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JUNE 1967

PRICE 2/6

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A magnificent triple speaker assembly containing a high flux 15″ unit for no compromise bass, and the new

MID RANGE & TWEETER MODULE

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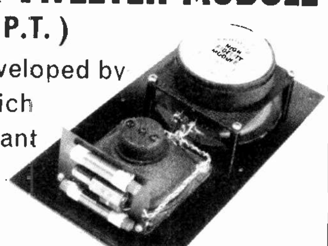
which has been developed by the same team which produced the brilliant High Fidelity Module.



THE SARABANDE OFFERS THE FINEST VALUE OBTAINABLE IN THIS PRICE RANGE OF LOUDSPEAKERS

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For 110 v. equipment. Input 240 v., output 110 v., 3,000 watts. Completely enclosed in strong metal case. Terminal block output. **£15**, carr. 15/-.

2,000 watts. Enclosed in case fitted with two 2-pin American sockets or terminal blocks. Neon indicator. On/off switch and carrying handle. **£10.19.6**, carr. 10/-.

Also available. Completely shrouded, fitted with 2-pin American sockets, or terminal blocks. Please state which type required.

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500	£3.15.0	6/6
300	£2.9.6	5/6
150	£1.19.6	4/6
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Type B84-9-1 w. F.W. bridge. Max. A.C. input 162 v. D.C. output 140 v. 2½ amps., **57/6.** P.P. 5/-. Type B67-9-1 w. 1½ amps. output. **37/6.** P.P. **5/-**. Type D84-4-3 w. Two required for F.W. Bridge. Max. A.C. input 72 v. D.C. output 60 v. 8 amps., **50/-** per pair. P.P. 5/-.

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MOST TYPES, FULLY SHROUDED AND TERMINAL BLOCK CONNECTIONS.
ALL PRIMARIES 220-240 VOLTS

*** Denotes Unshrouded Types**

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1C	25-33-40-50	6	£4 19 6	7/6
1D	25-33-40-50	3	£2 19 6	6/–
2A	4-16-24-32	12	£5 7 6	7/6
2B	4-16-24-32	8	£4 2 6	7/6
2C	4-16-24-32	4	£2 12 6	6/–
2D	4-16-24-32	2	£1 15 0	5/–
3A*	25-30-35	40	£12 15 0	15/–
3B*	25-30-35	20	£7 19 6	9/6
3C	25-30-35	10	£5 10 0	7/6
3D	25-30-35	5	£3 5 0	6/–
3E	25-30-35	2	£2 7 6	4/6
4A*	12-20-24	30	£9 15 0	10/–
4B	12-20-24	20	£5 19 6	8/6
4C	12-20-24	10	£3 19 6	7/6
4D	12-20-24	5	£2 15 0	6/–
5A	3-12-18	30	£7 5 0	7/6
5B	3-12-18	20	£5 9 6	7/6
5C	3-12-18	10	£3 5 0	6/–
5D	3-12-18	5	£2 5 0	5/–
6A	48-56-60	2	£2 17 6	4/6
6B	48-56-60	1	£1 19 6	4/6
7A*	6-12	50	£7 15 0	9/6
7B	6-12	20	£4 10 0	7/6
7C	6-12	10	£2 19 6	6/6
7D	6-12	5	£2 2 6	5/–
9A	15-30	1½	19 6	4/6
10A	1-15	2	19 6	4/6
11A	6-3	15	£1 17 6	5/6

Note: By using the Intermediate Taps many other voltages can be obtained. Example:

Range One 7-8-10-15-17-25-33-40-50 v.

Range Two 4-8-12-16-20-24-32 v.

Range Five 3-6-9-12-15-18 v.

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Switch contacts 15 amp. 250 v. A.C., complete with chrome bezel and control knob. Min. operation time, 30 seconds, max. 4 minutes, brand new **17/6**, p.p. 2/6.

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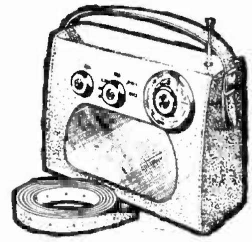
NEW ROAMER SEVEN Mk IV



7 WAVEBAND PORTABLE OR CAR RADIO

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

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

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

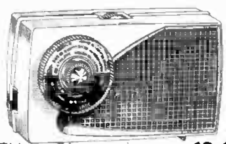
The perfect portable and the ideal car radio. (Uses PP7 batteries, available anywhere.)

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

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

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

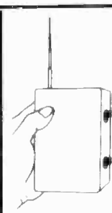
NEW MELODY MAKER SIX

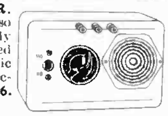


● **8 stages — 6 transistors and 2 diodes** Covers Medium and Long Waves and Extra Band for EASIER tuning of LUXEMBOURG, etc. Top grade 3in. Loudspeaker for quality output. Two R.F. stages for extra boost. High 'Q' 6in. Ferrite Rod Aerial. Approx. 350 Milliwatts push pull output. Handsome pocket size case with gilt fittings. Size 6¼ × 3¾ × 1½in. (Uses long-life PP6 battery).

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

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



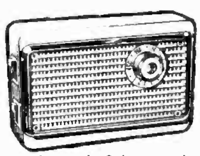


QUICK CHECK TRANSISTOR TESTER. Checks gain of R.F. and Audio Transistors. Also checks for noise level and duds. All parts ready to be assembled in attractive grey case with red grille, complete with Dial, Knobs, and Dynamic Speaker. Simple assembly instructions free with set of parts. **29/6.** P. & P. 2/6.

FAULT TRACER. A versatile Signal Injector. Something no constructor should be without. This ingenious device generates an audible signal through the Audio and R.F. ranges. With variable output. Telescopic Probe. Pocket size slim line case measures 4¾ × 3¼ × ¾in. Complete set of parts with full instructions. **19/6.** P. & P. 2/-.

NOW WITH 3IN. SPEAKER !

NEW TRANSONA FIVE



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

● **7 stages—5 transistors and 2 diodes**

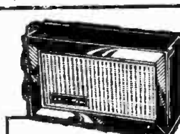
Fully tunable over Medium and Long Waves. Incorporates Ferrite rod aerial, tuning condenser, volume control, new type fine tone super dynamic 3 in. speaker, etc. Attractive case. Size 6¼ × 4¼ × 1½in. with red speaker grille. (Uses 1289 battery available anywhere.)

