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DEC. 76
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PART ONE

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Plus

INDEX

TO VOLUME 5

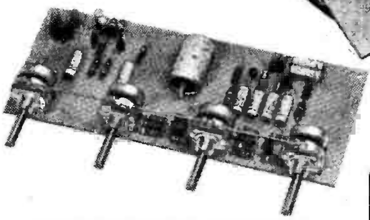
Stirling Sound

QV* MODULES FOR COST-CONSCIOUS CONSTRUCTORS

SS.140

40 watts r.m.s. into 4 ohms using 45V supply such as SS345. Ideal for small discos and P.A. 101 x 76 x 19mm (4" x 3" x ¾") **£3·95**

STIRLING SOUND policy is to ensure customer satisfaction by designing and making their products in their own factory in Essex and selling direct. Production control-checked throughout. All QV Modules are compatible within the range and with much other equipment.



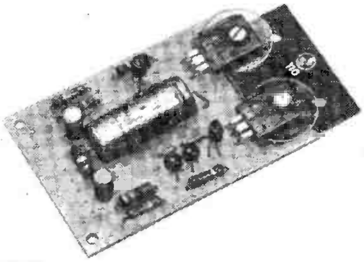
SS.100 Active tone control, stereo. ±15dB on bass and on treble **£1·60**

SS.101 Pre-amp for ceramic cartridges, radio, tape. Stereo. Passive tone control circuit shown in data supplied **£1·60**

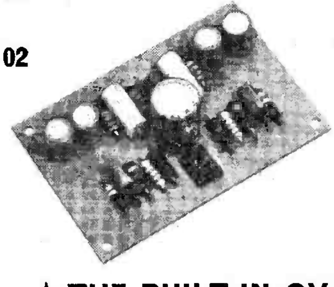
SS.102 Stereo pre-amp for low output magnetic P.Us. R.I.A.A. corrected. Linear feedback facility. **£2·65**

PRE-AMP/TONE CONTROL MODULES

Combined pre-amp with active tone-control circuits. ±15dB at 10Khz treble and 30 Hz bass. Stereo. Vol./balance/treble/bass. 200mV out for 50mV in. Takes 10-16V. **£7·80**



SS.110



SS.102

POWER AMPLIFIERS

SS.103 3 watt r.m.s. mono I.C. with built-in current, short, and thermal protection **£1·75**

SS.103-3 Stereo version of above **£3·75**

SS.105 5 watts r.m.s. into 4 ohms, using 12V **£2·25**

SS.110 10 watts r.m.s. using 24V and 4 ohm load **£2·75**

SS.120 20 watts r.m.s. into 4 ohms, using 34V **£3·25**

The above all measure 89 x 50 x 19mm (3½ x 2 x ¾ ins) Suitable power supplies will be found in the accompanying range.

FM TUNING MODULES

SS.201 Front end tuner, slow geared drive, two gang. A.F.C. facility. Tunes 88—108 MHz **£5·00**

SS.202 I.F. amplifier. Metering and A.F.C. facilities **£2·65**

SS.203 Stereo Decoder for use with the above or other FM mono tuners. A LED may be fitted **£3·85**

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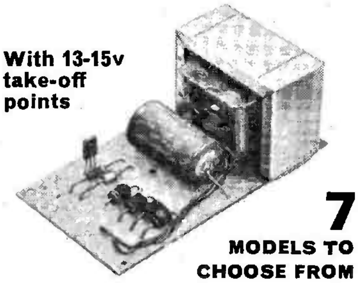
With 13-15v take-off points



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Complete with mains transformers and low volt take-off points. (except SS.300) All at 8% V.A.T. rate. Add 50p for p/p any model.

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SS.324	24V/1A	£4·60*
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SS.345	45/V2A	£6·25*
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SS.300 Power stabilising unit 10-50V adjustable for adding to unstabilised supplies. Built-in protection against short circuit (p/p 35p) **£3·25**

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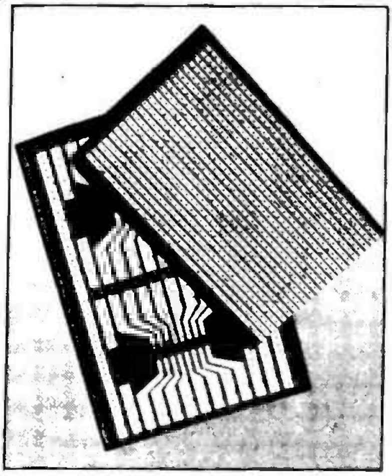
worth 30p



BLOB BOARDS

Circuit diagram to circuit board in minutes. Layout circuit plan on .1" graph paper. Select Blob Board, lay components out with leads on copper strip. Blob of solder onto lead and your circuit is complete. Blob Boards normally half price of competitive boards. Roller tinned to solder components directly. No drilling or mounting. Modifications in seconds. Blob Board is re-usable.

Blob Boards are circuit boards designed exclusively for the home constructor and prototype engineer and are normally half the price of competitive boards. Blob Boards are roller tinned for ease of soldering, most require no cutting or breaking of contact rails. HALF PRICE AND RE-USABLE. That is NEW!

Blob Board .1" or .15" All approx. inch sizes	1 off	3 off
ZB1V 2.5 x 5	£0.30	£0.75
ZB2V 2.5 x 3.75	£0.23	£0.57
ZB3V 3.75 x 5	£0.46	£1.14
ZB4V 10 x 6	£1.51	£3.78

Discrete Blob Board	1 off	3 off
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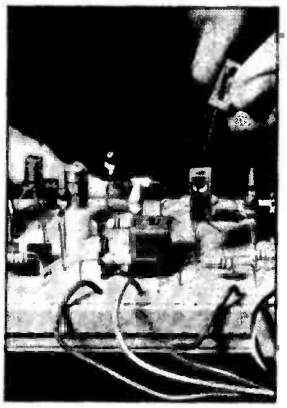
ZB6D 2.4. x 7.3	£0.42	£1.05
ZB7D 4.9 x 7.3	£0.69	£1.75
ZB8D 9 x 7.5	£1.62	£4.05

Dip Blob Boards	1 off	3 off
ZB11C 4.5. x 3	£0.36	£0.90
ZB21C 4.8. x 3.2	£0.40	£0.96
ZB41C 4.75 x 7.5	£0.85	£2.13
ZB81C 9.5 x 7.5	£1.70	£4.26

Sample pack: 1 off ZB1V + 1 off ZB8D + 1 off ZB21C normally £2.32 ohly £2.00 + free Blob Board.
Many other sizes and patterns available add 30p post + 8% VAT to all orders.

S-DeC

Take an S-DeC, take a small stock of components. Plug components into S-DeC, no soldering, make a radio receiver, light operated switch, 3 stage amplifier. When circuit is made unplug components and use them again to make a morse practice oscillator, LC oscillator, binary counter and any other discrete circuitry. See Practical Wireless for new series of S-DeC projects.
S-DeC + step by step instructions to build above projects and 3 more + which components to use + free control panel for mounting switches, lamps etc. + free Blob Board.
S-DeC only £1.98 + 37p (VAT + post) send only £2.35.



T-DeC

If you are using IC's to build circuits use T-DeC for 1 chip circuits and U-DeC A for 2 chip circuits. Draw circuit on graph paper, plug IC into Adaptor and plug into DeC. No soldering, no bent leads, no wasted IC chip. Lines on DeC show contact rails, plug discrete components in. Cross overs, connections are made using different coloured leads. Circuit completed and working unplug components and use for next circuit. No soldering, no damage to components. Use your DeC and small stock of components over and over again. T-DeC send £4.30. U-DeC "A" send £4.60. Adaptor send £2.30.

DRILL·SAW GRIND·BURR BRUSH·POLISH

PB announce a precision British built drill for the home constructor. Works better than most bigger drills and can be used for fine detailed work. Drills through any circuit board, need to break copper strip simply grind it off.
9000 RPM Drill + 20 Assorted tools £11.20 (+VAT + post) Send £13.00.
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Off cuts of fibre glass circuit board 5 sq. ft.	£1.50.
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Ferric chloride 5 litre mix	£2.00.
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Mr. John Evans Tel: 01-228 9227
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50µA (25–0–25µA) **EDGEWISE METERS**, modern type by Sangamo Western, display area ½ × 1½in with 2 mounting lugs (Can be zeroed left or right hand.) £1·50 each while stocks last.

MAINS ISOLATION TRANSFORMERS. Tapped mains input, 240V at 3A + 12V at 500mA output. New, boxed, made by Gardners, £12.

FLEXIBLE HEATER STRIP, 240V a.c., 150W, approx. 1 metre long (insulated with fibreglass) with mains connector block. Many, many uses. 80p each.

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110V NEONS, SCREW-IN-TYPE, 4 for 50p.

SLOW MOTION MOTORS (suitable for programmers, displays, etc.) 230–240V a.c. input, rotation, 1 rev. every two to three minutes, £1·25 each.

MINIATURE PLIERS High quality "Crescent" made in USA. £4·35 + VAT (35p).
SIDE CUTTERS, high quality, £3·70 + VAT in pairs 30p.

MIXED COMPONENT PACKS, containing resistors, capacitors, switches, pots, etc. All new (random sample bag revealed approx. 700 items). £2 per pack, while stocks last.

TUNED COILS, 2 section coils, around 1MHz, with a black smart tuning knob, which moves an internal core to vary the inductance, many uses, easily rewound, 3 for 50p.

HIGH QUALITY SPEAKERS, 8½in × 6in elliptical, only 2in deep, inverse magnet, 4 ohms, rated up to 10W. £1·50 each, or 2 for £2·75 (qty. discount available + 12½% VAT.

PROGRAMMERS (magnetic devices). Contain 9 microswitches (suitable for mains operation) with 9 rotating cams, all individually adjustable, ideal for switching disco lights, displays etc., or industrial machine programming (Need slow motion motor to drive cams, not supplied) 9 switch version £1·50.

HEAVY DUTY HEATSINK BLOCKS, undrilled, base area 2½in × 2in, with 6 fins, total height 2½in 50p each.

SPERRY 7-SEGMENT P.G.D. DISPLAYS, digit height 0·3in red, with decimal points, 150V to 200V (nominal 180V) operation. These are high-volt industrial type and therefore brighter than normal displays. All brand new. AT THE BARGAIN PRICE OF 50p PER DIGIT. TYPE 332 (two digits in one mount) £1 each, TYPE 333 (three digits on one mount) £1·50. (Sorry, no single digit available.) Data Supplied.

BSX20 (VHF Osc/Mult), 3 for 50p.
BC108 (metal can), 4 for 50p.
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SMALL MAINS SUPPRESSORS (small chokes, ideal for radio, Hi-Fi inputs, etc.) approx. ½in × 1½in, 3 for 50p.

PERSPEX TUNER PANELS (for FM Band 2 tuners) marked 88-108 MHz and Channels 0-70, clear numbers, rest blacked out, smart modern appearance, size approx. 8½in × 1½in, 2 for 35p. Lead suppressors (10kohm) for mobile plug leads, 4 for 50p.

HEAVY DUTY RELAYS, 24V d.c. operated (will work on 18V) 3 heavy duty make contacts (around 10A rating) + 4 change over contacts + 1 break contact. New, complete with mounting bracket (ideal for switching HT on Linears.) Many uses for this high quality unit. £1·50 each.

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1½in polythene chassis mounting fuseholders, 6 for 30p.

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Dubilier Electrolytics, 50µF, 450V, 2 for 50p.
Dubilier Electrolytics, 100µF, 275V, 2 for 50p.
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TCC Electrolytics, 1000µF, 30V, 3 for 50p.
Plessey Electrolytics, 1000µF, 180V, 40p each (3 for £1).
Dubilier Electrolytics, 5000µF, 35V, 50p each.
Dubilier Electrolytics, 5000µF, 50V, 60p each.
ITT Electrolytics, 6800µF, 25V, high grade, screw terminals, with mounting clips, 50p each.
Plessey Electrolytics, 10,000µF at 63V, 75p each.
Plessey Cathodray Capacitors, 0–0·4µF at 12·5kV DC. Screw terminals £1·50 each.
PLEASE ADD 12½% VAT TO ALL CAPACITORS

A LARGE RANGE OF CAPACITORS AVAILABLE AT BARGAIN PRICES, S.A.E. FOR LIST.

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TV Plugs (metal type), 5 for 50p.
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Solent Mark II Stereo Tuner Amplifier chassis with AM/FM radio covering long medium short and Stereo FM wavebands. Separate Bass and Treble controls. 30 watts total power output (frequency response 25-20,000 Hz) AFC Switching Tape record and playback facilities. Dimensions 18½" x 9" x 3½". The very latest BSR automatic record deck with cue and pause control. Two matching elliptical speaker units.

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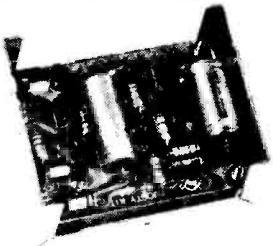
JOSTYKIT

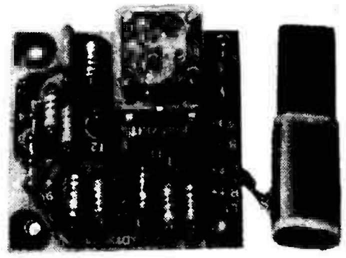
AF 300 3 WATT AUDIO AMPLIFIER



This is a 3 W complementary output stage, general purpose amplifier. Use it to boost the output from your record player, cassette recorder, transistor radio or drive it from one of the HF range of JOSTYKIT receivers. Try it with the HF 310 FM receiver in your car or boat. **£6·10**

JOSTYKIT

HF 61 DIODE MEDIUMWAVE RECEIVER



HF 61 is an extended diode receiver for mediumwave-reception. By means of a very simple technique a reasonable reception even from foreign medium stations is attained.
HF 61 is built on a small circuit board of the same size as the general purpose amplifier AF 380. The two assemblies should be connected to produce power for a loudspeaker. HF 61 is especially useful for beginners, who have not tried to assemble electronic kits before. **£4·30**

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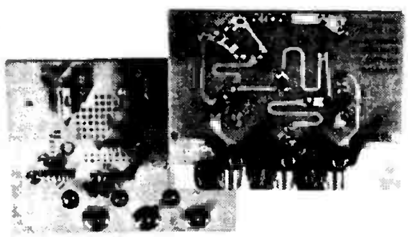

JOSTY KIT

A quality, printed circuit, no trimming, aerial amplifier. Fantastic frequency range due to use of printed coils, 21 dB amplification at 400 MHz. Two separate inputs for UHF and VHF. No loss of signal or intercommunication problems. **£5·80**

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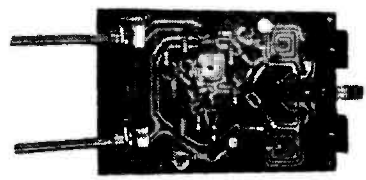

Extend the range of your transistor radio. Listen to Amateurs (2 metre band), Aircraft, Trawlers, etc. Two transistor circuit with printed circuit coils, varactor diodes and superior circuit design. Converts radio signals in the 100-200 MHz range to output signal at 100 MHz. Pipe this into your VHF receiver and you're in a new dimension. **£6·70**

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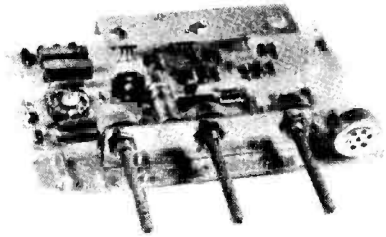
AT 365 3-CHANNEL DISCO LIGHT



A new concept in psychedelic lighting. Uses built-in microphone. Avoids awkward connections to amplifiers. Position light-show to best advantage without long trailing leads—just plug in to the nearest power point. Circuit combines latest integrated circuit techniques with solid-state power control. Quad op. amp. makes selection of bass, midrange and treble frequencies easy. Three thyristors (SCRs) control three separate lampbanks. Kit includes fused dc power supply and FET zero light adjustment. WARNING. Only experienced persons should attempt the interconnection of mains equipment. **£17·00**

JOSTYKIT

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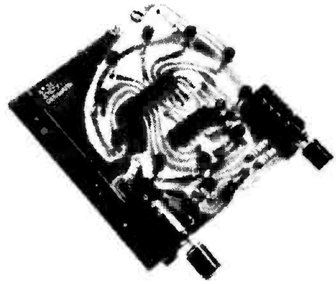

A set of exciting games for family and friends. In the home or in the pub they'll envy your electronics wizardry. Two integrated circuits provide a random number system. A 7490 counts the pulses and a 7442 decodes. The decoded outputs turn on a sequentially rotating L.E.D. light display. Your chance to try your hand with TTL digital electronics.
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All prices include VAT. Please add 25p Post and Packing.

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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 £3·45 including post & VAT. Made up model £1·00 extra.

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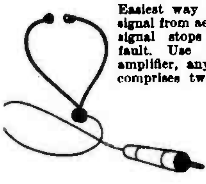
Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: main transformer rectifier, smoothing and load resistor condensers and instructions. Real snip at only £1·50 VAT & Postage 50p.



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, £2·95, twin stetho-set instead of earpiece. £1·00 VAT and postage incl.

MICRO SWITCH BARGAINS

Rated at 5 amps 250 volts, ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 for £1·00, VAT and post paid.

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With six 10 amp changeover switches. Multi adjustable switches are rated at 10 amp each so a total of 2000w's can be controlled and this would provide a magnificent display. For mains operating £4·25 post & VAT Paid. Ditto 9 switch £4·95 Post & VAT Paid. DITTO BUT 12 SWITCH £5·75 POST & VAT PAID.

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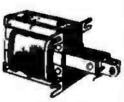
Ideal for chargers etc. 2" sq. full vision 0·8 amp 95p. 1½" *round* 0·2 amp 55p, 0·3 amp 65p. 0·4 amp 75p. Post & VAT 25p each.

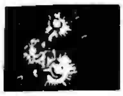
MAINS OPERATED SOLENOIDS



Model 772—small but powerful 1in. pull—approx. size 1¼ × 1¼ × 1½in., £1·00
Model 4001/—½in. pull. Size 2¼ × 2 × 14in. £1·50
Model TT1—1½in. pull. Size 3 × 2½ × 2in. £2·50
Prices include VAT & postage.

SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. £7·95 plus 95p VAT & Postage



RELAY BARGAIN

Type 600 relay with twin 500 ohm coils which may be joined in series or parallel thus relay will operate off voltages between 5 and 30 volts DC. Price 44p each, 10 for £4 post and VAT paid.

BATTERY CONDITION TESTER

Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese—nicad—silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace" "weak" or "good". The tester is complete in its case, size 3½" × 6½" × 2" with leads and prod. £4·50 post & VAT paid.

BATTERY CHARGER

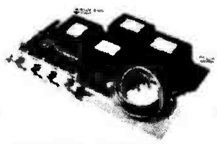
Famous Atlas in metal cas with meter, output lead terminated by crocodile clips. For 6 or 12V charging simply by changing plug on front panel. Ready built new and still £2·95 plus £1 Post & VAT

HONEYWELL PUSH BUTTON PANEL MOUNTING MICRO SWITCH

1-2-3 Bank, each Bank consisting of the changeover micro switch rated at 10 amps 250 volts. Through panel fixing by 2 lock nuts complete with black 1" diameter knob. Prices:—1 bank 40p—2 bank 55p—3 bank 70p.

MULLARD UNILEX

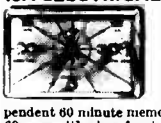
A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost any one in easy-to-assemble modular form and complete with a pair of Celestion speakers normally £8. This should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16·50 including VAT and postage.



TANGENTIAL HEATER UNIT

This heater unit is most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. Comprises motor, impeller. 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only needs control switch. £5·83 plus VAT & post £1. 2kW Model as above except 2kW £4·25 plus VAT & post 75p. Don't miss this. Control Switch 44p. P. & P. 40p.

ISA ELECTRICAL PROGRAMMER



Learn in your sleep; Have radio playing and kettle boiling as you wake—switch on lights to ward off intruders—have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 15 amp. on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price £2·95, VAT & Postage 60p, or with glass front, chrome bezel, £1·50 extra.

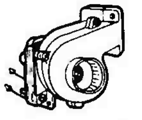
ROOM THERMOSTAT

Famous Satchwell, elegant design, intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0-30°C. Special snip this month £2·50, post and VAT paid.

MINI ORGAN
SCRABBLE TIMER

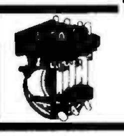
To receive parts for the projects featured this month, send the estimated price + 40p post. Any cash adjustment can be made later.

CENTRIFUGAL BLOWER



Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quick running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4½" × 4½" × 4". When mounted by flange, air is blown into the equipment but to suck air out, mount from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing flux smoke when soldering etc. etc. A real bargain at £3·30. 60p post & VAT.

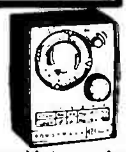
THIS MONTH'S SNIP



MAINS RELAYS

With triple 10 amp changeover contacts—operating coil wound for 230 volts AC, chassis mounting, one screw fixing, ex unused equipment 60p each, 10 for £5 post and VAT paid.

HORSTMANN 24-HOUR TIME SWITCH

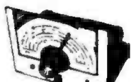


With 6 position programmer. When fitted to hot water systems this could programme as follows:

Programme	Hot Water	Central Heating
0	Off	Off
1	Twice Daily	Off
2	All Day	Off
3	Twice Daily	Twice Daily
4	All Day	All Day
5	Continuously	Continuously

Suitable, of course, to programme other than central heating and hot water, for instance, programme upstairs and downstairs electric heating or heating and cooling or taped music and radio. In fact, there is no limit to the versatility of this Programmer. Mains operated. Size 3in × 3in × 2in deep. Price £5·50. 80p Post and VAT. as illustrated but less case

SHORTWAVE CRYSTAL SET



Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 31, 29 metre bands. Kit contains chassis, front panel and all the parts £1·90—crystal earphone 55p including VAT and postage.

PAPST MOTOR

West German make, these fine motors are noted for their performance and reliability. Special features are the rotating heavy outer which acts as a flywheel to eliminate wow and flutter and switchable reversing.

We have four types in stock, all 1350 revs., including starting capacitor.

(1) Reference No. KLZ 20.50-4, 230 volts 50HZ, price £5·50
(2) Reference No. KLZ 32.50-4, 230 volts 50HZ, price £6·50
(3) Reference same as above, 115 volts 50HZ, price £2·50
(4) Reference same as above, 110 volts 60Hz, price £2·50
Post and VAT 80p each extra.

PANEL METER SNIP

Japan made 2" × 1¾" full vision flush mounting, 100uA f.s.d.—scale engraved DB easily changeable as perspex cover simply clips on. A real snip £1·75 post and VAT paid, or 10 for £15 post and VAT paid.

TERMS: Where order is under £5 please add 40p surcharge to offset packing expenses

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 103 TAMWORTH ROAD,
CROYDON CR9 1SG.

ITS FREE!

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—its an interesting list and its free—just send S.A.E. Below are a few of the Bargains still available from previous lists.

Spit motor with Carter gear box. Probably one of the best spit motors made. Originally intended to be used in very high priced cookers: however, this can be put to plenty of other uses, for instance your garden barbecue or to drive a colour disc for a dance or display or to drive a tumbler for stone polishing; in fact, there is no end to its uses. Normal mains operation. Special price during May and June £2·50 + 20p, post 30p + 2p.

Pulse transformer with circuit for sound to light unit. It is a very simple circuit and all parts are readily obtainable from us or you may already have them in your junk box. Price of the transformer with circuit 75p, post and VAT paid.

ORP 12 light cell. This device has been going for some years now but it has not been bettered and new applications keep being found for it. We have good stocks, price 65p + 5p.

Throat mikes. These are an ex WD item as used by air crew on their intercom, but being electro-magnetic they also serve as pick-ups on musical instruments, talking to passengers on motor bike and no doubt many other use. Price 60p a pair + 15p.

12½ watt speaker bargain, 8" round mid-range, made for high price hi-fi outfit, a really super speaker, £3 + 37p, post 60p + 15p.

O.C.P. photo transistor by Mullard, very popular for circuits such as infra-red burglar alarms, smoke detectors, etc. A big buy enables us to offer at the very favourable price of 25p each — 2p, or 5 for £1 + 8p.

Component boards, mainly ex computer, these contain many useful parts and represent fantastic value at 5 for £1 + 8p. We guarantee the 5 would be different. You would receive ICs etc., variable controls with long leads and so are easy to remove and re-use. Post 50p – 4p.

Microswitch bargain, made by Pye, Honeywell, Burgess and similar first class makers originally for the Post Office, in fact they have been fitted to Post Office Equipment which was never put into use. They are a changeover microswitch with 10 amp contacts offered at the very low price of 20 for £1 + 8p. Post 40p + 3p.

Ferrite pot core (Vinkor) made by Mullard, maker's ref. No. LA 14107402K, circular, size approx. 1½" x ⅞", a size which is the same as the one specified for the Scorpio car ignition system. Price only 50p + 4p per pair. Post 15p + 1p.

12v DC motor made by Smiths, powerful, ideal for car blower; motor size 4" long x 3" diameter, ¼" spindle, 1¼" long. £2. + 16p. Post 40p + 3p.

Thermostat with capilliary with sensor joined by approx. 1 metre of capilliary covering the temperature range 0-170°C capable of switching 16 amps at 250v. Made by the famous Ranco Company with screwed thread and spindle rather like a volume control—has dozens of applications. Offered at only 75p + 6p. Post 12p + 1 p.

Aerials. For medium and long wave, wound and fitted on ferrite rod, 6" long by ¼" diameter. Price 60p + 15p Post 10p + 5p.

Dial thermometer by Rotatherm, indicates from 50F to 250F, dial size 3½", chrome and glass front. 75p + 6p. Post 10p + 1p.

Instrument Mains Transformer, 6·3v at ½ amp and 115v at 100mA. This is an upright mounting open construction, small size (2½ x 2¼" x 2¼"). Price £1·40 + postage and VAT 60p. DITTO. 6·3v at 1 amp and 150v at 200mA. This is a fully shrouded upright mounting transformer, size approx. 2½" x 3" x 3". Price £1·95 + post and VAT 88p.

Instrument power supply mounted on a chassis size 9½ x 2½" x 4½". This is suitable for instruments which use valves and has AC output of 6·3v at 1 amp and a fully smoothed DC outputs of 150v and 200v. Price £2·50 + post and VAT 74p.

FM Band amplifier. This is a 4 valve amplifier tunable to cover FM and nearby frequencies. Tuning is by lecherlines in fully screened compartments and the whole is mounted on a heavy metal chassis size 9" x 2" x 2½" x 5". This requires a separate power supply of 150v DC at 100 mA and 6·3V at 1 amp. Price £3·75 + post and VAT £1·58.

Instrument case, grey steel finish size 9½" x 3½" x 2½". These cases are not secondhand but come from partly assembled equipment, so the front panel has a few holes already punched through. However, these are very suitable for toggle switches, etc. There are no really big holes, 50p each + post and VAT 36p.

Clock switch for Tricity cooker, made by Smiths and probably a replacement in many other cookers. This has clock in the centre and the two controls switches on the right-hand side. The top control switch sets the on-off times and is infinitely adjustable over the 12 hours; the lower switch selects manual or automatic No glass front, but you could take this off your existing clock. Price £1·75 each + post & V.A.T. 35p.

SMITHS 24-HR TIMER HEART

really the "Autoset" without its plastic case. This is a 24 hr twice on, twice off, clock switch which will repeat until re-programmed. Switches rated at 15 amps. Limited supplies. PRICE £4·45 INCL. POST & VAT.

