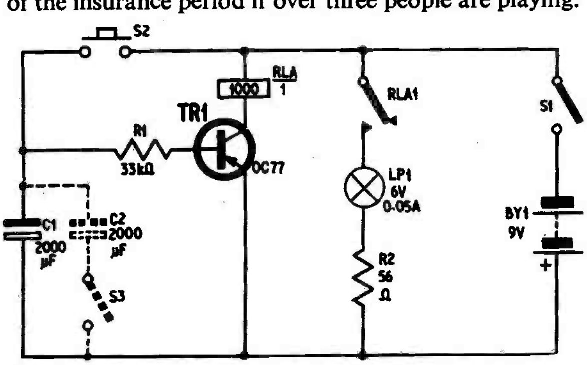


Fig. 1. Circuit-diagram of the bank raid insurance

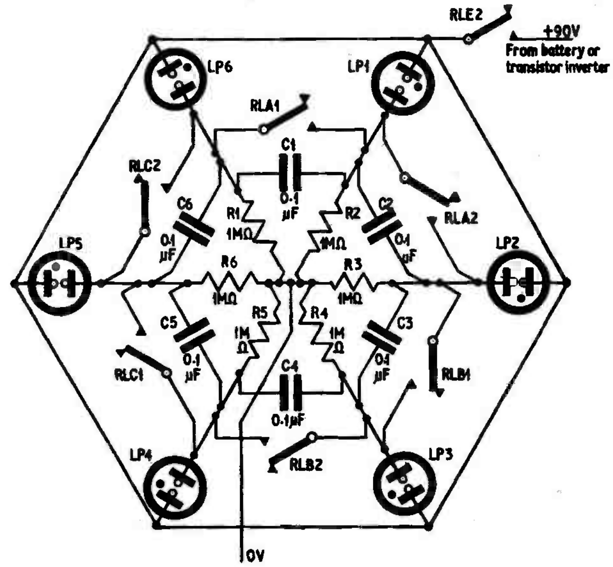


Fig. 2. The neon indicator arrangement for the electronic dice

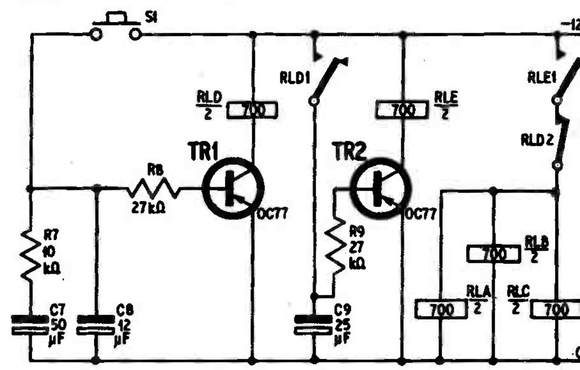


Fig. 3. Switching circuit for the electronic dice

The rules for the insurance are quite simple, and upon throwing a three a player may, if he wishes, forfeit his turn to transact or transfer his cash to his bank and instead "buy" insurance by pressing S2 and starting the timer. This insurance lasts until the lamp is extinguished and then the player is again vulnerable to a bank raid. Only one player may use this insurance at one time.

Electronic Dice

The final addition to the game is a completely automatic electronic dice. The circuit is shown in Figs. 2 and 3 and when S1 is pressed the neons light rapidly in turn for 2–8 seconds. The "throw" lights up for approximately 2 seconds, then the circuit switches itself off.

The neon bulbs can be arranged in a hexagon in a space on the Stockmarket top, with the circuit components mounted on the underside or installed in a separate case.

The relays used in the dice are 12V types with two sets of make and two break contacts. The neons are 65V miniature glass types and an ideal supply is a transistor inverter which gives 80–100 volts at approximately 5 milliamps or less, as the neons require very little power.

Andrew Copsey,
Pudsey, Yorks.

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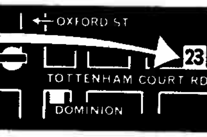

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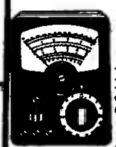

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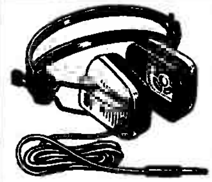

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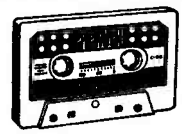

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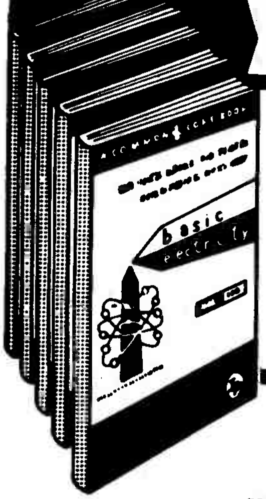

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UNIJUNCTION SUBSTITUTE

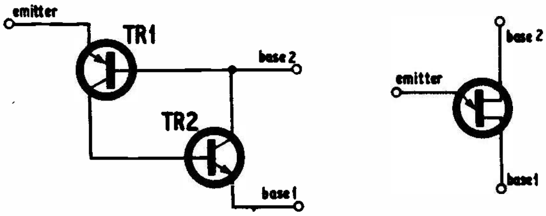


Fig. 1. Substitute for a unijunction transistor compared with the unijunction transistor symbol on the right

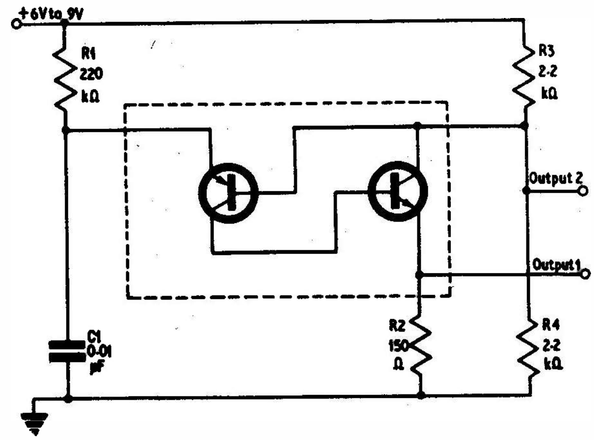


Fig. 2. Simple unijunction oscillator circuit with a frequency of operation of 1kHz

MANY experimenters have doubtless seen circuits which make use of a unijunction transistor (u.j.t.) and, not having a device of this type to hand, have fought shy of attempting to build this circuit.

A simple substitute for the unijunction transistor is shown in Fig. 1; the corresponding connections are as indicated.

Both transistors should be silicon, but the actual types used are not critical. I have had success with BSY95A, 2N929, 2N706 and BSY27 for TR1 and OC200 and OC202 for TR2.

When the emitter of TR1 is less positive than the base, neither transistor conducts, but when this emitter becomes more positive than the base 2, TR1 starts to conduct, so supplying current to TR2 base. This turns on TR2, which provides current for the base of TR1, causing TR1 to conduct harder. Very soon both transistors conduct heavily, and the impedance between emitter and base-1 falls to a low value, thereby reproducing the unijunction's characteristic.

One of many applications of this substitute unijunction is in the oscillator circuit shown in Fig. 2, which has a frequency of operation of 1kHz. Capacitor C1 charges via R1, until the unijunction fires, so rapidly discharging C1. The cycle of operation then repeats.

Other uses are in timers and as trigger units for thyristors.

J. N. Watt,
Camberley,
Surrey.

LIGHT METER

THE circuit in Fig. 1 was designed to detect the small colour change of various chemical indicators when responding to an extremely weak substance.

When the intensity of light in the vicinity of the OCP71 changes, the pitch of the output tone from the speaker also changes. The output tone is produced by the action of C1 charging through VR1 until it reaches a certain potential, when it then switches the unijunction "on" allowing the capacitor to discharge through the loudspeaker; this cycle of operations is then repeated.

Any change in the intensity of the light falling on the OCP71 gives a variation in its resistance which leaks away part of the accumulated charge present at C1 and alters the output tone pitch. The greater the light intensity the more current leaked away and the lower the output pitch. The light sensitivity of the circuit is controlled by potentiometer VR2.

To set up the circuit the OCP71 is disconnected and VR1 adjusted over its whole resistance range. At maximum resistance a slow clicking will be heard; as the resistance is decreased the clicking rate rises until a tone is heard; this continues to rise until it disappears when the unijunction is switched on and C1 is being permanently discharged. Slowly increase the resistance until a tone is once more heard and adjust the control for the highest pitch. Reconnect the OCP71 in the circuit and the instrument is ready for use. The base of the OCP71 is left disconnected.

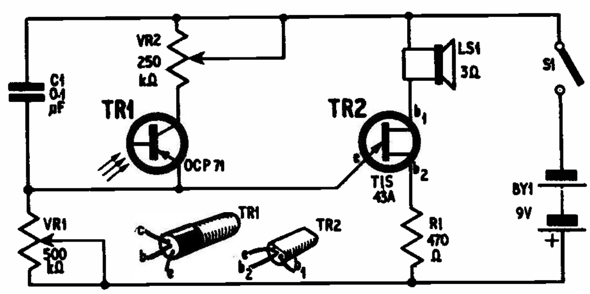


Fig. 1. Circuit diagram of the light meter and transistor wiring connection details

According to lighting conditions and the setting of VR2, a tone may or may not be heard when the OCP71 is reconnected. In either case, this control should be adjusted for the lowest tone for maximum sensitivity in the lighting conditions present.

Clive Woods,
Leicester.

CINE TAPE SYNC

By G.M. FARRER

CINE PROJECTORS and tape recorders are perhaps two of the most common hobbyist equipments to be found in many homes these days, and it is frequently the case that the cine enthusiast likes to add sound effects or commentary to his silent films.

When attempting to run the tape recorder simultaneously with the projector, problems of synchronism appear. All these can be tolerated to some degree (according to the nature of the subject) but by the time the film reaches its end the lack of synchronism can be so bad as to spoil the viewing.

Several ideas on simple synchronism have been published in several magazines, but most of those using plain tape are not always acceptable. What is required is some positive means of locking the tape speed precisely to film speed.

Electronic control is of value in assisting this synchronism, one obvious choice being the flip-flop. However, the circuit on its own has certain limitations and in this article a more accurate method is described which gives synchronism of better than two frames in 200 feet of film.

SPROCKETED TAPE

Most movie makers will already be familiar with the sprocketed recording tape known as "Cinetape". This is available in two or three types, but the one we are interested in here is known as "Type A", which has 16 perforations per 3¾ inches. With the necessary tape recorder and photo-transistor circuitry, the tape can provide 16 electrical pulses per second to act as a control for the projector.

In this connection it must be mentioned that it is vital that the projector's normal running speed is in excess of 16 frames per second, as the synchroniser will only *reduce* the projector speed to sync. Fortunately the majority of projectors have a normal speed of 18 frames.

PROJECTOR PULSES

It is necessary to carry out certain modifications to the projector in order to use most synchronising devices and this unit is no exception. Access must be gained to the interior of the projector so that the main motor wire can be located. The other modification is the fitting of a pair of contacts which will provide one pulse for every frame of film. This is usually fairly easy to provide; the shutter operating shaft is generally the point used to fit the contacts. These modifications will be described more fully later.

Having obtained the required pulses from the projector, they are fed, together with the pulses from the tape recorder, to the synchroniser, which then operates in the following manner.

A lamp, situated close to the sprocketed tape, provides energy to phototransistor TR1. The output triggers TR2 into conduction, TR2 and TR3 forming a Schmitt trigger. The square wave output from TR3 is differentiated by C2 and R9 to give positive and negative pips at the junction with D1. This diode largely removes the positive going pips to switch on TR4.

Transistors TR4 and TR5 are made up as a flip-flop so that, when TR4 is on, TR5 is off. A negative going pulse appears at TR5 collector and switches on TR6.

Although TR7 is normally in a non-conducting state, due to R19 being returned to a positive voltage, it is switched on by the negative pulse from TR6. Sufficient power is made available for TR7 to operate the reed relay RLA, its contacts providing a relative short circuit to the control resistor in the motor circuit.

Capacitor C5 is held charged through R16 and R17 until the contacts on the projector are closed to provide a rapid short circuit across C5 and R17. Now C5 discharges through R17 and feeds a negative going pip to TR5 base by way of D2. This action is similar to that given by the Schmitt trigger, but by electro-mechanical means.

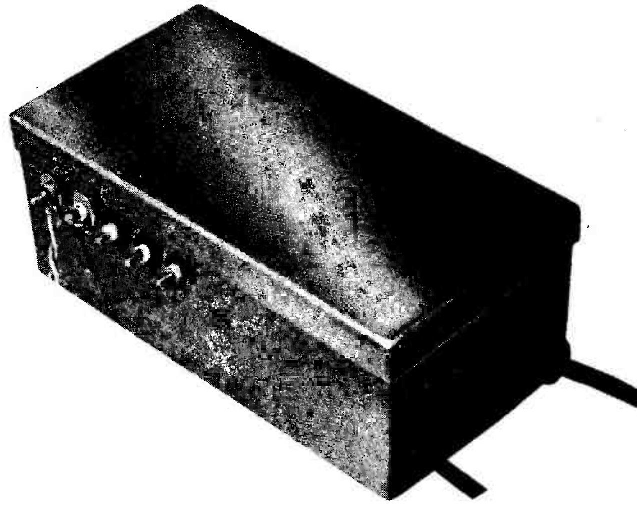
CONTROL CIRCUIT

The arrival of the pip at TR5 base will switch on TR5 again and switch off TR6 and TR7. Consequently the relay coil is de-energised, the short circuit removed from the control resistor and the motor restored to its controlled speed.

The other components in the control circuit, L1, L2, C7, C8, and R20, act as a transient suppression circuit to minimise radio interference. The inductors L1 and L2 have a sufficiently low d.c. resistance to be ignored in the control function.

It should now be seen that the tape pulse switches on the relay and the projector pulse switches it off again. This action continues all the time the unit is running, but if the projector speed increases slightly, the length of time that the relay holds on will be shorter due to the earlier arrival of the projector pulse.

If the projector speed drops then the reverse action takes place and thereby synchronism will be maintained. On the prototype, synchronism is held to less than two frames error in 200 feet of film.



The finished synchroniser incorporating transistor stages TR2 to TR7

Since the projector motor receives its power as a series of pulses, it is rather too much to expect a steady drive to be obtained unless the relay contacts have some partial by-pass. This is provided by resistor R21, which must have a power rating of about 10 watts as under some conditions a large proportion of the motor power is dissipated here.

The value of this resistor will be dependent to a large extent on the motor characteristics so that only a guide can be given. A probable figure will lie between 3 and 6 kilohms, but will need to be found by experiment.

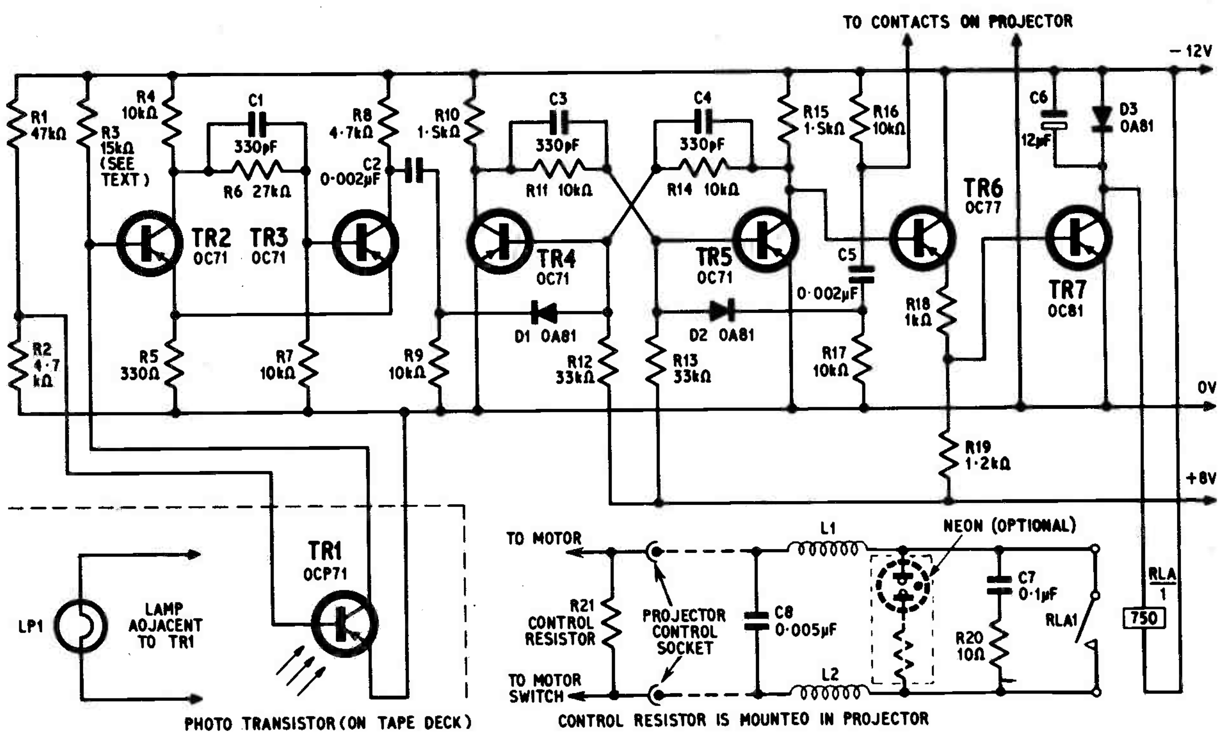


Fig. 1. Complete circuit of the synchroniser. LP1 and TR1 are mounted on the tape deck

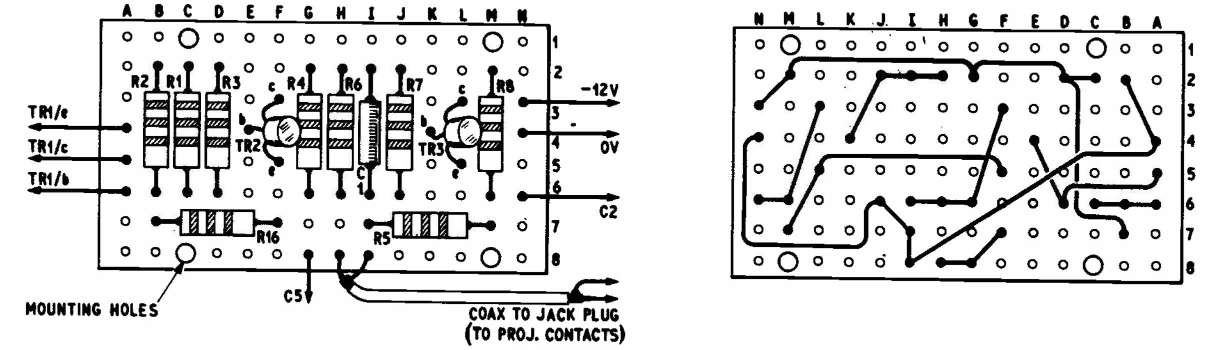


Fig. 2. Component layout and underside wiring of Board 1 (Schmitt trigger) later fitted in the synchroniser box

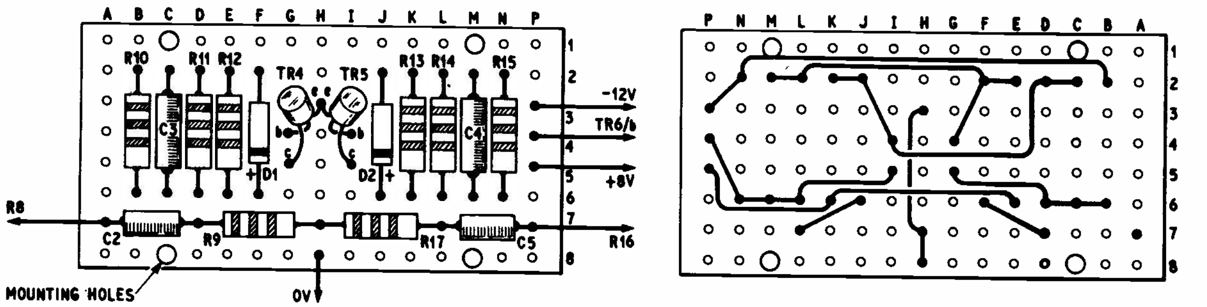


Fig. 3. Component layout and underside wiring of Board 2 (flip-flop) later fitted in the synchroniser box

CORRECT OPERATION

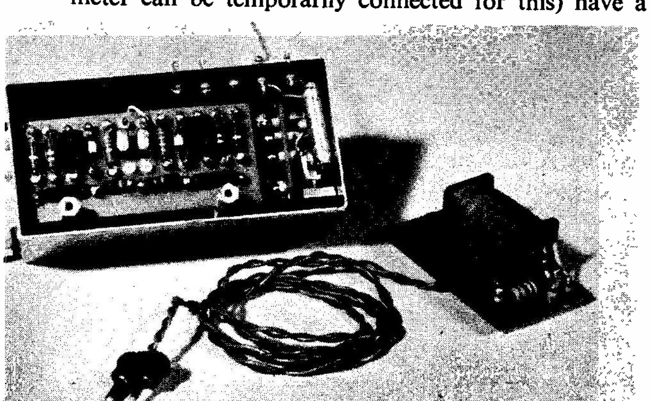
An indication of correct operation is by listening for a steady ticking from the relay contacts, or by fitting temporarily, or even perhaps permanently, a small mains voltage neon lamp across the reed contacts to give a regular flashing when operation is correct.

