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An elegant Stereogram Cabinet in modern Veneered Mahogany and cloth covered Front Panel

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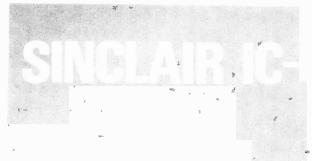
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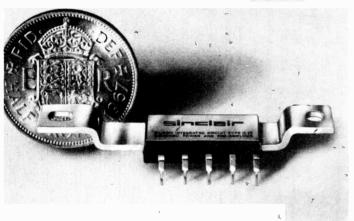
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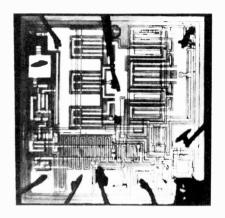
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MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP





the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by a hundredth of an inch thick, has an output 5 watts R.M.S. (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 Zener diode and 18 resistors, formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of such components as tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout) etc. The photographic masks required for producing monolithic I.Cs are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. It also enables us to cover every IC-10 with the Sinclair guarantee of reliability.

■ SPECIFICATIONS

10 Watts peak, 5 Watts R.M.S. continuous. Frequency response 5 Hz to 100 KHz±1dB. Total harmonic distortion Less than 1% at full output. Load impedance 3 to 15 ohms. 110dB (100,000,000,000 times) total. Power gain Supply voltage 8 to 18 volts. $1 \times 0.4 \times 0.2$ inches. Size Sensitivity 5mV. Adjustable externally up to Input impedance 2.5 M ohms.

■ CIRCUIT DESCRIPTION

The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feedback is used round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satisfactory.

APPLICATIONS

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

SINCLAIR

IC.10 with 1C-10 manual 59/6

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Simulair

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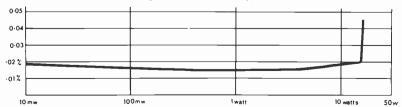
Z.30

THE WORLD'S LOWEST DISTORTION HIGH FIDELITY AMPLIFIER.

For four years, the Sinclair Z.12 dominated the constructor world, being the best selling unit of its kind this side of the Atlantic. Excellent as it was, the new Sinclair Z.30 is still better. Half the size of the Z.12, it has more than twice the power, very much greater gain and a level of distortion 50 times lower. This incredible figure results from using over 60dB of negative feed back with a constant current load to the driver stage obtained by incorporating a two transistor circuit in place of the more usual bootstrapping. 9 silicon epitaxial planar transistors are used to provide enormous power; up to 20 watts RMS sine wave (40 watts peak). The circuitry of this marvellous amplifier allows it to be operated from any voltage from 8 to 35 to perfection. At all output levels, distortion is only 0.02%. This puts true laboratory standards into the hands of every user of a Z.30. Two Z.30s and a new Stereo Sixty will make a stereo assembly of such perfection that it could not be bettered in its class no matter how much you spent. But the Z.30 has an enormous variety of applications, particularly where quality, precision and reliability are essential. It can also be used entirely on its own as an amplifier for an efficient economy record player.

APPLICATIONS

Hi-fi amplifier; car radio amplifier; record player amplifier fed directly from pick-up; intercom; electronic music and instruments; P.A.; laboratory work, etc. Full details for these and many other applications are given in the manual supplied with the Z.30.



SPECIFICATIONS

Power output—15 watts R.M.S. into 8 ohms using a 35V supply: 20 watts R.M.S. into 3 ohms using a 30V supply.

Output—Class AB.

Frequency response—30 to 300,000 Hz \pm 1dB.

Distortion—0.02% total harmonic distortion at full output into 8 ohms and at all lower output levels.

Signal-to-noise ratio—better than 70dB unweighted.

Input sensitivity-250mV into 100k().

Damping factor—> 500.

Loudspeaker impedances-3 to 15 ohms.

Power requirements—From 8 to 35V d.c. (The Z.30 will operate ideally from batteries if required.)

Size— $3\frac{1}{2} \times 2\frac{1}{4} \times \frac{1}{2}$ inches.

Built, tested and guaranteed, with circuits and instructions manual

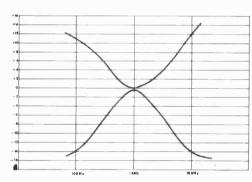
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Practical Electronics February 1970

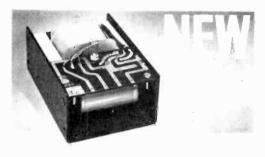




Curves to show bass and treble cut and boost

Ready built, tested and quaranteed with instructions

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This attractive and completely new unit is intended for use with two new Z.30 amplifiers to provide the finest possible standards of stereo reproduction. Four press buttons and four rotary controls are used to provide on-off, three input selectors and Volume, Bass cut/boost, Treble cut/boost and Stereo balance. The on-off button also switches the power amplifiers. The front panel in brushed aluminium is flush mounted to the cabinet front, it being necessary only to drill holes to accommodate the controls. Rear adjustable brackets hold the chassis tight to the cabinet. The very latest ganged rotary controls are used to afford compactness and extra long working life free from noise.

The Stereo-60 may also be used with 2 IC-10's or any other high performance amplifiers.

SPECIFICATIONS

●Input sensitivities—Radio—up to 3mV Magnetic Pickup-3mV: correct to R.I.A.A. curve ± 1dB; 20 to 25,000 Hz. Ceramic Pickup-up to 3mV: Auxiliary—up to 3mV
Output—250mV

Signal-to-noise ratio-better than

- ◆Channel matching—within 1dB.◆Tone Controls—TREBLE 15
- -15 to -15dB at 10 KHz: BASS - 15 to -15dB at 100 Hz.
- Power consumption 5mA.
- Front panel-brushed aluminium with black knobs and controls.

PZ.5 POWER SUPPLY UNIT

A new heavy duty mains power supply unit designed specially to drive two Z.30s and a Stereo Sixty. New compact design. For AC Mains, 110-240V. £4.19.6

USE THIS COUPON FOR Z.30, STEREO 60 AND P.Z.5.

Q.16 LOUDSPEAKER AND MICROMATIC ON NEXT PAGE

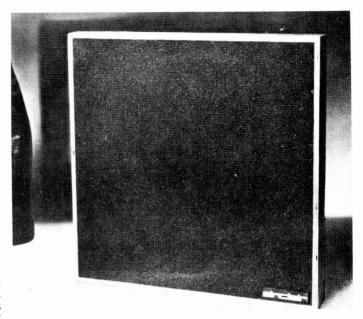
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SINCLAIR

Q.16

new elegance in an outstanding loudspeaker

All the superb features which went to make the Sinclair Q.14 have been incorporated in the new Q.16 which gives an exciting new opportunity for you to match your Sinclair equipment with modern decor. Employing the same well proven acoustic system in which materials, processing and styling are used in such a radical and successful departure from conventional design, the new Q.16 presents an entirely new appearance with its attractive teak surround and all-over special cellular foam front chosen as much for its appearance as for its ability to pass all audio frequencies without loss. The Q.16 is compact and slim. Its new styling makes it eminently suitable for shelf mounting, but it is no less versatile than its famous predecessor. Listen to a pair of Q.16s in stereo and marvel at the standards of quality and clarity they



The Q.16 will handle loading up to 14 watts R.M.S. and presents an 8 ohm impedance to the amplifier output. Frequency response extends from 60 to 16,000 Hz. with exceptional smoothness. A specially designed driver system is used in a sealed and contoured pressure chamber to ensure good transient £8.19.6 response at all frequencies. Size: 93/2 square \times 43" deep from front to back.

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59/6

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Mallary Mercury Cell RM675 (2 required) each 2/9d.

Black plastic with anodized aluminium front panel, spun aluminium dial. HER THE COURON FOR MICROMATIC AND O 16 OPPERS

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Transistor	10/8	
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I Watt Amplifier Module type PCM I

This amplifier unit is a printed circuit module incorporating the popular and well triep PA234 i.e. amplifier. The unit is a COMPLETE AUDIO AMPLIFIER and requires no sexternal components, you simply connect an 18V power supply and a 15 or 16 ohm speaker or headphone, even the supply smoothing capacitor and the output capacitor are included! The overall dimensions, including capacitors, are $2\frac{1}{10} \times 3$ in $-\frac{1}{2}$ in. The input for 1W output at 1kHz is typically 300mV into 100kohms. This unit is available at only 38/- net, complete with descriptive leaflet or 70/- net per pair.

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Complete stereo system - £29.10.0

The new Duo general-purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally. Type 1 SPECIFICATION:-

Impedance 10 ohms. It incorporates Goodmans high flux $6^{**}4^{**}$ speaker and $2\frac{1}{4}$ tweeter. Teak finish $12^{**}6\frac{1}{8}^{**}5\frac{1}{8}^{**}$. 4 guineas each. 7/6d, p. 6 p. Type 2 as type 1. Size $17\frac{1}{2}^{**} \times 10\frac{1}{2}^{**} \times 6\frac{1}{8}^{**}$. Incorporating $10\frac{1}{2}^{**} \times 6\frac{1}{8}^{**}$ bass unit and $2\frac{1}{4}^{**}$ tweeter. 3 ohms impedance $5\frac{1}{2}$ guineas plus 15/p. & p.

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Quetto Integrated Transistor Stereo Amplifier

£9 10 0

The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.

SPECIFICATION:—

SPECIFICATION:—
R.M.S. power output: 3 watts per channel into 10 ohms speakers.
INPUT SENSITIVITY: Suitable for medium or high output crystal cartridges and tuners. Cross-talk better than 30dB at 1 Kc/s.
CONTROLS: 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control.
TONE CONTROL: Treble lift and cut. Separate on off switch. A preser

balance control.





The Classic

Teak finished case

Plus P. & P. 7/6

SPECIFICATION:
Sensitivities for 10 watt output
at IKHz into 3 ohms. Tape Head: 3mY (at 3)?
Aux. 100mV. Tape/Rec. Output. Equalisation for each
input is correct to within +2dB (R.I.A.A.) from 20Hz to 20KHz.
Tone Control Ronge: Boss: 13dB at 60Hz. Treble: ±14dB at 15KHz. Total Distortion: (for 10 watt output) <1:5%. Signal Noise: <-60dB. A.C. Mains
200-250V. Size 12½in long. 4½in deep, 2½in high. Built and tested.



The Viscount FIDELITY TRANSISTOR STEREO AMPLIFER

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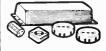


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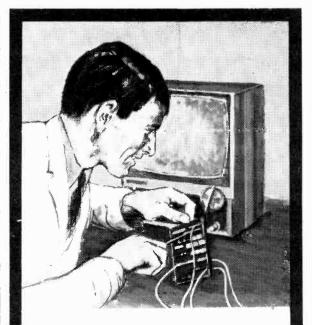
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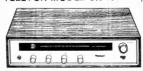
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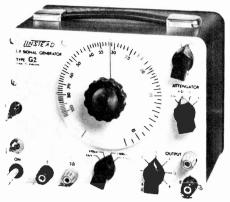
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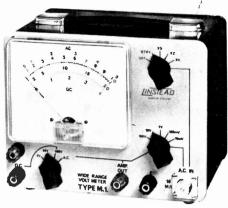
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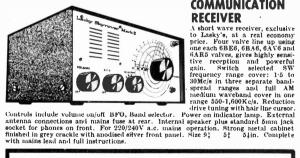
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MT64	75 W	$24 \times 21 \times 21$ in	11b 14oz	21/9 (P. & P. 4/6)
MT4	150W	$3\frac{1}{4} \times 2\frac{1}{4} \times 3$ in	31b	33/- (P. & P. 6/-)
MT65	200W	$31 \times 41 \times 4$ in	41b	39/6 (P. & P. 6/-)
MT66	300 W	4 × 4 × 3 ₹ in	6lb 7oz	59/4 (P. & P. 9/-)
MT110	400 W	$4\frac{1}{4} \times 4\frac{1}{4} \times 4$ in	111h	85/- (P. & P. 10/-)
MT67	500W	5½ × 4 × 4½ in	121b 8oz	89/- (P. & P. 10/6)
MT83	750W	44×54×51in	131b 4oz	95/7 (P. & P. 10/6)
MT84	1000W	$4\frac{1}{2} \times 5\frac{1}{2} \times 5\frac{1}{2}$ in	161b	142/2 (Carr. extra)
MT93	1500W	$5\frac{3}{16} \times 5\frac{7}{4} \times 6\frac{1}{2}$ in	281b 9oz	170/6 (Carr. extra)
MT94	1750W	5 % × 6 2 × 6 in	311b	195/- (Carr. extra)
MT95	2000W	$7 \times 6\frac{1}{2} \times 8\frac{1}{2}$ in	401b	211/2 (Carr. extra)
MT73	3000W	$67 \times 74 \times 83$ in	451b 8oz	300/~ (Carr. extra)

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MTIII	0.5A	3 - 21 < 11 in	12oz	15/3 (P. & P. 2/6)
MT71	2A	$27 \times 21 \times 21$ in	11b	19/- (P. & P. 3/9)
MT69	4A	31 21 21in	21b 4oz	28/- (P. & P. 6/-)
MT70	6A	4 × 3 × 3∦in	3lb 12oz	39/- (P. & P. 6/-)
MT72	10A	$31 \times 41 \times 4$ in	6lb 302	51/- (P. & P. 9/-)
MT115	20A	$4\frac{3}{4} \times 4\frac{1}{4} \times 4$ in	111b 13oz	95/- (P. & P. 9/-)
MT187	30A	$51 \times 42 \times 41$ in	161b 12oz	180/- P. & P. 13/6)

LOW VOLTAGE 24V RANGE

Primary	200/250V:	secondary 24V		
MT58	1 A	21 > 21 × 21	llb 7oz	23/9 (P. & P. 4/6)
MT114	3A	$2\frac{1}{2} \times 3 \times 3$ in	31b 6oz	38/- (P. & P. 6/-)
MT72	5 A	4×3 ? $\times 3$? in	51b 12oz	53/10(P. & P. 6/-)
MT17	8A	$47 \times 37 \times 4$ in	71b 8oz	72/7 (P. & P. 9/-)
MT115	10A	$4\frac{1}{4} \times 4\frac{1}{4} \times 4$ in	111b 13oz	95/- (P. & P. 11/-)

LOW VOLTAGE 30V RANGE

Primary 20	00/250V; sec	condary tapped 12-	-15-20	-24-30V					
MT112	0.5A	$31 \times 24 \times 13$ in	Hb	4oz	17/4				
MT79	1 A	$21 \times 21 \times 21$ in	21b		23/-	(P.	å	Ρ.	6/-
MT20	3 A	4 × 3 ½ × 3 ∄in	410	60 z	46/2				
MT51	5.A	$4? \times 3! \times 4$ in	61b	8oz	60/9				
MT88	8A	54×33×44in	91b	6oz	92/4	(P.	å	Ρ.	11/-
MT89	10A	5 ½ × 4 × 4 3 in	12lb	2oz	103/6	(P.	â	Ρ.	11/-

LOW VOLTAGE 50V RANGE

Primary	200-250V;	secondary tapped	19-25-33-40-50\	7			
MT102	0.5A	$21 \times 21 \times 21$ in	llb lloz	21/3	(P. &	Ρ.	6/-)
MT104	2 A	4 × 3 } × 3 ∦ in	5lb		(P. &		
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MT110	250-0-250V	120MA	$-6.3V \cdot 3.5A \cdot 5/6.3V \cdot 1A \cdot 4 \times 4 \times 3 \sin 44/9 \cdot 6/-$
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Editor F. E. BENNETT Assistant Editor M. A. COLWELL Editorial Assistants D. BARRINGTON G. GODBOLD M. KENWARD Art Editor J. D. POUNTNEY Technical Illustrators J. A. HADLEY P. A. LOATES

Advertisement Manager D. TILLEARD

JUST THINK!

THE usefulness of electronics is surely limited only by our imagination. And amateurs no less than professionals have the power to extend this general usefulness in very many ways.

Consider the constructional projects featured in these pages. Broadly speaking, they can be divided into two classes. There are those designed right down to the final detail for some specific and exclusive purpose. There are also those not designed for just one particular or specific application, but having general utility or wide adaptability.

In this second category appear from time to time circuits that perform well defined functions, usually in response to external influences, though their adaptation to a practical task is generally left to the individual constructor. There is good justification for this. Designs such as these form the core of electronics, and are the basis around which the most elaborate of systems can be built up. They can also be likened to tools, to be applied with skill and imagination in solving problems and easing difficulties commonly experienced in everyday affairs. The circuit designer can suggest some applications, but it is beyond his powers to perceive all the multitude of needs which a particular circuit could likely meet.

Thus the exploitation of many circuits is very much a matter for individual enterprise. And devising an application is, in its own way, an achievement just as important and creative as the original circuit design. Of course, not only imagination, but a down-to-earth awareness of current problems and needs is desirable for this purpose, if the maximum benefit is to be extracted from electronics.

This month a design of the kind we have been referring to appears in our pages in the form of a sound operated switch. The function of this circuit is immediately evident, but its possible use perhaps less so. But it could initiate the thinking process, and that is no bad thing. One idea that has been brought to our attention certainly deserves serious thought, and we pass it on to our readers for due consideration. It is suggested that disabled and infirm persons, especially if bedridden or house bound, could find an alarm or signalling system based on this sound operated switch a boon. Anyhow, it is a thought.

Really, it is quite amazing what important roles even a humble circuit like this can assume, when you come to think about it.

F.E.B.

THIS MONTH

RAINFALL GAUGE 116 P.E. ORGAN—10 134 SOUND OPERATED SWITCH 138 P.E. COMMUNICATIONS RECEIVER—5 144

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Our March issue will be published on Monday, February 16

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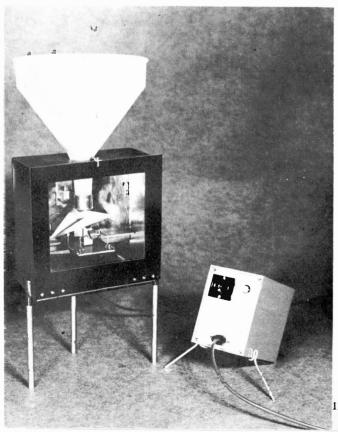
Editorial and advertisement offices: Fleetway House, Farringdon St., London, E.C.4. Phone 01-236 8080



By D. Bollen

Using digital readout this unit gives accurate measurement of rainfall with convenience of indoor monitoring

The main object of this rainfall gauge is that it should remove some of the outdoor discomforts of weather recording, by transmitting the desired information along wires to an indoor monitor. A metering accuracy of better than ± 1 per cent per inch of rain collected is desirable, while it should be capable of at least 6 months continuous operation on battery power.



RAIN GAUGES

A rain gauge which consists of a funnel and a graduated beaker is not a particularly convenient instrument for recording rainfall, because it involves direct measurement of water volumes.

More sophisticated gauges employ special bucket mechanisms to "digitise" the flow of water from a collecting funnel, and thereby give greater accuracy and convenience of measurement. However, where such instruments rely only on mechanical operation it is still necessary to go out of doors in all weathers to see how much rain has been recorded.

If the metering bucket is arranged to give an electrical pulse for every 0.01in increment of rainfall, it becomes a straightforward matter to record these pulses at some distance from the rain collecting funnel.

The prototype instrument uses such a system and, in fact, serves to demonstrate elementary analogue to digital conversion, and telemetry techniques.

BISTABLE BUCKET

It is quite often useful to consider the action of a mechanical device in terms of electrical circuit behaviour. The action of the "bistable" bucket can be related to that of a bistable multivibrator.

Looking at Fig. 1, the bucket has just attained one of its stable "states", and is in the process of discharging from the right-hand compartment while the left-hand compartment commences to fill. Note the "gating" action of the bucket partition; when the right-hand compartment is down the left-hand fills, and vice versa. Just at the point of tipping, when the weight of water has reached a pre-determined value, the bucket "flips" rapidly from one "state" to the other.

It is possible to adjust the amount of water discharged

It is possible to adjust the amount of water discharged from each compartment by screwing up or down the bucket stop on the opposite side; this also provides a convenient method of levelling the bucket so that equal volumes of water are metered by each compartment.

The counting accuracy of the "bistable" bucket is mainly determined by the amount of frictional force exerted on the pivot shaft. If there is too much friction, the bucket will tend to tip varying amounts of water at each throw, or may not tip at all.

REED SWITCH PULSER

Fig. 2 shows how a low force switch of excellent reliability can be made from a small magnet and a reed switch. When the poles of the magnet are vertically aligned the reed switch contacts are open, but a small rotational movement of the magnet clockwise or anticlockwise causes the contacts to close.

It follows that, if the magnet is attached to the pivot shaft, the reed switch contacts will open briefly when the bucket "flips", and remain closed in the stable positions. The amount of friction imposed on the pivot shaft by this form of switch is very small indeed, and the enclosed contacts are not affected by humid conditions.