SEMI-CONDUCTORS

TRANSISTORS

BRAND NEW FULLY GUARANTEED

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC117K	*0·30	AF178	*0·51	BC169	0·10	BC440	*0·31	BF117	*0·46	BFY53	*0·13	OC75	*0·18	2N706	*0·08	2N2646	*0·34	2N3703	0·09
AC126	*0·18	AF179	*0·51	BC169C	0·10	BC460	*0·37	BF118	*0·71	BSY19	*0·18	OC76	*0·16	2N706A	*0·09	2N2904	*0·14	2N3704	0·08
AC126	*0·14	AF180	*0·51	BC170	0·09	BD115	*0·83	BF119	*0·71	BSX20	*0·16	OC77	*0·26	2N708	*0·11	2N2904A	*0·18	2N3705	0·08
AC127	*0·11	AF181	*0·51	BC171	0·09	BD116	*0·81	BF152	0·56	BSY25	*0·16	OC81	*0·18	2N914	*0·15	2N2905	*0·18	2N3706	0·08
AC128	*0·11	AF186	*0·51	BC172	0·09	BD121	*0·81	BF153	0·46	BSY26	*0·16	OC81D	*0·18	2M918	*0·18	2N2905A	*0·18	2N3707	0·08
AC128K	*0·26	AF239	*0·38	BC173	0·09	BD123	*0·67	BF154	0·40	BSY27	*0·16	OC82	*0·16	2N1131	*0·18	2N2906	*0·12	2N3708	0·08
AC141	*0·19	AL102	*0·75	BC174	0·15	BD124	*0·70	BF155	*0·71	BSY28	*0·18	OC82D	*0·16	2N1132	*0·18	2N2906A	*0·14	2N3709	0·08
AC141K	*0·80	AL103	*0·75	BC175	*0·22	BD131	*0·36	BF156	*0·49	BSY29	*0·16	OC83	*0·20	2N1302	*0·15	2N2907	*8·15	2N3710	0·09
AC142	*0·19	BC107	*0·08	BC177	*0·16	BD132	*0·40	BF157	*0·56	BSY38	*0·19	OC139	*0·20	2N1303	*0·15	2N2907A	*0·10	2N3711	0·09
AC142K	*0·26	BC108	*0·08	BC178	*0·16	BD133	*0·67	BF158	0·56	BSY39	*8·19	OC140	*0·23	2N1304	*0·18	2N2923	0·15	2N3819	*0·14
AC153K	*0·24	BC109	*0·08	BC179	*0·16	BD135	0·41	BF159	0·61	BSY40	*0·29	OC169	*0·26	2N1305	*0·18	2N2924	0·15	2N3820	*0·40
AC176	*0·11	BC113	0·10	BC180	*0·25	BD136	0·41	BF173	*0·15	BSY41	*0·29	OC170	*0·26	2N1306	*8·21	2N2925	0·15	2N3823	*0·16
AC176K	*8·26	BC114	0·16	BC181	8·25	BD137	0·46	BF176	0·36	BSY95	*0·13	OC171	*0·26	2N1307	*0·21	2N2926G	0·09	2N3903	0·12
AC180	*0·20	BC115	0·16	BC182	0·09	BD138	0·51	BF179	*0·31	BSY95A	*0·13	OC200	*0·26	2N1308	*0·24	2N2926Y	8·09	2N3904	0·12
AC180K	*0·30	BC116	0·16	BC182L	0·09	BD139	0·56	BF180	*0·31	BU105	*1·90	OC201	*0·29	2N1309	*0·24	2N2926O	0·08	2M3905	0·14
AC181	*0·20	BC117	0·19	BC183	0·09	BD140	0·61	BF181	*0·31	MJE521	*0·56	OC202	*0·29	2N1613	*0·16	2N2926R	0·07	2N3906	0·14
AC181K	*0·30	BC118	0·09	BC183L	0·09	BD155	*0·81	BF194	0·10	MJE2955	*0·88	OC203	*0·26	2N1711	*0·16	2N2926B	0·67	2N4287	0·18
AC187	*0·17	BC119	*0·31	BC184	0·09	BD175	*0·61	BF195	0·10	MJE3055	*0·57	OC204	*0·26	2N2147	*0·73	2N3053	*0·15	2N4288	0·18
AC187K	*0·23	BC120	*0·81	BC184L	0·09	BD176	*0·61	BF196	0·92	MJE3440	*0·51	OC205	*0·38	2N2148	*0·58	2N3054	*0·40	2N4289	0·18
AC188	*0·19	BC137	0·16	BC186	*0·29	BD177	*0·67	BF197	0·12	MPF102	*0·28	OCP71	*0·44	2N2218	*0·18	2N3055	*0·46	2N4290	0·10
AC188K	*0·23	BC139	*0·41	BC187	*0·29	BD178	*0·67	BF198	0·12	MPF104	*0·28	ORP12/		2N2218A	*0·19	2N3402	*0·21	2N4291	0·18
AD140	*0·49	BC140	*0·31	BC207	0·11	BD179	*0·71	BF199	0·12	MPF105	*0·28	NSL4931	*0·48	2N2219	*0·18	2N3403	*0·21	2N4292	0·18
AD142	*0·55	BC141	*0·31	BC208	0·11	BD180	*0·71	BF257	*0·28	OC19	*0·36	ORP60	*0·41	2N2219A	*0·19	2N3404	*0·29	2N4293	0·18
AD143	*0·49	BC142	*0·31	BC209	0·12	BD185	*0·67	BF258	*0·36	OC20	*0·80	ORP61	*0·41	2N2220	*0·22	2N3405	*0·43	2N5172	0·12
AD149	*0·45	BC143	*0·31	BC212	0·10	BD186	*0·67	BF259	*0·46	OC22	*0·47	TIP29	*0·40	2N2221	*0·18	2N3614	*0·69	2N5457	*0·28
AD150	*0·65	BC145	0·46	BC212L	0·10	BD187	*0·71	BF262	0·56	OC23	*0·49	TIP30	*0·45	2N2222	*0·18	2N3615	*0·76	2N5458	*0·28
AD161	*0·36	BC147	0·09	BC213	0·10	BD188	*0·71	BF263	0·56	OC24	*0·57	TIP31A	*0·52	2N2368	*0·18	2N3616	*0·76	2N5459	*0·28
AD162	*0·36	BC148	0·09	BC213L	0·10	BD189	*0·77	BF270	*0·36	OC25	*0·39	TIP32A	*0·60	2N2369	*0·12	2N3646	0·09	40361	*0·30
AD161 &		BC149	0·09	BC214	0·10	BD190	*0·77	BF271	*0·31	OC26	*0·38	TIP41A	*0·65	2N2369A	0·12	2N3702	0·09	40362	*0·35
AD162(MP)		BC150	0·19	BC214L	0·10	BD195	*0·87	BF272	*0·81	OC28	*0·60	TIP42A	*0·72						
	*0·69	BC151	0·20	BC225	0·26	BD196	*0·87	BF273	0·36	OC29	*0·60	TIS43	*0·25						
AF114	*0·22	BC152	0·18	BC226	0·36	BD197	*0·92	BF274	0·36	OC35	*0·45	UT46	*0·20						
AF115	*0·22	BC153	0·29	BC251	0·10	BD198	*0·92	BFX29	*0·25	OC36	*0·51	ZTX107	0·07						
AF116	*0·22	BC154	0·20	BC301	*0·28	BD199	*0·98	BFX84	*0·19	OC41	*0·20	ZTX108	0·07						
AF117	*0·22	BC157	0·11	BC302	*0·25	BD200	*0·98	BFX85	*0·25	OC42	*0·25	ZTX109	0·07						
AF118	*0·32	BC158	0·11	BC303	*0·31	BD205	*0·81	BFX86	*0·22	OC44	*0·16	ZTX300	0·07						
AF124	*0·28	BC159	0·11	BC304	*0·37	BD206	*0·81	BFX87	*0·22	OC45	*0·13	ZTX500	0·09						
AF125	*0·28	BC160	*0·46	BC327	0·12	BD207	*0·98	BFX88	*0·22	OC70	*0·10	2N696	*0·10						
AF126	*0·28	BC161	*0·51	BC328	0·12	BD208	*0·98	BFY50	*0·13	OC71	*0·10	2N697	*0·11						
AF127	*0·26	BC167	0·10	BC337	0·12	BDY20	*1·02	BFY51	*0·13	OC72	*0·15	2N698	*0·20						
AF139	*0·31	BC168	0·10	BC338	0·12	BF115	*0·15	BFY52	*0·13	OC74	*0·15	2N699	*0·36						

VAT CHAT

Please add 8% to prices marked *. Remainder add 12½%. Do not add V.A.T. to prices marked †.

SUPER UNTESTED PAKS

THE FINEST VALUE IN UNTESTED SEMICONDUCTORS

PAK No.			
U50	100	Germ. Gold bonded OA47 diode	*0·60
U51	150	Germ. OA70/81 diode	*0·60
U52	100	Silicon Diodes 200mA OA200	*0·60
U53	150	diodes 75mA 1N4148	*0·60
U54	50	Sil Rect Top Hat 750mA	*0·60
U55	20	Sil Rect Stud Type 3 Amp.	*0·60
U56	50	400mW Zeners D07 Case	*0·60
U57	30	NPN Trans BC107/8 Plastic	0·60
U58	30	PNP Trans BC177/178 Plastic	0·60
U59	25	NPN TO39 2N697/2N1711 sil.	*0·60
U60	25	PNP TO59 2N2905 silicon.	*0·60
U61	30	NPN TO18 2N706 silicon.	*0·60
U62	25	NPN BFY50/51.	*0·60
U63	30	NPN Plastic 2N3904 silicon.	0·60
U64	30	PNP Plastic 2N3905 silicon.	0·60
U65	30	Germ. OC71 PNP.	*0·60
U66	15	Plastic Power 2N3055 NPN	*1·20
U67	10	TO3 Metal 2N3055 NPN.	*1·20
U68	20	Unijunction trans TIS43	*0·60
U69	10	1amp SCR TO39	*1·20
U70	8	3amp SCR TO66 case.	*1·20

Code No's mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

THYRISTORS

PIV	0·6A TO18	0·8A TO92	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
10	*0·13	*0·15	—	—	—	—	—	—	—	—
20	*0·15	*0·13	—	—	—	—	—	—	—	—
30	*0·19	*0·22	—	—	—	—	—	—	—	—
50	*0·22	*0·28	*0·20	*0·25	*0·36	*0·36	*0·48	*0·51	*0·54	*1·18
100	*0·25	*0·30	*0·25	*0·25	*0·48	*0·48	*0·51	*0·57	*0·58	*1·43
150	*0·31	*0·38	—	—	—	—	—	—	—	—
200	*0·30	*0·44	*0·25	*0·30	*0·50	*0·50	*0·57	*0·02	*0·62	*1·63
400	—	—	*0·30	*0·39	*0·55	*0·57	*0·62	*0·71	*0·77	*1·79
600	—	—	*0·39	*0·48	*0·69	*0·69	*0·70	*0·89	*0·90	—
800	—	—	*0·56	*0·65	*0·81	*0·81	*0·92	*1·22	*1·39	*4·07

SILICON RECTIFIERS

PIV	300mA (DO 7)	750mA (SO 16)
50	0·05	0·06
100	0·05	0·07
200	0·06	0·09
400	0·07	0·14
600	0·08	0·16
800	0·11	0·18
1000	0·13	0·28
1200	—	0·32

	1 Amp Plastic	1·5 Amp (SO 10)	3 Amp (SO 10)	10 Amp (SO 10)	30 Amp (TO 48)
IN4001	0·05	0·07	0·14	0·19*	0·56*
IN4002	0·06	0·09	0·16	0·21*	0·69*
IN4003	0·07	0·12	0·20	0·23*	0·93*
IN4004	0·08	0·14	0·28	0·35*	1·25*
IN4005	0·09	0·10	0·33	0·42*	1·76*
IN4006	0·10	0·18	0·35	0·51*	1·94*
IN4007	0·11	0·23	0·44	0·60*	2·31*
		0·28	0·54	0·69*	2·88*

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PROJECTS THEORY...

A HIGHLY SUCCESSFUL RUN

After a 15-month highly successful run, this month we say a fond farewell to *Teach-In 76*. A loss will be felt by those who have been diligently following this series, that we know from the many expressions of appreciation received by us during its run. Another edition of *Teach-In* will appear in due course naturally, for it is part of our established tradition.

But with regard to the present, all who have studied these 15 articles and carried out the experiments and exercises will now be well initiated into the mysteries of electronics. Mysteries that are in fact more apparent than real, as *Teach-In* and, for that matter, all other articles we publish set out to demonstrate.

This fact should give added encouragement to anyone approaching electronics for the first time. Beginners are especially welcomed to our pages at anytime. And it is always the right time to start. Apart from the longer series like *Teach-In* and *Doing It Digitally* (now just entering upon its third part) a wide variety of short series or individual articles and features having some immediate appeal and usefulness to the beginner are presented regularly in EVERYDAY ELECTRONICS.

GOING SHOPPING

Building electronic projects is of course the main attraction. Many of our constructional projects should present no problem to the average person, provided the articles are read carefully and the details in the diagrams studied closely.

Good practical advice is given every month in *Shop Talk* on particular points relating to components and materials that might present some difficulties.

Advice to acquire a selection of catalogues from the established component stockists is frequently given in *Shop Talk* and elsewhere. It is not amiss to repeat it here. A collection of catalogues is a valuable and indispensible reference library for any constructor. Their pages provide a good shop window for the reader, wherever he or she may be, to gaze into at will.

AN ANNUAL PROBLEM

It's always a puzzle deciding what to give at Christmas time. What to give young Elsie or Harry, to say nothing of those parlour game fanatics Aunt Mary and Uncle Brian. The *Mini Organ* and the *Scrabble Timer*, at any rate, should provide the solution for a couple of presents.

The value of such gifts is greatly increased by the knowledge that you the donor have made them yourself.

Fred Bennett.

Our January issue will be published on Friday, December 17
See page 655 for details.

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VOL. 5 NO. 12 DECEMBER 1976

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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rabble Timer

By S.R. LEWIS B.S

A Party time Project

Adds to the excitement of the game.

ADDING a time limit to each move in Scrabble can liven up the game considerably—it prevents those situations where one player spends minutes pondering over a move, while the other players mutter their frustration. The timer to be described has a continuously variable nominal range of 5 to 70 seconds.

Such a timing system is often used in chess but in Scrabble there are often more than two players and to increase the excitement a random time factor can be introduced whereby a player does not know how long he has to make his move. If he makes his move quickly then the next player must use the remaining time and so on until the "time up" signal indicates that the player whose move it is at the time must lose some points. An apt name for this type of game is "panic" Scrabble.

ELECTRONIC TIMER

A simple electronic timer which could be used for the "normal" game is shown in block form in Fig. 1.

An audio oscillator generates a frequency which, when amplified and fed to a speaker, produces a tone indicating time up. The output of the oscillator is fed to an electronic "gate" which has another input to which is connected a capacitor to ground and a variable resistor to the positive supply.

This "gate" will only allow the signal from the oscillator to pass through to its output when the voltage at input B is above a certain threshold.

To start a timing period, switch S_A is pressed which completely discharges C_A. The voltage across C_A will be 0V which closes the gate.

When S_A is released, C_A starts to charge up to the supply voltage via VR_A. Eventually the voltage on C_A and hence at input B will exceed the threshold and the gate will open, allowing the oscillator signal to be amplified.

The timing period is propor-

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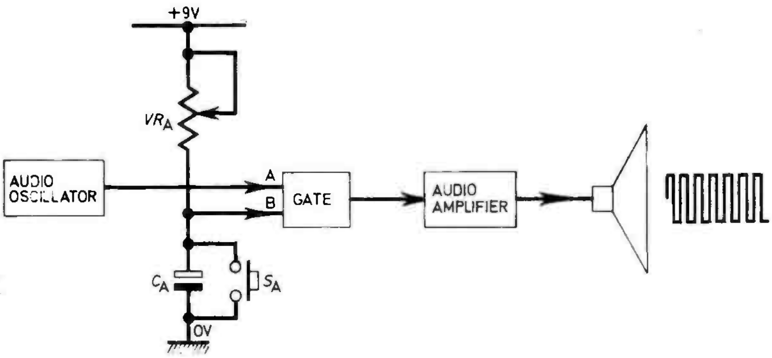


Fig. 1. Block diagram of the Scrabble Timer for the "normal" game.

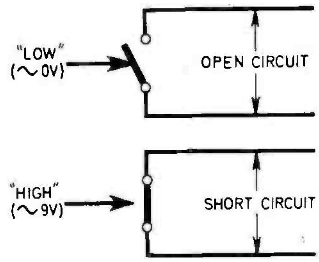


Fig. 3. Basic idea of the electronic switch in the CD4016.

tional to the value of the capacitor and the resister (C_A and VR_A) —increasing either will increase the timing period.

If the threshold voltage of the gate is half the supply voltage, then the time taken for the capacitor to charge to this voltage from zero will be $0{\cdot}7C_AVR_A$ seconds where C_A is in microfarads and VR_A in megohms.

RANDOM TIMING

The simple timing system described above is incorporated in the complete Scrabble Timer whose block diagram is shown in Fig. 2.

THE VERY IDEA
The idea for a Scrabble Timer was proposed by B. M. Phillips of Whitehaven, Cumbria who receives our special award.

The two position switch S_B is used to select normal timing, with the period set by VR_A, or "panic" timing where the period is random (or nearly so).

In order to achieve "random" timing some way must be found of altering the capacitor, the resistor or the threshold voltage of the gate in a random manner. The method used here is to vary the timing resistor.

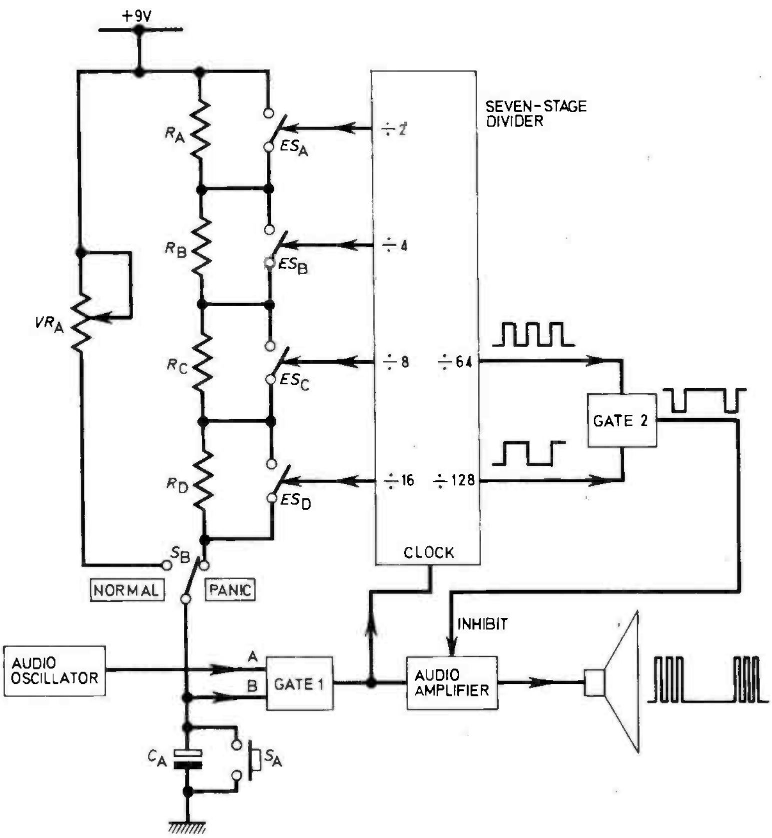
It will be seen that in Fig. 2, with the switch on "panic" instead of VR_A a chain of four resistors R_A and R_D is placed in series with the capacitor. Across each of the resistors is a switch but not an ordinary switch, an electronic one!

ELECTRONIC SWITCHES

Unlike an ordinary switch, the electronic switch does not need a finger to operate it—just an electrical signal.

Applying a low voltage to the control input causes the switch to be open circuit and a high voltage

Fig. 2. Block diagram of the complete Scrabble Timer incorporating the "panic" game.



causes it to be a short circuit. The two states are indicated in Fig. 3.

So much for theory, what about the switch in reality? Well, electronic switches are obtainable, four to a package in an integrated circuit designated CD4016.

The CD4016 is one of the family of CMOS, or Complementary Metal Oxide Semiconductor, integrated circuits which are cheap, highly efficient logic circuits. They work on a wide range of supply voltages and consume only minute currents.

In Fig. 3, the switches have been shown as either open or short circuits. The electronic switches in the CD4016 are not ideal having a resistance of about 300 ohms in one state and about 10^{12} ohms in the other. Also, the switches need to be supplied with power, not being "powerless" as Fig. 3 would suggest.

COUNTER

Well, we have found a way of varying the timing resistor electronically but where do the control voltages come from?

The answer is: the seven stage divider of Fig. 2. This is another CMOS i.c. designated CD4024. What it does is to take the frequency at its input and successively divide it by two seven times. Thus if the input frequency is f, the outputs are: $f/2$, $f/4$, $f/8$, $f/16$, $f/32$, $f/64$, $f/128$.

If we look at the outputs of the first four stages we see that the sequence shown in Table 1 keeps repeating. (A "1" indicates a 9V output and a "0" a 0V output.)

As soon as button S_A is pressed and the timing period started, the divider will "freeze" in one of the states in the table. Which particular one is impossible to predict.

The four outputs of the first four stages of the divider are connected to the electronic switches so that the combination of resistors in series with C_A depends on the state of the divider. For example if the divider stopped with its outputs at 1, 0, 0, 1, then ES_A and ES_D would be closed and ES_B and ES_C open so that C_A would charge through R_B and R_C in series.

Components

Resistors
R1 120kΩ
R2 150kΩ
R3 470kΩ
R4 120kΩ
R5 1MΩ
R6 220kΩ
R7 10kΩ
R8 47Ω
All ±5% ¼W carbon

Capacitors
C1 0·01μF disc ceramic
C2 50μF 10V electrolytic

Semiconductors
D1 OA91 germanium diode
TR1 ZTX500 silicon *npn*
IC1 CD4011 (or MC14011) quad two-input NAND gate
IC2 CD4016 (or MC14016) quad bilateral switch
IC3 CD4024 (or MC14024) seven stage divider

Miscellaneous
VR1 2MΩ linear potentiometer
S1 d.p.d.t. toggle switch
S2 s.p.d.t. toggle switch
S3 Momentary contact pushbutton
LS1 40Ω (or 35Ω) 57mm speaker
B1 9V PP3 battery and connector
0·1in matrix stripboard 95 x 63mm, case 135 x 75 x 40mm, control knob, 6BA fixings, connecting wire, etc.

Table 1: Divider outputs

f÷2 (pin 12)	f÷4 (pin 11)	f÷8 (pin 9)	f÷16 (pin 6)
0	0	0	0
1	0	0	0
0	1	0	0
1	1	1	0
0	0	1	0
1	0	1	0
0	1	1	0
1	1	1	0
0	0	0	1
1	0	0	1
0	1	0	1
1	1	0	1
0	0	1	1
1	0	1	1
0	1	1	1
1	1	1	1

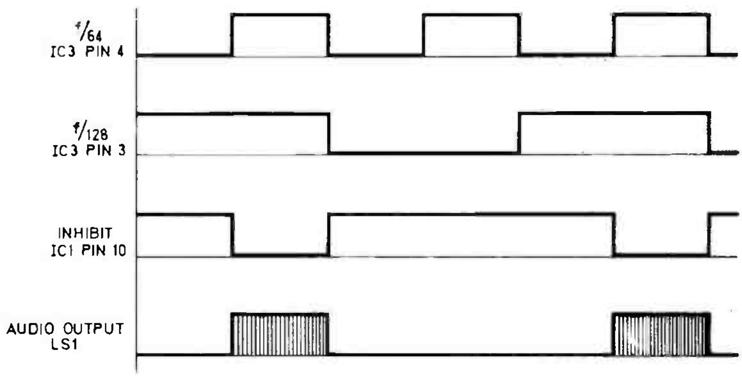


Fig. 4. Shows how the bleeping tone is produced using the f/64 and f/128 outputs.

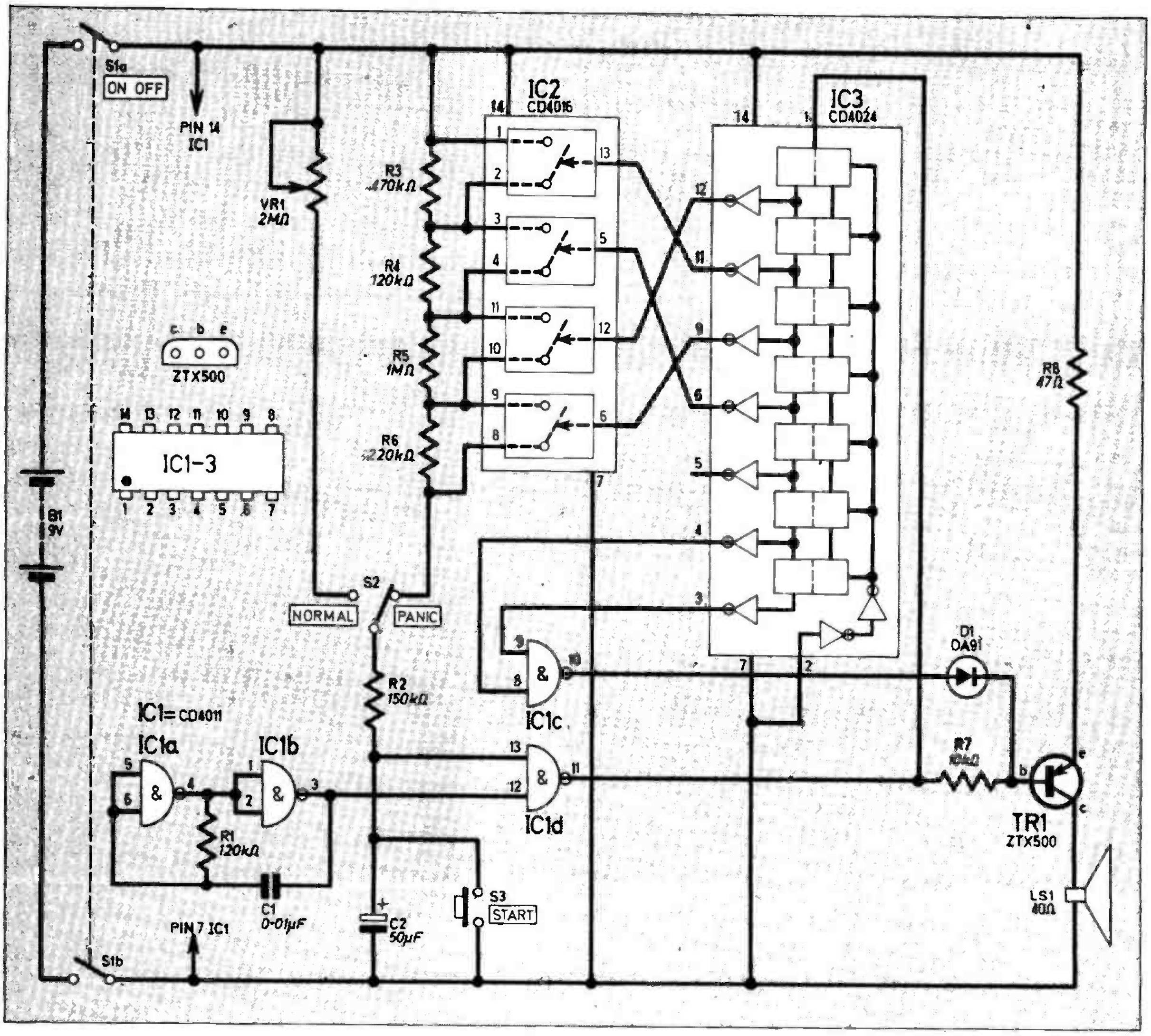


Fig. 5. The complete circuit diagram of the Scrabble Timer.

The resistors R_A to R_D are chosen to be roughly in the ratio 1:2:4:8, so that sixteen different values (and hence timing periods) are possible.

INHIBIT

The counter has only been partly used, the $f/32$, $f/64$ and $f/128$ outputs being unused so far. Now, if the input frequency is about 250Hz (round about middle C on the piano) then the $f/128$ output will be at about 2Hz. If we could somehow arrange for this signal to switch the amplifier on and off then we would get a bleeping output rather than a boring continuous tone. We can go further than this: by gating together the $f/128$ and the $f/64$ outputs we will produce short blips at the output rather than equal on and off time bleeps.

The outputs of the counter and the gate which generates this inhibit signal are shown in Fig. 4.

CIRCUIT DIAGRAM

The complete circuit of the Scrabble Timer is shown in Fig. 5. It is easy to associate the components with the block diagram.