The other resistor which may require adjustment is R3, whose nominal value is 15 kilohms. It may be found that this value is correct, but due to gain spreads of transistors it may be necessary to choose a slightly higher or lower value here to obtain correct working of the Schmitt trigger circuit. In this connection an oscilloscope is very useful here.

If the collector of TR3 is monitored whilst the tape recorder is running with a length of "Cinetape", a good steady square wave at this point indicates a correct set up. Usually quite small changes in R3 (a potentiometer can be temporarily connected for this) have a great effect due to direct coupling of the circuit, so go slowly. Values of 10 and 20 kilohms should be the outside limits required here.

If an oscilloscope is not available, then proceed as follows. A high resistance test meter should be connected across R8, and the "Cinetape" drawn slowly past the light scanning head. Correct operation is now shown by a sharp rise and fall of meter reading as the light pulses reach the OCP71. Once again, proceed slowly with R3 changes.

When first testing this unit, it is most important to have a correctly aligned scanning head (OCP71 and associated lamp). Obtain correct operation of the Schmitt trigger circuit before attempting to connect the projector or set the value of R21.



Interior of the synchroniser box showing the Schmitt trigger and flip-flop

PERFORATED BOARDS

The actual construction of the synchroniser should present no difficulty as it follows quite normal lines. Component layout and wiring diagrams for perforated boards are shown in Figs. 2, 3, 4 and 5. The layout is in no way critical.

The prototype was, in fact, built in three separate units while the reed unit is mounted inside the projector itself. This way, the mains connections are kept tidily in the projector, although a further switch had to be fitted to enable normal operation to be achieved.

The method used will be dictated to some extent, of course, by the space available inside the projector and also how far one wishes to go in this project.

RELAY

The relay coil was wound on a former made up from a length of s.r.b.p. or other insulated tubing (fairly thin walled) with two square end plates of the same material made up as shown in Fig. 6. The plates are secured with Araldite.

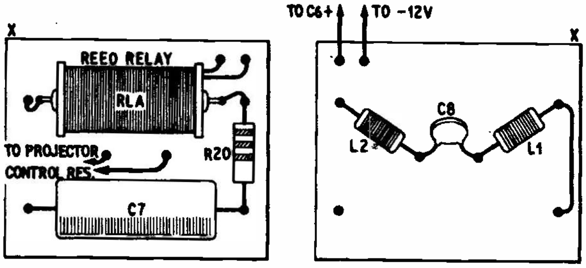


Fig. 4. Layout and wiring of components on the reed relay board, to be mounted in the projector

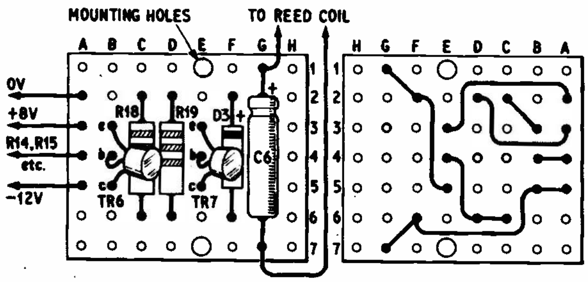


Fig. 5. Component layout and wiring of the switching unit (Board 3). This board may be made larger if desired to include the reed relay

Wind about 10,000 turns (or as many as needed to fill the bobbin) of 41 s.w.g.enamelled copper wire on to the former using a hand drill and long bolt. The coil former is fitted on to the bolt which is held in the drill chuck. If the gear ratio of the drill is determined first by counting the teeth on the gears, it is then easy to count the number of turns of the handle required to give approximately 10,000 turns of the chuck. Layer winding is not necessary but care must be taken not to allow turns to ride up and cause heaping of wire in one point. A layer of thin non-adhesive tape and thicker lead-out wires will prevent later damage to coil. The reed switch should slide comfortably into the coil centre with the end contacts protruding. These may be soldered to pins on the circuit board to hold the assembly in place.

PROJECTOR MODS

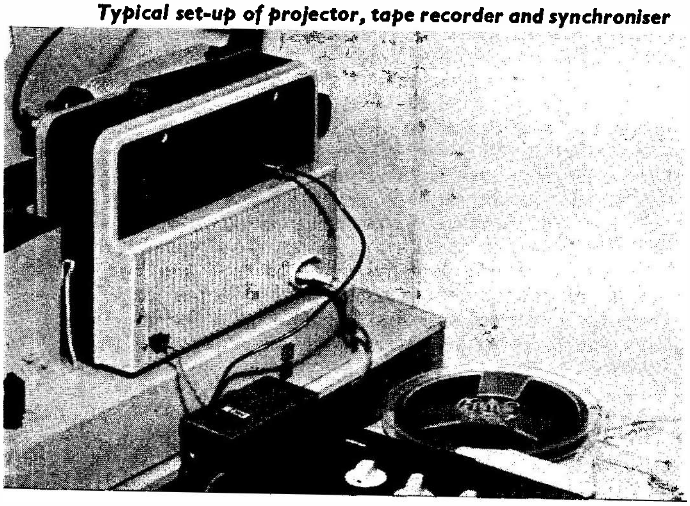
Coming now to the projector modifications, which is the most difficult part, it cannot be stressed too strongly that great care must be taken with insulation here, as mains voltages will be present. Never work on the projector while it is connected to the mains supply.

First locate the main motor lead and cut it. This lead must supply the motor only and not be a common lead to motor and lamp. If in any doubt, it would be advisable to consult either your photographic dealer or the manufacturer for guidance.

Having located and cut the required lead, the two ends should be taken to a mains rating socket fitted in some convenient position on the projector. The size and shape of this socket will depend on the space available but two suggestions are given in the components list, one being flat, the other round.

It may also be convenient to fit the control resistor into the projector adjacent to this point, but if so, bear in mind that it can get very hot, so it needs plenty of room for ventilation. Two plugs could be obtained to fit this socket. One is used to connect to the synchroniser; the other is fitted with a shorting link so that it may be inserted in place of the control plug for normal operation.

Typical set-up of projector, tape recorder and synchroniser



COMPONENTS. . . .

Resistors

R1	47k Ω	R12	33k Ω
R2	4·7k Ω	R13	33k Ω
R3	15k Ω (see text)	R14	10k Ω
R4	10k Ω	R15	1·5k Ω
R5	330 Ω	R16	10k Ω
R6	27k Ω	R17	10k Ω
R7	10k Ω	R18	1k Ω
R8	4·7k Ω	R19	1·2k Ω
R9	10k Ω	R20	10 Ω
R10	1·5k Ω	R21	3k Ω to 6k Ω 10W wirewound (see text)
R11	10k Ω		

All $\pm 10\%$, $\frac{1}{4}$W carbon except R21

Capacitors

C1 330pF
C2 0·002μF
C3 330pF
C4 330pF
C5 0·002μF
(C1–C5: mica or ceramic)
C6 12μF elect. 25V
C7 0·1μF
C8 0·005μF
(C7, C8: paper 600V d.c. *or* metal foil 400V d.c., 250V a.c.)

Inductors

L1 and L2 2 amp television suppressor chokes

Transistors

TR1 OCP71 phototransistor
TR2, 3, 4, 5 OC71 *or* OC75 (4 off)
TR6 OC77
TR7 OC81

Diodes

D1, 2, 3 OA81 (3 off)

Reed Relay

RLA Coil wound from 41 s.w.g. wire (see text)
Reed XS2 (Hivac) *or* type 2RSR (Radiospares) with normal open contacts

Miscellaneous

Jack plug and socket 2·5mm
Mains plug and socket 2-pin (e.g. P345) *or* 3-pin (e.g. Type P438) (Bulgin)
Perforated s.r.b.p. (see drawings)
Metal case

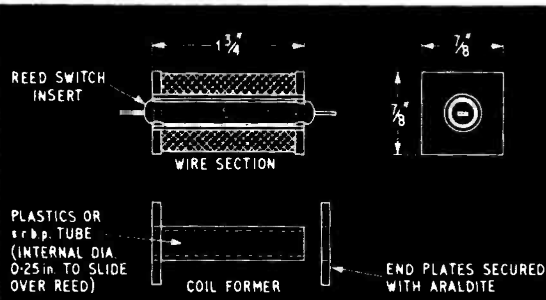


Fig. 6. Construction of reed relay coil former

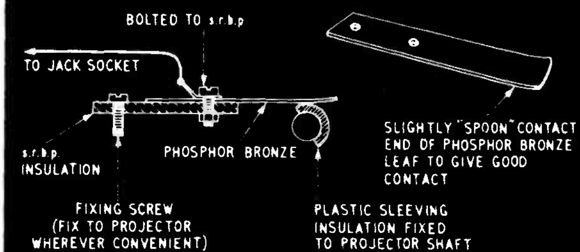


Fig. 7. Construction of the pulsing contact to be fitted to the projector near the sprocket spindle

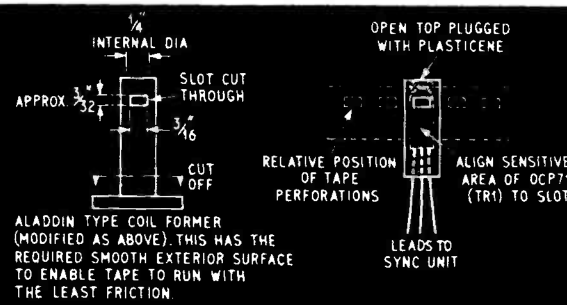


Fig. 8. Construction of the phototransistor housing and its relationship to the tape

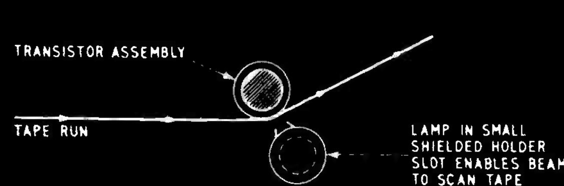
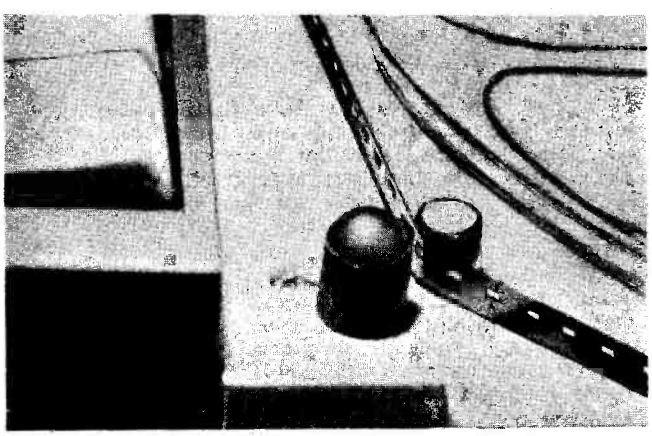


Fig. 9. Plan view of the positions of phototransistor, lamp, and Cinetape

The "pulse" contact is made from a piece of phosphor bronze strip and is insulated from the projector frame with a piece of s.r.b.p. This contact must not have any contact with the motor wiring, or case, or anything else except the 2·5mm jack tip connection. The sleeve connection on the jack should be connected to a part of the projector frame that is in contact with the shaft used for the pulse contact. Details are shown in Fig. 7.

OTHER USEFUL HINTS

It was found very satisfactory to use a length of small diameter co-axial cable for the 2·5mm jack plug connection to the synchroniser. The wires linking the motor with the reed relay control circuit should have thick insulation; mains cable would be suitable here.



The suppressor components should be fitted close to the reed relay to be most effective, so that these components will be in the synchroniser box if this is where the relay is fitted.

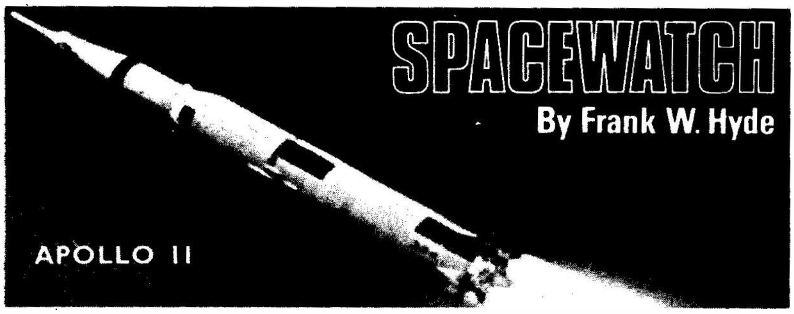
The tape recorder and synchroniser must, of necessity, be located close together, but the tape recorder and projector may be placed anywhere convenient, as the length of connection between them, within reason, does not affect the operation.

The prototype unit is powered by a small mains power supply unit, so the lamp supply was derived from this by using the 12 volt negative and 8 volt positive lines. The 20 volts so produced were found to be sufficient for the 28 volt bulb used. This lamp must be run from a d.c. source. If a.c. is used, the fluctuations of brilliance at mains frequency would cause spurious pulses to appear at TR1 and affect the operation.

Exact details of photo-transistor and lamp assembly are not given as tape decks vary greatly in their design. A small plate to attach to the deck, upon which the lamp and OCP71 are assembled, can be made to individual requirements. Suggestions are shown in Figs. 8 and 9.

One small point about maintenance of consistent operation, which came to light during early tests: the slot in the OCP71 housing must be kept free of tape dust, otherwise erratic running of the projector will result. An occasional light brushing will keep it clean.

When the complete synchroniser is set up satisfactorily, it may be fitted into a case and connected up. Start marks should be made on both tape and film, which are lined up when subsequent runs are made. Projector and tape deck are then switched on simultaneously and should remain in synchronism as described earlier. ★



THE BIRTH OF A NEW PLANET

The asteroid belt which circles the sun and lies between the orbits of Mars and Jupiter has been well studied over many years. It is made up of groups or families which lie in well-known orbits. One of these, the family Flora, has been studied very closely by Dr Alfven of the Royal Institute of Technology in Sweden. The individual members of this group have been very accurately observed and it seems that the orbits of the three distinct sub groups that it comprises have a special significance. In each sub group the individual members each of the group have almost identical orbits.

Dr Alfven points out that this would not be possible if there had been an explosion of a large body, nor could it result from the focusing effect of Jupiter's gravitational field. This is at variance with the widely held view that the asteroids were the debris of a former planet. The structure of the asteroid belt as revealed by Alfven's work is incompatible with such a possibility. He now tends to support the view that it is possible that in fact the belt of units is a planet in the process of formation. This theory has many supporters now including Prof. Hoyle.

It is thought that the asteroids are an intermediate stage of planetary formation by the accretion of inter-stellar dust grains. This is of some significance since it is a means by which any star can collect a planetary system. It could mean that most of the stars which are like our sun will have planets like the solar system and doubtless some of them could be capable of supporting life as we know it.

A NEW AERIAL FOR SPACE VEHICLES

Goodyear Aerospace have developed an unusual type of aerial for use in space. It is a dish shaped reflector consisting of a number of hinged "petals" framed with Bondolite. This is extremely light in weight though rigid and is formed of a honeycomb sandwich of aluminium. It can be folded up to about a quarter of its full size and can fit inside a vehicle nose cone in a similar manner to an umbrella. When it is opened in space an aerial of 30 feet in diameter is available. This is the largest dish ever designed for orbiting vehicles.

MARTIAN ATMOSPHERE

At the McDonald Observatory of the University of Texas astronomers have obtained the first conclusive proof of water on Mars. The amount of water vapour measured was equivalent to a film of liquid water 0·05mm thick in the southern hemisphere and about half that in the northern. Although the frozen caps have been said to consist of carbon dioxide, this latest assessment indicates quite definitely that there is a considerable amount of water ice. The clouds sometimes seen also tend to confirm this view.

JUPITER AQUIRES MORE SATELLITES

In 1967 L. Wilson of the University of London Observatories and E. L. G. Bowell of the Meudon Observatory in France put forward the proposition that there was an undiscovered satellite associated with Jupiter.

It is not always possible to devise a method of checking the calculations in matters of this kind. However the decametre radiation from Jupiter has provided one method of doing this. E. K. Bigg of the Radio Physics Observatory of Sydney applied a technique of record checking which he developed in 1964 with regard to the effect of the satellite "10" on the decametre radiations. He has found in the case of the predicted satellite of Wilson and Bowell a very significant correlation of a modulation period which must be regarded as confirmation of the existence of this thirteenth satellite. It is also significant that Bigg found evidence of another possible satellite in the records.

From this examination also he found a very strong confirmation of the effect of satellite "V" known as amalthea. This particular item is of special interest to the writer for in 1964 in discussions with Bigg about "10" the writer put forward the idea of the important influence on the radiation from Jupiter by amalthea. Later in a special interview with Patrick Moore in "The Sky at Night" programme the writer demonstrated the reasons for this influence. It is therefore gratifying to have confirmation of the hypothesis from such an important and independent source.

The success of this method of using the planet's own radiation will encourage more intense investigation of Saturn and Uranus for the decametric radiation.

At the moment there is no certainty of radiation in this region for these two planets, though there is some reason to believe that there is radiation from Saturn. If the decametric radiation can be detected then the same technique could be used for the confirmation of possible satellites, not yet discovered but strongly suspected, at least in the case of Saturn.

GERMANY IN SPACE

An agreement between America and Germany in a joint space research programme has been signed by the two countries. There are two main projects of which Helios is the principle and most ambitious. There are to be two solar probes and each of these is to fly past the sun at a distance of approximately 50 million kilometres off the sun. There are to be ten experiments aboard each time.

The first of the probes which will weigh about 210kg will be launched on January 4, 1974. This will be put into trans-solar orbit by an atlas-centaur rocket provided by NASA. After travelling for 95 days the probe will pass within 0·3 astronomical units of the sun; it will then go behind the sun for 185 days and reach the limit of its path. Then returning toward the earth it will go into solar orbit.

Communications will be tested as never before in this event, for the probe will be twice the solar distance from control on the earth. The radiation to which the probe will be exposed in this circuit will be some ten times greater than that received on Earth and special precautions will be needed to protect instruments from the heat.

HELIOS DESIGN

There are two designs being prepared for Helios, one by ERNO Raumfahrttechnik GmbH in Bremen and one by Messerschmitt-Bolkow in Munich. It may be that the two designs will be combined when the tenders are finalised. Germany will be responsible for the development and control of the probe itself and for seven of the ten experiments aboard each. The other three experiments will come from Goddard Space Flight Center in a collaboration unit of American, Australian and Italian scientists.

The primary object of the probes is to provide new information about the processes on the sun by the study of the solar wind, cosmic radiation and cosmic dust as well as the electric and magnetic fields. There will also be study of the cosmic radiation from distant systems and the chemical composition of interplanetary dust and micrometeorites.

