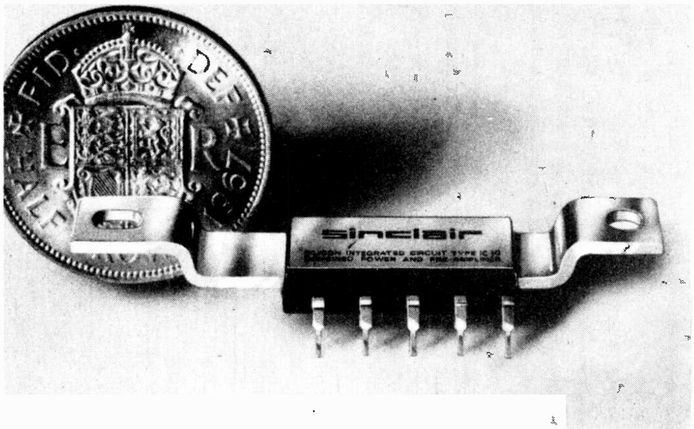
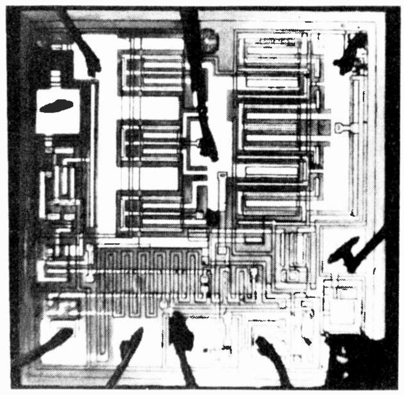
PRACTICAL
ELECTRONICS
FEBRUARY 1970
THREE SHILLINGS

SOUND OPERATED SWITCH

SINCLAIR IC-

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

Output	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.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	1 × 0.4 × 0.2 inches.
Sensitivity	5mV.
Input impedance	Adjustable externally up to 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 feed-back 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 IC-10 manual* **59/6**

POST FREE

sinclair

SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD · CAMBRIDGE
Tel. 0223-52731

Complete stereo system – £29.10.0

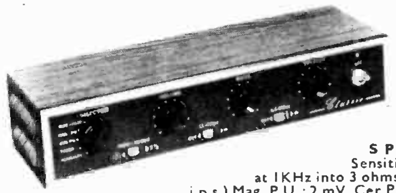
The new Duo general-purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally.
Type 1 SPECIFICATION:–
Impedance 10 ohms. It incorporates Goodmans high flux 6"×4" speaker and 2¼" tweeter. Teak finish 12"×6¾"×5¼". 4 guineas each. 7/6d. p. & p.
Type 2 as type 1. Size 17½" × 10¾" × 6¾". Incorporating 10½" × 6½" bass unit and 2¼" tweeter. 3 ohms impedance 5½ guineas plus 15/- p. & p. 7/6d. p. & p.
Garrard Changers from £7.19.6d. p. & p. 7/6d.
Cover and Teak finish Plinth £4.15.0d. 7/6d. p. & p.

Duetto Integrated Transistor Stereo Amplifier £9.10.0 plus 7/6d. p. & p.

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

These 5 items can be purchased together for £29.10+£1.10 P.&P.

The Classic



Teak finished case

£9

Plus P. & P. 7/6

SPECIFICATION: Sensitivities for 10 watt output at 1KHz into 3 ohms. Tape Head: 3mV (at 3¾ i.p.s.) Mag. P.U.: 2 mV. Cer.P.U.: 80mV. Tuner: 100mV. Aux. 100mV. Tape/Rec. Output. Equalisation for each input is correct to within +2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone Control Range: Bass:* 13dB at 60Hz. *Treble:* ±14dB at 15KHz. *Total Distortion:* (for 10 watt output) < 1·5%. Signal Noise: < −60dB. A.C. Mains 200–250V. Size 12½in long, 4½in deep, 2¾in high. **Built and tested.**

The Viscount

INTEGRATED HIGH FIDELITY TRANSISTOR STEREO AMPLIFER

£14.5.0

Plus P. & P. 7/6

SPECIFICATION: *Output:* 10 watts per channel into 3 to 4 ohms speakers (20 watts monoral). *Input:* 6-position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All inputs 100mV into 1·8M ohm. *Frequency Response:* 40Hz–20KHz ±2dB. *Tone Controls:* Separate bass and treble controls. *Treble* 13dB lift and cut [at 15KHz]. *Bass:* 15dB lift and 25dB cut [at 60Hz]. *Volume Controls:* Separate for each channel. *A.C. Mains Input:* 200–240V, 50–60Hz. *Size:* 12¼ × 6in × 2¾in teak-finished case. Built and tested. P. & P. 7/6.
Viscount Mark II for use with magnetic pick ups specification as above. Fully equalised for magnetic pick ups. Suitable for cartridges with minimum outputs of 4mV/cm/sec. at 1kc. Input Impedance 47k. **15 gns.** plus 7/6 P. & P.

THE RELIANT Mk. II

SOLID STATE GENERAL PURPOSE AMPLIFIER

£6.16.0 Plus P. & P. 7/6

In teak finished case

SPECIFICATION: *Output:* 10 watts into a 3 ohms speaker. *Inputs:* (1) for mike (10mV). Input (2) for gram. radio (250mV) individual bass and treble control. *Transistors:* 4 silicon and three germanium. *Mains input:* 220/250 volts. *Size:* 10¼ × 4¾ × 2¼in. *Mike to suit (crystal):* 12/6 plus 1/6 P. & P. 8 × 5in speaker 14/6 plus 3/- P. & P. Mk. I £5.15.0 plus 7/6 P. & P. Less teak finished case.

SPECIAL OFFER

Complete stereo systems comprising BALFOUR 4 speed auto player with stereo head, 2 DUO speaker systems size 12 × 6¾ × 5¼in. Plinth (less cover) and the DUETTO stereo amplifier. All above items

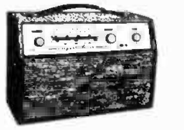
£20 Plus P. & P. 20/-

NEW COMPLETE HI-FI STEREO SYSTEM

£39

Comprising SP 25 Garrard Mk. II with diamond stereo cartridge, Viscount amplifier Mk. I, Two type 2 speakers, Plinth and cover. £39 plus £2 P. & P.

THE ELEGANT SEVEN Mk. III (350mW Output)

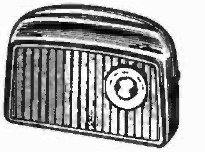


7-transistor fully tunable M.W.-L.W. Superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction. **MAINS POWER PACK KIT: 9/6 extra.**

Price £4.9.6 Plus P. & P. 7/6.

Circuit 2/6. Free with parts.

THE DORSET (600mW Output)



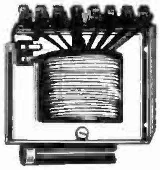
7-transistor fully tunable M.W.-L.W. Superhet portable with baby alarm facility. Set of parts. The latest modulated and pre-alignment techniques makes this simple to build. Sizes: 12 × 8 × 3in.
MAINS POWER PACK KIT: 9/6 extra.

Price £5.5.0 Plus P. & P. 7/6.

Circuit 2/6. Free with parts.

RADIO & TV COMPONENTS
R+TV
(ACTON) LIMITED

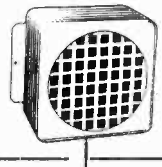
QUALITY MAINS TRANSFORMER



Input 250V OUTPUT (All RMS values) 4 windings of 11·5V connected in series total 46V at 4·5 amps (conservatively rated). The following combinations may be used. 1. 23—0—23V; 2. 46V. Both of these above voltages are commonly used in medium to high powered transistor amplifiers, power supplies, etc.

Price 35/- Plus P. & P. 7/6

Also see opposite page

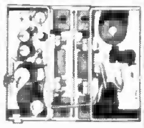


EXTRACTOR FAN

AC mains 230/250V, complete with pull switch. Size 6 × 6 × 4 in.

Price 27/6 Plus 7/6 P. & P.

X101 10W SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP



Specifications: *Power Output* (into 3 ohms speaker) 10 watts. *Sensitivity* (for rated output): 1mV into 3K ohms (0·33 microamp). *Total Distortion at* 1KHz. at 5 watts 0·35%, at rated output 1·5%. *Frequency Response:* Minus 3dB points 20Hz and 40KHz. *Speaker:* 3–4 ohms (3–15 ohms may be used). *Supply voltage:* 24V d.c. at 880mA (6–24V may be used).

Price 69/6 Plus 2/6 P. & P.

Control assembly: including resistors and capacitors.
1. Volume: PRICE 5/–.
2. Treble: PRICE 5/–.
3. Comprehensive bass and treble: PRICE 10/–.

The above 3 items can be purchased for use with the X101.

Power Supplies for the X101: P101 M (for mono) 35/– plus 4/6 P. & P.
P101 S (for stereo) 42/6 plus 4/6 P. & P.

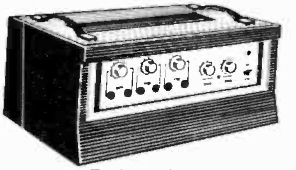
CAR TRANSISTOR IGNITION SYSTEM

(by famous manufacturer)

For 6V or 12V positive earth systems. Comprising: special high voltage working hermetically sealed silicon transistor mounted in finned heat-sink, high output ignition coil, ballast resistor and hardware (screws, washers etc.).

Price £4.19.6 (Post and Packing 5/- extra)

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



Price £28.10.0
Plus 20/- P. & P.

An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money. **TECHNICAL SPECIFICATIONS** 3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The volume controls for each channel are located directly above the corresponding input sockets. **SENSITIVITIES AND INPUT IMPEDANCES.** Channels 1 & 2 4mV at 470K. These 2 channels (4 inputs) are suitable for microphone or guitars. Channels 3 & 4 300 mV at 1m. Suitable for most high output instruments (gram, tuner, organ etc.). Input sensitivity relative to 10w output. **TONE CONTROLS ARE COMMON TO ALL INPUTS. Bass Boost** +12dB at 60 Hz/s. **Bass Cut** −13dB at 60 Hz/s. **Treble Boost** +11dB at 15 KHz/s. **Treble Cut** −12dB at 15KHz/s. With bass and treble controls central −3dB points are 30Hz/s and 20 KHz/s. **POWER OUTPUT.** For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For sine wave 38·5 watts rms. Nearly 80 watts peak. Total distortion at rated output 3·2% at 1KHz/s. Total distortion at 20 watts 0·15% at 1KHz/s. Output to match into 8 or 15 ohms speaker system. **NEGATIVE FEED BACK** 20dB at 1KHz/s. **SIGNAL TO NOISE RATIO** 60dB. **MAINS VOLTAGES.** Adjustable from 200–250V. A.C. 50–60Hz/s. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.

THREE-IN-ONE HI-FI 10 WATT SPEAKER

A complete Loud Speaker system on one frame, combining three matched ceramic magnet speakers with a low loss cross over network. Peak handling power 10 watts. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40–60 c/s. Frequency range 50c/s to 20kc/s. Size 13½ × 8 1/16 × 4½ inches. By famous manufacturer.

List Price £7. **Our Price 74/6** Plus 5/- P. & P.

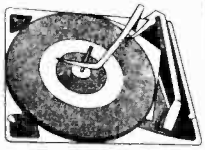
Similar speaker to the above without tweeters in 3 and 15 ohms 44/6 plus 5/– P. & P.

LIVINGSTONE LAB

50 watt RMS Base Transistor Amplifier. This amplifier is designed and manufactured by L.L. using the best quality components, thus making it extremely reliable and almost indestructible. Size (Power supply) 16 × 9¼ × 6½in. (Amplifier) 14½ × 9 × 4in; sensitivity for rated output 1V.

£28.10.0 Plus 20/- P. & P.

RECORD PLAYER SNIP A.C. MAINS 240V



The "Princess" 4-speed automatic record changer and player engineered with the utmost precision for beauty, long life, and trouble free service. Will take up to ten records which may be mixed 7in to 10in or 12in. Patent stylus brush cleans stylus after each playing and at shut off, the pick-up locks itself into its recess, a most useful feature with portable equipment—other features include pick-up height adjustment and stylus pressure adjustment. This truly is a fine instrument which you can purchase this month at only **£5.19.6** complete with cartridge and ready to play.

Only £5.19.6 Post and insurance 7/6 extra.

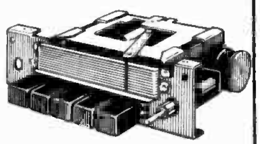
STEREO PRE-AMPLIFIER

Inputs—6 position rotary switch (3 position mono, 3 position stereo). Tuner 150 mV into 680k. Magnetic pick-up fully equalised and suitable for magnetic cartridges with minimising output of 4mV/cm/sec. Load 47k. Ceramic pick-up 150 mV into 680k. Sensitivities taken for 200mV output. Controls—separate volume controls for each channel. Twin ganged bass, 12dB lift and 15dB cut at 60c/s. Twin ganged treble, 10dB lift and 15dB cut at 10kc/s. Voltage required 23-30v D.C. at 5mA. Size 12½" × 3½" × 2¾". In teak finished case, complete with front panel and knobs. Built and tested.

Price £7.7.0 Plus 5/- P. & P.

PYE CAR-RADIO

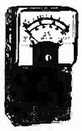
PUSH BUTTON TUNING HEART



This PRESTOLOCK 5 station Push-Button Tuner Heart with Manual Over-ride is an ideal basis for a quality AM car radio. Size 6½ × 4 × 2in. As illustrated but without knobs.

25/- Plus 3/- P. & P.

POCKET MULTI-METER

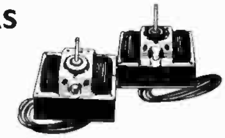


Size 3⅞ × 2½ × 1⅜in. Meter size 2¼ × 1⅜in. Sensitivity 1000 O.P.V. on both A.C. and D.C. volts. 0–15, 0–150, 0–1000 D.C. current 0–150mA. Resistance 0–100kΩ. Complete with test prods, battery and full instructions.

Price 42/6 Plus 3/6 P. & P.

FREE GIFT for limited period only. 30 watt Electric Soldering Iron value 15/– to every purchaser of the Pocket Multi-Meter.

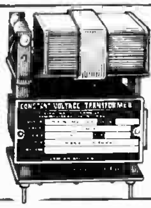
GARRARD TAPE MOTORS



Fast forward and fast re-wind motors, as used by famous manufacturer. Size 3 × 2½ × 2¾in. Spindle 5/32in. A.C. Mains 250V.

39/6 per pair Plus 7/6 P. & P.

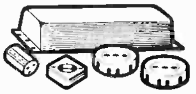
ADVANCE CONSTANT VOLTAGE TRANSFORMER



Output 7·5V at 1 amp and 30V at 100MA. Mains input 125V (2 can be used in series for 250V).

Price 22/6 Plus 7/6 P. & P.

40W FLUORESCENT LIGHT KIT



Incorporating **GEC** Choke size 8¼ × 1½ × 1¾in, 2 bi-pin holders, starter and starter-holder. P. & P. 5/6. **11/6**

Similar to above: 80W. Fluorescent Light Kit incorporating **GEC** choke size 11½ × 1½ × 1¾in. 2 bi-pin holders, start and starter holder. P. & P. 6/6. **17/6**

B.S.R. TD2 TAPE DECK

This tape deck takes 5¾in spools complete with two-track heads. Size 13¼in long by 8¾in wide.

Price £8.19.6 Plus P. & P. 7/6.

RADIO & TV COMPONENTS R+TV (ACTON) LIMITED

TERMS C.W.O.
All enquiries S.A.E.

Goods not despatched outside U.K.

RADIO & TV COMPONENTS (ACTON) LTD.

21d High Street, Acton, London, W.3

Also at 323 Edgware Road, London, W.2

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Brand New Fully Guaranteed
TRANSISTORS & DEVICES