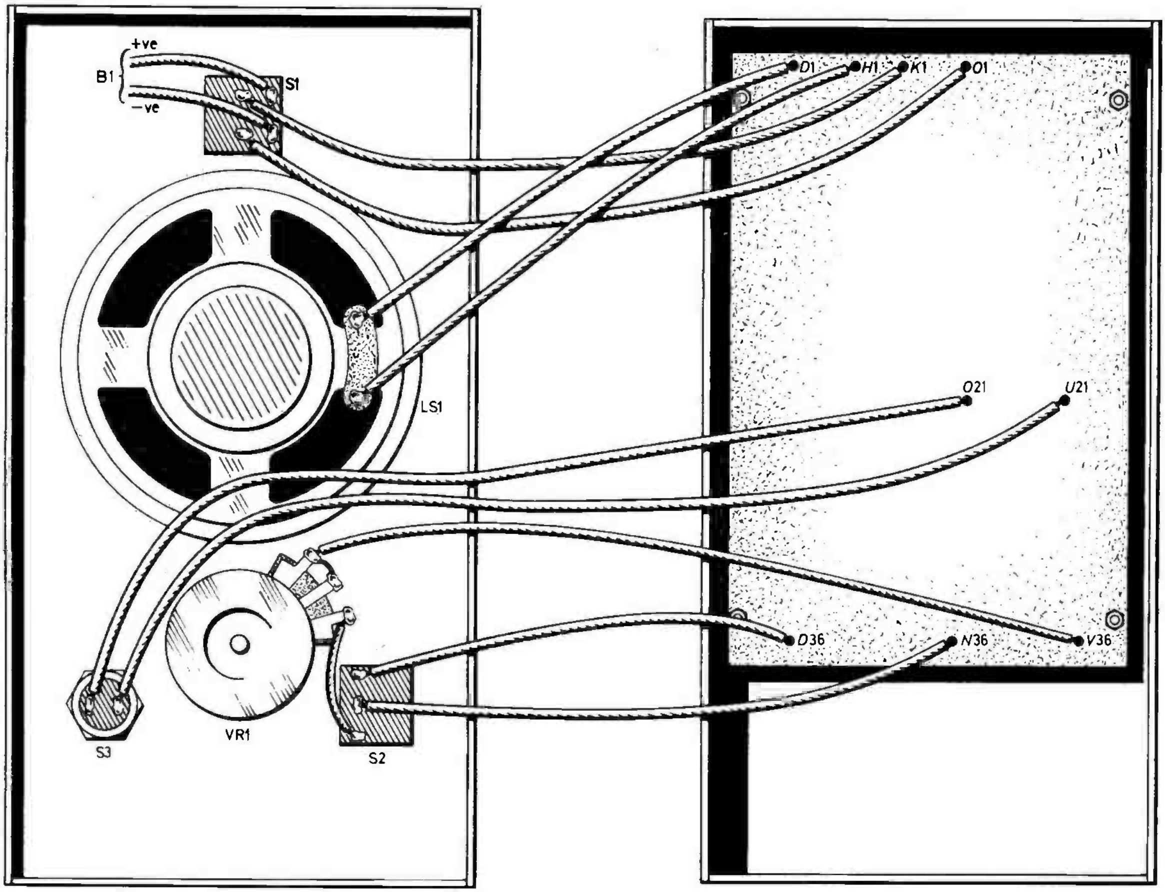
Another CMOS integrated circuit type CD4011 is used for the two gates and for the oscillator (gates IC1a and IC1b). All the gates are NAND gates which means they only produce a low (about 0V) output when both inputs are simultaneously high (about 9V).

The timing components are connected to IC1d. The threshold voltage of this type of gate is about half the supply voltage (4·5V in this case) but it can vary by ±33 per cent.

Resistor R2 sets the minimum timing period and also prevents S3 from shorting the battery.

The amplifier consists of TR1, R7 and R8; TR1 will only conduct (i.e. allow current to flow into LS1) when the output of IC1d is 0V and at the same time the output of gate IC1c is 0V.

The diode D1 is there to prevent IC1c switching on the transistor when its output goes low. Note that a germanium type must be used as the forward voltage drop across a silicon diode can



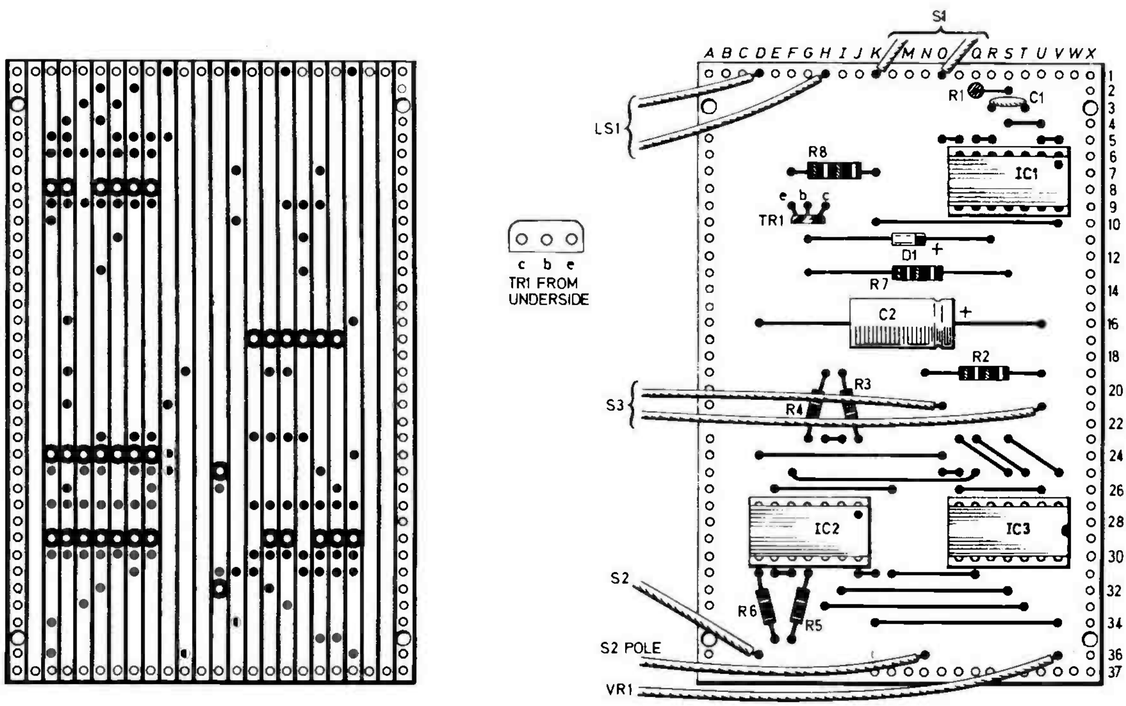


Fig. 6 (above). Position of the components and board within the case and (below) the layout of the components on the stripboard and the breaks to be made on the underside.

cause TR1 not to switch off properly when IC1c output is high.

Resistor R8 limits the current through the transistor to a maximum of about 100mA.

There is a reset input to IC3 which, when taken high sets all the outputs low. This facility is not needed so this input is connected to 0V.

With the timing components shown, the timing period can be varied (using VR1) from nominally about five seconds to about 70 seconds. The exact period can vary greatly since the value of C2 can be −50 to +100 per cent of its nominal value and also the threshold voltage of the i.c. can vary by ±33 per cent. In the prototype the timing period at maximum setting of VR1 was 98 seconds.

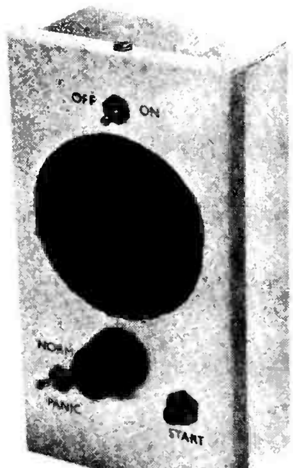
CONSTRUCTION

All components except the controls are mounted on a standard size piece of stripboard, cuts in the copper tracks being as shown in Fig. 6. In the prototype sockets were used for the i.c.s but these are not essential.

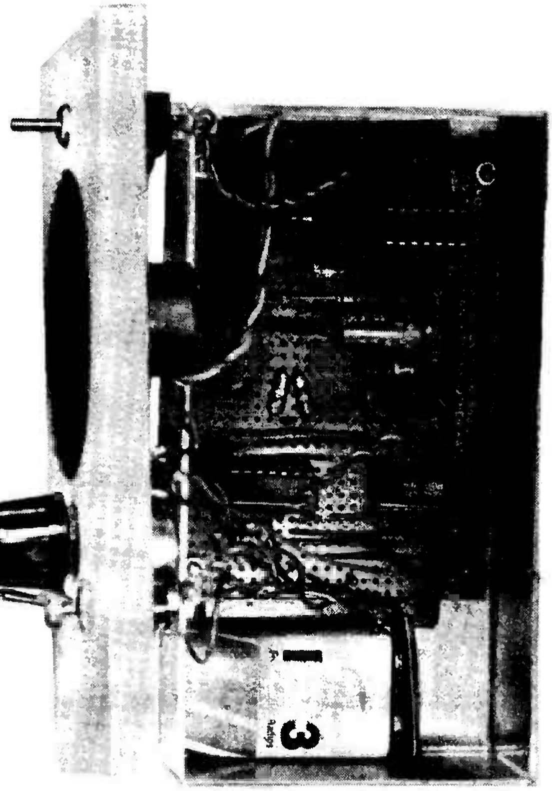
Note that different manufacturers use different prefixes for CMOS i.c.s. The two companies are RCA who use CD4XXX and Motorola who use MC14XXX. Sometimes advertisers just refer to them as the 4000 series.

The orientation of the i.c.s is important, the dot or indentation indicating pin 1.

The best order to proceed in building up the board is first to make the breaks in the copper



The completed prototype.



Photograph showing the prototype with lid removed.

tracks then insert the i.c. sockets (if used). Next connect all the wire links and terminal pins as shown in Fig. 6. Insert all resistors, then the two capacitors followed by the diode then transistor.

Finally insert the i.c.s. No special precautions are needed when handling *these* CMOS i.c.s but try to avoid handling the pins too much.

The controls are fitted to the lid of the aluminium box. Connect them to the appropriate pins on the component board leaving the wires about 6cm long. The board is bolted into the bottom of the box. There is a space for the battery if the specified box is used and this can be held in place with a piece of double-sided sticky tape.

To improve the appearance, the lid was covered with self-adhesive vinyl and the controls labelled with rub down lettering.

The holes over the speaker were covered with a small piece of speaker fret.

If it is thought that miniature toggle switches are too expensive then miniature slide switches can be used although this does mean cutting rectangular holes—not an easy matter.

IN USE

To use the unit, first decide whether to play normal or panic Scrabble. For normal Scrabble set the speed knob to the required setting—the higher the setting, the faster the game. The first player then presses the START button and the second player begins his go. If the timer sounds "time up" then he loses a fixed number of points or misses his turn. If he moves before this then he presses the button and play moves to the next player.

For "panic" Scrabble the switch is set to PANIC and Player A begins his go. When he has finished Player B has to make his move in the time remaining and so on until the "time up" signal sounds when the player whose go it is loses the points or his turn. He then presses the START button and play proceeds round the table.

There are numerous other games where this timer could be used. One game which immediately springs to mind is Musical Chairs, where, instead of stopping the music, the bleep of the timer would indicate when to grab a chair, thus eliminating any bias. ☐

Try these for

5 CASSETTE POWER SUPPLY

THIS simple unit will find an immediate use in the car or connected to a simple 12V power supply to reduce the voltage for transistor radios, cassette recorders etc. It was designed for use in a car to supply a cassette recorder which it does very well.

The output voltage can be set from zero to about 10V on a 12V supply or up to 12V on a 14V (nominal car) supply.

The circuit is shown in Fig. 1. A voltage is taken from the wiper of the potentiometer to the base of TR1. Voltage at TR1 emitter will always be about 0·7V less than that at its base and will hence depend on the setting of VR1. Transistor TR1 then feeds a larger current into the base of TR2 and TR2 operates in the same way as TR1. Thus the output voltage at TR2 base is always about 1·4V less than that set at VR1 wiper.

Transistor types are not important providing TR1 has a reasonable gain and TR2 has high enough dissipation to supply the unit being operated. The BFY50 used in the prototype can only pass about 70mA at 3V, rising to 200mA at 10V output. If greater current is required the BD131 can be used—this can pass about 1A at 3V and 2A at 9V and above. Construction with the BFY50 fitted is shown in Fig. 2.

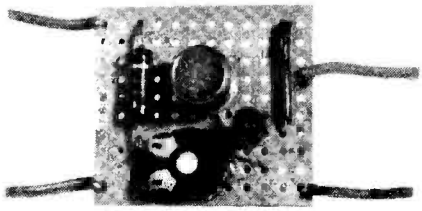
Components

Resistor
R1 1kΩ ¼W ± 5% carbon

Semiconductors
TR1 2N2926 silicon *npn*
TR2 BFY50, BD131 (see text) silicon *npn*

Miscellaneous
VR1 47kΩ horizontal carbon preset
Stripboard 0·1 inch matrix 11 holes by 10 strips; connecting wire; solder.

ESTIMATED COST OF COMPONENTS excluding V.A.T. £0.50



Voltage variation in the car will cause the output voltage to vary but this was not found to be a problem, provided the output voltage is set when the engine is running (not just ticking over) i.e. voltage is high. This can easily be done on most cassette recorders using the battery voltage indicator and gradually turning up VR1 until the needle is slightly into the green section. Alternatively a voltmeter can be used across the output. ⌑

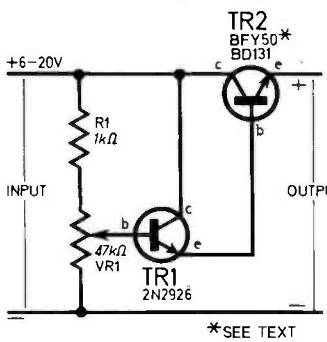


Fig. 1. Circuit diagram of the Cassette Power Supply.

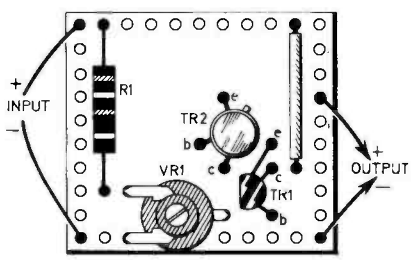


Fig. 2. The layout of the components on the stripboard. There are no breaks on underside. Strips run from left to right.

6 AMPLIFIER & R.F. PROBE

THIS project, a two stage audio amplifier with volume control, is a "big brother" to the one stage audio amplifier for crystal sets described last month. It is suitable for a wider range of applications, as we shall see.

One use for this amplifier is that of tracing signals in audio circuits, the input of the amplifier being connected across signal points in the circuit being examined. This enables the user to determine the presence, or otherwise, of signals at any given point.

For example let us assume that it is desired to locate a fault in an audio amplifier. The input of the test audio amplifier can be connected to the input of the first stage of the equipment being tested, where a signal should be heard if all is in order. This

Starters...

6 AMPLIFIER & R.F. PROBE

being so, the signal tracer can then be connected to the input of the second stage, and so on towards the loudspeaker until the signal cannot be heard. When this has been determined we know that the fault lies between that point and the last testing place where the signal was heard. A thorough examination of the circuit between these two points should reveal the faulty component or connection.

It is also possible to trace distortion in audio equipment using this approach, the signal tracer indicating at which point in the circuit the distortion is occurring.

When the amplifier is to be used in this application an isolating capacitor of about 0·1μF, 400V, should be connected in series with the active input terminal in Fig. 1 (top of the 10 kilohm pot). Additional isolation can be provided by adding a resistor in series with the capacitor, say 10 kilohm or as much higher as can be tolerated without serious loss of gain.

Components

Resistors
R1 10kΩ
R2 1kΩ
R3 100kΩ
R4 1·2kΩ
All ¼W carbon ± 5%

Capacitors
C1 5μF 10V elect.
C2 33μF 10V elect.
C3 1nF plastic or ceramic

Semiconductors
TR1 BC108 silicon *npn*
TR2 BC108 silicon *npn*
D1 OA91 or similar germanum diode

Miscellaneous
T1 Miniature transistor output transformer with primary impedance greater than 1kΩ (LT700)
LS1 Miniature loudspeaker, coil impedance 3 to 15Ω
Stripboard 0·1 inch matrix size 11 holes x 10 strips; crocodile clip; screened lead; connecting wire; exhausted ball point pen (for probe).

The sensitivity of this amplifier is such that it may be connected directly to tape heads, microphones and pickups to check their outputs. However, there are no equalisation circuits in this amplifier and, where equalisation is necessary due to the recording characteristics of either tape or disc, or where mismatch between pickup or microphone and the amplifier input suppresses the base response, the overall balance may sound "thin" or "tinny".

As it stands, this circuit can

ESTIMATED COST OF COMPONENTS excluding V.A.T. £1.75

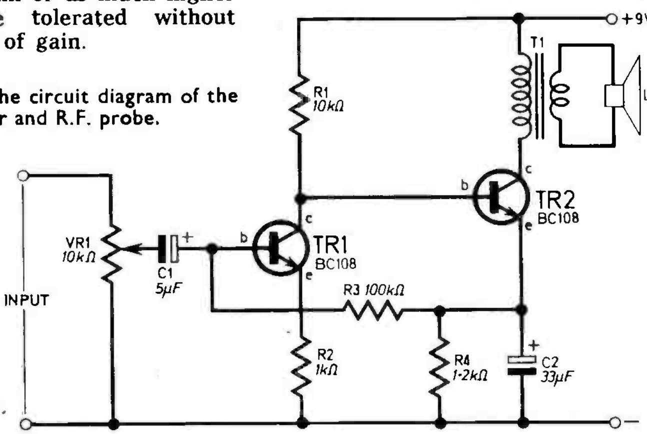
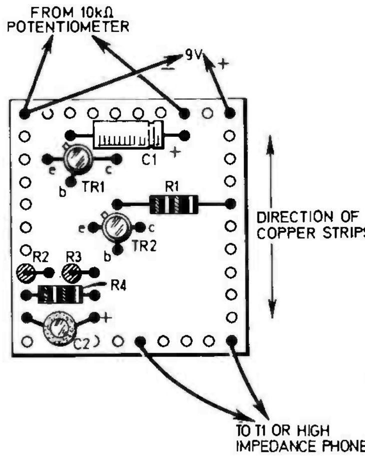


Fig. 1. The circuit diagram of the Amplifier and R.F. probe.



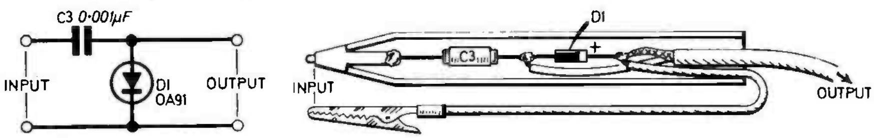


Fig. 2. The layout of the components on the stripboard (no breaks) and left details of the probe.

Try these for Starters

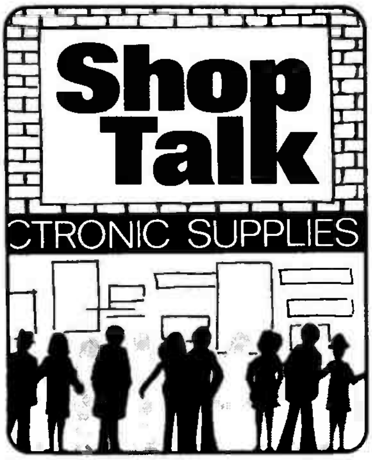
only be used for tracing audio signals. In order to trace modulated r.f. signals it is necessary to precede the amplifier with a detector or demodulator. Such a device is simplicity itself, and consists of only two components, as shown in Fig. 2.

The r.f. signal is applied across the OA91 or similar germanium diode via a 0·001μF capacitor, and, with the circuit connected to the amplifier, the 10 kilohm input potentiometer acts as the diode load. Such a piece of equipment is called an r.f. probe.

As the circuit contains only two components. It is possible to construct it in a number of ways as a small and handy item. Probably the most convenient method is to house the capacitor and diode in a hollow pen-like holder, such as the plastic case of a ball-point pen. Suitably cleaned, and with the components soldered to it, the metal part housing the actual ball-point becomes the probe tip with which to pick up signals whilst a flying lead may be taken away and connected to chassis, thus giving a compact and easy to handle unit. Veroboard layout and wiring for the amplifier is shown in Fig. 2.

The combination of r.f. probe and amplifier allows r.f. signals in radio receivers to be traced by merely connecting the probe between any desired point in the circuit, and chassis. In most cases it should be possible to trace the r.f. signal path for any discontinuity between the detector and the output of the receiver.

As can be seen from the photograph, the components comprising the amplifier are easily accommodated on a small piece of Veroboard. The drawings illustrate the layout used, and the soldered connections necessary to form the circuit in conjunction with the copper strips and components. ☐



By Mike Kenward

New products and component buying for constructional projects.

ONCE again this month we have more items than there is really room for. Now that the winter is coming—it will probably be here by the time you read this—the number of new products is increasing and, as always, we have more items to get into the magazine than we have pages for. We must be brief.

The best way to overcome the problem is to give each item a mention and leave you to follow them up if you are interested—please remember to tell the suppliers where you read about the products, it does help us to keep you informed in the long run.

New Products

Might as well start with the one item very few of our readers will probably be able to afford—a 'scope. The 4D10A costs about £170 is made by Scopex, now well known for low price 'scopes, and has been designed to offer good performance with ease of use and low cost. The bandwidth is d.c. to 10MHz, sensitivity 10mV/cm to 50V/cm ±3 per cent.

This dual trace 'scope employs stabilised power supplies to prevent "drift" with mains variation, has been developed from the 4D10 and incorporates some features of the more expensive 4D25.

The 4D10A should be available from Maplin by the time you read this—see back of this issue for their address.

Next down in price is a 150 watt mixer amplifier from Baker Loudspeaker Company. Obviously designed for the "pop" field it has four inputs each with its own level control and outputs for 4, 8 or 16 ohm loads.

The specification quotes 150 watts into 8 ohms r.m.s. music power. We do not know what that means but suspect that it will only deliver 150 watts for short duration sounds. It is *definitely not the same* as quoting 150 watts *continuous* r.m.s.

The amplifier weighs approximately 14lbs, carries a 12 month guarantee, is solid state and costs £75 plus V.A.T. etc. from Baker Loudspeaker Company, Bensham Manor Road Passage, Thornton Heath, Surrey.

We presume we are still following the reducing price order although RMS Audio did not supply a price for their Scan-ic Tuner. This tuner is for f.m. medium and longwave, and has been designed as an economically priced quality tuner having a high technical specification. At present the tuner is only available through RMS Audio Limited, The Old Maltings, Cavendish, Sudbury, Suffolk CO10 8AZ.

Bits and Pieces

That concludes the equipment and now we come to the remaining bits and some literature. BASF, the German tape firm have launched a new range of audio accessories all under the Checkpoint banner. They stress that these items are put together in Britain although the actual parts come from all over the world. There are 24 items in the range costing from 40p for 2 cassette boxes, 2 index cards and 4 labels up to £10·28 for a complete reel-to-reel tape care kit (prices exclude V.A.T.), not cheap but BASF have a name for quality.

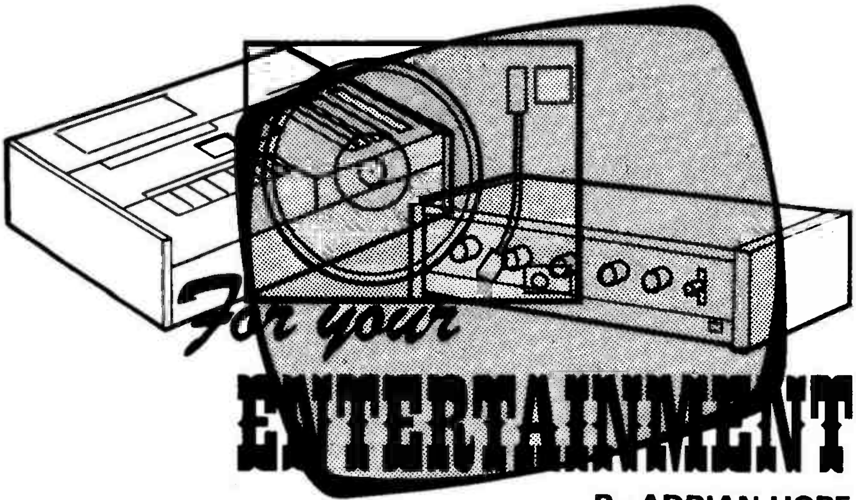
One item of particular note is the test cassette, although this costs £3·52 it is very good and has been recorded on BASF LH Super Cassette which BASF claim is the best tape for all machines. Only one point with which we are not happy—we feel that the enthusiasts guide should be free with any item, instead it costs 40p.

Glue—it's been well advertised on T.V. and we tried it; for some jobs it cannot be beaten, but not for all. Super Glue 3 bonds in seconds even your fingers or eyelids if you are not careful enough! The cost is 99p including VAT and it should last a long time even though the tube is small. Available from most hardware shops.

Constructional Projects

Once again, and fortunately because of the space available, most of the components we have used in the constructional projects this month are easily obtainable from the various component suppliers throughout the country.

The *Mini Organ* employs a fair number of miniature potentiometers so make sure the price is right before buying. The only other items needing a mention is the relay used in the *Flasher Light*, this is an R.S. type and is available from Doram Electronics Ltd. at P.O. TR8 Wellington Road, Industrial Estate, Wellington Bridge, Leeds, LS12 2UF. The cost is £1·42 including VAT and postage, etc. The transformer for the Amplifier and R.F. Probe is available from Henries, price 75p inclusive of postage, but other versions may be available locally.



For your ENTERTAINMENT

By ADRIAN HOPE

THERE is an old saying to the effect that if it is nice, it must be either illegal, immoral or make you fat. But there are a few things in the world of pop that, although fitting none of these categories, have some decidedly unpleasant side effects. It can no longer come as news to anyone that excessively long exposure to excessively loud music can be as dangerous to the ear (in terms of causing long term deafness) as handling an unmuffled pneumatic drill. Although the GLC risks being over-protective in the safeguards it still plans to bring in, (the mooted peak limit of 102dBA would outlaw most pop concerts in London) the Council is at least showing itself aware of a very real problem.

Far more realistic an approach however, and much easier to adopt, would be to ensure that at no concert is there ever any loudspeaker which can fire direct into the ears of even the tallest teenager crowding up close to the stage.

Strobe Lights

Odd things also happen with stroboscopic lights. It was in the late sixties "flower power" era that pop groups started using high power strobes on stage, and I can speak from bitter experience of how ill prolonged exposure to a powerful strobe light can make one feel. Some people are physically sick, others faint, and a few throw epileptic fits. If the strobe is particularly bright, you cannot even escape it by closing your eyes—the flashing radiation still gets through the eyelids.

Frequencies

One theory proposed is that the trouble starts when the strobe frequency coincides with a natural biorhythm of the brain

A few years ago the GLC employed some neuro-ophthalmic consultants who came up with two interesting facts. First, even people who are not normally prone to epilepsy can be induced to throw a fit at some strobe frequencies. Secondly, the most dangerous area is in the range 11–28Hz, and things are worse if the strobe rate is varied while it is switched on.

As a result the GLC now insists that strobe lights in public places must be run only at a fixed frequency between 1 and 8 Hz.

Lasers

The GLC has also looked closely at the potential risk of lasers used as a high power decorative light source in theatres and at pop concerts. As most people also by now know, a laser light beam is immensely powerful and can cause blindness if it is fired either direct into the eye or if it bounces into the eye from a good, plane reflective surface.

Although the actual power of a laser beam is only a few watts, all that power is concentrated into a pencil of coherent (in-phase) monochromatic (single colour) light. What is more, the light pencil is parallel rather than divergent or convergent, and so in theory can go on for ever. In practice it is gradually absorbed over a long journey by any foreign particles in the atmosphere. But in a confined space, such as a pop concert, a raw laser beam could do a considerable amount of damage to rear and front row spectators alike.

I recently saw one such beam, with a power of less than 2 watts concentrated into its 1.5mm width, draw smoke from a lump of plywood in its path. It is not hard to see why the retina of any unprotected eye even briefly catching that beam full on would be instantly and irrevocably fried.

Luckily, most people using lasers in the theatre realise the problems and use defraction gratings in front of the beam to split it into hundreds or thousands of tiny sub-beams. Some laser tubes will not switch on unless a grating is present. Also, the GLC now has a list of 15 stringent conditions which must be met before they will allow a laser to be used in any place of public entertainment.

Over Protective?

One laser manufacturer with whom I spoke acknowledged that most of these restrictions were reasonable and necessary to protect audiences against incompetent, careless or stoned operators. But he also argued that the laser light levels regarded by the GLC as safe were over-protective and ten years behind research findings.

I don't doubt he's right, but in this case tend to feel happier about being over-protected. Whereas most of the risk from an excessively loud and clumsily handled sound system is in the long term, the risk from an irresponsible operator with a high power laser is very much in the short term.