● **Extended M.W. band for easier tuning of Luxembourg etc.**

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

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

POCKET FIVE *NOW WITH 3in. SPEAKER!*



● **7 stages—5 transistors and 2 diodes.**

Covers Medium and Long Waves. On test Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and fine tone 3 in. moving coil speaker, built into attractive black and gold case. Size 5½ × 1½ × 3½in. (Uses 1289 battery, available anywhere.)

● **Extended M.W. band for easiert uning of Luxembourg etc.**

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

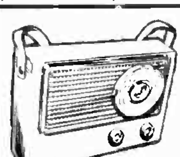
Parts Price List and easy build plans 1/6 (FREE with Kit)

STOP PRESS!

Pocket 5 Med and Long wave version with miniature speaker

29/6 P. & P. 3/-

NEW ROAMER SIX



NOW WITH PHILCO MICRO-ALLOY R.F. TRANSISTORS

● **6 WAVEBAND !!**

● **8 stages—6 transistors and 2 diodes**

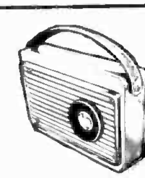
Listen to stations half a world away with this 6 waveband portable. Tunable on Medium and Long Waves, Trawler Band and two Short Waves. Sensitive Ferrite rod aerial and telescopic aerial for short waves. Top grade transistors. 3-inch speaker, handsome case with gilt fittings. Size 7½ × 5½ × 1¾in. (Carrying Strap 1/6 extra.)

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

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

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

TRANSONA SIX



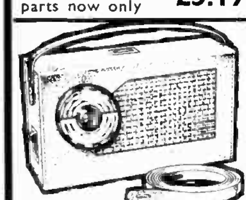
● **8 stages—6 transistors and 2 diodes**

This is a top performance receiver covering full Medium and Long Waves. High-grade 3in. speaker makes listening a pleasure. Push-pull output. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6¼ × 4¼ × 1½in. (Uses PP4 battery available anywhere.) Carrying Strap 1/- extra. ● **Extended M.W. band for easier tuning of Luxembourg etc.**

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

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

MELODY SIX



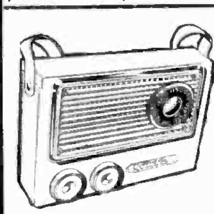
● **8 stages—6 transistors and 2 diodes**

Our latest completely portable transistor radio covering Medium and Long Waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. Ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208 and many Continental stations. Handsome leather-look pocket size case, only 6¾ × 3¼ × 1⅞in. approx. with gilt speaker grille and supplied with hand and shoulder straps.

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

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

SUPER SEVEN



● **9 stages—7 transistors and 2 diodes**

Covers Medium and Long Waves and Trawler Band. The ideal radio for home, car, or can be fitted with carrying strap for outdoor use. Completely portable—has built-in Ferrite rod aerial for wonderful reception. Special circuit incorporating 2 RF Stages, push-pull output, 3in. speaker (will drive large speaker). Size 7½ × 5½ × 1½in. (Uses 9v battery, available anywhere.)

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

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

Callers side entrance Barratts Shoe Shop.

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EB34	1/6
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EF73	5/-
EF74	4/-
EF80	5/-
EF85	4/6
EF86	6/6
EF89	5/-
EF91	3/6
EF92	2/-
EF95	5/-
EF95	5/-
EF183	6/6
EF184	6/6
EH90	7/6
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EL41	8/-
EL42	8/-
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EL81	8/-
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EL84	4/3
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EL91	4/6
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PCL83	8/6
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PL36	9/-
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PL81	7/-
PL82	6/6
PL83	6/-
PL84	6/6
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PY81	5/6
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TP22	5/-
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U81	8/-
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U18	6/-
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6F7	6/-
6F17	5/-
6F8G	6/6
6F12	4/6
6F13	5/-
6F32	4/-
6F33	20/-
6G6G	2/6
6H6GT	1/9
6H6M	1/6
6J4WA	10/-
6J5	6/-
6J5G	2/-
6J6	3/6
6J6W	6/-
6J7G	5/-
6J7M	8/-
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6K7G	2/-
6K7GT	4/9
6K8G	3/-
6K8GT	8/3
6K8M	8/6
6L5G	6/-
6L6GA	7/6
6L7G	4/-
6L34	3/-
6LD20	5/9
6N7	6/-
6N7G	5/9
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6R7	5/6
6SA7	7/-
6SA7GT	6/6
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6SC7	7/-
6SC7GT	5/-
6SF5GT	5/6
6SH7	3/6
6SJ7	5/-
6SJ7GT	5/6
6SJ7Y	6/6
6SK7	5/6
6SL7GT	5/6
6SN7	3/6
6SQ7GT	6/-
6SS7	2/-
6V6G	5/-
6V6GT	7/6
6V6M	8/-
6X4	3/6
6X5G	5/-
6X5GT	5/3
6Y6G	6/-
6-30L2	8/6
6Z4	5/-
7B7	7/6
7C5	10/-
7C6	7/-
7C7	6/-
7H7	7/3
7Q7	7/-
7V7	5/-
7Y4	8/-
7Z4	4/6
8D2	2/6
9D2	3/-
9D6	2/-
10F9	9/-
12A6	2/6
12AH7	5/-
12AT6	5/-
12AT7	4/-
12AT7WA	5/6
12AU7	5/-
12AV6	5/6
12AX7	6/-
12AY7	10/-
12BA6	5/6
12BE6	7/-
12BH7	7/-
12C8	3/-
12H6	2/-
12J5GT	2/6
12J7GT	6/6
12K7GT	2/-
12K8M	10/-
12Q7GT	3/3
12SA7	4/6
12SC7	4/-
12SG7	3/-
12SH7	3/-
12SJ7	5/-
12SK7	5/-
12SN7GT	5/9
12SR7	5/-
12Y4	2/-
14L7	7/-
14S7	18/-
15D2	6/-
20P4	12/6
21B6	7/-
25L6GT	5/6
25Y5	6/-
25Z4G	6/6
25Z5	7/6
25Z6GT	8/6
28D7	6/-
30	5/-
30C15	10/-
30C18	11/-
30F5	8/6
30FL1	10/6
30FL12	19/-
30FL13	6/-
30FL14	13/-
30L15	15/-
30P12	9/-
30P19	13/-
30PLI	15/-
30PL13	15/-
35L6GT	7/-
35T	17/6
35W4	5/-
35Z3	10/-
35Z4GT	6/-
35Z5GT	6/-
37	4/-
38	4/-
50CD6G	27/6
50L6GT	8/-
53A	7/6
57	6/-
58	6/-
59	6/-
75	5/6
76	5/-
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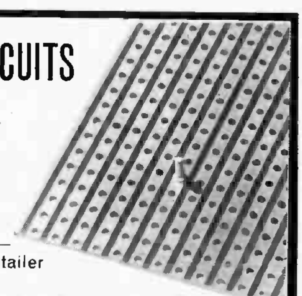