1N4001	2/-	2N3711	3/6	AF118	12/6	BSY66	5/-	OA95	1/6
1N4002	2/3	2N3730	10/-	AF124	6/-	BSY67	5/-	OA200	1/9
1N4003	2/6	2N3731	12/6	AF125	5/-	BSY95A	4/6	OA202	2/-
1N4004	3/-	2N3819	8/-	AF126	4/-	BSY95	3/-	OA210	6/-
1N4005	3/6	2N3820	19/6	AF127	4/-	BTY42	18/6	OA211	9/6
1N4006	4/-	2N3823	17/6	AF139	6/-	BTY79/400R	35/-	OAZ200	11/-
1N4007	5/-	2N4058	5/6	AF178	9/6	BTY84	12/6	OAZ201	10/-
1N4009	1/6	2N4061	4/-	AF181	8/6	BTY88	15/-	OAZ202	8/6
1N4148	1/9	2N4286	3/-	AF186	9/-	BUY10	12/6	OAZ203	8/6
1N4785	10/-	2N4288	3/-	AF239	8/-	BUY11	18/6	OAZ204	8/6
2G210	12/6	2N4289	3/6	AFY19	22/6	BY100	3/6	OAZ205	8/6
2G240	49/6	2N4290	3/-	AFZ11	8/-	BY103	4/6	OAZ206	8/6
2G301	4/-	2N4291	3/-	AFZ12	10/-	BY114	5/-	OAZ207	9/6
2G302	4/6	2N4292	3/-	ASY26	6/6	BY126	5/-	OAZ208	6/6
2G303	5/-	40361	12/-	ASY27	7/6	BYX22/600	5/3	OAZ209	6/6
2G306	7/6	40362	13/6	ASY28	6/6	BYZ10	10/-	OAZ210	6/6
2G308	7/6	2S001	10/-	ASY29	6/-	BYZ11	9/-	OAZ211	6/6
2G309	6/-	2S002	10/6	ASY36	5/-	BYZ12	8/-	OAZ212	6/6
2G339A	3/-	2S003	9/6	ASY50	3/6	BYZ13	5/-	OAZ213	9/6
2G371	4/6	2S004	9/6	ASY51	8/-	BYZ15	20/-	OAZ222	9/6
2G374	5/6	2S005	15/-	ASY67	9/6	BYZ16	12/6	OAZ223	7/6
2G381	5/-	2S012	25/-	ASY83	5/-	BZY88C3V3	4/-	OAZ224	7/6
2G382	6/-	2S012A	22/6	ASY86	6/6	BZY88C4V7	4/-	OAZ225	7/6
2G378A	4/6	2S013	20/-	ASZ21	8/6	BZY88C5V6	4/-	OAZ228	7/6
2G383	5/-	2S013A	25/-	ASZ23	20/-	BZY88C5V1	4/-	OAZ229	9/6
2G304	4/6	2S017	15/-	AUY10	19/6	BZY88C6V8	4/-	OAZ231	9/6
2G305	5/-	2S018	17/6	AU101	30/-	BZY88C7V5	4/-	OAZ234	7/6
2N404	4/6	2S020	50/-	B3M	19/6	BZY88C8V2	4/-	OAZ238	9/6
2N456	15/-	2S024	50/-	BA110	5/-	BZY88C9V1	4/-	OAZ241	4/6
2N458	20/-	2S025	60/-	BAY31	2/-	BZY883V9	4/-	OAZ242	4/6
2N503	9/6	2S026	100/-	BC107	3/-	BZY886V2	4/-	OAZ244	4/6
2N599	12/6	2S034	12/6	BC108	2/9	BZY94C10	4/-	OAZ245	4/6
2N601	3/6	2S036	25/-	BC109	3/-	BZY94C11	4/-	OAZ246	4/6
2N696	4/6	2S102	10/-	BC113	6/-	BZY94C12	4/-	OAZ247	4/6
2N697	5/-	2S103	12/6	BC116	8/-	BZY94C15	4/-	OAZ272	4/6
2N698	8/6	2S104	12/6	BC118	7/6	BZY94C16	4/-	OAZ290	7/6
2N706	1/6	2S131	7/6	BC134	7/6	CP404	12/6	OAZ291	7/6
2N706A	2/6	2S301	6/-	BC135	6/-	CRS1/05	5/-	OAZ292	7/6
2N707	12/6	2S302	7/6	BC136	7/-	CRS1/10	5/-	OC16	10/-
2N708	3/-	2S303	10/-	BC137	8/-	CRS1/20	7/6	OC19	7/6
2N711	7/6	2S304	12/6	BC138	8/-	CRS1/30	8/-	OC20	19/6
2N711A	7/6	2S305	15/-	BCY30	5/6	CRS1/35	8/6	OC22	9/6
2N721	11/-	2S320	9/-	BCY31	8/6	CRS1/40	9/6	OC23	12/6
2N743	4/-	2S321	6/-	BCY32	10/-	CRS3/05	6/-	OC24	12/6
2N744	6/-	2S322	7/6	BCY33	5/-	CRS3/10	6/-	OC25	7/6
2N753	5/-	2S323	10/-	BCY34	6/-	CRS3/20	7/6	OC26	5/-
2N865	12/6	2S324	12/6	BCY38	7/-	CRS3/30	8/6	OC28	12/6
2N914	4/6	2S501	8/6	BCY39	8/6	CRS3/40	10/-	OC29	12/6
2N916	4/6	2S502	8/6	BCY40	10/-	CRS400/40	39/6	OC35	10/-
2N918	7/6	2S503	9/6	BCY42	5/-	CRS3/025 AF	5/-	OC36	12/6
2N919	4/-	2S512	9/6	BCY43	5/-	CRS25/025	15/-	OC41	5/-
2N920	5/-	2S701	8/6	BCY70	4/-	DD006	3/9	OC42	6/-
2N922	8/6	2S702	11/-	BCZ11	7/6	DD058	6/-	OC43	8/-
2N930	7/6	2S724	50/-	BC147	3/9	DD190	12/6	OC44	4/-
2N1090	6/-	2S731	8/6	BC148	2/9	DD226A	7/6	OC44M	4/-
2N1091	6/6	2S732	8/6	BC149	4/-	DD262A	3/9	OC45	3/6
2N1131	6/-	2S733	9/6	BF152	6/-	DK110	1/6	OC45M	3/6
2N1132	8/-	2S743	50/-	BF182	6/6	DT3200	7/6	OC46	5/6
2N929	4/6	2S745A	30/-	BF194	3/6	FST1/1	3/-	OC57	12/-
2N1303	4/6	AA129	4/-	BF195	3/-	FST2/0	3/6	OC58	12/-
2N1304	5/-	AA178	8/6	BTY79/100R	15/-	FST2/1	3/-	OC59	13/-
2N1305	5/-	AAY11	2/-	BT102/500R	15/-	FST3/0	3/-	OC70	3/-
2N1306	5/-	AAY12	5/-	BD119	12/6	FST3/1	4/-	OC71	3/-
2N1307	5/-	AAZ12	4/-	BD124	12/6	FST3/8	6/-	OC72	5/-
2N1308	6/-	AAZ13	2/6	BEN3000	5/-	FST3/05 AF	3/-	OC73	6/-
2N1309	5/-	AAZ17	2/-	BF115	5/-	GET102	6/-	OC74	6/-
2N1420	18/6	AC126	5/-	BF154	8/-	GET103	4/6	OC75	5/-
2N1483	9/6	AC127	5/6	BF158	6/-	MPF102	8/6	OC76	5/-
2N1613	5/-	AC127Z	12/6	BF159	12/-	MPF103	7/-	OC77	8/-
2N2147	17/6	AC128	5/-	BF163	8/-	MPF104	7/6	OC78	5/-
2N2160	15/-	AC154	3/-	BF167	5/-	MPF105	8/-	OC78D	2/6
2N2287	25/-	AC169	3/-	BF173	6/-	OA5	3/-	OC79	4/6
2N2297	9/6	AC153	4/-	BF180	7/6	OA7	4/-	OC81	5/-
2N2484	7/6	AC176	5/-	BF181	7/6	OA9	3/-	OC81D	4/-
2N2646	10/6	AC187	5/-	BFX30	6/-	OA10	4/-	OC81M	5/-
2N2784	10/-	AC188	6/-	BFX88	5/-	OA47	2/-	OC81DM	3/-
2N2904	8/6	ACY17	6/-	BFY17	6/-	OA70	2/-	OC81Z	7/6
2N2905	10/-	ACY18	4/-	BFY18	5/-	OA71	2/-	OC82	5/-
2N2925	4/-	ACY19	5/-	BFY19	5/-	OA73	2/-	OC82D	3/-
2N2926	2/6	ACY20	4/-	BFY20	12/6	OA74	2/-	OC83	5/-
2N3011	7/6	ACY21	4/6	BFY50	5/-	OA79	2/-	OC84	5/-
2N3053	5/-	ACY22	3/6	BFY51	4/6	OA81	2/-	OC122	10/-
2N3054	12/6	ACY28	3/6	BFY52	5/-	OA85	2/6	OC123	10/-
2N3055	15/-	ACY34	4/-	BFY53	4/-	OA86	4/-	OC139	5/-
2N3133	6/-	ACY36	5/-	BFY64	8/6	OA90	2/-	OC140	7/6
2N3136	6/-	ACY39	9/6	BLY10	20/-	OA91	1/6	OC141	15/-
2N3142	7/6	ACY40	3/-	BLY11	22/6			OC169	5/-
2N3232	15/-	AD140	11/-	BPY10	19/6			OC170	5/-
2N3233	15/-	AD149	12/6	BSX20	4/-			OC171	6/-
2N3235	30/-	AD161	7/6	BSX21	5/-			OC200	5/-
2N3228	10/-	AD162	7/6	BSX76	4/-			OC201	9/6
2N3528	9/6	ADT140	10/-	BSY27	4/-			OC202	12/6
2N3702	3/6	ADZ11	24/6	BSY28	5/-			OC203	7/6
2N3703	3/6	ADZ12	29/6	BSY29	5/-			OC204	8/-
2N3704	4/-	AEY11	10/-	BSY50	5/-			OC205	12/6
2N3705	8/6	AEY12	12/6	BSY51	5/-			OC206	15/-
2N3707	4/-	AF102	15/-	BSY53	5/-			OC207	15/-
2N3709	3/6	AF114	6/6	BSY64	5/-			OCP71	19/6
2N3710	3/-	AF115	6/-	BSY65	5/-			ORP12	9/6
2N3135	6/-	AF116	6/6					ORP60	8/-
2N3794	2/6	AF117	5/-						

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HENRY'S RADIO
303 EDGWARE ROAD
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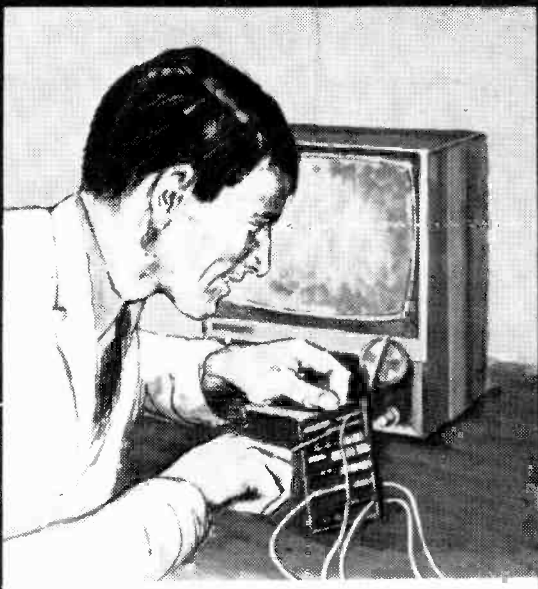
OPEN MON-SAT 9am-6pm THURS 9am-1pm



Train for tomorrow's world in Radio and Television at The Pembridge College of Electronics.

The next full time 16 month College Diploma Course which gives a thorough fundamental training for radio and television engineers, starts on 15th April.

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Please send, without obligation, details of the Full-time Course in Radio and Television.

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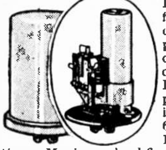
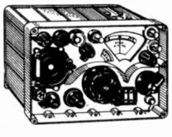
CAR LIGHT FLASHERS



Heavy duty light flasher employs a condenser discharge principle operating on electro mechanical relay. (As inset.) Housed in strong plastic case. Flashing rate between 60-120 per minute. 12 volt DC operation. Maximum load 6 amps. Size 2 11/16" dia. . 4". Supplied brand new at a fraction of original cost. **6/6** each. P. & P. 2/6. (3 for **17/6.** P. & P. 4/6.)

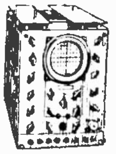
R209 MK II COMMUNICATION RECEIVER

11 valve high grade communication receiver suitable for tropical use. 1·20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, BFO. Aerial trimmer, internal speaker and 12 V d.c. internal power supply. Supplied in excellent condition, fully tested and checked.



£15 Carr. 20/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES

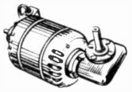


An excellent general purpose D/B oscilloscope. T.B. 2 c/s-750 kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33 mV/CM. Operating voltage 0/110/200/250 V. a.c. Supplied in excellent working condition. **£22.10.0** or complete with all accessories, probe, leads, lid, etc. **£25.** Carriage 30/-.

MARCONI CT44/ TF956 AF ABSORPTION WATTMETER

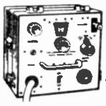
1 μ/watt to 6 watts.
£20. Carr. 20/-.

GEARED MAINS MOTORS



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

CLASS D WAVEMETERS

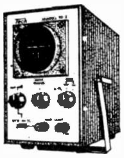


A crystal controlled heterodyne frequency meter covering 1·7-8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. **£5.19.6.** Carr. 7/6, or brand new with accessories. **£7.19.6.** Carr. 7/6.

CLASS D WAVEMETERS No. 2

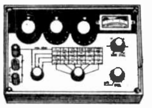
Crystal controlled. 1·2-19 Mc/s. Mains or 12V d.c. operation. Complete with calibration charts. Excellent condition. **£12.10.0.** Carr. 30/-.

TO-2 PORTABLE OSCILLOSCOPE



A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS-1 MHZ. Input imp. 2 megΩ 25 P.F. Illuminated scale. 2in. tube. 115 × 180 × 230mm. Weight 8lb. 220/240 V a.c. Supplied brand new with handbook. **£22.10.0.** Carr. 10/-.

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



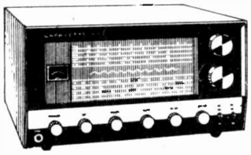
A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11·1 megΩ 6 Ranges ±1%. L.1 μH - 111 HENRYS 6 Ranges -2%. C. 10pF ± 1110 mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000-1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¾×5×2in. **£20.** P. & P. 5/-.

UNR-30 4-BAND COMMUNICATION RECEIVER

Covering 550 Kc/s-30 Mc/s. Incorporates BFO. Built-in speaker and phone jack. Metal cabinet. Operation 220/240V. a.c. Supplied brand new, guaranteed with instructions. Carr. 7/6 **13 gns.**

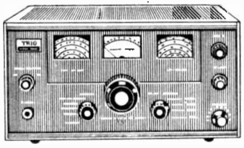
TRIO JR-310 NEW AMATEUR BAND 10-80 METRE RECEIVER. In stock. **£77.10.0.**

LAFAYETTE SOLID STATE HA600 RECEIVER



5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 kc/s-400 kc/s and 550 kc/s-30 Mc/s FET front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V a.c./12V d.c. neg. earth operation ● RF gain control. Size 15in × 9¾in × 8¼in. Weight 18lb. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

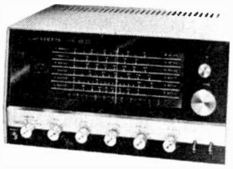


4 band receiver covering 550Kc/s to 30Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 445Kc/s ● Audio output 1·5W. ● Variable RF and AF gain controls. 115/250V A.C. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. **£42** Carriage paid.
TRIO COMMUNICATION TYPE HEADPHONES Normally **£5.19.6.**
OUR PRICE **£3.15.0** if purchased with above receiver.

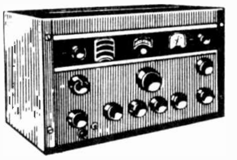
TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER £69.10.0

TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £212

LAFAYETTE HA.800 SOLID STATE AMATEUR COMMUNICATION RECEIVER SIX BANDS 3.5-4, 7-7.3, 14-14.35, 21-45, 28-29.7, 50-54 Mc/s.



Dual conversion on all bands. 2 × 445 Kc/s mechanical filters. Product detector. Variable B.F.O. 100 Kc/s crystal calibrator. 'S' meter. Huge slide rule dial. Operation 230v AC or 12v DC. Size 15"×9¼"×8¼". Complete with instruction manual. **£57.10.0.** Carr. paid.
(100 Kc/s Crystal 39/6 extra)



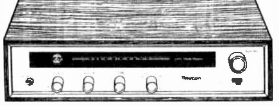
RCA COMMUNICATION RECEIVER AR88D

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

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

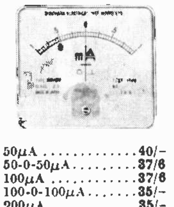
A completely new transistorised receiver covering 152-174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75Ω aerial input. Headphone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

TELETON MODEL CR 10T AM/FM STEREO TUNER AMPLIFIER



A new model from Teleton. 31 solid state devices. 4 + 4 watt output. Inputs for ceramic/crystal cartridge. Frequency range AM 540-1600 KHz FM 88-108 MHz. Automatic FM stereo reception. Stereo indicator. Controls: Tuning, function selector, Tone and R & L volume controls. AFC switch. Stereo headphone socket. Size: 13¾" × 3½" × 9¼" approx. Price **£34.** Carr. 7/6.

CLEAR PLASTIC PANEL METERS



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

500-0-500μA **27/6**	50mA **27/6**	150V. D.C....**27/6**
1mA **27/6**	100mA **27/6**	300V. D.C....**27/6**
1-0-1mA **27/6**	150mA **27/6**	500V. D.C....**27/6**
2mA **27/6**	200mA **27/6**	750V. D.C....**27/6**
5mA **27/6**	300mA **27/6**	15V. A.C.....**27/6**
10mA **27/6**	500mA **27/6**	50V. A.C **27/6**
50μA **40/-**	750mA **27/6**	3V. D.C......**27/6**	150V. A.C....**27/6**
50-0-50μA **37/6**	1 amp **27/6**	10V. D.C.....**27/6**	300V. A.C....**27/6**
100μA **37/6**	2 amp **27/6**	20V. D.C.....**27/6**	500V. A.C....**27/6**
100-0-100μA **35/-**	5 amp **27/6**		S meter 1mA.**32/-**
200μA **35/-**	20mA **27/6**	100V. D.C....**27/6**	VU meter....**42/-**
500μA **40/-**			

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

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock Single hole fixing, ¼in. dia. shafts. Bulk quantities available.
25 WATT. 10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms, **14/6.** P. & P. 1/6.
50 WATT. 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, **21/-.** P. & P. 1/6.
100 WATT. 1/5/10/25/50/100/250/500/1,000 or 2,500 ohms, **27/6.** P & P. 1/6.

CRYSTAL CALIBRATORS No. 10

Small portable crystal controlled wavemeter. Size 7"×7½"×4". Frequency range 500 Kc/s. 10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. **89/6.** Carr. 7/6.

AVO 48A. Perfect order with set of shunts and resistances. **£12.10.0.** P. & P. 7/6.

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

10 meg. input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1·2Mc/s. Decibels -40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17.10.0.** Carr. 5/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0·20 Kc/s on 2 ranges. Output 500Ω or 5kΩ. Operation 200/250V. A.C. Supplied in perfect order. **£12.10.0.** Carr. 10/-.

TE-65 VALVE VOLTMETER

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

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

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

AM/FM SIGNAL GENERATORS

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

PLESSEY SL 403A

3 watt Integrated Amplifier Circuit
49/6 POST PAID

EDDYSTONE VHF RECEIVERS MODEL 770R. 19-165 Mc/s. Excellent condition. **£150.**

TE-16A Transistorised Signal Generator. 5 ranges 400 kHz-30 mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 kHz modulation. 5¼×5¼×3¼. Complete with instructions and leads. **£7.19.6.** P.&P. 4/-.

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

SOLARTRON CD. 711S.2 OSCILLOSCOPES

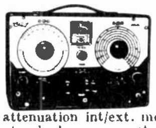
Double beam. D.C. to 9 Mc/s. Perfect order. **£65.** Carr. 50/-.

AUTO TRANSFORMERS

0/115/230v. Step up or step down. Fully shrouded.
150 W. **£2.2.6,** P. & P. 3/6
300 W. **£2.19.6,** P. & P. 4/6
500 W. **£4.10.0,** P. & P. 6/6
1,000 W. **£6.10.0,** P. & P. 7/6
1,500 W. **£7.19.6,** P. & P. 8/6
7,500 W. **£15.10.0,** P. & P. 20/-

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

ARF-100 COMBINED AF-RF SIGNAL GENERATOR

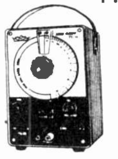


A.F. SINE WAVE 20–200,000 c/s. Square wave 20–30,000 c/s. O/P. **HIGH IMP. 21V.** P/P600Ω 3·8 V. P/P. TF 100 kc/s–300 Mc/s. Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF output and % mod. on R.F 220/240 V a.c. **£30.0.0.** Carr. 7/6.

TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120kc/s to 500Mc/s on 6 bands. Directly calibrated. Variable RF attenuator, audio output. Xtal socket for calibration. 220/240V a.c. Size 140 × 215 × 170mm. Brand new with instructions. **£15** Carr. 7/6.

TY75 AUDIO SIGNAL GENERATOR



Sine Wave 20c/s to 200kc/s. Square Wave 20c/s to 30kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts a.c. Size 210 × 150 × 120mm. Brand new with instructions. **£16** Carr. 7/6.

MARCONI TF142E DISTORTION FACTOR METERS. Excellent condition. Fully tested. **£20.** Carr. 15/-.

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER

2pF–2,000 mfd 2 ohms–200 megohms. Also checks impedance, turns ratio, insulation, 200/250V a.c.
Brand New £17.10.0. Carr. 7/6.

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.