COUNTER CIRCUIT

The circuit in Fig. 3 shows an *npn-pnp* pair TR1 and TR2, which are held non-conducting when the contacts of S1 are closed; a small current due to R1 will flow along the line.

When the bucket tips, S1 contacts open briefly, R1 biases TR1 on, and the joint amplification provided by TR1 and TR2 causes a large current pulse to activate the electromagnetic counter.

Lamp LP1 is included to show line discontinuities,

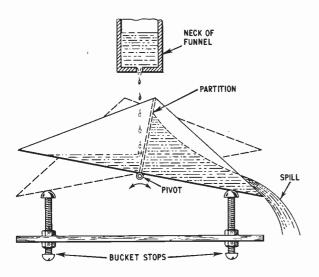
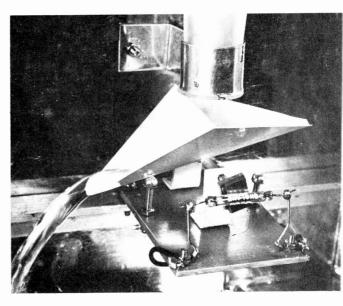
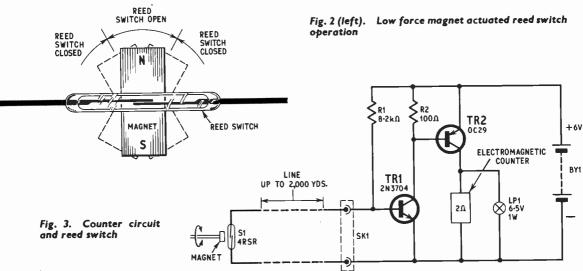


Fig. 1. Sectional view of the "bistable bucket" for metering liquid





COMPONENTS . . .

Resistors

 $\begin{array}{ccc} \text{RI} & \text{8.2k}\,\Omega \\ \text{R2} & \text{100}\,\Omega \end{array}$

±10%, ½W carbon

Transistors

TRI 2N3704 TR2 OC29

Switch

SI Reed switch type 4RSR, 500mA contacts (Radiospares) Short bar magnet 0.44in (Radiospares)

LPI 6.5V IW l.e.s. with l.e.s. lampholder

Socket and Plug

SKI Non-reversible panel mounted, two-

Battery BY! 6V type 996

Miscellaneous

4 or 5 digit resettable electromagnetic counter (P.O. type meter) Copper laminated s.r.b.p. 2in × 3in × 32 in Plain s.r.b.p. sheet $2\frac{1}{2}$ in \times $\frac{1}{8}$ in Aluminium sheet 18 s.w.g. 3in × ½in Brass rod $2in \times \frac{3}{32}in$ dia. Pillars $\frac{1}{2}in$, 6 and 8B.A. nuts and bolts Twin cable 14/0076 p.v.c. covered Enamelled copper wire 26 s.w.g. for counter

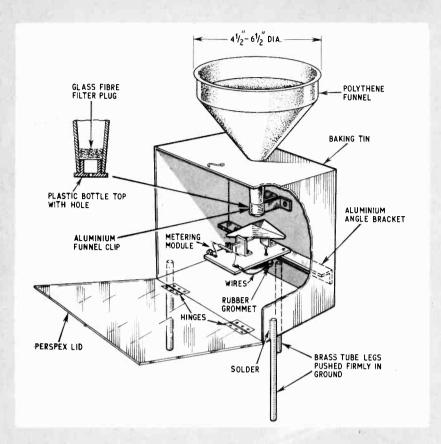
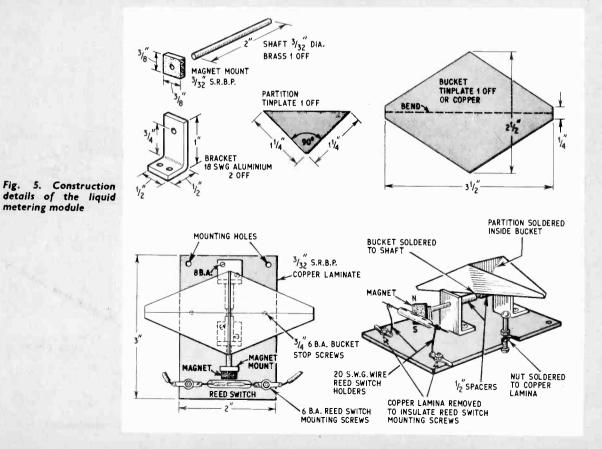


Fig. 4. Suggested layout for rain metering unit



and gives a rough indication of the battery condition under full load, when the plug is removed from SK1.

The reason for not having an on-off switch in circuit is that it might be left inadvertently in the "off" position and thus falsify rainfall records. During a period without rain, circuit current drain is typically 1mA or less, most of which flows through R1.

At 1mA continuous, a 996 battery should give more than 10,000 hours' service, which is not much shorter than expected shelf-life. Although at the instant of pulsing, current rises to more than 2A, this will average out to less than 10mA equivalent continuous drain during periods of rainfall approaching the rate of 3in per hour.

LIQUID METERING MODULE

The metering module comprises a "bistable" bucket and a low force reed switch pulser mounted on a copper laminate panel. It is designed for use with plastic funnels from 4½ in to 6½ in diameter. A suggested

housing for the module is shown in Fig. 4.

Module constructional details are given in Fig. 5. The bucket can be made up from tinplate, cut from a can or tobacco tin. Resin cored solder and a 60W electric soldering iron are quite suitable for bucket joints provided that the tinplate is thoroughly cleaned before soldering. After construction, remove surplus flux and paint the bucket with bitumen or similar proofing to prevent rusting.

When cutting and drilling the copper laminate panel, remove copper from around the holes where the reed switch mounting screws are situated. The 6B.A. nuts, to take the bucket stop screws, are soldered to the copper on the underside of the panel. Lock nuts may be

fitted to the stop screws after final assembly.

Ensure that the pivot shaft moves freely in the bearing brackets with a small amount, but not excessive, "end To check correct switch action, listen for a float". closure "click" from the reed switch just before the bucket touches either stop. A rough test of bucket operation can be obtained by holding the module under a dripping tap.

INDOOR COUNTER UNIT

Component layout and underside wiring of the amplifier panel appear in Fig. 6, and a suggested layout of the complete indoor counter unit is shown in Fig. 7.

When wiring up the amplifier panel, avoid overheating TR2, as this might cause a permanent increase in leakage current, with a consequent shortening of battery life. LPI tabs were soldered directly to the turret tags on the prototype amplifier panel.

Spring terminals on the 996 battery can make contact with small squares of tinned copper laminate which are glued to the front panel. The battery is held firmly against the contacts by the back of the counter

Having obtained an electromagnetic counter, it will almost certainly be necessary to rewind it for 6V operation, because the majority of this type of counter are intended for higher voltages. All of the existing winding should be removed from the coil first; it would not matter if the counter has a damaged coil to start with; it is not needed.

Where the electromagnet is mounted by a single stud, it is a simple matter to grip the stud in the chuck of a hand-drill, and then wind on 600 turns of 26 s.w.g. enamelled wire, maintaining even layer winding as far

as possible.

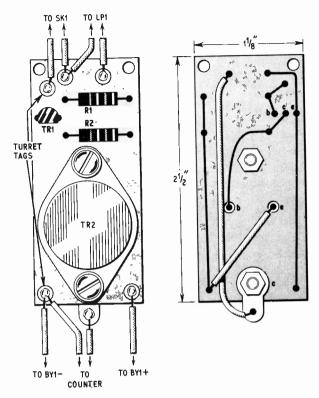


Fig. 6. Amplifier panel, components side and underside

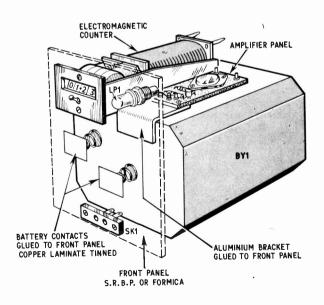


Fig. 7. Layout of the counter unit

There are many factors which affect radar operation: receiver noise, transmitter power, aerial beam shape, transmitter frequency, rain or cloud. For meteorological radar, signals reflected by rain or cloud provide valuable information, but for early warning enemy missile detection radar such echoes would be most unwelcome.

Each radar parameter has to be optimised for the specific application—marine, airfield, missile detection, and so on, but the principles to be described are common to all classifications.

Since radar echo signals are minute in comparison with the transmitted energy they must be detected in some manner which readily distinguishes them from the

transmitted signal.

In pulsed radar this is done by turning off the transmitter for most of the time, so that any signals received during this "off" time can be recognised as echoes. This "off" to "on" duty period for the transmitter may be 1,000: 1 or more. If the word radar is used without qualification then pulsed radar is almost always implied.

It is possible to recognise echoes even when the transmitter is operating and for specialised applications continuous wave radar may be used. Equipments where the transmitted signal is continuous or has a low duty cycle, typically 10:1, will be lumped into the category of c.w. radar.

Pulsed radar will be described first.

PULSED RADAR

The fundamental principles underlying the operation of a pulsed radar system are illustrated in Fig. 1.1. The transmitter is switched on for a short time (microseconds) to produce a burst or pulse of r.f. energy which is radiated from a directional aerial, much in the same way as a torch beam is directed.

If the energy encounters a target some of it is reflected back towards the receiver. ("Target" is the term used in the sense of the object to be located, rather than in the military sense.) This reflected energy is collected by the receiver aerial, amplified, and displayed on an indicator to show the radar operator that there is a target within range.

Although two aerials are shown in this diagram to aid the description, in practice a common aerial is usually used for both transmission and reception. To locate an object the radar must obtain three-dimensional information expressed as:

(1) The bearing angle of the object with respect to ship track or north, or some other datum line.

(2) The elevation angle of the object.

(3) The range, or distance, of the object from the radar.

These three requirements are illustrated in Fig. 1.2.

RANGE MEASUREMENT

Radio waves travel through space at a velocity of 186,000 miles per second, but to avoid cumbersome units this figure may be converted to a scale more convenient for the application. For range measure ment the time taken for a pulse to reach the target and return to the receiver is determined.

For the radio wave to travel 1,000 yards, the time taken would be 3μ s, so that for a target at 10,000 yards range, the pulse takes 30 µs to reach it. The reflected energy travels another 10,000 yards back to the receiver. Therefore, the returned signal has travelled a total of 20,000 yards and has taken 60μ s to do so.

The scales most commonly used to relate range and time delay are shown in Table 1.2.

Table 1.2. SCALES OF RANGE AND TIME DELAY

Range	Elapsed time between transmitted and received pulses		
1,000 yards	6·1µs		
l mile	10·7μs		
I nautical mile	12·4μs		

Range measured like this can be displayed on a cathode ray tube in a number of ways.

SIMPLE-RANGE DISPLAY

As the pulse is transmitted the sweep of a spot across the screen is initiated. When it has travelled its full sweep the spot flies back to the start and waits for the next transmitted pulse to trigger it again. A small sample of the transmitted pulse and the reflected signals are applied across the Y plates.

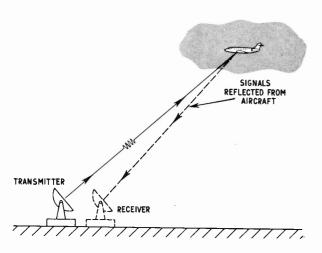


Fig. 1.1. The basic principle of a pulsed radar set

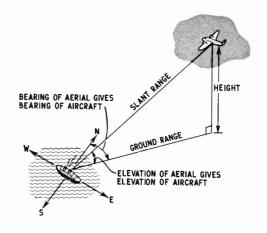


Fig. 1.2. The three information requirements for a radar set



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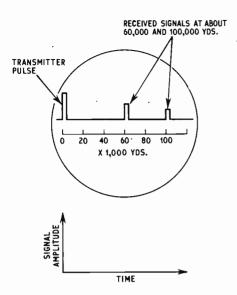


Fig. 1.3. "A" 'scope display of range

Since the pulse repetition frequency (p.r.f.) of the radar is high, typically 1kHz, the spot moves rapidly and the display appears continuous. This type of display is sometimes known as an "A" 'scope, Fig. 1.3.

If the radar p.r.f. is 1kHz then the spot could travel across the screen in 1ms. (Slightly less than 1ms in fact, because the spot cannot return to the start of the sweep instantaneously.) If the length of the sweep is 5in then each 1in represents 200µs or 20 miles.

The total length of scan represents the maximum attainable range of 100 miles since for targets beyond this range the reflected energy does not arrive back at the receiver before the next transmitted pulse. (A target at 110 miles could produce an indication as though it were at 10 miles, but the signal strength would be so low that it would be obvious that there was no real target at 10 miles.)

If the sweep speed is increased then the element of range represented on the screen is decreased, a sweep time of 200/s represents the first 20 miles of the available range. In this case the spot sweep is triggered by the transmitted pulse and takes 200/s to scan the screen. It then flies back to the start and waits for about 800/s during "dead time", until the next transmitted pulse again initiates the sweep.

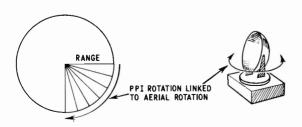


Fig. 1.4. The p.p.i. display principle for indicating both range and bearing

This "A" 'scope range display has the disadvantage that it can only display signals reflected from one direction at a time. This can be overcome by rotating the aerial and using a different form of display.

PLAN POSITION INDICATOR DISPLAY (P.P.I.)

For the p.p.i. display the spot sweep starts from the centre of a screen and moves outwards, so the distance between the centre of the screen and the circumference represents the range. Each sweep then rotates in step with the aerial, Fig. 1.4. The sweep from centre to circumference still occurs at the radar p.r.f. but the aerial rotation through 360 degrees occurs slowly due to mechanical limitations in moving the aerial mass,

The signals to be displayed are applied to the grid or cathode of the c.r.t. to "bright-up" the screen where a target appears. The screen is coated with a material having long afterglow properties so that the echo signals remain visible on the screen until the sweep has completed 360 degrees. The repeated rotational sweep brightens the display again.

A typical p.p.i. display is shown in Fig. 1.5, from which the range and bearings of all targets can be determined. The position of the transmitting and receiving aerial is normally indicated by the centre of the screen, but for some purposes such as ship navigation, it may be more

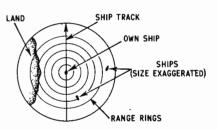


Fig. 1.5. A typical p.p.i. display for a ship

convenient to move the indication of the transmitter position to some other point on the screen, typically on the circumference.

HEIGHT MEASUREMENT

We have already seen how range can be determined by measuring the time it takes for a pulse to reach an object and return, and how bearing can be determined by rotating the aerial. For ship navigation purposes this is sufficient since all the ships, or land, are on the same plane as the transmitting ship, and the range measured is in this case the true ground range. However, for some applications, such as air traffic control, where the aircraft are not at a previously known elevation, it is important to determine height and ground range.

The elevation angle of an aircraft can be determined by allowing the aerial to "nod" up and down, and so locate the elevation at which maximum signal returns appear.

Once the target slant, range, and elevation have been determined, a straightforward trigonometrical calculation will give ground range and height, Fig. 1.6. In the early days of radar these computations for range and height were done mechanically, but now electronic methods are more reliable.

A "resolver" is provided with slant range and elevation information by an operator and produces height and ground range information which can be displayed as dial readings or on separate c.r.t's.

TYPICAL RADAR SYSTEM

The various sections of a radar installation are linked as, for example, in Fig. 1.7. The timing circuit generates a pulse at the radar p.r.f. which triggers the modulator at the required interval. Since the transmitter has to produce a very high power short pulse, it cannot be controlled by a normal electronic switch, and the modulator switches on the transmitter magnetron for the pulse duration required.

To avoid the need for two aerials, an electronic transmit-receive (t.r.) switch connects the transmitter to the aerial for the duration of the transmitted pulse and the receiver to the aerial for the intervals between pulses. This operation is not as simple as it sounds since, during the transmission of the high powered pulse, the receiver has to be protected from breakthrough which might damage it, and yet an instant later the receiver has to be ready to detect the very small signal returns.

These returns are mixed with the signal from a local oscillator to produce an output at the intermediate frequency. This i.f. signal is amplified and detected by

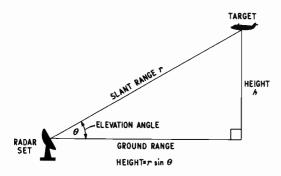


Fig. 1.6. Calculation of height from slant range and elevation information

a crystal detector and then applied as video information to the indicator display. The i.f. is typically 45MHz and these amplifiers are similar to those used in a television receiver.

On receive, the target information, aerial bearing, and elevation angles, are fed to the indicator unit, which displays the range, bearing, and height of all aircraft within range. An input from the timing circuit ensures that the c.r.t. can be synchronised to the transmitter p.r.f.

FACTORS AFFECTING PERFORMANCE

Each parameter of the radar will affect its maximum range and resolution; some are within the control of the designer and some remain the operator's responsibility. The designer can choose an aerial, receiver gain, transmitter power, p.r.f., pulse width, and display consistent with the application, while the operator may have to choose the location for transportable equipment. This must be sited so that it is not shielded by hills or tall buildings, and is well away from man-made electrical interference.

Some other interfering factors, such as target size and sea or weather conditions, may be beyond the control

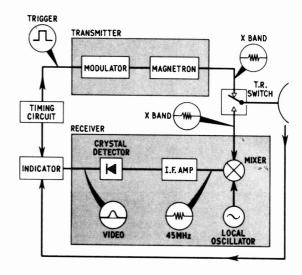


Fig. 1.7. The block diagram for a typical pulsed radar installation

of both designer and operator. These are as follows:

(a) P.R.F. The interval between transmitted pulses must be long enough for the pulse to reach a target at maximum range and return to the receiver, since if a second pulse is transmitted before the first has returned, the reflected pulse may be lost or at best, if displayed on the c.r.t. after the second pulse has been transmitted, could cause confusion to the operator.

To avoid this problem the radar p.r.f. is chosen so that there is ample time for a pulse to be reflected from a target at the maximum range of interest before a second pulse is transmitted. The sweep speed of the display is chosen so that only the range of interest is indicated.

A long range early warning search radar would have a low p.r.f. while an airfield local radar, with a maximum range of perhaps 10 miles, could have a high p.r.f. If the p.r.f. is made too low then the amount of information presented per second on an "A" 'scope or a p.p.i. is low, and performance will suffer.

This problem with a low p.r.f. may be partly overcome by using a storage tube display rather than p.p.i. In this system information is read on to the storage tube at the p.r.f. but retrieved by scanning at a faster rate and displaying the information on a conventional television type of tube.

(b) PULSE WIDTH. The pulse width affects two things, the minimum range and the resolution of the radar. Range measurement on an "A" scope is made from the leading edge of the transmitted pulse to the leading edge of the received pulse, if an object is so close that the echo pulse is received before the end of the transmitted pulse then it is impossible to interpolate the range on the screen.

If the transmitter has a pulse width of, say, 12μ s then for a target at 1 mile the start of the echo signal would be received before the end of the transmitted pulse, Fig. 1.8a, and range cannot be measured. For a target at 1.5 miles the start of the echo pulse would be received shortly after the end of the transmitted pulse, Fig. 1.8b; in this case range can be measured.

In practice, pulse widths are normally shorter than the 12μ s chosen for this example; 1μ s is more common.

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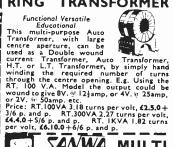
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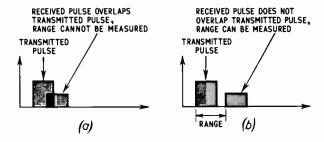


Fig. 1.9. The appearance of noise on an "A" 'scope Fig. 1.8. Minimum range depends on pulse width

Even this is too long for some airborne interception applications since this represents a range of about 500ft.

If two targets in a direct line from the aerial are only separated by a short distance, then the front edge of the signal reflected by the furthest target will be combined with the trailing edge of the signal from the nearest target, and a "single" target indication would appear on the screen.

For very close ranges or for a high resolution, pulse widths of 0.1μ s may have to be used. However, for a given peak amplitude a long pulse contains more energy than a short pulse, so that the short pulse requirements for a high resolution may have to be weighed against the maximum energy requirements for a long range.

(c) TRANSMITTER POWER AND RECEIVER NOISE. The maximum range of the radar will be limited by the ability of the receiver to detect the weakest echoes in the presence of noise. This noise input to the receiver is made up from atmospheric disturbance and thermal agitation in the receiver input stages. On an "A" 'scope display, the noise looks like "grass" which may hide the weak echoes, Fig. 1.9. The input to the receiver consists of signals plus noise in a specific ratio, and due to the extra noise contributed by the receiver itself, the signal to noise ratio at the output is smaller than the signal to noise ratio of the input signal.