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VOL. 3 No. 6
JUNE 1967

PRACTICAL ELECTRONICS

COMMON GROUND

MANY interesting facts are revealed through readers' letters. One point that frequently comes to light is that many newcomers make their very first acquaintance with do-it-yourself electronics because of their interest in some other quite different and seemingly unrelated hobby or pastime.

It is not hard to imagine how such introductions first come about. . . . The amateur photographer decides to build an electronic flashgun to keep up with his more affluent friends with their commercial equipment; the motorist, alert to the dangers of contemporary acquisitive society, decides to install a car alarm system; the amateur horticulturist realises the benefits to be derived from a remote temperature monitoring system for the greenhouse, particularly on those cold winter evenings. Even the more sedentary individual who normally asks nothing more than to be left alone in peace in his armchair with a book or television set as sole companion, suddenly awakens to the fact that a doorphone intercom unit could save all that bother of plodding to the front door on what are often fruitless missions.

Yes, these are representative of some different characters with widely differing ideas as to how best to spend their spare time. But they all can share common ground in amateur electronics.

Some of our new friends will limit their excursion into constructional activities strictly to the one project in mind. Others, the far larger proportion, we trust, will suddenly see the light: what a shame to ignore all the countless other possibilities of using electronics around and about the house. Not that they need become fanatics at the game, to the exclusion or detriment of any other hobby or interest; indeed home constructed electronic devices can enhance the scope and enjoyment of so many other spare time pursuits.

Furthermore, as committed electronics constructors, they will be brought into touch with an even wider range of non-vocational activities as illustrated by the specialised applications of the projects featured regularly in these pages. That common ground may well prove exceedingly fertile—in more ways than one.

THIS MONTH

CONSTRUCTIONAL PROJECTS

VIDEO PATTERN GENERATOR 415
DIAL-A-NAME GAME 420
MODEL CONTROL INSTALLATIONS 432
C.R.O. TRACE DOUBLER 443

SPECIAL SERIES

COMPUTER EVOLUTION—2 425
THE ELECTRONIC ORGAN—7 439

GENERAL FEATURES

PRESS-FIT TERMINALS 414
INGENUITY UNLIMITED 429
FIELD EFFECT TRANSISTORS 448

NEWS AND COMMENT

EDITORIAL 413
MEETINGS 438
BOOK REVIEW 442
ELECTRONORAMA 446
THE 73 PAGE 456
MARKET PLACE 459
DETACHED PARTICLES 463
READOUT 464

Our July issue will be published on Friday, June 16

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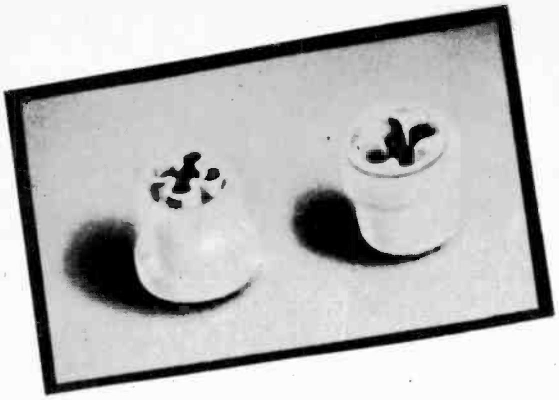


Another wiring technique for the constructor using

PRESS-FIT SOLDERING TERMINALS

OF THE many forms of circuit wiring now open to amateurs and laboratory technicians, each has its inherent advantages.

This month we feature Sealectro "Cloverleaf" press-fit soldering terminals which can be used with Lektrokit perforated chassis plates No. 7 or can be mounted as required on plain aluminium plates.

The "cloverleaf" is a sub-miniature p.t.f.e. insulated press-fit, feed through terminal. P.T.F.E., otherwise known by the trade names of "Teflon" or "Fluon" has an extremely high insulation resistance, and the capacity to withstand large temperature variations.

Although rather costly, this method gives a neat appearance and is particularly suitable for h.f. work.

FITTING THE TERMINALS

The insulators are very slightly tapered so that they are wedge fitted into pre-punched tapered holes in the chassis plates. Two projects are described on pages 415 and 443 using this method, but in order to illustrate the full details of mounting, the photographs on this page show the terminals being mounted on plain aluminium sheet.

The pre-punched plates are ideal for prototype or breadboard circuit assemblies; the components can be simply positioned on the plate so that their junction points are established. These points coincide with the terminals. Modifications or changes can easily be made for optimum component density; since the system lends itself to above and below chassis wiring, a considerable reduction in circuit area can be affected.