VM.76 **VALVE VOLTMETER R.F. measurements in excess of 100Mc/s and d.c. measurements up to 100V with accuracy of ±2% d.c. range 300 MV to 1kV a.c. range 300MV to 300V RMS. Resistance 0·02–500M Ω. Price £72.**

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

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

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

TT1S **TRANSISTOR TESTER. £37.10.0. Carriage 10/- per item.**

MODEL ZQM TRANSISTOR CHECKER

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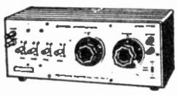

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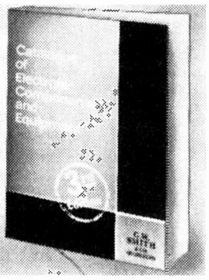

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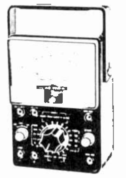

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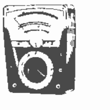

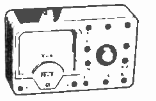

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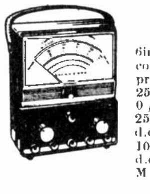

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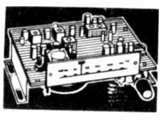

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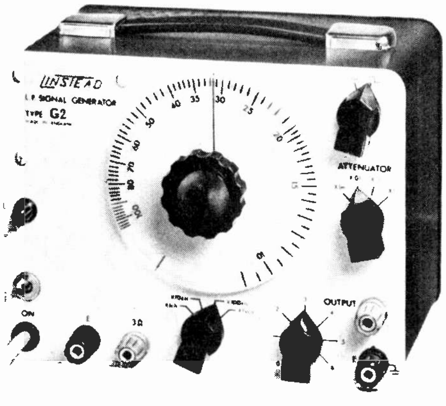

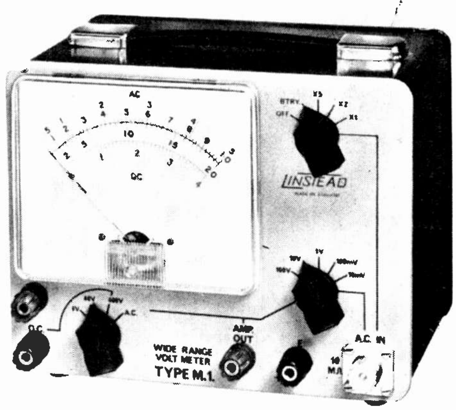

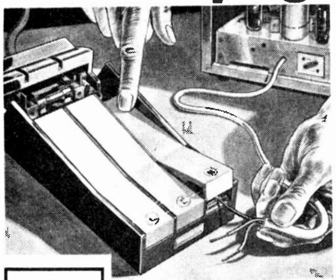

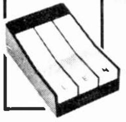

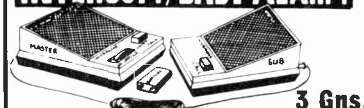

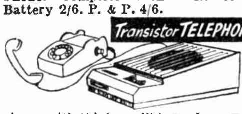

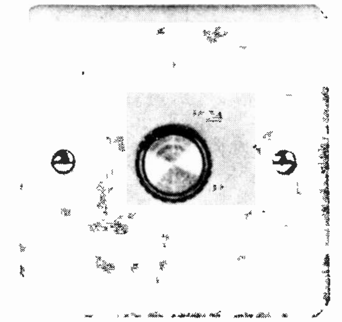

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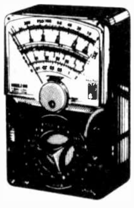

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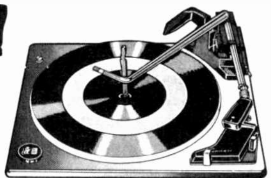

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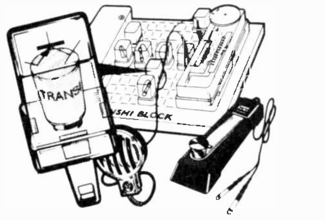

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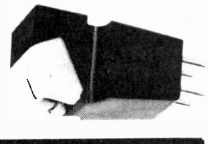

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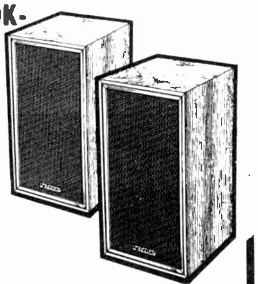
Lasky's

NEW FOSTER "Criterion" Mk II

2 SPEAKER TWO WAY BOOK-SHELF SPEAKER SYSTEM



Another high quality sub-miniature book-shelf system from Foster. The "Criterion" Mk II is a sealed infinite baffle type enclosure using 5½in bass/mid-range woofer with rolled cloth edge and a 2½in HF cone type tweeter. The compact cabinet is constructed ½in laminate with handsome oiled walnut veneer finish and black woven acoustic gauze front panel with satin chrome edge insert. SPEC: Frequency range 90-20,000Hz. Power handling 10 watts. Impedance 8 ohms. HF crossover. Screw tag connections at rear. Size 12½ × 7¾ × 6¾in. The performance of the "Criterion" is superior to many larger and more expensive units and at Lasky's exclusive price offers absolutely unbeatable value.

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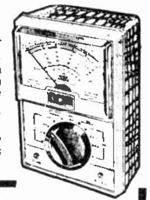
LASKY'S PRICE £9.10/- or 2 for £17.10/-

TTC MODEL C-1000



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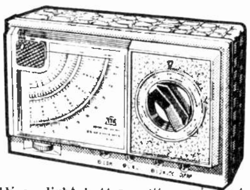

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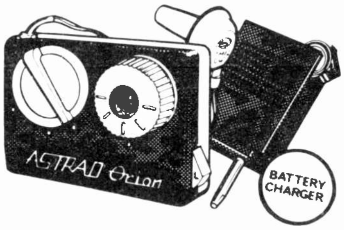

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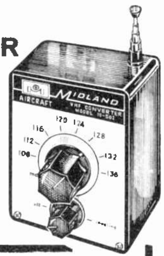

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February 1970

PRACTICAL ELECTRONICS

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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

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Our March issue will be published on Monday, February 16

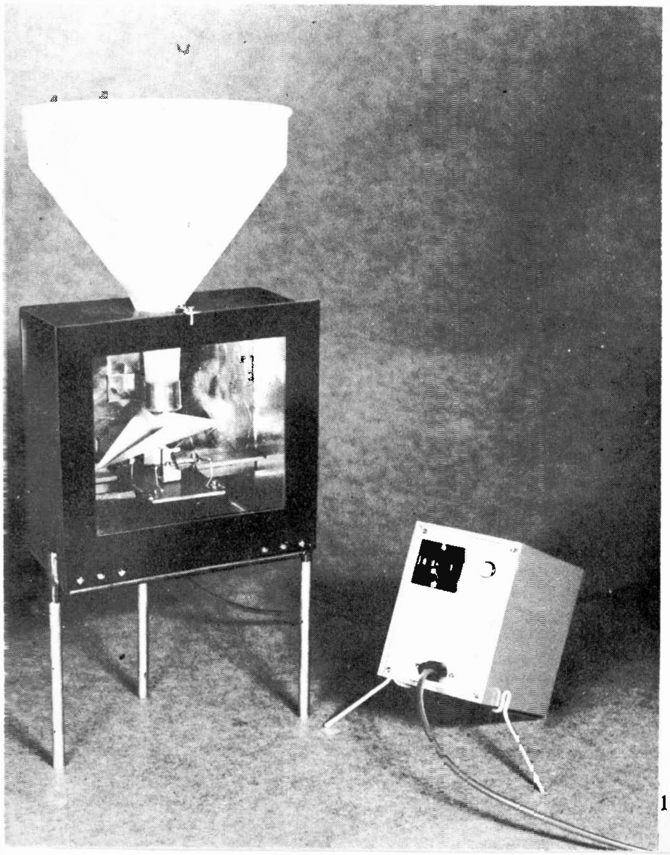
Editorial and advertisement offices: Fleetway House, Farringdon St., London, E.C.4. Phone 01-236 8080

RAINFALL GAUGE

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 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,

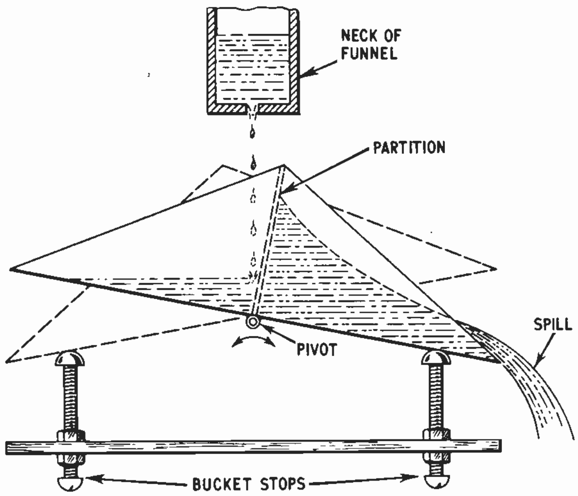
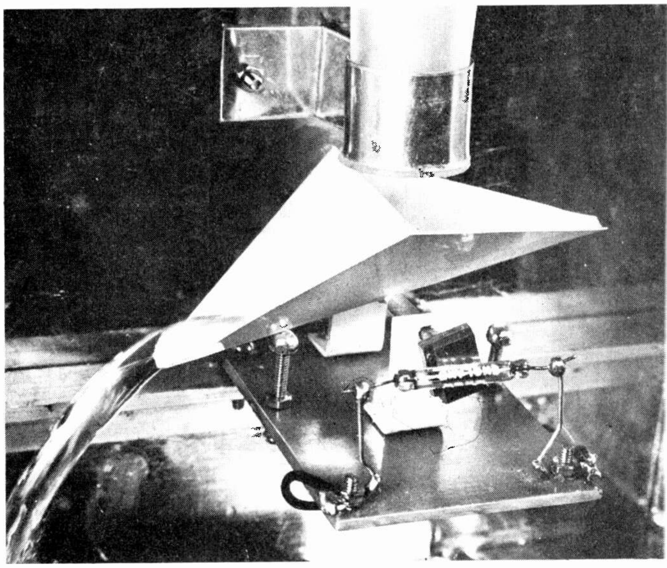


Fig. 1. Sectional view of the "bistable bucket" for metering liquid



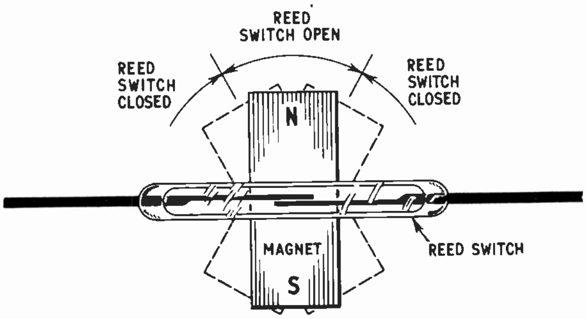


Fig. 2 (left). Low force magnet actuated reed switch operation

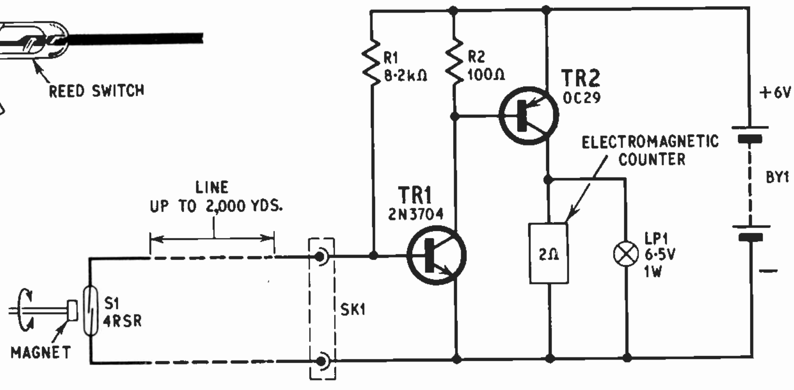


Fig. 3. Counter circuit and reed switch

COMPONENTS . . .

Resistors
R1 8·2kΩ
R2 100Ω
±10%, ½W carbon

Transistors
TR1 2N3704
TR2 OC29

Switch
S1 Reed switch type 4RSR, 500mA contacts (Radiospares)
Short bar magnet 0·44in (Radiospares)

Lamp
LP1 6·5V 1W l.e.s. with l.e.s. lampholder

Socket and Plug
SK1 Non-reversible panel mounted, two-way

Battery
BY1 6V type 996

Miscellaneous
4 or 5 digit resettable electromagnetic counter (P.O. type meter)
Copper laminated s.r.b.p. 2in × 3in × $\frac{3}{32}$in
Plain s.r.b.p. sheet 2½in × 1⅛in
Aluminium sheet 18 s.w.g. 3in × ½in
Brass rod 2in × $\frac{3}{32}$in dia.
Pillars ½in, 6 and 8B.A. nuts and bolts
Twin cable 14/0076 p.v.c. covered
Enamelled copper wire 26 s.w.g. for counter

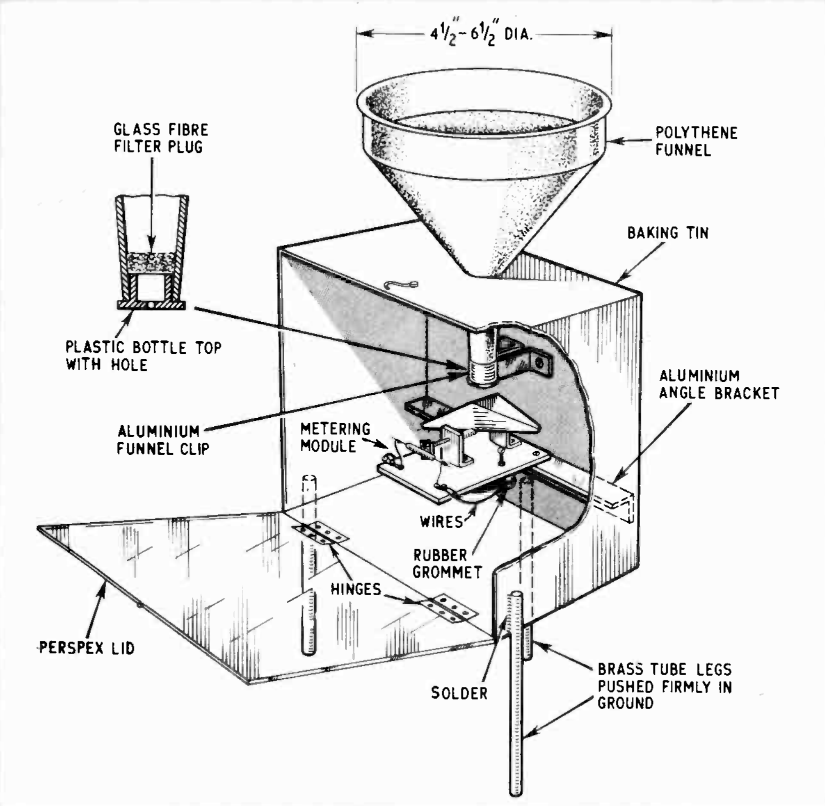


Fig. 4. Suggested layout for rain metering unit

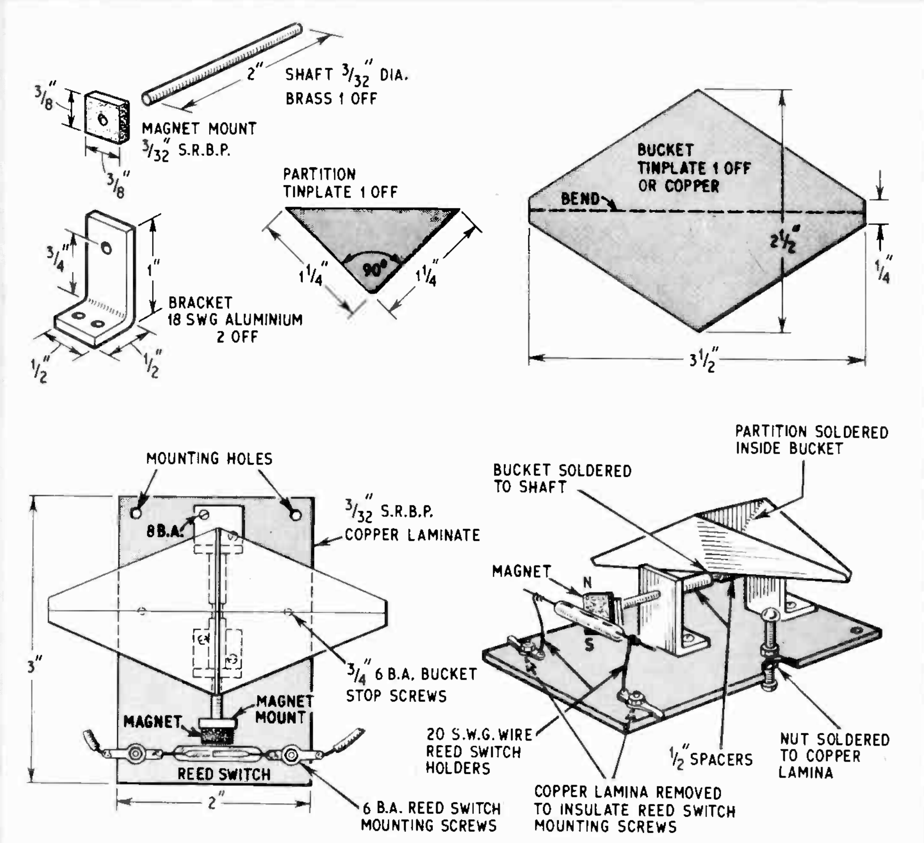


Fig. 5. Construction details of the liquid metering module

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 4½in to 6½in 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 float". To check correct switch action, listen for a 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. LP1 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 box.

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.

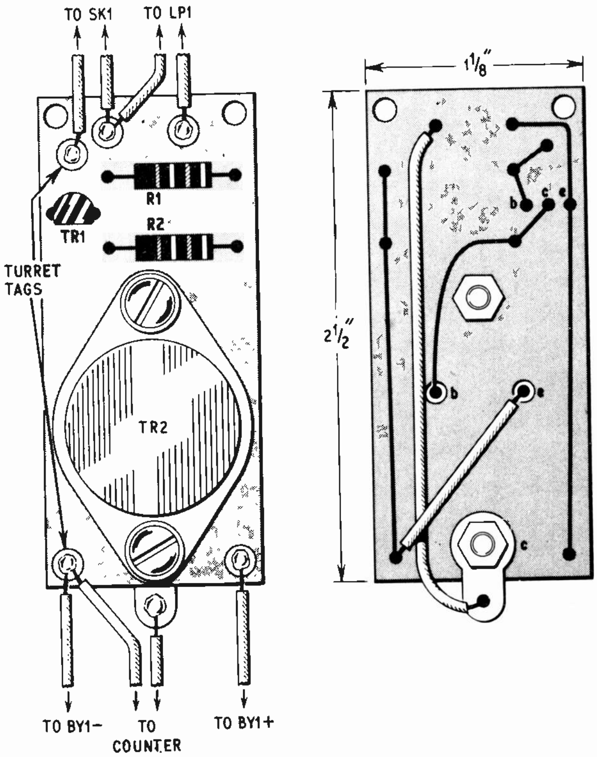


Fig. 6. Amplifier panel, components side and underside

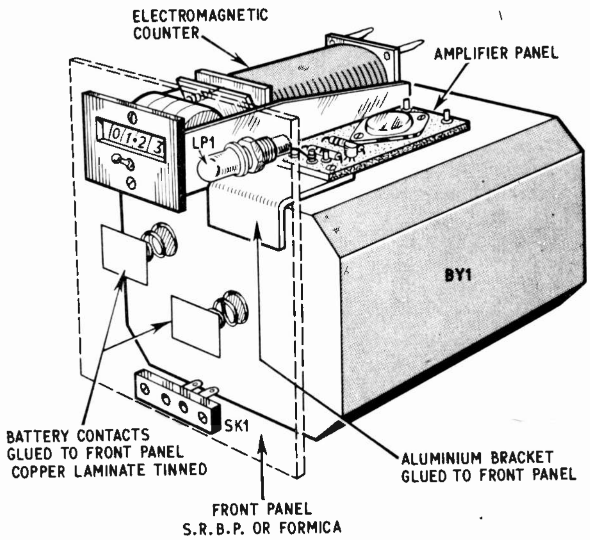


Fig. 7. Layout of the counter unit

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 measurement 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 3μs, so that for a target at 10,000 yards range, the pulse takes 30μs 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 60μs 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
1 mile	10·7μs
1 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.