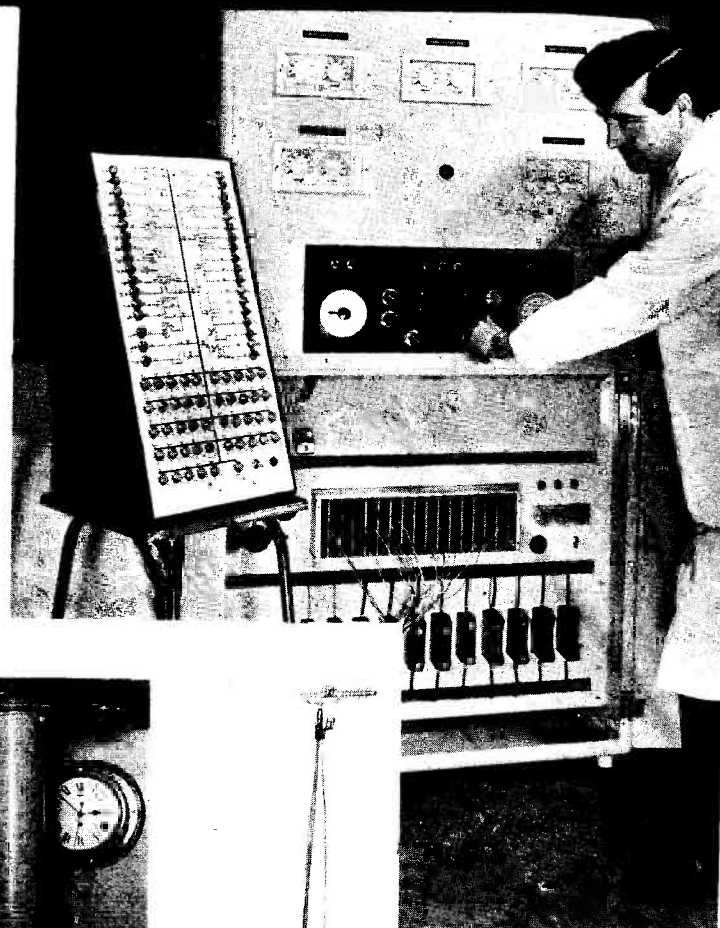
ELECTRONORAMA

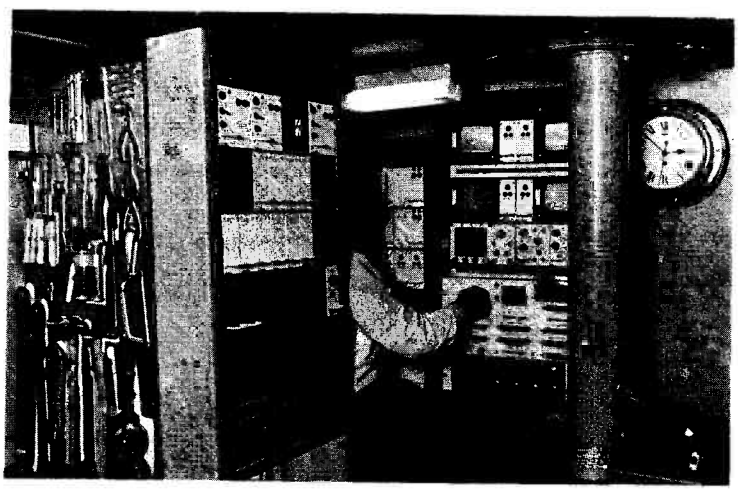
Interplas '69

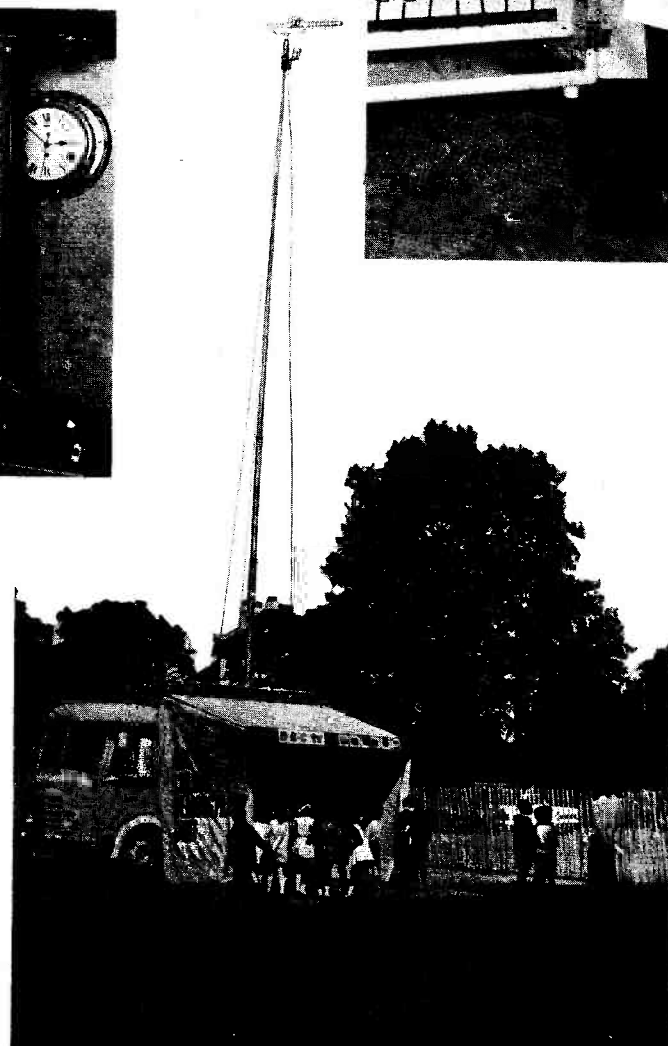
Plastics are used for many electronic applications and some of these were displayed at the Interplas '69 exhibition recently. Many circuit boards and modules were displayed and an astounding variety of cabinets, front panels, switches, knobs and other ancillary electronic components.

Manufacture of plastics parts is a fast expanding business and electronics is in turn playing its part in automating machines and processes. Bipel injection moulding machines will be available with solid state controls after October 1 and all the Bipel injection machines displayed at Interplas were fitted with the system.

The photograph shows a technician using a test unit to check circuitry in the control console for an injection moulding machine. The control system uses Norbit logic control modules mounted on plug-in circuit cards. The modules are encapsulated in plastics.







BBC Mobile Colour TV Demonstration Unit

The BBC's Mobile Colour Demonstration Unit with Tricia Madden, is touring the country this Summer, giving demonstrations of colour television at Holiday Camps and other venues where large captive audiences can be guaranteed. With the added "selling power" of BBC-1 and ITV programmes appearing in colour later this year, it is hoped that the demonstrations will help to push sales of colour sets.

The pictures show the unit with mast extended, and the interior of the vehicle. A comprehensive tool kit is carried to cope with all emergencies! The left-hand rack contains sound apparatus; in background are u.h.f. receivers, distribution amplifiers picture monitors and systems control panel. Right foreground: base of telescopic mast atop control box which houses servo motor.

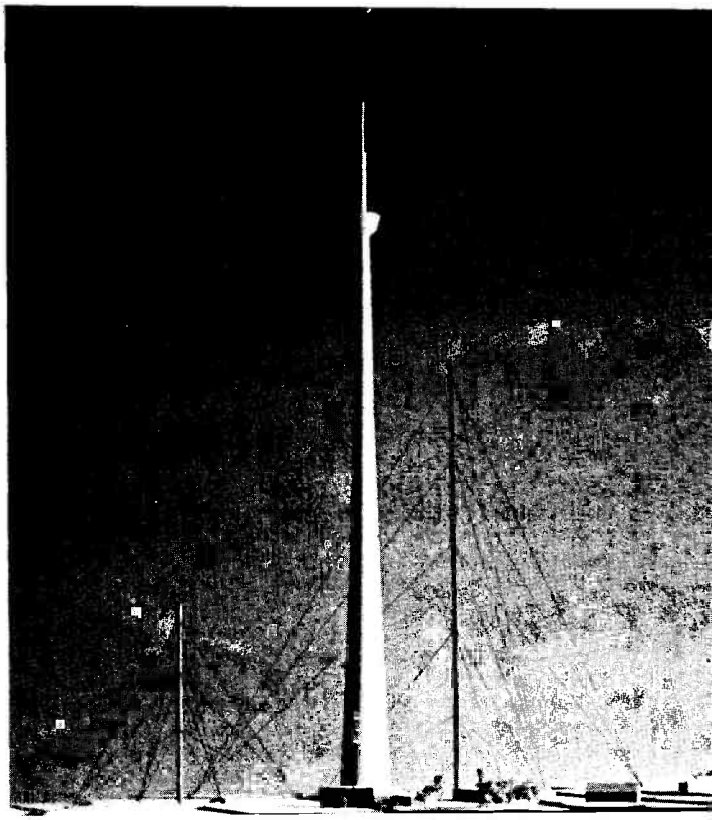
Britain's First Concrete T.V. Tower

Both B.B.C.-2 and I.T.A. u.h.f. Yorkshire transmissions will share the existing 300ft B.B.C. aerial mast at Emley Moor in the autumn as an interim measure, until the completion of a new joint tower, 1,080ft high, late in 1970. The new tower will be of self-supporting reinforced concrete of exponentially tapered section, similar in design (but much higher) to that built in South Africa in 1961.

The decision to adopt concrete construction, as opposed to steel, has resulted from research into erection time, cost and service coverage and has no bearing on the collapse of the old tubular steel mast in March. (The enquiry into this incident has not been completed; fatigue tests are being carried out on the metal structure.)

The new tower will carry all television channels for I.T.A. and B.B.C., and will serve as a G.P.O. microwave link. Outside broadcasts can also be picked up and redistributed via the microwave equipment room at 900ft. Above this point a lattice steel construction 180ft high will be erected for carrying the transmitting aerials.

On completion, the 300ft mast and the 675ft Swedish mast will be dismantled.



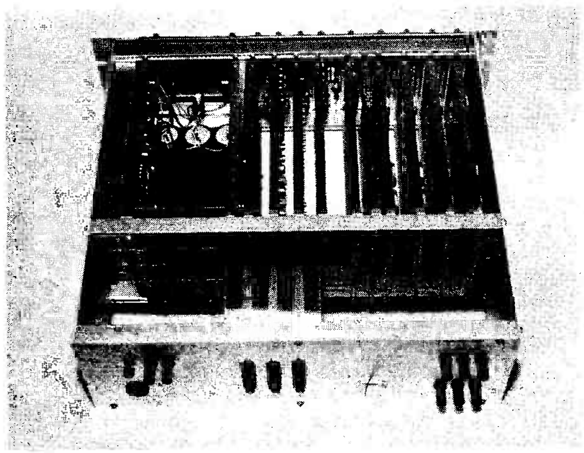
A scale model of the new Emley Moor tower next to the existing steel masts (right). The G.P.O. microwave aerials are shown at about the "100ft high" position on the tower

DVM to Data Logger

For those laboratories and workshops that possess a digital voltmeter, Solartron Electronic Group have now produced a box that can convert it, with a readout device, to a data logger.

The Data Transfer Unit is the first device to convert the digital output from a digital voltmeter into a form that can be accepted by a teleprinter, digital printer typewriter or magnetic recorder for direct logging. Consequently the user can go away and leave this set-up to take voltage readings for him, automatically, at any preset time interval, and write them down.

Reliability is inbuilt by using integrated circuits and flexible wiring cards with printed circuit fibre glass plug-in boards.



The photograph above shows an open top rear view of the Solartron DTU showing the printed circuit boards plugged into a motherboard and the flexible printed wiring to the rear panel input and output plugs. The lower photograph shows a research worker demonstrating the simplicity of operation of the DTU using a digital voltmeter and strip printer

THE ORGAN PART 5

By Alan Douglas, Sen. Mem. I.E.E.E.

MANY readers will know that a musical sound consists of a fundamental pitch note plus some harmonics or overtones. Harmonics are mathematically related frequencies; overtones, or partials are not so related. All can exist together.

BASIC VOICES

In most musical instruments, the harmonic texture, loudness, noise and other factors are constantly changing, even during the playing of a single note. But an organ is a sustained tone instrument, so the very complex factors associated with orchestral instruments are greatly simplified. It is for this reason that the organ is a poor imitator of orchestral instruments, and much more suited to the production of the sounds associated with simple pipes or tubes.

The church or concert organ is really based on diapasons and flutes, with other stops to artificially introduce powerful harmonics.

The theatre organ is based on the tibia, which is merely an exaggerated flute. Although reed stops are provided on the larger organs, to produce more harmonics, there is more concentration on string-like sounds which are extremely rich in harmonics, but low in amplitude. The net combination of strings, tibias and flutes tends to sound rather tubby, but takes on a curiously liquid and attractive sound when modulated by a tremulant. In short, the less harmonic the sound, the more one depends on the tremulant—or vibrato, as it is commonly called on electronic instruments.

SQUARE WAVE LIMITATION

It is clear then that there is going to be some tonal limitation if we decide on a theatre organ type of specification, and this is further dependent on the kind of waveform supplied by the generators; for no one waveform will form all sounds equally well, unless it be a multiplicity of sine waves for additive synthesis. Multiple waveform generators are expensive, and appeal more to the professional organists than to the average home performer.

As we have said, this organ uses a single square waveform for all its effects, and so we must accept the limitations imposed. However, we have considered the case of the average house, where a larger and more powerful organ might not be welcome, whilst at the same time the limited resources of the very small organs would soon be exhausted. It is indeed very difficult to try and strike a balance and it is impossible to please everyone.

We said in Part One that if all the playing facilities were put in at the start, the way would be open for future modifications; and this is perhaps the best way to look at it.

The constructor will be able to make tonal alterations after a little experience is gained and a number of alternative tone circuits will be given later. After all, there are only four basic types of organ tones and the many dozens of variations are only in degree or pitch range. In saying this, we do not of course include percussion, sustain, reverberation, glide or rhythm circuits which are now popular.

SUBTRACTIVE FILTERS

It might be opportune here to expound a little on the principles underlying the various kinds of subtractive filter. Suppose that we have an initial waveform which contains 40 harmonics. Evidently this will mean many octaves in addition to the fundamental pitch. Of course, if they were pure octaves, then it would only make the sound very bright and perhaps shrill, but still a pure note. But in this band are many other frequencies, if the wave is square, and these will nearly all be odd harmonics. In Fig. 5.1 is shown a symmetrical square wave of the kind produced by the dividers. The accompanying graph illustrates the relative amplitudes, compared to the fundamental, of a representative number of constituent odd harmonics.

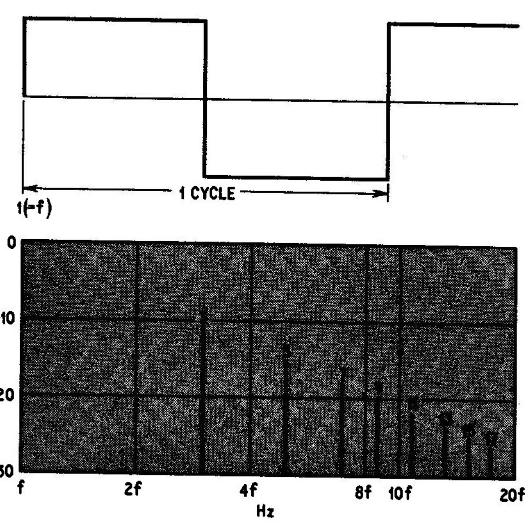


Fig. 5.1. Harmonic intensity of a symmetrical square wave. If the square wave is asymmetric the harmonic content alters

INTRODUCTION TO TONE CIRCUITS

The square wave itself is not an objectionable sound, but if more than one is combined, the harmonics can beat together and form sum and difference tones which are not concordant; and as we must be tuned to the equally tempered scale, there will be bound to be discords.

The presence of such discords has been proved to be only objectionable in certain kinds of sounds; in others, the discords actually heighten the effect—as in a trumpet stop in a pipe organ.

It is also found that if the fundamental pitch is removed, or greatly reduced in strength, that the harmonics do not sound so unpleasant. But in cases where the fundamental must predominate, as in flute tones, many harmonics produce discords. These are removed as far as possible by low pass filters. The tibia and diapason groups also require severe pruning of the upper harmonics. String-like tones require exactly the reverse, partial or complete removal of the foundation tones. All reed-like sounds are based on resonance methods, where a tuned LC circuit is excited first by its principal resonant frequency, and subsequently by harmonics of that frequency.

The width of the resonant band is controlled by the Q or sharpness of tuning of the circuits, which may be arranged to either accept or reject the resonance. So really all tone circuits are quite simple, and with adjustable L, C and R elements they can all be explored.

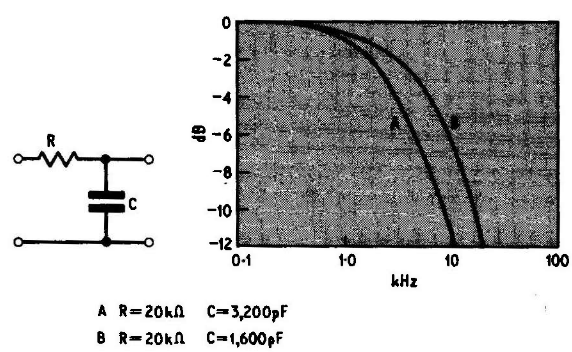


Fig. 5.2. Simple low pass RC filter section with response curves showing effect of varying capacitance with fixed resistance

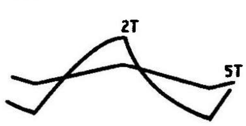


Fig. 5.3. Effect of varying low pass filter time constant on a square wave

LOW PASS FILTERS

A simple single stage low pass filter with its response for differing values of capacitance is shown in Fig. 5.2.

The time constant of the section shown is CR, and to ensure suppression of the higher harmonics at some point on the slope, CR must be at least five times greater than the time for the width of the incoming pulse. By varying this time constant, most conveniently done by adding sections of differing values to the first section, one can produce, from a square wave, effects as in Fig. 5.3. Note that the majority of the unwanted harmonics are brought down to a very low level.

However, this effect will clearly not be uniform over the whole keyboard and if complete harmonic suppression is required, then there must be several different time constants over the range of notes employed, since the frequency range exceeds 30 : 1.

But is complete suppression really desirable? Some say yes, some say no.

TAILORING THE HARMONICS

The author contends that traces of upper harmonics give character to even a flute tone, for whilst a pipe organ open metal flute is commonly fundamental and second harmonic, an orchestral flute can contain up to 8 harmonics—and few would deny that this latter is a more lively sound. Therefore in this organ we have allowed harmonics to appear in 16, 8, 4 and 2ft tones by careful grading of the time constants of the six low pass filter circuits used. Allied to this is the question of which is the most important part of the keyboard where the maximum effect is required? Here we subdue the bottom octave of the 16ft tibia (a tibia is really only a powerful flute; in pipe organs it is made of wood which gives it a duller tone than metal); we also reduce the bottom of the 8ft flutes but not so much, and the 4ft and 2ft registers are virtually untouched except for the very highest harmonics.

If one required a completely smooth and "sweet" sound from a flute, then one filter per octave would be the minimum number required. Some organs filter every five or six notes and a few of the larger ones filter on every single note. It is clear that it is quite easy to work out the time constants if the frequencies are accurately known.

IMPORTANCE OF BEING IN TUNE

In assuming the simple filters above, it is imperative that the organ be in tune. Very small departures from this condition bring about unpleasant results. This, by the way, is why we do not have a twelfth or $2\frac{2}{3}$ft stop. Unless this is sinusoidal, it produces a rasping effect and to eliminate this, it has to be reduced in volume so that it cannot fulfil its function as a brightener at all. With a sine wave organ, it is a valuable stop; with a harmonically rich wave, the effect is better obtained from other stops.

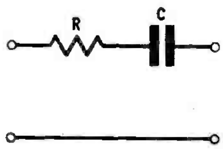


Fig. 5.4. Simple high pass filter section which removes the lower frequencies and passes the higher ones.

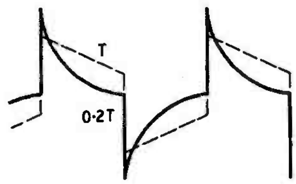


Fig. 5.5. Effect of varying high pass filter time constant in a square wave

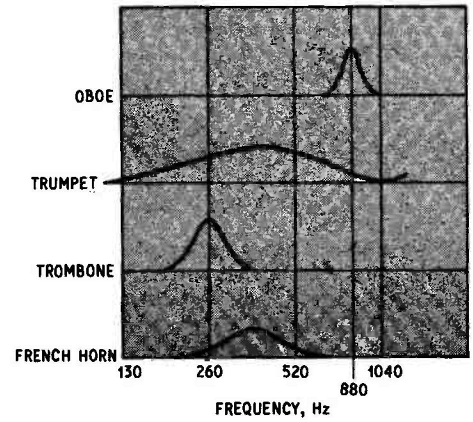


Fig. 5.6. Formants for four orchestral instruments

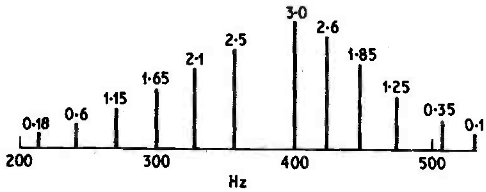


Fig. 5.7. A more exact analysis of the French Horn formant where the figures above the ordinates indicate relative amplitudes

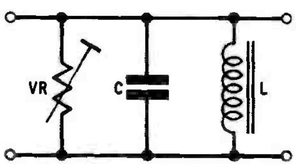


Fig. 5.8. Parallel resonant filter with shunted potentiometer, adjustment of which can both reduce the total response and broaden the resonance peak

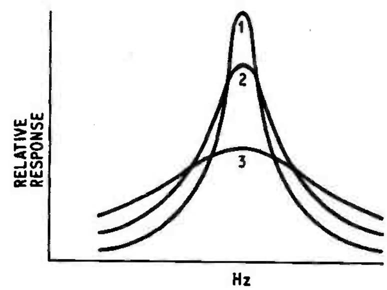


Fig. 5.9. The effect of shunting the resonant LC circuit with increasing resistance. Curve 1, the resistance is negligible; Curve 3, the resistance has increased considerably with a broadening of the response curve

PITCH AMPLIFIERS

The low pass filters employed consist of from two to four cascaded sections having various time constants. Since every shunt capacitor has its charging time controlled by a series resistor, and of course there are anti-robbing resistors as well in all the filters for this organ, there must be attenuation of the signal. Thus we apply a preamplifier for every pitch—but not every stop—and feed from the tone filters into a post amplifier (see Fig. 1.1). Incidentally, the output capacitors from these preamps are graded in some cases to further control the frequency pass band.

The tibias, 16, 8, 4 and 2ft and the flutes 8ft and 4ft are the stops using the low pass filters. Nevertheless, they all sound slightly different and this is how it should be, though they are all flutes. The characteristics, therefore, of this class of sound are strong lower notes and weak upper harmonics. We can get a reasonable approximation to pipe tone from these circuits.

STRING TONES

The next most important sound is the organ string or viole tones. It must be admitted that even in the best pipe organs, these sounds are nothing like orchestral strings. This is evident, as they must operate on a fixed wind pressure, whilst strings under the influence of a bow continually change in character.

These sounds are very attractive and useful, so we provide five of them. Since it has become standard practice to include string tones on the accompaniment manual, we find the high pass filter in use here.

HIGH PASS FILTERS

The action of the high pass network is the exact reverse of the flute filters; we want to take away the fundamental tones and leave a lot of harmonics, though at a reduced loudness. Fortunately, the ear does not attempt to analyse the structure of such complex sounds, so the problem is made easier and simple filters suffice; in fact, they are all single section filters.