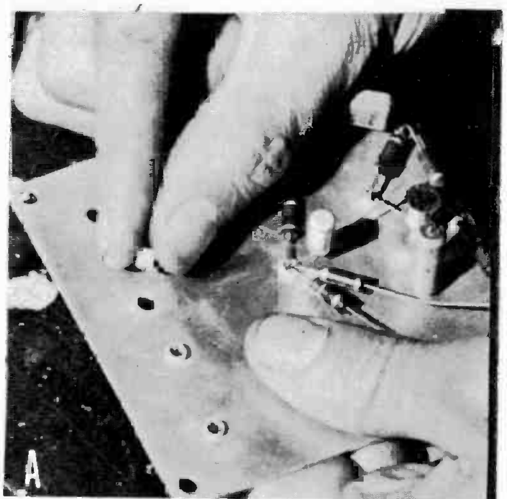
If one intends using a plain 18 s.w.g. aluminium sheet or chassis the circuit components should be laid out the same as in the pre-punched system to establish the junction points. (It is a good idea to sketch a rough plan on paper.) These should be marked with a scriber and holes drilled at these points with a No. 29 drill. The tapered entry for the terminal is achieved by lightly countersinking this hole half-way through the sheet with a No. 22 drill. The p.t.f.e. inserts should then be press fitted into position as in Photo. A.

WIRING

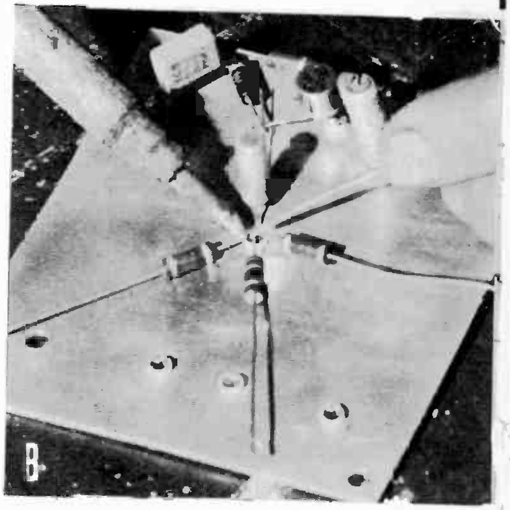
Each "cloverleaf" junction will accommodate four components or wiring leads, with a centre hole for an additional length of 21 s.w.g. bare tinned copper wire.

Soldering is a simple procedure as the "cloverleaf" provides capillary channels so that the solder flows easily when the iron is applied (Photo B). The photographs at the bottom of the page show close up, the soldered components on the board (C) and a cut-away view of a plate (D) with a terminal and components fitted.

The terminals and chassis plates are obtainable from Home Radio (Mitcham) Ltd.



A



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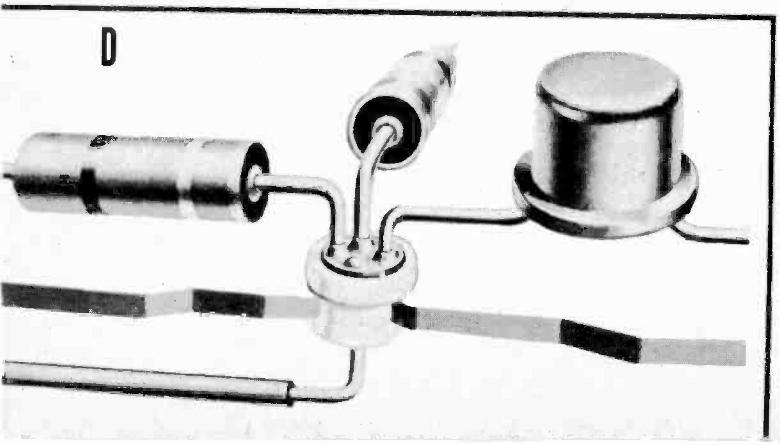

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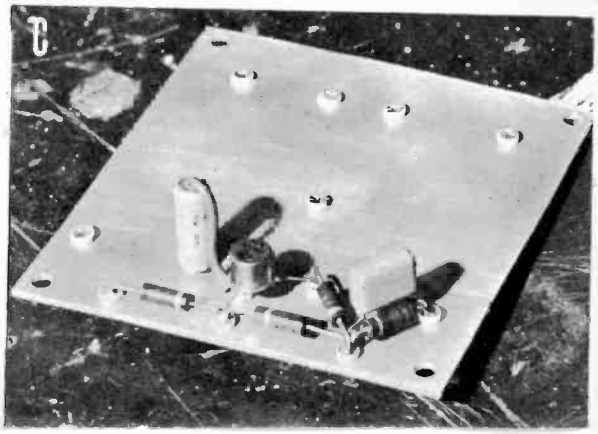
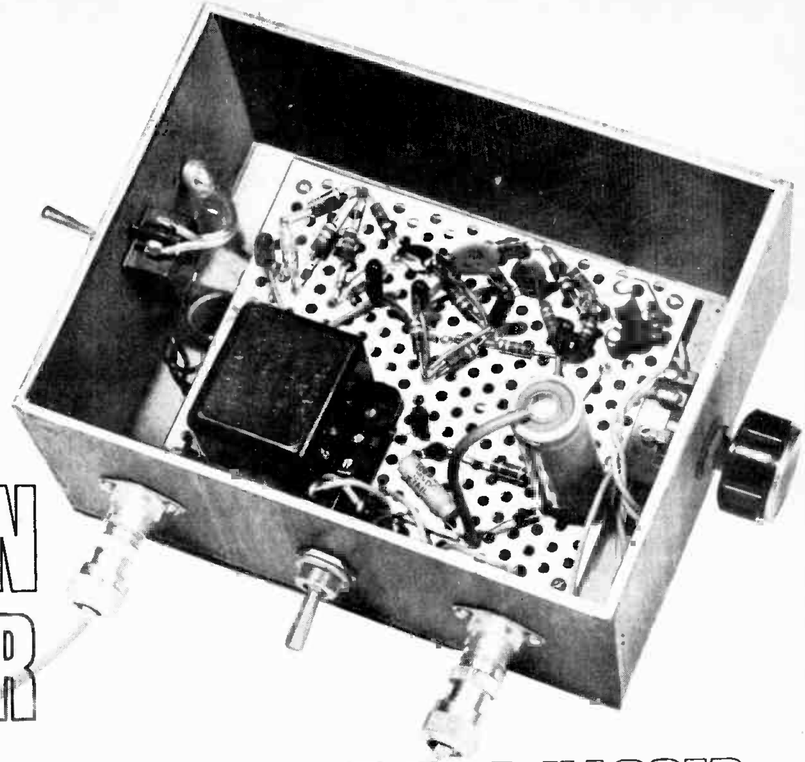


C

VIDEO PATTERN GENERATOR



By J.E. KASSER

THIS simple piece of equipment can be used to provide a pattern on the screen of a television receiver, showing vertical bars. It is suitable for use with such sets that have been converted to receive standard one volt peak-to-peak video signals.