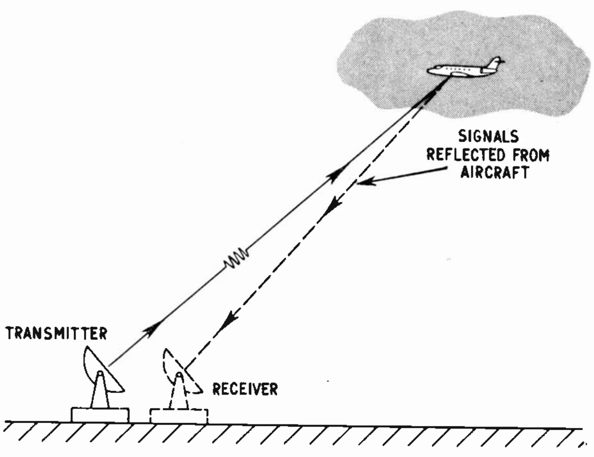


Fig. 1.1. The basic principle of a pulsed radar set

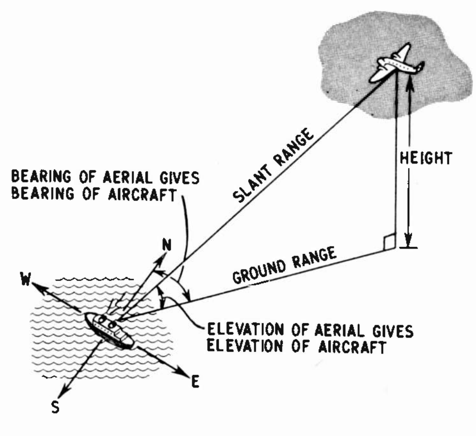
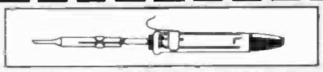
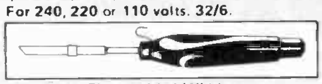


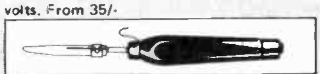
Fig. 1.2. The three information requirements for a radar set



G 18 watts. Fitted 3/32" bit for miniature work on production lines. Interchangeable spare bits, 1/8", 3/16" and 1/4" available. For 240, 220 or 110 volts. 32/6.



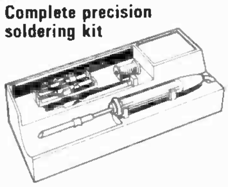
E 20 watts. Fitted with 1/4" bit. Interchangeable spare bits 3/32", 1/8", 3/16" available. For 240, 220, 110 volts. From 35/-



ES 25 watts. Fitted with 1/8" bit. Interchangeable bits 3/32", 3/16" and 1/4" available. Ideal for high speed production lines. For 240, 220, 110, 24 or 12 volts. From 35/-

F 40 watts. Fitted 5/16" bit. Interchangeable bits 1/4", 3/16", 1/8", 3/32" available. Very high temperature iron. For 240, 220, 110, 24 or 20 volts. From 42/6
Spare bits and elements for all models and voltages immediately available from stock.

Complete precision soldering kit



This kit—in a rigid plastic "tool-box" — contains

- Model CN 15 watts miniature iron, fitted 3/32" bit. Interchangeable spare bits 1/16", 3/16".
- Reel of resin-cored solder
- Felt cleaning pad
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PLUS 36-page booklet on "How-to-Solder"—a mine of information for amateur and professional.

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15 watts - 240 volts
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I enclose cheque/P.O./cash value
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.... P.E.2

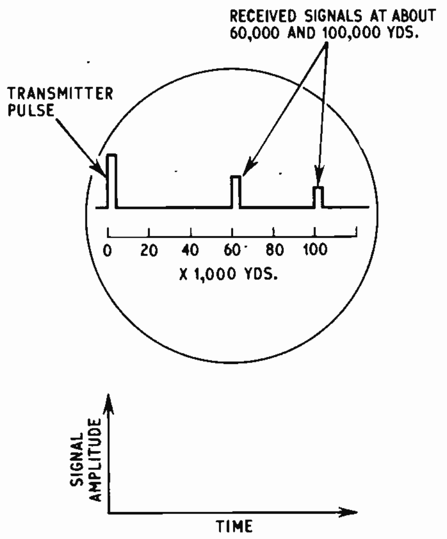


Fig. 1.3. "A" 'scope display of range

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 200μs represents the first 20 miles of the available range. In this case the spot sweep is triggered by the transmitted pulse and takes 200μs to scan the screen. It then flies back to the start and waits for about 800μs during "dead time", until the next transmitted pulse again initiates the sweep.

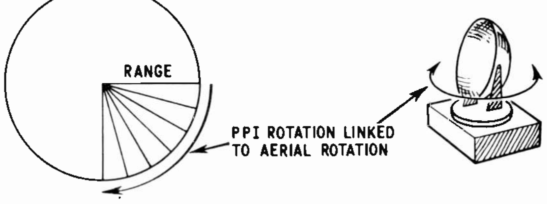


Fig. 1.4. The p.p.i. display principle for indicating both range and bearing

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

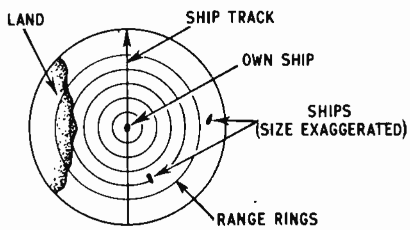


Fig. 1.5. A typical p.p.i. display for a ship

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 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.

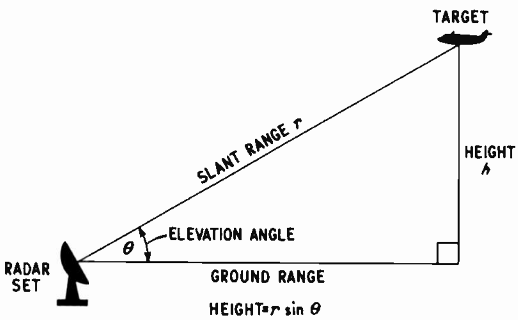


Fig. 1.6. Calculation of height from slant range and elevation information

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 of both designer and operator. These are as follows:

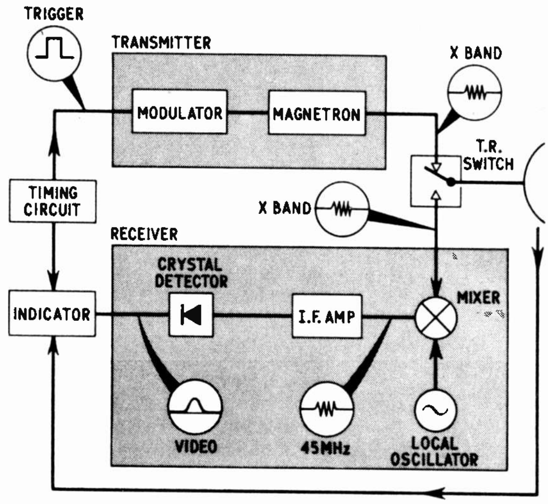


Fig. 1.7. The block diagram for a typical pulsed radar installation

(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, 12μs 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 12μs chosen for this example; 1μs is more common.

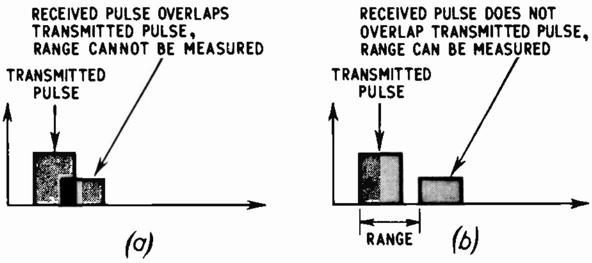


Fig. 1.8. Minimum range depends on pulse width

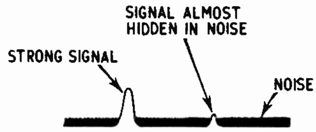


Fig. 1.9. The appearance of noise on an "A" 'scope

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 0·1µs 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.

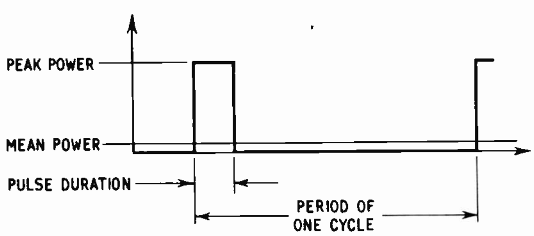


Fig. 1.10. The relationship between peak and mean power

Since the transmitter may have a pulse duration of 1µs 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.

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:

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

(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.

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

where:

P_t = transmitter power
R_{max} = maximum detectable range
G = aerial gain, using the same aerial for transmission and reception
λ = wavelength
σ = radar cross-section of the target
S_{min} = minimum 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

MARKET PLACE

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

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 applications report giving details of a 50-joule 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

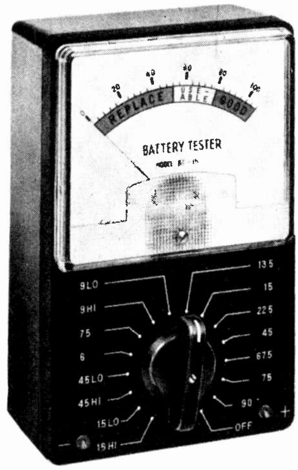
A robust general purpose bridge, type PW3, for d.c. resistance measurements with a range from 0·001 ohm to 10 Megohm is the latest product from **Croydon Precision Instruments.**

A transistor inverter, powered by seven 1½V dry cells, automatically 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

Soder Wick from Southern Watch and Clock Supplies

DESOLDERING

Most desoldering products on the market consist of special soldering iron attachments and work on vacuum suction for removing solder. The "Soder Wick" from **Southern Watch and Clock Supplies,** is different in that it acts like "blotting paper" when applied to molten solder.

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 resoldering.

The wick, available in varying widths, can be used for all types of solder connections, from integrated circuits and printed circuit boards to electrical appliances or complex electrical apparatus.

The solder wick is supplied in 1⅞in 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.

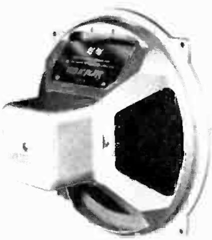
LITERATURE

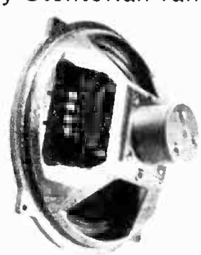
To save unnecessary costs and wastage, the *Mullard Technical Handbook* is now being issued as a series of three volumes. Each book deals with a particular section of Mullard manufactured components and is divided into several parts or chapters. The first part contains details of semiconductor and integrated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

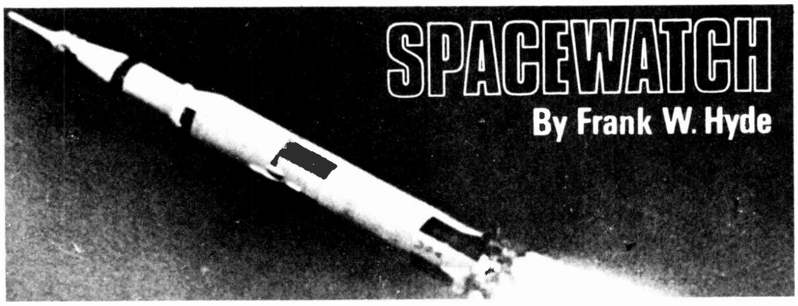
The final book deals with components and materials and is divided into three parts covering electrical components, ferrite, PXE, permanent magnets, and ferroxcube inductor cores.

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.







SPACEWATCH

By Frank W. Hyde

INTELSTAT IV

The largest communications 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 geo-stationary 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.

Intelsat, 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. If applied to the location of aircraft it would help to fit them into the air-space available with great precision and cut down congestion at the air-ports. 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 synchronised 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. The 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 spacecraft. This was not satisfactory 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.

PE ORGAN PART 10

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 $\frac{3}{4}$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 1in 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 $\frac{3}{4}$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 absorbing 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 $\frac{1}{16}$in thick 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 $\frac{1}{4}$in plywood with a centre hole of $\frac{5}{32}$ 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 $\frac{5}{8}$in by $\frac{1}{16}$in 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 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 1in 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 1in 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 $\frac{1}{8}$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.

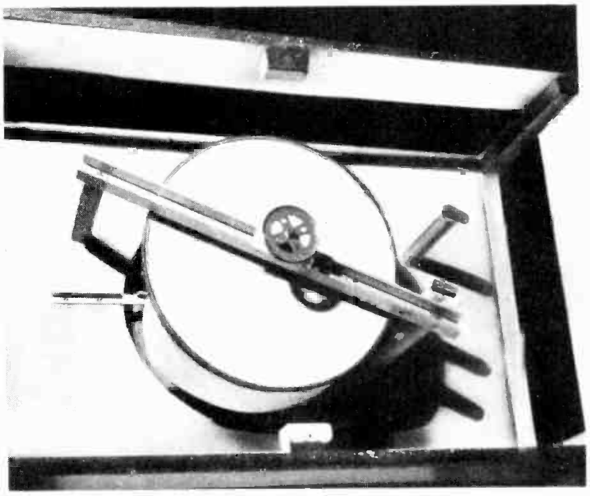
The final adjustment is for the height of the rotor above the speaker. Ideally the gap should be about $\frac{1}{8}$in, but it may not be possible to get quite as close as this. A larger gap will not affect the higher frequencies, but will progressively reduce the lower ones. So some control over the modulation is possible.

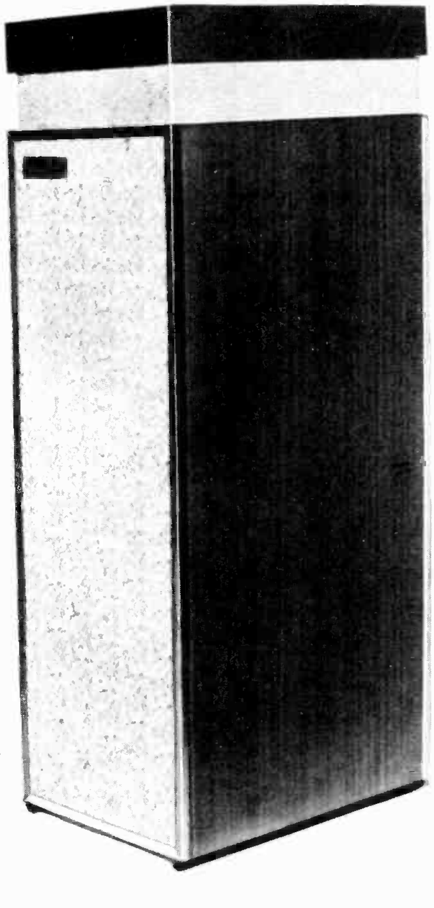
ALL VOICES MODULATED

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.





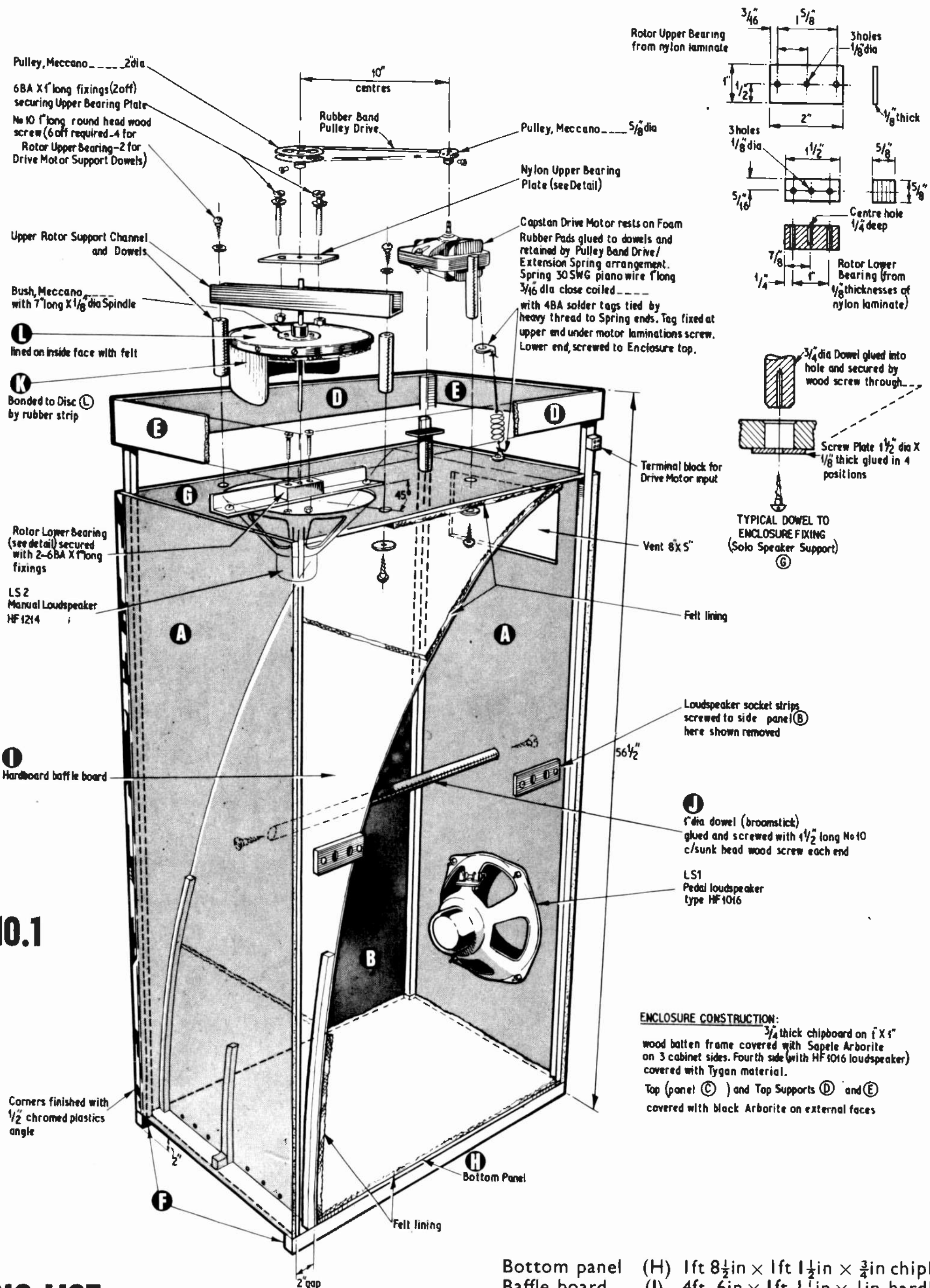


Fig. 10.1

CUTTING LIST

Enclosure

Sides	(A)	(2 off)	3ft 11in × 1ft $1\frac{1}{2}$in × $\frac{3}{4}$in chipboard
Sides	(B)	(2 off)	3ft 11in × 2ft × $\frac{3}{4}$in chipboard
Top	(C)	(1 off)	2ft × 1ft 3in × $\frac{1}{2}$in ply
Top supports	(D)	(2 off)	2ft × 3in × $\frac{3}{4}$in chipboard
Top supports	(E)	(2 off)	1ft $1\frac{1}{2}$in × 3in × $\frac{3}{4}$in chipboard
Feet	(F)	(2 off)	2ft × 2in × 1in hardwood
Solo speaker support	(G)	(1 off)	1ft $10\frac{1}{2}$in × 1ft $1\frac{1}{2}$in × $\frac{3}{4}$in chipboard
Bottom panel	(H)		1ft $8\frac{1}{2}$in × 1ft $1\frac{1}{2}$in × $\frac{3}{4}$in chipboard
Baffle board	(I)		4ft 6in × 1ft $1\frac{1}{2}$in × $\frac{1}{8}$in hardboard
Baffle board dowel	(J)		1in dia. (length as required)

Rotor Assembly

Rotor baffle	(K)	18in × 4in × $\frac{1}{16}$in balsa
Rotor top	(L)	$11\frac{1}{2}$in × $11\frac{1}{2}$in × $\frac{1}{4}$in ply
Rotor support dowels (2 off)		5in × 1in dia.
Motor support dowels (2 off)		4in × 1in dia.
Upper rotor support		1ft 3in × $\frac{3}{4}$in × $\frac{3}{4}$in duralumin channel
Lower rotor support		1ft 3in × $\frac{5}{8}$in × $\frac{1}{16}$in alloy angle

MISCELLANEOUS PARTS

Meccano pulleys: 2in dia. (1 off); ⅝in dia. (1 off)
Meccano bush $\frac{3}{32}$in 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 × 1in (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

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.