Counting

Calculators continue to capture the imagination. In the USA there is now a book out by Edwin Schlossberg and John Brockman called *The Pocket Calculator Game Book*. It is published in the USA by William Morrow & Co. at $6·95 but should soon (if not already) be available in the UK. The book gives the rules for fifty games you can play with an electronic calculator. The intriguing titles include Lovers' Maze, Commander-in-Chief, and Mind Control. Perhaps some of our readers have already devised their own games?

A friend recently pointed out not a game but a useful trick that enables you to use a calculator easily to count objects one by one—such as paying customers through a door or sheep while you try to get to sleep. If the machine has "constant" facility on the "addition" function, the procedure is pretty obvious—you simply press the "1" key over and over again, to raise the readout figure from 1 to 2 to 3 to 4 and so on *ad infinitum*.

But only a few machines have a constant facility on the "addition" function; more likely they have it only on "multiply" and "divide". In this case the procedure is less obvious but just as simple. Punch in 1·0000001 and multiply it by 1·1 repeatedly on the constant function. The last digit of the readout will then increase by 1 on each subsequent multiplication.

The only possible source of confusion is that the display may shift momentarily every tenth entry to suppress end zeros but in practice this doesn't matter—try it and you will see what I mean.

TEACH-IN 76

By A.P. STEPHENSON

Part Fifteen

15·1 UNIJUNCTION OSCILLATOR

A special kind of transistor called the **unijunction transistor** (u.j.t.) (circuit symbol shown in Fig. 15.1a) can produce a simple **sawtooth** waveform and in addition, a narrow pulse waveform; Fig. 15.1b shows that a bar of *n*-material called the **channel** has two wires brought out, the bottom one called **base 1** and the top **base 2**. A piece of *p*-material is embedded about halfway up (in fact the actual fraction of the way up is called the **intrinsic stand-off ratio** (η) and varies with different species) and a wire called the **emitter** is brought out; Fig. 15.1c is the equivalent circuit—the channel is shown as two resistors tapped by a diode representing the *p* to *n* junction.

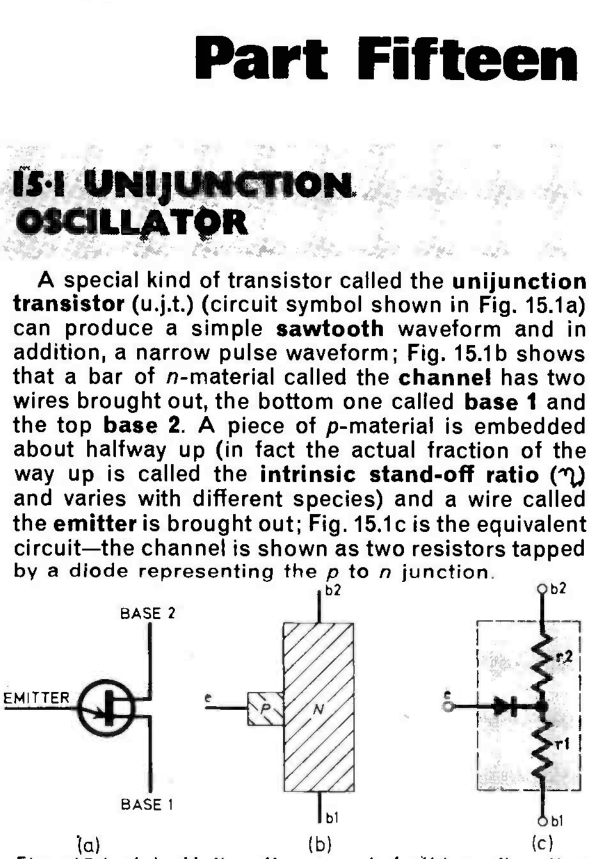


Fig. 15.1 (a) Unijunction symbol (b) unijunction schematic and (c) equivalent circuit.

To use the u.j.t. as an oscillator the circuit of Fig. 15.1d is the most popular and operates as follows:

Assume *C1* is initially uncharged but is slowly rising towards $+V_s$ on a time constant *C1* x R_e. At some point on the upward climb the diode will start to conduct. This point will be about 0·6 volts more positive that η x V_s.

As soon as the emitter conducts, more charges are released into the bottom half of the channel, i.e. r_1 becomes a lower resistance so the voltage across it drops, which makes the diode conduct harder still, which releases more charges.

This is another one of those avalanches which causes the bottom half of the channel to behave as a short circuit. The onset of avalanche results in a rapid discharge of *C1* to the point where the diode ceases conduction.

The waveform at the emitter is thus a climb, then a rapid fall, then a climb again, and so on. The shape is thus a rough kind of sawtooth and as a by-product a narrow pulse wave at b1 due to the avalanche actions in the channel.

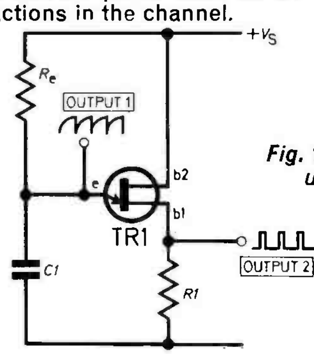
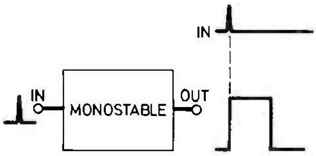


Fig. 15.1d. Details for wiring up a u.j.t. as a relaxation oscillator.

15.2 MONOSTABLE

The **monostable** may be aptly described as a "pulse-stretcher"; Fig. 15.2a shows the black box and 15.2b shows a possible circuit which, you may notice, bears a striking resemblance to the Schmitt trigger. In fact the only difference is the **capacitive** instead of resistive coupling between stages.

Fig. 15.2a. Black box representation of a monostable multivibrator.



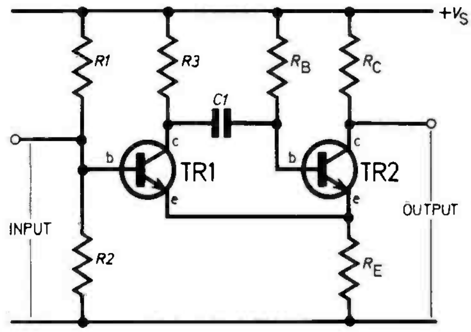


Fig. 15.2b. Circuit diagram of a basic monostable multivibrator.

Like the Schmitt trigger, TR1 is normally off and TR2 is on. A narrow positive pulse at the input will upset this state and turn on TR1. Instantly its collector falls and because of *C1* the base of TR2 falls and cuts off the collector current. Then follows the relaxation period (determined by the time constant $C1 \times R_B$ which ends when the capacitor voltage rises again to a point where TR2 re-conducts. A reverse avalanche then restores the circuit to its normal resting state.

The action can be summarised as (a) prior to trigger pulse—TR1 off, TR2 on so output is low. (b) trigger arrives—TR1 on, TR2 off so output switches to high and remains high until end of relaxation period.

By suitable choice of *C1* and R_B, the output pulse widths of anything from microseconds to minutes may be obtained.

15.3 DIFFERENTIATION

A wide pulse can be converted to positive and negative spikes by passage through a short time constant *CR* network, see Fig. 15.3a.

The term "short" normally means ten times shorter than the pulse width of the input. The explanation should be clear from what has been said previously about capacitor behaviour. The title **differentiation** is because output is proportional to rate of change of input.

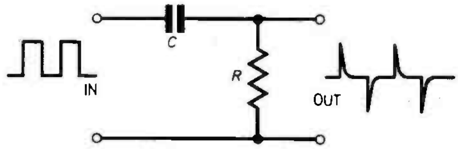


Fig. 15.3a. A simple differentiator circuit showing action on a square wave input.

TEACH-IN '76 EXPERIMENTS

EXPERIMENT 15A

To demonstrate monostable trigger action.

PROCEDURE

Assemble the components on the Circuit Deck according to Fig. 15A.1, leaving the flexible wire probe anchored safely. The lamp should be on because TR1 is conducting.

1. Measure the voltage across R_E—it should be around 4 volts due to the lamp current passing through. Measure point *A* to ground which by voltage division should be (4·7/14·7) 9 volts = 2·88 volts. Thus TR1 is off, due to the base being less positive than the emitter.

2. Momentarily touch *A* with the probe. The result is the virtually instantaneous flash-over of the circuit causing TR2 to cease conducting and TR1 to come on. Since TR1 only draws a small current, the voltage across R_E is held low—which is why TR1 can remain on. This state of affairs lasts until the negative plate of *C1* returns to the cut-on point of TR2 when the circuit instantly flashes back again to its original state with the lamp on.

The time the lamp is off depends on the resistance in the base circuit of TR2 and *C1*.

For example, if VR1 is set to maximum resistance, the total resistance is 35 kilohms so the "relaxation time" (during which the lamp is off), is about $0{\cdot}7CR = 2{\cdot}45$ seconds.

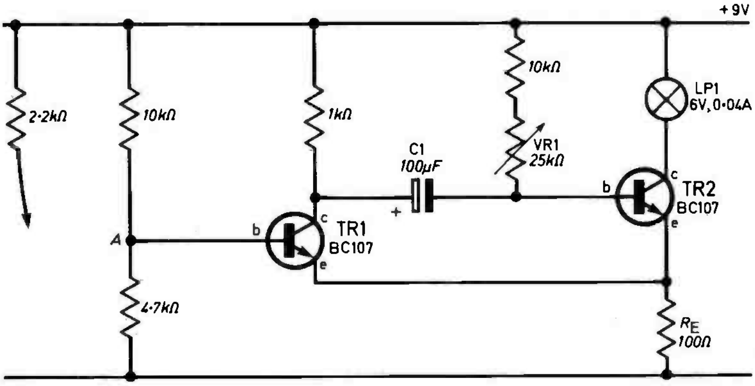


Fig. 15A.1. The circuit diagram for experiment 15A.

3. Repeat the experiments with different settings of VR1 and also with a 1000 microfarad capacitor in place of the present 100 microfarad type.
4. Exchange the 1 kilohm resistor in the collector of TR1 for another 6 volt, 0·04A lamp. The circuit no longer works. Why?

EXPERIMENT 15B

To demonstrate the unijunction sawtooth oscillator.

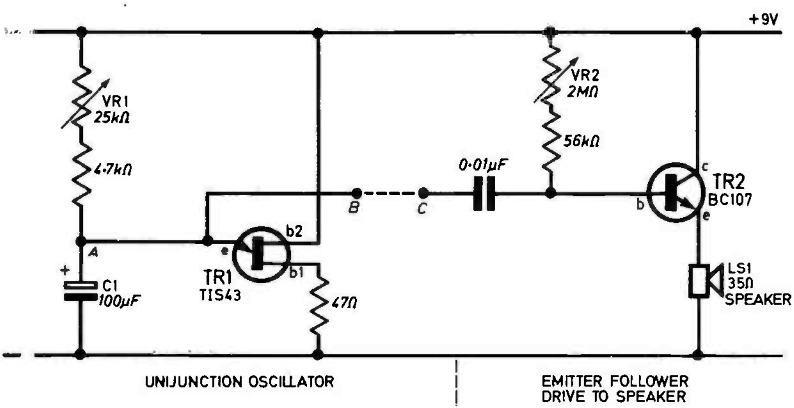
PROCEDURE

Assemble the circuit as shown in Fig. 15B.1 but leave out the wire (shown dotted) across *BC*.
1. Connect the voltmeter across *A* and ground. The needle should be flicking rhythmically, slowly up to about 4 volts and sharply down. Varying VR1 will be found to alter the frequency of the oscillator.
2. Change the 100 microfarad capacitor *C1* to 0·01 microfarad and connect a wire across *BC*. This will cause the sawtooth wave at point *A* to enter the emitter follower via *C2* and an audible tone should be heard from the speaker. The potentiometer VR2 should be varied to suit the bias requirements and optimise the audible output.

The frequency (with VR1 at maximum resistance) should be between 3 kilohertz and 4 kilohertz but will incrase to a frequency above the capabilities of the speaker as VR1 is reduced. ⌑

This concludes the Teach-In 76 series, students who have completed the course will find other interesting series and articles to follow in this and future issues (e.g. Doing It Digitally*). Next month we will be publishing constructional details of a* Multi-Tester *which has been designed by the author of the series to employ many of the parts originally specified. This Tester should prove very useful for future construction and fault finding work. A second project using more of the components will also be published shortly.*

Fig. 15B.1. Circuit diagram for experiment 15B.



JACK PLUG & FAMILY...

Your Career in Electronics

by Peter Verwig

PHILIPS INDUSTRIES

IN the May 1976 issue of EE, when I wrote on a career in radio and television servicing, I chose as my company example Combined Electronic Services Ltd., which provides service facilities for Philips and Pye consumer products. Combined Electronic Services is just one part of a giant organisation operating in the United Kingdom under the corporate banner of Philips Electronic and Associated Industries Ltd which, in turn, is part of a world-wide federation of Philips companies.

To the outsider, the organisation of Philips is confusing and even insiders, those actually in the organisation, often joke that they have difficulty in keeping abreast of events in what, by any standards, is a dynamic industrial and commercial operation subject to change in response to market demands and to advancing technology. This doesn't mean that Philips is plagued by instability. What it means is that Philips is a responsible and progressive company continually adapting itself to meet changing circumstances and that very flexibility is, itself, a good index of competent management.

STRUCTURE

A continuing theme in our "careers" series is to inform the reader on the structure of the electronics industry as well as to highlight particular career opportunities. A person applying for a post in electronics will make a far better showing at an interview if he or she understands the nature of a company and its background and where it fits in to the industry in general. Philips employs some 50,000 people in the UK and it is inevitable that a fair proportion of new intake into electronics will find themselves becoming involved somewhere in the Philips group.

Philips is among the oldest companies in electronics with its early origins in electric lamp manufacturing. The company was founded in 1891 by the Philips family in Eindhoven, Holland, the parent company still bearing the name Philips Gloeilampenfabrieken, and even today when the company employs nearly half a million people with manufacturing plants in 50 countries and sales organisations in many more, Philips is still very much a family concern.

HEADQUARTERS

The headquarters are still in Eindhoven, a bustling town which grew with Philips as the dominant local employer to the extent that Eindhoven was virtually Philipsville, the housing estates round the factories being occupied almost entirely by Philips workers and their families. Although the introduction of other large industries in recent years has diminished Philips dominance, if you go to Eindhoven today you are still very much aware of Philips influence and the historical role of the Philips family in developing not only the wealth of the town but also its social and cultural activities.

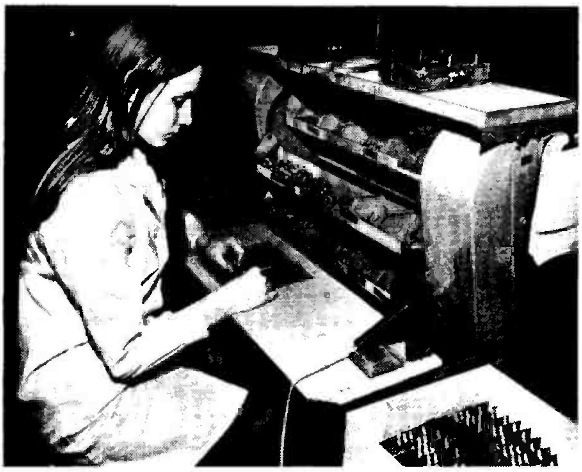
The Philips family had virtues which, today, might be considered old-fashioned and even, by some unthinking people, the subject of derision. The fact remains that the family built up a great concern, providing employment over succeeding generations to millions of people throughout the world and serving the needs of many more millions. The regime was paternalistic, but benevolently so, with the wider family of employees enjoying protection in the way of pensions, medical services, housing and recreational facilities as well as earned income as the concern flourished.

U.K.

Philips came to the United Kingdom in 1925 and through a series of acquisitions and internal growth has developed a very strong position in the electrical and electronic industries. Although the manufacturing plants and other operations in the UK operate more or less autonomously with their own local British managers and even with company names other than Philips, the family atmosphere still prevails and young people entering the company today who can perform well in their jobs can expect a high level of security.

The changing conditions of world trade have, from time to

Heading photo shows an alphanumeric display with MOS random access memory under development at Central Applications Laboratory, Mitcham.



Electronics in washing machines. A young operator assembles control modules at the Blackburn plant.

Electrolytic capacitor testing at Blackburn.

time, created redundancies and will continue to do so. Perfect job security can never exist but, within the bounds of the possible, Philips offers excellent long-term prospects and growth opportunity.

Philips is one of the world's great multinational companies but likes to be known not as a multinational but as the Worldwide Philips Federation. The Federation's international and official language is English although it is not unusual at meetings in Eindhoven for a mix of languages to be spoken. Because of the international ramifications of Philips a large number of executives are multilingual but all are expected to speak English.

To the man-in-the-street, Philips means consumer electrical and electronic goods. Washing machines, refrigerators, freezers, toasters, food blenders, lighting and heating, cleaning appliances, shavers and electronic home entertainment in the shape of radio, TV, tape recorders, hi-fi. Indeed, this is a very large part of the business but by no means all.

Philips is also great in the professional and industrial sectors of electronics, including defence electronics, and thus offers far more scope for technician and graduate engineers than might at first be realised. At last September's Farnborough Air Show, for example, no less than 13 Philips companies from seven countries (Holland, West Germany, UK, Canada, USA, France and Sweden) showed joint capabilities in aerospace from airfield lighting, through air traffic control and air communications, to missile tracking and fire control radars.

It is important to realise, however, that the design and production of consumer goods for the mass market is no less demanding than designing and producing for the so-called high technology markets such as aerospace. In some ways the former is more demanding.

To design and produce a really good colour TV for domestic use to sell in the £200-£300 price bracket is in many ways a greater achievement than an exotic CRT display for defence costing, say, £10,000. Although they may be similar in appearance they are two quite different animals, each demanding a special type of skill. Philips, with a huge spread of activities, offers scope for engineering talent right across the whole spectrum of electronics from components to large systems.

TWO GROUPS

In the UK, Philips Electronic and Associated Industries Ltd is the parent company responsible for the whole of Philips operations throughout the country. For convenience it is generally known as Philips Industries. The organisation then splits into two broad streams, one being the original Philips Group in the UK founded over 50 years ago but since considerably developed, the other being the Pye of Cambridge Group as a comparatively recent acquisition. For simplicity let them be called Philips and Pye.

The main Philips companies include Philips Electrical and Philips Domestic Appliances making and selling all sorts of consumer products, many of them through the company's own retail outlets which include Loyds Retailers Ltd. with 300 shops, Eclipse cash-and-carry stores, and with TV rental through Loyds Surevision with 160 showrooms. Then there are Mullard, Britain's largest electronic component manufacturer, M.E.L. Equipment Co. Ltd. which designs and manufactures professional electronic systems, Philips Medical Systems involved in X-ray machines and other medical electronics, Philips

An experimental automatic drill for use with PCBs, developed at Mullard Research Laboratories. It uses TV techniques and a minicomputer to control the drilling routine.

Electrologica in business machines and Philips Electric Arc Welding. The whole of Philips manufacturing is spread over 17 locations in the UK.

PYE

If we now look at Pye we find over 40 subsidiary companies with a geographical spread in another 12 locations. As well as companies with easily identifiable names such as Pye TMC, Pye Unicam, Pye TVT, there are subsidiaries like Magnetic Devices Ltd. (relay manufacture), Newmarket Transistors Ltd., Ekco Plastics Ltd. and Cathodeon Crystals Ltd.

From being a company almost entirely in domestic radio and TV, Pye has in the last two decades or so moved strongly forward in the professional market. It dominates the civil mobile radio business, has made (through Pye TMC) a strong impact in telecommunications and has a booming trade (through Pye TVT) in TV studio and transmitting equipment. Pye Unicam is a leading supplier of scientific and industrial instrumentation and is the UK marketing outlet for all instruments of Philips origin.

There is a great deal of local product development at factory level but long-range R and D is concentrated at Mullard Research Laboratories near Redhill, Surrey. This is one of five large Philips research establishments in Europe which operate closely with Philips companies and with Government research establishments in their own countries, and with the great Natuurkundig Laboratorium research complex in Eindhoven.

Mullard has a long history of co-operation with educational authorities in the UK and with the world of science and, in passing, we should note that Mullard, through endowments, has assisted what are now known as the Mullard Radio Astronomy Observatory, Cambridge; the Mullard Cryomagnetic Laboratory, Oxford; and the Mullard Space Science Laboratory, London. The Mullard Gold Medal is also awarded annually by The Royal Society for technological achievement.

OCCUPATIONS

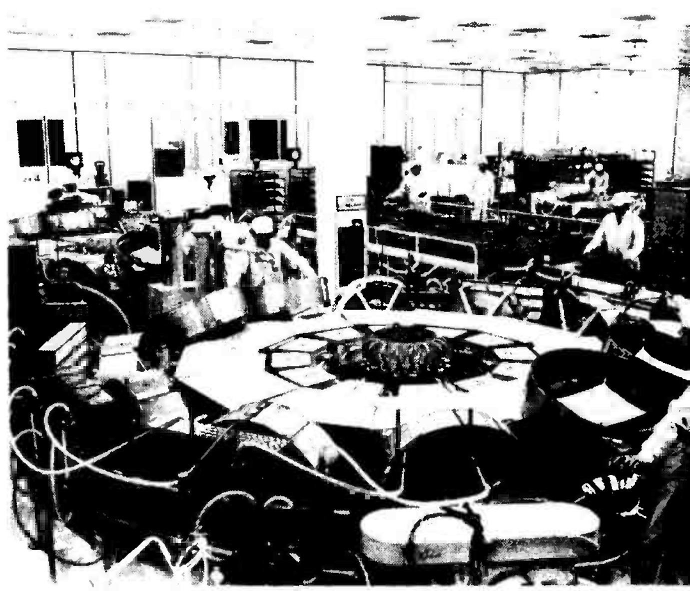
It can be seen that, overall, Philips in the UK is an extremely powerful technology-based organisation in its own right and this power is further re-inforced by federation with sister organisations in Europe, North America and elsewhere in the free world. Thus, a career with Philips, has all the "plus" ingredients for a long term future limited only by personal ability.

The broad activities of the company provide a larger than normal spread of occupations and specialities and, once you are established and respected for your abilities, there is the opportunity of climbing not only the local management ladder but also of gaining promotion by transfer within the operating groups and companies, generally at home, although there are opportunities for transfer overseas. Senior grade people inevitably find themselves involved in international liaison and there is a daily shuttle service by Philips own private aircraft between Gatwick and Eindhoven.

Technician or would-be technician engineers should apply to their local factories for information on student apprenticeship schemes as these tend to vary according to local conditions. As a generalisation, training normally lasts five years with day or block release for courses leading to ONC and HNC. All fees are paid by the company and full pay is given for time spent studying. Age limits for admission under these schemes are 16-19 years.

Younger applicants with four "O" levels, including English, Mathematics and Physics, get preference. Those nearer the top end of the entry age are expected to have two "A" levels, preferably in Mathematics and Physics. Write in before the end of February for interviews and selection tests in May or June to start training in August or September. But check on dates with the local establishment; there are variations.

Domestic TV studies at Central Applications Laboratory, Mitcham.



Flowcoating the screen of colour TV tube face plates at Mullard, Durham.

As your interests are in electronics your best chances are at Mullard, Stockport; Mullard, Blackburn; Mullard, Southport; Mullard, Mitcham; Mullard, Simonstone; M.E.L., Crawley; Philips Medical, London, S.W.12; Philips, Croydon; or practically any of the Pye establishments.

GRADUATES

Graduates should apply to the Graduate Appointments Officer, Philips Industries, City House, 420-430, London Road, Croydon, CR9 3QR. Ask initially for a copy of "Graduate to Philips" which has a useful chart of 16 mainstream commercial and engineering occupations within Philips set against 14 educational disciplines, showing where you might fit in to the organisation.

The greatest demand is for electrical and electronic engineering graduates but, like all great organisations, there is also a demand for those with degrees in economics, the arts, social sciences and psychology. Most vacancies are for direct appointment to specific jobs for which training will be given and Philips prides itself on the level of encouragement given to further develop your own ability and experience. This may be by change of job within an establishment, transfer to another establishment or, in some cases, by attending Philips own or external courses of instruction.

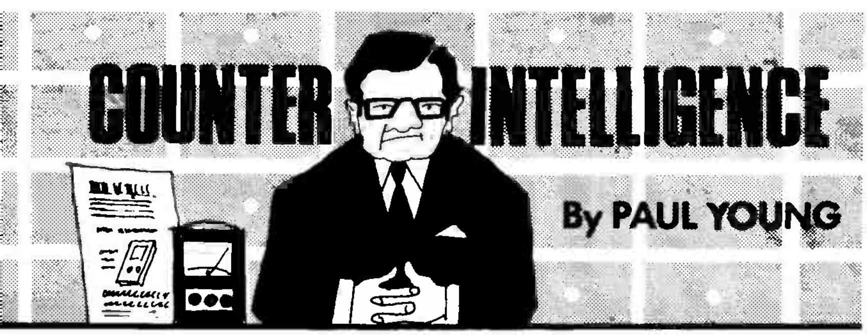
SELECTIVE

In conclusion I would like to stress the hard fact of life that nobody owes you a living. Neither Philips, nor anyone else. An employer of the calibre of Philips can afford to be selective and, indeed, must be in its choice of employees if it is to be efficient and prosperous. It is just as important at any interview to show yourself as being keen and enthusiastic and willing to learn and adapt yourself as to show academic ability.

Don't start off asking what the company can give you. Try to put yourself in the employer's position. Look at yourself in a mirror and ask, what can this young person offer me if I employ him? What contribution can he or she make? What qualities does he or she have that could make a real contribution to the success of a company?

If you can remember that there are two sides to a bargain and that you should demonstrate your willingness to honour your side, then any employer with vacancies suited to your actual or potential talents will favour your application.

A managing director of a large electronics company was telling me in September that he took on every school leaver who had recently applied directly for a job. Still needing more, he approached the local employment office. The job applicants from there had been waiting for the State to find them a job. He told me that not only were they unsuited to his vacancies but, in his opinion, were virtually unemployable in any occupation.



COUNTER INTELLIGENCE

By PAUL YOUNG

ONE of the few remaining delights of being a shopkeeper (and there are not many left today, either shopkeepers or delights) is the anticipation of the unexpected happening. I am going back to the time before the Post Office Giro system was heard of, and our shop was still half radio and television and half components. One day a rather swarthy looking gentleman entered wearing a heavy overcoat with a turned up collar, and a black homburg hat, and asked for the manager. After we had reached my office, he leant across my desk and in a low voice said, "We want to include you in a film, are you willing to cooperate?"

Well, I had felt for years Hollywood had neglected me, so I positively beamed at him "Yes of course I will," To which the stranger replied coldly. "No not, *you*, although you may appear in it, I mean your shop".

And so was born "Watt and Ohm Ltd", that was our name for the purpose of the film. What we were not prepared for, were the subsequent events. The day arrived and having warned the staff, we all stood by expectantly.