The noise figure N of the receiver is defined as the ratio of "signal-to-noise ratio at the input" divided by "signal-to-noise ratio at the output". If the receiver were perfect and contributed no noise of its own, then this ratio would be 1 or 0dB. Since the receiver does contribute some noise power, then the noise figure may be 10dB at X-band unless special low noise techniques are used.

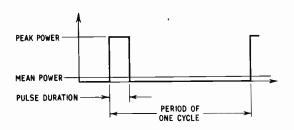


Fig. 1.10. The relationship between peak and mean power

Since the transmitter may have a pulse duration of 1 µs and a p.r.f. of 1kHz the mean power developed may be low, while the peak power (which determines the strength of the echo signals) may be very high. So that the mean power ratings of the transmitter components can be lower than might be expected at first sight. One cycle of operation is shown in Fig. 1.10, where the power output remains at the peak level for only a small part of the complete cycle.

SIGNAL ALMOST HIDDEN IN NOISE

NOISE

STRONG SIGNAL

If the peak power is 100kW, the pulse width 1µs, and the p.r.f. 1kHz (1ms duration) then the mean power is given by:

mean power =
$$\frac{\text{peak power}}{\text{duty cycle}} = \frac{100 \times 10^3}{1,000} = 100 \text{ watts.}$$

(d) THE RADAR EQUATION AND MAXIMUM RANGE. By considering the transmitter power, the gain of the directive aerial, and the effective radar cross-sectional area of the target, the maximum radar range can be determined.

$$R_{\text{max}} = \left[\frac{P_{\text{t}} G^2 \lambda^2 \sigma}{(4\pi)^3 S_{\text{min}}} \right]^{\frac{1}{4}}$$

where:

 $P_{\rm t} = {\rm transmitter\ power}$

 $R_{\text{max}} = \text{maximum detectable range}$ G = aerial gain, using the same aerial for transmission and reception

 λ = wavelength

 $\sigma = \text{radar cross-section of the target}$

 $S_{\min} = \min \max \text{ detectable signal.}$

This simplified version of the radar equation can only be used as a guide to expected performance since many factors, atmospheric conditions for example, have been omitted. It is difficult to make generalisations about performance from this equation alone since all the parameters are interdependent in a practical system.

However it can be seen that the maximum range is proportional to the fourth root of transmitter power, so that sixteen times the power is required to obtain twice the range. It may prove easier to improve the minimum detectable signal value by using low noise receiver techniques rather than attempt to increase the transmitter power.

Alternatively the maximum range is proportional to the square root of aerial gain, so that only four times the

aerial gain will double the range.

Part of the art of system design consists of optimising conflicting parameters to achieve a required performance within a given size, weight, and complexity requirement.

To be continued

NARKE

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

FLASH TUBES

Readers who like to construct their own photographic equipment will find the range of CD xenon filled flash tubes available from W.E.L. Components Ltd., suitable for electronic flash gun construction experiments.

Three basic tubes are made. The CD10 is U shaped with wire ends and a light output rating of 50 joules. The tube operates from 500V but requires a minimum trigger voltage of 2kV. The maximum recycling time is 10 seconds.

The CD11 is similar to the CD10 but is mounted on an octal base. The CD14 uses the same xenon tube mounted on an octal base but incorporates a pulse transformer and integral reflector. Pulse transformers type PT56 are recommended for use with types CD10 and 11.

Further data, including an applica-tions report giving details of a 50joule flash unit, is available from W.E.L. Components Ltd., 5 Lovelock Road, Reading. A small charge is made for posting and packing.

BATTERY TESTER

One of the many new ranges of Eagle products announced recently is a battery condition test meter type BT-15. The meter will test the condition of 1.5V to 90V dry cell batteries on load in 15 switched ranges.

On the switched ranges for 1.5V, 4.5V and 9V batteries there is a high and low position, which shows the battery condition for high and low

current drain.

The meter scale is divided into three segments which read "replace" for less than 50 per cent efficiency; "useable" for between 50 and 80 per cent efficiency; and "good" for 80 to 100 per cent efficiency.

The BT-15 battery tester costs £9

and is housed in a plastics case, similar in appearance to a multimeter.

RESISTANCE BRIDGE

A robust general purpose bridge, type PW3, for d.c. resistance measurements with a range from 0.001 ohm to 10 Megohm is the latest product from Croydon Precision Instruments.

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supplies the correct voltage for the bridge according to the range selected. The four measuring controls are connected in a form of Kelvin Varley potential divider network and a seven position range selection switch, for values of up to 1,000, 100, 10, 1, 0·1, 0·01 and 0·001, also incorporates a battery check position.

Under all conditions of measurement there is never less than 5,000 ohms in series with the galvanometer and Rx terminals. This gives a certain amount of protection to the meter when the battery key is opened while measuring the resistance of inductive circuits.

Another claimed feature of the bridge is that it has a true zero irrespective of range setting. There are no switch contacts in series with Rx, so eliminating any resistance variations due to contact resistances.

The PW3 bridge is housed in an attaché style case and full details and cost can be obtained from Croydon Precision Instruments Co., Hampton Road, Croydon, CR9 2RU.



Eagle Products battery tester



PW3 Resistance Bridge marketed by Croydon Precision Instruments



DESOLDERING

Most desoldering products on the market consist of special soldering iron attachments and work on vacuum suction for removing solder.
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The joint to be desoldered is heated by any standard iron and as soon as the solder begins to melt the wick is applied directly to the joint, drawing the solder into itself. It is claimed that this method avoids any excessive heating and leaves the joint completely clean and ready for resolder-

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The solder wick is supplied in 17 in plastics containers and there is approximately 60in of wick. Prices range from 18s to 20s per reel, according to width.

Further details can be obtained from Southern Watch and Clock Supplies, Ltd., Industrial Tools Division, 48-56 High Street, Orpington, Kent.

LITERATURE

To save unnecessary costs and wastage, the Mullard Technical Handbook is now being issued as a series of three volumes. Each book deals with a particular section of Mullard manufactured components and is divided into several parts or chapters. The first part contains details of semiconductor and integrated circuit devices and is divided into six parts. The second contains five parts dealing with valves and tubes.

The final book deals with components and materials and is divided into three parts covering electrical components, ferrite, PXE, permanent magnets, and ferroxcube

inductor cores.

As only certain sections will be of interest, according to particular requirements, each of the 14 parts can be purchased separately at 12s each, post free.

Further details and orders for the handbook should be addressed to Central Technical Services, Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

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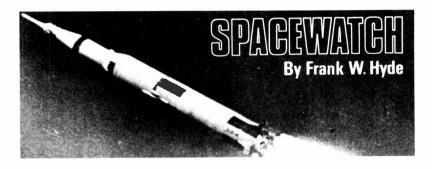
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INTELSTAT IV

communications largest satellite in the world is due to be launched in 1971. It has been designed for world wide communications and will be placed in a geostationary orbit at 22,300 miles above the earth. Almost 18ft high and 8ft in diameter, it will be capable of a number of combinations of voice and video transmissions. For example, it could carry 12 colour TV broadcasts or 6,000 two-way telephone conversations.

Intelstat, the International Tele-Telecommunications Satellite Consortium, owns the earlier Intelstat satellites which have already linked the countries of the world in a global communications service. There are now some 69 member countries of Intelstat. They jointly own the satellites but the terminals and land distribution systems are the property of the member governments or of private enterprise in the countries where they are installed.

The new generation of satellites for Intelstat described above will be built by the Hughes Aircraft Corporation of California. Of the four satellites to be built under this contract, two will be assembled in Europe by the British Aircraft Corporation, and then shipped to California for final testing.

POSITION FIXING BY SATELLITE

A system that can locate ships within five nautical miles has been developed by G.E.C. of America. Such an accuracy is as high as any system in use at the moment. applied to the location of aircraft it would help to fit them into the airspace available with great precision and cut down congestion at the airports. Applied to ships it could be used where crowded harbours are involved with small and large vessels.

The NASA Applications Technology satellites I and II have been used for this purpose. A ground station sends out coded signals which are relayed by either of the pair of satellites. Coded signals are returned to the ground station from the vessel or aircraft taking part in the. same way. In each case two signals, one from each satellite, are monitored by a computer at the ground station.

The positions of both satellites being known accurately, the timing of the returned signals can be used to calculate the position of the craft. As the computer does this in a few seconds, the fix is very fast.

Tests made of the system showed that all sorts of vehicles could be tracked. One test included a mobile van, a coast-guard ship, and two aircraft. The system was developed by Roy A. Anderson who points out that use of a higher frequency of operation would still further increase the accuracy by the reduction of the interaction of v.h.f. signals in the ionosphere. However its wider application is assured at the moment because the majority of installations have v.h.f. as standard equipment.

PIN POINT NAVIGATION

Still another system using very low frequencies has come into use. This is the accurate navigation system developed by the US Navy, which has been named OMEGA. It is swift and efficient in operation, virtually error proof, and should be of benefit to all seafaring nations.

The system consists of eight transmitters strategically set up round the world. Four of these have already been set up and are in operation. The remainder should be

completed by 1972.

OMEGA began life 18 years ago when the US Navy were seeking a more efficient system covering long distances. Three stations were set up as a first experiment. After two years of tests the Navy ordered equipment to extend its use to surface and underwater craft. Now more than half of the world can be covered by the system and two of the largest commercial ocean going liners, the Queen Elizabeth II and Challenge, have been equipped.

When the world wide system is in operation there will be transmitters in Minnesota, Hawaii, Norway, Japan, Trinidad, Australia or New Zealand, Chile or Argentina, and La Reunion Island off Madagascar. These stations will cost less than £250,000.

VERY LOW FREQUENCY

The OMEGA transmitters use a very low frequency of operation, namely 10 to 15kHz. These low frequency waves are bounced continually between the earth and the ionosphere and enable signals to be received at distances of more than 8,000 miles from the transmitter.

The basis of the fix is a comparison between two signals. The stations will each have a power of one kilowatt fed into a four wire aerial slung across a valley or fiord. The one installed at Bratland, Norway, spans 11,000ft across and has a mid-height of 1,435ft. The aerial at Trinidad spans 4.800ft and the midspan height is 800ft. The signal is continuously pulsed for one second out of ten seconds. Only one station transmits a given frequency at a given time. The pulses from each station differ slightly in length for identification purposes and the stations are syn-chronised by the use of "atomic" clocks. It is not expected that phase drift will exceed more than one micro-second per day.

There is a direct read-out on the front of the receiver and the time for a fix is about one minute. It is reported that underwater vessels down to 50ft can use the system.

THE RE-ENTRY BLACKOUT

The radio blackout that accompanies the entry of the space craft into the earth's atmosphere has been given some close attention. radio silence lasts some four minutes and could be vital. In the event of space shuttles this period could be as long as 15 minutes. The Air Force Cambridge Research Laboratories at Hanscom Field, Massachusetts, are experimenting with a possible solution to the problem.

The plasma sheath formed by the ionised gas around the re-entry vehicle needs de-activation so that its transparency to radio waves may be accomplished. Past attempts have not been very successful. The Air Force Laboratories approach was an attempt to "mop up" as it were the free electrons with water or some other chemical sprayed out of the This was not satisspacecraft. factory but an alternative and more novel approach is being tried.

If the plasma sheath could be raised to an even higher energy level it could result in the combination of the free electrons with the ions faster than they were disassociating. The reduction of the density of the electrons would allow the radio communication to continue.

The condition required can be accomplished by radiating r.f. power into the plasma sheath from the spacecraft. It was found that 20 watts of r.f. at 7MHz could neutralise the plasma. Experiments are being carried using this method backed up by spray methods using sulphur hexafluoride which absorbs more electrons. A space test was arranged to test the scheme under Apollo entry conditions. Doubtless the system will be incorporated in an early mission.

EOROAN PA

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

As we know, the manual voices of this organ are applied to one loudspeaker, the pedal tones to another. These units are external to the console, as this is the only way in which the sound can be properly heard.

CHOICE OF SPEAKERS

It is constantly claimed by loudspeaker manufacturers that their products reproduce everything equally well. This is no doubt largely true, but they do not all do it in the same way. Consequently we must accept the fact that loudspeakers have a voice of their own, and the use of "A" will not necessarily produce the same sound as the use of "B".

This factor assumes even greater importance with an organ, the power versus frequency distribution of which is quite different from broadcast programme music. Therefore we must decide on a specific type of loudspeaker and balance things up to suit this.

The organ was voiced on the WB.HF1214 for the manuals and the WB.HF1016 for the pedals. These were selected after comparative voicing tests with other loudspeakers.

ENCLOSURE CONSTRUCTION

The two loudspeakers are housed in a cabinet which makes the most of the space whilst completely separating the channels. Although of fair cubic capacity, it only occupies 24in by 15in floor space, and this is not thought excessive for an organ. Fig. 10.1 shows the principal details of the enclosure, which is constructed from {in chipboard, which is cheap and very suitable acoustically as it is almost dead.

The box is divided as shown by a hardboard panel, the curvature and the small width making it quite rigid. At the one possible point of flexure, a lin dowel is secured to prevent vibration.

SPEAKER POSITIONS

The upper loudspeaker is the manual one, HF.1214. This faces upwards, eliminating any noise. It speaks into the Leslie type rotor but the back wave is also used (unlike the usual concept) and this issues from a small slot just above the floor. It is very important that the battens supporting the box should allow about a 2in gap here.

The underside of the {in chipboard mounting panel and the top 12in of the baffle have thick felt glued on—just a drop of glue at the corners, otherwise the absorb-

ing power of the felt will be reduced.

The lower or pedal loudspeaker, HF.1016, is near the floor and faces outwards but away from the player. It has a vent equal to the cone area near the top of the box, and again felt is used behind this unit for 12in up the baffle and on the panel beneath the cone. Connections are brought out to a terminal block or sockets, where convenient.

Sealing at the top of the baffle is by one of the adhesive plastic tapes and along both sides of the baffle by Sealastik, a preparation which never fully hardens. This is quite easy to do if the bottom panel is fitted last. It is most important that the whole structure is airtight, otherwise we may get a weak bass and possible interference, since there is no way of phasing the two loudspeakers. In the prototype, all panel edges were glued by Evostik resin glue type W, which makes an extremely strong joint.

To match the console, the enclosure should be finished in Arborite Superdec Sapele laminate with a contrasting black gloss laminate for the top and supports. Contact adhesive is a suitable fixative.

EFFECT OF TREMULANT

We thus have two loudspeaker cabinets in one, as it were, and the distance between the top of the manual speaker and the floor vent produces subtle changes in phase when the tremulant is working since the floor vent signal is steady but the radiation from the top of the cone is modulated by the rotor.

A further valuable feature of the rotating device is that the sound appears to come from a much larger area than that of the loudspeaker cone, thus completely avoiding the "point source" effect, which is so, undesirable in an organ.

Many instruments have two speeds for the rotor, but there are mechanical difficulties and, in general, one speed is quite acceptable. This rotor revolves at 360 r.p.m., and is driven by a standard tape recorder capstan motor.

ROTOR ASSEMBLY

To ensure easy starting the rotor is made from hinthick balsa wood, and bent to the shape shown in Fig. 10:1 by steaming and careful shaping. This material is obtainable from any model aircraft shop.

The top, to which the rotor edge is glued, is made from ¼in plywood with a centre hole of ½ in diameter to take a Meccano spindle. To help in setting the rotor curtain, a rubber band can be fixed round it while the glue dries. The underside of the top plate is lined with typewriter felt glued on, which prevents vibration which at certain frequencies could cause spindle chatter.

To minimise acoustic cut-off and provide stiffness, we use a piece of sin by hin wall alloy angle to support the lower end of the spindle. This is shown in the figure and is held onto the top panel by two screws at each side.

The bottom bearing for the spindle is made from a little block of nylon, drilled halfway through. Note that this material tends to close in after drilling, so the drill must be larger than the spindle. Screw the block onto the angle with two 6B.A. screws tapped into the metal.

The upper mounting for the spindle is exactly the same, but of course the bearing hole is drilled right

LOUDSPEAKER & FINAL TUNING

through. Make the hole in the metal somewhat larger, so that the spindle cannot rub on it.

The top angle is supported from the speaker mounting board by two pieces of lin dowel, glued and screwed into holes cut in the speaker support.

Now the rotor should spin round with the greatest ease and no noise. A trace of graphite where the spindle passes through the top bearing may be advantageous.

MOUNTING THE MOTOR

Hysteresis motors of the type specified hum or vibrate to some extent under load, due to magnetic slip. Therefore we must mount the motor on rubber. There are many ways of doing this, but two simple strips of foam rubber as in the figure will do very well.

These, as can be seen, are again mounted on two lin dowelling pillars, to bring the height of the motor pulley in line with the spindle pulley. The diameters of these must be chosen to give the correct ratio, this depending on the actual motor speed. Such pulleys can often be standard Meccano types, held to the spindles by grub screws.

An ordinary rubber band about in wide will drive the very light rotor quite well, and to maintain the tension and align the motor spindle, we attach a light spring as shown to pull in the opposite direction. In any event, there must be no joints in the driving belt, but a metal spring type of belt is noisy. Plastic belts can be used, but are sometimes inclined to be stiff. The belt must be very flexible.

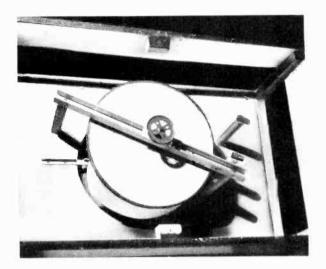
The final adjustment is for the height of the rotor above the speaker. Ideally the gap should be about in, but it may not be possible to get quite as close as this. A larger gap will not affect the higher frequencies, but will progressively reduce the lower ones. So some control over the modulation is possible.

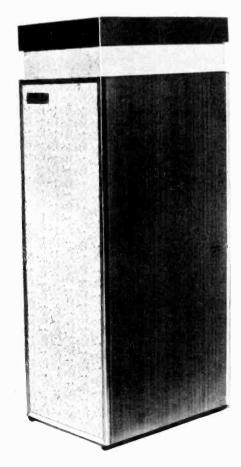
ALL VOICES MODULATED

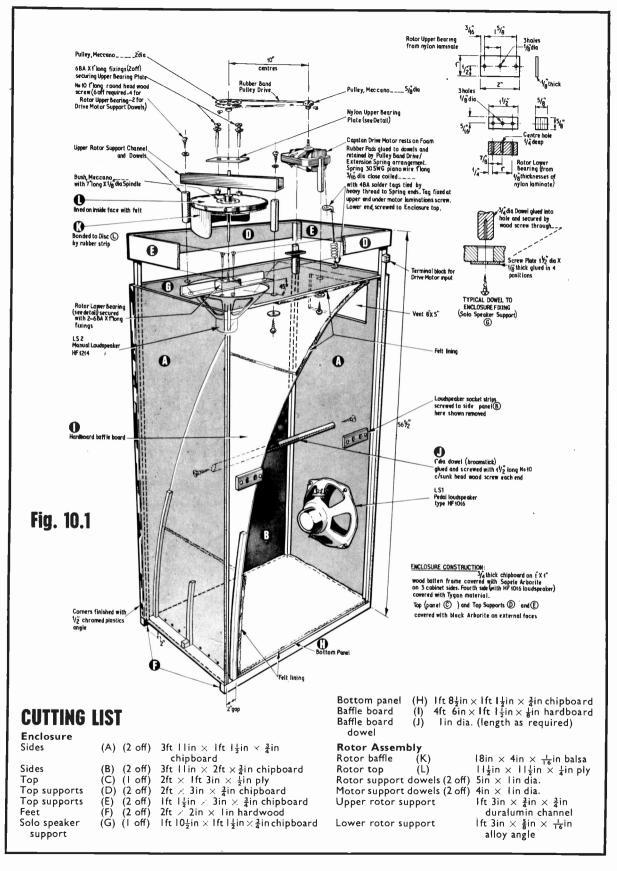
It is often said that only tibias and flutes can be treated by a rotating tremulant, but in fact we apply all the tonecolours in the organ and they are all effective—though naturally the lower notes are less modulated than the upper ones; but then, this is just what happens with pipes. The deepest tremulant is obtained when a re-entrant pipe enters the rotor, but this would be too much for some voices. It is felt that the arrangement outlined will suit most people.

There are other forms of Leslie device, such as rotating horns and rotating loudspeakers, but these either have special applications or are too complicated for our purpose.

As a matter of passing interest, the first rotating horn tremulant was patented by the late John Compton in 1932, but the original Doppler effect rotating paddle was in use over 100 years ago in reed organs. It was realised even then that both amplitude and frequency must cyclically change to produce the most pleasing effect.