SOUND OPERATED SWITCH

By J. E. KASSER

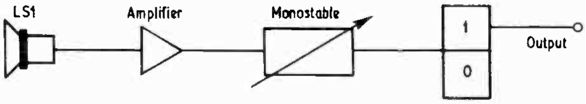


Fig. 1. Block diagram of the sound operated switch

COMPONENTS . . .

Resistors

R1	75kΩ	R13	8·2kΩ
R2	15kΩ	R14	15kΩ
R3	4·7kΩ	R15	1·2kΩ
R4	1·5kΩ	R16	8·2kΩ
R5	2·2kΩ	R17	15kΩ
R6	3·9kΩ	R18	15kΩ
R7	3·3kΩ	R19	8·2kΩ
R8	4·7kΩ	R20	1·2kΩ
R9	2·2kΩ	R21	100kΩ
R10	120kΩ	R22	15kΩ
R11	1·5kΩ	R23	10kΩ
R12	3·9kΩ		

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

Capacitors

C1 10μF elect. 12V
C2 10μF elect. 12V
C3 10μF elect. 12V
C4 20μF elect. 12V
C5 0·01μF
C6 0·01μF
C7 25μF elect. 12V

C4 can be adjusted to change the monostable delay time constant

Semiconductors

TR1, TR3–TR9 2N2926 *or* similar (8 off)
TR2 OC201 *or* similar
D1–D4 OA202

Miscellaneous

X1 Crystal microphone insert (can be used in place of T1 and LS1)
T1 LT700 *or* similar push-pull audio output transformer. Connect loudspeaker to secondary and connect primary to input of amplifier
LS1 3Ω (miniature) loudspeaker
BY1 9V battery
S1 SPST toggle switch
Case } see text
Foam rubber } see text
Veroboard $5\frac{7}{8}$in × $1\frac{5}{8}$in, 0·15in matrix

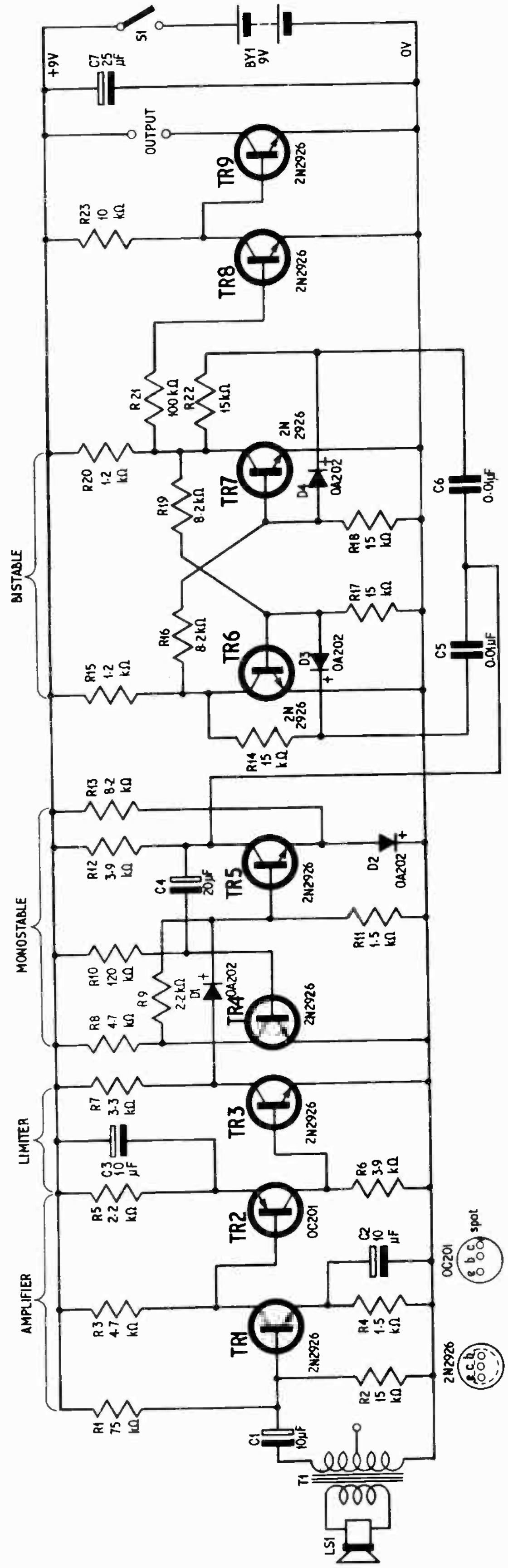
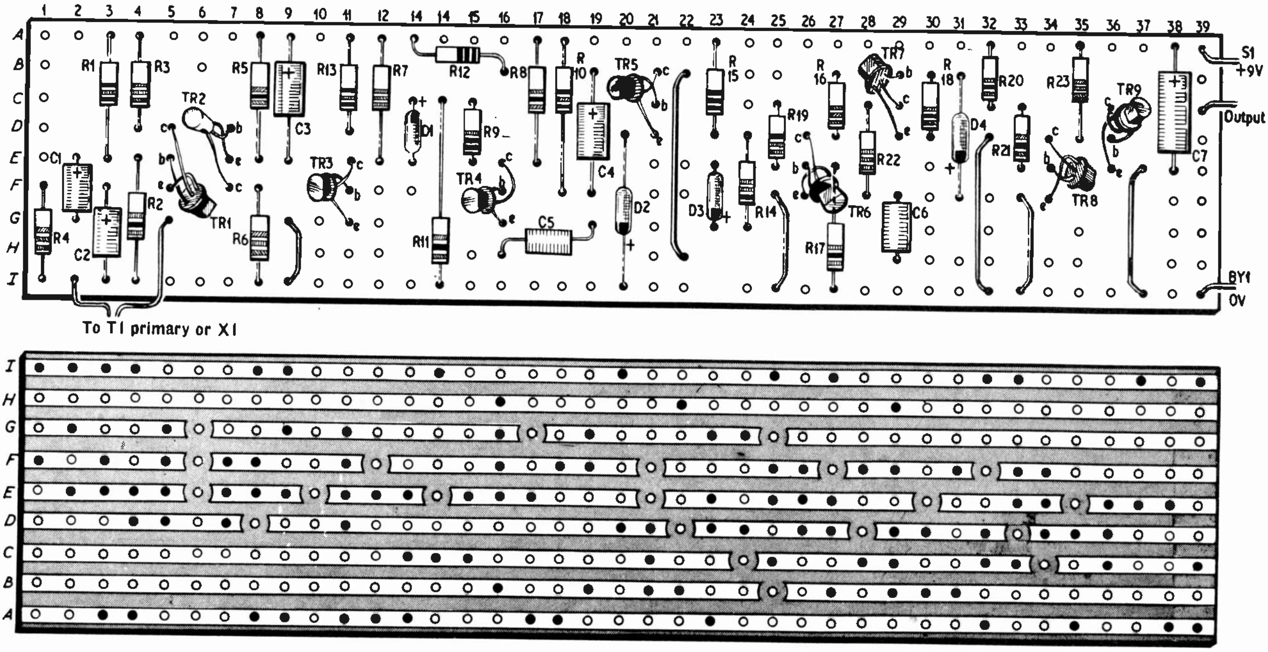


Fig. 2. Circuit diagram of the sound operated switch



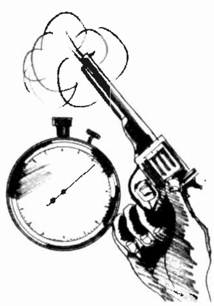


Fig. 3. Veroboard layout and wiring for the sound operated switch

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.

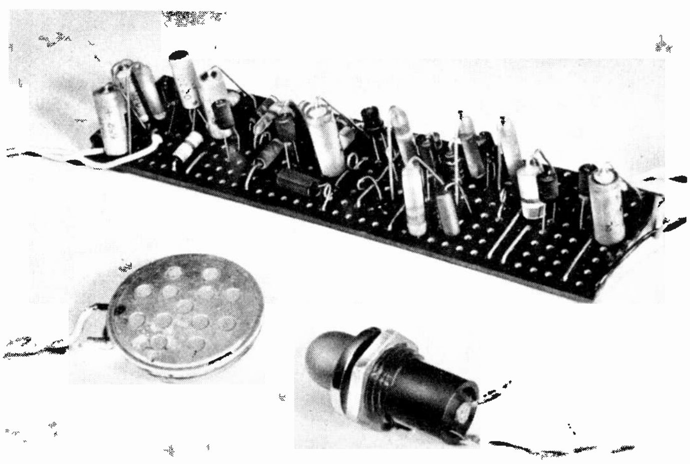
The current flowing in R21 due to the applied potential difference across it is the base current of transistor TR8. Thus when TR7 is off, its collector is at a high potential, and current flows in R21. When TR7 is on, its collector is at earth potential and no current flows in R21. When current flows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



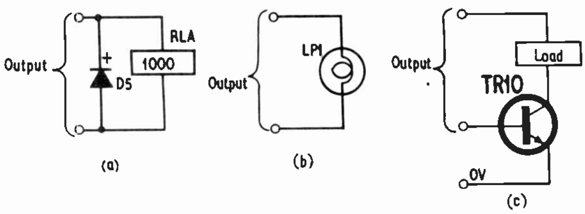


Fig. 4. Output load connections, (a) using relay to switch load, (b) miniature bulb as load, (c) power transistor used to switch load directly

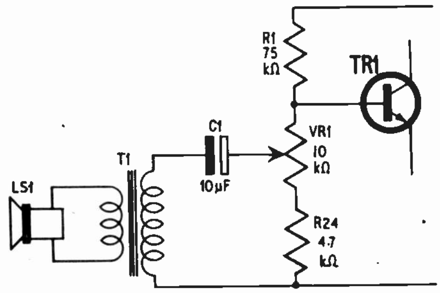
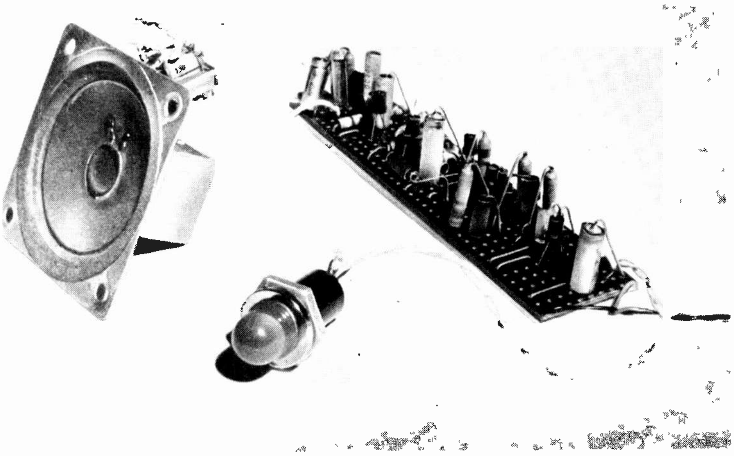
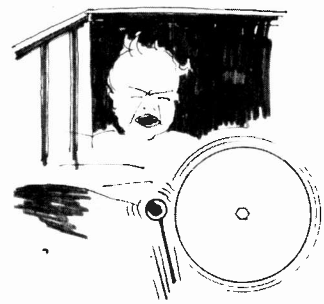


Fig. 5. Circuit for a sensitivity control





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. ★

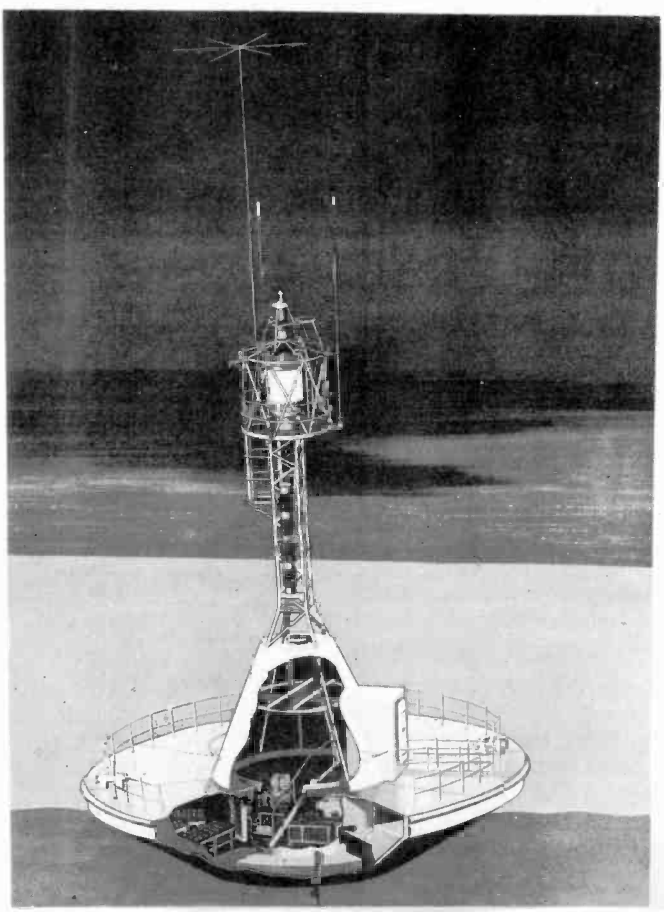
I.T.N. Sound Equipment

I.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 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

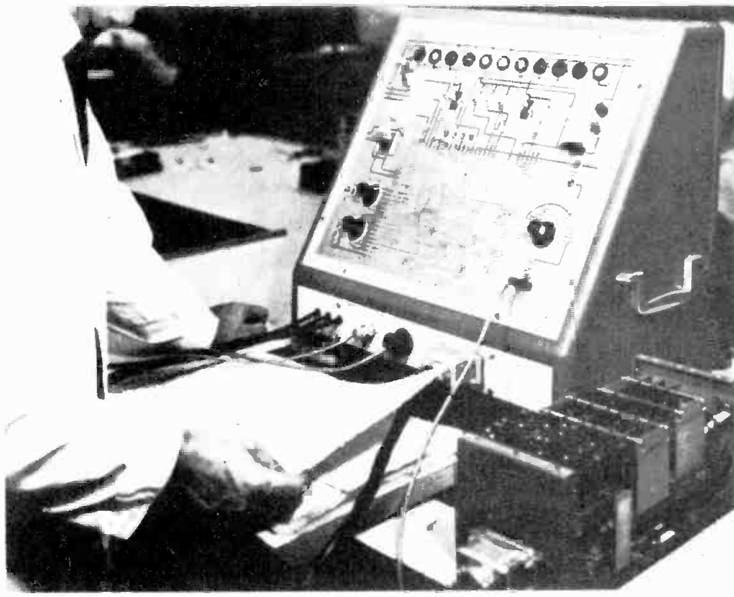
ELECTRONIC equipment is playing an ever increasing role in the running of airports and airlines. Aircraft have always been assisted by electronics but the systems are improving, giving greater reliability and speeding up many processes.

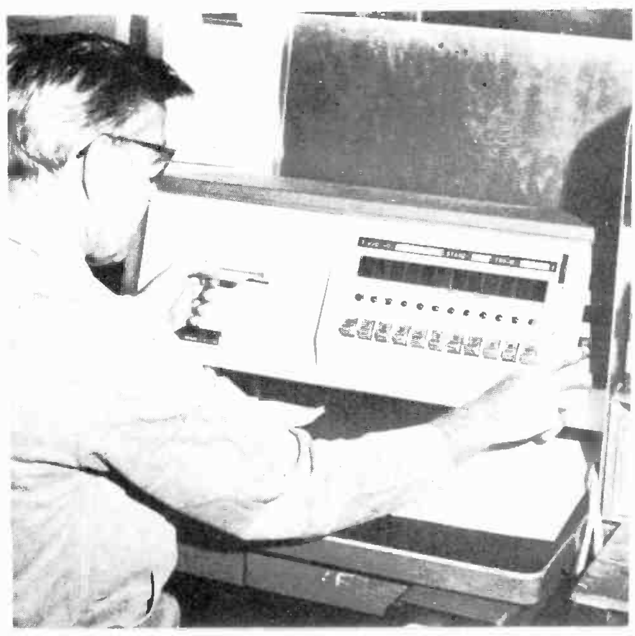
During the last few weeks there have been a number of additions and improvements to electronic equipment being used by the major airlines and large airports. Some of the recent additions are shown on this page.

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. COMMUNICATIONS RECEIVER

By R. HIRST S.T.C. LTD.

PART FIVE SIDEBAND FILTER AND A.F. MODULES

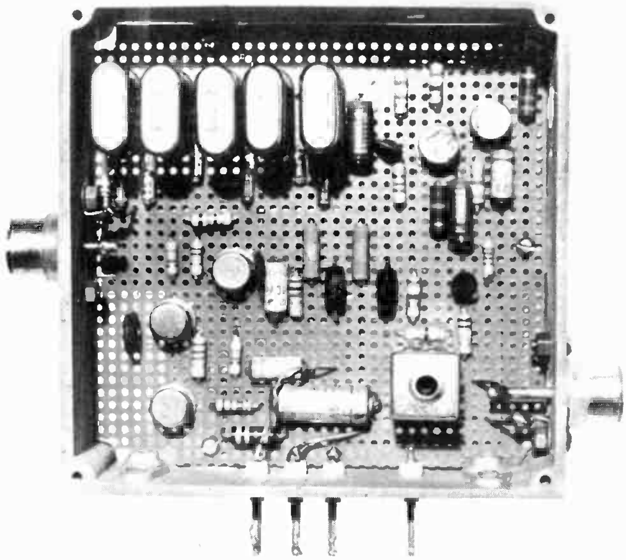
Two further modules are described in this part, the modules are the Sideband Filter Unit and the A.F. Unit, and, as before, these were described briefly in the first part of the series.