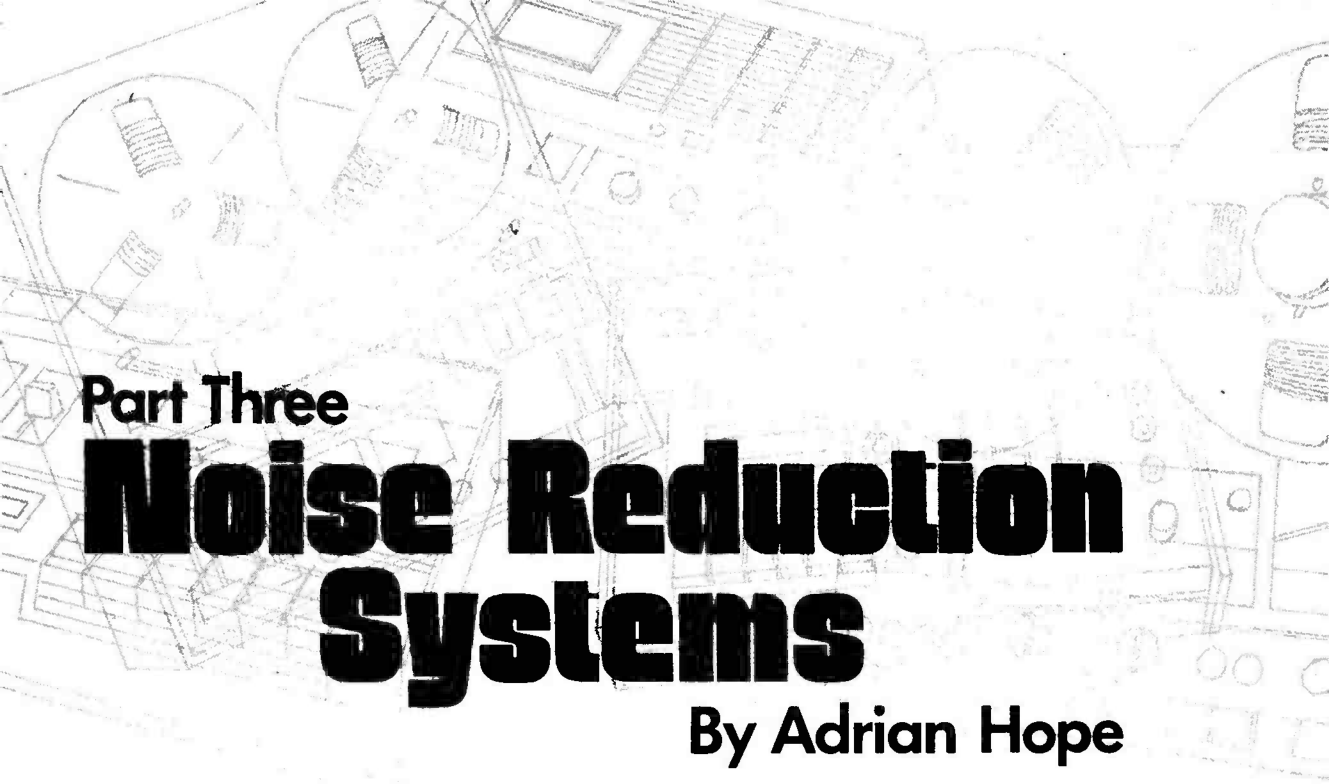
A line of about four lorries arrived filled with gear and a dozen technicians. Our shop was not all that large, but without batting an eyelid, they wheeled in these enormous spotlights, camera platforms, cameras, miles of heavy cable, booms, dollies, microphones, and mixers. It overflowed into the street, and a crowd, that always appears like magic at the sight of the unusual, started to gather round the doorway. The lights were tested the cameras run, the sound checked and the camera crews sat back and waited for the arrival of the director.

The great man arrived and he was the genuine article, right out of a Hollywood movie. Temperamental, arm waving, wearing a black beret, which in moments of agitation he would hurl to the ground and jump on. After that the chief cameraman arrived, an excitable Hungarian with an unruly mass of white hair who quarelled unceasingly with the director, followed by the assistant cameraman.

I had to pay the cashier and walk to the door. The director's final instructions were, "When you get to the door, shake hands with Stanley, smile and freeze it". Unfortunately just at the crucial moment, some passers by would walk by and the whole sequence had to be repeated. When you have "smiled" and "frozen it" eight times in a row, something happens to your facial muscles, which accounts for my present appearance. However what with dry runs and re-runs these film characters were there the whole day.

After this, we sat back and waited for our contracts to arrive. We thought, it's bound to be on television and then our names will be household words. People will nudge each other in the street and say "Look there are the Giro men" . Children will queue for our autographs.

We scanned the box nightly, but to no avail. In the end in desperation I wrote to the director to ask if we might see the film. It was a very amusing film. It lasted half an hour and it put over Giro very well, what is more we were all in it, but I am not too certain that the film moguls will be sending for me, you see the total time that we were on the screen was ninety seconds!



Part Three

Noise Reduction Systems

By Adrian Hope

WE continue this month with basic descriptions before moving on to the situation in practice.

110 SERIES

The other *dbx* consumer unit is the 110 series (units 117-119) but these are not strictly noise reduction units, and thus cannot be used to decode professionally made discs or tapes or indeed even domestic tapes made using a 120 unit. Whereas all the professional and consumer *dbx* units so far mentioned encode by compressing on "record" and expanding on "playback" together with equalisation and frequency weighting, the 110 series simply compress and expand, and have no frequency weighting.

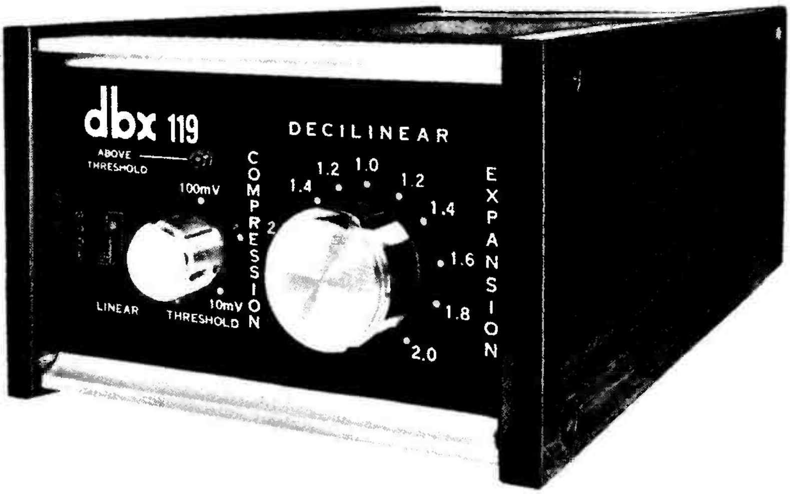
Thus an amateur recording made using a 110 unit is encoded simply by compressing the material and decoded on playback simply by expanding it again to the same degree with consequent noise reduction. It follows from the absence of any frequency weighting curve, that the 110 series is incompatible with every other *dbx* series but can be used not only "double-ended" to encode on "record" and decode on "playback" but also "single-ended" to compress or expand any existing programme material.

Thus 110 series models are frequently used in background music systems and discotheques, to compress the material into a smaller-than-natural dynamic range, so that no passages of music fall below a given level and no passages rise above a given level. In this way, background music never becomes inaudible through ambient noise such as conversation and never drowns out conversation by peaking too high.

As previously noted much of the output of BBC Radio One is already compressed in similar fashion, to the irritation of audio enthusiasts but to the satisfaction of pop pickers listening to noisy reception on transistor radio sets. Just as the 110 series can be used to compress existing programme material passively, so it can also be used passively to expand existing material.

Any signal fed through a 110 series *dbx* unit can have its recorded dynamic range expanded to make soft sounds softer and the loud sounds louder. Up to a point, this can be an invigorating experience, because most commercial tape and disc recordings (and of course broadcasts such as Radio One) have an unnaturally limited dynamic range. On the other hand it can sound decidedly

The *dbx* model 119 compandor



unnatural to have any programme source expanded to an exaggerated extent.

JVC—ANRS

It is anybody's guess why the Japanese firm, JVC, should have gone to the lengths of developing a noise reduction system of its own (ANRS) and marketing it on a domestic level, when other systems (notably Dolby) were already available and commercially successful.

However, JVC developed its own automatic noise reduction system to cope with the particular difficulties which the company was encountering in producing CD-4 quadraphonic discs. Having produced a noise reduction system for this professional purpose, JVC took matters a stage further by adapting it for domestic use, i.e. in a manner parellel to that in which Dolby first developed the A system (for professional tape recording, land lines and even video) and then developed the modified B system for the domestic market.

The JVC ANRS system provides up to 10dB of noise reduction (mostly in the higher frequencies where hiss predominates), and in this respect exactly parallels Dolby. It achieves this by a compression-expansion system, which could best be described as a hybrid cross between, on the one hand, the *dbx* system (where all signals are compressed and expanded in substantially the same way) and, on the other hand, the Dolby system (where the extent to which the signals are compressed and expanded depends on their level and frequency). Thus the JVC ANRS domestic system applies neither compression nor expansion to high level (loud) high frequency signals and to low frequency signals of any level, but compresses and expands wanted low level (quiet) high frequency signals.

In other words bass notes pass through the system unaffected, regardless of how loud they are; high notes, as for instance from violins, are also passed through unaffected if they are loud; but quiet, high frequency signals, as for instance from violins played softly, will be boosted on "record" and de-boosted on "playback". Thus, irrespective of whether or not any bass notes are present, tape noise will on playback be de-boosted and reduced as necessary. Hence there is no audible "breathing" due to modulation.

Because the ANRS system treats some signals in direct dependence upon their amplitude or level, it must, like the Dolby system, be set up with accurate calibration to ensure that the internal circuitry always has a working point of reference from which to determine what is a loud and what is a soft signal.

Both the Dolby B and ANRS systems are now available as fully integrated circuits or chips, and can thus be incorporated in even the smallest cassette machine without loss of valuable internal space.

There has now been launched the Super-ANRS system, and cassette machines are to be marketed with a three-position switch, of which one position is ANRS and a second position Super-ANRS. Super-ANRS exactly resembles the standard ANRS system but has additional circuitry to compress the high level (i.e. loud) high frequency signals which the basic ANRS system leaves untouched.

This compression is matched by mirror-image expansion on playback and is intended to provide additional head room during cassette recording by reducing the risk of overloading the narrow tape tracks with excessive high level, high frequency signal. The system is claimed to come into its own when there is a requirement to record live music, which has an intrinsically high dynamic range. However few people have both the inclination and the opportunity to cassette-record live music for themselves without breaking the copyright laws and risking ejection from a concert.

PHILIPS DNL

Finally we come to Philips DNL, which is a playback only system. And as indicated above, there is also a professional Burwen system which in some respects a highly sophisticated version of the DNL.

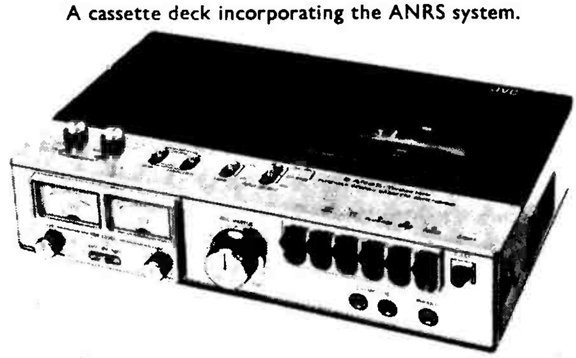
The fact that DNL is used only for the playback of existing programme material (such as a conventional tape or disc recording or radio transmission) rather than to decode an encoded tape, disc or transmission, suggests that it might be closely comparable with the *dbx* 110 series, which can also be used on conventional material. However, this is not the case.

The *dbx* 110 functions to expand the material with constant slope, and as a by-product produces noise reduction effects. DNL does not, however, produce linear expansion, and is instead designed as an active noise gate. All noise gate systems suffer from the inherent disadvantage that they cannot be expected to distinguish between sounds that are wanted (such as quiet high notes) and sounds that are not wanted (such as hiss). Also, they can almost always be heard "breathing" as they come into and out of operation.

In the case of a DNL, breathing noise is minimised because the circuit is able to distinguish between high and low frequencies at different levels. Moreover DNL philosophy, like that of Dolby, is based on the masking effect whereby the presence of high level sounds of a given frequency mask the presence of low level sounds of a similar frequency.

When a signal is fed through a DNL unit, the circuit automatically evaluates how much is present in the way of high frequency sound. The result of this

A cassette deck incorporating the ANRS system.



evaluation is then used to control a high frequency filter.

If the unit circuitry senses that a fairly reasonable level of high frequency sound is present (in other words, if the violins are playing fairly loud), it does absolutely nothing and the signal passes through the unit untouched. If, however, the circuitry senses that there is only a low level of high frequency content, in other words if there is mainly only tape hiss to be heard, it brings the high frequency filter progressively into action, to roll off the high frequencies.

The problems begin when the unit is confronted with desirable high frequency sounds at a level which is not much above that of undesirable hiss (e.g. our old friends again, the violins, playing softly). Automatically recognising that there are no high frequency sounds of sufficient level to mask the hiss, or mistakenly regarding the high frequency sounds as hiss, the unit simply rolls off everything that is remaining in the top end.

It thus eliminates not only hiss but musical content as well. However, the DNL in fact works far better in practice than this bare description suggests.

COMPROMISE

By now the general principles of noise reduction should be clear, along with the specific manner in which the various commercial systems work. But it should also by now be clear that no one system is perfect and each is very much a compromise between, on the one hand, a large degree of noise reduction and, on the other hand, freedom from unwanted side effects.

Moreover the discussion so far has been predominantly theoretical and, as often happens, the situation in practice is somewhat different.

HISTORY

When Philips Electrical invented the audio cassette a decade ago, it was intended only as a convenient aid to dictation. Subsequently, enthusiasm grew in the public sector for convenience in tape recording comparable to that made available to amateur film makers by the Super-8 film cassette.

The main obstacle to the Philips cassette as a domestic hi-fi medium was that of tape hiss, the narrow tracks on the narrow tape and the low running speed of the tape making the sound of the individual magnetic particles as irritating on good audio equipment as the photographic grain of a home movie film projected on a full-sized cinema screen. However, Dolby Laboratories proposed the use of the Dolby B format to reduce tape noise by 10dB (which is equivalent to using tape of ten times the width or a transmitter of ten times the power) and most of the rest is well documented history.

But it is not so well documented how Philips, the inventors of the cassette, was one of the last companies to acknowledge publicly that the Dolby system did have something to offer. For several years, while Dolbyised Musicassettes and machines on which to play them and make encoded recordings were emerging on the market from more and more firms under licence from Dolby Laboratories, Philips continued without a licence.

During all this time, anyone enquiring of Philips as to when a Dolby licence was likely to be taken was told that the matter was under consideration but that Philips had faith in its own DNL system. This attitude, more than anything else, accounted for the quite unreasonably severe criticism which has been levelled at the DNL system.

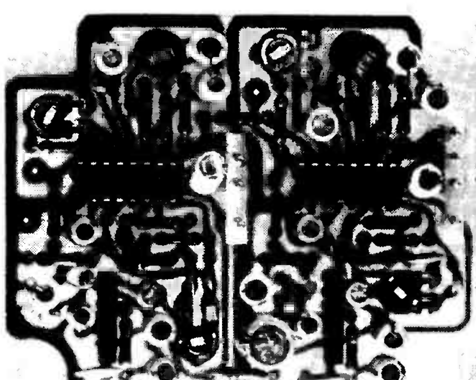
ADD-ON DNL

Initially available as an add-on unit as well as switched circuitry built into some of Philips own cassette machines, DNL provides a valuable function when used to replay cassettes already recorded without the Dolby system. The add-on unit also proved useful when used in conjunction with a reel-to-reel tape recorder, or f.m. stereo radio receiver, in that the DNL circuitry is remarkably effective at generally minimising unwanted background noise while only occasionally making its presence felt by undesirable intrusion. (Recordings of voice and piano are most likely to show up breathing effects and very quiet violin passages may suffer roll off.)

In offering DNL as an *alternative* to Dolby, rather than as an addition, Philips almost killed the system. Indeed, manufacture of the add-on DNL unit has long since ceased (a fact which many informed audio enthusiasts now regard as regrettable). Philips now has a Dolby licence and is producing machines with Dolby circuitry and some Philips cassette machines (along, incidentally, with others for instance from BASF) incorporate both Dolby and DNL circuitry.

The DNL circuitry is switched in for tapes recorded without the Dolby system, and the Dolby circuitry is switched in for Dolbyised tapes. In some cases it is an improvement to use both Dolby and DNL together.

The ANRS system integrated into a single i.c. chip.



DOLBY CALIBRATION

As explained, it is essential that Dolby circuitry be correctly calibrated. Briefly, the requirement is as follows. A professionally prerecorded test tape carrying a Dolby tone of carefully fixed and standard level is played on the machine and the internal circuitry adjusted until the machine meters register Dolby level (which will either be at zero dB, where the black markings change to red, or some other defined point in the scale).

Next, a blank tape is loaded into the machine, and a similar tone also of fixed level is produced by an internal local oscillator and recorded on to the tape. The tape is then played back, and the output level, as registered by the meters, is noted. If the registered level is above Dolby level, then the test is repeated, but with the internal pre-sets governing the record level of the machine pulled back slightly; if the registered level is below Dolby level, then the test is repeated with the pre-sets turned up slightly.

This trial-and-error procedure continues until the pre-sets in the machine are set so that it always records a standard level Dolby tone at standard Dolby level on tape.

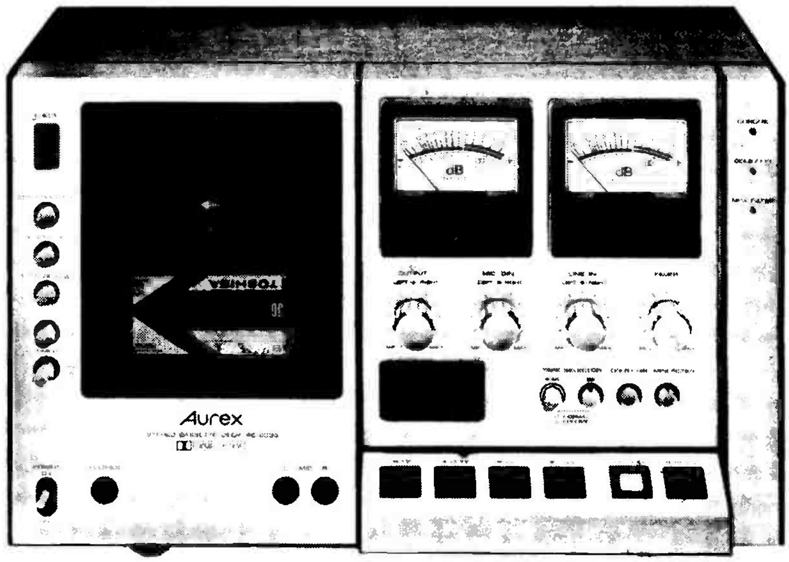
As we have previously seen, the principle of the Dolby system demands that, for correct operation, the circuitry treats all signals of the same level in the same way. The described calibration technique provides the necessary level reference point for the circuitry. When the machine is set up in this way, any tape recorded on a properly calibrated machine anywhere in the world will match any other correctly calibrated machine.

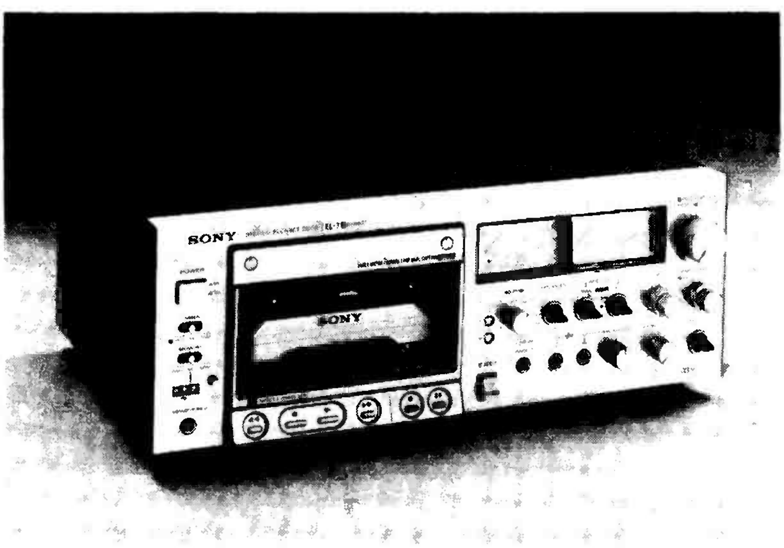
VARIOUS TAPES

Fortunately for the domestic user, most good quality cassette machines now on the market contain built-in Dolby circuitry which has already been calibrated (both for "play" and "record") at the factory. Thus there is in theory no need, and often no facility, for the user to check or alter calibration. Indeed usually more harm than good is done by ill-informed knob twiddling. The only snag with this otherwise ideal approach is that different tape types record fixed level signals at different strengths!

Tests which I have carried out show that the difference in coating as applied to tape types of two or three years ago and on similar tape types of today, may account for a difference in recorded level of up to 6dB. In other words, a fixed Dolby level fed from an oscillator to a tape two or three years old may produce 6dB less signal on playback than an exactly similar tone fed to a more modern type of tape, used in exactly the same way on the same machine.

There may even be a marked difference (3dB) between the performance of a C-60 and a C-120 of *exactly* the same, modern tape type. What this means is that a factory-calibrated machine will





Two cassette decks which incorporate Dolby B noise reduction circuitry and have a switched calibration facility with front mounted pre-set adjustments (above) the Toshiba PC-6030 and (left) the Sony EL-7 Elcaset.

A Dolby A (professional) noise reduction unit.

only give correct Dolby results when used domestically with the tape type for which it was calibrated. Although the difference in output level performance between similar tape types may be insignificant and overshadowed by frequency response variations, the difference in output level performance between remote tape types may be sufficient to affect Dolby performance; in extreme cases miscalibration distorts the dynamic range.

It is thus essential that anyone using a Dolby cassette machine for anything other than casual purposes should establish the tape type for which that machine was factory-calibrated and then try always to use the same tape In all too few cases the instruction book may help in this respect, but as a general guide in Europe, current calibration is centring round the use of a C-90 BASF Super LH cassette (and a C-90 BASF chrome cassette for the chrome setting) and in Japan calibration usually centres round the use of Maxell tape.

ADD-ON DOLBY

Although the Philips DNL add-on units are no longer available, Dolby add-on units (or "processors" or "adaptors") are still available. These are useful either to Dolbyise a non-Dolby, but otherwise treasured, cassette machine, or to Dolbyise one of the many reel-to-reel recorders which do not incorporate Dolby circuitry.

When Dolby adaptors first appeared on the market, several years ago, there was considerable confusion in the minds of the trade and public alike over the need to calibrate. Some adaptors were sold without calibration tapes; others were sold with calibration cassettes but not reel-to-reel tapes; and some were sold with blank tapes, even though the instruction books accompanying the machines clearly referred to the manner in which a prerecorded calibration tape must be used! Some ill-informed or unscrupulous salesmen even made their own calibration tapes, which, in every case so far encountered, have proved to be useless.

Thus it is essential to establish from the outset that any calibration tape you use has a good pedigree. eg from Metrosound.

Apart from the matter of calibration the main snag in using an add-on unit is that it is awkward to use; not only the machine but also the add-on unit must always be switched from "record" to "playback" and *vice versa.* Also the user must remember to control levels during recording by operating the Dolby unit controls and maintain the tape machine controls at fixed level.

ANRS SYSTEM

As previously noted, the JVC ANRS system is in many respects similar to Dolby B. The two systems are not strictly compatible and on some programme material under some conditions a listener may be able to detect when an ANRS recording is replayed with Dolby circuitry or *vice versa.* But I have used both systems side by side, with recordings made on one replayed on the other, and I have never been disturbed by the results.

However, the difference in transfer characteristics of the circuits shows that anomalies must inevitably occur on the reproduction of some material, and it seems pointless to mix systems if it can be avoided. Although JVC sell cassette decks which incorporate ANRS rather than Dolby circuitry, the company does have a Dolby licence, and has already brought out a model with Dolby circuitry. Also although the NR1020 ANRS add-on unit marketed by JVC is a well-engineered reasonably priced, and stylish piece of equipment, it seems superfluous on the market while there are Dolby add-on units available, for instance from Videosonic and Teac.

An important point worth noting is that because the ANRS system requires reference level calibration in exactly the same manner as the Dolby system, all the comments relating to calibration problems and tape type anomalies apply to ANRS as they do to Dolby. It is also worth noting that JVC have sensibly chosen the same calibration level standards for ANRS as are standard for Dolby; thus an ANRS calibration tape may be used to set up or check Dolby equipment, or *vice versa.*

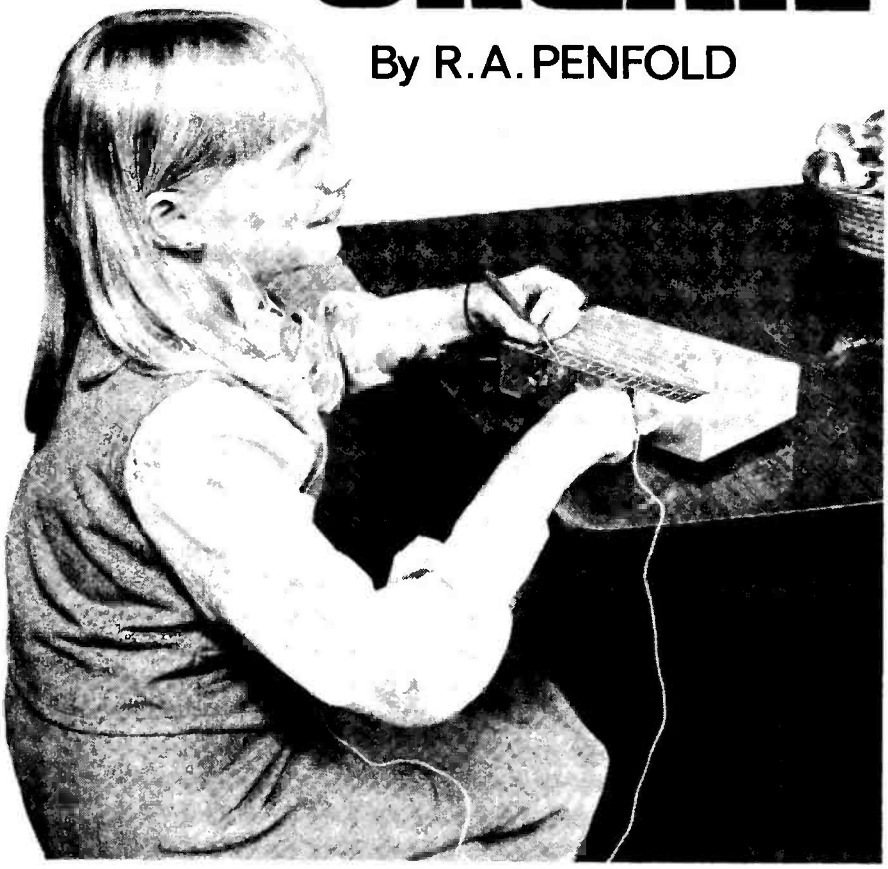
Continued next month

The JVC CD-S200 cassette deck which incorporates the ANRS system.

A Party time Project...

Mini ORGAN

By R.A. PENFOLD



MOST miniature electronic organ designs for the home constructor, while providing a lot of fun for a modest outlay, leave a lot to be desired musically. The main reasons for this are that these designs cannot produce chords, but are limited to one note at a time. Also they are usually fitted with a miniature speaker which limits both the volume and tone of the instrument.

It is not really feasable to overcome the former in a very simple unit, but the latter is easily overcome by designing the instruments to feed into a hi-fi system or other speaker/amplifier combination. Suitable amplifiers are described in E.E. from time to time. Simple circuits to enhance the effect of the organ can then be included in place of the now unnecessary output stage and internal speaker. In this way a very versatile but simple organ can be produced at low cost.

It was with these points in mind that the organ described in this article was produced. It is of the stylus operated type for the sake of cheapness and simplicity, and has two circuits which help to give a more pleasant and interesting sound. The first effect is vibrato, and the second is an envelope shaper. The envelope shaper was originally included to enable the instrument to simulate a reed organ.

A reed organ has a sound which builds up to normal volume relatively slowly (although the actual time taken is only a fraction of a second), whereas the basic electronic organ builds up to normal volume instantaneously. The purpose of the envelope shaper is to delay this build up very slightly so as to give a smoother and more pleasing sound, not unlike a read organ.

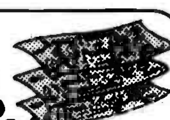
The time taken for the volume to swell up to maximum is adjustable, and it can be set to give a fairly long build up well in excess of one second. This produces a completely different and rather weird effect from the unit. Both the vibrato and envelope shaping circuits can be switched in and out of circuit as required.

THE CIRCUIT

The unit comprises three separate stages, these being the tone generator, the envelope shaper, and the vibrato oscillator, as can be seen by referring to the circuit diagram of the instrument. This appears in Fig. 1.

A unijunction transistor in a relaxation oscillator circuit is used as the tone generator, and this part of the circuit is quite conventional. Two octaves are covered (C to C), these being the ones above and below middle C. The frequency of oscillation is

FOR GUIDANCE ONLY



ESTIMATED COST OF COMPONENTS excluding V.A.T.