A brief introduction of the theory of pulse circuitry is given in this article, but the reader should consult text books for a fuller explanation of how the various circuits, used in this piece of equipment, work.

PULSE WAVEFORM

The waveform required for displaying vertical lines is a pulse waveform that is synchronised to the line frequency or is capable of locking itself to the line frequency. The block diagram is shown in Fig. 1.

Fig. 2 shows a video pulse waveform. On the 405-line system, the top of the pulse is at the white level, while the bottom is below the black level. The two intermediate levels are shades of grey, the lower one being the darker. The portion of the wave below the black level can be used to lock the signal into the timebase of the receiver if it is of the order of the line timebase frequency.

The waveform generated in an astable multivibrator is given in Fig. 3a. Pulses from this free running square wave generator pass into a bistable multivibrator where it is converted to a castellated waveform (Fig. 3b) which is a factor of the frequency of the pulses in Fig. 3a. This waveform is 1 volt peak-to-peak (the standard video signal).

The number of "battlements" on the castellated waveform is controlled by VR1, which can give from two to about fifty "battlements" per half-cycle. Each "battlement" is of a fixed time duration, and changes the repetition frequency of the wave (Fig. 3c and 3d), and thus the number of bars seen on the screen. It will be found that adjustment of VR1 will lock a picture with say four bars, then with further adjustments the picture goes out of lock, then locks again with three bars.

If the bistable multivibrator divides on both the positive and negative half-cycles of the original frequency a "staircase" waveform (Fig. 3e) would result. This would give rise to bars of different tones of grey from white to black being shown on the screen.

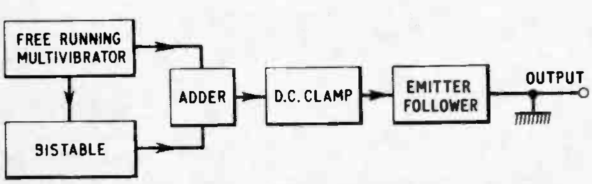


Fig. 1. Block diagram of the video pattern generator

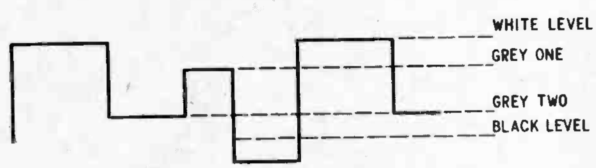


Fig. 2. A typical video monochrome pulse waveform

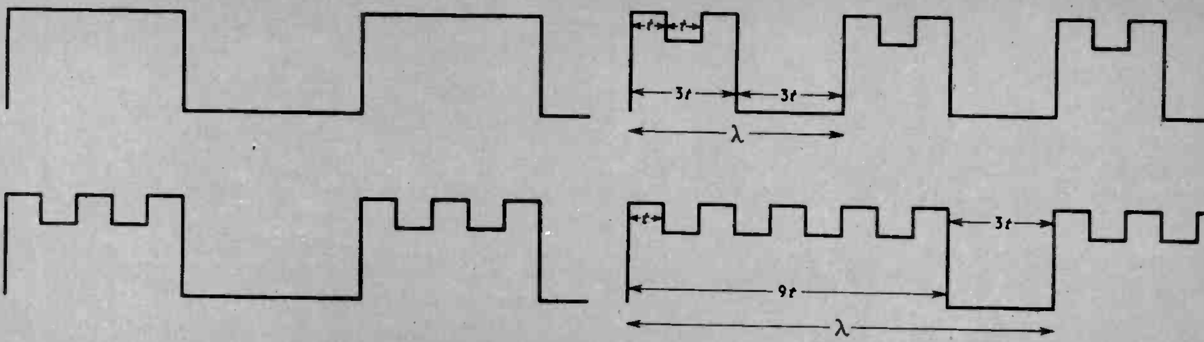
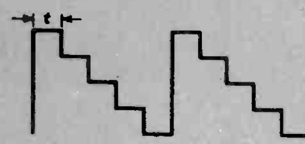


Fig. 3. Square wave conversion to video pattern waveform

3a (top left). Output from the astable multivibrator

3b (lower left). Castellated by the bistable multivibrator



3c (top right). Two "battlements" per half wave. λ = 6t

3d (lower right). Five "battlements" per half wave. λ = 12t

3e (left). Staircase waveform

It would give the same effect as viewing colour bars on a monochrome receiver (see photographs).

The astable or free running multivibrator generates a symmetrical square wave at approximately 21·6kHz which is a little more than twice the standard 405-line frequency (10·125kHz). The circuit (Fig. 4) is conventional; the frequency is controlled by C1 and R2.