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

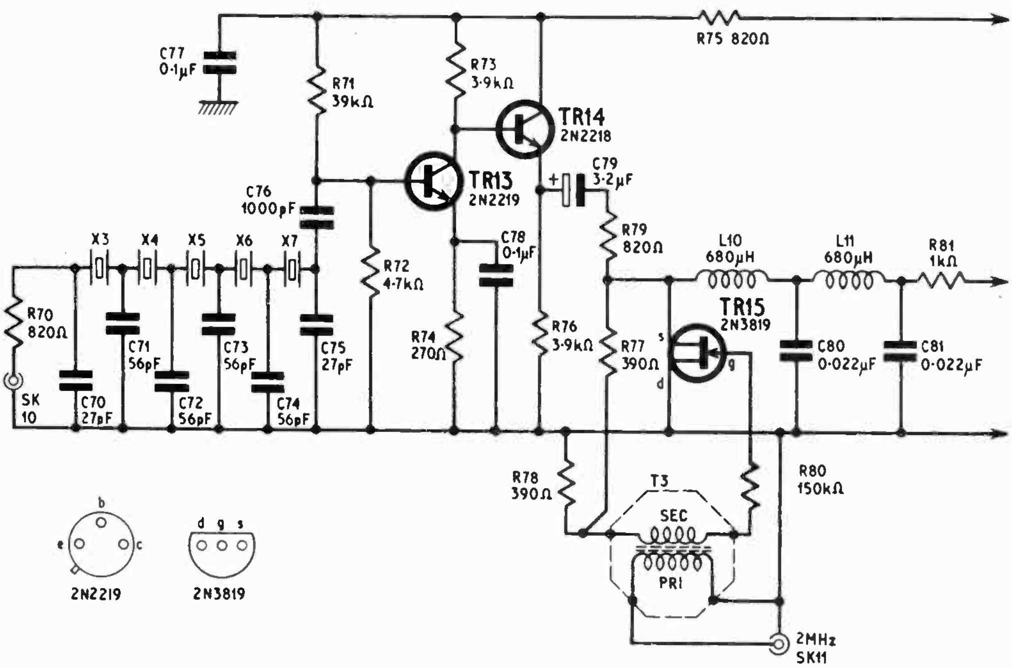
CRYSTAL FILTER

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 pass-band 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



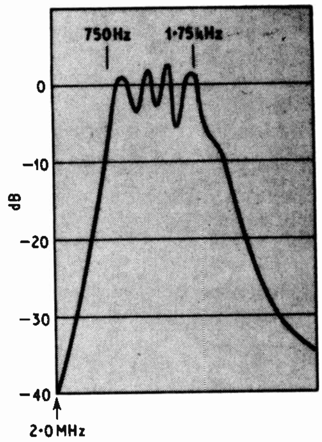


Fig. 5.2. Passband curve using the five stage filter

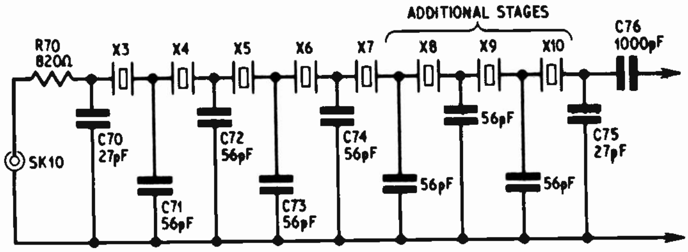


Fig. 5.3. Alternative eight stage crystal filter

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

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.

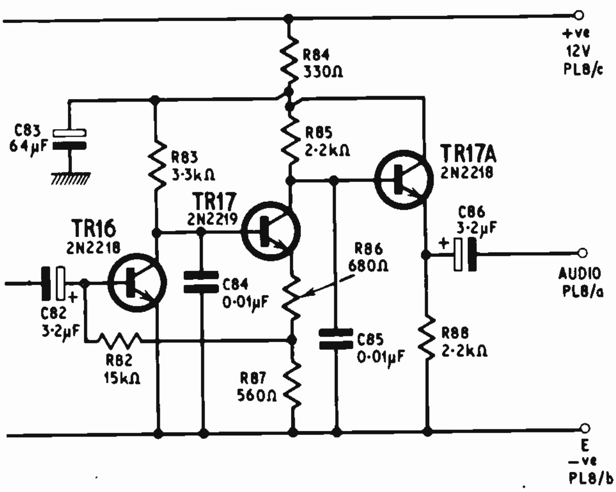


Fig. 5.1. Circuit diagram of the Sideband Filter Unit with a five stage crystal filter

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.

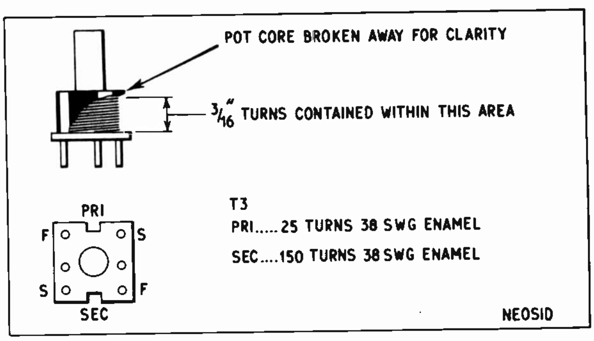
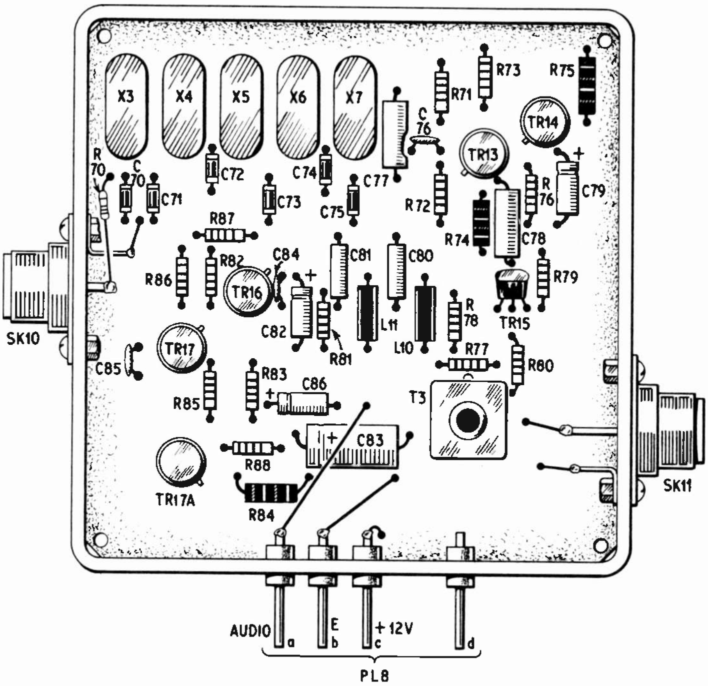


Fig. 5.4. Coil winding details for T3



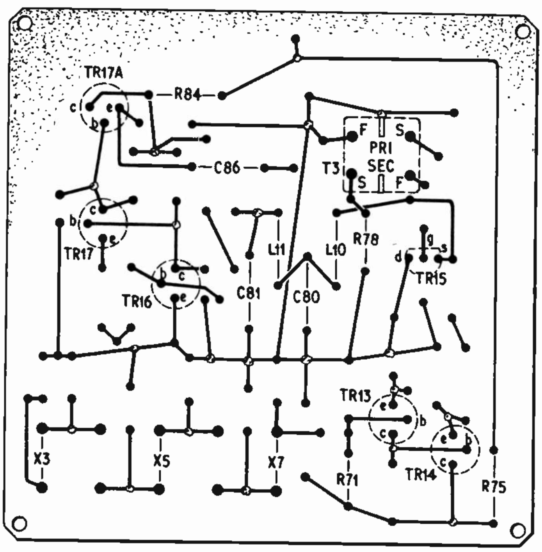


Fig. 5.5. Layout and wiring diagram of the Sideband Filter Unit

COMPONENTS . . .

SIDEBAND FILTER UNIT

Resistors

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
R81 1kΩ
R82 15kΩ
R83 3·3kΩ
R84 330Ω
R85 2·2kΩ
R86 680Ω
R87 560Ω
R88 2·2kΩ

Capacitors

C70 27pF }
C71 56pF }
C72 56pF }
C73 56pF } polystyrene 2½%
C74 56pF }
C75 27pF }
C76 1,000pF }
C77 0·1μF polyester
C78 0·1μF polyester
C79 3·2μF elect. 12V
C80 0·022μF polyester
C81 0·022μF polyester
C82 3·2μF elect. 12V
C83 64μF elect. 12V
C84 0·01μF ceramic
C85 0·01μF ceramic
C86 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)

Inductors

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

Miscellaneous

PL8/a, b, c, d insulated lead through connectors (4 off)
SK10, 11 coaxial chassis mounted sockets (2 off)
Plain perforated Veroboard 3½in × 3½in, 0·1in 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 1V 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	10·1V
	Vb	5·4V
	Ve	4·6V
TR16	Vc	3·1V
	Vb	0·65V
	Ve	0V
TR17	Vc	5·6V
	Vb	3·1V
	Ve	2·4V
TR17A	Vc	10·0V
	Vb	5·6V
	Ve	5·0V

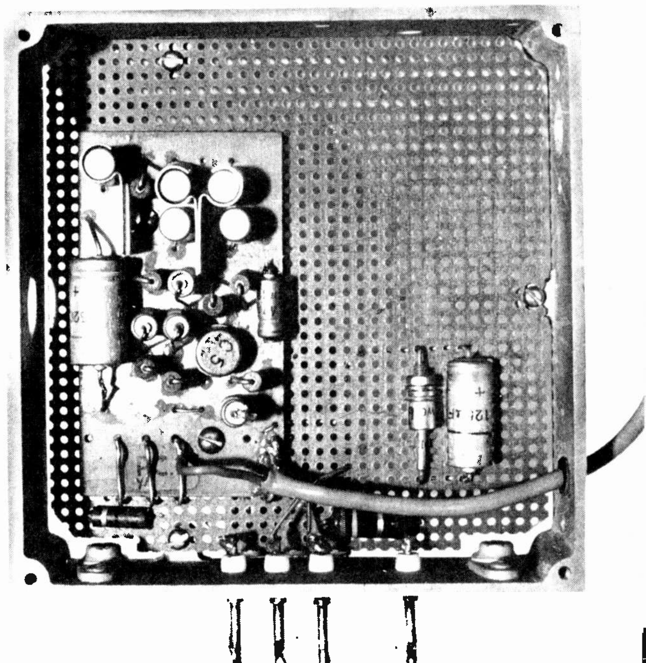
A.F. UNIT

The Audio Frequency Unit simply consists of a pre-built 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, 1 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

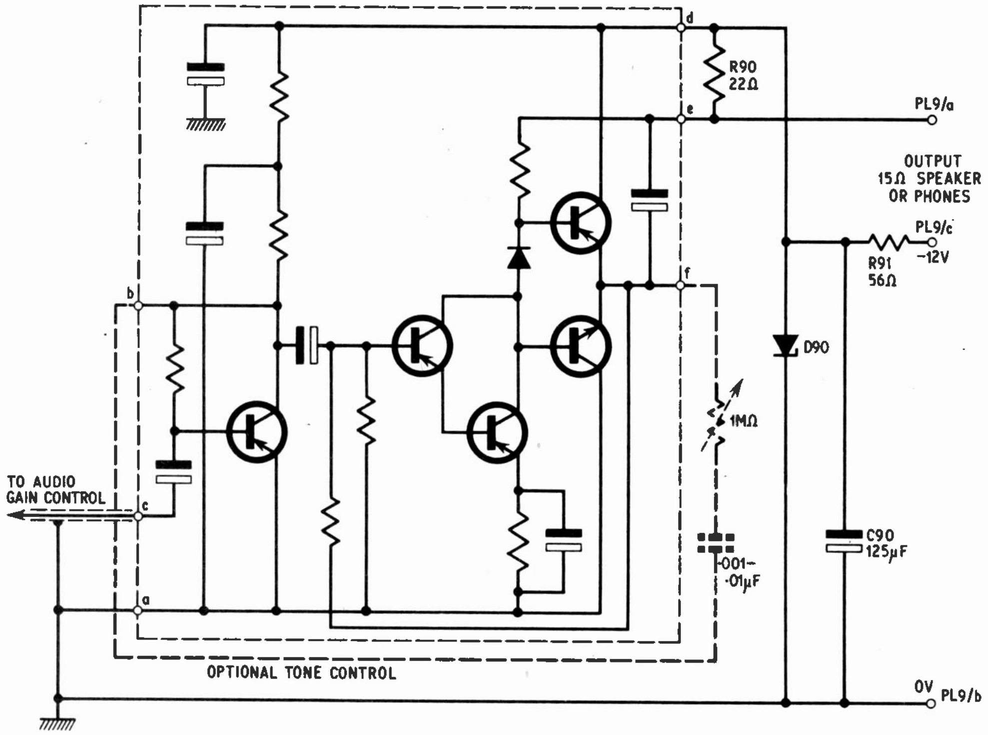


Fig. 5.6. Circuit diagram of the A.F. Unit

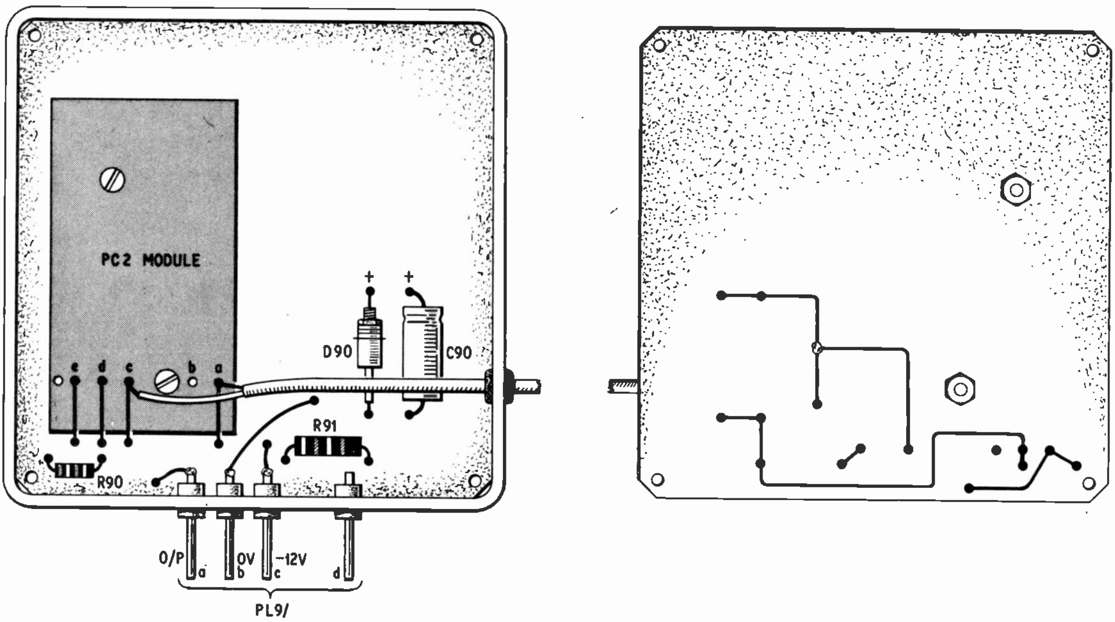


Fig. 5.7. Layout and wiring diagram of the A.F. Unit

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 $\frac{1}{2}$W 10%
R91 56Ω 1W 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 × 3$\frac{1}{2}$in, 0·1in grid
Screened audio lead (12in)

SETTING UP INSTRUCTIONS

Equipment required:

(a) **Power supply** 12V at 100mA.

(b) **Signal generator** capable of delivering up to 1mV 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 1 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

BOOK REVIEWS

ELECTRONICS

By Roland Worcester
Published by The Hamlyn Publishing Group Ltd.
159 pages. 7$\frac{1}{8}$in × 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.

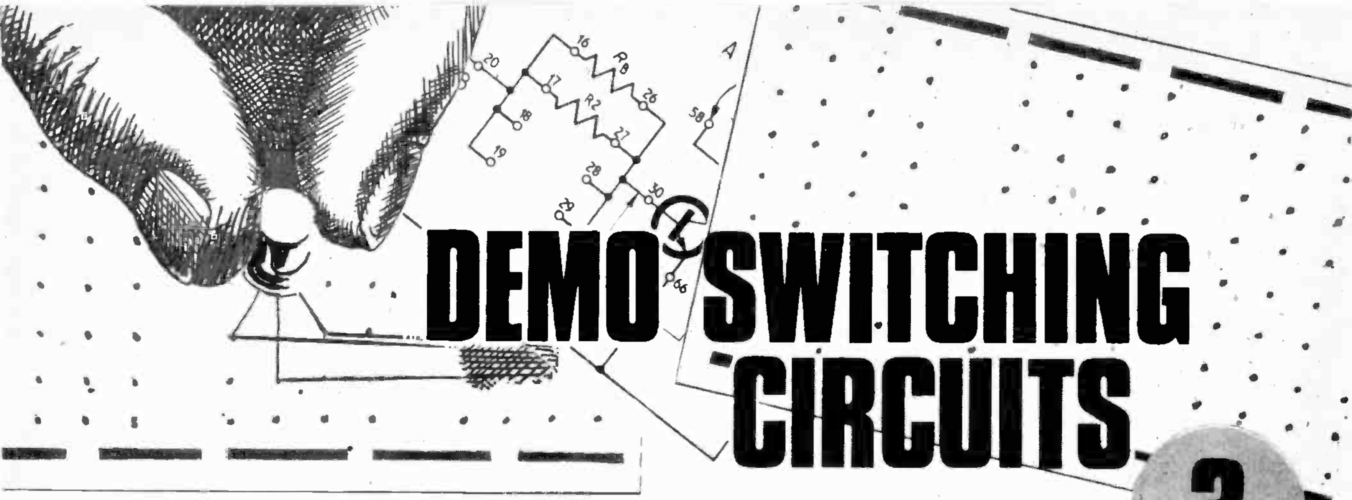
HI FI YEAR BOOK 1970

Edited by Colin Sproxton
Published by IPC Electrical-Electronic Year Books Ltd.
432 pages, 8$\frac{3}{4}$in × 5$\frac{3}{4}$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



DEMO SWITCHING CIRCUITS 3

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:

$$V_{be(sat)} = 0{\cdot}8\text{V (silicon transistors)}$$

$$= 0{\cdot}3\text{V (germanium transistors)}$$

$$V_{ce(sat)} = 0{\cdot}2\text{V to } 0{\cdot}3\text{V}$$

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:

$$I_{c1} = \frac{V_{CC} - V_{ce1(sat)}}{R_1} \simeq \frac{V_{CC}}{R_1}$$

$$I_{b1} = \frac{I_{c1}}{h_{FE}} = \frac{V_{CC} - V_{be1(sat)}}{R_3} \simeq \frac{V_{CC}}{R_3}$$

$$= V_{ce1(sat)} \simeq 0$$

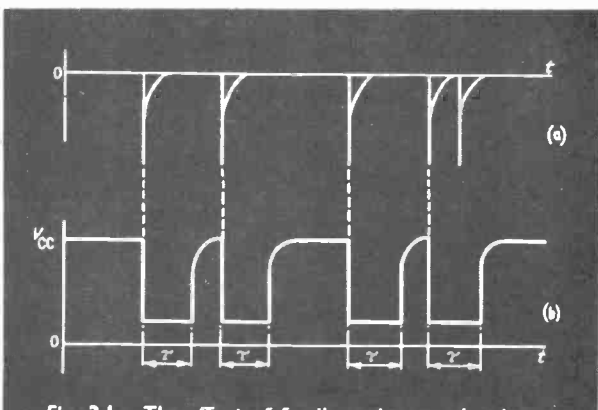


Fig. 3.1. The effect of feeding trigger pulses into a monostable multivibrator. (a) input pulses, (b) the output at TR2 collector

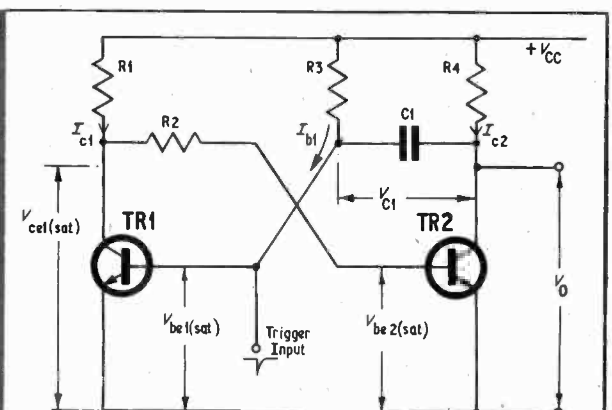


Fig. 3.2. Theoretical circuit of the monostable multivibrator

When TR2 is on:

$$I_{c2} = \frac{V_{CC} - V_{ce2(sat)}}{R_4} \simeq \frac{V_{CC}}{R_4}$$

$$I_{b2} = \frac{I_{c2}}{h_{FE}} = \frac{V_{CC} - V_{be2(sat)}}{R_1 + R_2} \simeq \frac{V_{CC}}{R_1 + R_2}$$

$$= V_0 = V_{ce2(sat)} \simeq 0$$

Suppose that a negative trigger pulse is applied to the base of TR1. The transistor is driven towards cut-off and V_{ce1} rises towards the supply voltage V_{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 quasi-stable 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

$$\tau = 0{\cdot}69 C_1 R_3 \qquad (2)$$

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

$$V_{C1} = 2V_{CC}(1 - e^{-t/C_1R_4}) \qquad (3)$$

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,

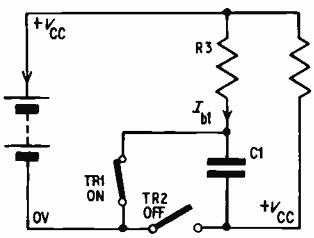


Fig. 3.3 TR1 on and TR2 off

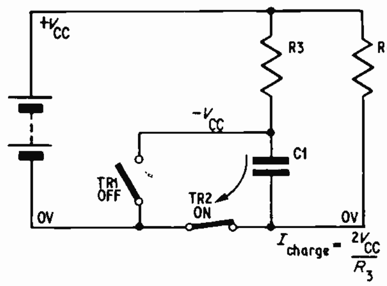


Fig. 3.4. TR1 off and TR2 on

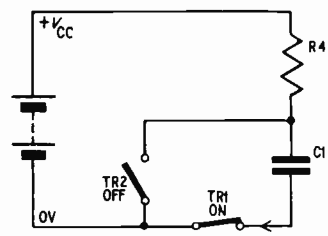


Fig. 3.5. Alternative configuration when TR1 is on and TR2 off

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_{CC} to a value just greater than zero. V_{be1} therefore drops from its initial value of about zero by a similar amount, and finishes up at $-V_{CC}$.