MISCELLANEOUS PARTS

Meccano pulleys: 2in dia. (1 off); §in dia. (1 off)
Meccano bush ¾in dia. and 7in spindle to suit
Capstan drive motor 240V (1 off) (G. W. Smith &
Co. Ltd)

4 way terminal block

2 way socket strip (2 off)

Foam rubber, felt lining, rotor bearing material (nylon or Perspex), plastics corner angle, spring and rubber band for motor.

Screws and nuts 6B.A. (4 off), screws, wood, No. $10 \times lin$ (6 off).

POSITIONING OF ENCLOSURE

Although this organ should be completely free from hum, signal leakage or noise of any kind, it may well be that the most effective pedal sound is obtained when the pedal cone faces into a corner, about 3ft away. This perhaps will not be possible, in which case the cone should be parallel with the wall.

In small rooms, a frequency of 32Hz (wavelength 35ft) cannot be properly reflected, and if it is too near a wall some of the lower room resonances can be excited, giving rise to what appear to be changes in pitch as one moves about the room. So every effort should be made to avoid this effect by suitable placing of the unit in the room.

The worst results are always noticed in rooms of the same length, height and width, and in circular rooms.

TUNING THE ORGAN

The oscillators require careful tuning. It will be understood that as the dividers produce square waves, there will be many harmonics present, some of which are discordant. In such circumstances, if the organ is only slightly out of tune, these harmonics will beat with others

Since the natural frequencies of the oscillators are high, it is more convenient to tune on a divider some octaves down. This is also in the range covered by the common type of tuning fork. Since one must have a standard for tuning, it is best to try and borrow a dozen forks covering the octave 261–523Hz, that is, middle C to the octave above. However, with care it is possible to tune by ear if we have one standard fork, C 261·62Hz.

TUNING PROCEDURE

In referring to the frequency chart given in Part Three, we can see that there is no top C 2ft therefore the lowest oscillator frequency starts at 4,186Hz which is the top C 4 ft.

The remaining oscillators run up to 2ft terminating at B, 7,902Hz.

The tuning capacitors listed are applied to each oscillator as shown. Note, however, that these values

B (7,902Hz)	21,600pF	F	23,200pF
A sharp	21,750pF	E	26,700pF
A	22,000pF	D sharp	27,000pF
G sharp	22,600pF	D	32,200pF
G	23,470pF	C sharp	39,190pF
F sharp	22,000pF	C (4,186Hz)	52,000pF

All polystyrene

are only approximate since the tolerances of the units used are not known exactly. Note also that the core of the Vinkors only allows a 7 per cent frequency adjustment

These values should give a near enough approximation to the note required to allow fine tuning to commence. Again, the way the coils are wound and the tightness of the core clamp may alter some of the values shown. This is rather a tedious process, but it only has to be done once.

Having tuned middle C 261 6Hz exactly to the fork of this frequency so that no beat notes exist, hold the G above (note number 32 on the upper manual at 8ft pitch) with the tuned middle C and move the core of the G oscillator coil until there is no beat. The G is now flattened, or reduced in frequency, until there are 9 beats in 10 seconds.

With the G so tuned this is held with the D below (note number 27) and the oscillator of the latter adjusted for zero beat. This D is now flattened to produce 13 beats in 10 seconds.

Now D and A34 (note number 34 on upper manual) are adjusted for zero beat, then the A is flattened to 10 beats in 10 seconds.

This sequence is continued for A34 and E29, 15 beats. E29 and B36, 11 beats. B36 and F sharp (31), 17 beats. F sharp (31) and C sharp (26), 13 beats. C sharp (26) and G sharp (33), 9 beats. G sharp (33) and D sharp (28), 14 beats. D sharp (28) and A sharp (35), 11 beats. A sharp (35) and F30, 16 beats.

The second notes should always be flattened; the beats should never be obtained by sharpening the tuning.

If all that has gone before has been done carefully, then by holding C25 and F30, the beat rate should be 12 in 10 seconds. Very likely this will not come right the first time, but persevere until it is correct.

VOICE BALANCE AND ROOM SIZE

Readers will no doubt appreciate that electronic organs sound very different in different rooms, and this is in part due to the fact that the sound comes from a very small area, virtually a point source. Obviously this is a bad thing, since the area occupied by even the smallest assembly of pipes is some hundreds of times greater than that of the loudspeaker cones.

We have to remember also that the sound field changes with the frequency, lower notes spread out whilst higher ones concentrate more and more on the axis of the cone. All this means that the position of the loudspeaker in relation to the player will affect the balance of the sound spectrum. In fact, where extremely small rooms are concerned, it is practically impossible to obtain a correct balance for all stops, the more complex voices appearing to be shrill compared with flutes and the like.

STOP ADJUSTMENT

In this organ there is provision for regulating the loudness of such stops as might cause difficulties. The small adjustable pots in the tone networks can be set to give an agreeable balance for most conditions.

If the constructor still finds some voices too loud relative to the others, the particular resistor feeding the outlet busbar can be increased until the balance seems correct.

Next month: the concluding article in this series will discuss some additional circuits for various effects, and also organ playing technique.

• BABY ALARM

• PHOTOGRAPHIC TRIGGER

• SPORTS EVENT TIMER TRIGGER

• GARAGE DOOR CONTROL

AID FOR THE DISABLED

THE sound operated switch described here incorporates a holding or locking action. The first sharp pulse of sound switches on the device, and after a short period of time the next pulse of sound will switch the device off. Thus this sound operated switch is different to others in that it only requires a sound to switch it on, and it will then remain switched on until a second sound turns it off.

CIRCUIT DESCRIPTION

,138 °

A block diagram of the unit is shown in Fig. 1. A loudspeaker or microphone is used as a transducer, to pick up the sound which is applied to an audio amplifier (via a matching transformer in the case of LS1).

The amplified signal is then fed to a monostable circuit via a limiter. The monostable has a preset time constant to prevent it being switched more than once by a burst of sound. The output from the monostable is then fed to a bistable which switches the load via two further transistors.

The amplifier consists of a direct coupled *pnp-npn* transistor pair (TR1 and TR2 in Fig. 2) followed by a limiter (TR3). The base emitter junction of TR3 is in

effect a diode connected across R6; this means that any voltage above 0.7V will switch TR3 on. Thus when the high amplitude audio is applied to the base of TR3, the output across R7 is a series of pulses corresponding to the sharp audio peaks.

MONOSTABLE

These pulses are passed through the diode D1 to the monostable multivibrator. The monostable switches over on receipt of the first pulse and remains switched on for a preset period, determined by the time constant R10 C4, inhibiting the system and blocking any other sound from the bistable multivibrator.

A sharp sound (i.e. a "snap" of the fingers or a whistle) consists not of one single sound, but of a burst of sound, containing many separate pulses. Thus if this burst is amplified and then limited, a burst will appear across R7 containing a random number of individual pulses. If this burst was applied straight to the bistable, the multivibrator would "flip" backwards and forwards and have a fifty-fifty chance of staying in the original state, or of having changed state at the end of the burst.

Practical Electronics

February 1970





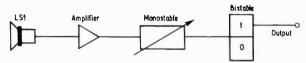
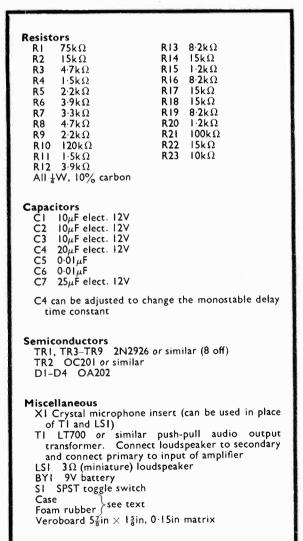
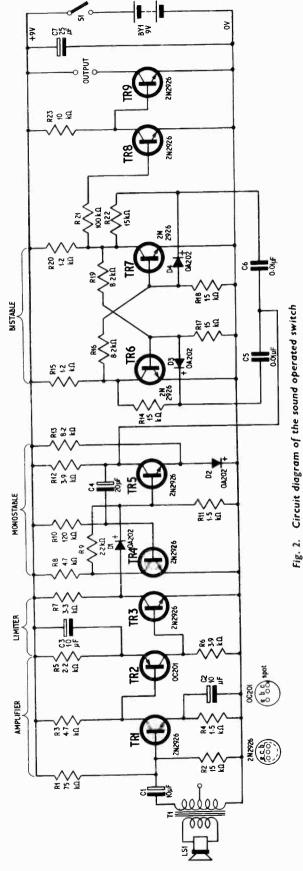


Fig. 1. Block diagram of the sound operated switch

COMPONENTS . . .





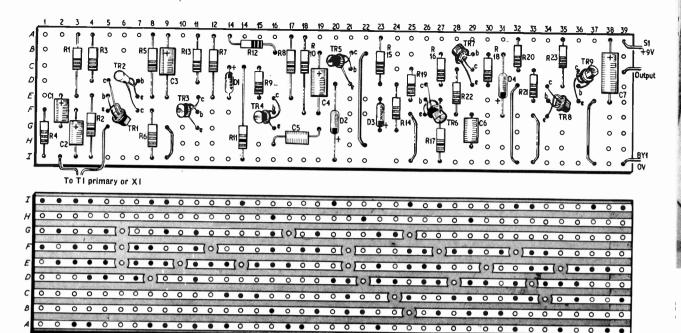




Fig. 3. Veroboard layout and wiring for the sound operated switch

Therefore, the monostable multivibrator acts on the first pulse of the burst, and can not flip back until after the whole burst has passed. The delay due to the time constant (R10 C4) is set up to do this, and will also ensure that there is an inherent operating delay built in, so that a short period of time must elapse before a second change of state can take place.

BISTABLE

The output pulse from the monostable is passed to the bistable multivibrator, and is steered by the diodes to the correct transistor in order to change the state of the bistable. For when a pulse arrives at the input it finds one transistor switched on, the other off; thus one diode (D3 or D4) is reverse biased so that the pulse is steered through the other diode and switches over the multivibrator. The next pulse will find exactly the same situation, but the "roles" of the transistors and diodes will be reversed.

The current flowing in R21 due to the applied potential difference across it is the base current of transistor TR8. Thus when TR7 is off, its collector is at a high potential, and current flows in R21. When TR7 is on, its collector is at earth potential and no current flows in R21. When current flows in R21, TR8 is switched on, its collector falls to earth potential and switches off TR9, thus no current will flow in the load

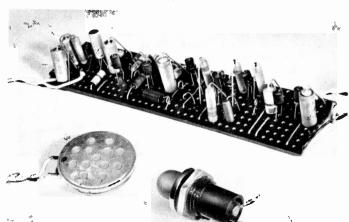
connected across the output terminals. When the unit is in the other state TR9 is switched on and current flows in its collector and load circuit.

CONSTRUCTION

Construction is straightforward, but is carried out in reverse, that is starting at the output stage and working back to the input. Build the bistable and output circuit first, and test this by momentarily shorting the junction of C5 and C6 to the negative line, when the switching action may be observed. Then build the monostable, connect it to the bistable, and test by momentarily touching the negative end of D1 to the positive line. Finally, build the audio amplifier and limiter and test the complete unit. Sensitivity should be such that one can talk quite near the loudspeaker without switching the unit, but a snap of the fingers from across the room should operate the device.

Layout is not critical, and the unit may be built on Veroboard, tag board or on a printed circuit. Layout and wiring of the complete unit mounted on Veroboard is shown in Fig. 3.

The transistor types are not critical; TR2, the *pnp* type, can be almost any silicon transistor; an OC201 was used in the prototype. The *npn* types can be 2N2926, BSY27, ZTX300, or any similar transistor; the diodes used are all OA202.



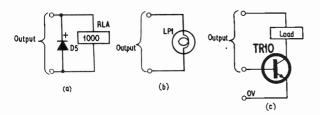


Fig. 4. Output load connections, (a) using relay to switch load, (b) miniature bulb as load, (c) power transistor used to switch load directly

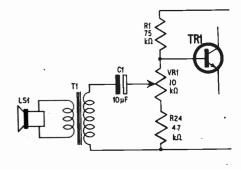
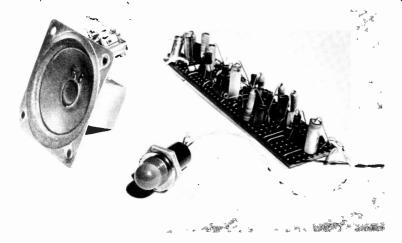
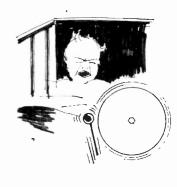


Fig. 5. Circuit for a sensitivity control





OUTPUT CIRCUITS

Having built the sound operated switch it must be connected to the load. The simplest way is shown in Fig. 4a, a relay coil (with a diode to remove any back e.m.f. generated) is connected across the output terminals. Almost any type of relay will do provided that it will operate on a 9V supply, at a current up to 40mA.

An alternative method of using the sound operated switch is shown in Fig. 4b. If a small bulb taking 60mA or less is connected across the output the sound signals will control the lamp directly. This may be used in the photographic dark-room to illuminate the light switch—just snap your fingers and the light will come on, enabling you to see the switch. The reason for using the small light and not controlling the main lighting directly is to prevent spurious sounds from turning on the main lights and thus ruining the film. The small bulb does not produce enough light to ruin papers and film, and the lamp can be shielded so that no direct lighting can fall on the working area.

A method of obtaining a greater load current is shown in Fig. 4c; this uses transistors TR9 and TR10 as a direct coupled current amplifier, and may thus control a load without the use of a relay. Transistor TR10 could be any *npn* power type such as a 2N3055, the size of the load will be limited by the power handling of this transistor.

INSTALLATION

Once the sound operated switch is working on the bench it may be noticed that extraneous noise or vibrations may trigger it. These unwanted effects can be countered in a number of ways.

The loudspeaker or microphone, which may be used remotely, can be mounted in sponge rubber. This

will effectively isolate the transducer from vibrations. The noise triggering level may be controlled by the simple addition of a sensitivity control as shown in Fig. 5, where R2 is replaced by a 10 kilohm potentiometer and 4.7 kilohm resistor in series.

The complete sound operated switch can be housed in any suitable cabinet; the loudspeaker may be mounted away from the circuitry if required.

USES

With a suitable delay period in the monostable the sound operated switch can be used to count the number of times a certain noise occurs. To do this the output may be fed to an electromagnetic counter.

The switch could also be used as a sound operated remote control unit to switch lights on or off; in the photographic darkroom as described earlier, or for room lighting. If a frequency sensitive amplifier is placed in the input circuit, the unit will only respond to tones of a given frequency, and may be used to switch almost any device on and off from a distance. (Suitable frequency sensitive amplifiers were described in PRACTICAL ELECTRONICS, January 1967 in the Remote Control Series—unfortunately we can no longer supply this issue—Ed.)

The sound operated switch can be used to help disabled persons as it can be connected to sound a bell or other call device. This application makes it possible for help to be summoned without the operator making any bodily movement. By using various frequency selective amplifiers and a number of switches, various operations may be activated by different sounds.

There are of course, other uses for the unit and no doubt many readers will find numerous interesting and useful applications for the sound operated switch.



I.T.N. Sound Equipment

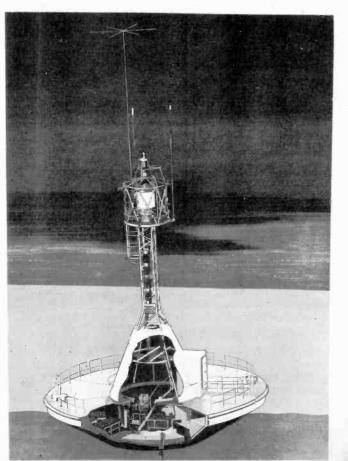
T.N.'s new studios in Wells Street, London, were recently opened by Her Majesty, The Queen. The new studios were built for the new full colour transmissions.

Elcom (Northampton) Ltd., have provided the full sound facilities for the entire complex and the equipment consists of a 24 channel sound mixer and a grams desk for

each of the two studios, a dubbing mixer with an associated grams desk and a talk back system using the master to master technique covering all editorial locations.

Most of the equipment has been specially designed to I.T.A.'s requirements; the photograph above shows the grams unit (in the foreground), a 24 channel sound mixer, and the production desk in Studio 1 central control room.

ELECTRONORAMA



Navigation Buoy

A NEW navigational buoy, designed as an automatic replacement for a lightship, was recently handed over to Trinity House (the general lighthouse authority for England, Wales and the Channel Islands) by Hawker Siddeley Dynamics Ltd. The buoy is 40ft in diameter, 20ft from top to bottom, excluding the aerials, and weighs 84 tons.

Contained inside the buoy are three generating sets, logic and control equipment for the lights and fog signals. A u.h.f. control and monitoring link carries two-way data between the buoy and its shore station. Speech relay facilities are also included for use by servicing personnel. The radio equipment is duplicated to increase reliability and the standby equipment on the buoy has an automatic changeover.

The shore control station can monitor and control up to five buoys depending upon line-of-sight range. The buoys are completely automatic except for the operation of the fog signal. The telemetry system monitors each of the buoy's functions to check its operation and allows remote manual intervention should any automatic facility fail to operate. The buoy will be visited at six-monthly intervals for simple maintenance checks, refuelling and boosting the batteries. During maintenance periods, two exhaust fans ventilate the engine room, workshop and battery and electronic compartments.

"Lanby" (Large Automatic Navigational Buoy), as

"Lanby" (Large Automatic Navigational Buoy), as the new buoy is known, has been fitted with many safety facilities and is designed to operate in winds up to 100 m.p.h., waves up to 40ft high and tidal currents of 7 knots. The drawing on the left is an artist's impression showing a cutaway view of the new buoy; after full operational trials in the North Sea the Lanby buoy will be towed to its permanent site off Portland Bill to replace the Shambles lightship.

Electronics Aids Airlines

ELECTRONIC equipment is playing an ever increasing role in the running of airports and airlines. Aircraft have always been assisted by electronics but the systems are improving, giving greater reliability and speeding up many processes.

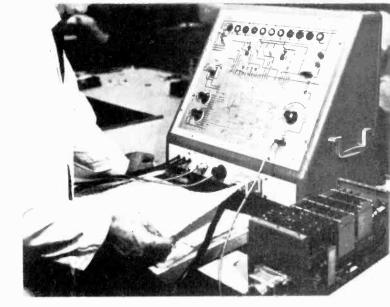
During the last few weeks there have been a number of additions and improvements to electronic equipment being used by the major airlines and large airports. Some of the recent

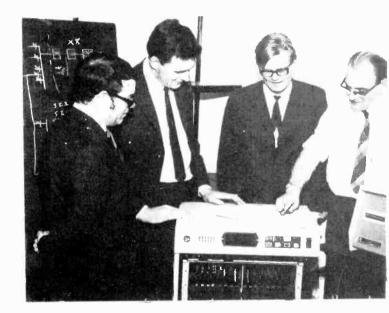
additions are shown on this page.

The photograph at the top right-hand corner depicts a new type of aircraft power generating system test set. A range of these test sets have been developed by Kenure Holt and Company Ltd., and a typical test configuration for a Boeing 707, B.A.C. VC10 and B.A.C. One-eleven costs £6,000 to £9,000; much less than other test systems in use. The system, named "Kenair", can test up to four aircraft equipment panels simultaneously, thus reducing testing time and costs.

A data collection system for B.E.A.'s engine overhaul department at Heathrow has been installed for operation in conjunction with the B.E.A. computerised scheduling system for engine rework. In the initial installation the system, which was manufactured by Feedback Ltd., will accept information relating to movement of components from the outstations located in various work areas. Output data is transferred via punched tape to B.E.A.'s ICL 1903 computer; it is hoped that at a later date the punched tape stage will be eliminated. The centre and lower photographs on the right of this page show B.E.A. staff under instruction during a course with Feedback when they studied the new data collection hardware, and one of the outstations in use in the engine overhaul department.

The remaining photograph on this page shows a B.O.A.C. supervisor at Heathrow checking a VC10 before departure. The Multitone receiver in his breast pocket is part of a new u.h.f. paging system installed by B.O.A.C. for their maintenance division. The maintenance staff found that the v.h.f. equipped vans previously used were no longer adequate as a form of ground communication. Using the new system in conjunction with the old, a much more flexible network is obtained and staff can be called from any part of the airport, even inside an aircraft.









P.E. WIDEBAND H.F. GOMMUNIGATIONS RECEIVER

By R. HIRST S.T.C. LTD. PART FIVE SIDEBAND FILTER AND A.F. MODULES

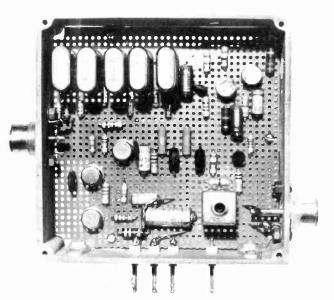
Two further modules are described in this part, the modules are the Sideband Filter Unit and the A.F. Unit, and, as before, these were described briefly in the first part of the series.