Because of the low power involved, we simply rely on the extremely high reactance of the very small series capacitors, so that the filter becomes a capacitive attenuator, having values of megohms. The circuit is shown in Fig. 5.4 and the effect on a square wave in Fig. 5.5.

This filtering does perhaps make the extreme bass notes a little thin, but string filters are notoriously difficult and it is thought that the circuit values shown

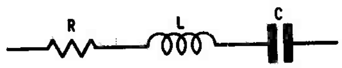


Fig. 5.10. Series resonant circuit

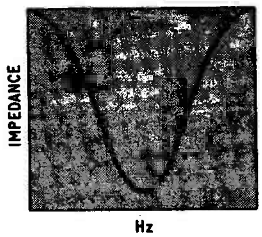


Fig. 5.11. Typical response curve for series resonant circuit

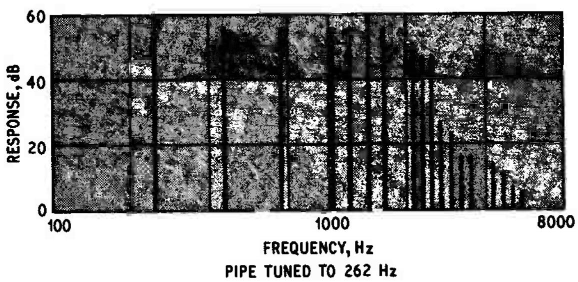


Fig. 5.12. Central analysis of pipe organ trumpet

will satisfy most constructors. One can of course go to six pipe organs and hear six quite different qualities of string sound from stops of the same name. The great thing is to avoid what is commonly called a wiry sound. We have 16ft, 8ft and 4ft strings on the solo manual, and 8ft and 4ft on the lower one.

This brings us to the final and most controversial kind of filters, the resonant circuits. These are widely employed in electronic organs to simulate reed or brass instrument kinds of sounds.

FORMANTS

It was found, during research into the sound producing mechanism of orchestral instruments in the latter part of the last century, that no matter what note was played on, say, an oboe, a French horn or a trumpet, a certain band of frequencies always appeared and this was called a formant. It is evident that if we produce a circuit which will resonate over the formant band, and add fundamental tones to it, we can imitate some of the instruments having this property.

To illustrate this, we show the formant bands for four instruments, the oboe, trumpet, trombone and French horn in Fig. 5.6. Fig. 5.7 gives a more detailed formant analysis of the latter instrument. The numbers above the ordinates indicate relative amplitudes compared to the fundamental.

RESONANT CIRCUITS

A parallel-tuned circuit as shown in Fig. 5.8 will suffice for the resonant, or formant, band and this may be tuned by a capacitor as required. The coil should have a moderate Q, in the 20 to 100 range, because then the band can be broadened or narrowed by the variable resistor across it as in Fig. 5.9 and the sharpness or flatness of the formant can be reasonably imitated.

There are cases, however, when for special effects we want to take away a resonant band. For this a series resonant circuit is needed of the form shown in Fig. 5.10. In referring to the resonance curve of Fig. 5.11 it can be seen that the impedance falls to a relatively low value at the resonant frequency which means that the circuit functions as a selective shunt for a band of frequencies.

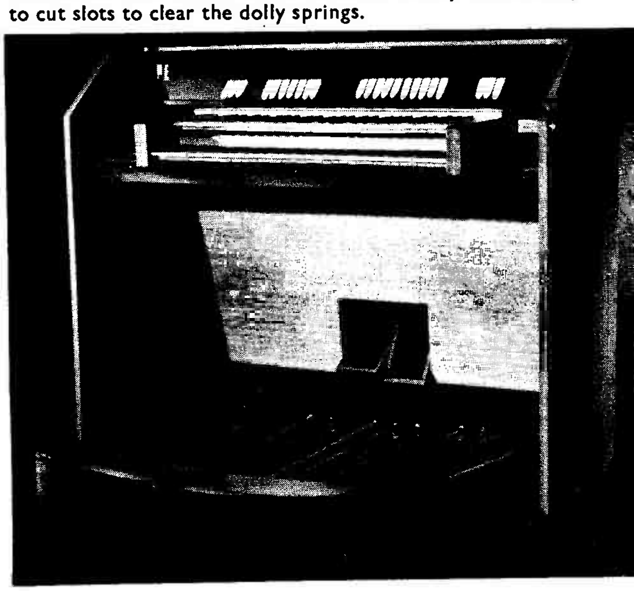
In the organ filter coils are wound on ferrite cores; this prevents any external field which would result in crosstalk and signal pickup in other parts of the tone circuits.

The Q value should not be too high, since the voltage across the coil at resonance is approximately Q times the impressed voltage. The capacitors to earth in circuits used for formants have values which not only tune the coils properly, but act as high-frequency shunts to earth for the higher harmonics which we do not want. But in fact there is some harmonic leakage which does not seem to impair the effect.

Spectral analysis of pipe organ reeds shows many harmonics outside those really required and the pipe is tuned to emphasise the fundamental; but still very many of the reed harmonics sound, as exemplified in Fig. 5.12, which is a spectral analysis of a pipe organ trumpet.

Next month we start the construction of the tone forming circuits.

Note: A few readers have experienced difficulty in aligning the Kimber-Allen keyboard with the Harmonics switch assemblies (see last month's article). If purchasing a Kimber-Allen keyboard, constructors are advised to make sure that a close match can be achieved. It may be necessary to cut slots to clear the dolly springs.



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.

TEST GEAR

Two new products are announced from Eagle Products. They are the EP100LN multimeter/transistor tester and a 30kV probe, type number DC30.

Both items are particularly suitable for the service engineer and EP100LN features a 100,000 ohms per volt movement which combines with a special socket for quick transistor checks.

The brief technical specification for the multimeter is: d.c. volts 0·12 to 600V f.s.d. in seven ranges; a.c. volts 6 to 600V f.s.d. in four ranges; d.c. current 12μA to 12A f.s.d. in five ranges; resistance 10 kilohms to 10 megohms in three ranges; and a decibel range of —20dB to +18dB.

The range of the transistor tester is: I_{co} 0–12μA; h_{fb} 0–0·9965; and h_{fe} 0–280.

The DC30 probe, for use with the EP100LN meter and other models, allows a range of up to 30kV to be measured. It is ideally suited for colour television service work where correct e.h.t. voltages are very critical.

The price of the EP100LN is £16 16s, the DC30 £3 10s and more details of all Eagle products can be obtained from **B. Adler and Sons (Radio) Ltd.,** Coptic Street, London, W.C.1.

MUSICAL NOTES

Some months ago we mentioned the "Mister Bassman" musical accompaniment instrument from **D.E.W. Ltd.,** Ringwood Road, Ferndown, Dorset.

This company is now producing an improved Mk II Model B2 that can be tuned to any key by a single knob, so that a player used to the key of C, for instance, can accompany a group playing in such awkward keys as E-flat, B-flat, etc. whilst still using his well-learned technique of footwork in C.

Apart from an 8ft to 16ft octave change footswitch there is another for foot-off sustain with a variable time range of 0·5 to 5 seconds.

The price of the Model B2 is £37 plus 10s carriage.

TOOLS

Two tools for the toolbox are the Bib Model 3 wire stripper and cutter and the "King Klik" riveting tool. Both these new models are claimed to be improved versions of previous models, and the King Klik riveter has just gained recognition from the Council of Industrial Design.

The new riveter is excellent for any chassis work, still required in certain cases, and can be used were only one surface is accessible. The tool works with a plier action and has a swivel turret to take $\frac{1}{8}$in and $\frac{5}{32}$in diameter rivets.

The "King Klik" riveter is available singularly or in kit form which includes back-up plates, rivets and an instruction leaflet from **Riveting Systems Ltd.,** Todmorden, Lancs.

The only obvious difference between the Bib Model 3 and previous wire strippers is the cutting aperture setting arrangement. The aperture setting for different diameter wires is now simply adjusted by a sliding screw set in one of the handles.

Manufactured by **Multicore Solders Ltd.,** each wire stripper is packed on an instruction card and the recommended retail price is 5s 6d.

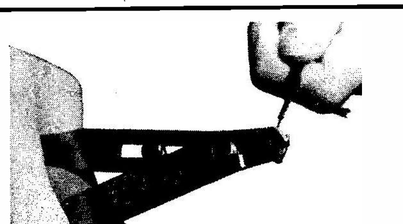
FIBRE OPTICS

The advance of fibre optics is providing many solutions in industry to old problems, and in certain instances cuts manufacturing and maintenance costs by the elimination of bulbs, hardware and wiring.

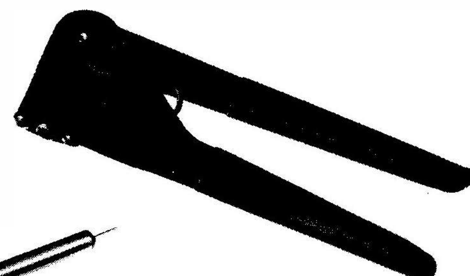
A new company has been formed called **Fibre Light,** and they have been appointed as authorised distributors of "Teknis" continuous lengths of glass fibre optic non-coherent light guides, in quantities of less than 1,000ft. The fibres are contained within a flexible p.v.c. sheath and the 0·013in multi-fibre bundle is capable of transmitting light over distances of up to 12ft.

The fibre can be used for piping light from one lamp to remote areas requiring illumination, or be used to influence a remotely mounted photocell of any changes of light intensity. There are numerous other applications and is already being used in cars, computers, security systems and liquid level sensing.

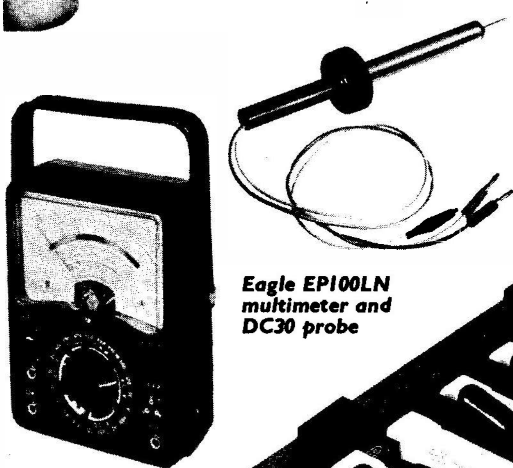
Obviously there are many other applications that will spring to the mind of the ingenious experimenter. An introductory 5ft length is available from Fibre Light, Teknis House, Stoke Road, Guildford, Surrey, price 19s 6d including postage and packing.



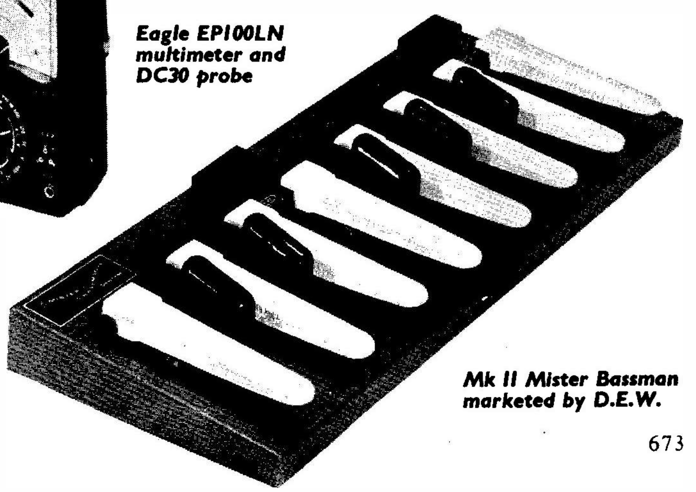
Bib Model 3 wirestripper



"King Klik" riveter from Riveting Systems



Eagle EP100LN multimeter and DC30 probe



Mk II Mister Bassman marketed by D.E.W.

FOR THE WORKSHOP

There are several interesting products this month worthy of consideration for the workshop or laboratory. The first of these is the new Speedread direct readout micrometer made by **GKN Shardlow Metrology Ltd.**, Petre Street, Sheffield, S4 8LY.

Two versions are available, the Imperial measurement (inches) system and the Continental metric system. Each instrument is precision made and the precise measurement is shown numerically in windows on the barrel of the micrometer. A conventional vernier scale, for those who like doing it the hard way, is also incorporated to give measurements to finer limits.

At the moment the micrometers are available in size 0in to 1in (reading to 0·0001in) and 0 to 25mm (reading to 0·01mm, equivalent to 0·0004in).

Another measuring instrument that slide rule users will appreciate is the Otis King spiral slide rule marketed by **Carbic Ltd.**, 54, Dundonald Road, London, S.W.19.

The instrument is in telescopic form and measures only 6in in length when closed and 10in fully extended. There are two models, K and L, for multiplication, division, and logarithms. Model K is for multiplication and division, while model L also gives logarithms enabling it to be used for roots and powers.

Both models cost £4 2s 6d post free and a leather carrying case is available at 8s 9d extra.

Numerous times when working in the workshop the need to cut holes of various shapes and sizes in varying materials is reached and how best to tackle this problem has to be overcome.

Although we have not had the pleasure of trying the Adel nibbling tool being marketed by **West Hyde Developments,** this would seem to be a most suitable product for cutting holes in chassis and cabinet panels. Suitable for card, p.v.c., aluminium, copper and steel the Adel nibbling tool cuts almost any shaped hole and works on the punch and die principle, claimed not to distort or "wrinkle" the material.

The tool is easily operated by hand, will cut up to 16 gauge aluminium or 18 gauge steel and is priced at 59s 6d plus 3s posting and packing. Spare punches cost 32s 6d plus 2s 6d posting and packing from West Hyde Developments Ltd., 30, High Street, Northwood, Middlesex.

Having enough mains power outlets is another problem for the workshop and **Abbey Electrical Systems Ltd.** produce a fairly large range of excellent distribution outlets for the workshop. Already completely wired and factory tested the 13A outlet Busboards, as they are called, are available in eight different combinations.

All units are completely insulated for maximum safety and fitted with a mains indicator light. Intended for portable or static use the boards are claimed to be lightweight and virtually unbreakable under normal conditions of use.

Other uses for the mains outlet boards, apart from the workshop, are for offices, garages, public address systems and photographic studios.

More details and prices are available from Abbey Electrical Systems Ltd., 95, Victoria Street, St Albans, Herts.

COMPONENT BOXES

Storage space for components is always at a premium in any workshop and the new plastics storage cases from **S. Leboff (Fobel) Ltd.**, Hyde House, The Hyde, Edgware Road, Colindale, N.W.9, should be a useful addition to any workshop.

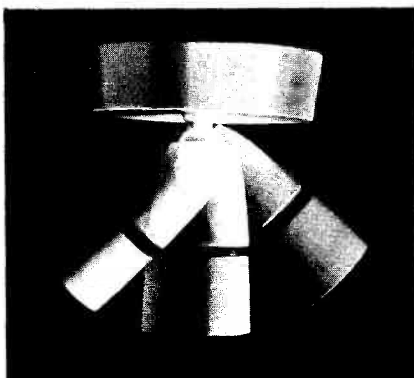
Called Fobel "Storaboxes" they are available in three different sizes, each 5½in long. The main feature of these boxes is that they can be interlocked side by side or one on top of the other, enabling a combination of different sizes to be made up if required. The boxes can also be attached to a wall or shelf.

A single box and drawer with removable partition retails at 2s 6d, and a large box with two drawers subdivided by partitions retails at 8s 11d.

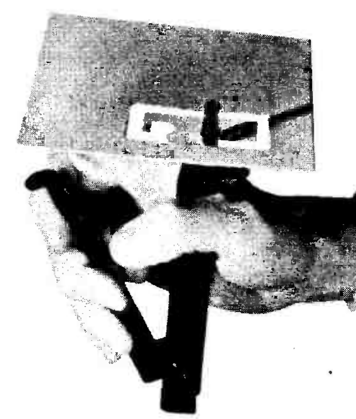
WORKSHOP LIGHT

A new panoramic batten bulb holder has been announced by **Rock Electrical Accessories Ltd.** Called the Monolink this holder would be very useful in the workshop and can be tilted at an angle of 45 degrees in most directions via a ball and socket joint.

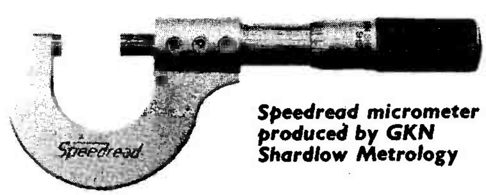
The base of the bulb holder also constitutes the ceiling rose and is simply wired up and screwed in place of the existing ceiling rose. Full details can be obtained from Rock Electrical Accessories Ltd., Rock Works, 6 Commerce Road, Brentford, Middlesex.



Monolink adjustable ceiling light from Rock Electrical Accessories

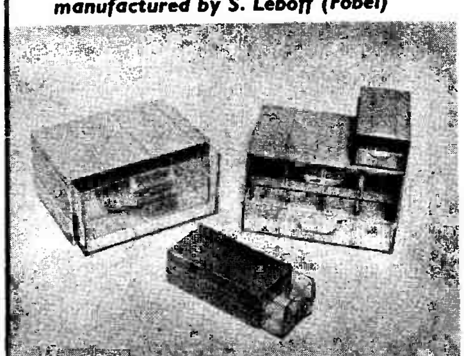


Adel nibbling tool from West Hyde Developments



Speedread micrometer produced by GKN Shardlow Metrology

Interlocking storage boxes manufactured by S. Leboff (Fobel)



Carbic Otis King spiral slide rule

THIS circuit was developed to help check the characteristics of the "surplus untested" diodes that are at present remarkably cheap in bulk lots. The resulting test set can be used for a number of applications—details are given in the text.

The components used are not costly and the prototype was built mainly from spare parts. By carrying out stage by stage tests during construction, the performance available from the particular components used can be checked.

The high voltage supply around which the test set has been designed has also proved useful as an e.h.t. generator for oscilloscopes and insulation testers. The basic principles involved in the design of this supply will be described first and then constructional details of the tester will be given. By following this method it is hoped that constructors will be able to understand the operation of the supply and thus be able to use the design for a wide variety of applications.

INSULATION AND DIODE TEST SET

By D. H. King

TRANSFORMER ACTION

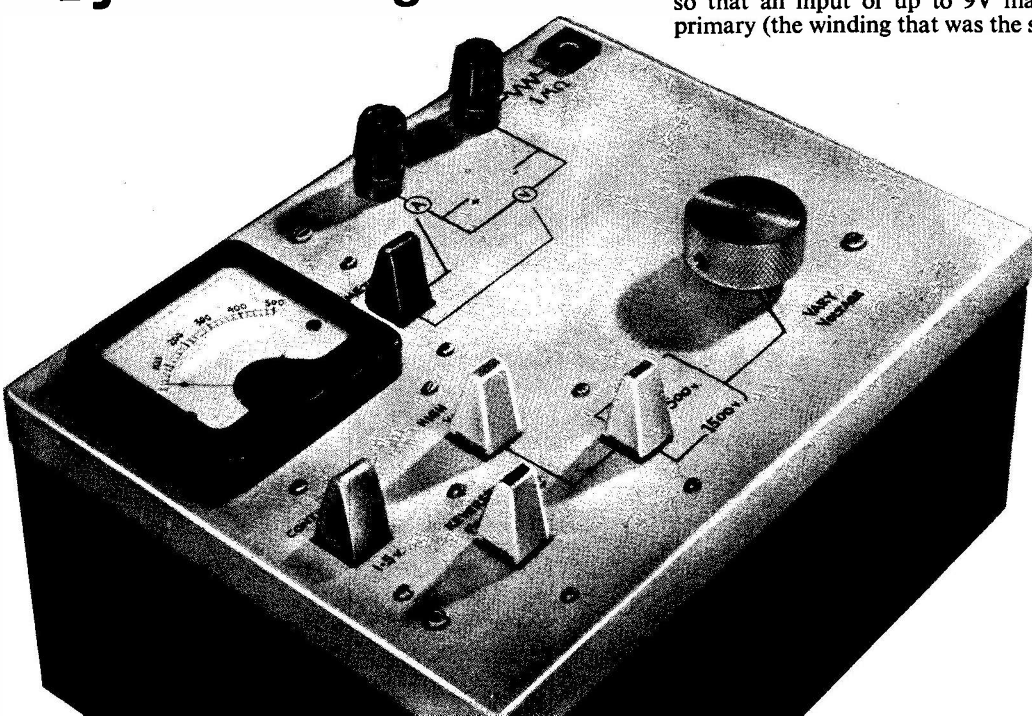
If a sinusoidal supply is available, then a transformer will transform the supply up or down as required, the output voltage being sinusoidal in waveform. It is often forgotten though that it is the changing input *current* that produces the changing magnetic flux, and it is the rate of change of this flux that induces the voltage into the secondary winding (and into the primary as a back e.m.f.) from which the secondary current is available. Thus a sinusoidal waveform is not necessary to drive a voltage step-up transformer; a near square wave primary current will produce high secondary voltages and will also result in less power loss in the current switching device.

The waveforms shown in Fig. 1 give the comparison between part of a 50Hz sine wave and a square wave changing in, say, 100 microseconds, by the same amount of current in a primary winding. The faster changing current induces the larger voltage in the secondary.