£5.00

excluding case

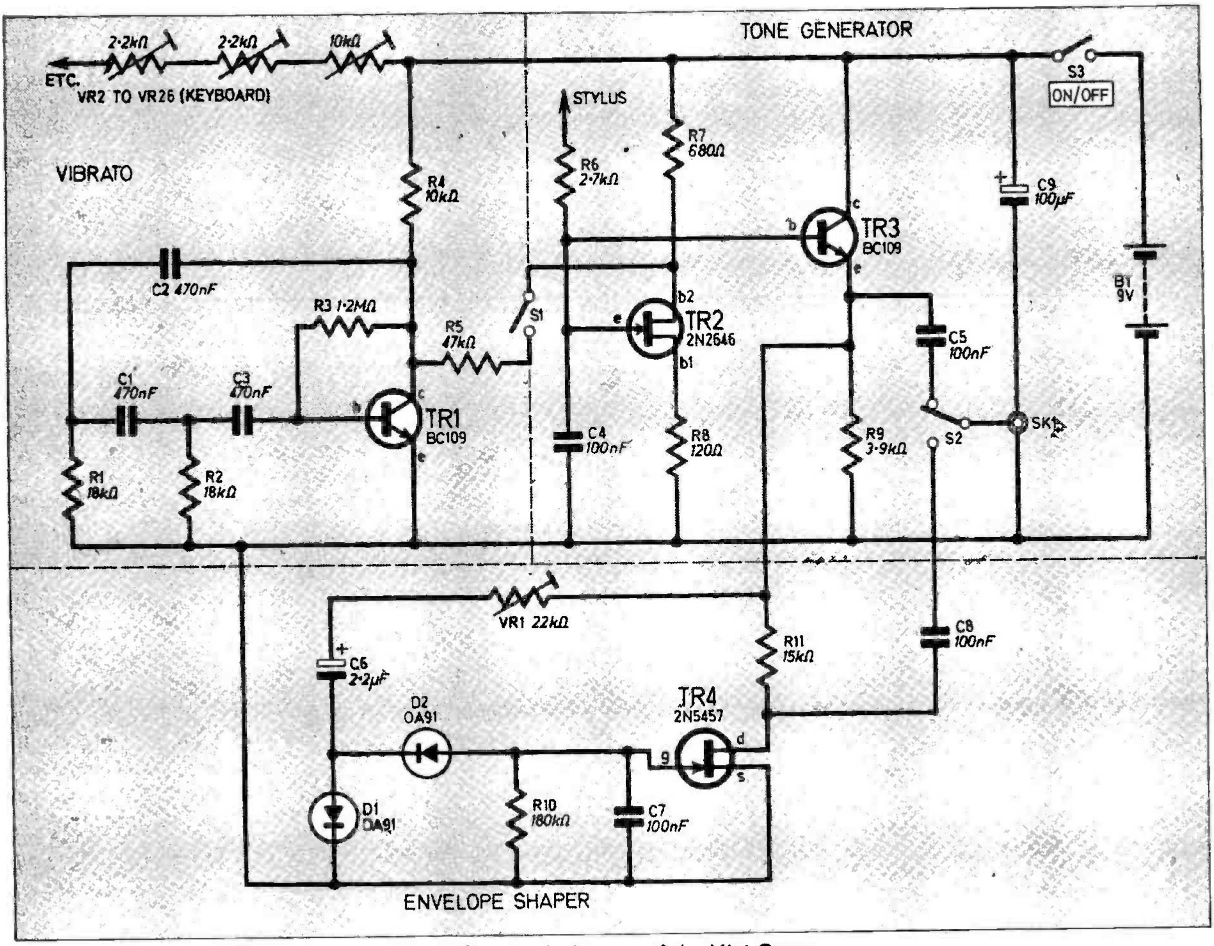


Fig. 1. The circuit diagram of the Mini Organ.

determined by the values given to the capacitor C4, and the resistance between TR2 emitter and the positive supply. Preset resistors connected in series provide 25 resistance values between the stylus and the positive supply rail, one preset being used to precisely tune each note. This type of oscillator is quite stable, and variations in supply voltage due to battery ageing do not significantly detune the tone generator.

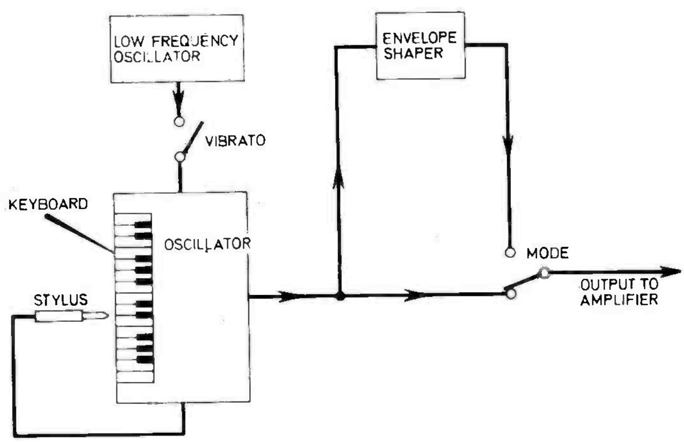
The output at the emitter of TR2 is a sawtooth waveform of quite high amplitude (about 1·8V peak to peak) but is at a fairly high impedance. An emitter follower buffer stage using TR3 is interposed between TR2 and the output. TR3 provides only about unity voltage gain, but has a low impedance output which is capable of supplying enough current to drive the envelope shaper circuitry.

The envelope shaper is built

HOW IT WORKS

An audio oscillator produces a range of two octaves (25 notes) and this can be fed either direct to an amplifier and speaker, or via an envelope shaper. The envelope shaper slightly delays the otherwise instantaneous build up of the output, to give a smoother more pleasant tone which is a simulation of the sound produced by a reed organ. It can also be adjusted to give a long build up which gives a weird effect.

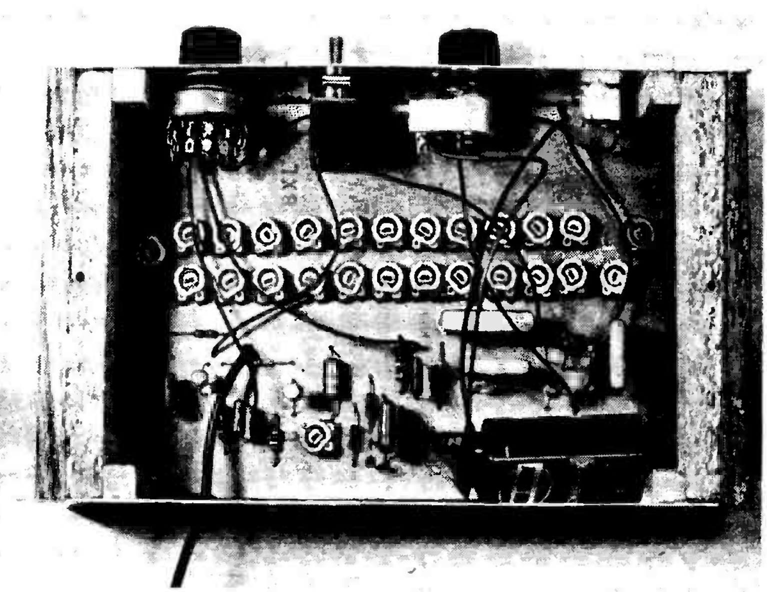
A low frequency oscillator can also be switched into circuit to modulate the tone generator oscillator to provide a vibrato effect.



around TR4, which is a field effect transistor (f.e.t.). This has its gate and source connections tied together via R10, and under static conditions the d-s resistance of TR4 is only a few hundred ohms at most. The output from the attenuator formed by R11 and the d-s resistance of TR4 is therefore virtually zero. This attenuator is fed from the output of TR3.

When a signal is present at TR3 emitter, some of this signal is fed via VR1 and C6 to a voltage doubling rectifier circuit using D1 and D2. Capacitor C7 smoothes the output from these to a negative d.c. potential which reverse biases TR4. This increases the d-s resistance of TR4 to many megohms, and increases the output level from TR4 drain to virtually that appearing at TR3 emitter.

It takes a short while for the bias on C7 to build up to maximum, and so it also takes a while for the signal at TR4 drain to swell to maximum as well. By adjusting VR1 it is possible to vary this time from little more than zero to a second or so. Although the stylus is only removed from the keyboard for a fraction of a second between notes, this is long enough for C7 to largely discharge through R10, so that the process starts off afresh at the beginning of each note.



Capacitors C5 and C8 provide d.c. blocking at the output, and S2 selects the output either direct from the tone generator or via the envelope shaper.

VIBRATO

A phase shift oscillator is used in the vibrato generator; TR1 is biased as a high gain common emitter amplifier, and frequency selective positive feedback is provided between its collector and base via the three stage phase shift network using C2-R1, C1-R2, and C3-input impedance of TR1. This oscillator provides a sinewave output at a very low frequency (about 5 Hertz). When S1 is closed this is fed to the b2 terminal of TR2 via R5. This has the effect of frequency modulating, and to a lesser extent amplitude modulating the tone generator oscillator. This gives a fuller, more satisfying tone on most types of music.

Switch S3 is the on/off switch and C9 is the sole supply decoupling component.

CASE

It would probably be possible to fit the unit into any case of adequate dimensions, but a tailor made case will give the most compact and neat finish. The case design used by the author is probably easier from the constructional point of view than adapting a ready made case.

Two 118 x 40 x 19mm pieces of chipboard form the sides of the case and two 196 x 40mm pieces of 20 s.w.g. aluminium form the front and rear panels. The front panel is drilled to take the controls and SK1, and the general layout of this can be seen from the photographs. These case parts are then glued together using any good general purpose adhesive. Four 36 x 10mm square timber

Components

Resistors

R1	18kΩ	R7	680Ω
R2	18kΩ	R8	120Ω
R3	1·2MΩ	R9	3·9kΩ
R4	10kΩ	R10	180kΩ
R5	47kΩ	R11	15kΩ
R6	2·7kΩ		All ¼W carbon ± 10%

Potentiometers

VR1 22kΩ horizontal miniature preset
VR2 10kΩ horizontal miniature preset
VR3 to VR26 2·2kΩ horizontal miniature preset (24 off)

Capacitors

C1	470nF C280 type	C6	2·2μF 10V elect.
C2	470nF C280 type	C7	100nF C280 type
C3	470nF C280 type	C8	100nF C280 type
C4	100nF C280 type	C9	100μF 10V elect.
C5	100nF C280 type		

Semiconductors

TR1 BC109 silicon *npn*
TR2 2N2646 unijunction
TR3 BC109 silicon *npn*
TR4 2N5457 *n* channel f.e.t.

See Shop Talk page 636

Miscellaneous

S1,3 s.p.s.t. toggle or rotary (2 off)
S2 s.p.d.t. toggle or rotary
B1 9V type PP3
SK1 3·5mm jack socket
Printed circuit board size 156 x 114mm plus etching materials; battery clip to suit; test prod or similar for stylus; control knobs (2 off); materials for case; suitably terminated screened lead for connecting unit to amplifier.

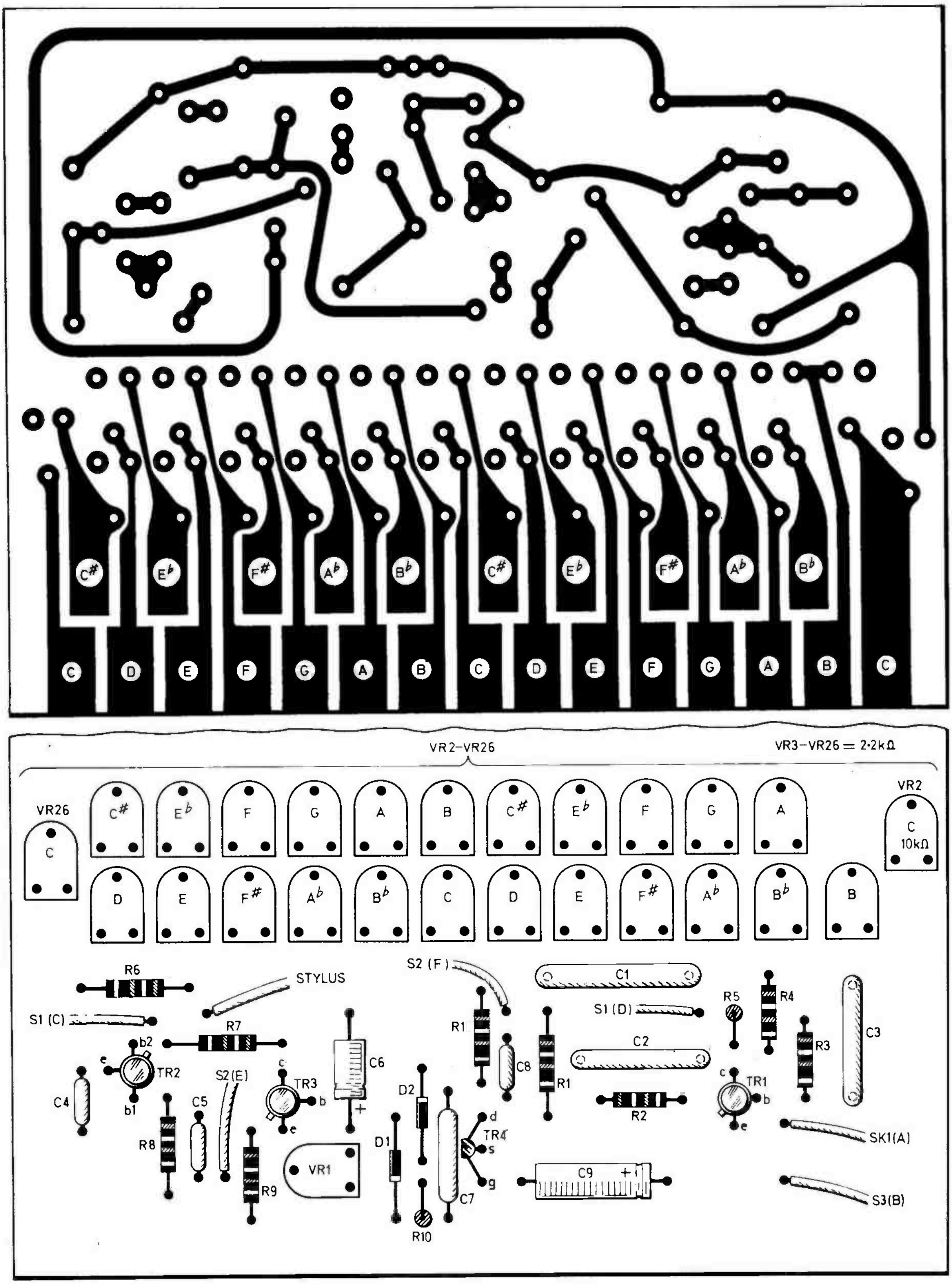
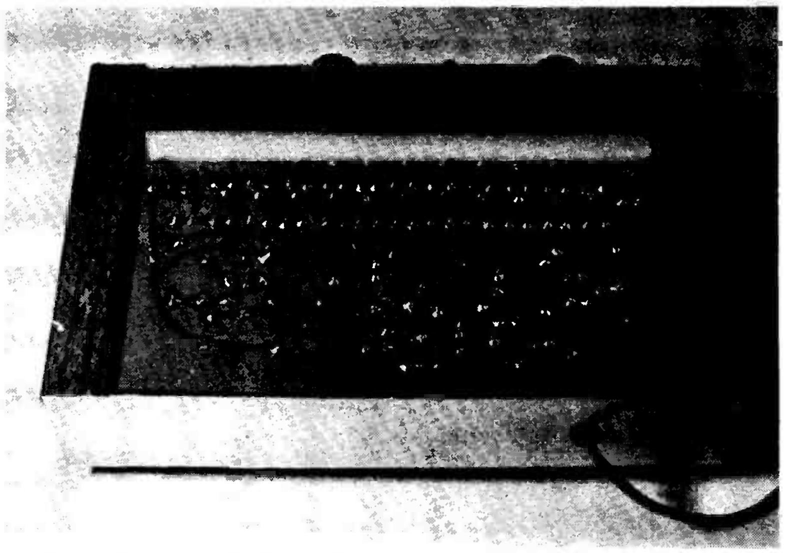


Fig. 2. Layout and wiring of the p.c.b. shown full size.

corner pieces are then glued into position, and the p.c.b. will eventually fit on top of these. They fit flush with the bottom of the case.

A 196 x 118mm piece of 20 s.w.g. aluminium forms the base-plate of the case, and 196 x 90mm panel of the same material is used as a lid. These are each held in place by two small wood-screws which screw into the chip-board sides. The base panel must be fitted with cabinet feet to prevent its mounting screws from scratching the surface on which the organ is placed.

Cover the lid completely with Fablon or a similar self adhesive plastic material. This acts as insulation as well as providing a neat finish. The ends of the case can also be finished with this material.



Underside view of the board showing key section and case mounting.

P.C.B.

All the small components are mounted on a printed circuit board, and this also contains the keyboard, as can be seen from Fig. 2. This shows both sides of the p.c.b. and is reproduced actual size so that the design can be easily copied.

Commence construction of the p.c.b. by cutting out a panel of the required size using a hack-saw, and then clean the board thoroughly (Brillo Pad or similar). Then mark out and drill the component mounting holes using a twist drill of about 1 to 1·5mm diameter.

Next draw the keyboard onto the board using a hard (4H) pencil. The dimensions of the key-board can be obtained from Fig. 2. When it has been completed, the areas representing the keys are filled in with etch resist. This is most easily done using a resist pen and ruler, filling in the appropriate areas with a succession of overlapping lines working steadily down the board. In areas where one slips over the line, the dried resist can be removed with the point of a compass. The rest of the design can then be marked out.

After the board has been etched in ferric chloride solution it is cleaned again to remove the resist, and the components can then be mounted and soldered in. Leave the semiconductors until last, and be especially careful not to overheat the diodes while they are being soldered into circuit.

When all the components have been mounted, the top and base panels of the case are removed and the p.c.b. is placed in position. It is then an easy matter to complete the remaining wiring. This is shown in Fig. 3.

A strip of self adhesive foam rubber (sold as draught excluder) can be placed along the rear of the keyboard, and this will fill in the gap between the lid and the board and thus produce a neat finish. The lid is used to trap the p.c.b. in position, and it will be necessary to fix some foam rubber, Bostik Blue-Tak, or something of this nature to the under-side of the lid to ensure that the board is firmly secured in place.

TUNING

The organ is tuned against a piano or pitch pipes starting with the highest C, and working down chromatically to the lowest C. *It must be tuned in this sequence.* Fig. 2 shows which preset is used to tune which note.

Preset VR1 is merely adjusted to give the attack time which the user finds most acceptable, and a little experimentation is called for here.

The level of vibrato can be varied if desired by altering the value of R5. The lower the value of R5 the greater the amount of vibrato.

The output of the unit can be fed to any amplifier which has a high level, high impedance input, such as a crystal or ceramic cartridge input. A screened lead is used to connect the two pieces of equipment. It can also be used with a crystal earpiece for private listening and practising. ☐

PLEASE TAKE NOTE

The answer to Exercise 13.5 *Teach-In 76* October issue should be approx 715Hz.

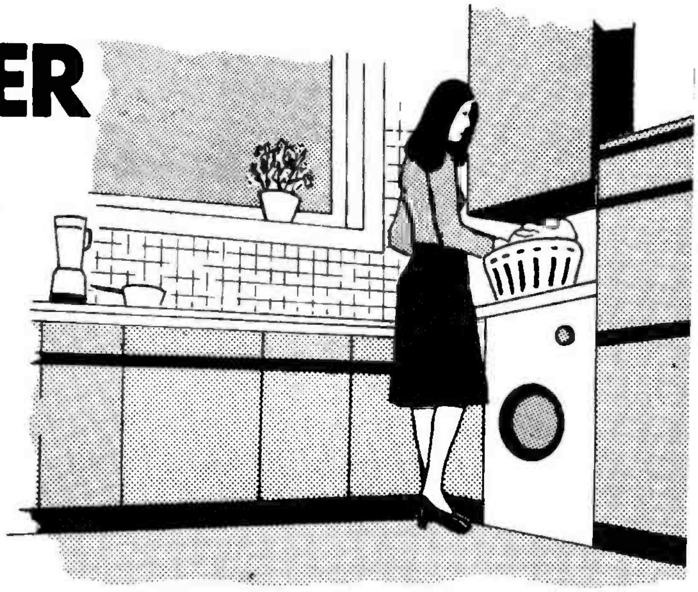
In *Doing It Digitally* part 1 October issue the 1kΩ potentiometer called for in the components list should be lin. not log. We apologise for these errors.

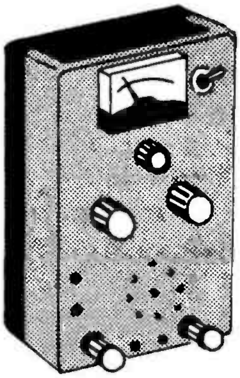
Next Month...

GET OFF TO A GOOD START!

TUMBLE DRYER CONTROLLER

Not only does this controller ensure your clothes are dried just the right amount, but it also saves you money by switching off the machine when the preset level is reached.





MULTI-TESTER

A multi purpose test instrument designed specifically to incorporate many of the parts used in *Teach-In 76* but which will be attractive to all constructors.

SPECIAL OFFER
SOLDERING KIT

Plus...

- Photocube Receiver
- Car Brake Warning Device
- Soldering in Easy Steps

everyday electronics

JANUARY ISSUE
ON SALE FRIDAY
DECEMBER 17th

A Simple Display Unit for the Home...

LIGHT FLASHER

By JAMES RAWSON

THIS simple mains powered Light Flasher will find many uses for entertainment around the home, such as an unusual light show at a party. It will also enhance the appearance of pop groups and discos alike. The prototype was constructed with two circuits in one unit to give a more interesting display but any number can be employed provided the power supply unit can handle the load. With the transformer specified, ten relays (as specified) can be operated simultaneously.

The total bulb wattage handled by each channel will depend on the rating of the relay contacts. With the type specified, up to 500 watts per pole can be achieved.

CIRCUIT DESCRIPTION

The complete circuit diagram for one channel of the Light Flasher is shown in Fig. 1, and is seen to be a simple astable multivibrator driving a "transistor switch" TR3 loaded with relay RLA.

Suppose that initially TR1 is off, and TR2 is on so that the relay contacts are open. The base of TR1 is at a low voltage. Capacitor C2 is charged up by the current flowing through VR2, and when the voltage at the base of TR1 becomes high enough, TR1 switches on which brings the collector of TR1 to low voltage. This immediately brings the other side of C2, and hence the base of TR2, to a low voltage, and TR2 switches off. This causes TR3 to switch on and close the relay contacts.

Capacitor C2 now charges up from the current flowing through VR1, until the base of TR2 is at a high enough voltage, and then TR2 switches on (TR3 then switches off and relay contacts open) causing the base of TR1 to go to a low voltage once again. This process continues for as long as the supply is switched on.

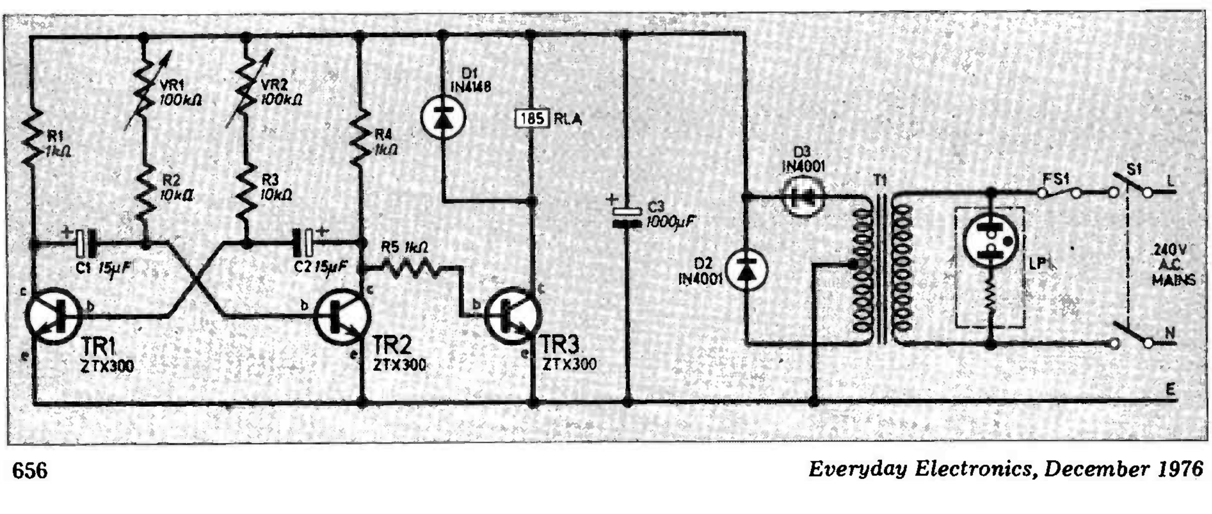
Presets VR1 and VR2 control the rate that C1 and C2 charge up and therefore the time the relay is on and off respectively.

The power supply for the unit is mains derived. Mains voltage is stepped down by T1 and then full wave rectified by D2 and D3 and finally smoothed by capacitor C3 providing about 9 volts d.c.

CONSTRUCTION

In the prototype having two channels, the circuit was constructed on two pieces of 0·15 inch matrix stripboard, one holding components for channel 1, power supply rectifiers and smoothing capacitor (board A) and the other for channel two components (board B) which is identical to board A up to hole 22.

Fig. 1. Shows the circuit diagram of the power supply and one channel of the Light Flasher.



If only one channel is required, ignore board B. If more than two channels are required, board B should be repeated for as many times as required.

The layout of the components on the stripboard is shown in Fig. 2. Begin by making the breaks on the underside of the board as shown in Fig. 2 and then position and solder the link wires, resistors and capacitors in place followed by the semiconductors. Remember to use a heatshunt when soldering the latter in place to prevent possible thermal damage.

The size of the case to house the unit will depend on the number of channels required. The layout of the components is not critical and can be changed to suit individual requirements. A wiring diagram is shown in Fig. 3 for guidance but the exact location within the case may vary according to proposed use.

Begin by preparing the case to accommodate all the components and then secure these in position. The terminal blocks may be glued or bolted in place. The terminal blocks for connecting to the lamps may be substituted by two-pin sockets for ease of use and storage. Fixing brackets can be made from aluminium or tin plate to hold the relays in position.

If a metal box is employed, it is important that this is earthed. Make sure of this by checking that the solder tag fixed to the transformer fixing makes good contact. Also, the component board(s) should stand well clear of the base of the case. Spacers are recommended and it may be a good idea to lay a strip of insulating tape on the metal base immediately below the board position. The flying leads should be attached to the component boards and the boards fixed in position and the unit wired up as shown.

TESTING

When the wiring up has been thoroughly checked, the unit may be tested. If a testmeter is available, set to 100 volts d.c. and fix across capacitor C3. Do not connect any load to the relays (do not connect the lamps) and then switch on. The mains neon should light up and the reading on the meter should be about 9 volts. You should hear the relays clicking in and out and the frequency of "clicking" should be variable by means of the potentiometers.

Components

Resistors
R1 1kΩ
R2 10kΩ
R3 10kΩ
R4 1kΩ
R5 1kΩ
All ¼W/carbon ±10%

See **Shop Talk** page 636

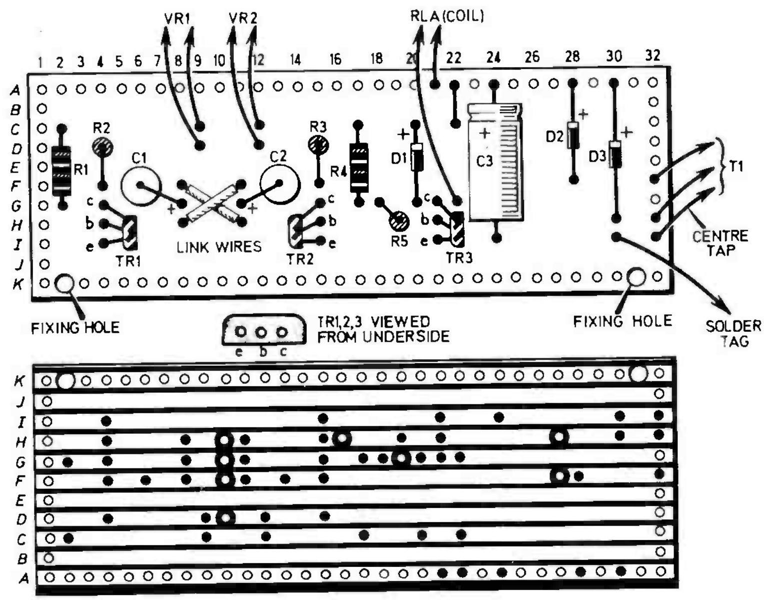
Potentiometers
VR1 100kΩ carbon lin.
VR1 100kΩ carbon lin

Capacitors
C1 15μF 12V elect.
C2 15μF 12V elect.
C3 1000μF 12V elect.