The sideband unit can be broken down into three separate circuit configurations each of which performs a quite individual task.

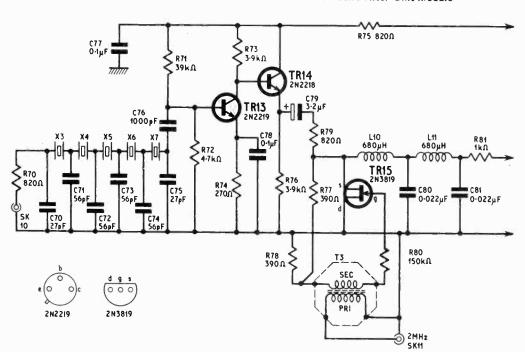
CRYSTAL FILTER

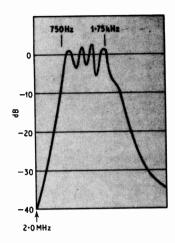
Crystals X3 to X7 in conjunction with C70 to C75 act as a steep sided filter (Fig. 5.1) passing frequencies from 2·00075MHz to 2·001750MHz. Five crystals are the minimum quantity that can be used and they have been slightly staggered in frequency to get as wide a coverage as possible with the five crystals. The passband has some ripple in it as can be seen from Fig. 5;2.

The resultant audio bandwidth achieved with this number of elements is barely substantial but as the crystals are relatively expensive items it seems reasonable to indicate the minimum quantity that could be used. Should the constructor wish to improve the bandwidth it is quite easy to add another three crystals,



The Sideband Filter Unit module





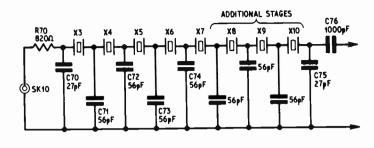


Fig. 5.3. Alternative eight stage crystal filter

Fig. 5.2. Passband curve using the five stage filter

as shown in Fig. 5.3, making a maximum total of

With the alternative arrangement all the capacitors going from the junctions of the crystals down to earth can be adjusted slightly in value to compensate for individual crystal characteristics to give a reasonably flat bandwidth of 3kHz.

AMPLIFIER AND DEMODULATOR

Transistors TR13 and TR14 form a directly coupled amplifier where the signal is amplified by TR13 and transformed in impedance by TR14. The Field Effect Transistor TR15 is used as a demodulator in the following manner. The 2MHz switching frequency, which is derived from the 2MHz oscillator, is transformed up to approximately 7 volts by the transformer T3.

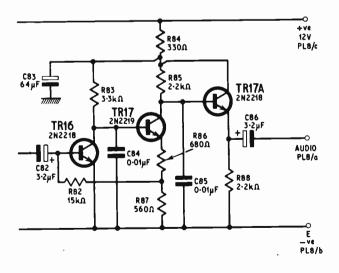


Fig. 5.1. Circuit diagram of the Sideband Filter Unit with a five stage crystal filter

The f.e.t. which has been placed directly across the signal path goes alternately open and short circuit at the switching frequency thus producing an audio tone. This can be shown by subtracting from the signal frequency, which is from 2·000750MHz to 2·001750MHz, the switching frequency of 2·0MHz. Therefore if the sideband filter is wider in its passband, a greater audio range may be achieved. The r.f. is removed by the following low pass filter, L10, L11, C80, and C81.

PREAMPLIFIER

The resultant audio signal is now pre-amplified by TR16, TR17 and TR17A and is fed out to the audio gain control on the front panel of the receiver. The preamplifier uses three transistors in a directly coupled mode arranged so that the configuration is self temperature compensating by virtue of the d.c. negative feedback applied to the base of TR16 via R82. Capacitors C84 and C85 have been introduced to ensure that no r.f. signal gets through into the audio amplifier.

The preamplifier starts to cut off rapidly at approximately 4kHz but is very stable in its gain characteristics due to the considerable a.c. negative feedback applied via R82 to the base of TR16. This degree of negative feedback allows a wide spread in the tolerances of the transistors that may be used in all these stages. The audio output is taken from one of the pins at the base of the module via a screened lead to the gain control.

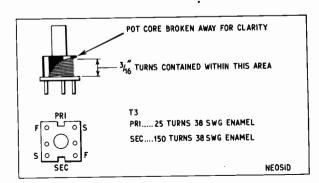
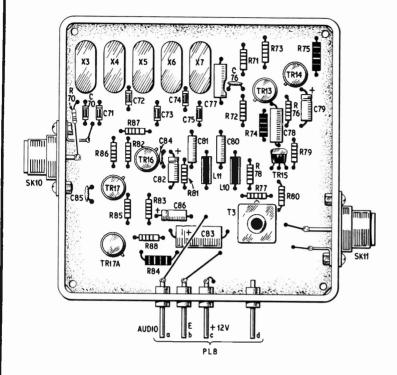


Fig. 5.4. Coil winding details for T3



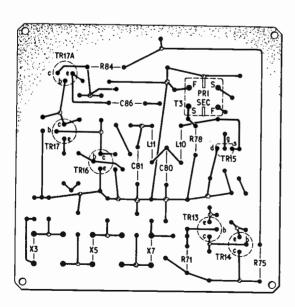


Fig. 5.5. Layout and wiring diagram of the Sideband Filter Unit

COMPONENTS . . .

SIDEBAND FILTER UNIT

Resiste	ors
R70	820Ω
R71	39kΩ
R72	4·7kΩ
R73	3.9kΩ
R74	270Ω
R75	820Ω
R76	3.9kΩ
R77	390Ω
R78	390Ω
R79	820Ω
R80	150kΩ
R8I	lkΩ
R82	I5kΩ
R83	3-3kΩ
R84	330Ω
R85	2·2kΩ
R86	680Ω
R87	560Ω
R88	2·2kΩ

Capaci	itors
Ċ70	27pF
C71	56pF
C72	56pF
C73	56pF polystyrene 2½%
C74	56pF / / / 2/0
C75	27pF
C76	I,000pF j
C77	0·1μF polyester
C78	0·IμF polyester
C79	3·2μF elect. I2V
C80	0·022μF polyester
C81	0.022μF polyester
C82	3·2μF elect. 12V
C83	64μF elect. I2V
C84	0.01 uF ceramic

٠,	-04	3.74L elect. 17A
	283	64μF elect. I2V
(284	0.01 μF ceramic
(285	0.01μF ceramic
	286	3.2µF elect. 12V

Transistors
TR13 2N2219
TR14 2N2218
TR15 2N3819
TR16 2N2218
TR17 2N2219
TR17A 2N2218

Crystals
X3-7 2MHz fundamental
(5 off—see text)

T3 See Fig. 5.4 L10 680μH choke L11 680μH choke

Miscellaneous
PL8/a, b, c, d insulated lead
through connectors (4 off)
SK10, II coaxial chassis
mounted sockets (2 off)
Plain perforated Veroboard $3\frac{1}{2}$ in \times $3\frac{1}{2}$ in, 0·lin grid

There is very little overall gain in the Sideband Unit due to the losses associated with the crystal filter and the mixer circuit, hence the following A.F. Unit has an input sensitivity in the order of 300 microvolts.

CONSTRUCTION

Winding details for T3 are given in Fig. 5.4; this coil should be wound before commencing construction of the module. It should be noted that the screw core used for this transformer is coded "grey" not violet as has been used previously; a cup core is also used for T3, see Fig. 5.4. Layout and wiring details are given in Fig. 5.5; this module is constructed along the same lines as previous modules using component leads for connecting up where possible. All components are mounted on a perforated board inside the module case described in the second part of this series.

SETTING UP INSTRUCTIONS Equipment required:

(a) Power supply 12 volts at 50mA.

(b) Signal generator capable of supplying 2mV at 2MHz, variable plus or minus 6kHz from 2MHz; impedance 50 ohms.

(c) Signal generator capable of giving out IV at 2MHz; impedance 50 ohms.

(d) Valve voltmeter with a sensitivity of 500 microvolts at audio frequencies; impedance greater than 100 kilohms.

PROCEDURE

Apply 12 volts in the correct polarity to the module. Check all the potentials at the base collector and emitter of the transistors to ensure that they correspond with the values given in Table 5.1. If these levels are correct apply a signal at 1kHz above 2MHz (i.e. 2.001MHz) to the input SK10 at a level of 2 millivolts. Secondly, apply a signal at 2MHz, plus or minus 50Hz, to SK11 at a level of 800 millivolts; this measurement is taken in circuit with the amplifier switched on. The valve voltmeter can now be connected to PL8 where there should be an audio output in excess of 2 millivolts. It would be advantageous to connect an oscilloscope across PL8 at the same time to ensure that the waveform is undistorted and is free from r.f.

Table 5.1. SIDEBAND UNIT D.C. VOLTAGES

Stage		Voltage
TR13	Vc	5·4V
	Vb	1·2V
	Ve	0·4V
TR14	Vc	10⋅1∨
	Vb	5·4V
	Ve	4·6V
TRI6	Vc	3·1V
	Vb	0·65V
	Ve	0V
TR17	Vc	5·6V
	Vb	3.17
	Ve	2·4V
TR17A	Vc	10.0∨
	Vb	5·6V
	Ve	5.0∨

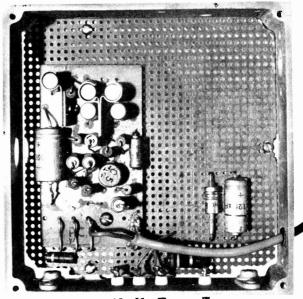
A.F. UNIT

The Audio Frequency Unit simply consists of a prebuilt audio package, purchased as a proprietary item, mounted in a module case. The 12 volt negative rail has been reduced to 8·2 volts within this unit by means of a resistor and Zener diode. The Zener has been shunted by a capacitor to ensure that the rail is adequately decoupled, see Fig. 5.6.

PERFORMANCE

The unit is capable of delivering, at minimum, I volt into a 25 ohm speaker for an input of 300 microvolts, giving an output of 40 milliwatts into the load. The audio amplifier type PC2 may be purchased from Newmarket Transistors Ltd., or one of their agents. The amplifier is entirely directly coupled except for the input stage thus ensuring, due to the large amount of d.c. negative feedback, a high degree of temperature stability.

The input signal has been brought directly to the input terminal of the package via a flying screened lead from PL8, to avoid any of the output current passing via the earth return of the input circuit therefore reducing the possibility of feedback being applied due to the common earth coupling. It is possible to get up to 100 milliwatts from this package if the speaker load is reduced to 15 ohms and the 56 ohm resistor in series with the negative rail is reduced to 39 ohms.



The A.F. Unit module

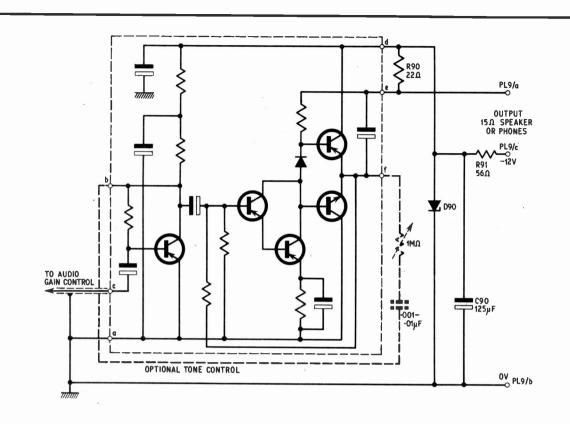
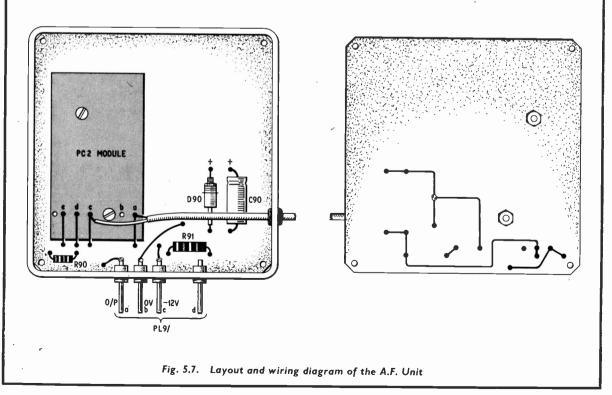


Fig. 5.6. Circuit diagram of the A.F. Unit



CONSTRUCTION

As has been stated the amplifier is purchased as a complete module, this module is mounted on the perforated board using 6B.A. fixings and the power supply and output wiring is connected up. A layout and wiring diagram is shown in Fig. 5.7.

COMPONENTS . . .

A.F. UNIT

Resistors

R90 22Ω ½W 10% R91 56Ω IW 10%

Capacitor

C90 125µF elect. 10V

Zener Diode

D90 8.2V, 1.5W

Amplifier Package

Type PC2 (Newmarket Transistors)

Miscellaneous

PL9/a, b, c, d lead through connectors (4 off) Veroboard, plain perforated $3\frac{1}{2}$ in \times $3\frac{1}{2}$ in, 0-1 in grid Screened audio lead (12in)

SETTING UP INSTRUCTIONS

Equipment required:

- (a) Power supply 12V at 100mA.
- (b) Signal generator capable of delivering up to ImV in the frequency range 300Hz to 3kHz.
- (c) Valve voltmeter covering the audio range with a sensitivity of 300 microvolts.
- (d) Oscilloscope capable of measuring I volt at audio frequencies.

PROCEDURE

Apply 12 volts in the correct polarity to the power terminals of the unit and check that the voltage levels

correspond with those given above.

Inject an input signal, via the flying lead, at a level of 300 microvolts at 1kHz and connect the valve voltmeter and the oscilloscope across a 25 ohm resistor placed across the output terminals. The level measured at the output point should not be less than 1 volt. The waveform should be examined on the oscilloscope to ensure that there is no clipping of the output waveform or any other form of apparent distortion.

Change the input frequency to 300Hz maintaining the input level at 300 microvolts and check to see that the output has not reduced or increased by more than 3dB. Repeat this last test with the input frequency changed

to 3kHz.

Next month: R.F. Attenuator and Power Supply details



ELECTRONICS

By Roland Worcester Published by The Hamlyn Publishing Group Ltd. 159 pages. $7\frac{1}{8}$ in \times $4\frac{3}{8}$ in. Price 6s.

The foreword to this book contains the following sentence in its final paragraph: "Hence the general reader owes it to himself to find out what electronics is all about, and this is one need that the book has been

written to supply.'

One would expect therefore that the book would be written with the beginner to electronics in mind, using simple terms to build up the knowledge of the reader. However, this is not the case and, in fact, some of the sentences and occasionally whole paragraphs just do not make complete sense. Descriptions of many circuit components are inadequate and could cause confusion.

Parts of the book have been written the wrong way around and it is not at all easy to follow. This point is illustrated by the explanation of capacitive reactance on page 19 although the capacitor is not described until page 28—presumably the reader is expected to understand reactance before he knows the basic operation of a capacitor!

"Electronics" has over 300 illustrations, nearly all of which are in colour; the book would have been greatly improved if some of the colour had been dropped and more care taken with the drawings—perhaps some

photographs would assist the reader.

It is stated in the blurb that: "Roland Worcester is a pseudonym that conceals the identity of one of the leading authorities in Britain on the theory and applications of electronics." If this is true one wonders why the author's true name does not adorn the cover of this book.

M.K.

HI FI YEAR BOOK 1970

Edited by Colin Sproxton
Published by IPC Electrical-Electronic Year
Books Ltd.
432 pages, 8\frac{3}{4}\text{in} \times 5\frac{3}{4}\text{in}. Price 20s.

THE casual purchaser of hi fi equipment has a vast range to choose from, which can be perplexing in deciding on the ultimate set-up. This annual publication (now under new management) is a great help in showing technical specifications and illustrations of almost all of the currently available hi fi equipments on the U.K. market. Prices at the time of going to press are those recommended by the manufacturers and may be adjusted due to the abolition of retail price maintenance.

The sections I found most interesting were the articles at the beginning (47 pages) by some well-known authors. John Borwick shows how to select equipment pieces to suit each other, and explains the different types so that the reader can begin to understand the specifications in the directory. R. C. Norris enlarges on speaker

continued on page 170

DEMOSWITCHING CIRCUITS

THE MONOSTABLE By B. Pounder

Last month's article showed the effects of applying rectangular voltage pulses across a series CR network. Let us now apply these properties to a number of useful switching circuits, starting with the multivibrator series. There are three circuits of this type, the monostable, the astable and the bistable multivibrators. This article will deal with the first of these.

MONOSTABLE MULTIVIBRATOR

Fig. 3.1a shows a number of sharp trigger pulses that can be applied to the input of a monostable circuit; the output of the circuit is shown in Fig. 3.1b.

On receipt of a trigger pulse, the circuit switches from a stable state to a state of quasi-stability. The quasi-stable state persists for a time period τ , the length of which can be varied in the circuit design. Note that the fifth trigger pulse shown in Fig. 3.1 is ignored by the circuit as it has been applied during one of the quasi-stable periods.

The monostable acts as a pulse generator, an output pulse occurring after each trigger impulse applied during one of the stable periods. The circuit is often used as a "gate" which can be opened for a well defined interval of time.

CIRCUIT OPERATION

The basic monostable circuit is shown in Fig. 3.2 in which the d.c. conditions are indicated for the state in which TR1 is saturated, or on, and TR2 is cut-off.

To understand the operation of the circuit, it is necessary to recall from the first article that when a transistor is in saturation, the following approximations apply:

$$V_{\rm be(sat)} = 0.8V$$
 (silicon transistors)

= 0.3V (germanium transistors)

$$V_{\rm ce(sat)} = 0.2 \text{V to } 0.3 \text{V}$$

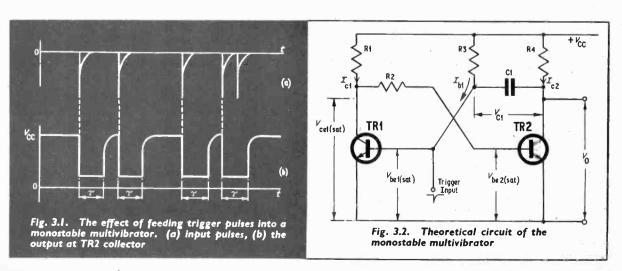
These figures are valid for small general purpose or switching transistors. They will be assumed zero in the approximate analyses which follow.

When TR1 is on:

$$I_{c_1} = \frac{V_{CC} - V_{ce_1(sat)}}{R_1} \simeq \frac{V_{CC}}{R_1}$$

$$I_{b_1} = \frac{I_{c_1}}{h_{FE}} = \frac{V_{CC} - V_{be_1(sat)}}{R_3} \simeq \frac{V_{CC}}{R_3}$$

$$= V_{ce_1(sat)} \simeq 0$$



When TR2 is on:

$$I_{c_2} = \frac{V_{CC} - V_{ce_2(sat)}}{R_4} \simeq \frac{V_{CC}}{R_4}$$

$$I_{b_2} = \frac{I_{c_2}}{h_{FE}} = \frac{V_{CC} - V_{be_2(sat)}}{R_1 + R_2} \simeq \frac{V_{CC}}{R_1 + R_2}$$

$$= V_0 = V_{ce_2(sat)} \simeq 0$$

Suppose that a negative trigger pulse is applied to the base of TR1. The transistor is driven towards cut-off and $V_{\rm ce_1}$ rises towards the supply voltage $V_{\rm CC}$. This rise in collector voltage causes an increase in the base current of TR2 which flows through R2, so TR2 begins to conduct and its collector voltage V_0 falls.

The voltage at the other side of the capacitor at TR1 base also falls, since the potential difference across the plates of a capacitor cannot change instantaneously. As TR1 base voltage falls, TR1 is held hard off.

The circuit therefore contains a regenerative feedback loop which causes the transistor driven towards cut-off to drive the other transistor into conduction and vice versa. The change of state to that in which TR1 is off and TR2 is on is rapid because of this regenerative action.

pass from negative to positive through zero. Soon after this happens, the base-emitter junction of TR1 becomes forward biased so this transistor begins to conduct once again. The collector voltage of TR1 now begins to fall; this fall, in being transmitted to the base of TR2, causes TR2 to turn off.