Since $t \simeq 0{\cdot}7(R_2C_1 + R_3C_2)$

and $R_2C_1 = R_3C_2$

$$t \simeq 1{\cdot}4R_2C_1$$

but $f = \frac{1}{t} = \frac{1}{1{\cdot}4C_1R_2}$

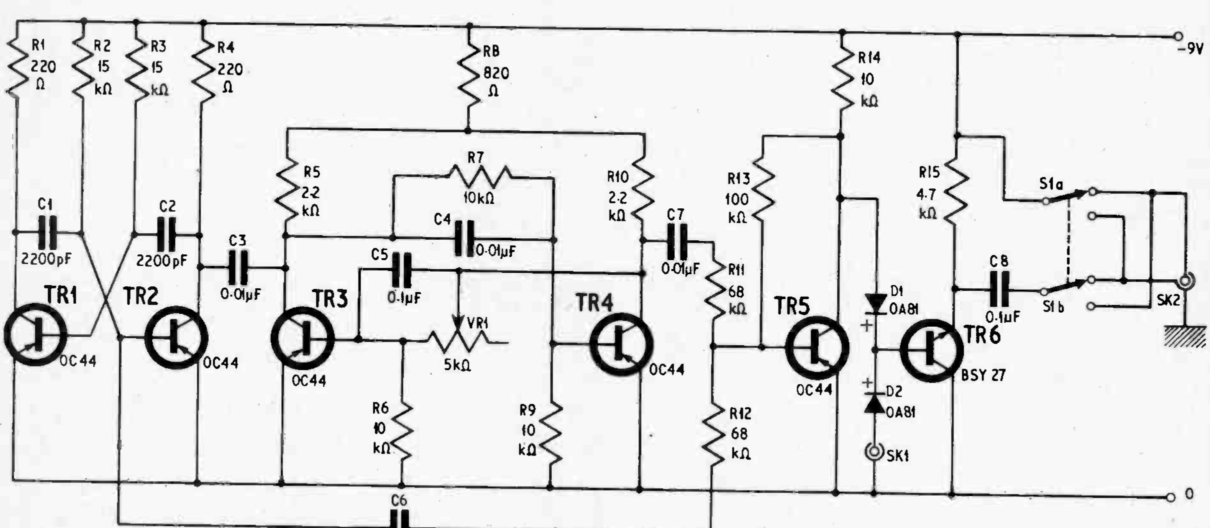
Circuit values are, C_1 is 2,200pF and R_2 is 15 kilohms.

$$\text{Therefore } f = \frac{10^{12}}{1{\cdot}4 \times 2{,}200 \times 15 \times 10^3}$$

$$f \simeq 21{\cdot}64\text{kHz}$$

In theory, the value of C_1 and C_2 would have to be 2,353pF to give a frequency of exactly twice the 405-line standard frequency, but 2,200pF is the nearest preferred value and is close enough.

Trigger pulses are taken from TR2 to the bistable multivibrator. The bistable operates on half the original frequency, i.e. at approximately 10·8kHz. Its rate of division is altered by VR1. This alters the time constant of the circuit and the mark/space ratio.



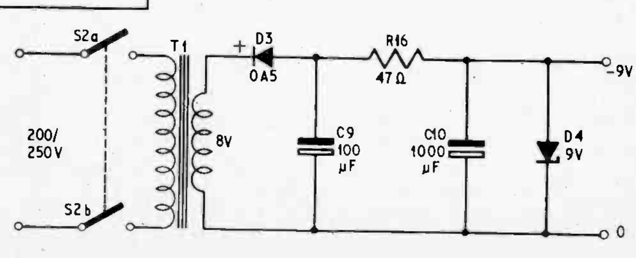


Fig. 4. Complete circuit diagram of the video pattern generator and power unit

ADDER

The outputs from the astable and bistable multivibrators are combined in the adder circuit of TR5. Fig. 5 shows an adder circuit, the gain of which is the ratio R_{13}/R_{12} where R_{11} and R_{12} provide the two inputs and determine the level of voltage injected into the transistor, for assuming a unity stage gain, i.e. $R_{13} = R_{12}$ (resistor R_{14} is R_L in Fig. 4).

$$v_0 = -\frac{R_{13}}{R_{12}}(v_1 + v_2)$$

the negative sign showing a 180 degree phase shift.

The values of R11, R12, R13, and R_L have been calculated to give a 1 volt peak-to-peak output waveform. R11 and R12 can be varied. This will vary the level of each waveform, and will change the shade of the bars seen on the screen. From the collector of TR5 the signal passes through D1, which clamps it to "earth" level (earth being zero volts in this part of the circuit). The clamping process clips the negative going pulse on the output waveform as shown in Fig. 6.

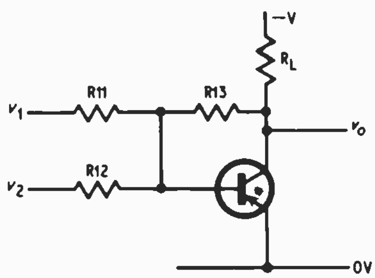


Fig. 5. Basic adder circuit of TR5

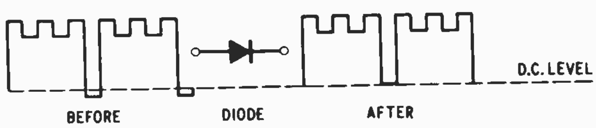


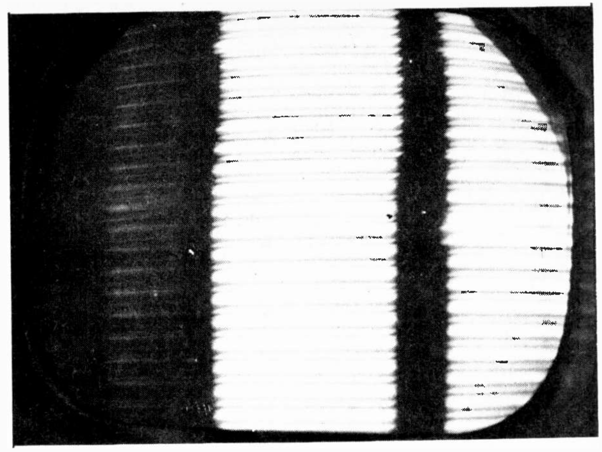
Fig. 6. Effect of clipping negative pulses at the output from TR5

TR6 is an *npn* transistor used as an emitter follower, and is biased by the current flowing through the diode D1. Frame sync pulses can be inserted into the waveform via SK1 and D2. This will enable the frame timebase of the receiver to be tested.

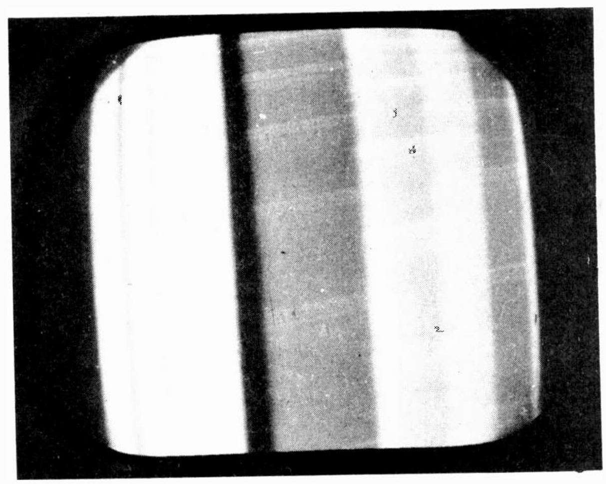
The high frequency transistor used for TR6 ensures a fast rise time on the waveform, and sharp transistions from black to white can be seen. If TR6 is a BSY18, BFY27, BSY27, etc. the fast rise time is an advantage, but an OC139 should work just as well. The output from the emitter follower is taken via a 0·1μF capacitor C8 to the phase reversal switch. This enables the signal to be changed from peak white to peak black.