A simple transistor oscillator of the form shown in Fig. 2 will work quite well but has two distinct disadvantages. Firstly, the performance often varies enormously between use off load or with a loaded secondary because when off load the feedback is larger than when loaded, hence a promising secondary high voltage dies miserably when asked to supply more than a milliamp or two. Secondly, the switch, in this instance the transistor, is handling neither sine nor square wave but an unknown complex waveform that will give an unknown but probably low working efficiency. Because of these factors, a 100 per cent working design is difficult to achieve unless very tight specifications are maintained for all components.

The frequency of the supply determines the number of turns per volt required for a particular core cross section, so that if the frequency is increased above the lowest for which the transformer was designed, then so may the input voltage be increased in the same ratio. For example, a typical small valve output transformer, designed to handle down to approximately 80Hz, has a ratio of about 80 to 1 and produces 2 to 3 volts to feed the loudspeaker speech coil.

Now if this transformer is fed at 5,000Hz it will accept considerably higher voltages without saturating so that an input of up to 9V may be applied to the primary (the winding that was the secondary when used



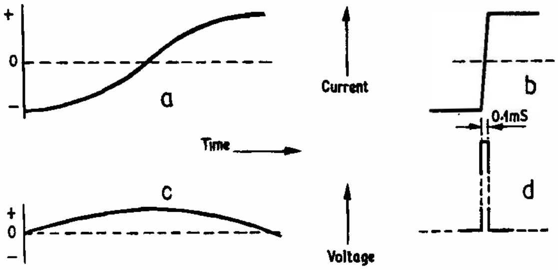


Fig. 1 (a). Half cycle of a 50Hz sine wave current lasting 10ms. (b) Same change of current as in (a) lasting 0·1ms. (c) Induced e.m.f. in coil as a result of (a). (d) Induced e.m.f. in coil as a result of (b); approximately 40 times the amplitude of (c)

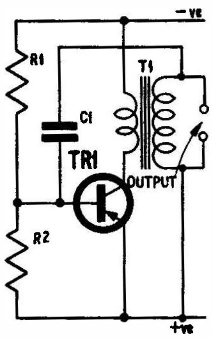


Fig. 2. A simple transistor oscillator

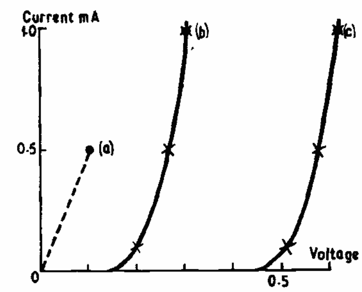


Fig. 3. Comparative volt drop for:
(a) a 200Ω, 500μA meter
(b) a typical germanium junction
(c) a typical silicon junction

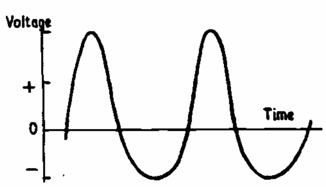


Fig. 4. Example of a non-symmetrical a.c. wevaform

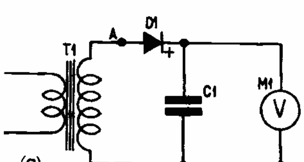


Fig. 5a. Simple half wave rectifier system

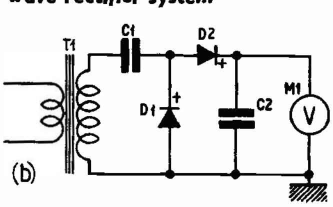


Fig. 5b. A peak to peak rectifier system

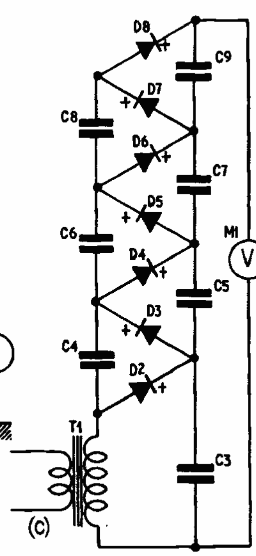


Fig. 5c. A seven stage voltage multiplier system with an off load voltage approximately seven times that obtained from the circuit of Fig. 5a. Diodes are reversed for a positive earth system

as an output transformer) giving 500 to 700V at the secondary. Smoothing problems are also reduced at the higher frequencies, since where one would need a 10μF reservoir capacitor for a 50Hz rectifier system, 1μF will have the same effect at 500Hz and at 5,000Hz only 0·1μF need be used; both capacitance and physical bulk are reduced.

TRANSISTORS

The transistor driving the transformer will have to handle the peak currents that are switched—possibly an ampere or more in spite of the average current being measured at a much lower value; also, the high back e.m.f. induced into the primary will be considerably higher than the low voltage supply used—60V has been measured at the collector during the switch-off period even though only a 5V supply was being used. This means that there is a strong chance of collector-emitter breakdown if a low voltage transistor is used but if the supply voltage is increased slowly during testing then the start of breakdown is seen on the supply ammeter and the supply may be switched off or reduced before the transistor suffers permanently.

It is worth remembering that whilst conducting, a germanium junction diode or the base-emitter junction in a transistor will drop about 0·3V (the barrier voltage) while silicon devices will drop from 0·6V to 1·0V. With less voltage than this across the junction, the current flow through the junction will be effectively zero so that these voltage drops may be usefully employed (a) to identify the junction material, germanium or silicon; (b) to replace a low voltage Zener diode where the exact voltage is not critical; (c) to give a good indication of correct functioning of transistors in amplifiers (see Fig. 3).

RECTIFIER SYSTEMS

The half wave rectifier and reservoir capacitor action is well known, but a peculiarity of single ended oscillator fed transformers is that the secondary waveform will probably not be of equal amplitude above and below the electrical zero axis. Considering the waveform shown in Fig. 4 as the voltage at point "A" relative to the chassis in Fig. 5a, then the voltage stored on the reservoir capacitor C1 will be twice that obtained when the rectifier D1, or the secondary winding of T1, is reversed. This also accounts for disappointing results when using simple feedback oscillators of the type shown in Fig. 2.

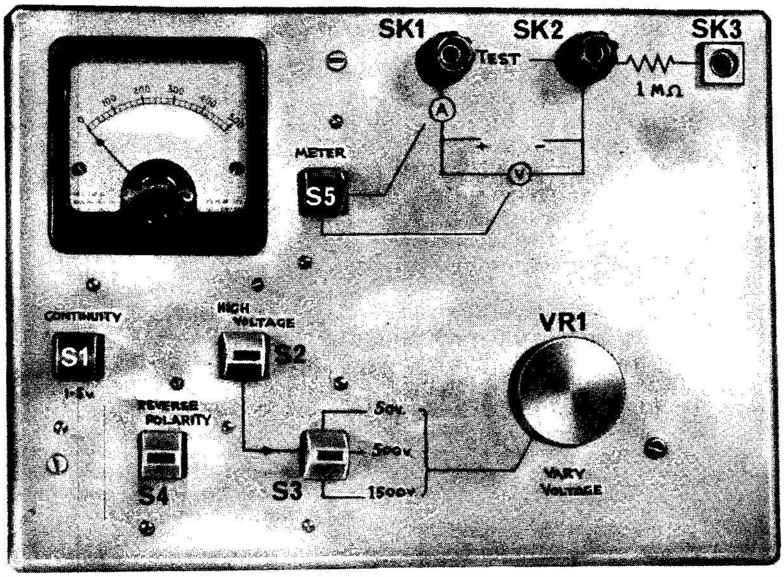
The voltage doubler system is thus seen to "double" the voltage obtained from a half wave system only if the positive and negative peaks are of the same amplitude, otherwise the system might be better known as a peak to peak rectifier system (Fig. 5b), this being its real action.

For really high voltages of a kilovolt or more a voltage multiplier ladder is recommended so that a low d.c. supply and fairly low voltage components may be used to obtain the final high voltage at small cost.

VOLTAGE MULTIPLIER

Consider a succession of half cycles, preferably square wave, and starting with the "live" end of the transformer (Fig. 5c) as positive relative to the chassis.

(1) D2 conducts to charge C3 to the peak positive voltage.
(2) D3 conducts to charge C4 to the sum of the winding peak negative voltage and the voltage stored on C3.



Front panel of the prototype, showing positioning of all switches, VR1, M1 and the test terminals

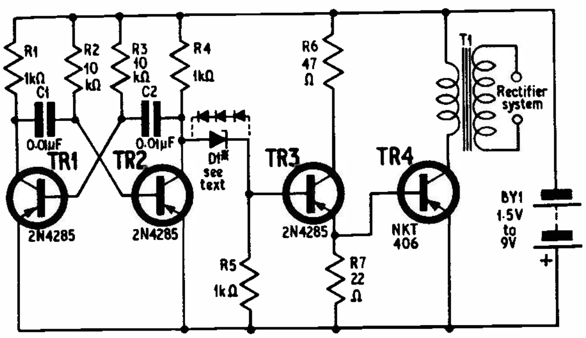


Fig. 6. The basic oscillator circuit used in the final supply system. T1 supplies the voltage multiplier

(3) C3 is recharged via D2. The voltage stored on C4 is lifted or pumped via D4 on to C5, which now has the peak to peak voltage stored on it.

(4) C4 is recharged via D3 to the peak to peak voltage. D5 is pumped so that C5 charges to the peak to peak voltage.

This continues for as long as you can afford to house the mounting heap of diodes and capacitors. The final result is that, apart from C3 which is charged to the positive going peak voltage, all other capacitors and diodes must withstand the peak to peak voltage (which may be fairly low) but a final voltage is obtained which is the sum of all the voltages stored on one of the stacks of capacitors.

The effective capacitance of the series arrangement of capacitors is smaller than each individual capacitance and all the output must be supplied by the stored charges, so do not hope for too large a current at, say, 2kV. One milliamp at 2kV represents a load of 2W and the transformer must be able to transfer this amount of power, while the switching transistor will be handling a low voltage but proportionately high current peaks, allowing for an efficiency of between 25 and 40 per cent.

FINAL SUPPLY CIRCUIT

Transistors TR1 and TR2 (Fig. 6) are a conventional astable multivibrator circuit, guaranteed to oscillate if the transistors are half good and the components near to the suggested values. The output is not a true square wave, but TR2 collector is switching pretty rapidly between effectively zero and the full supply voltage. TR4 cannot be fed directly with this voltage swing because the base-emitter junction of TR4 would not allow TR2 collector to rise higher than about 0·3V (for a germanium transistor TR4) and so the oscillation would be uncertain. TR4 is therefore fed from an emitter follower (TR3) and the 22 ohm emitter resistor R7 ensures that the leakage through TR4 is a minimum when TR3 is turned off.

Transistor TR4 would still clamp TR2 collector voltage to a low value via TR3 emitter-base junction, so a Zener diode, D1 is inserted. D1 may be either a low voltage Zener diode of about 1·5V less than the d.c. supply used, or a suitable number of silicon diodes used in their forward conducting sense. The result is that TR4 base is not turned on until TR2 collector has risen by at least two or three volts towards the supply line voltage. If only a 1·5V supply is used, omit D1.

Transistors TR1, TR2 and TR3 are *pnp* low-current types of 10mA 10V minimum ratings, either germanium or silicon as available; a wide range of cheap devices is suitable. TR4 is a power type, to handle up to 2A collector current and of as high a voltage rating as is cheaply available, say NKT406, OC28 or OC36.

Transformer T1 is a small valve output type, which should not be damaged since there may be up to a kilovolt between primary and secondary windings if the input voltage is increased too fast during testing The winding ratio is not particularly important, but the higher the ratio, then the fewer the stages of multiplication that will be needed for the final high voltage. The transformer used in the prototype had a ratio of 40 to 1 but much higher ratios can be used if cheaply available; a higher ratio would require fewer multiplier stages to attain the same voltage.

CONSTRUCTION AND TESTING

The TR1, TR2, TR3 circuit was constructed on perforated board as shown (Fig. 7), producing a simple layout of the components on the two sides, a tag board is equally suitable. Before joining TR4 base to R7, connect the circuit so far built to the d.c. supply and listen to the output across R7 with an earpiece, or check with an oscilloscope that the frequency is in the region of 5,000Hz and squarish. A voltmeter across R7 should show the average voltage of 0·2 to 0·3V, indicating a peak drive voltage for TR4 of twice that amount, assuming a nearly square waveform at this point.

The free air dissipation of TR4 will be about 1·5W and so TR4 will need no heat sink unless an attempt is made to obtain a large output power. Thus the mounting of TR4 is simplified by bolting down to the circuit board; connect the base to R7. With the transformer secondary feeding a rectifier and capacitor only, and a voltmeter across the capacitor (as Fig. 5a), increase the d.c. supply in small steps. The voltmeter will show the peak voltage available, probably about 300V from a supply of only a few volts, while an ammeter in the supply circuit will give warning of TR4 breakdown if the supply voltage is increased too far.

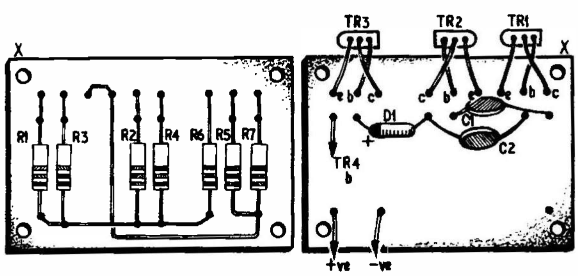


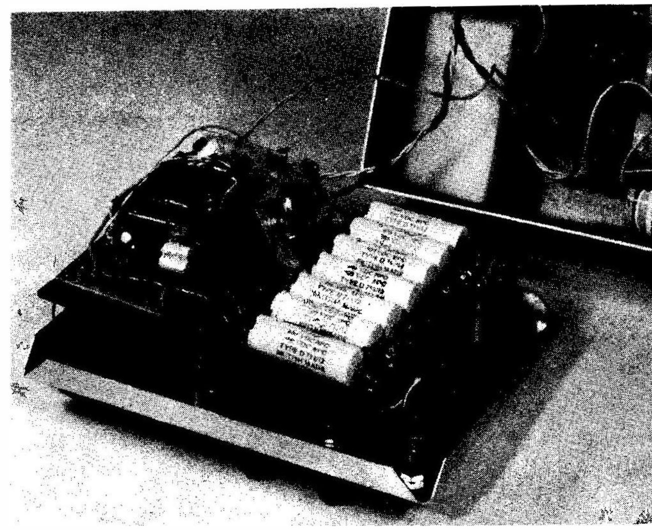
Fig. 7. Layout and wiring of the oscillator board. TR4 and T1 are mounted separately

Reverse the connections from the secondary winding of T1, switch on to the same voltage supply as before and note the d.c. voltage produced. This voltage will differ from that noted before and the sum of the two output voltages indicates the secondary peak to peak voltage induced for the particular d.c. input used.

There will probably be a healthy whistle (or even a shriek) coming from the core of the transformer; this is not dangerous and may be quietened by careful clamping, squeezing or waxing of the core.

Now build the voltage multiplier ladder network (Fig. 9) stage by stage; the size of board used will depend upon the size of the capacitors and upon the number of stages that prove to be needed. It is suggested that each time a stage of a capacitor and a diode is added, the resultant voltage is measured across a loading resistor that will draw a milliamp or two when connected between the chassis and the top of the latest capacitor to be added.

One faulty or leaky component causes the whole multiplier system to fail; do not forget to discharge each capacitor when you switch off during testing—the voltmeter will do for this—otherwise you will be reminded when you handle or go to modify the circuit. A bleeder resistor will be fitted finally, of course.



View of the rear of the prototype showing original positioning of components. Size of case and layout depend on the components used and the number of multiplier stages required

COMPONENTS

The resistors are $\frac{1}{4}$W types for the transistor circuit, but on the high voltage side of the circuit remember that there are maximum voltage ratings to observe as well as the wattage rating to calculate. For $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$ and 1W resistors these maximum voltages are about 250, 350, 500 and 750V respectively. If the normal carbon composition types are used, and the maximum voltage is exceeded for any length of time, you may expect the resistance to vary unpredictably.

The diodes are low current rating types, having a p.i.v. rating to suit the particular circuit, so one of the "bulk" suppliers is suggested, assuming that a diode tester is not already available to test the characteristics of cheaper diodes.

Capacitors must be new, or tested to above their final working voltage for zero leakage; it is well worth while checking carefully through the various advertisement pages in this magazine to compare the economics of using a few high voltage diodes and capacitors with a high ratio transformer (100 to 1), or using rather more lower voltage components, with a slightly lower ratio transformer, at less total cost (and possibly greater reliability).

TYPICAL EFFICIENCY

This will depend very much upon the individual components used; one circuit using a peak to peak rectifier system, was fed from 6V and the following noted:

Input current 0·14A Output 900V into voltmeter (20μA)
Input current 0·19A Output 600V into 2MΩ (0·3mA)
Input current 0·28A Output 500V into 390kΩ (1·3mA)

Another circuit with a seven stage multiplier, also fed from 6V:

Input current 0·5A Output 1,600V into 3MΩ (about 0·5mA)

TEST SET CIRCUIT

A simplified block diagram and functions of the tester are shown in Fig. 8. The high voltage generator has already been described; the TR1, TR2, TR3 circuit

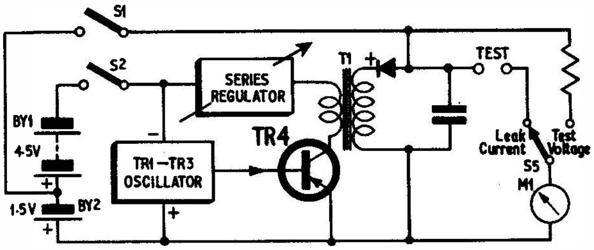


Fig. 8a. Basic circuit of the insulation and diode test set

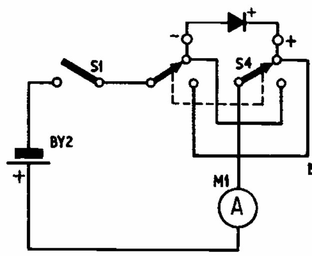


Fig. 8b. Circuit for low voltage checking

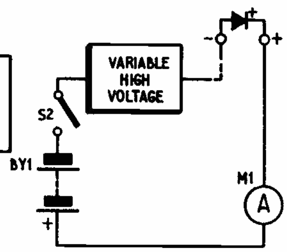
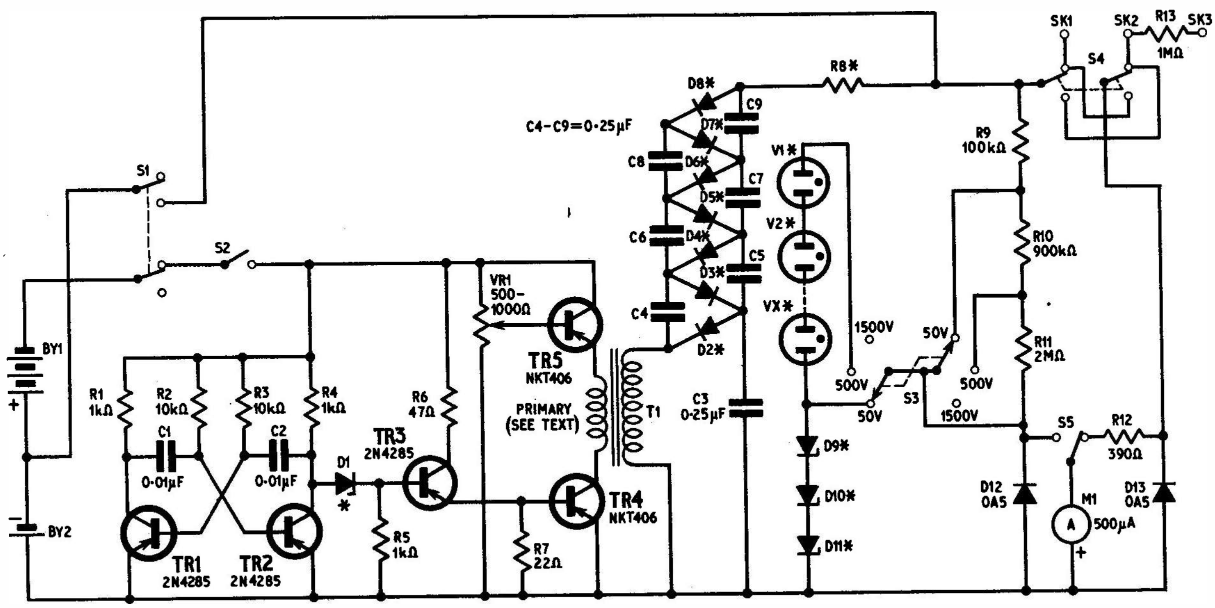


Fig. 8c. Circuit for high voltage check on leakage

is fed from 6V immediately upon switching on, but TR4 is fed via a simple series regulator thus giving full control of the output from zero to maximum voltage.

Switches S1 and S4 (Fig. 8b) are used first for simple diode or continuity checks enabling open or short circuit diodes to be rejected and the diode polarity to be confirmed, since the cathode (+ve) end of the diode connected to the positive test terminal should show zero current. Only 1·5V is used rather than the available 6V so that low voltage Zener diodes are not rejected. S4 will have the full test voltage across it at all times but since it is switching negligible currents, a normal toggle or biased type should operate satisfactorily at up to about 2kV. Any leakage will be seen on the meter, so this is self-checking.