TIME FACTOR

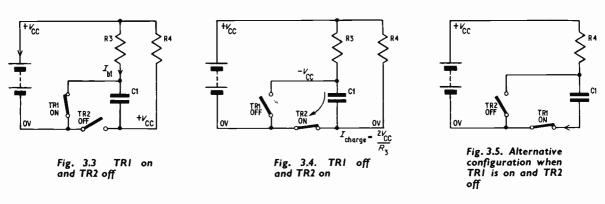
The time period for which the circuit is in its quasistable state is easily found from equation (1). All we need do is substitute $t = \tau$ when the potential difference $V_{C1} = V_{CC}$. The result of such a substitution is that

$$\tau = 0.69C_1R_3 \tag{2}$$

Note that following the second switch-over, C1 completes its charging process through R4, having charged sufficiently to make $V_b = 0$. The equation for the final part of the charge process is therefore

$$V_{\rm c_1} = 2V_{\rm CC}(1 - e^{-t/C_1R_4}) \tag{3}$$

The circuit conditions at the important instants during the operation period are illustrated in the approximate equivalent circuits shown in Figs. 3.3, 3.4,



Equivalent passive circuits for illustrating certain instants in the operation of the circuit in Fig. 3.2

Just after the change of state has taken place, V_0 has dropped by almost $V_{\rm CC}$ to a value just greater than zero. $V_{\rm be1}$ therefore drops from its initial value of about zero by a similar amount, and finishes up at $-V_{\rm CC}$.

The potential difference across R3 at this instant is twice the supply voltage, or $2V_{\rm CC}$, so a current $2V_{\rm CC}/R_3$ commences to flow through R3. But this current cannot flow into TR1, for this transistor is cut-off. It therefore flows into C1 which commences to charge at an initial rate of $2V_{\rm CC}/R_3$.

This current then falls exponentially on a time constant C_1R_3 . The series CR circuit reacts as though a potential difference of $2V_{\rm CC}$ had been applied suddenly across it so the potential difference across C1 is given by

$$V_{\rm C_1} = 2V_{\rm CC}(1 - e^{-t/C_1R_a}) \tag{1}$$

The circuit is in its quasi-stable state while C1 is in the first part of its charging process.

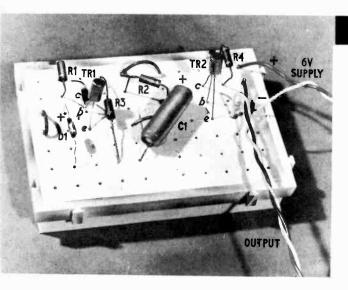
The rising potential difference given by equation (1) eventually causes the actual potential at TR1 base to

and 3.5. In each of these, the base-emitter junction of an on transistor is depicted as a closed switch, while the collector-emitter terminals of an off transistor are depicted as an open switch. Charge paths for the capacitor currents are also shown.

Equation (3) indicates that the circuit regains its initial state rapidly after the second switching instant. For example, if we substitute $t = \tau = 0.69C_1R_3$ and $V_{\rm C_1} = 0.98\,V_{\rm CC}$ into the equation, we find that $R_3 = 5.7R_4$. Now R_3 is bound to be greater than this, unless a transistor with an abnormally low value of $h_{\rm FE}$ were used in the circuit. Thus in the time period τ following the period of quasi-stability, $V_{\rm C_1}$ will have completed much more than 98 per cent of its total change.

CALCULATION OF COMPONENT VALUES

The circuit component values are calculated using the formulae which were used with Fig. 3.2 and equation (2).



The procedure is summarised as follows.

Design Procedure

Step 1. Choose V_{CC} equal to the desired output voltage swing which is to appear across R_4 at the switching instants.

Step 2. Choose a value for I_{c_2} sufficiently large to meet the load requirements and

calculate $R_4 = V_{\rm CC}/I_{\rm c_2}$. Step 3. Calculate $(R_2 + R_1) = h_{\rm FE}V_{\rm CC}/I_{\rm c_2}$. If $h_{\rm FE}$ is the minimum value quoted for the particular transistor, this result will ensure that TR2 will saturate. If in doubt, take a value of 20 or 30 for h_{FE} .

Step 4. Choose a small value for I_{e_1} , but not so small as to cause a drop in $h_{\rm FE}$. A value of about lmA is often adequate, a current at which here is very unlikely to be less than 30. Calculate $R_1 = V_{CC}/I_{c_1}$.

Step 5.

Step 6.

Calculate $R_2 = (R_2 + R_1) - R_1$. Calculate $R_3 = h_{\rm FE}V_{\rm CC}/I_{\rm e_1}$. Calculate $C_1 = \tau/0.69R_3$. If R_3 is in megohms, C_1 will be in μF . If the Step 7. value of C_1 is unsuitable, R_3 can be altered provided that Step 4 is repeated in order to allow for the resulting change in Ic1.

CIRCUIT EXAMPLE

Suppose the requirement is for the monostable output pulses to be of 6V amplitude across a 10 kilohm load.

Hence
$$V_{CC} = 6V$$
. (step 1)

If $I_{e_2} = 5 \text{mA}$, the circuit will be little affected by the

load. Hence
$$R_4 = 6/5 = 1.2k\Omega$$
. (step 2)
and $(R_1 + R_2) = 6 \times 30/5 = 36k\Omega$. (step 3)

If
$$I_{c_1} = 1 \text{ mA}$$
, $R_1 = 6/1 = 6 \text{ k} \Omega$. (step 4)

so
$$R_2 = 30 k \Omega$$
. (step 5)

Also,
$$R_3 = 6 \times 30/1 = 180 \text{k} \Omega$$
. (step 6)

If we choose $\tau = 2$ seconds, a value long enough to

Monostable

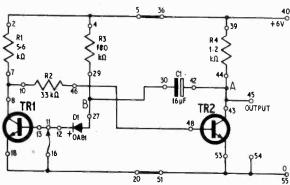


Fig. 3.6. Monostable circuit with hole numbers for S-DeC "breadboard"

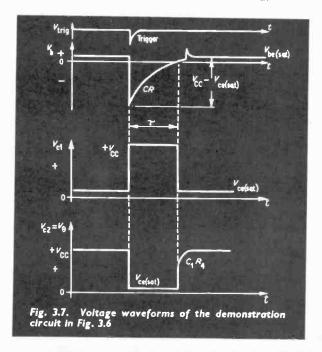
make demonstration of the circuit operation easy,

then
$$C_1 = 2/(0.69 \times 0.18) \simeq 16 \mu \text{F}.$$
 (step 7)

Of course, the values calculated do not always fall in line with preferred value components so the nearest types can be used. These are as follows:

R4	1·2k Ω	(step 2)
R1 + R2	$39k\Omega$	(step 3)
RI	5·6k Ω	(step 4)
R2	$33k\Omega$	(step 5)
R3	180 k Ω	(step 6)
C 1	16µF	(step 7)

The circuit is shown in Fig. 3.6 with S-Dec connections. It is triggered by momentarily connecting the base and emitter leads of TR1 together in order to turn this transistor off. The output voltage is observed with the aid of a high resistance voltmeter connected between the collector and emitter leads of TR2.



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13 ohms	220 ohms	I·5k Ω	3·6k Ω	7·5k Ω	22k Ω	39k Ω	62k Ω	130k Ω	560k Ω		8-2M Ω
22 ohms	470 ohms	I-8k Ω	4-3k Ω	10k Ω	24k Ω	43k Ω	75k Ω	360k Ω	620k Ω	3·6M Ω 5·1M Ω	9·IM Ω
36 ohms	560 ohms	2·2k Ω	4·7k Ω	16k Ω	27k Ω	47k Ω	82k Ω	430k Ω	1·2M Ω		IOM Ω
47 ohms	750 ohms	2·4k Ω	5·6k Ω	18k Ω	30k Ω	51kΩ	91kΩ	470k Ω	1-5M Ω	6-2M Ω	101-112
91 ohms	lkΩ	3⋅3k Ω	6-8k Ω								
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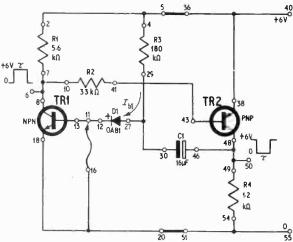


Fig. 3.8 Alternative monostable circuit using one npn and one pnp transistor

Note that the circuit includes a diode in the base lead of TR1. This shields the base from the drop in voltage to $-V_{\rm CC}$ which occurs at the junction of R3 and C1 at the instant of switching and therefore eliminates the possibility of reverse bias breakdown of the base-emitter junction.

It is worth remembering that the base-emitten junctions of many modern silicon transistors can break down by the application of only a few volts reverse bias.

The important voltage waveforms are shown in Fig. 3.7, which includes the effects of finite values of $V_{\text{be(sat)}}$ and $V_{\text{ce(sat)}}$, ignored in the analysis above.

Interesting modifications can be made to the demonstration circuit if R_4 is replaced by a 6V, 100mA bulb or a 180 ohm relay, the design procedure being used to calculate the values of the other components. If the bulb circuit is tried, the transistor used for TR2 must be capable of operating safely at a 100mA collector current. Any npn TO-5 canned device should be suitable.

COMPLEMENTARY MONOSTABLE

In the previous circuit, *npn* transistors could be replaced by *pnp* transistors if the polarities of the supply and diode were reversed. If C1 is an electrolytic or tantalum capacitor, its polarity would also need reversing.

In addition to the straightforward circuits using either *npn* or *pnp* transistors, it is possible to use both types of device in the same circuit as shown in Fig. 3.8. This so-called "complementary circuit" is the same as Fig. 3.6 except that TR2 has been turned "upside down".

Note that in this circuit, when TR1 is on, receiving base current via R3 its collector voltage is approximately zero. The base voltage of TR2 is almost $V_{\rm CC}$ because $V_{\rm be}$ for TR2 is small. R2 therefore passes base current to TR2 so this transistor is on as well.

Both are switched off during the quasi-stable state of period τ . The calculation of component values is the same with this circuit as with the other and the formula for the period τ is again given by $\tau = 0.69CR$.

However, the recovery time constant is not C_1R_4 in this case (it is shorter in fact) because of the more complicated charging path for C1 after the second switching instant. The circuit is easily triggered by momentarily shorting the base of TR1 to the bottom rail by means of a jumper lead as before.

To be continued

NEWS BRIEFS

Air Ionization

A ninstrument that "negatively ionizes the air" has been produced by Medion Ltd. The instrument, named Airtone, has been designed with the needs of hay fever, asthma and migraine sufferers particularly in mind. It has been stated that "invigorating air is a balanced distribution of electrically-charged air molecules called ions. Unfortunately, present-day conditions result in air which is deficient in ions and in which the balance between those with a positive and negative charge is seriously disturbed." The Airtone has been designed to combat this situation.

Airtone is fully transistorised, incorporates a double probe radiation and focusing system and is claimed to be already well proven in clinical and other applications.

PLER Monitoring System

A NEW system called PLER after its location (at the Royal Canadian Air Force's Primrose Lake Evaluation Range) is now being used to track aircraft and measure their nose temperature or the structural stress on either wing while in flight.

The equipment is initially to be used in test programmes for ground weapons delivery systems and pilot training in bombing techniques. Ground radar units detect and record analogue signals from various sensing devices on the aircraft and convert them into digital signals for processing by a Honeywell DDP 516 computer. The results are projected on a circular plotting board and also retained on high speed magnetic tape as a permanent record.

More Reliable Meter

A TRANSISTOR controlled parking meter designed to run for 12 months from a single specially developed Mallory battery is now being used, for the first time, in West Germany.

The meter, called the Parkatron, is of completely new design and is controlled by two printed circuits. The relation between the value of the coin and the parking time can be programmed and the meter will automatically assess the value of up to three different coins.

The shape of the meter is slightly different from those in use in this country (see below) but perhaps we will soon see this type in Britain—unfortunately electronics brings improved reliability to everything!





ELECTRONIC BROKERS

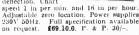
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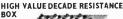
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5	Silicon Rects, 400 FTY 250mA OC75 Transistors Power Trans. OC20 100V OA202 Sil. Diodes Sub-min. Low Noise Trans. NPN 2N929/30. Sil. Trans. NPN VCB 100 ZT86 OA81 Diodes.	10/-
1	Power Trans. OC20 100V	10/-
10 2	Vow Noise Trans NPN 2N020/30	10/-
î	Sil. Trans. NPN VCB 100 ZT86	
8	OA81 Diodes	10/-
4	OC77 Transistors	10/-
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5	SII. Trans. NPN VUS 100 Z186 OA81 Diodes OC72 Transistors OC77 Transistors 801. Rects. 400 P1V 500mA GET884 Trans. Eqvt. OC44. GET883 Trans. Eqvt. OC45. 2N708 811. Trans. 300Mc/s NPN GT31 LF Low Noise Germ Trans. IN914 811. Diodes 75 P1V 75mA OA95 Germ. Diodes 8ub-min. IN69	10/-
2	2N708 Sil. Trans. 300Mc/s NPN	10/-
3	GT31 LF Low Noise Germ Trans.	10/-
8	OA95 Germ. Diodes Sub-min. IN69	10/-
3	OA95 Germ. Diodes Sub-min. IN69 NPN Germ. Trans. NKT773 Eqvt	10/-
2 2	OC22 Power Trans. Germ	10/-
4	AC128 Trans. PNP High Gain	10/-
3	AC127/128 Comp. pair PNP/NPN	10/- 10/- 10/- 10/-
	CG62H Germ. Diodes Eqvt. 0A71	10/-
3 12	NPN Germ. Trans. NKT773 Eqvt 0C22 Power Trans. Germ. 0C25 Power Trans. Germ. AC128 Trans. PNP High Gain AC127/128 Comp. pair PNP/NPN 2N1307 PNP Switching Trans CG62H Germ. Diodes Eqvt. 0A71 AF116 Type Trans. Assorted Germ. Diodes Marked. AC126 Germ. PNP Trans. Silicon Rects. 100 PIV 750mA AF117 Trans. OC81 Type Trans.	10/-
4	ACI26 Germ. PNP Trans.	10/-
4	Silicon Rects. 100 PIV 750mA	110/-
3 7 3	OC81 Type Trans.	10/-
3	OC81 Type Trans. OC171 Trans.	10/- 10/- 10/-
5	OC171 Trans. 2N926 Sil. Epoxy Trans. OC71 Type Trans. 2S701 Sil. Trans. Texas. 10 A 600 PIV Sil. Rects. 1845 R BC108 Sil. NPN High Gain Trans. 2N910 NPN Sil. Trans. VCB 100 1000 PIV Sil. Rect. 15 A R63310 AF RSY95A Sil. Trans. NPN 200Mc/s CC900 Sil. Trans.	
2 2	28701 Sil. Trans. Texas	10/- 10/- 10/- 10/-
3	10 A 600 PIV Sil. Rects. 1845R	10/-
1	2N910 NPN Sil. Trans. VCB 100	10/-
3 3	1000 PIV Sil. Rect. 1:5 A R53310 AF	
3	OC200 Sil. Trans. NPN 200Mc/8	10/-
2	GET880 Low Noise Germ. Trans	10/- 10/- 10/-
3	NPN Trans. 1 ST141 & 2ST140	10/-
4	Madt's 2 MAT100 & 2MAT120	10/-
3	Madt's 2 MAT101 & 1 MAT121	10/-
3	AC127 NPN Germ. Trans.	10/- 10/- 10/- 15/-
1	2N3906 Sil. PNP Trans. Motorola	10/-
2	Sil. Power Trans. NPN 100Mc/s.	13/-
	BNY95A Sil. Trans. NPN 200Mc/s 0C200 Sil. Trans. GET880 Low Noise Gerin. Trans. AF139 PNP High Frey. Trans. NPN Trans. 1 8T141 & 28T140 Madt's 2 MAT100 & 20MAT120 Madt's 2 MAT101 & 1 MAT121 0C44 Gerin. Trans. AF AC127 NPN Gerin. Trans. 2N3906 Sil. PNP Trans. Motorola. Sil. Power Rects. BYZ13 Sil. Power Trans. NPN 100Mc/s. TK201A. 2N1132 PNP Epitaxial Planar Sil.	15/-
3	2N1132 PNP Epitaxial Planar Sil	10/- 15/-
4	Germ. Power Trans. Eqvt. OC16	15/-
2	Unijunction Trans. 2N2646	15/- 15/-
ĩ	Tunnel Diode AEY11 1050 Mc/s	15/-
28	2N2712 Sil. Epoxy Planar HFE225 BV100 Type Sil. Beats	15/- 20/-
25	Sil. and Germ. Trans. Mixed, all	
	2N1132 PNF Epitaxial Planar Sil. 2N697 Epitaxial Planar Trans. Sil. Germ. Power Trans. Eqvt. OC16 Unijunction Trans. 2N2646 Sil. Trans. 200Mc/s 60Vcb ZT83/84 Tunnel Diode ABY11 1050 Mc/s 2N2712 Sil. Epoxy Planar HFE225 BY100 Type Sil. Rects. Sil. and Germ. Trans. Mixed, all marked, New	30/-

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UL	120 Glass Sub-min. General Purpose Germanium Diodes	10
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U3	75 Germanium Gold Bonded Diodes sim. OA5, OA47	10
U4	40 Germanium Transistors like OC81, AC128	10
U5	60 200mA Sub-mln, Slf. Diodes	10
U6	40 Silicon Planar Translators NPN sim. BSY95A, 2N706	10
U7	16 Silicon Rectifiers Top-Hat 750mA up to 1,000 V	10
U8	50 Sil. Planar Diodes 250mA OA/200/202	10
U11	20 Mixed Volts 1 watt Zener Diodes	10
U13	30 PNP Silicon Flanar Translators 10-3 8th. 281132	10
U14	150 Mixed Silicon and Germanium Diodes	10
U15	30 NPN Silicon Planar Transistors TO-5 sim. 2N697	10
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV	10
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10
Ŭ18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	10
U19	30 Silicon NPN Transistors like BC108	10
U20	12 1.5-amp Silicon Rectifiers Top-Hat up to 1,000 PIV	10
U21	30 A.F. Germanium alloy Transistors 2G300 Series & OC71	10
U23	30 Madt's like MAT Series PNP Transistors	10
1.54	20 Germanium 1-amp Rectifiers GJM up to 300 PIV	10
U25	25 300Me/s NPN Silicon Transistors 2N708, BSY27	10
U26	30 Fast Switching Silicon Diodes like IN914 Micro-min	10
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc., 8 Assorted Pieces	20
U29	10 1 amp SCR's T0-5 can up to 600 PIV CRS1/25-600	20
U31	20 Sil. Planar NPN trans. low noise Amp 2N3707	10
U32	25 Zener diodes 400mW D07 case mixed Volts, 3-18	10
U33	15 Piastic case 1 amp Silicon rectifiers 1N4000 series	10
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 28302/4	10
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U36	25 Sil. Planar NPN trans. TO-5 BFY50/51/52	10
U37	30 Sil. alloy trans. SO-2 PNP, OC200 28322	10
U38	20 Fast Switching Sil. trans. NPN, 400Me/s 2N3011	10
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U40	10 Dual trans. 6 lead TO-5 2N2060	10
U41	30 RF Germ. trans. TO-1 OC45 NKT72	10
U42	10 VHF Germ. PNP trans. TO 1 NKT667 AF117	10
Code the P	Nos, mentioned above are given as a guide to the type of dev. ak. The devices themselves are normally unmarked	ice i

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PIV	each	PIV	each	PIV	each	PIV	each	PIV	each
50	4/6	50	5/-	50	9/6	50	10/6	25	20/-
100	5/-	100	6/6	100	10/6	100	12/6	50	23/-
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2A 6A 10A (TO- (TO- (TO-1) 66) 48) 14/- 15/- 22/6 17/6 20/- 28/-20/- 24/- 35/-Blocking volt. VBOM 2A 400 20/- 24/- 35/-VBOM = Blocking voltage in either direction.

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Identical encapsulation and Identical encapsulation and pin configuration to the following: SL402-3, 1C10 and IC403. Each circuit incorporates a pre-amp and class A.B. Power amp stage capable of delivering up to 3 watts RMS. Fully tested and guaranteel. Supplied complete with circuit details. and data, CODED BP.1010. OUR LOWEST PRICE 25/- each. 10 up 21/- each.

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8/8 each miss device is a monolithic LC, that acts as combined threshold detector and trigger circuit for controlling a triac. It is designed to pulse the gate of a thyristor at the point of zero supply voltage, and therefore eliminate radio interference when used with resistive loads.

when used with resistive loads.
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A Silicon Planar, mono-lithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuits available on request.

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INTEGRATED CIRCUITS
Epoxy case 18-5 lead
temp. range 15°C to 55°C.
UL900, Buffer, 10/8 each.
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Audio Power Amplifier, 30/- each.

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120 VCB NIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407. 2N1893 FULLY TESTED AND CODED ND120. 1-24 3/8 each. To-5 N.P.N. 25 up

Sit. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX 300 1/- each. Any Qty.