The unit can be made up quite compactly on a piece of perforated board or Lektrokit chassis plate No. 7 using Sealectro press-fit terminals. Figs. 7 and 8 show the layout. Full instructions are given on page 414.

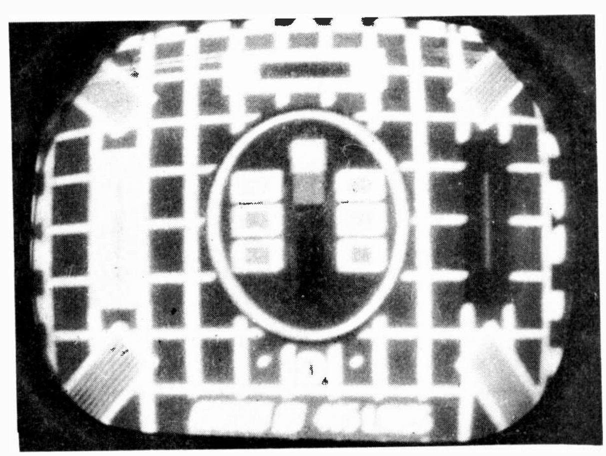
The photographs, taken direct from the television screen, show that different effects may be seen by adjusting VR1, S1 and the line hold control (line timebase frequency) on the receiver. Test Card D gives some idea of the definition of the picture compared with the pattern generator bars.



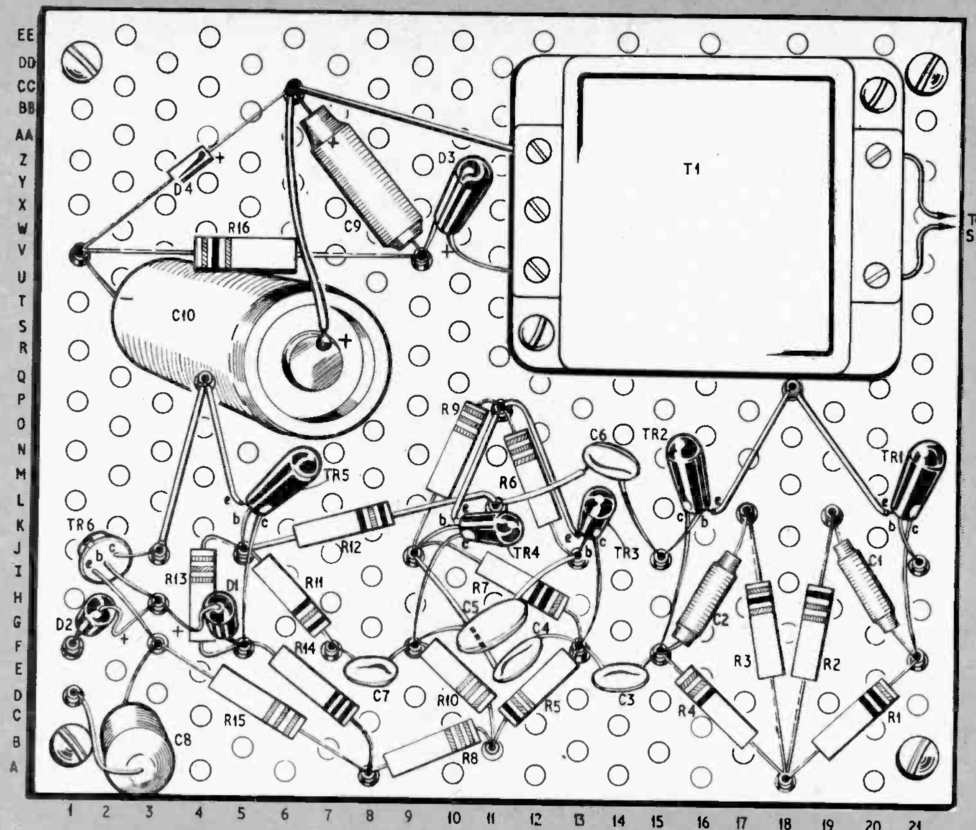
Two pattern bars of horizontal lines shown on the screen. The number of bars is determined by the setting of VR1



Graduated tones from black to white provided by the staircase waveform when the bistable multivibrator divides on both positive and negative half cycles