The potential difference across R3 at this instant is twice the supply voltage, or $2V_{CC}$, so a current $2V_{CC}/R_3$ 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 $2V_{CC}/R_3$.

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

$$V_{C1} = 2V_{CC}(1 - e^{-t/C_1R_3}) \qquad (1)$$

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

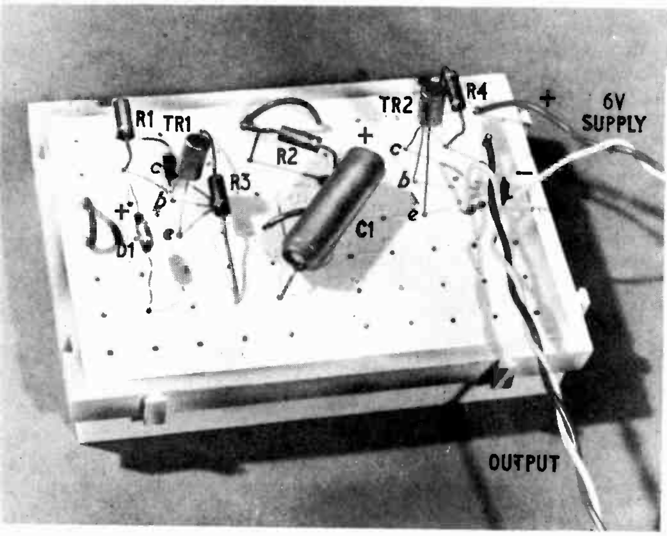
The rising potential difference given by equation (1) eventually causes the actual potential at TR1 base to

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 $t = \tau = 0{\cdot}69C_1R_3$ and $V_{C1} = 0{\cdot}98V_{CC}$ into the equation, we find that $R_3 = 5{\cdot}7R_4$. Now R_3 is bound to be greater than this, unless a transistor with an abnormally low value of h_{FE} were used in the circuit. Thus in the time period τ following the period of quasi-stability, V_{C1} 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).



Monostable

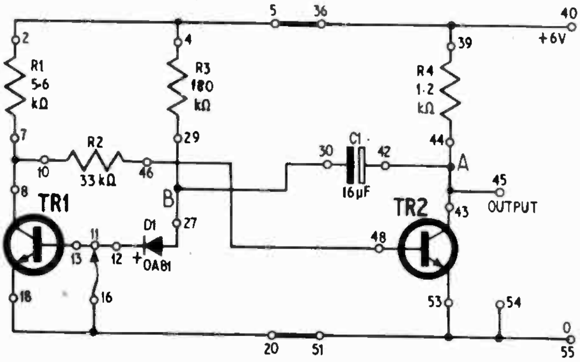


Fig. 3.6. Monostable circuit with hole numbers for S-DeC "breadboard"

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_{c2} sufficiently large to meet the load requirements and calculate $R_4 = V_{CC}/I_{c2}$.

Step 3. Calculate $(R_2 + R_1) = h_{FE}V_{CC}/I_{c2}$. If h_{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_{c1}, but not so small as to cause a drop in h_{FE}. A value of about 1mA is often adequate, a current at which h_{FE} is very unlikely to be less than 30. Calculate $R_1 = V_{CC}/I_{c1}$.

Step 5. Calculate $R_2 = (R_2 + R_1) - R_1$.

Step 6. Calculate $R_3 = h_{FE}V_{CC}/I_{c1}$.

Step 7. Calculate $C_1 = \tau/0{\cdot}69R_3$. If R_3 is in megohms, C_1 will be in μF. If the 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 I_{c1}.

CIRCUIT EXAMPLE

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

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

If $I_{c2} = 5$mA, the circuit will be little affected by the load. Hence $R_4 = 6/5 = 1{\cdot}2\text{k}\Omega$. (step 2)

and $(R_1 + R_2) = 6 \times 30/5 = 36\text{k}\Omega$. (step 3)

If $I_{c1} = 1$mA, $R_1 = 6/1 = 6\text{k}\Omega$. (step 4)

so $R_2 = 30\text{k}\Omega$. (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 make demonstration of the circuit operation easy,

then $C_1 = 2/(0{\cdot}69 \times 0{\cdot}18) \simeq 16\mu$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	1·2kΩ	(step 2)
R1 + R2	39kΩ	(step 3)
R1	5·6kΩ	(step 4)
R2	33kΩ	(step 5)
R3	180kΩ	(step 6)
C1	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.

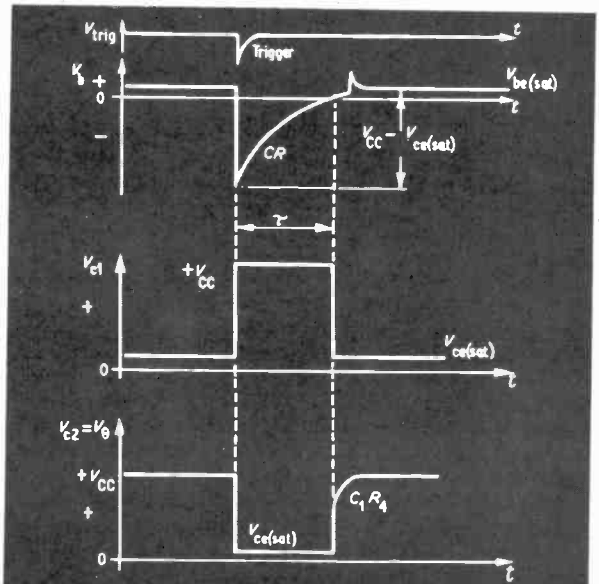


Fig. 3.7. Voltage waveforms of the demonstration circuit in Fig. 3.6

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36 ohms	560 ohms	2·2k Ω	4·7k Ω	16k Ω	27k Ω	47k Ω	82k Ω	430k Ω	1·2M Ω	5·1M Ω	9·1M Ω
47 ohms	750 ohms	2·4k Ω	5·6k Ω	18k Ω	30k Ω	51k Ω	91k Ω	470k Ω	1·5M Ω	6·2M Ω	10M Ω
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4pF	8pF	18pF	30pF	62pF	100pF	158pF	200pF	500pF	820pF	1,500pF	3,000pF
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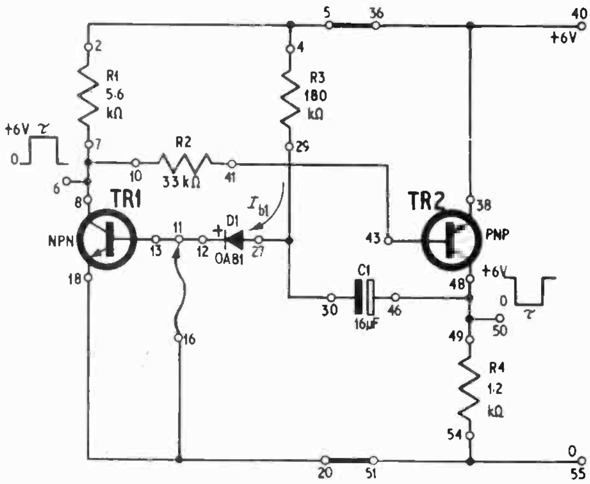

Fig. 3.8 Alternative monostable circuit using one npn and one pnp transistor

Note that the circuit includes a diode in the base lead of TR1. This shields the base from the drop in voltage to $-V_{CC}$ 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-emitter 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 $V_{be(sat)}$ and $V_{ce(sat)}$, 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_{CC} because V_{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 $\tau = 0{\cdot}69CR$.

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

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AN instrument 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.

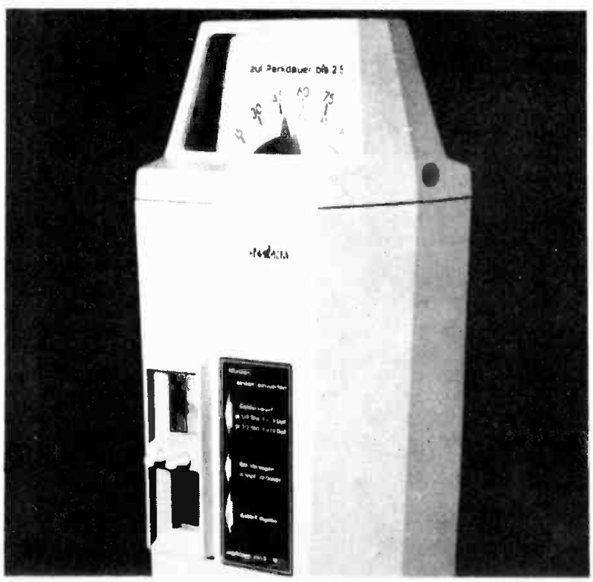
The equipment is initially to be used in test programmes for ground weapons delivery systems and pilot training in bombing techniques. Ground radar units detect and record analogue signals from various sensing devices on the aircraft and convert them into digital signals for processing by a Honeywell 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!



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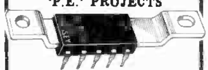

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AUDIO TRENDS

By F. C. JUDD

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 ± 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.

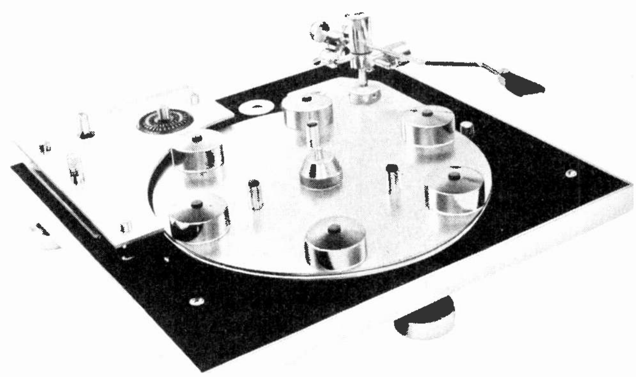
Features include tape monitoring, loudness control, headphone jack and switchable double speaker connections, i.e. for two speakers per channel. The retail price of this new Akai stereo tuner amplifier was not available at the time of compiling this report but should by now be obtainable from the U.K. 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 20–20,000Hz ± 1dB.

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 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.

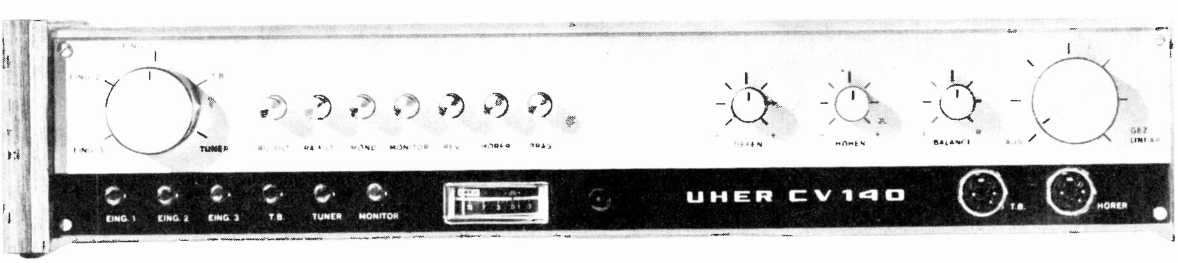


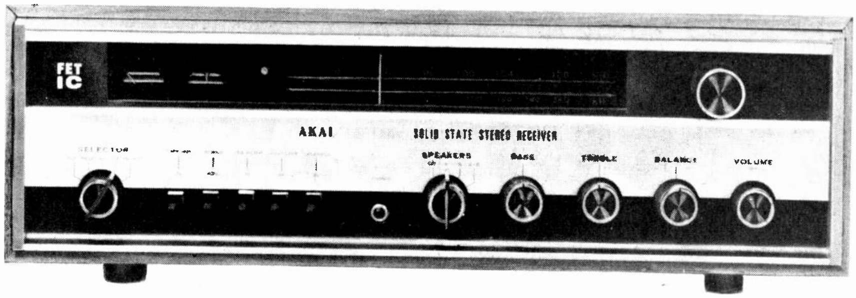
The Hydraulic Reference Turntable by Transcriptors Limited

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 CV140 stereo amplifier has a built-in level meter for checking all input signals

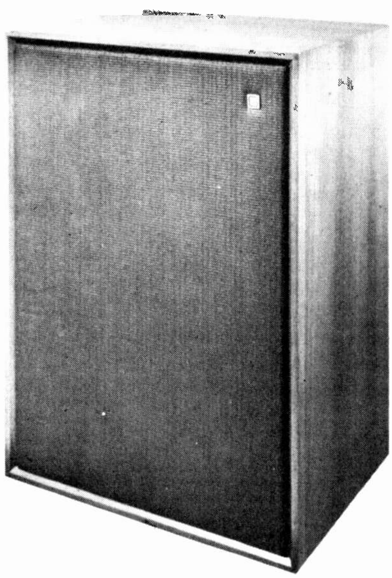




The new Akai AA-6600 stereo tuner amplifier features integrated circuits and field effect transistors

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 27in × 20in × 14in 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 1½-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

Readout—

A SELECTION 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 professional bodies 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.
—Ed.

Guildford group

Sir—An inaugural meeting of electronic enthusiasts was held on Saturday, November 22, at Chalklands, 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.

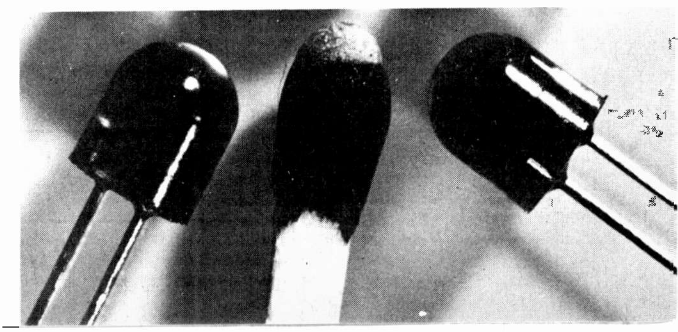
The new centre will house the present Research Department stationed at Dollis Hill in North London; there will be plenty of space for expansion and for large scale field experiments. It is hoped that the new centre will attract graduates to a career in research to provide the best possible telecommunications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

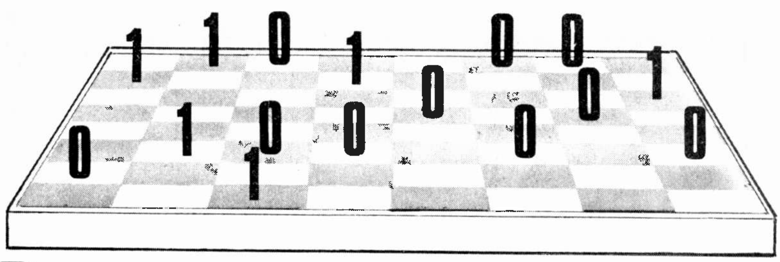
With a staff of up to 2,000 engineers, scientists and supporting technicians, the centre will bring increased spending power and new employment opportunities to the Ipswich area.

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.





A NOVEL DEMONSTRATION OF BINARY ARITHMETIC

CHESSBOARD COMPUTER

By J. F. ROWLANDS

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, 64μF, 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.