The high voltage generator is energised by S2 as long as S1 is not operated; S2 must be spring biased to the OFF position so that there is no chance of accidents—even though the output current is limited. The voltmeter multiplier resistance is altered by S3 which also shunts the test terminals with Zener diodes or small neons in the lower voltage positions to avoid damage to the meter (Fig. 9). The Zeners and neons are not necessary initially however, and may be added after the rest of the unit is working and available to test the characteristics of these safety devices.



* SEE COMPONENTS LIST

Fig. 9. The complete circuit diagram of the insulation and diode test set

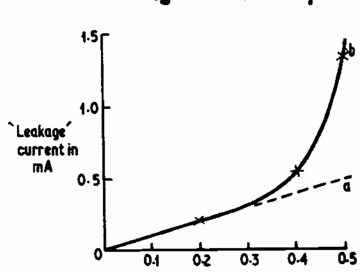
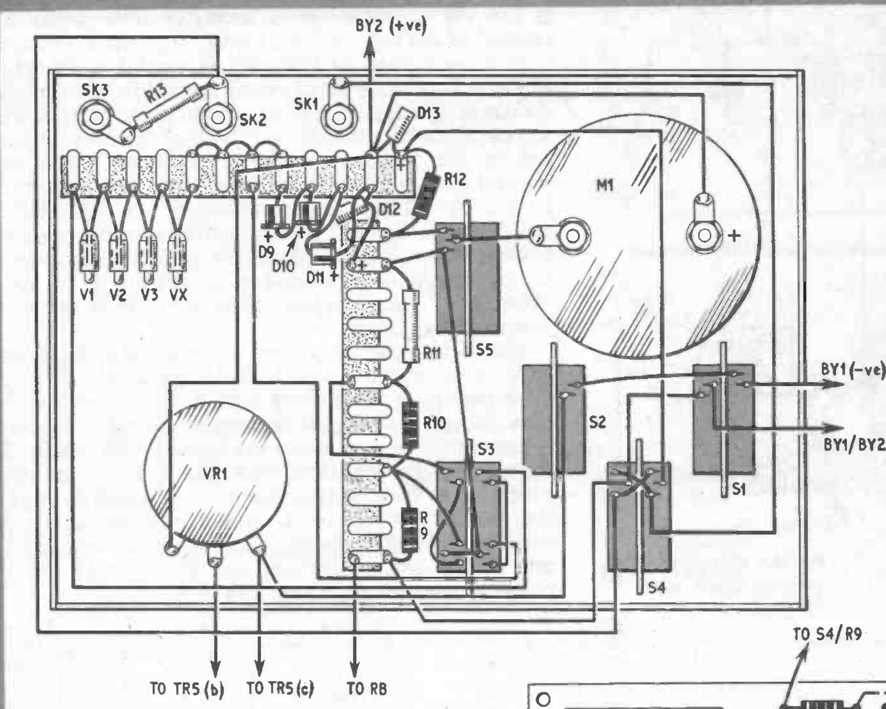


Fig. 10. Graph showing the effect of adding R12 (390 Ω) to the 500µA, 190 Ω meter; "a" without R12, "b" with R12—no alteration of first half of scale linearity

To switch the meter movement across either D12 or D13, S5 is incorporated. D12 and D13 are germanium junction types—OA5 were used in the prototype but a germanium transistor base-emitter junction would do as well. Inclusion of these diodes ensures that the circuits are never left open as the meter is switched over, yet the meter when connected across a diode, "robs" the diode of its turn-on voltage and so all the current flows through the meter alone (see Fig. 3). R12 was added to decrease the sensitivity of the meter at full scale and yet leave the low scale readings unaltered to show small



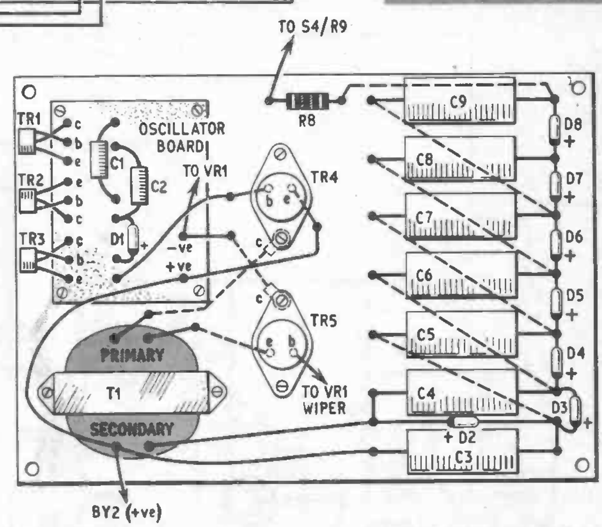


Fig. 11. Layout and wiring of the complete test set. The board must be made big enough to accommodate as many voltage multiplier stages as are required; it is mounted behind the front panel (top) on four pillars. Wiring shown dotted is on the underside of the board

COMPONENTS . . .

Resistors
R1 1kΩ
R2 10kΩ
R3 10kΩ
R4 1kΩ
R5 1kΩ
R6 47Ω
R7 22Ω
R8 47kΩ to 100kΩ (see text)
R9 100kΩ ±2%, ½W
R10 900kΩ ±2%, ½W
R11 2MΩ ±2%, 4W
R12 390Ω selected to suit meter and D13
R13 1MΩ ±2%, 1W
All ±20%, ¼W carbon except where stated

Potentiometer
VR1 500–1000Ω wirewound

Capacitors
C1 0·01μF polystyrene
C2 0·01μF polystyrene
C3–9 0·25μF paper 600V (7 off)

Semiconductors
D1 Low voltage Zener (see text)
D2–8 600V p.i.v. silicon miniature (7 off, see text)
D9–11 Zener diodes, total voltage 50–60V (3 off)
D12, 13 OA5 germanium diode (2 off)
TR1, 2, 3 2N4285 or any low current *pnp* type (3 off, see text)
TR4, 5 NKT406, OC28 *or* OC36 (2 off, see text)

Switches
S1 DPDT biased
S2 SPST biased
S3 2-pole 3-way
S4 DPDT biased
S5 SPDT biased
} toggle, yaxley or GPO 1000 type

Miscellaneous
V1–Vx Neons, total striking voltage about 500V
M1 500μA moving coil meter
T1 Small high ratio valve output transformer (see text)
BY1, 2 High power 1·5V U2 battery (4 off)
SK1, 2 Insulated terminals (2 off, red and black)
SK3 Wander plug socket
Perforated s.r.b.p. board 2¾in × 1¾in
Laminated plastics board
Solder pins
Mounting pillars (4 off)
12 way tag strip (2 off)
Control knob
Metal case (size depends on components used)

COMPUTER MULTI-CORE CABLE

12 14/0076 copper cores, each one insulated by coloured P.V.C. then separately screened, the 12 metal braided cores laid together and P.V.C. covered overall making a cable just under ½in. dia. but quite pliable. Price 7/6 per ft. Any length cut.

FLEX BARGAINS

SCREENED 3 CORE FLEX
Each core 14/0076 copper P.V.C. insulated and coloured, the 3 cores laid together and metal braided overall. Price £3.15—per 100yd coil.

15 AMP 3 CORE NON-KINK FLEX
70/0076 insulated coloured cores, protected by tough rubber sheath, then black cotton braided with white tracer. A normal domestic flex as fitted to 3Kw. fires. Regular price 3/6 per yd. 50yd. coil. £4.10 or cut to your length 2/6 per yd.

10 AMP 3 CORE NON-KINK FLEX
As above but cores are 28/0076 copper. Normal price 2/6 per yd. 100yd. coil £7.10 or cut to your length 1/9 per yd.

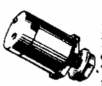
6 AMP 2 CORE FLEX
As above, but 2 cores each 23/0076 as used for vacuum cleaners, electric blankets, etc., 39/6 100yd. coil.

15 Amp FOOT SWITCH

Suitable for sewing machine motor, drilling machine or in fact to switch any job where both hands are to be left free. Rated at 13A, 250V. Price 22/6.

3 DIGIT COUNTER

For tape recorder or other application, re-settable by depressing button. Price 8/6.



TRANSDUCER

Made by ACOS, reference No. 1.D.1001. For measuring vibration, etc., to be used in conjunction with "G" Meter. Regular price £5. Our price 49/6. Brand new and unused.

ISOLATION SWITCH

20A D.P. 250V. Ideal to control water heater or any other appliance. Neon indicator shows when current is on, 4/6. 48/- per dozen.

LIGHT CELL

Almost zero resistant in sunlight increases to 10K. ohms in dark or dull light, epoxy resin sealed. Size approx. 1in. dia. by ¼in thick. Rated at 500MW. wire ended. 8/6 with circuit.

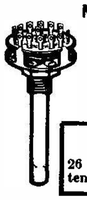
INSTRUMENT BUZZER

6-12V, adjustable tone, a very neat metal cased U.S.A. made unit approx. 1¼ × ¾in. thick. 6/6 each.

12 VOLT SOLENOID

For energizing Reed Switches, etc., size approx. 1⅜in. long by 1⅛in. diameter. Hole through solenoid approx. ⅜in. 8/6 each.

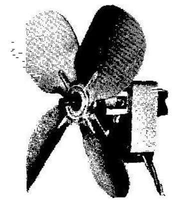
MINIATURE WAFER SWITCHES



2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at 3/6 each. 36/- dozen, your assortment.

WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. 10/- post free.

AC FAN



Small but very powerful mains motor with 5½" blades. Ideal for cooling equipment or as extractor. Silent but very efficient. 17/6, post 4/6. Mounts from back or front with 4BA screws.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions 19/6 plus 2/6 post and insurance. Or available made up 29/6 plus 2/6 post.

500W IMMERSION HEATER

For small process tanks, etc., 200/240V, 4⅞in. into tank, 2¼in. outside of tank, dia. approx. 1 in., chrome plated 14/6. Post and insurance 4/6.

THE FULL-FI STEREO SIX

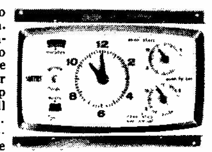
The amplifier sensation of the year

You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled and teak finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6 watts R.M.S. split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners, it has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. Other controls include "treble lift and cut", "balance" and separate mains on/off switch.
Price is £9.9.0 plus 7/6 post and insurance.
Speakers (with tweeters) in oiled teak finish cabinets to match amplifier. £8.8.0 pair.

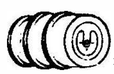
COMBINATION DIAL SWITCH

3 separate settings of the dial are necessary before this can be switched on or off. Combinations can be changed as required. A useful switch for security or novelty. Contacts rated at 1A. 35/- each.

ELECTRIC CLOCK WITH 20 AMP SWITCH



Made by Smith's these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set—also on the left is another timer or alarm—this may be set in minutes up to 4 hours. At the end of the period a bell will sound. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—only 45/-, less than the value of the clock alone —post and insurance 2/9.



NICAD RECHARGEABLE BATTERIES

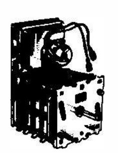
3·6V 500mA size 1¼ 1⅝in. dia. type ref. DKZ500 really powerful will deliver 1 amp for ½ hour. Regular price 32/6 our price 17/6 each. New and guaranteed. Other voltages available, single cell 1·2V 6/6. 5 cell 6V 29/6. 10 cell 12V 65/-.

THIS MONTH'S SNIP

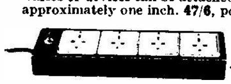
Horstmann "Time and Set" Switch

(A 15A switch). Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price 29/6, post and insurance 4/6.

MOTORISED CAM SWITCH

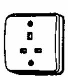


Made by the famous meter company Chamberlain and Hookham, these have a normal mains 200-240V motor which drives a ratchet mechanism so geared to give one ratchet action per minute on a wheel with 60 teeth thus a complete revolution of the cam takes place in one hour. The cam operates 8 switches (6 changeover and 2 on/off thus 480 circuit changes per hour are possible). Contacts, rated at 15 amps have been set for certain switch combinations but can, no doubt, be altered to suit a special job. Also other switch wafers or devices can be attached to the shaft which extends approximately one inch. 47/6, post and insurance 4/6.



DISTRIBUTION PANELS

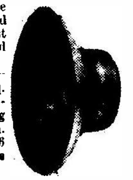
Just what you need for work bench or lab. 4 13 amp sockets, in metal box to take standard 13 amp fused plugs. Supplied compete with 6 feet of heavy cable and 13 amp plug. Similar panels advertised at £5. Our price 39/6, plus 3/6 post and insurance.



G.E.C. 13A SOCKETS

Opportunity to re-equip your house or workshop, or if a contractor, to stock up for future jobs. We offer bakelite 13A sockets for flush or surface mounting made by the famous G.E.C. company and listed from 6/6 each. YOU CAN HAVE A BOX OF 12 flush type 24/-, surface type 29/6, post and insurance 4/6 (Gross or more carr. free.)

HI FI BARGAIN



FULL FI 12-INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address.
Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Cone Moulded fibre—Freq. response 30-10,000 c.p.s.—specify 3 or 15 ohms—Main resonance 60 c.p.s.—Chassis diam. 12 in.—12⅜in. over mounting lugs—Baffle hole 11in. diam.—Mounting holes 4, holes—¼in. diam. on pitch circle 11⅝in. diam.—Overall height 5⅛in. A £6 speaker offered for only £3.9.6 plus 7/6 p. & p. Don't miss this offer. 15in. 30 watt £7.19.6.

INDICATOR LAMP

Panel mounting, consists of neon lamp in red Plastic lens with resistor in leads for mains operation. 2/6 each, 24/- dozen.

12V BLOWER

Heavy duty motor with centrifugal blower coupled to one end. Ideal for car heater. 12/6 plus 4/6 post.

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semiconductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

RADIO STETHOSCOPE

Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. 29/6—twin stethoset instead of earpiece 11/- extra—post and ins. 2/9.

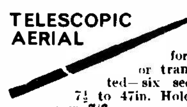
MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 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, condensers and instructions. Real snip at only 19/6 plus 3/6 postage.

PROTECT VALUABLE DEVICES

From thermal runway or overheating. Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protected; simply make the contact thermostat part of the heat-sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90°-190°F. or with the dial removed range setting is between 80° to 800°F. Price 10/-.

TELESCOPIC AERIAL

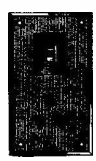


for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. 7/6.

REED SWITCH

Suitable for dozens of different applications, such as burglar alarms, conveyor belt switching. These are simply glass encased switches which can be operated by a passing permanent magnet coil. A special buy enables us to offer these at 2/6 each, or 24/- dozen. Suitable magnets are 1/- each.

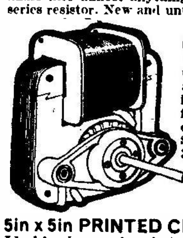
5A, 3 PIN SWITCH SOCKETS



An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered 5A switch sockets for only 10/- plus 3/6 post and insurance. (20 boxes post free.)

MOVING COIL METER BARGAIN

Panel meters are always being needed and they are jolly costly when you have to buy them in a hurry—so you should take advantage of this offer: 2in. moving coil flush mounting meters only 9/6. These are actually R.F. meters and cost about £3 each but if you don't want them for R.F. then all you have to do is to remove the thermocouple and you will have a 2-3 mA. meter which you can make into almost anything by adding shunts or series resistor. New and unused.



MAINS MOTOR

Precision made — as used in record decks and tape recorders—ideal also for extractor fans, blower, heater, etc. New and perfect. Snip at 9/6. Postage 3/- for first one then 1/- for each one ordered. 12 and over post free.

5in x 5in PRINTED CIRCUIT BOARD

Ideal for dozens of projects. Heavy copper on $\frac{1}{16}$ sheet, 1/6 each or 15/- per dozen.

HEAVY DUTY MAINS TRANSFORMER

30V, 37A. Primary tapped 200/240 in 10V steps. A really beautiful "C" core transformer. Made by Parmeko, impregnated and varnished. Weight approx. 50 lb, size approx. 8in. wide, 6¼in. deep and 8¼in. high. Metal framed for free standing and fitted with E.S. screen. Probably priced £40-£50 from Parmeko. Ex equipment, but perfect. £20 each, carriage paid.

ELECTRONICS (CROYDON) LTD

Dept. PE, 266 London Road, Croydon CRO 2TH

Also 102/3 Tamworth Road, Croydon

leaks. Fig. 10 shows the effect of this resistor used with a 500μA meter of 190 ohm internal resistance, but the effect will vary according to the particular diode and meter used.

The meter used was scaled 0–500 and so the voltage ranges chosen were 50, 500 and 1,500V. A more sensitive meter movement would load the circuit less because of the higher value resistors used in the voltmeter circuit and would also show up leakage more readily; a less sensitive meter is not recommended for the same reasoning.

CONSTRUCTIONAL DETAILS

The high voltage unit can be built up on a sheet of laminated plastics—perforated board is as convenient—while the meter, switches, voltage control and terminals are fitted to the front aluminium panel of the unit. The high voltage board (Fig. 11) is supported on pillars behind the front panel with all the interconnecting wires grouped together at one side so that the two parts may be "hinged" apart easily, without disconnecting, for testing or modification.

Do not try to miniaturise or cramp the layout; very close spacing could lead to unexpected leaks. Space should be found in the completed unit for a row of series connected high power U2 type cells so that the tester is self contained.

USE OF UNIT

Capacitor or insulation test: the chosen test voltage is applied; after allowing time for a capacitor to charge up, there should be zero leakage. An electrolytic capacitor may be expected to leak considerably and will not test satisfactorily with this tester since a ten minute forming period should be allowed first. If a current is indicated, the leakage resistance may be simply calculated from R = test voltage/leak current. The 1 megohm resistor on the front panel is fitted because the final sub-circuits of electrical installations should have an insulation in excess of 1 megohm at 500V and a direct comparison can be quickly made if meter accuracy is in doubt.

Zener diode test: using the low voltage range the test voltage is increased until 0·5 to 1·5mA is indicated; the Zener breakdown voltage is now read from the meter by using S5, and it will be seen that this voltage will stay nearly constant as the current is varied from maximum to zero.

Rectifier diode test: increase the test voltage until leakage is indicated, then read off the test voltage. A rule of thumb for permissible leakage is to allow for one thousandth or 0·1 per cent of the forward current to leak at the maximum reverse voltage. If desired, a graph of leakage current against reverse voltage may be drawn to show the breakdown characteristics.

SAFETY

The maximum current available at the test terminals, under any conditions, is limited to 1·5mA by R8; the normal body resistance, hand to hand, lies between 10,000 and about 50,000Ω so that the highest voltage that will be across a careless or accidental body should not exceed about 75V. Adjust R8 so that 1·5mA is the *maximum* available current. *Never be careless with capacitors that have just been tested at a high voltage and not allowed time to discharge;* the shock may not kill you, but by tripping over a stool you may easily break an arm or leg! ★

NEWS BRIEFS

Earth Station Communicates

THE FIRST Earth station for satellite communication in the Middle East and Africa was officially opened at Bahrain on July 14. The inaugural telephone call was made by the Ruler of Bahrain, H.H. Sheikh Isa bin Sulman Al-Kalifa to H.R.H. the Duke of Edinburgh. Sheikh Isa made the call from the new Earth station before 300 guests. Prince Phillip received the call at Windsor Castle.

The station, owned and operated by Cable and Wireless Ltd., operates via the Intelsat III satellite stationed in orbit over the Indian Ocean and provides the States of the Arabian Gulf with direct links to the worldwide satellite system.

Bahrain is the third station to line up with the Indian Ocean satellite, following the U.K. and Japan. During the next 18 months Hong Kong, Germany, India, Indonesia, Italy, Kenya, Kuwait, Pakistan, Singapore and Spain are all expected to be using the satellite.

Computer Control

NOWADAYS computers are being used to control many processes and people. Two recently announced systems are a planned installation by Cable and Wireless to process passengers at Hong Kong's Kai Tak airport and an installation at the Port of New York Authority's £250 million World Trade Center (the world's highest building).

The Kai Tak system will help the processing of passengers, baggage and freight and will be especially useful when the "jumbo jets" come into service. Many other computerised control systems are already in operation around the world but this latest Cable and Wireless project will be different because it will offer individual and confidential processing to all airlines. The system will operate 24 hours a day and is planned to come into service in the autumn of 1970.

Costing nearly £3 millions, the installation at the World Trade Center is designed around a Honeywell DDP 516 real-time processor which will be linked to more than 6,500 sensors situated in and around the building. The computer which, in addition to its 16,384 word core memory, has a 196,000 word disc memory, will scan the sensors, extract the pertinent values and compare them with other variables or pre-set numerical limits. It will also make analyses of trends, efficiencies and operating profiles, taking into consideration, not only the conditions inside the World Trade Center, but also those outside the building at four different elevations. Monitoring temperature, humidity, wind direction and speed at these different points is necessary because the height of the building is such that it could be sunny on floor 110 but foggy at ground level!

Reconnaissance System Flown

THE COMBINED radar, infra-red linescan and camera pod designed by EMI Electronics for the Royal Air Force Phantom aircraft had its first flight trial recently.