Semiconductors
D1 1N4148 or similar diode
D2, 3 1N4001 or silicon rectifier diodes (2 off)
TR1 ZTX300 silicon *npn*
TR2 ZTX300 silicon *npn*
TR3 ZTX300 silicon *npn*

Miscellaneous
T1 mains primary 6-0-6 280mA secondary type MT280
LP1 panel mounting mains neon with built-in resistor
RLA type H/D 12V (Doram) 185 ohm coil mains/2A contacts
FS1 500mA fuse with holder
S1 d.p.d.t. mains toggle switch
Veroboard: 0·15 inch matrix size 11 strips x 32 holes (board A), 11 strips x 22 holes (board B); mains cable; grommets; 2A terminal block; knobs; case; 4BA fixings and spacers.

Fig. 2. The layout of the components on the board and breaks to be made on the underside for the first channel. For further channels repeat up to hole 22.



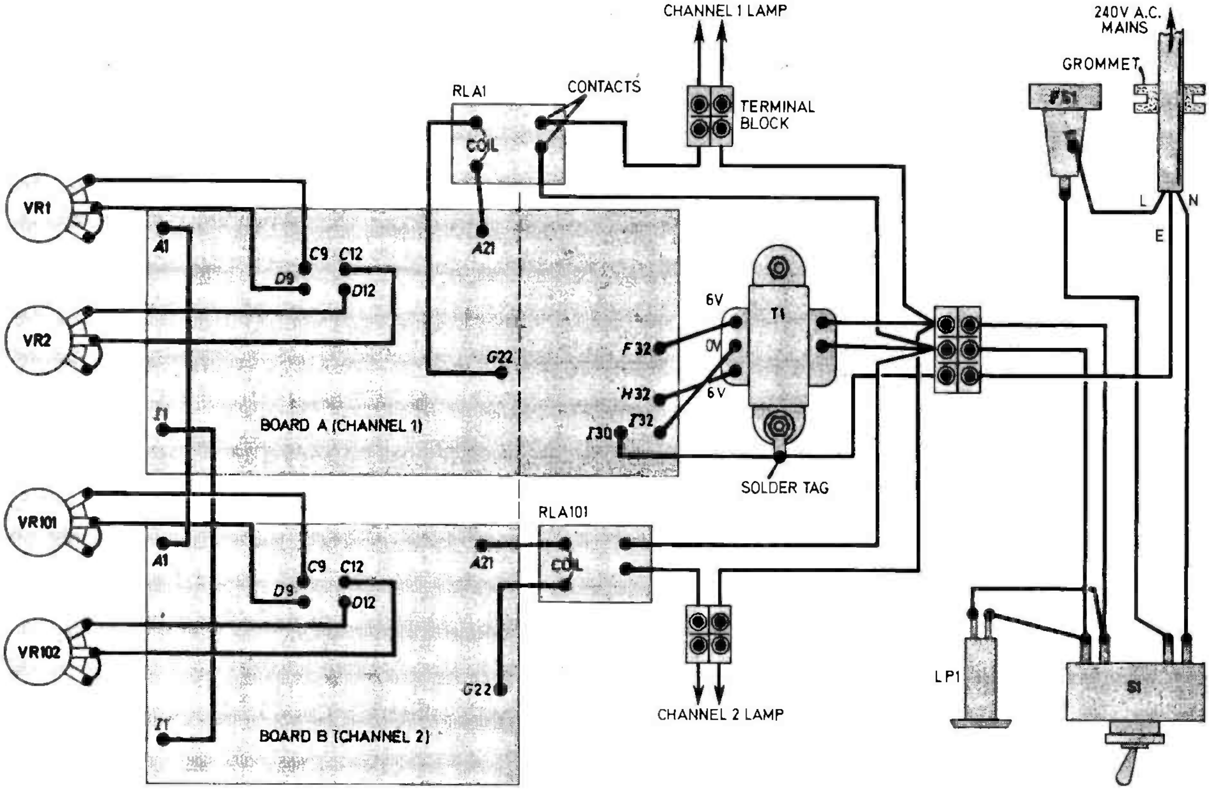


Fig. 3. Shows wiring up of a two channel system.

If all is well, switch off and set the meter to read 250 volts a.c. and connect to the lamp terminal blocks. Switch on. The meter needle will be reading alternately zero and 250V.

If all is well, switch off and replace the meter by a bulb. On switching on the bulb should flash on and off, the on and off times being controlled by the potentiometers VR1 and VR2.

Check the other channels in the same way.

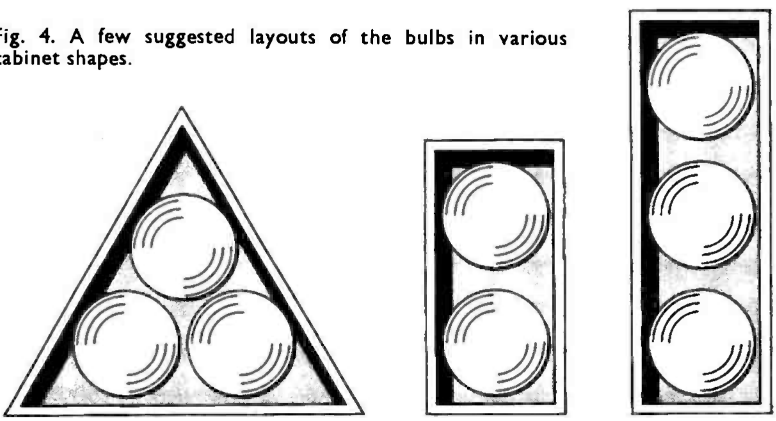
A greater range of flash times can be obtained by using potentiometers of greater value. If a different range of flash times is desired, then different capacitors must be used. For faster flash rates, smaller value capacitors and vice versa.

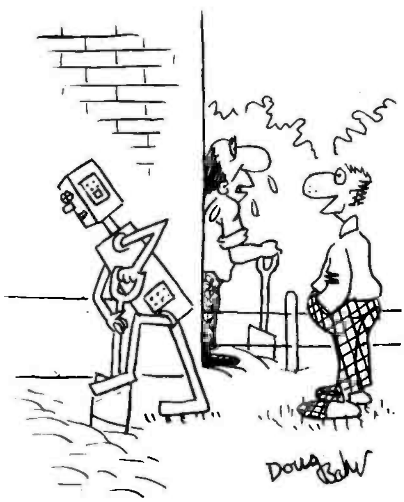
LAMPS

As stated earlier, the relays specified in the components list can handle up to 500 watts per contact pair. This can be made up in many ways eg. 2×250W, 3×150W, 5×100W or combinations of these and other wattages in same or different colours.

Cabinets to house the lamps are left to the designs of the constructor. The author suggests a few basic designs made from wood, and suitably ventilated (see Fig. 4). ☐

Fig. 4. A few suggested layouts of the bulbs in various cabinet shapes.





"Electronics? Why do you think I ought to start taking an interest in electronics?"

Physics is FUN!

THIS MONTH.... A selection of readers "Favourite Experiments"

The Impossible

Here's a simple experiment, which I have used many times for amusement.

Stick a needle vertically in a block of wood. Balance a spoon on the needle. Rub a candle on clothing and push or pull the spoon around on top of needle without touching the spoon, see Fig. 1.

The spoon can be made to spin quite fast. I always present it as, "you can make the spoon move without touching it".

Children like this one, and continue to do the "impossible", themselves.

E. Sharp,
Leeds

A good and simple trick demonstrating attraction and repulsion from static electricity. Fun to do.

Magic Box

I am enclosing details of a very simple gadget which I call the Magic Box. I made it up at the request of my grand daughter when she was invited to a teenage party, and wanted a little gadget to impress those present of her magical powers.

The little box, details in Fig. 2, is passed around the company present, with instructions to see if anyone has enough electricity in their hand, on picking up the box, to light the lamp.

It does not matter how they pick it up, they will always fail to light the lamp. But being returned to the operator, on being picked up, it never fails to light. Now how is this done?

The person passing around the box has a small circular magnet fixed to the palm of their right hand, this, when the hand is placed over the box, operates the reed switch.

The magnet can be securely fixed to the palm of the hand by a small narrow strip of sticking plaster. The box is cheap to construct, simple to operate (even a child can do so) and provides hours of entertainment at all sorts of parties.

Hoping this will be of interest to your readers.

F. G. Sadler, G3UZ
Worthing.

Thank you Mr. Sadler. An amusing toy that anyone can make.

Ring Levetator

I have tried this experiment (see Fig. 3) at school and reasonable results occurred. It was found the larger the ring (heavier) the better it was lifted and if there was a break in the ring, levetation would not occur.

I am not too sure how it works but there is some connection between this experiment and the eddy current experiment in *Physics is Fun*, May, 1976.

Richard Baker,
Newcastle-Upon-Tyne.

There are links here with many basic facts about electricity and magnetism—some that have already been published in Physics is Fun! *including the electromagnet and magnetic repulsion, and some that are due to be published that include induced magnetism and the transformer.*

Briefly, a magnetic field is formed round the coil by the passage of the current, and the iron rod is also magnetised. (Note that this experiment will only work with a.c.) The rod induces a current in the ring which causes a magnetic field which is repelled by the coil magnet. The rod therefore serves a dual purpose, the second of which is to keep the ring positioned above the coil. A nice one, Mr. Baker!

Moving Cotton!

I would like to submit this experiment which is very simple, and I think the explanation is in line with your explanation of the electroscope and light bulb experiment.

Take a simple 100 watt light bulb as shown in Fig. 4, and very gradually dangle a length of black cotton toward it with the cotton end about at the level of the centre of the bulb.

It will be found that the end of the cotton will jump or be pulled towards the surface of the bulb.

A. P. Pedrick,
Selsey.

I have tried duplicating this experiment, but I am not satisfied with the results that I get. I suppose that my study is too draughty! Perhaps readers will have better luck.

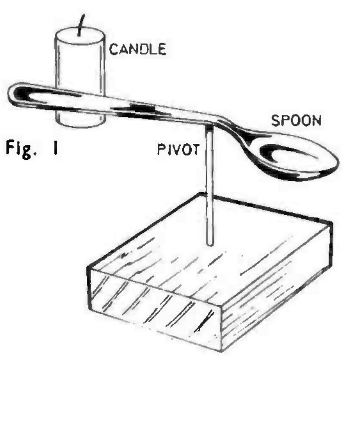


Fig. 1

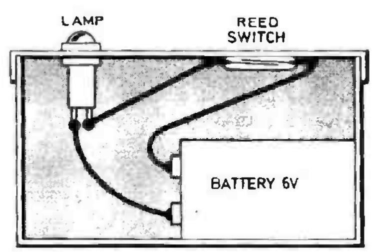


Fig. 2

Fig. 3

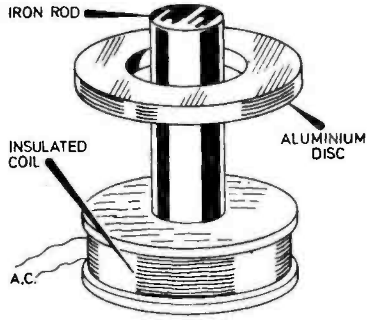
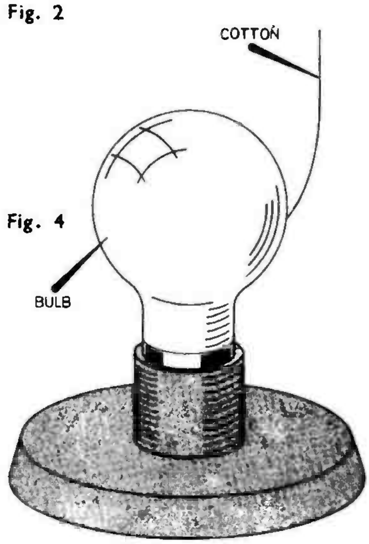


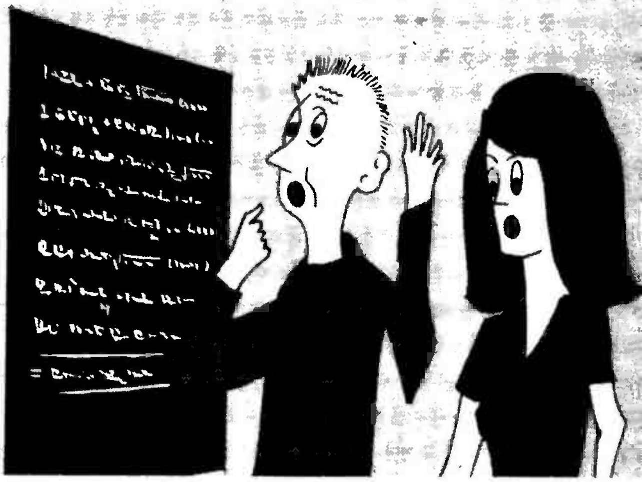
Fig. 4



DO MATHS BOTHER YOU?...

LET'S FIGURE IT OUT

Part 1



By PHIL ALCOCK

ONE of the aspects of electronics that sometimes troubles readers is the need to employ maths for some of the circuit calculations and descriptions. Fortunately we can learn quite a lot of electronics without using any difficult maths and this initial article is intended to help those readers who, in the past, have tended to shy away from equations and similar "unknowns" that crop up from time to time.

This article has been prompted by correspondence from readers of E.E., some of whom have followed the Teach-In series', but it is not necessary to have read these articles to follow the topics covered here.

NAMES, SIZES AND UNITS

If we wish to measure some quantity such as current, voltage or resistance we need two things. The first requirement is an indication of the *unit* of measurement for the quantity considered. For example, a length of wire can be measured in centimetres, inches or yards.

Each of these names represents a particular choice of *unit of length* and, of course, they differ in magnitude. The yard unit is longer than the inch unit and similarly the inch unit is longer than the centimetre unit.

Some units are preferred because of the need to standardise but it is also necessary to be able to convert from one unit to another, since the information that we wish to use may be given in different units to those required.

As well as the unit of measurement we need to say *how many* of these units represent the size of our particular article or quantity. Let us see how this works in practice. If we wish to measure the size of this page using the centimetre unit, we need a rule which is calibrated in terms of this standard length. We lay the rule on the paper with one edge at the "start" of the centimetre scale and read off the scale at the other edge of the page and we get an answer of 24·9 centimetres.

Since each of these centimetres contains 10 millimetres (which are simply smaller sub-divisions of the standard metre length) we could express the length as 249 millimetres. In the case of imperial units the answer would be approximately $9\frac{3}{4}$ inches.

Often it is convenient to abbreviate the unit name, to save space, and in addition we may use various letters to indicate sub-divisions or multiples of the basic unit. Some examples are ms (millisecond), μF (microfarad), mm (millimetre), MΩ (megohm).

Usually a small letter indicates a *subdivision* of the unit, as in ms for millisecond (one thousandth part of a second) whereas a capital letter indicates a multiple of the unit as in MΩ for a million ohms. One exception to this rule is the use of a small "k" (for kilo) in kΩ (kilohm). Most rules have exception!

TOLERANCES

When dealing with the sizes of electronic components we may find that the manufacturer only provides his goods in certain specific sizes. In addition, because of manufacturing difficulties or the economics of production the component values will have a spread or tolerance which simply means that the actual value is within a certain range. Tolerance is usually expressed by a percentage (%) and since the value may be high or low we find expressions like

$$R1 = 100k\Omega \pm 5\%$$

In this expression the value of a certain resistor, R1, is given as 100 kilohms (100,000 ohms) and the maximum possible deviation from this value during manufacture is plus 5% (higher than 100kΩ) or minus 5% (lower than 100kΩ). Since "one per cent" means "one hundredth part", which in this example corresponds to 1kΩ, the resistor R1 may have a value as high as

$$100k\Omega + 5k\Omega = 105k\Omega$$

or may be as low as

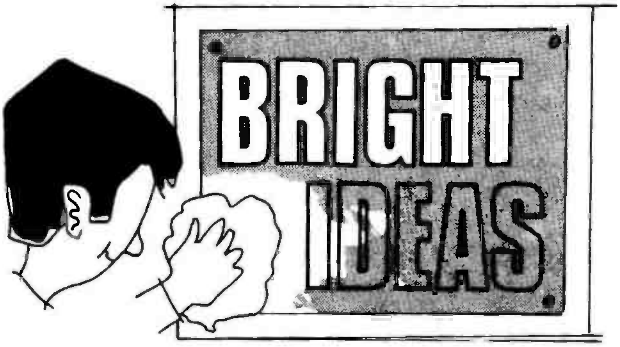
$$100k\Omega - 5k\Omega = 95k\Omega$$

The 100kΩ is sometimes called the *nominal* (or average) value.

Whenever we measure any quantity the result is only known to a certain accuracy, i.e. there is always some uncertainty in the answer. Accuracy here simply means closeness to the true value.

Electronic components can be tested in various ways to see if they are free from damage—they can also be tested to determine their electrical value.

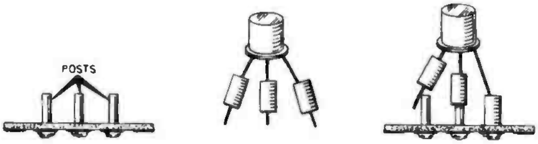
Continued next month



By using pieces of wire classed as scrap by an electrician, unlimited transistor holders can be made.

The solid-core plastic covered wire that will fit in the 0·15 inch and 0·1 inch matrix holes should be soldered in the holes required and then these "posts" cut to length as shown in Fig.1. Remove the plastic insulation pieces and place on the transistor leads, see Fig.2. and then push insulation piece over the post as shown in Fig.3.

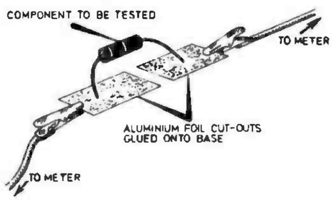
E. R. Wall,
Charlton, London.



When testing many components on a meter to find their value, e.g., unmarked resistors, it is time-consuming to clip and unclip croc clips to each component in turn. A couple of aluminium foil plates, about 12 × 25 mm, separated from each other as in the diagram, and glued to the meter unit or elsewhere, can be used for quick testing.

The component is held onto the plates while the measurement is made, ensuring there is no contact with leads on the hand, and any size component can be fitted onto the plates. Large batches of unmarked parts can be quickly tested.

L. Robinson,
Cheshire.



I have discovered a good way of brightening up a dull aluminium, plastic or diecast box or case.

The method involves a new material on the market for aero-modellers.

It is a cellophane type material which tightens up and adheres to smooth surfaces when it is touched with a warm iron.

This material comes in many different colours, transparent and opaque.

If applied according to the instructions given a finish superior to the best of paint works is achieved in under ten minutes. It is fool proof and hard wearing.

The material is available from aero-modeller shops under the name of "Solar film" and costs about £1 which should last for a long time.

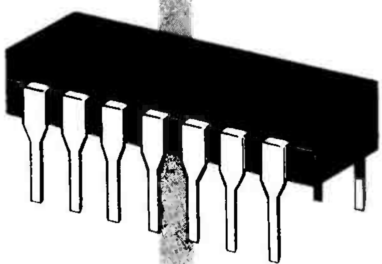
This idea will prove invaluable to the constructor who wishes to put a professional touch to his/her project.

R. Gorden,
East Lothian.

Doing it Digitally...

New Series Part 3

By O. N. Bishop



An introduction to or revision of, digit techniques.

WHEN trying out the NOR circuits, was the circuit of Fig. 3.1 encountered?

Each gate receives its input from the output of the other gate. If this has not been tried already, wire it up and see what it does. To get the most information about it, wire up one lamp to each output (see Fig. 3.2). (If only one lamp is available, connect it to each output in turn.)

Connect both inputs to negative then make the battery connections. Which lamp lights?

Remove one of the inputs from negative (no need to touch it to positive as in effect the input has been taken high by leaving it open). What happens to the lamp?

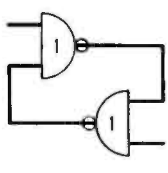


Fig. 3.1. The circuit of a bistable using two NOR gates.

Replace the input on negative. What happens? Take it away again. Replace it.

Remove input 2 from negative (keeping input 1 on negative) and so on.

Keep on removing one wire at a time from negative, sometimes 1 sometimes 2, sometimes 1 several times in succession, sometimes 2 several times in succession, sometimes 1 and 2 alternately.

Try to work out the behaviour of this circuit.

THE BISTABLE

The circuit can be in either of two different states. In Fig. 3.3 the shaded wires show the high parts of the circuit and the unshaded the low parts.

If the inputs and outputs of each gate are checked against the NOR truth table it will be seen that all is correct. The circuit is stable in either state. This is called a **bistable** circuit for this reason.

To get from one state to the other we have to do what was

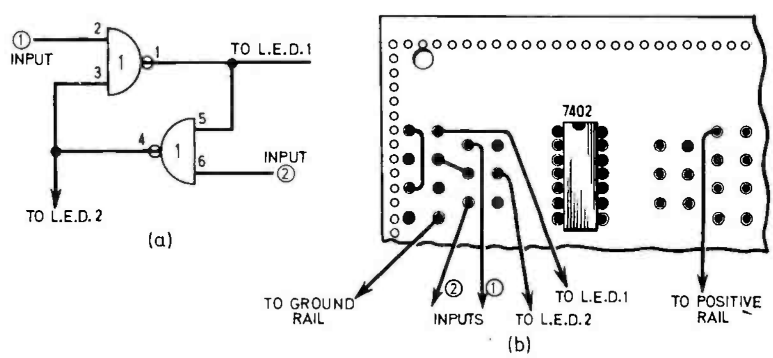


Fig. 3.2. Operation of a bistable can be investigated using the circuit shown in (a), the physical arrangement being shown at (b).

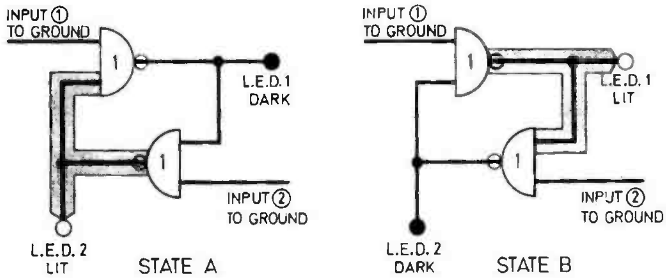


Fig. 3.3. The bistable has two stable states as shown above. The shaded wires indicate parts of the circuit which are high.

done in the experiment—let one input go high. Fig. 3.4 shows the sequence of events.

The bistables will not be affected if output 2 is removed from negative again. To change back to state A input 1 must be removed from negative then it will stay in state A until input 2 is taken high.

The circuit can "remember" which input was last removed from ground. If someone plays with the circuit while the reader is away then he could tell on coming back which input was the last to be removed from negative even though both inputs had been put back to negative.

This kind of circuit is used in some of the later gadgets and circuits.

The circuit works very quickly so that it will change state even if the input is removed from negative for less than a millionth of a second.

Having looked at the 7402 quad two-input NOR gate, we now go on to a new i.c., the 7400, described as a quadruple two-input NAND gate. We will also look at the construction of an i.c. "clock".

NAND GATES

The 7400, like the 7402 contains four identical gates each of which performs the NAND function. What does this gate do? The symbol for the NAND gate gives a clue (Fig. 3.5a), and the best way to work it out is to wire up a gate and make out the truth table.

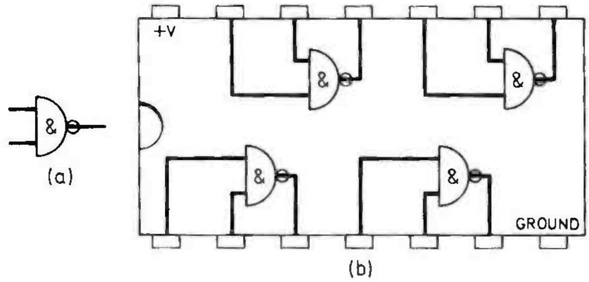


Fig. 3.5. The 7400 integrated circuit (a) shows the symbol for a NAND gate, (b) shows the pin connections for the i.c.

When wiring up the i.c. on the breadboard constructed in Part 2, note that the gates in the 7400 are connected to different pins from the NOR gates in the 7402. Their outputs are on pins 3, 6, 8, and 11 (Fig. 3.5b). The voltage pins are the same as the 7402.

When the truth table for the 7400 gate has been worked out, check it against Fig. 3.6 and at the same time check the other gates in the i.c. to see that they are working properly.

If a NOR gate was made by putting an INVERTER after an OR gate, perhaps a NAND gate can be made by putting an INVERTER after an AND gate, but what is an AND gate?

It seems sense to think of this as a gate which gives a high output only when one input AND the other are high, otherwise its output is low. This is shown in Fig. 3.6, the fourth column showing

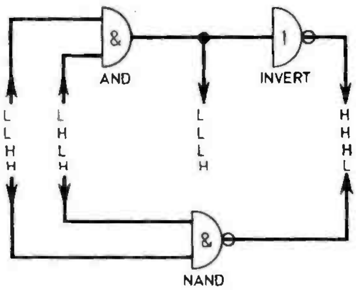


Fig. 3.6. Diagram and table indicating the equivalence between an AND gate followed by an inverter and a NAND gate.

the output inverted, to give NAND; NAND gates are used a lot in logic circuits and they will appear many times in this series.

Sometimes an AND gate i.c. is required and there is the 7408 which contains four of these. Usually contractors make up an AND gate by taking a NAND gate and wiring another gate after it.

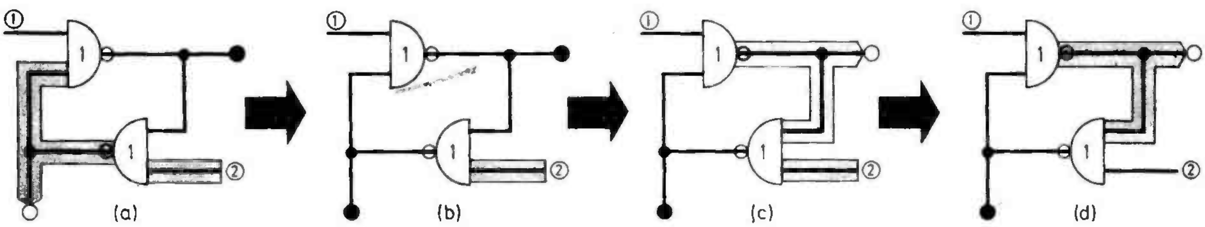


Fig. 3.4. To change from one state to another the sequence of events shown here takes place. Again shaded wires are high.

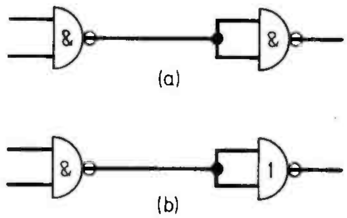


Fig. 3.7. Two ways of constructing an AND gate from a 7400 and a 7402 i.c. (a) uses two NAND gates, one acting as an inverter and (b) uses one gate from the 7402 as the inverter.

How can this be done? Work it out first and then construct the circuit on the breadboard to test the idea. Two possible solutions are shown in Fig. 3.7.

Now try other ways of wiring up NAND gates. Try joining them in the same patterns as the NOR gates in Part 2 but remember that the pin connections of the 7400 will not be the same.

Work out a circuit to solve this problem: "I will not go out today if the sun is NOT shining AND I have a cold. I do not have a cold and the sun is not shining—shall I go out?" When working this out use the following inputs and outputs.

Input 1: The sun is shining = high
Input 2: I have a cold = high
Output: I go out = high.

A NAND BISTABLE

Wire up a bistable using NAND gates. The circuit is shown in Fig. 3.8. The connections are the same as for the NOR bistable though the pins of the i.c. are different. The NAND bistable behaves the same as the NOR bistable in some way but not in others Find out what the differences are. It will be found that the bistable changes state when one of its inputs (normally high) is touched to ground.

There are lots of ways to wire up NAND gates so we will just look at the more interesting ones.

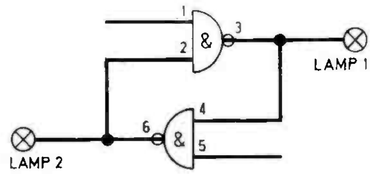


Fig. 3.8. A NAND gate bistable.

SAME OR DIFFERENT?

The first combination of NAND gates that we will look at is very interesting in that it tells if its two inputs are the same (both high or both low) or if they are different (one high and one low).

Five gates are needed, two of which are INVERTERS. The circuit is shown in Fig. 3.9a. Two i.c.s are required, one of these being the three NAND gates and one INVERTER, and the other a 7402 to give the remaining INVERTER.

The wiring of the circuit is shown in full in Fig. 3.9b.

The truth table of the circuit, worked out in stages, is shown in Table 3.1. It will be seen that the lamp lights when the two inputs are the same.

The output of IC1a is obtained by NANDing the two inputs—it is high except when both inputs are high. Outputs of IC2a and IC1b are simply the inputs inverted. The output of IC1d is the outputs of IC2a and IC1b passed through a NAND gate. Finally the output of IC1c is the outputs of IC1a and IC1d passed through a NAND gate.