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One 10/- Pack of your own choice free with orders valued £4 or over,

DIFFUSED SILICON PHOTO-DUO-DIODE TYPE IS701 (2N2175) for Tape Readout, high switching and measurement indi cators, 50V, 250mW. OUR PRICE 10/-EACH. 50 OR OVER 8/6 EACH, FULL DETAILS.

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LOW COST F.E.T. Fully Tested, Guaranteed Perameters equit, to 2N3819, MPF102, 2N-5459, 1-24 7/8 each; 25-99 6/3 each; 100 up 5/8 each. Coded FE19. Full data sent. TO-72 case.

BI-PAK MONOLITHIC DIGITAL CIRCUITS (10 lead TO-5)

BP305A. 6-Input AND gate, 9/6 each. BP314A, 7-Input NOR gate, 9/6 each. BP305A.

BI-PAK GUARANTEE SATISFACTION OR MONEY BACK KING OF THE PAKS



THE success or otherwise of the recent Audio Fair, held for the first time at Olympia and combined with the Photo-Cine Fair, is still a subject for discussion in hi fi circles. Many manufacturers claimed greater benefits despite the fact that the first scheduled day of the fair was rendered null and void by an industrial dispute.

At the moment, however, we are literally between "audio fairs" for, as reported in the last edition of Audio Trends, the Federation of British Audio Promotions Limited are running a hi fi exhibition in April 1970 at the Skyways Hotel, near the London

Heathrow Airport.

Confirmed dates are now April 24 to 26 inclusive with the first day set aside for trade and press visitors only. For the remainder of the days the exhibition will be open to the public who will be admitted by ticket only, these being obtainable from local hi fi equipment dealers or from the Federation of British Audio Promotions Limited, 49 Russell Square, London, W.C.1.

NEW TUNER AMPLIFIER

Few manufacturers have yet exploited the possibilities of integrated circuits although many are now using field effect transistors. The new Japanese-made Akai AA-6600 stereo tuner amplifier, however, features both integrated circuits and f.e.t.'s.

The tuner front end employs f.e.t.'s for low noise and extra sensitivity followed by i.c.'s in the i.f. stages for high selectivity. The amplifier section caters for tape and pick-up and has a frequency response (according to

the maker's specification) of 20-50,000Hz \pm 3dB. The power output is rated at 37.5 watts r.m.s. (or 50 watts music power) per channel for an 8 ohm load.

Features include tape monitoring, loudness control, headphone jack and switchable double speaker connections, i.e. for two speakers per channel. The retail price of this new Akai stereo tuner amplifier was not available at the time of compiling this report but should by now be obtainable from the U.K. distributors—Rank Audio Visual Limited, P.O. Box 70, Great West Road, Brentford, Middlesex.

FIRST UHER STEREO AMPLIFIER

An interesting new stereo amplifier is the first ever from the German Uher company who are already well known for their tape recorders. The CV140 is rated at 35 watts r.m.s. per channel with a 4 ohm load (70 watts music power per channel) and has a frequency response of $20-20,000\text{Hz} \pm 1\text{dB}$.

Six input sockets (DIN) provide for low impedance microphone, magnetic or ceramic pick-up, and tape recorder. All inputs are linked to a selector switch and all functions except volume, tone controls and balance are selected by push button.

A special feature of the CV140 is a front panel meter for monitoring the level of all input signals, which can



The Hydraulic Reference Turntable by Transcriptors Limited

be individually adjusted by preset controls. This amplifier is of course transistorised and retails at £166. distributors are Bosch Limited (Uher Division), Rhodes Way, Radlett Road, Watford, Herts.

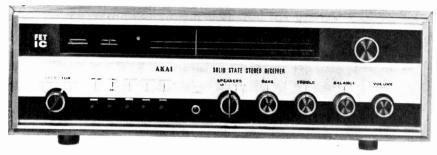
TRANSCRIPTION REFERENCE TURNTABLE

Perfect reproduction from records is the aim of most hi fi enthusiasts and a weak link in the hi fi chain could well be the record transcription unit. The "Transcription Hydraulic Reference Turntable" is an

The new Uher CVI40 stereo amplifier has a built-in level meter for checking all input signals



The new Akai AA-6600 stereo tuner amplifier features integrated circuits and field effect transistors



attempt to offer what might be considered at the moment as the ultimate in record transcription units. It is a precision instrument designed to perform to a very rigid specification.

The full technical details would take up the whole space devoted to this feature. The photograph, however, gives some idea of the complexity of this turntable which has a claimed total wow and flutter performance of only 0.06 per cent.



The Goodmans "Magister" loudspeaker

It operates at two speeds (33 and 45 r.p.m.) and has a built-in illuminated stroboscope. The makers claim that friction generated by the "unipivot" pick-up arm is so low in all planes as to defy measurement.

This instrument has a high performance, but is nevertheless very costly. The turntable unit costs £81 12s 6d plus £17 17s 6d purchase tax and the pick-up costs £19 2s 8d plus £3 13s 8d purchase tax. (These prices are subject to alteration.) For further details, write to Transcriptors Limited, 551 Holloway Road, London, N.19.

40 WATT "MAGISTER"

With transistorised amplifier outputs going up, and with the output impedance now reasonably firmly established at 8 ohms nominal, there is a demand for complementary matching loudspeakers.

The new Goodmans "Magister" fulfils the demand for it has a power handling capacity of 40 watts r.m.s. and an impedance of 8 ohms. If features a 15in bass speaker, a specially designed 5in mid-range speaker and two custom made treble units. The cabinet measures $27\text{in} \times 20\text{in} \times 14\text{in}$ and is available in teak or walnut finish, price £57. Details from dealers or Goodmans Loudspeakers Limited, Axiom Works, Lancelot Road, Wembley, Middlesex.

POCKET SIZED ELECTRONIC ORGAN

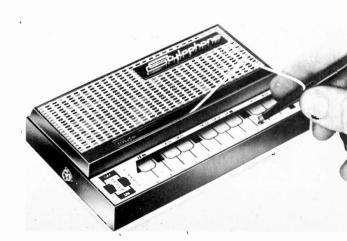
Many readers will no doubt have seen the "Stylophone" featured by Rolf Harris on television and although really unrelated to hi fi, it is worth mentioning for the benefit of those who feel the P.E. Electronic Organ a little too ambitious for them.

The "Stylophone" is a complete miniature 1\frac{1}{2}-octave electronic organ with a pleasing tone and vibrato. Despite its built-in 3in speaker it delivers a surprisingly large volume, enough in fact to play with say a piano accompaniment or the recorded accompaniment available on a 45 r.p.m. disc from the makers Dubreq Studios Limited, 275-281 Cricklewood Broadway, London, N.W.2.

It is a monophonic instrument with standard keyboard layout for the notes, but instead of pressing the keys, a pen-like stylus makes contact with them, thus producing the required notes. It has an output for direct connection to an external amplifier or a tape recorder.

The Stylophone retails at £8 10s and the accompaniment record complete with a tune book are available from the makers as above or musical instrument dealers. The record and tune book costs 10s plus 1s 6d purchase tax,

The "Stylophone" pocket sized electronic organ features a unique stylus contact keyboard system



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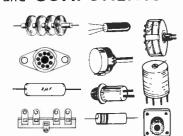
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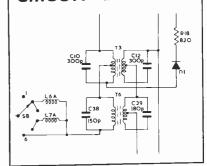
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FLUORESCENT CONTROL KITS Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Groluvi' tubes for fish tanks and indoor plants. Chokes are supersilent, mostly reain filled. Kit A—16-20w. 19(6, Kit B—30-40w. 19(6, Kit C-80w. 19(6, Kit E—55w. 19(8, Kit MF) is for 6in., 9in. and 12ln. miniature tubes, 19(6, Postage on Kits A and B 4/8 for one or two kits then 4/6 for each kit of kit A for each kit ordered. Kit MP1 3/6 on first kit then 3/6 on each two kits ordered. Kit MP1 3/6 on first kit then 3/6 on each two kits ordered. kit then 3/6 on each two kits ordered

BLANKET SWITCH

Double pole with neon let into side so luminous in dark, ideal for dark room light or for use with waterproof element, new plastic case 5/6 each, 3 heat model 7/6.

HIGH CAPACITY ELECTROLYTICS.

Brand new, not ex equipment. 100 mfd 25v, 1/3 each, 12/- doz. 200 mfd 25v, 1/6 each, 15/- doz. 500 mfd 12v, 2/- each, 21,1,0 doz 500 mfd 12v, 2)-cach, \$1.1,0 doz. 1,000 mfd 12v, 4)-q each, \$1.10,0 doz. 5,000 mfd 12v, 4)-q each, \$2.8,0 doz. 10,000 mfd 6v, 5)-q each, \$2.0,0 doz. 10,000 mfd 18v, 8)-q each, \$4.10,0 doz. 10,000 mfd 10v, 10)-q each, \$5.0,0 doz. 60,000 mfd 8v, 25)-cach, \$5.0,0 doz. 60,000 mfd 8v, 25)-cach, \$10.0,0 doz.

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For portable, car radio or transmitter. Chrome plated—six sections, extends from 74 to 47in. Hole in bottom for 6BA screw. 7/6.

TOGGLE SWITCH 3 amp 250v with fixing ring 1/6 each, 15/- doz.

80 OHM BALANCED ARMATURE EAR PIECE

Usable as microphone or loudspeaker 4/6 each.

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As used with imported pocket radio 1/6 each 15/-doz.

ISOLATION SWITCH

20 Amp D.P. 250 volts. Ideal to control Water Heater or any other appliance. Neon indicator shows when current is on, 4/6, 48/- per dozen.



8

Screened 3 Core Flex. Each core 14/0076 Copper PVC insulated and coloured, the 3 cores laid together and metal braided overall. Price \$3.15.

together and metal braisled overall. Price \$3.15, per 100 yds. coil.

15 Amp 3 Core Bon-kink Flex. 70/0076 insulated coloured cores, protected by tough rubber sheath, then black cotton braided with white tracer. A normal domestic flex as fitted to 3 kw. fires. Regular price 3/6 per yd. 50 yd. coil \$4.10, or cut to your length 2/6 per yard.

10 Amp 3 Core Mon-kink Flex. As above but cores are 28/0076 Copper. Normal price 2/6 per yd. 100 yd. coil \$27.10, or cut to your length 1/9 yd. 6 Amp 2 Core Flex. As above, but 2 Cores each 23/0076 as used for Vacuum Cleaners, Electric Blankets, etc. 39/8 100 yd. coil.

15/20 AMP CONNECTORS

Polythene insulated 12 way strip 2/6 each 24/- doz.



13 AMP FUSED SWITCH Made by G.E.C. For connecting water heater etc., into 13 amp ring nain. Flush type 3/6 each, 30/- doz. Metal boxes for surface mounting, 1/6 each, 15/- doz.

REED SWITCHES

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

Miniature. 1in, long x approximately in. diameter.

space or a larger quantity may be packed into a square solenoid. Rating 1 amp, 200 volts. Price 6/-

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Small ceramic magnets to operate these reed switches 1/3 each. 12/- dozen.

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An imposing instrument ideal for modern reception centre or for Managing Director's modern form of the modern reception centre or for Managing Director's confice-definitely a showpiece to create interest and efficiency—mains frequency controlled so always keep right time without adjustment in black semi-matt perspex case—made up, tested and guaranteed—offered for only the cost of components \$29,10.0, post and insurance 10/-.



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Beautifully made by famous German Company. PAPST System, 230/240 A.C. Mains operated, size \$\frac{1}{2}\text{in}\$. \$\times\$ \$\text{d}\text{in}\$ in \$\times\$ \$\text{d}\text{in}\$ in \$\text{cooling}\$ but ideal to incorporate in a cooker hood, etc. \$\frac{65}{2}-\$.



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Standard 13 amp fused plugs. Supplied complete with 6 feet of heavy cable and 13 amp plug. Similar advertised at £5. Our price 39/6 in kit form + 4/6 P. & I. wired up.



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Norstmann "Time and Set" Switch (A 15 amp switch). Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost period of up to 3 hours. Equally suitable to control processing. Regular price probably around 25. Special snip price 29/6, p. & ins. 4/6.



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Mains operated. Adjustable Contacts give on/off per 24 hours. Contacts rated 20 amps, repeating mechanism so ideal for shop window control, or to switch hall lights (anti-burgiar precaution) while you are on holiday. Made by the famous Smiths Company. This month only 39/6 plus 3/6 postage and insurance, a real snip which should not be missed.

PROTECT VALUABLE DEVICES FROM THERMAL RUNAWAY OR OVER-HEATING: Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protect, which use heat-sinks can easily be proetc., which use heat-sinks can easily be pro-hected. Simply make the contact thermostat tart of the heat-sink. Motors and equipment penerally, can also be adequately protected by gaving thermostats in strategic spots on the casing. Our contact thermostat has a cali-brated dial for setting between 90 deg. F. to 190 deg. F. or with the dial removed range setting is hetween 80 to 800 deg. F. Price 10/-.



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With Capstan control. This unit is extremely well made and measures approx. 6×5×2ln. deep. Has three piano key type controls for Record, Playback and Rewind. Motor is a special heavy duty type intended for operation off 4/5 voits. Supplied complete with 2 spools ready to install. Record. Replayhead is the sensitive M4 type intended for use with transispost and insurance 4/6.



ATLAS SLIMLINE FLUORESCENTS



THE TWENTYLITE

A Fluorescent lighting unit made by the famous Atlas .company, with super silent polyester filled choke and radio suppressed springs in and out flue whoe unit last economical. If left on all the time costs only one penny per day (uses \(\frac{1}{2}\) unit). Measures 2ft. long. Is ideal in Kitchen, Bedroom, Hallway, Porch, Loft, etc. Don't miss this anazing after, 39/8 with tuhe. Assembled ready to install. 4ft. twin model 59/8. Postage and insurance 6/6 extra.

WATT AMPLIFIER & PREAMP

5 transistors—highly efficient, made for use with tapehead (14 but equally sultable for microphone or pick up—limited quantity 29/8. Full circuit diag, also shows tape controls 5/-.



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Will dim incandescent lighting up to 600 watts from full brilliance to out. Fitted on M.K. flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob \$3.13.6.

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Flux Density 11,006 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Come Moulded fibre—Freq. response 30-10,000 c.p.s.—specify 3 for 15 ohns—Mains resonance 60 c.p.s.—Chassis Diann. 12in. 12in. over mounting lugs—Baffle hole 11in. Diann.—Mounting holes 4, holes—iin. diam. on pitch circle 11;in. diam. Overall height 5;in. A 26 speaker offered for only \$3.9.6 plus 7/5 p. & p. Don't miss this offer. 15in. 30 watt \$7.19.5. 18in. 100 watt \$24.10.0.

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2 pole, 2 way—4 pole, 2 way—

3 pole, 3 way—4 pole, 3 way—2

pole, 4 way—3 pole, 4 way—2 pole

6 way—1 pole, 12 way. All at 3/6

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cooling equipment or
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1250 watts—4ft. long but bent to U shape, ideal for overhead heater—just mount reflector above, 12/6 each, plus 4/6 post. \$6 doz. post paid.

12/6 cach, plus 4/6 post. \$6 doz. post paid.

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250 volt working. Single hole fixing. 2/6 each. 284- dozen. Contacts open when plunger is depressed. Prevents lights being left on. 15 amp contacts. 230 volt working. Made by Arrow. 3/6 each, 36/- per dozen. Rotary Appliance Switch. 16 amp, 230 volt on moulded ceramic base. Operated by pointer knob (not supplied). 2/- each, 18/- per dozen. 1/40th hp. Motor. Made by the French (Cassor) Company. This is an excellent totally enclosed motor, powerful enough to operate small lathe, drilling machine, washing machine, etc. Its speed is 1,450 r.p.m. Made for normal 50 cycle, 230/250 volts mains, totally enclosed, size 2½ × 3½in. dla. with lin, of jin. spindle. Price 19/6 plus 4/6 postage and insurance.

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REGULATION FROM OUR POSTBAG

Correspondents wishing to have a reply must enclose a stamped addressed envelope. We regret we are unable to guarantee a reply on matters not relating to articles published in the magazine. Technical queries cannot be dealt with on the telephone.

"Academic barrier"

Sir—In your thoughtful editorial last month, "The Non-Registered Engineer", you expressed concern over the composite engineering register to cover chartered engineers, technician engineers and technicians which the Council of Engineering Institutions intends to set up in collaboration with over 40 organisations for "non-chartered engineers" and technicians of all disciplines.

It may not generally be understood that the award and registration of legally protected titles and designatory initials will not be dependent upon educational attainment alone evidence of practical training and experience will also be required, and one may feel sure that the circumstantial human aspects to which you have referred will not be overlooked by those now planning the registration arrangements.

Engineers and technicians whom you felt might be worried about the constraints such an "academic barrier" could impose upon ingenious minds, or be wondering whether ambition and progress might be frustrated for some, would be looking at registration in isolation, for it will be but the "end product"—the identification and status derived

from education, training, experience and responsibility.

Designers of proposed new education and training patterns are stressing the importance of ample opportunities being given for the inventive and other creative work that you mentioned. For instance, the recently published recommendations of the Engineering Industry Training Board, "The Training of Technician Engineers", with their factors of basic training, general training, and then the objective training that is designed to develop expertise, should foster those opportunities.

The improved standing that registration could bring about, and the better opportunities for education and training now being developed, should combine to offer greater incentive to young people to seek a worthwhile career in industry where, it was authoritatively stated recently, a force of over one million technician engineers and technicians will be needed by 1975.

E. A. Bromfield, Secretary, The Institution of Electrical and Electronics Technician Engineers, London, W.C.2.

I have no doubt that the professionalbodies make every attempt to assay the practical qualities of candidates, in addition to examining their educational standards. The burden of my editorial was a different matter—concern for the large number of technicians and engineers usefully engaged in industry who, in the eyes of the institutions, would be deemed "unqualified".

For various reasons these technicians and engineers do not wish, or are unable, to undertake the study necessary in order to pass the examinations of the professional bodies. Perhaps it is a pity that they do not make this effort, but the point is that countless individuals are happy this way. Most of them no doubt enjoy their work and satisfy their employers. Status seeking is not their goal. Amongst their numbers are likely to be some really bright brains and—this is the crux of my argument—we cannot afford to jeopardise this source of novel and stimulating ideas.

Guildford group

Sir—An inaugural meeting of electronic enthusiasts was held on Saturday, November 22, at Chalk-lands, Hog's Back, Seale, Farnham, when it was decided to form the Guildford and District Group of the British Amateur Electronics Club. Four members were present; there are in addition two other members in the group. Mr E. J. Phillips was appointed chairman and secretary.

Future plans of the group, which will hold monthly meetings, were discussed and it is anticipated that members will combine their efforts to produce some interesting projects after their next meeting.

If any inexperienced enthusiasts or experts wish to join they should apply to the secretary at the above address.

E. J. Phillips, Farnham, Surrey.

NEWS BRIEFS

New Research Centre

A NEW research centre is to be built for the Post Office on the former Martlesham Heath airfield near Ipswich, Suffolk. Construction of the new centre, said to be the finest of its kind in Europe, will commence in the near future and is expected to be complete towards the end of 1972.

The new centre will house the present Research Department stationed at Dollis Hill in North London; there will be plenty of space for expansion and for large scale field experiments. It is hoped that the new centre will attract graduates to a career in research to provide the best possible telecommunications and postal systems for Britain, thus maintaining her place as a world leader in the fact developing global communications system

fast developing global communications system.

With a staff of up to 2,000 engineers, scientists and supporting technicians, the centre will bring increased spending power and new employment opportunities to the

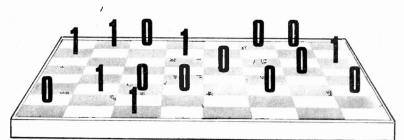
Ipswich area.

Solid State Lamps

A SERIES of new high power infrared solid state lamps have recently been introduced by the General Electric Company of the U.S.A. These small size lamps are particularly suited for use in computers and tape reading equipment. The high power output is obtained by a double lens construction. An inner plastics lens, covering the gallium arsenide chip, is surmounted by a conventional glass lens which hermetically seals the unit.

The photograph below illustrates the size of the new lamps—their diameter is ¼in.





CHESSBOARD COMPUTER

This demonstration of binary arithmetic was recorded by John Napier, the Scottish mathematician, and inventor of logarithm tables, as long ago as 1580 a.d.

As a matter of interest this kind of binary arithmetic is incredibly ancient—quite as old as the chessboard itself which is so archaic that no-one knows just when the first one was made—certainly it is more than 4,000 years ago. It was used long before the decimal system was perfected and quite apart from the binary computer it is used extensively today, maybe in ways that we do not readily recognise, such as the piano keyboard, in which an octave above a given note is exactly double the frequency of that note.