The pod was attached below the belly of a trials Phantom which was flown from the Hawker Siddeley Aviation Ltd. airfield at Holme on Spalding Moor in Yorkshire.

The aircraft flew at 400 knots at low level and in excess of Mach 1·3 at medium level. No difficulty was experienced and further trials are now proceeding.

The revolutionary reconnaissance system will enter service with the R.A.F. early in 1971.

LIND·AIR OPTRONICS LTD

See our vast range of Electronic Components and Accessories at our enlarged Component Centre 25 Tottenham Court Road

HI-TONE RECORDING TAPE

BRITISH MADE TOP QUALITY

J1001	3"	Long Play PVC	225ft	5/6	P. & P. 1/2
J1002	3"	Triple Play Poly	600ft	10/6	P. & P. 1/2
J1003	5"	Long Play PVC	900ft	10/-	P. & P. 1/8
J1004	5"	Double Play Poly	1200ft	15/-	P. & P. 1/8
J1005	5¾"	Long Play PVC	1200ft	12/6	P. & P. 2/-
J1006	5¾"	Double Play Poly	1800ft	22/6	P. & P. 2/-
J1007	7"	Standard Play PVC	1200ft	12/6	P. & P. 2/6
J1008	7"	Long Play PVC	1800ft	17/6	P. & P. 2/6
J1009	7"	Double Play Poly	2400ft	25/-	P. & P. 2/6
J1010	7"	Triple Play Poly	3600ft	50/-	P. & P. 2/6

Visit our Brand New Hi-Fi Demonstration Room, Tape, Record Bar and Scientific Show of Microscopes, Binoculars, Telescopes and Watches at 18 Tottenham Court Road

MAINS KEYNECTOR
SAVES TIME—SAFELY!

One mains "Keynector" instantly and safely connects electrical appliances to mains supply without the use of a plug. A number of appliances may be used simultaneously up to the full 13 amp rating of this device. A red light glows when "live". The "Keynector" is fused and has its own robust switch which is interlocked to prevent connections when "live".
Invaluable to handymen, servicemen, demonstrators, etc.

39/6 P. & P. 3/-.

VHF AIRCRAFT BAND CONVERTOR.
When placed within 1in. of a MW band radio full coverage of VHF Aircraft Band 108-136Mc/s. can be obtained. All transistor, 9V battery operation. Fully tunable 18½in. × 7-section telescopic aerial. Size 4 × 2¾ × 1½in. **79/6.** P. & P. 3/6.

MODEL MAKER'S MOTOR No. 15RN. Voltage 11·5V. Current 400mA. Torque 12g.cm. Body size 1¾" × long × ⅞" dia. Shaft 5/16" long × 1/16" dia. Ideal for small models and toys. **5/6** each. P. & P. 1/3. 3 for **15/-**. P. & P. 2/6.

DE-LUXE STEREO HEADPHONES

With soft rubber earpieces. Impedance 8-16 ohms. Frequency response 23-13,000cps. With lead and stereo plug.
Only **59/6.** P. & P. 3/6.

NEW STEREO/MONO HEADPHONES.
SDH-7. Soft rubber earpieces with slide switch for mono/stereo listening and ind. vol. controls. Impedance 8–16 ohm Freq. response 25–15,000cps. With lead and stereo plug.
£6.6.0. P. & P. 3/6.

VENNER SYNCHRONOUS MOTOR UNIT
Brand New. Mains voltage (200/250V), 1 rev. per hour. Precision movement (enclosed in case), self starting, silent running. Shaft complete with knurled clamping nut. Overall dimensions: 2¾in diam., 2 11/16in deep (including shaft). Shaft diam. 3/32in. **27/6.** P. & P. 3/6.

TRANSFORMERS

AUTO WOUND TRANSFORMERS

All winding voltage ratings and tappings 0–115–200–220–240V, except MT113 0–115–210–240V

		Size	Weight	Price	
MT113	20W	2¾ × 1 11/16 × 1¾in	11oz	12/6	(P. & P. 2/6)
MT64	75W	2¾ × 2½ × 2¾in	1lb 14oz	21/9	(P. & P. 4/6)
MT4	150W	3½ × 2¾ × 3in.	3lb	33/-	(P. & P. 6/-)
MT65	200W	3½ × 4½ × 4in	4lb	39/6	(P. & P. 6/-)
MT66	300W	4 × 4 × 3¾in	6lb 7oz	59/4	(P. & P. 9/-)
MT110	400W	4¾ × 4½ × 4in	11lb	85/-	(P. & P. 10/-)
MT67	500W	5½ × 4 × 4½in	12lb 8oz	89/-	(P. & P. 10/6)
MT83	750W	4½ × 5½ × 5½in	13lb 4oz	95/7	(P. & P. 10/6)
MT84	1000W	4½ × 5½ × 5½in	16lb	142/2	(Carr. extra)
MT93	1500W	5 5/16 × 5½ × 6½in	28lb 9oz	170/6	(Carr. extra)
MT94	1750W	5 5/16 × 6¾ × 6½in	31lb	195/-	(Carr. extra)
MT95	2000W	7 × 6½ × 8½in	40lb	211/2	(Carr. extra)
MT73	3000W	6½ × 7½ × 8¾in	45lb 8oz	300/-	(Carr. extra)

LOW VOLTAGE 12V RANGE

Primary 200-250V; secondary 12V

MT111	0·5A	3 × 2½ × 1¾in	12oz	15/3	(P. & P. 2/6)
MT71	2A	2¾ × 2½ × 2½in	1lb	19/-	(P. & P. 3/9)
MT69	4A	3½ × 2¾ × 2¾in	2lb 4oz	28/-	(P. & P. 6/-)
MT70	6A	4 × 3 × 3¾in	3lb 12oz	39/-	(P. & P. 6/-)
MT72	10A	3½ × 4½ × 4in	6lb 3oz	51/-	(P. & P. 9/-)
MT115	20A	4¾ × 4½ × 4in	11lb 13oz	95/-	(P. & P. 9/-)
MT187	30A	5½ × 4¾ × 4¾in	16lb 12oz	180/-	(P. & P. 13/6)

LOW VOLTAGE 24V RANGE

Primary 200/250V; secondary 24V

MT58	1A	2¾ × 2¾ × 2½	1lb 7oz	23/9	(P. & P. 4/6)
MT114	3A	2½ × 3 × 3in	3lb 6oz	38/-	(P. & P. 6/-)
MT72	5A	4 × 3¾ × 3¾in	5lb 12oz	53/10	(P. & P. 6/-)
MT17	8A	4¾ × 3¾ × 4in	7lb 8oz	72/7	(P. & P. 9/-)
MT115	10A	4¾ × 4½ × 4in	11lb 13oz	95/-	(P. & P. 11/-)

LOW VOLTAGE 30V RANGE

Primary 200/250V; secondary tapped 12–15–20–24–30V

MT112	0·5A	3½ × 2 7/16 × 1 11/16in	1lb 4oz	17/4	(P. & P. 3/9)
MT79	1A	2¾ × 2½ × 2¾in	2lb	23/-	(P. & P. 6/-)
MT20	3A	4 × 3½ × 3¾in	4lb 6oz	46/2	(P. & P. 6/-)
MT51	5A	4¾ × 3½ × 4in	6lb 8oz	60/9	(P. & P. 9/-)
MT88	8A	5¾ × 3¾ × 4½in	9lb 6oz	92/4	(P. & P. 11/-)
MT89	10A	5½ × 4 × 4½in	12lb 2oz	103/6	(P. & P. 11/-)

LOW VOLTAGE 50V RANGE

Primary 200–250V; secondary tapped 19–25–33–40–50V

MT102	0·5A	2¾ × 2¾ × 2½in	1lb 11oz	21/3	(P. & P. 6/-)
MT104	2A	4 × 3½ × 3¾in	5lb	45/8	(P. & P. 6/-)
MT106	4A	4¾ × 4½ × 4	9lb 4oz	77/-	(P. & P. 9/-)
MT118	8A	5½ × 5½ × 4¾in	18lb 9oz	132/-	(P. & P. 13/6)
MT119	10A	6½ × 4½ × 6½in	19lb 12oz	165/-	(P. & P. 15/6)

LOW VOLTAGE 60V RANGE

Primary 200/250V; secondary tapped 24–30–40–48–60V

MT124	0·5A	3½ × 2¾ × 2¾in	2lb 4oz	24/-	(P. & P. 6/-)
MT127	2A	4 × 3½ × 3¾in	5lb 6oz	52/10	(P. & P. 6/-)
MT123	4A	4½ × 3¾ × 4½in	10lb 6oz	99/-	(P. & P. 11/-)
MT122	10A	6½ × 5 × 6½in	23lb 2oz	152/-	(Carr. extra)

MAINS H.T. RANGE

				Size	Price	P&P
MT1AT	250–0–250V	80MA	6·3V 3·5A 5/6·3V 1A	3½ × 3 × 3in	33/-	6/-
MT6AT.	250–0–250V	100MA	6·3V 3·5A 5/6·3V 1A	4 × 3½ × 3½in	38/3	6/-
MT110	250–0–250V	120MA	6·3V 3·5A 5/6·3V 1A	4 × 4 × 3½in	44/9	6/-
MT11AT	300–0–300V	100MA	6·3V 3·5A 5/6·3V 1A	4 × 3½ × 3¾in	37/9	6/-
MT12AT	300–0–300V	120MA	6·3V 4A 5/6·3V 1A	4 × 3¾ × 3¾in	46/2	9/-
MT33AT	300–0–300V	150	6·3V 4A 5/6·3V 1A	4 × 4 × 3½in	59/4	9/-
MT2AT	350–0–350V	80	6·3V 3·5A 5/6V 1A	4 × 3½ × 3¾in	38/6	6/-
MT7	350–0–350V	100	6·3V 3·5A 5/6·3V 1A	4 × 3½ × 3¾in	42/4	6/-
MT8	350–0–350V	120	6·3V 3·5A 5/6·3V 1A	4 × 3¾ × 3¾in	50/-	6/-

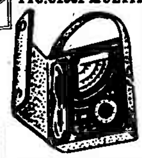
BATTERY CHARGER TYPES

Primary voltage 200–250V; secondary 6–12V

MT77	1A	2¾ × 2½ × 2¾in	1lb 6oz	15/-	(P. & P. 4/6)
MT45	1·5A	2¾ × 2¾ × 2¾in	1lb 9oz	21/9	(P. & P. 4/6)
MT46	2A	3½ × 2½ × 2¾in	2lb 4oz	25/4	(P. & P. 6/-)
MT47	3A	4 × 3 × 3¾in	3lb 8oz	28/4	(P. & P. 6/-)
MT5	4A	4 × 2¾ × 3½in	3lb 11oz	33/-	(P. & P. 6/-)
MT78	5A	4 × 3½ × 3¾in	5lb 4oz	42/-	(P. & P. 6/-)
MT86	6A	4 × 3½ × 3¾in	5lb 12oz	48/-	(P. & P. 6/-)
MT48	7A	4 × 4 × 3¾in	6lb	56/7	(P. & P. 9/-)
MT146	8A	3½ × 4 × 4in	6lb 4oz	75/-	(P. & P. 9/-)
MT49	9A	4¾ × 3¾ × 4in	7lb 8oz	99/-	(P. & P. 9/-)
MT147	10A	4¾ × 3½ × 4in	9lb 3oz	105/-	(P. & P. 9/-)
MT50	12·5A	5½ × 4½ × 4¾in	11lb 14oz	125/-	(P. & P. 11/-)

Amperages are d.c. with nominal selenium bridge rectifiers
MAINS ISOLATING RANGE also available

TTC.C1001 MULTITESTER in leather case. 20,000 opv. AC volts 10, 50, 250, 1,000V. DC. volts 5-25, 125, 500, 2,500V. D.C. Current 0–50μA, 0–250mA Resistance 0–60K, 0–6 Megohm. Decibels −20 to +22dB. Size of meter 4½ × 3¾ × 1in. **85/-.** P. & P. 3/6.



SHIRA 62D MULTI-TESTER 20,000 o.p.v.
DC voltage: 5-25-50-250-500-2·5K (20,000 ohms per volt). AC Voltage: 10-50-100-500 1000 volts (10,000 ohms per volt). DC Current: 0-50μA, 0-2·5mA, 0-250mA. Resistance: 0-6K, 0-6Mg (300 ohm and 30K at centre scale). Capacitance: 10pf. to ·001 mfd, ·001μf to ·1μF. Decibels: −20 to +22dB. Size 4½ × 3½ × 1in. Complete with case 77/-. P. & P. 3/6.

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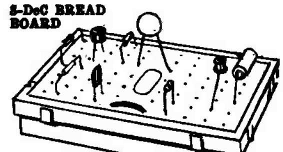

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COLD CATHODE TUBES

By J.B.Dance M.Sc.

ARC DISCHARGE TUBES

Cold cathode gas filled glow trigger tubes and their circuits were discussed last month. However, there are a number of other types of gas filled device which can be switched to the conducting state by the application of a triggering pulse to a starter electrode. Some of these tubes operate in the glow discharge region, whilst others operate in the arc region where a much greater current flows.

ARC DISCHARGE TUBES

The flash tube operates in the arc discharge mode, but can be used only under pulsed conditions. Flash tubes are used in stroboscopes, electronic flash equipment for photography, and in doped crystal lasers.

Some of the tubes used for stroboscopic purposes have an internal triggering electrode, whereas the triggering electrode of most types of flash tubes designed for photographic and laser applications consists of a wire secured to the outside of the tube.

Another type of arc discharge tube is used as a protective device; when the potential between the trigger and cathode of such a tube becomes much higher than normal, the tube fires and this prevents the voltage surge from damaging other equipment.

FLASH TUBES

The operation of a flash tube involves the rapid discharge of a capacitor through the tube. The basic circuit is shown in Fig. 4.1. Both the main capacitor, C1, and the triggering capacitor, C2, charge from the power supply through the resistor R1.

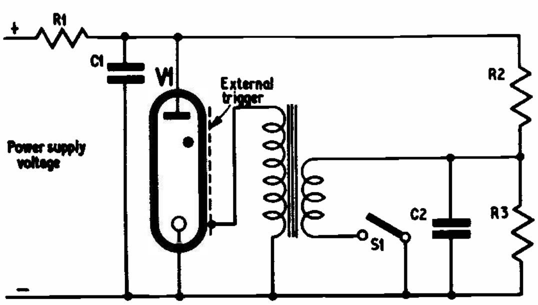


Fig. 4.1. A simple flash tube circuit

When they are adequately charged, switch S1 may be closed so that a pulse of current flows from C2 through the transformer winding. This results in a high potential (typically some kilovolts) being developed across the secondary winding of the transformer.

This high potential is applied to the external triggering electrode and distorts the electric field in the gas so much that ions are formed and the main discharge is initiated. The main capacitor, C1, then discharges through the flash tube.

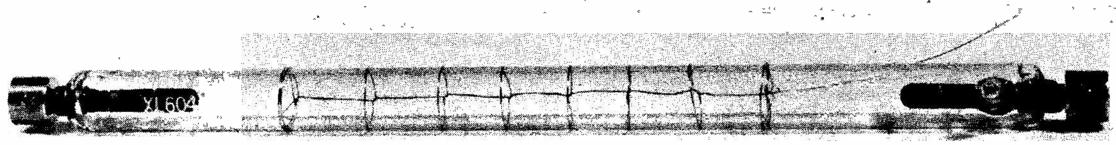
The energy stored in this capacitor is $\frac{1}{2}C_1V^2$ where V is the potential across it. If the potential across C1 before the flash occurs is V_1 and that after the flash is V_2, the energy given up by the capacitor is $\frac{1}{2}C(V_1^2 - V_2^2)$. The efficiency of such tubes is quite high.

A photographic flash tube is normally filled with either argon or with a mixture of krypton and xenon, since these gas fillings produce a flash which has a spectral energy distribution very similar to that of daylight. Although this energy distribution actually changes with time (becoming more red towards the end of the flash), the overall distribution is very similar to that of daylight.

Fairly long tubes are normally used for photographic and laser work, since this enables a greater efficiency to be obtained. In order that a reasonably long tube can be manufactured in a comparatively compact form, flash tubes are often manufactured in the form of a helix or a U-shape.

The duration of the flash from a tube is typically of the order of one hundred microseconds for tubes operating at a few kilovolts, but is about a millisecond for low voltage tubes. If the inductance and resistance in series with a high voltage tube is reduced to the absolute minimum, flashes of less than ten microseconds can be obtained.

The amount of power which can be passed to a tube is limited. If an excessive amount of power is dissipated in a tube, gas may be evolved from the walls of the tube or some parts of the tube may be damaged. The tube may then fail to operate when a further trigger pulse is applied.



English Electric flash tube type XL604 with the trigger electrode wire round the outside of the tube

STROBOTRON

The electrode structure of a typical flash tube designed for stroboscopic purposes is shown in Fig. 4.2. This type of tube employs an internal triggering electrode, G1, which consists of a wire entering the cup shaped cathode, K. The anode is some distance away from the other electrodes.

A positive potential (about 100 volts) is applied to G2. If a suitable negative going pulse (about 40 to 100 volts) is then applied to G1, the tube will fire. The current rises rapidly to about 5 amps, but the discharge ceases when the anode to cathode voltage falls to about 20 volts, this being the potential required to maintain the arc discharge.

Tubes of this type are known as "Neostrons" (Ferranti) or "Strobotrons" (Sylvania).

The arc discharge tubes discussed above cannot be operated in such a way that a continuous current flows, since such a current would damage them permanently. Another type of triggered tube known as an "Arcotron" was developed by the Cerberus Company of Switzerland in 1961.

Arcotron tubes can pass a continuous current of a few amperes and can be used to replace hot cathode thyratron tubes or thyristors. However, it is understood that these tubes are no longer recommended for use in currently designed equipment and they will not therefore be discussed further. A special type of arc discharge tube is being manufactured by the Cerberus Company for use in the ignition system of Wankel rotary engines.

GLOW THYRATRON

The glow thyratron, developed a few years ago, is very similar to the common trigger tube, but the discharge is initiated by the controlled introduction of ions from an auxiliary discharge into the main gap. The auxiliary discharge takes place continuously when the tube is operational, the introduction of the ions being controlled by the potential applied to a grid.

Glow thyratrons have the advantage that they require a very much smaller control voltage than normal trigger tubes, but their input impedance is much smaller. They are therefore especially suitable for use with transistor circuits. Glow thyratrons have pure metal cathodes and therefore the tubes have close tolerances, a long life and are very reliable when correctly used.

The electrode structure of the glow thyratron is shown in Fig. 4.3. The auxiliary discharge takes place between the auxiliary cathode, denoted HK ("Hilfskathode"), and the main cathode K. The auxiliary cathode HK is normally connected via a current limiting resistor to a source of negative potential and the main cathode (which is usually at approximately earth potential) acts as the anode for the auxiliary discharge.

Some electrons from the auxiliary discharge penetrate through a hole in the cathode into the space between the latter and the grid, G. In this space the electric field strength is a function of both the grid and the anode voltages.

If the grid is sufficiently negative with respect to the cathode, the electrons passing through the hole in it are quickly decelerated and return to the cathode. If, however, this negative grid voltage is reduced, the electrons are accelerated by the field from the anode (which, to some extent, penetrates through the holes in the grid). They therefore pass into the grid-anode space and create ions by the avalanche effect discussed in previous articles. A discharge is thus initiated between the main cathode and anode.

As in the case of the trigger tube, the glow thyratron is not affected by changes of grid potential once it has been switched to the conducting state. The anode voltage must be reduced in order to return the tube to the initial state where the main gap is non-conducting.

FIRING CHARACTERISTIC

The firing characteristic of a glow thyratron is shown in Fig. 4.4. This curve shows the conditions required for main gap conduction in a tube, through which an auxiliary discharge current of 160μA is passing and which is being used in circuit with a 220 kilohm grid resistor. The curve does not apply once the main gap has been switched to conduction.

At points on the lower left parts of the graph the tube will not fire across the main gap. As the grid

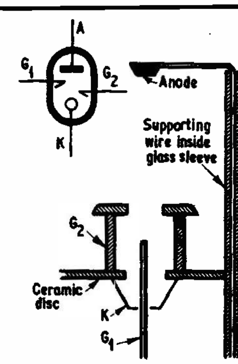


Fig. 4.2 (left). Sectional view through a stroboscope tube

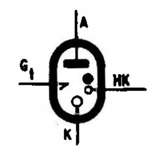
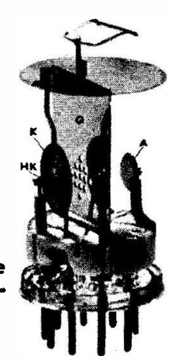


Fig. 4.3. Circuit symbol of a glow thyratron

Glow thyratron type GT21 (left)



Electrode structure of the glow thyratron (right)

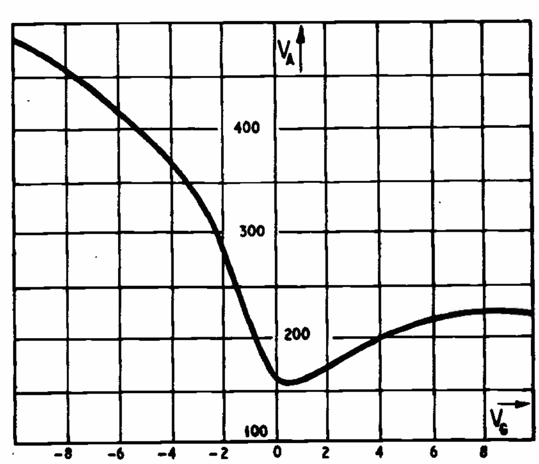


Fig. 4.4. Typical firing characteristic of a glow thyratron

voltage is made less negative at an anode potential of between 200 and 450 volts, the tube will fire as the operating point on the graph crosses the curve.