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

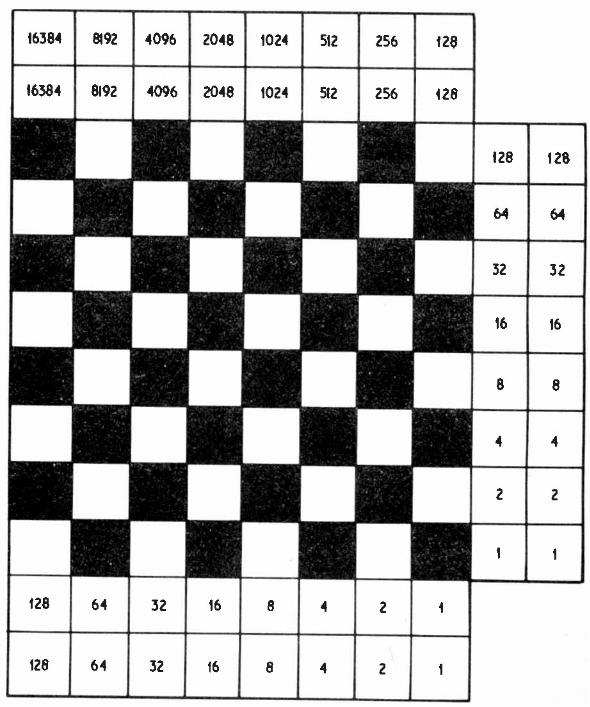


Fig. 1. Chessboard layout with margin numbers

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6BJ6	8/6	30P4	12/-	ECC85	5/-	GZ34	9/9	PY33	10/-	UY41	7/6
6BW6	13/-	30P12	13/9	ECC91	3/-	KT61	8/9	PY81	5/3	UY85	5/9
6F13	3/6	30P19	12/-	ECC804	12/-	KT66	16/-	PY82	5/3	VP4B	10/-
6F14	9/-	30PL1	13/9	ECF80	6/6	N78	17/6	PY83	5/9	W119	7/-
6F23	14/3	30PL13	15/6	ECF82	5/9	PABC80	7/-	PY88	6/9	Z77	2/9
6F25	13/-	30PL14	15/6	ECH35	6/-	PC86	10/3	PY800	7/6	AC107	3/6
6J6	3/-	35L6GT	8/6	ECH42	13/6	PC88	10/3	PY801	6/9	AC127	2/6
6K7G	2/6	35W4	4/6	ECH81	5/9	PC96	8/6	R19	6/6	AD140	7/6
6K8G	2/9	35Z4GT	5/-	ECH83	8/3	PC97	8/6	R20	12/6	AF115	3/-
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6SN7GT	4/3	AC/VP2	10/-	ECL80	7/-	PCC84	6/6	U26	12/-	AF117	3/3
6V6G	3/3	AZ31	9/6	ECL82	6/9	PCC85	6/-	U47	13/6	AF125	3/6
6V6GT	6/6	B729	12/6	ECL83	8/6	PCC88	9/-	U49	13/6	AF127	3/6
6X4	4/3	CCH35	13/6	ECL86	8/-	PCC89	10/6	U78	4/3	OC44	2/3
6X5GT	5/9	CL33	18/6	EF37A	6/6	PCC189	11/6	U191	12/6	OC45	2/3
7B7	7/-	CY31	6/9	EF39	4/9	PCF80	6/6	U193	8/6	OC71	2/6
7C6	6/9	DAC32	7/3	EF41	10/9	PCF82	6/6	U251	14/6	OC72	2/6
10F1	14/-	DAF91	4/3	EF80	4/6	PCF86	11/6	U301	10/6	OC75	2/6
10F18	7/-	DAF96	7/3	EF85	5/3	PCF200	13/6	U329	14/6	OC81	2/3
10P13	15/6	DF33	7/9	EF86	6/3	PCF800	13/6	U801	19/6	OC81D	2/3
12AT7	3/9	DF91	2/9	EF89	5/3	PCF801	6/9	UABC80	6/6	OC82	2/3
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card, or perhaps as a series of channelled impulses recorded on a magnetic tape.

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 × 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.

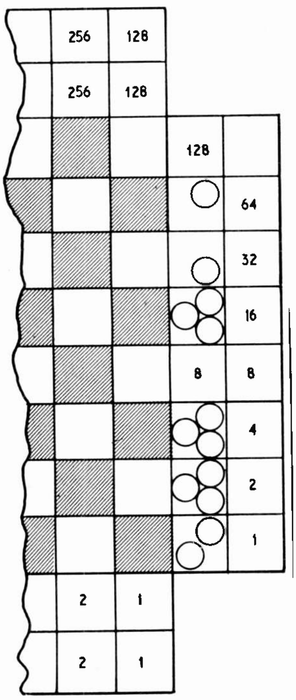


Fig. 2. Arrangement of counters at start of addition

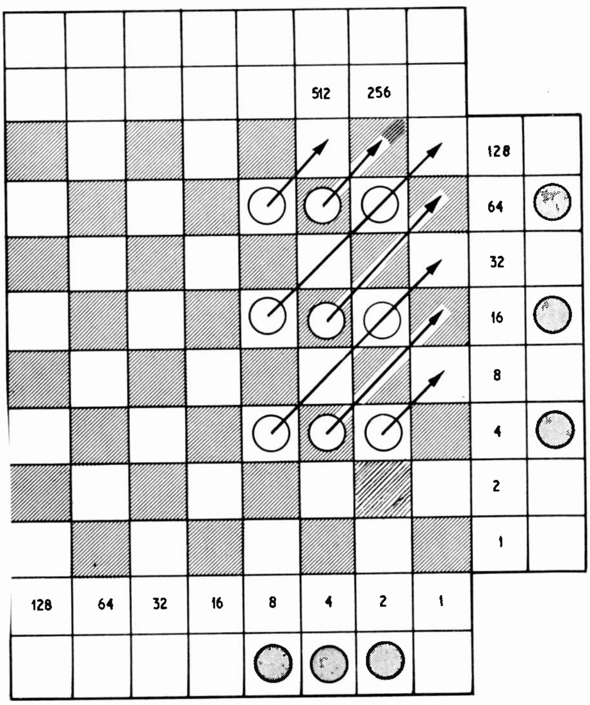


Fig. 3. Move (4) in multiplication

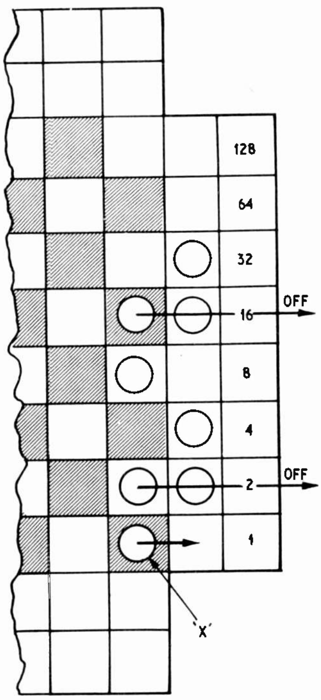


Fig. 4. Arrangement of counters at start of subtraction. Notice the position of the X counter

Table 1: MOVES FOR 54 − 27

	Counter X		Nearest counter above X			Fill in space(s)
Move	Left	Right	From	To	Remove at	
1		X	4	2	—	NIL
2	X		8	4	—	2
{3		X	—	—	2	—
{4	X		—	—	2	—
5		X	32	16	—	8, 4, 2
6	X		4	2	—	NIL
{7		X	—	—	2	—
{8	X		—	—	2	—
9		X	4	2	—	NIL

(2) 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 1 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 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.

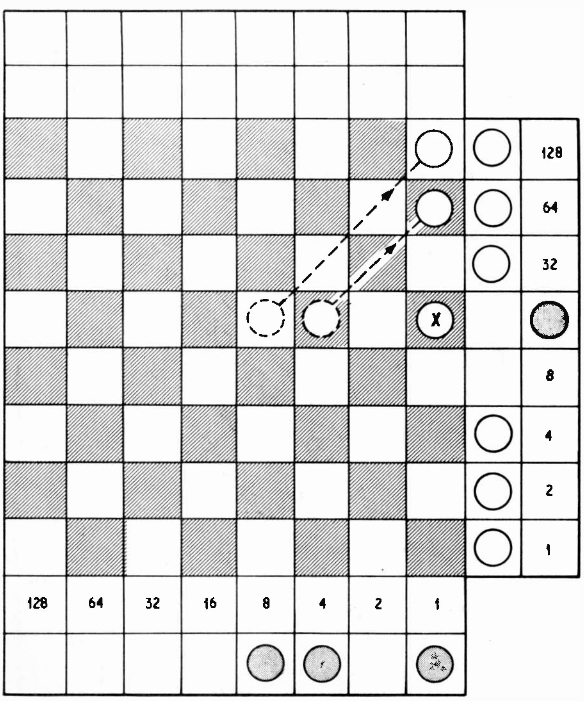


Fig. 5. Move (4) in division

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 ÷ 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.

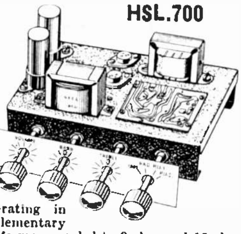
(6) Place a counter in the square immediately next to the highest side counter 16 and repeat as at (2), (3), and (4) above. This time, however, you will be unable to subtract as above, since the values of the counters on the left are higher than those in the margin. The routine in cases such as this 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.

★

MONO TRANSISTOR AMPLIFIER HSL.700



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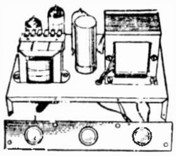

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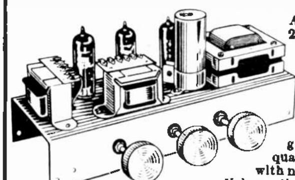

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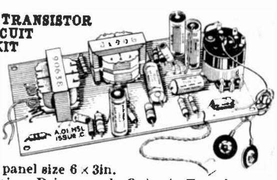

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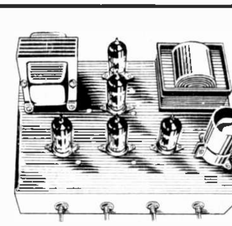

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A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment according to its merit.

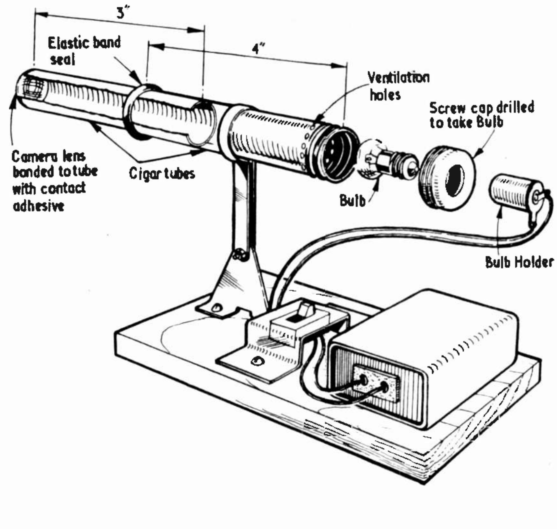


Fig. 1. Light source for light operated switch

ADJUSTABLE LIGHT SOURCE

WHILST 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.

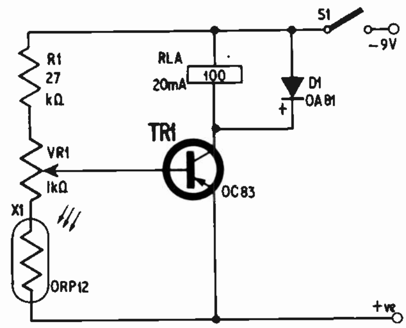


Fig. 2. Relay circuit

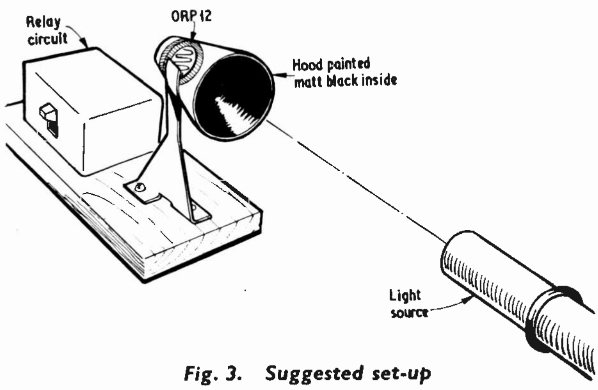


Fig. 3. Suggested set-up

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 VR1, 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 VR1 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 5μs.

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.

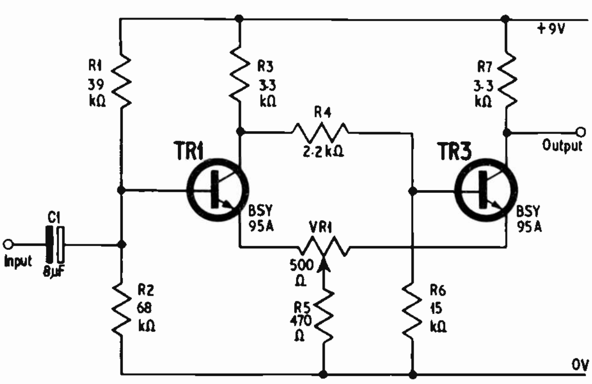
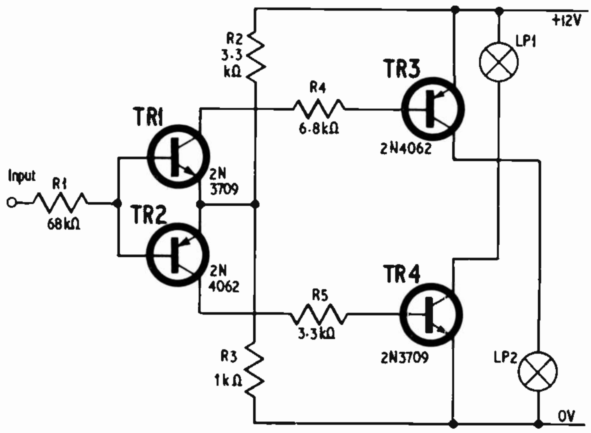


Fig. 1. Circuit diagram of the improved Schmitt trigger

LOGIC PROBE



I 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.

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

M.A.C.

ELECTRIC CLOCK WITH 25 AMP SWITCH

Made by Smith's, these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only **39/6**, less than the value of the clock alone—post and insurance 2/9.

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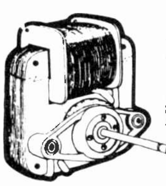
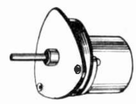
MAINS MOTOR



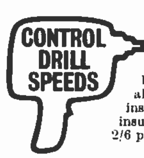
Precision made — as used in record decks and tape recorders—ideal also for extractor fans, blower, heater, etc. New and perfect. Snip at **9/6.** Postage 3/- for first one then 1/- for each one ordered. 12 and over post free.

INSTRUMENT MOTORS WITH GEARBOX



Made by famous Smiths Company. Very powerful, although only quite small. Overall dimensions approx. 1¼in. deep by 2in. dia. Following models available please specify required speed. Revs per day, 2-8-12. Revs per hour, 1, 2, 4, 6, 12, 20,30. Revs per minute, 1, 2, 3, 4, 6, 8, 15, 30, 60. **17/6** each.

DRILL CONTROLLER



Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions, **19/6** plus 2/6 post and insurance. Made up model **37/6** plus 2/6 p. & p.

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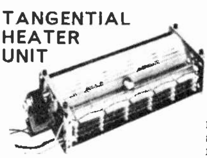
2 poles	6/6	6/6	6/6	6/6	6/6	6/6	10/6	10/6
3 poles	6/6	6/6	6/6	6/6	10/6	10/6	14/6	14/6
4 poles	6/6	6/6	6/6	10/6	10/6	10/6	18/6	18/6
5 poles	6/6	6/6	10/6	10/6	14/6	14/6	22/6	22/6
6 poles	6/6	10/6	10/6	10/6	14/6	14/6	26/6	26/6
7 poles	6/6	10/6	10/6	14/6	18/6	18/6	30/6	30/6
8 poles	10/6	10/6	10/6	14/6	18/6	18/6	34/6	34/6
9 poles	10/6	10/6	14/6	14/6	22/6	22/6	38/6	38/6
10 poles	10/6	10/6	14/6	18/6	22/6	22/6	42/6	42/6
11 poles	10/6	14/6	14/6	18/6	26/6	26/6	46/6	46/6
12 poles	10/6	14/6	14/6	18/6	26/6	26/6	50/6	50/6

TANGENTIAL HEATER UNIT



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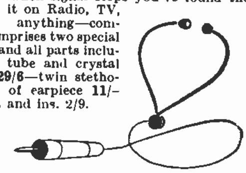

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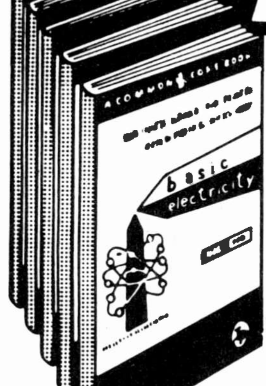

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BC114	7/5	300R	47/-	NKT163	5/4	OA95	1/6	ZT86	27/6	2N1306	6/6	2S304	15/-
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BC116	9/-	BY125	3/6	NKT165	5/8	OA202	2/-	IN23A	20/-	2N1308	8/-	2S322	8/-
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BC138	12/-	ME4103	6/-	NKT674	6/-	OC203	8/3	IN914	4/-	2N2148	12/6	40362	16/3

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4V	8	32	64	125	250	400
6.4V	6.4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2.5	10	20	40	80	125
25V	1.6	6.4	12.5	25	50	80
40V	1	4	8	16	32	50
64V	0.64	2.5	5	10	20	32
Price	1/6	1/3	1/2	1/-	1/1	1/2

MIN. POLYESTER CAPACITORS. Printed circuit type 250 Vdc working. 0.01, 0.015, 0.022, 7d each; 0.033, 0.047, 8d each; 0.068, 0.10, 9d each.

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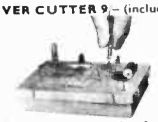

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10A	8/-	12/6	13/6	16/6	16/6	19/6	23/-	30/-
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MC790P	Dual JK Flip Flop	32/6
MC792P	Triple 3 Input Gates	17/6
MC799P	Dual Buffer	29/6

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L914 Dual Gate	11/-	9/6	8/4
L923 JK Flip Flop	14/-	12/6	11/9
L709 Operational Amplifier	27/6	23/-	21/-

Quantity Prices on Application

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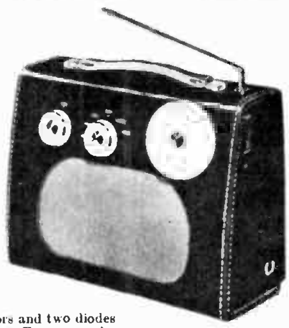

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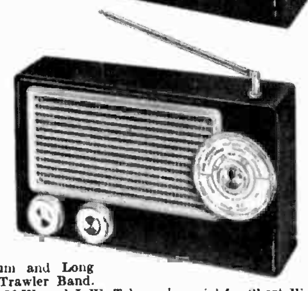

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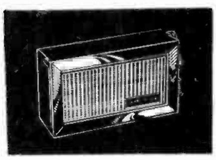

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transona five

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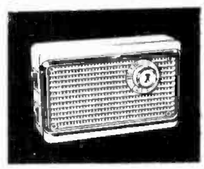

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roamer six

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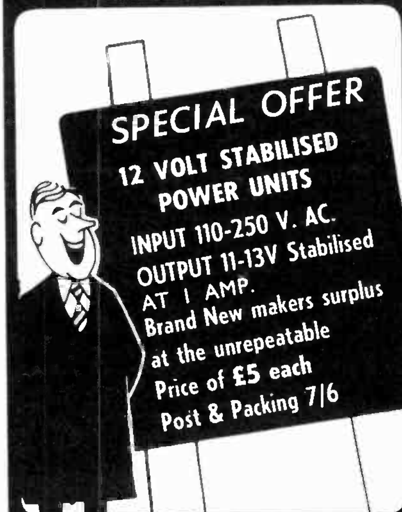

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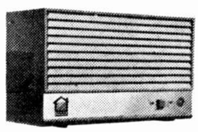

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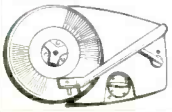

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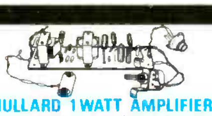

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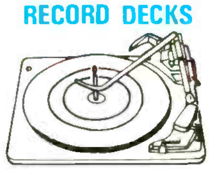

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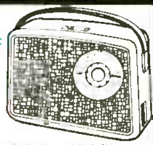

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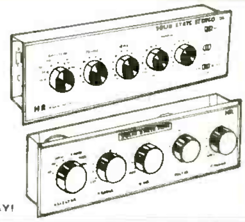

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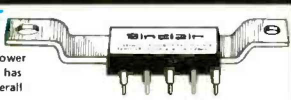

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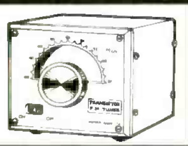

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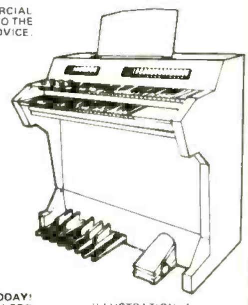

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