The binary system is essentially a practical system of arithmetic—given a simple conversion table you can do any calculation without any knowledge of multiplication tables, or how to "carry" in addition, or "borrow" in subtraction—it is used, unwittingly, by musicians, joiners and greengrocers as the most convenient method.

In radio circuitry, electrolytic capacitors are usually 1, 2, 4, 8, 16, 32, $64\mu F$, a typically convenient binary series. Our system of balance weights (though soon to be replaced by the metric system) is another example: 1 dram, $\frac{1}{4}$ ounce, $\frac{1}{2}$, 1, 2, 4, 8 ounces, 1 pound.

Binary arithmetic is of interest today because the operations involved are closely analagous to the principle of the modern electronic binary computer. Those who are familiar with electronic switching circuits will recognise that the squares on a chess board could represent electronic switches. The placing of a counter in a square represents an impulse to the switch, and the presence or absence of the counter indicates on or off respectively.

Other analogies will make themselves obvious later, but it must be realised that manual operation of binary arithmetic can be a very long and tedious process and quite impractical, but the comparatively simple rules, plus the fact that the numerous operations can be carried out electronically at fantastic speeds makes the system ideal for the modern computer.

It is not intended in this article to give details of the circuits of the electronic switches which the squares represent, but the on/off analogue will be grasped by those who are even slightly familiar with this aspect.

CONVERSION

The chessboard must have a fairly wide margin, and if this is not so the board must have strips of cardboard glued to three of its sides. The numbers of the binary series, 1, 2, 4, 8, 16, and so on, each number being twice the value of the previous one, is printed on it as shown in Fig. 1.

By J. F. ROWLANDS

About two dozen counters of one colour are required, and about a dozen of a different colour for use as "markers" in division.

The first rule in binary arithmetic is: "All ordinary numbers must be expressed in terms of the numbers of the binary series."

For the purpose of this demonstration, this can be done by subtracting from the ordinary numbers, and in turn from the remainders, the highest binary factor possible, until the remainder is nil.

For example, 136 - 128 = 8, and 8 - 8 = 0, so 128 and 8 are the binary factors of 136.

This method of extracting the binary factors, more often than not, requires more effort and arithmetic than that required to do the original calculation in the ordinary way, and Napier drew up a simple conversion table so that no ordinary calculation was called for.

In the electronic computer the conversion is done as a part of the process known as "programming". The result is fed into the machine in the form of a punched

	1		1	Т	Г—	r	1	1	
16384	8192	4096	2048	1024	512	256	128		
16384	8192	4096	2048	1024	512	256	128		
) i								128	128
N Sastrian		A 18 40 17 10 18						64	64
								32	32
								16	16
								8	8
	-							4	4
								2	2
								1	1
128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1		

Fig. 1. Chessboard layout with margin numbers

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RESISTORS

Code	Power	Tolerance	Range	Values available	I to 9	10 to 99 16d	100 up 15d
C	20 W	5%	100 Ω –220k Ω	E12			
C	ĪW	5%	4·7 Ω = I M Ω	E24	2 5d	2d	1.75d
Ċ	ĬW	10%	4·7 Ω = 10M Ω	E12	2·5d	I ∙75d	I-5d
č	1w	5%	4-7 Ω=10M Ω	E24	3d	2·25d	2d
мo	łŵ	2%	18Ω- MΩ	E24	9d	8 d	7 d
	ĨŴ	10%	4-7Ω-10MΩ	E12	4d	3 25d	3 d
ww	iw	$10\% \pm \frac{1}{20} \Omega$	0-22 Ω = 3-3 Ω	E12	15d all	quantities	
ww	300	5% = 20 **	12 Ω = 10k Ω	Ē∤2		quantities	
ww	7W	5%	12Ω-10kΩ	E12	15d all	quantities	

CODES: C = carbon film, high stability, low noise. MO = metal oxide, Electrosil TR5, ultra low noise. WW = wire wound, Plessey.

VALUES: El2 denotes series: 1, 1-2, 1-5, 1-8, 2-2, 2-7, 3-3, 3-9, 4-7, 5-6, 6-8, 8-2 and their decades.

El2 denotes series: as El2 plus I-1, 1-3, 1-6, 2, 2-4, 3, 3-6, 4-3, 5-1, 6-2, 7-5, 9-1 and their decades.

Prices are in pence each for each ohmic value and power rating. (Ignore fractions of one penny on total resistor

COLVERN 3 watt wire-wound potentiometers: $10~\Omega$, $15~\Omega$, $25~\Omega$, $50~\Omega$, $100~\Omega$, $150~\Omega$, $250~\Omega$, $500~\Omega$, $1k~\Omega$, $1.5k~\Omega$, $2.5k~\Omega$, $5k~\Omega$, $10k~\Omega$, $15k~\Omega$, $2.5k~\Omega$, $50k~\Omega$. Price only 5/6 each.

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Single gang linear: $220\,\Omega$, $470\,\Omega$, $1k\,\Omega$, etc. to $2.2M\,\Omega$ Single gang log: $4k\,\Omega$, $10k\,\Omega$, $22k\,\Omega$, etc. to $2.2M\,\Omega$ Any type with $\frac{1}{2}$ amp double pole mains switch: extra 2/3 Dual gang linear: $4k\,\Omega$, $10k\,\Omega$, $22k\,\Omega$, etc. to $1M\,\Omega$ 8/6 Dual gang log: $4k\,\Omega$, $10k\,\Omega$, $22k\,\Omega$, etc. to $2M\,2\,\Omega$ 8/6 Log/Anti-log: $10k\,\Omega$, $47k\,\Omega$, $1M\,\Omega$ only 8/6 Dual anti-log: $10k\,\Omega$ only 8/6

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Transistors for one channel £7.5.6. list, with 10% discount only £6.11.0. Transistors for two channels £14.17.6. list, with 15% discount £12.7.5. Capacitors and/resistors for one channel list £2. Printed circuit board free with each transistor set. Complete unregulated power supply kit £4.17.6. mono or stereo, subject to discount. Complete regulated power supply kit £9.5. subject to discount. Further details on application.

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Almost any simple mathematical process can be carried out by binary arithmetic on this chessboard. Details of the routine for addition, multiplication, subtraction and division, will now be given, with a few simple examples as illustrations.

ADDITION

Take, for example 23 + 54 + 87 = 164

(1) Convert all numbers to their equivalent binary factors:

$$23 = 16 + 4 + 2 + 1$$

 $54 = 32 + 16 + 4 + 2$
 $87 = 64 + 16 + 4 + 2 + 1$

(2) In the inner side margin place 13 counters in the squares appropriate to the above factors (Fig. 2).

(3) A basic rule in this type of binary arithmetic is that no square must have more than one counter on it (obviously in an electronic circuit you cannot close a switch which is already closed).

In the example, several of the squares have more than one counter; the routine to rectify this is to remove any counters in excess of one, two at a time. For each pair so removed add one counter to the next higher square. Start by removing the two counters from square 1 and place one more on square 2—making a total of four in this square. Remove these, two at a time placing one for each pair on square 4 which will now have five counters. Remove two pairs of these, leaving one in place and place two counters in the empty square 8, and so on until you have three counters left: one in square 128, one in square 32 and one in square 4. The total is 164, the answer to 23 + 54 + 87.

Any series of numbers can be added on a 64 square board, as long as the total does not exceed 32,767.

MULTIPLICATION

One example for multiplication could be $84 \times 14 = 1,176$.

- (1) Place markers in the outer side margin representing the binary factors of the larger number (i.e. at 4, 16, and 64 for 84) and in the outer lower margin for the smaller number (at 2, 4, and 8 for 14).
- (2) In the same horizontal row as the highest side marker (64). Place one counter in each square vertically above the markers at the bottom.
- (3) Repeat this in each horizontal row from the other side markers (16 and 4).
- (4) Move all the counters within the chess board diagonally up and right until they are all on the edges of the board next to the inner margins. See Fig. 3.
- (5) Some squares will now have more than one counter, so rectify this by following the method as in "addition".
- (6) The sum of the values of the counters after doing this will be 1,176.

The 64-square board limits the size of the numbers to be multiplied to 255×255 (i.e. a marker in all eight divisions of each margin and a total of 64 counters on the board before the diagonal move), and even this calls for a few imaginary squares to the left of 16,384.

If you can rake up enough counters it should be good practice in addition.

SUBTRACTION

(1) Start by placing counters in the inner side margin representing the binary factors of the larger number, and similarly for the smaller number in the adjacent column of squares to the left Fig. 4.

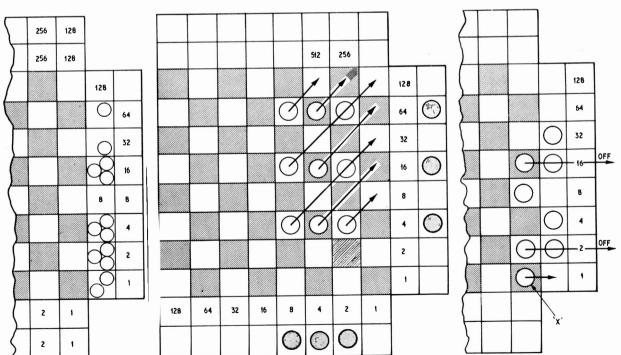


Fig. 2. Arrangement of counters at start of addition

Fig. 3. Move (4) in multiplication

Fig. 4. Arrangement of counters at start of sub-traction. Notice the position of the X counter

Table I: MOVES FOR 54-27

	Coun	ter X	Neares ab	Fill in space(s)		
Move	Left	Right	From	To	Remove at	
-		×	4	2	_	NIL
2	X		8	4		2
∫3		×	_		2	_
ጎ 4	X		-		2	
`5		X	32	16		8, 4, 2
6	X		4	2		NIL
∫7		X			2	-
18	X				2	
`9		×	4	2		NIL

- Remove any counters which occupy adjacent squares in both columns.
- (3) Move the lowest value counter from whichever column it is in, to the corresponding position in the other column. This counter, which we can call "X", has to be moved from one column to the other repeatedly. Each time it is moved to a different column the following routine has to be carried out with the nearest counter above it.
- (4) The nearest counter above has to be moved down one place, and the intervening empty places (if any) must be filled in with a counter in each. If the nearest counter above is in the next square remove it from the board.
- (5) Move counter "X" (Fig. 4) to the other column and repeat the above routine before returning it, and so on until the left-hand column is empty.

To make all this clear, Table I shows all the moves of counter "X", and the subsequent movement of the counter above it, required to subtract 27 from 54. Place counters at 32, 16, 4 and 2 in the inner side margin

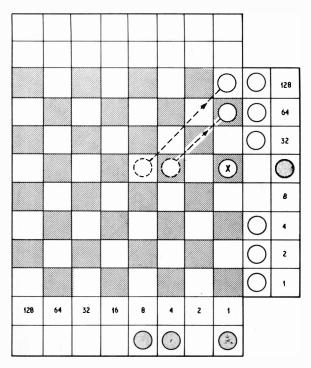


Fig. 5. Move (4) in division

and 16, 8, 2 and 1 in the squares on their left. Remove the "common" counters at 16 and at 2 and move the lowest ("X") counter to the right. Follow the sequences as in the Table.

The answer is the sum of the values of the counters in

the margin, i.e. 16 + 8 + 2 + 1.

Practice subtraction with various numbers, following this procedure exactly. After some practice it will be found that some moves can be "short cut", such as 3 and 4, and 7 and 8 in the chart, by removing both counters without moving X, and carrying on with the next move as though X had moved twice.

It is important to practise subtraction until you can do it confidently because it will have to be done under slightly different conditions in division and unless the principle is understood it can be confusing.

DIVISION

There is nothing difficult about division by binary arithmetic—in fact it is one of the most efficient of "mechanical" methods, the only snag being that the largest number that can be divided on a 64 square board is 255. Numbers up to 32,767 can be divided by a modified process, but the simplest solution is to make up a board with 16×16 squares (256). However, the main principles can be shown on the 64 square board with an example such as $231 \div 13$.

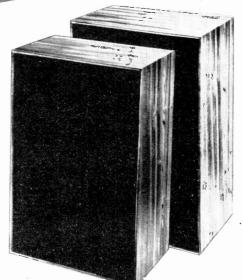
- (1) Place counters representing 231 (128, 64, 32, 4, 2, and 1) in the inner side margin, and "markers" of a different colour for 13 (8, 4, and 1) in the outer bottom margin.
- (2) Place a counter in the square to the left of the highest side counter (128) and move it down diagonally until it is in a square vertically above the highest bottom marker (8).
- (3) In the same horizontal row as this counter, place a counter in each square vertically above the other markers (4 and 1), and a marker in the outer side margin.
- (4) Now move the counters within the board diagonally up and right until they are adjacent to the margin. See Fig. 5.
- (5) Ignoring for the moment any counters below the side marker, subtract the counters on the left from those in the margin. In the example this is simple; after removing the "common" counters, the first move of X eliminates the counter at 32 and the subtraction is complete.
- (6) Place a counter in the square immediately next to the highest side counter 16 and repeat as at (2), (3), and (4) above. This time, however, you will be unable to subtract as above, since the values of the counters on the left are higher than those in the margin. The routine in cases such as this is to move each counter and the side marker down one square and try again. In this case it is now possible, but with larger numbers on a larger board it may be necessary to repeat the process more than once.
- (7) After subtraction you find you have a marker at 16 and at 1, the sum of which is 17 (the quotient), and counters at 8 and 2, the sum of which is the remainder (10).

A little consideration will show how to use the top margin for larger numbers, but you will have to keep a clear picture of what you are doing when it comes to "turning the corner" and the best solution is to use a larger board, which will also give you a bigger divisor.

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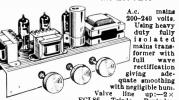
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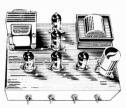
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A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment accord-

ADJUSTABLE LIGHT SOURCE

HILST experimenting with various types of light operated switches, I found a need for an adjustable light source which would give a narrow beam of light without the use of complicated lens systems. The one here described was found to work extremely well and has been used to work quite a few types of circuits, both very sensitive and the more robust types.

The basic component consists of two cigar tubes, one of slightly larger diameter than the other. The larger of the two has the rounded end sawn off and the screw cap end left intact. The smaller tube has both ends sawn off to leave a tube of thin aluminium about 3in long, whilst the larger tube should be about 4in in length when the cap is screwed on.

The two tubes are now made to slide together rather stiffly; this can be achieved by reaming out the end of the smaller tube until a firm fit is made. Any stray light that may escape around the joint can be eliminated by a snug fitting elastic band of fairly wide dimensions, fitted after completion. The assembly is shown in Fig. 1.

The choice of lens is not critical and the one that I used was taken from a vintage box camera. After removal from the body of the camera, the lens was fastened onto the smaller of the cigar tubes with contact adhesive, great care being taken to ensure a light proof fit. When finally set, the joint was covered with a single layer of black plastic tape to neaten the job.

The layout of the complete tube system is now built and tested for operation before the bulb assembly is made. This consists very simply of a hole in the screw cap of the larger tube with the bulb fastened in place with an ordinary m.e.s. lampholder.

Only one point is important in the choice of bulb used; the filament must be of the "spot" type and as small as possible. I tried quite a few types and makes before discovering that the ordinary 3.5V torch bulb was the most efficient. Before assembling the unit, drill or punch a few small holes for heat dissipation as near to the screw cap as possible (Fig. 1). The heat from even a small bulb in so confined a space is quite remarkable.

Strip aluminium was used to make the bracket which was jointed in the centre to allow for beam adjustment.

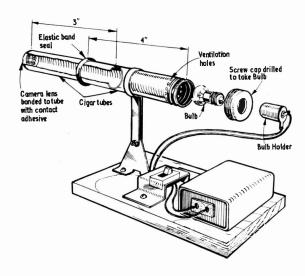


Fig. 1. Light source for light operated switch

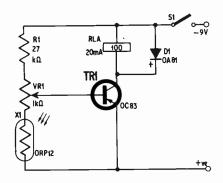
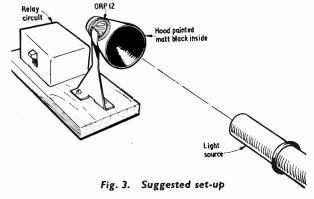


Fig. 2. Relay circuit



As the completed unit is very light I did not find it necessary to wrap the aluminium strip right around the tubes, a very firm fit was obtained using only hand pressure. Care may be needed here to avoid distorting the thin aluminium.

The whole unit can be mounted on a board to suit individual requirements and a switch added to conserve battery drain.

The sliding tube assembly allows for a form of focus to be achieved but the light pattern will be found to be a small circle of light easily adjusted to the dimensions of the ORP12 and providing ample illumination for distances up to 6ft. At distances greater than this some distortion of the pattern will be met but not too great and, providing the circuit used is sensitive enough, it will still be effective.

Fig. 2 shows a simple circuit controlling a relay RLA which can be of 100 ohms resistance or more and suitable for operation with a 9V battery and OC83 transistor. A typical set-up is shown in Fig. 3 which can be used to register objects breaking the light beam.

R. W. Lawrence, 6 Verdun Road, Monton, Manchester, Lancs

IMPROVED SCHMITT TRIGGER

THE popular Schmitt trigger frequently occurs in constructional projects published in PRACTICAL ELECTRONICS. It would often be advantageous to reduce the hysteresis, or backlash, especially in those circuits which use a Schmitt to produce a square wave from a sine wave.

The circuit in Fig. 1 includes VRI, careful adjustment of which enables the hysteresis to be reduced to a very low level. This is because any unbalance in transistor characteristics is balanced out by the different amounts of VRI which are included in each emitter lead.

It is usually convenient to set the hysteresis to 50mV or so. An input of 1kHz at a level of 120mV peak to peak (about 40mV r.m.s.) produces a square wave output with very fast rise and fall times—less than 5 μ s.

Component values are given here to suit the transistors quoted, but the modification shown will improve any existing Schmitt trigger by reducing the hysteresis as described.

VR1 can be set by adjusting it for a square wave output with successively smaller input signals until the required sensitivity is reached; attempts to reduce hysteresis to too low a value will result in the circuit oscillating.

J. N. Watt, Camberley, Surrey.

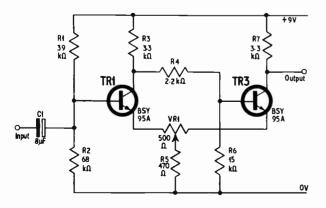
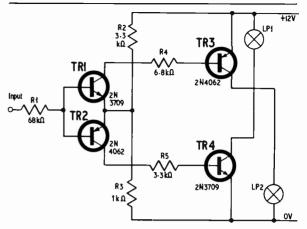


Fig. 1. Circuit diagram of the improved Schmitt trigger

LOGIC PROBE



AM enclosing a circuit diagram for a "0" and "1" logic test-probe which I have recently made. It is designed around a simple gating circuit. The probe operates from a +12V supply and has a threshold voltage of +3V at the input.

I designed it for use with 6V logic. Both lamps are normally off (indication of a disconnection). Lamp A glows for inputs of 2V; lamp B glows for inputs of 4V. The input impedance is adequately high. Threshold voltage may be selected by varying the values of R2 and R3.

The lamps I used were 12V 20mA types ex-G.P.O. signal lamps, but the circuit could easily be modified for higher power lamps by using suitable higher power transistors.

K. L. Spence,

London, N.W.7.

BOOK REVIEWS continued from page 149

enclosures, explaining the acoustic properties and the effects of resonances.

Anyone asked to suggest a list of recorded music, suitable for starting a collection, must have a difficult task; one man's meat may be another man's poison. W. A. Chislett has attempted to give micro-miniature reviews on more than 120 items, whilst admitting that "any great work is capable of more than one valid interpretation, which does not necessarily make one better than another".

Also included are chapters on Care and Storage of Records by A. C. Williams; Tape Recorders and Recording by H. W. Helyer; Stereo Radio—How it Works by Roy Prince; Radio Tuners by Gordon J. King.

This last article really illustrates how far advanced radio receiver techniques have become. It includes the description and use of f.e.t.'s and integrated circuits in f.m. tuners. Of the most recent techniques of improving selectivity, the use of d.c. controlled variable capacitance diodes for tuning and a.c. controlled feedback to them for a.f.c., really make one wish that these features had been invented some 14 years ago. An interesting experience described as the "Northampton Effect" just goes to show that the average listener places rather less faith in his tuner than perhaps is due. Here the BBC is not entirely blameless in providing the basis of 10kHz "burbling" on stereo.

basis of 10kHz "burbling" on stereo.

Armchair shopping with this handbook can save headaches later, but do not expect it to give you all the answers to your problems.

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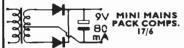
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