It is also possible to fire the main gap by increasing the anode voltage, but this has little practical application the anode voltage, but this has little practical application. At positive grid voltages, the firing characteristic rises again somewhat, since the electrons tend to pass to the grid instead of to the anode.

There are some small tolerances in the actual position of the firing characteristic from tube to tube, variations of up to 1 volt in the grid potential required to fire the tube being permissible. Temperature effects on the firing characteristic are generally fairly small (less than 0·5 volt change in the grid potential at which firing occurs over the range −30 to +90 degrees C).

However, if the glow thyratron becomes hot due to a fairly large anode dissipation, the grid voltage must be reduced a little more than normally before the tube can

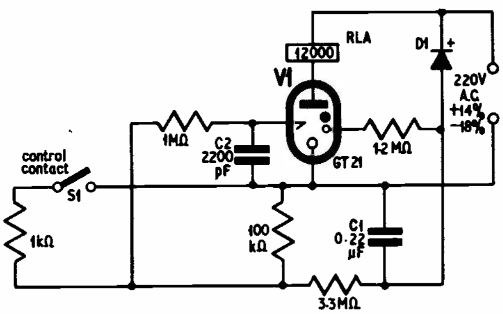


Fig. 4.5. A glow thyratron used to control a relay

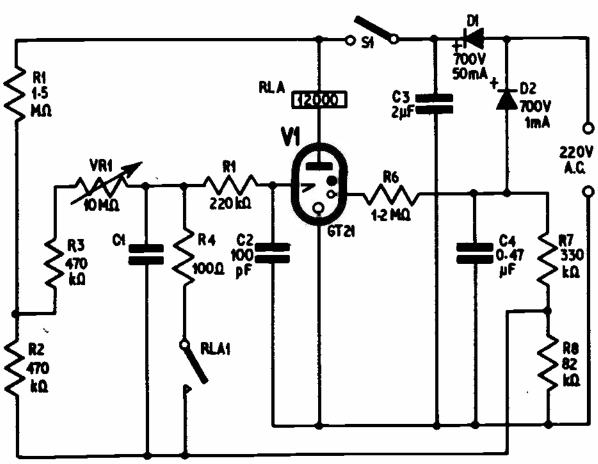


Fig. 4.6. Delay circuit using the thyratron

be made to conduct again. The magnitude of the auxiliary current has little effect on the firing point. However, the flow of grid current results in the firing point being dependent on the value of the grid resistor used.

The glow thyratron has the advantage of a short ionisation time, partly because ions are always present in the tube from the auxiliary discharge. When the grid of the tube is switched suddenly from −10 volts to zero, the typical ionisation time lies between 0·5 microsecond, for an anode supply voltage of 400, and 200 microseconds for an anode voltage of 200.

The deionisation time varies over a range of about 400 to 1,200 microseconds for anode currents of between 5 and 40mA and supply voltages in the range 300 to 400.

Some typical circuits published by the manufacturers of the glow thyratron are given below. The tube has been allocated the coding GT21.

RELAY CONTROL

The circuit in Fig. 4.5 may be used to operate a relay from a very sensitive pair of small contacts, which could not themselves pass the current required to operate the relay directly. Only a low voltage appears across the relay contacts and no sparking therefore occurs. Thus the amount of wear on the small contacts is negligible. Even if the contacts have a resistance of several thousand ohms, the circuit will function satisfactorily.

During the negative half cycles of the mains supply, a negative potential is applied to the tube anode, the diode D1 will conduct so that capacitor C1 becomes charged. During the next half cycle of the main supply voltage, when the anode of the tube is made positive with respect to the cathode, the grid is held negative with respect to the cathode by some of the charge from C1 which passes to C2. The tube does not therefore strike in the main gap.

Capacitor C1 also supplies the current required by the auxiliary cathode HK via the 1·2 megohm current limiting resistor.

When the control contacts are closed, the grid potential becomes little different from that of the cathode potential owing to the resistance values employed. Thus the glow thyratron fires on the half cycles of the mains supply voltage during which its anode is positive.

The use of the alternating mains supply voltage in this way ensures that the tube is extinguished at the end of each half cycle and also eliminates the cost of a mains transformer. However, it must not be forgotten that one of the contacts is connected directly to one side of the mains. An isolating transformer must be used if the contacts are likely to be touched by a person or an earthed object.

The current passing through the relay consists of half-wave rectified pulses at the mains supply frequency. In order that the relay contacts shall not "chatter", the relay should contain a suitable number of shorted turns. Alternatively a capacitor of value about 1μF may be connected across the relay to supply a current during the half cycles when the tube is not conducting.

The voltage across the open contacts cannot exceed 13 volts and the maximum current which passes through the contacts is 100μA. The open contacts should have an insulation resistance of not less than 0·5 megohm.

A DELAY CIRCUIT

A circuit for producing time delays is shown in Fig. 4.6. When the control contacts S1 are closed, capacitor C1 commences to charge via the resistor chain. When the potential across C1 is great enough, the glow thyratron tube fires on each half cycle of the mains supply voltage during which its anode is positive with respect to its cathode.

The time delay may be altered by changing the value of C1 or VR1, since this alters the time required for C1 to charge to the firing voltage. The contacts RLA1 are used to discharge capacitor C1.

As in the case of the circuit in Fig. 4.5, the auxiliary cathode negative supply voltage and the quiescent negative grid potential are obtained by half-wave rectification of the mains supply by means of diode D2.

COINCIDENCE CIRCUIT

A simple coincidence circuit is shown in Fig. 4.7. The glow thyratron is in the non-conducting state if one or more of the inputs A, B or C is at zero volts with respect to the cathode, owing to the negative potential applied to the grid of the tube via R3. If, however, all of the inputs are at a positive potential of not less than 6V (at input impedances of not more than 15 kilohms) the tube fires and the relay is energised.

This type of circuit may be used with a counting circuit to form a batch counter, which initiates an operation at any pre-determined number of counts.

PHOTOELECTRIC CONTROL

The circuit in Fig. 4.8 may be used when it is desired to energise a relay when the light falling on a photodiode increases above a certain level. As the light intensity falls, the circuit will cause the relay to be de-energised again. However, the circuit incorporates a "switching interval", that is the level of illumination at which the relay becomes de-energised is less than that at which it becomes energised. This avoids the possibility of the circuit repeatedly switching itself on and off as the level of illumination rises and falls by very small amounts.

The diode D1 ensures that the grid of the glow thyratron never becomes appreciably positive. The diode D2 provides a half wave rectified supply for the auxiliary cathode and the grid bias voltage to hold the tube in the non-conducting state.

In the circuit in Fig. 4.8, the photocell X1 has a high resistance when the level of illumination is low. A negative potential is therefore applied to the grid of the glow thyratron. When light falls onto the photocell, however, its resistance falls to a value which is much smaller than that of the 6·8 megohm resistor in series with it. Thus the voltage across the cell (and hence the grid to cathode voltage) becomes small and the tube fires.

The photodiode used should pass a dark current of not more than 25 microamps and when illuminated should pass not less than 50μA. Suitable diodes are the Texas H11 or the Siemens TP51 II. The diode D1 should have a peak inverse voltage rating of at least 50 volts and a maximum reverse current of 5μA. The Texas 1S130 or the Mullard OA200 are suitable. The diode D2 should have a peak inverse voltage rating of at least 700 volts and should be able to pass a forward current of 5mA.

The relay should have a suitable number of shorted turns or alternatively a suitable capacitor must be placed across it. The switching interval may be eliminated by connecting the relay between points 1 and 2 and by short-circuiting the points 3 and 4 (Fig. 4.8).

If it is desired to use the circuit for switching at relatively high levels of illumination, R3 and R2 should be reduced in value.

ELECTRONIC TOUCH BUTTON

The GK11 electronic touch button is another unique type of trigger tube. It is operated by the touch of a person's finger on an external trigger electrode, which is attached to the outside of the tube. It may, for example, be used as a touch button for calling a lift.

When the appropriate touch button is touched, the tube is switched to the conducting state and remains illuminated until the anode to cathode voltage is reduced below the maintaining voltage for this gap which, in the case of a lift call button, would occur when the lift arrived at the floor in question. Touch buttons can also be used in various types of instruments.

The construction of the GK11 is shown in Fig. 4.9. The tube itself contains an internal anode and cathode, the trigger electrode being connected to the touch plate by means of a small spring.

A high resistivity transparent material such as polythene must be employed between the touch plate and the front mounting panel. The red glow from a conducting tube passes through this material which acts as a lens.

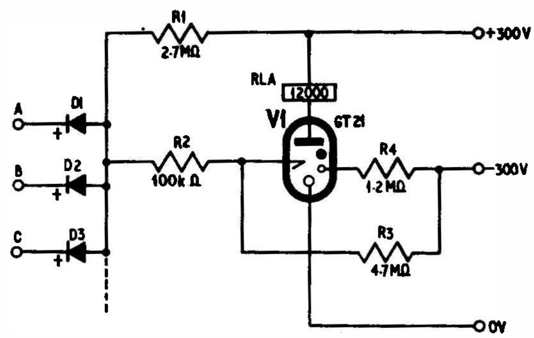


Fig. 4.7. Thyratron coincidence circuit

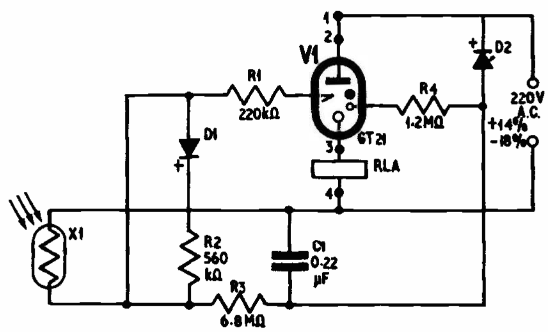
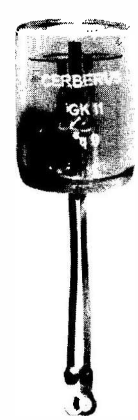


Fig. 4.8. The relay is energised when the photocell is illuminated



Touch button type GK11

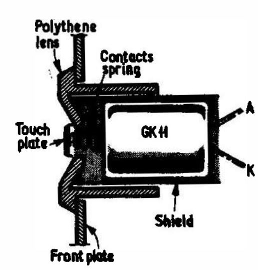


Fig. 4.9. Section of a touch button housing

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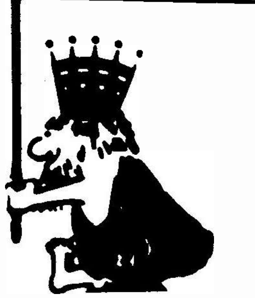

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CIRCUITS

The basic circuit for the electronic touch button is shown in Fig. 4.10. The tube does not strike when nothing is touching the touch plate, since the rectified mains voltage is below the striking voltage of the main gap of the tube.

If a person's finger is placed on the touch plate, however, a capacitive current passes between the cathode and the touch plate. Enough ions are formed to initiate a discharge in the main gap and hence energise the relay. The tube can control an anode current of over 10mA.

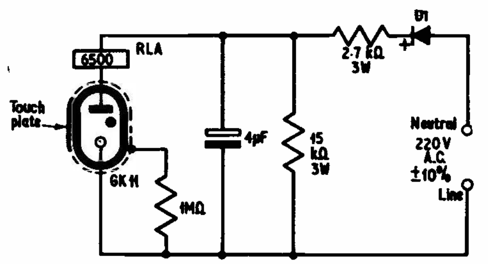


Fig. 4.10. The touch button controls a relay

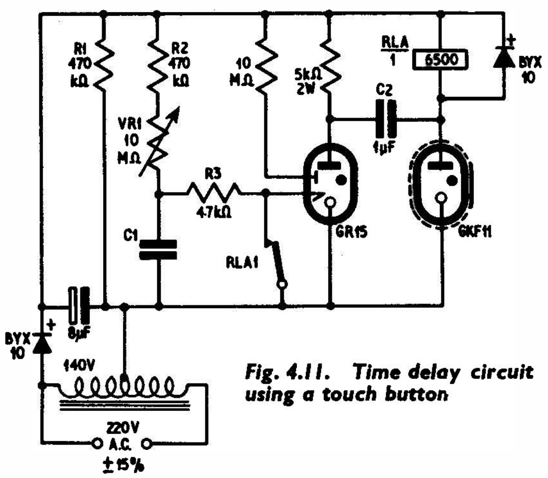


Fig. 4.11. Time delay circuit using a touch button

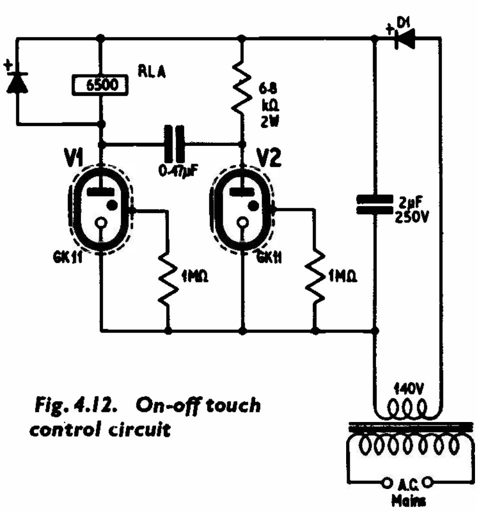


Fig. 4.12. On-off touch control circuit

Even if the person touching the touch plate is wearing gloves, the capacitance can exceed 5pF; this is quite adequate to cause the tube to fire. Any earthed object or any object with a large capacitance to earth can be used to cause the tube to strike.

Once the tube has fired, the touch plate will have no further effect. The anode voltage must be reduced in order to cause the tube to return to the non-conducting state. This may be accomplished by interrupting the anode current by a switch, by operating the tube from an alternating supply, or by extinguishing the tube with the aid of a second touch button (or other trigger tube) arranged in a bistable circuit. This last method is illustrated in Figs. 4.11 and 4.12.

TIME DELAY CIRCUIT

When the GKF11 assembly in Fig. 4.11 is touched, the relay will be energised and the GKF11 will glow for a predetermined time interval, after which the GR15 tube will ignite and the GKF11 will be extinguished. The relay may be used to carry out any desired operation.

When the GKF11 is touched and fired, a negative going pulse appears at its anode and is applied via C2 to the anode of the GR15 trigger tube. The latter is extinguished by the pulse. Contacts RLA1 are part of the relay and open when the relay is energised. Capacitor C1 commences to charge via the resistor chain.

After the preset time interval, the potential across this capacitor is great enough to cause the GR15 tube to fire. A negative pulse appears at the anode of this tube and is applied to the anode of the GKF11 via C2. The GKF11 is thus extinguished, the relay de-energised, and the circuit returned to its initial state. Contacts RLA1 close so that C1 discharges through R3.

The time for which the relay is energised is determined by the charging time of capacitor C1. This depends on the value of C1 and the setting of VR1. For a given value of C1, alteration of the resistor setting will change the time interval by a factor of up to ten. The time for which the relay is energised is given by the approximate formula:

$$t = 1{\cdot}1(0{\cdot}47 + R)C_1$$

where R_v is the value of the variable resistor VR1 in megohms and C_1 is in microfarads.

"ON/OFF" TOUCH CIRCUIT

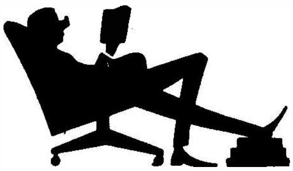
The circuit in Fig. 4.12 is a bistable touch operated circuit, whereas that in Fig. 11 is a monostable one. When either of the touch button tubes in Fig. 4.12 is touched, that tube will conduct (if it is not already in the conducting state) and the other tube will be extinguished.

When the tube V1 is touched, the relay will be energised and will remain energised until the V2 is touched. The state of the circuit is shown by the glow emitted from the tube which was touched last. When one tube is switched to the conducting state, a negative pulse is developed at its anode which is passed through the anode coupling capacitor to extinguish the other tube.

OTHER DEVICES

Many other types of triggered tube are available, including those for protecting equipment from high voltage surges. However, it is felt that the types discussed above are those of direct interest to the amateur experimenter.

Next month: Decade counting tubes



BOOK REVIEWS

SOLDERING HANDBOOK

By B. M. Allen
Published by Iliffe Books Ltd.
120 pages, 8½in × 6in. Price 45s.

THE AUTHOR of this "practical manual for industry and laboratory" is senior works chemist at Multicore Solders Ltd., and this immediately stamps the work with authority. This most comprehensive and up-to-date book on the subject of soldering is divided into three parts. Part One is intended for the operator and deals with making a joint. All the essentials are here in word and diagram, and to hammer home the vital points, these are spelt out in capitals at the end of each section. Part Two is intended for the designer and engineer and it enlarges on methods and materials (i.e. solders and fluxes) for particular jobs. Part Three comprises a collection of data concerning materials and specifications.

Soldering is a subject generally taken much for granted. Yet, seemingly, thousands of people must be guilty of adopting undesirable methods—quite unwittingly! For example: in dealing with electronic circuit assembly, and emphatic warning is given against the use of "side-cutters" when shortening wires after soldering. We are told that the pinching action of these cutters may seriously damage the component or weaken a soldered joint. The recommendation is that if wires *must* be cut after soldering, then cutters with a shearing action like the Bib stripper should be used. Perhaps this is aimed specifically at industrial operators. No doubt in vital apparatus destined for a trip into space, this question of shock or stress on wires or components, however minute, may be a very serious matter.

This example does illustrate the thoroughgoing techniques preached by this book. It sets out to describe the perfectionist approach. If the methods given are followed, then the overall reliability of electronic equipment must be greatly enhanced.

F.E.B.

THE ELECTRONIC MUSICAL INSTRUMENT MANUAL

By Alan Douglas
Published by Sir Isaac Pitman & Sons Ltd.
372 pages, 8¾in × 5½in. Price 55s

APART from the theramin, no novelty instruments are contained in this handbook. It is really about electronic organs written by a man whose name is synonymous with this subject and who, of course, designed the P.E. Organ. Whilst this singularity of choice might belie the title, there is a very good reason, for it is in the electronic organ that we find the circuits of tonal synthesis of almost every instrument including the percussion family.

The first two chapters, which are short, deal appropriately enough with the physics of sound and music. From here on, the treatment is entirely electronic in the dissection and presentation of organ circuitry.

In common with most of the circuits in this handbook, practicality abounds. In the large chapter on the frequency generation, division and tone forming, there are many working examples, fully annotated, and featuring both valves and transistors as active elements. It might be added, besides the more conventional types of sine, square and sawtooth generators presented, there are the electromagnetic, electrostatic and photoelectric forms, all of which add up to a very comprehensive treatment of this fascinating subject.

In the subject of division, passive tone forming and amplification, the same liberality of example abounds, and in consequence the complete tyro will experience no qualms when attempting the copius chapter—Commercial Electronic Instruments, where complete console inset circuits, bearing such resounding pedigrees as Hammond, Wurlitzer and Baldwin are available for inspection, backed up by a very informative text.

A final chapter on experimental methods departs from the essentially commercial orientated subject matter, and presents the reader with some guidelines in experimental techniques, both in tone production and realisation.

The handbook is made complete with useful appendices, glossary and bibliography.

G.G.

QUESTIONS AND ANSWERS ON COLOUR TELEVISION

By J. A. Reddihough
Published by Newnes-Butterworths
108 pages, 6¾in × 4¾in. Price 10s

FOR THOSE about to embark on colour television servicing, or for the radio enthusiast wishing to broaden his knowledge, this pocket book is a valuable addition to the Newnes Q and A series. The contents are presented in easily understood terms with short explanations of colour derivation, separation, transmission reception, decoding and display.

It is adequately illustrated and has an index of terms, circuitry, and explanations. Difficulties in obtaining optimum colour resolution through convergence adjustments are described in a special chapter, with guidance on how one can set up the controls for best results.

A great deal of information is packed into this small book, none of which is superfluous to the knowledge required in understanding colour television.

M.A.C.

TAPE RECORDING YEAR BOOK—9th edition

Published by Tape Recording Magazine
88 pages, 9¼in × 6in. Price 10s 6d

BEING limited to only one branch of electronics, this Yearbook contains 30 pages of details of tape equipments. The remainder of the space is devoted to articles written by well-known authors, the law in relation to recordings, details of competitions, table of tape playing times, glossary of terms, and lists of tape recording clubs and manufacturers.

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25V	1·6	6·4	12·5	25	50	80
40V	1	4	8	16	32	50
64V	0·64	2·5	5	10	20	32
Price	1/4	1/3	1/2	1/-	1/1	1/2

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16V	250	400	640	1,000
25V	160	250	400	640
40V	100	160	250	400
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