Working like this across a table, it is not too hard to work out how any circuit will behave but it is still a good idea to build the circuit and test it, when any errors will be discovered.

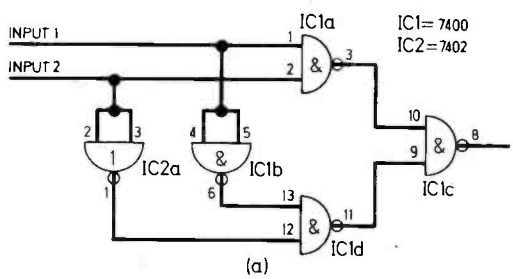
A NAND GATE LATCH

A latch holds something in position. The logic latch "freezes" the circuit output whenever it is necessary. To see how it operates, build the circuit of Fig. 3.10. Again, two i.c.s are required, the 7400 to give the four NAND gates and the 7402 to give the INVERTER.

Part of the circuit should be familiar. IC1c and IC1d are connected as a bistable only, it is drawn a little differently in the diagram. Also only one lamp is used though a second lamp can be connected to the output of IC1c if desired.

To operate the circuit, first disconnect both inputs (or connect them to the positive rail). Now, touch input 1 against ground, then take it away, then touch to ground again. What happens?

It will be found that the lamp is off when input 1 is grounded and on when it is open circuit or touched to positive. The truth table (Table 3.2) could not be simpler.



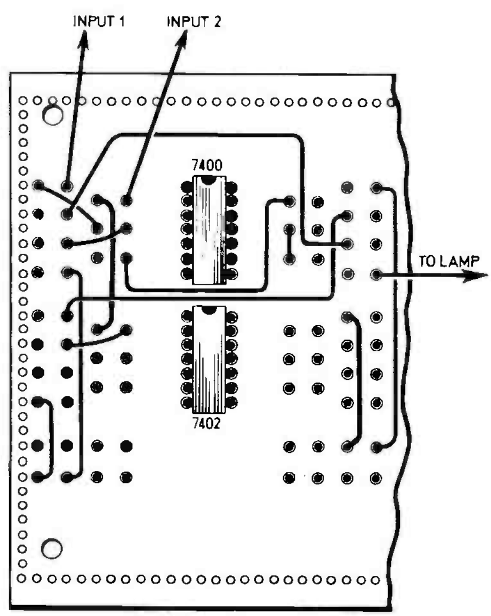


Fig. 3.9. An equivalence gate constructed from a 7400 and a 7402 i.e. (a) shows the circuit and (b) the practical layout.

Table 3.1: Truth Table for the circuit of Fig. 3.9

Inputs 1	2	Outputs IC1a	IC2a	IC1b	IC1d	IC1c
L	L	H	H	H	L	H
L	H	H	H	L	H	L
H	L	H	L	H	H	L
H	H	L	L	L	H	H

Now, if input 2 is grounded, the result depends on what state input 1 was at the time that input 2 was grounded.

When input 2 is grounded the output remains fixed (or "latched") at either high or low just as it was at that moment. When input 2 is made positive again the output once more follows input 1.

The explanation of this is that the output comes from the bistable (IC1c and IC1d) and this bistable can only change state if one or other of its inputs goes low. A low will only be obtained from IC1a and IC1b if both inputs to either one of these gates are high. So unless input 2 is high, outputs from IC1a and IC1b can never be high and the bistable can never change state—it remains latched in whatever state it was when input 2 went high.

Table 3.2: Truth Table of Fig. 3.9 with Input 2 high

Input	Output
L	L
H	H

AN I.C. "CLOCK"

An i.c. pulse generator, or "clock" as computer designers call it, is a circuit which crops up in nearly all complex systems.

It does not look like a clock—no hands or dials—but it can be made to tick and tell the time and has several other uses as well.

The clock is made from a single i.c., the 7400, as well as a few other components, namely two resistors and two capacitors. The exact value of the capacitors depends on how fast the clock is to run. In fact, it is best to have several pairs of capacitors so that the clock can be set to run at different speeds.

For a start, to get used to the circuit, it is best to use two capacitors of fairly large capacity, say 470μF, capable of storing a large charge. Capacitors of this value will almost certainly be "electrolytic" and the positively marked end must not be allowed to become negative with respect to the other end. With most other capacitors it does not matter which way round they are connected.

It is also interesting to have a pair of capacitors of medium capacity (1μF) and low capacity (0·1μF).

For this work in which the highest voltage encountered is 6V, there is usually no problem as to the working voltage of the capacitors as most are well over this rating.

THE CIRCUIT IN ACTION

The clock circuit is shown in Fig. 3.11a and the practical layout on the breadboard in Fig. 3.11b.

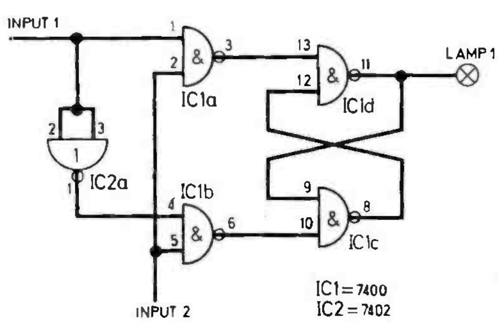


Fig. 3.10. A latch constructed from a 7400 and a 7402 i.c. This circuit "freezes" the state of the bistable when input 2 is taken low.

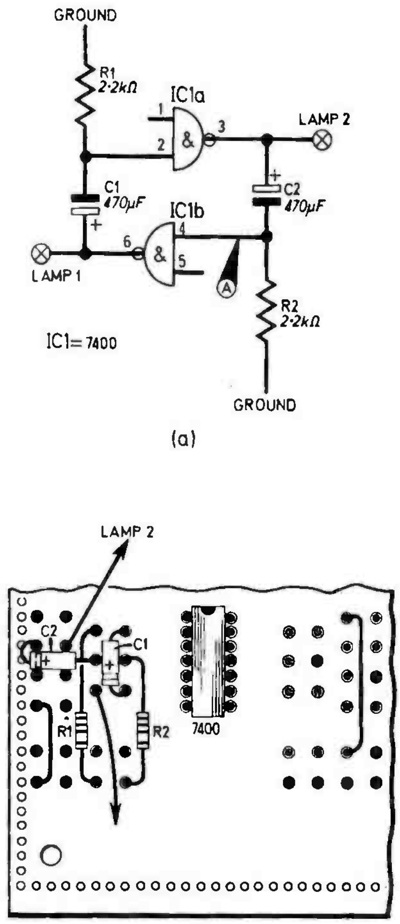


Fig. 3.11. An integrated circuit clock. (a) shows the circuit and (b) the layout. The frequency of oscillation may be changed by altering the value of the two capacitors C1 and C2.

When it is assembled switch on the supply and watch the lamps.

The lamps will be flashing on and off alternately, the rate of flashing being governed by the values of the two capacitors. With 470μF capacitors there will be about 30 flashes per minute.

Actually if the lamps are watched carefully, it will be noticed that when one lamp goes off the other comes on, each being on for the same time that it is off.

There is something about this regular sequence and also something about the circuit diagram that brings to mind the bistable circuit constructed earlier. This circuit too has two states but it is not stable in either of them—as soon as it changes to one state something happens that causes it to eventually revert to its former state.

The circuit is therefore unstable

in either state and this is how it gets the name "astable".

The circuit of Fig. 3.11a uses only one input to each of the NAND gates, the other being left disconnected — effectively high. Try connecting one of them to the ground rail, then connect the other and try to explain what is observed.

CIRCUIT OPERATION

The action of the circuit is best explained by looking at the state of the voltages just after one gate has switched from low to high.

Capacitor C2 cannot change its charge instantaneously, so as the voltage at the output of IC1a goes from about 0V to 6V, point A also rises from 0V to 6V, thus giving a high input to IC1b whose output goes low.

Now point A is connected to ground via R2 and capacitor C2 gradually charges up until eventually the voltage at point A falls to a voltage equivalent to a low input to IC1b whose output then switches to a high which, in turn, causes the input to IC1a to go high. The output of IC1a switches from 6V to 0V.

Capacitor C1 charges through R1 and capacitor C2 now discharges through R2. Eventually, the voltage at the input to IC1a falls to a low, the output of IC1a goes from low to high and the whole cycle begins again.

FREQUENCY

Even if this description of how the circuit operates is too difficult to follow, it can be realised that it depends on the charging and discharging of capacitors. This takes time — the larger the capacitance the longer charging or discharging takes and the slower the clock runs.

Try using smaller capacitors, say 1μF. The flashing effect will now probably be too fast to see, the lamps will just appear to glow at half their usual brightness.

To find out what is happening attach a high-impedance earphone to the circuit. Connect one lead of the earphone to one of the outputs and the other to ground. Now the clock can be heard as a tone. The outputs are changing state about two or three hundred times per second, the exact frequency or pitch depending on the values of the capacitors which, though marked as 1μF can vary from this by about 20 per cent.

The author found the frequency with 1μF capacitors was the same as the A below middle C on the piano—about 213·5 vibrations per second (213·5Hz).

With a pair of 0·1μF capacitors the note was the same as C three octaves above middle C. Since an octave means a doubling of frequency and middle C is 256Hz, the note therefore had a frequency of about 2048Hz. Though this is a rough and ready way of measuring frequency it has shown that the frequency with 0·1μF capacitors is approximately ten times that with 1μF capacitors, which makes sense.

To measure other frequencies with the aid of a piano, the frequencies of other notes, starting from middle C are given in Table 3.3.

Table 3.3: Frequencies of notes on the piano (Hz)

C	D	E	F	G	A	B	C	D
256	288	320	341	384	427	480	512	576

We now have a clock which can give slow pulses useful for timing and can also make "musical" sounds. This finds many uses in later parts of this series.

Before proceeding to the next section, put back the 470μF capacitors and connect the earphone. The clock "ticks", making a sort of electronic metronome. It could be used as a darkroom timer but to be really useful in this application the ticks need to be louder.

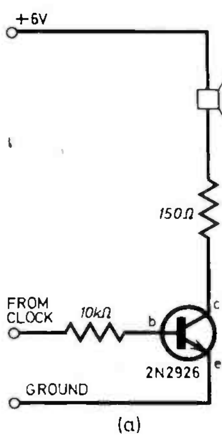


Fig. 3.12. Circuit for a loudspeaker unit.

LOUDSPEAKER UNIT

The loudspeaker unit uses a transistor to switch current on and off through the speaker in time with the output of the clock. The speaker cannot be directly connected to the clock as it would take too much current.

The output of the clock is connected to the base of a transistor through a 10 kilohm resistor which limits the current. The circuit is shown in Fig. 3.12.

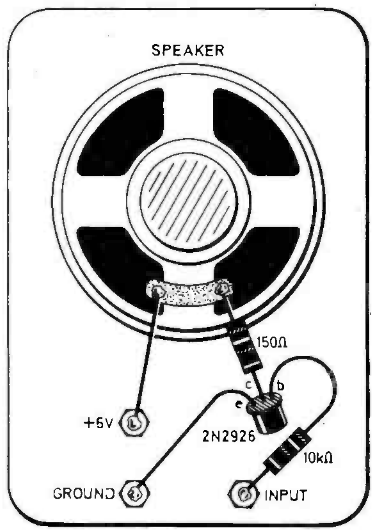


Fig. 3.13. The speaker unit may be constructed as a permanent unit.

When the clock output goes high, current flows into the base which switches the transistor on and a much greater current flows through the speaker and resistor (which simply limits the maximum current) through the collector and emitter to ground.

The circuit gives a really loud note—if it is too loud increase the value of the 150 ohm resistor to about one kilohm or a variable resistor of about one kilohm could be wired in series with the 150 ohm resistor.

For use later on in the series, the loudspeaker unit could be built into a box (Fig. 3.13) although this is by no means essential.

Continued next month

The Extra-ordinary Experi-ments of Professor Ernest Eversure

by Anthony John Bassett

THE Professor continued his comments on Bob's idea for using an electronic impedance converter (Fig. 1) for the matching of an 8 ohm amplifier to a 4 ohm load consisting of two 8 ohm speakers connected in parallel.

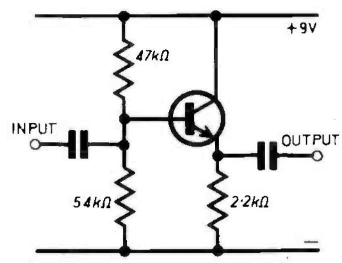


Fig. 1. Bob's circuit for an impedance converter.

"The special type of impedance-converter circuit which may be used really consists of two impedance-converters similar to the one you have drawn, one handling the positive half of the waveform and one the negative half. Special high-gain power-transistors are used, of a type known as 'Darlington transistors'. Each Darlington transistor really consists of two transistors in one case, and often the case also contains two resistors."

The Professor drew a few small sketches (Fig. 2) to show how a 'Darlington' transistor may consist of two transistors and two resistors in one case.

THE CIRCUIT

He also drew another diagram (Fig. 3) showing the circuit of an experimental impedance converter suitable for use in matching extra loud-speakers to an audio amplifier.

"This circuit uses one Darlington *npn* power transistor (TR1), and one Darlington *pnp* transistor (TR2). To avoid crossover distortion, each transistor must have a small amount of d.c. passing through it, even when no audio signal is present, and in order to adjust this two preset variable resistors (VR1, VR2) are used to control the bias, one on each transistor".

"Can we build these impedance converters in time?" Tom wanted to know.

"Yes", the Prof. informed him, "I've got all the parts in stock, and if we all work on it we can build one today".

The Prof. gave some instructions to his experimental robot, and it began to deliver a series of components onto the workbench from the laboratory stores. A few minutes later it delivered a cardboard parcel onto a nearby workbench.

Meanwhile as Tom built a ventilated case for the impedance converter, and Bob assembled the Darlington transistor onto a large finned heatsink, using insulating washers to isolate each transistor from the heat sink, and silicon-

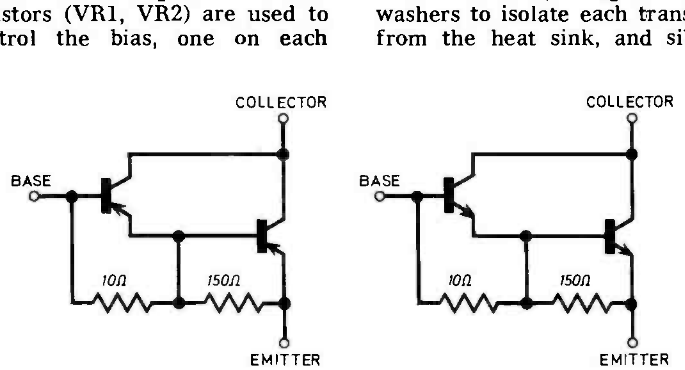


Fig. 2. Basic arrangement of a Darlington transistors.

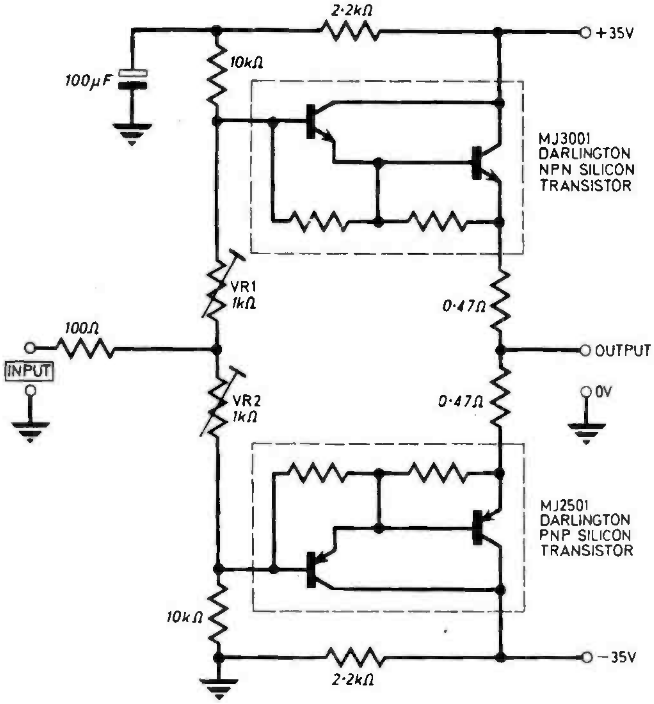


Fig. 3. Circuit diagram of the Profs. impedance converter.

grease to assist heat-transfer. the Professor gave Maurice instructions on how to build a suitable mains power-supply.

POWER SUPPLY

"Although an electronically regulated power supply would be best", the Professor told Maurice, "for this purpose it is not necessary, and we can build a much simpler and less expensive power supply". He sketched a layout and connection diagram so that Maurice could assemble the power-supply on a metal panel (Fig. 4).

GROUP BOARD

Meanwhile Bob had assembled the remaining components onto a groupboard, (Fig. 5) which the Professor inspected very carefully.

"This impedance-converter is a 'Class AB' circuit, and like most other class AB circuits the construction and the bias are very important", the Professor informed Bob. "To begin with we will set the bias to zero".

The Prof. adjusted VR1 and VR2 to give lowest resistance. Soon Maurice brought along the power-supply which he had built, and after a brief inspection of this, the Prof. connected it to the mains and switched on. He measured the voltage across each of the capacitors in turn.

"35-0-35 volts. That is O.K." The Prof. informed Maurice. He disconnected the power-supply from the mains supply, and used a 100

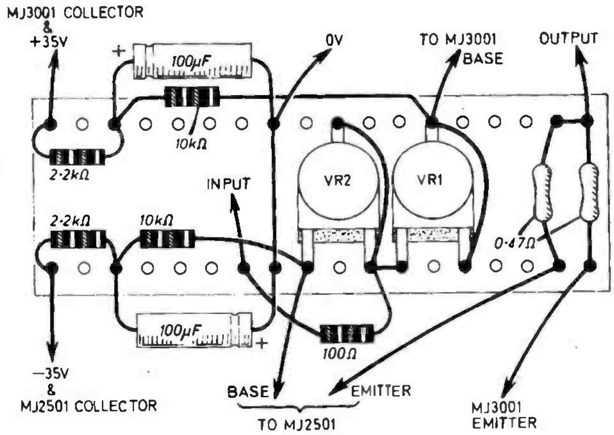


Fig. 5. Bob's layout and wiring of the impedance converter.

ohm wirewound resistor to discharge each capacitor, then connected the three output terminals of the power supply to the appropriate terminals of the impedance converter.

"Now we are ready to set the bias," the Prof. informed Bob and Maurice, "and with this circuit the bias can be set individually on each output transistor".

To be continued

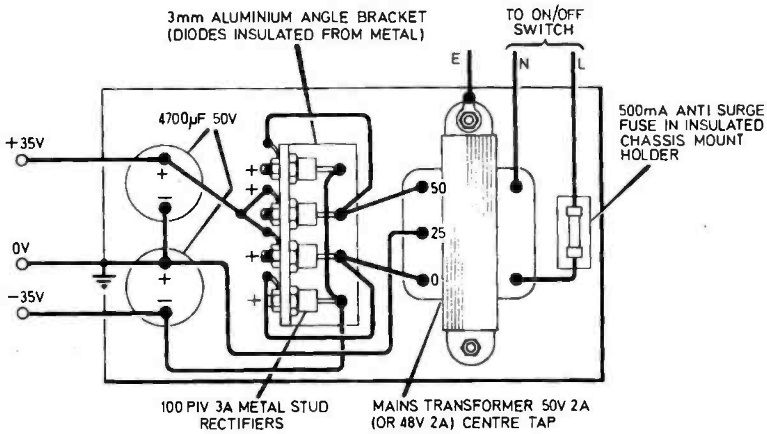


Fig. 4. Layout and wiring of a simple power supply for the converter.

GEORGE HYLTON brings it down to earth

SEVERAL readers have asked how to add smoothing filters to mains-operated d.c. supply units (also known as battery eliminators, a.c./d.c. convertors, and, loosely, as power packs and power supply units or P.S.U.s). They think that adding a smoothing filter will reduce "mains hum" in the equipment.

Well, it may not, but that's a subject in itself. Assuming that you do have a "power pack" which gives out too much ripple, how do you remove the ripple without also removing the d.c.?

It often helps to have a circuit to think about, so try Fig. 1a. This is a common sort of "mains power pack." The high mains voltage (around 240V) is transformed to a low voltage (e.g. 6V) by *step-down transformer* T1. This low voltage is rectified by the four diodes. These form a *bridge rectifier* which allows current to flow into the *reservoir capacitor* C1, only in the direction which drives the upper plate of C1 positive and the lower plate negative. (D2 and D3 conduct for one half-cycle, D1 and D4 for the next, and so on.)

LOAD EFFECT

If no current (d.c.) is taken from the unit, i.e., if it is "off load," C1 charges to a voltage close to the *peak* of the a.c. input voltage. The peak is about 1·4 times the nominal voltage; e.g. a voltage of 10V r.m.s. will give about 14V out.

When d.c. is drawn from the unit (by connecting a piece of apparatus) two things happen. First, the output voltage falls. Secondly, it is no longer completely steady, but rises and falls

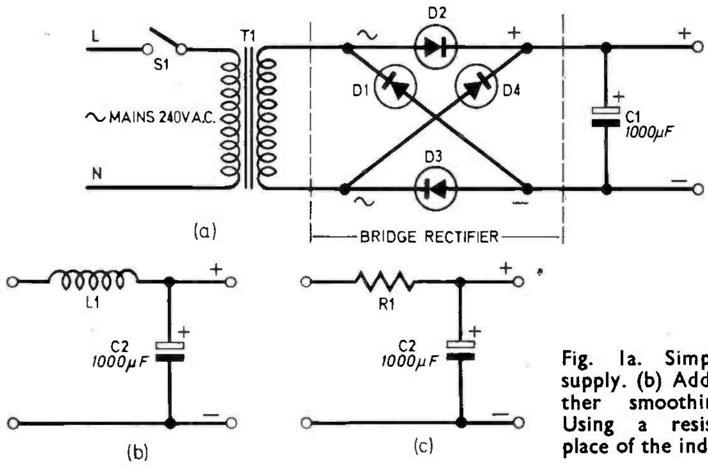


Fig. 1a. Simple d.c. supply. (b) Adding further smoothing. (c) Using a resistor in place of the inductor.

during each half-cycle of the mains frequency.

The reason for this is quite simple. The d.c. output drains part of the charge from C1 and causes the voltage to fall. The voltage is replenished from the transformer, via the rectifier. But the rectifier can only conduct when the a.c. voltage exceeds the d.c. voltage.

Since the a.c. voltage is constantly changing from zero to a peak value and back it follows that the rectifier can only conduct for part of the time; i.e. when the a.c. voltage approaches its peak. The rest of the time, the d.c. voltage stored on C1 exceeds the a.c. voltage and the diode cannot conduct.

This means, in practice, that the rectifier conducts in short sharp bursts. Each burst charges C1 quickly to something like the peak value. Thereafter, until the next burst arrives, the charge on C1 drains away. The resulting *ripple* on the d.c. output is a sawtooth wave at twice the mains frequency.

REDUCING RIPPLE

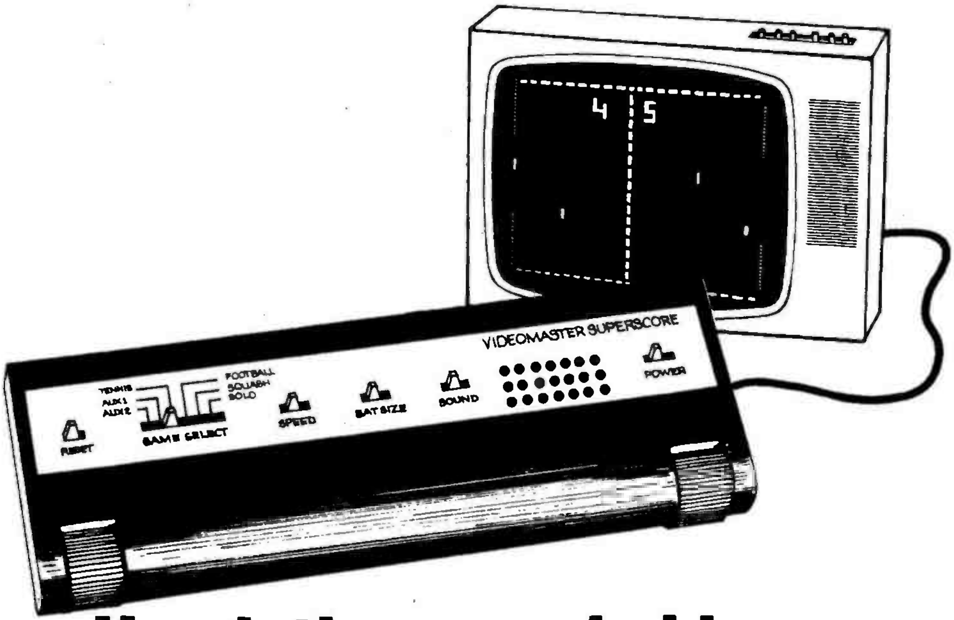
The ripple voltage can cause mains hum in audio apparatus powered by the unit. One way of reducing the ripple is to increase C1. Doubling the capacitance halves the ripple, and so on. To get a tenfold reduction needs a tenfold increase in capacitance, which can mean a large capacitor!

A more effective method is to add a second capacitance, C2, the size of C1, or larger, connected via an inductance L1 (Fig. 1b). It is the property of an inductance that it resists any attempt to change the current it is passing. Thus if the current tries to fall, the inductance tries to prevent it, and vice versa. Capacitor C2 therefore gets a more constant current, so the voltage across it is more constant (less ripple).

Unfortunately, suitable inductors are expensive. They must have a low resistance and an inductance high enough to be effective. A typical inductor for a power unit rated to supply 100mA would have an inductance of 0·1H (100mH) with 100mA d.c. flowing and a resistance of not more than 10 ohms. Used with a C2 of 1,000µF or more, a 10-fold reduction in ripple will be obtained. The ripple is attenuated by a factor of about 4LC/10,000 where L is in millihenries and C in microfarads, and full wave rectification of 50Hz is used.

If you can't get a suitable choke (and they are not easy to obtain) you have to use a resistor (Fig. 1c). The snag here is, that the output voltage is reduced. If R1 = 50 ohms, and the power pack delivers 100mA, 5V is lost. Fortunately, useful extra *smoothing* of the d.c. output (i.e. ripple reduction) can often be obtained without losing too much voltage.

If C2 = 1,000µF its impedance at the ripple frequency (100Hz for 50Hz mains) is about 1·6 ohms. So long as R1 is substantially more than the impedance of C2 at the ripple frequency, a useful amount of ripple reduction is obtained. Whether it is *enough* is another matter—it depends on how strong the hum is to begin with. The factor by which the ripple is reduced for a 50Hz supply with fullwave rectification is approximately 6CR/10,000 where C is in microfarads and R in ohms. Eg. C = 1,000µF, R1 = 10Ω gives a sixfold reduction.



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everyday electronics

VOLUME 5 INDEX

JANUARY 1976 TO DECEMBER 1976

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We are unable to provide back numbers or copies of articles.

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SPECIAL SERIES

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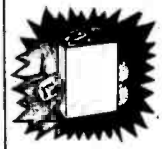

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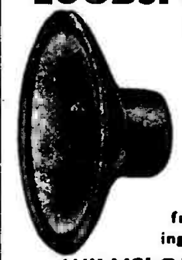

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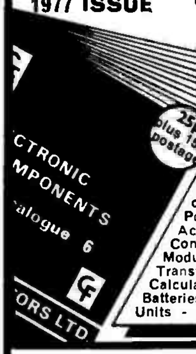

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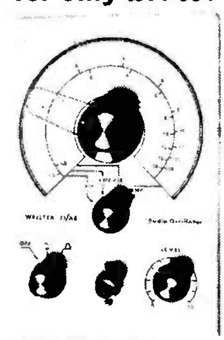

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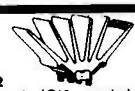

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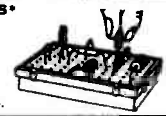

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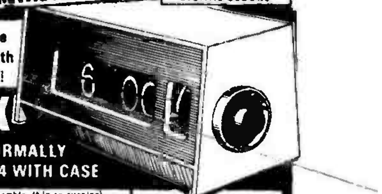

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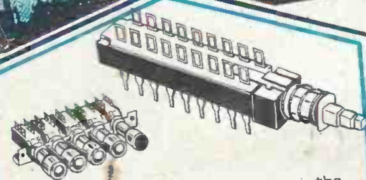

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