This picture of Test Card D (405 lines) shows poor definition and non-linearity



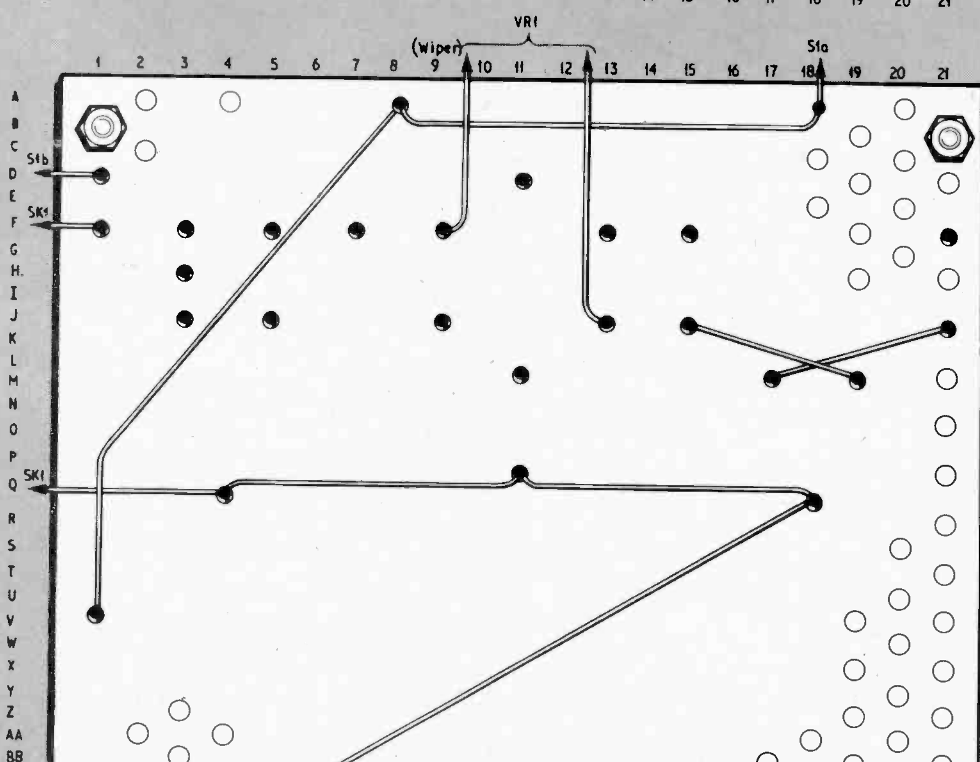


Fig. 7. Top and underside views of the perforated aluminium chassis plate No. 7

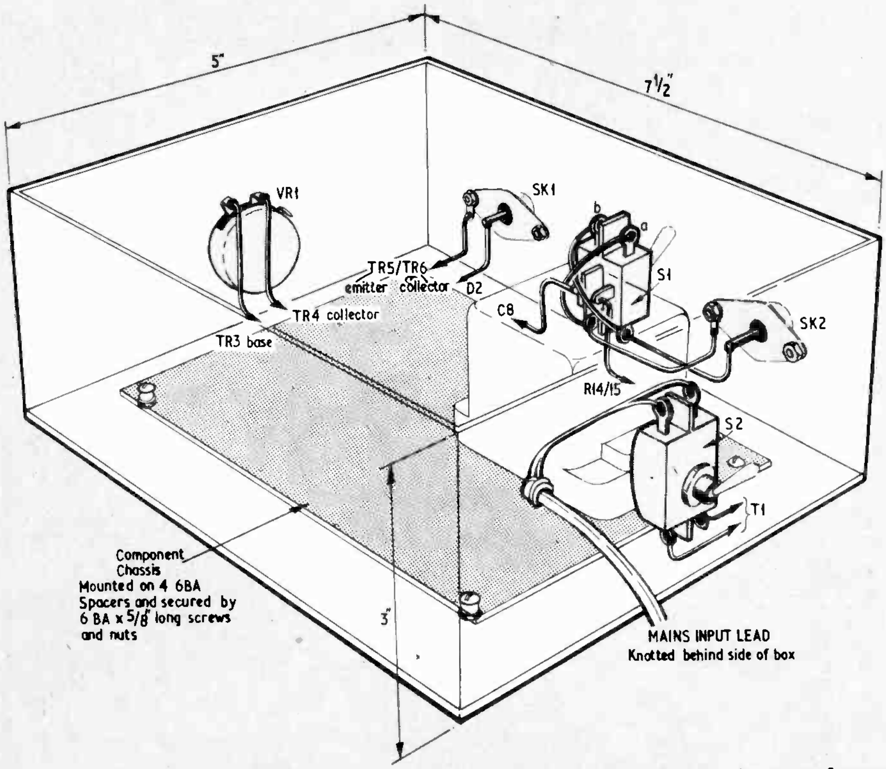


Fig. 8. Layout of components in the box

COMPONENTS . . .

Resistors

R1	220Ω	R9	10kΩ
R2	15kΩ	R10	2·2kΩ
R3	15kΩ	R11	68kΩ
R4	220Ω	R12	68kΩ
R5	2·2kΩ	R13	100kΩ
R6	10kΩ	R14	10kΩ
R7	10kΩ	R15	4·7kΩ
R8	820Ω	R16	47Ω

All 10%, ½ watt carbon

Potentiometer

VR1 5kΩ linear carbon

Capacitors

C1 2,200pF polyester 500V
C2 2,200pF polyester 500V
C3 0·01μF disc ceramic 30V
C4 0·01μF disc ceramic 30V
C5 0·1μF disc ceramic 20V
C6 0·01μF disc ceramic 30V
C7 0·01μF disc ceramic 30V
C8 0·1μF disc ceramic 20V
C9 100μF elect. 15V
C10 1,000μF elect. 15V

Transistors

TR1 to 5 OC44 *or* OC42 (5 off) (Mullard)
TR6 BSY27 (Mullard)

Diodes

D1, 2 OA81 (2 off)
D3 OA5
D4 OAZ 247 *or* ZF9·1 (9V Zener)

Transformer

T1 Pri. 200–250V; see 8V (Bell transformer)

Switches

S1 Double-pole, 2 way toggle switch
S2 Double-pole, on/off toggle switch

Sockets

SK1, 2 Coaxial sockets with plugs

Miscellaneous

Press-fit "cloverleaf" terminals (Sealectro)
Chassis Plate No. 7 (Lektrokit)
(Home Radio (Mitcham) Ltd.)

On some settings of the controls white horizontal lines will be obtained equispaced on the picture to allow one to set the linearity controls.

The unit can be used to test video stages of receivers, transmitters, monitors, etc. and for the budding television "ham" produces an inexpensive electronic test pattern.

The power supply to the generator (9V d.c.) is fairly critical as a higher voltage will not allow the capacitors to charge up properly, and will upset the waveforms in all parts of the circuit. As the unit draws 35mA a mains power pack should be used; Fig. 4 shows a simple one that can be used. D4 is a Zener diode which stabilises the supply to 9 volts. ★

Dial-a-Name Game

By. R. Maker

HERE is a novel idea which can give endless amusement, especially at a party or similar larger gathering. With the summer months rapidly approaching this game would be a great attraction at summer fêtes.

The purpose of the game is to score points which are derived from a system of coding for the letters of the alphabet. An element of handicap of sorts is introduced by giving certain letters a "buzz" code. These are shown in Table 1. The numerical and "buzz" codes can be altered to suit the individual, providing allowance is made on the wiring.

CODE COUNTING

Table 2 shows how the code is applied to some examples of christian names. The numbers corresponding to the name letters are added together, but a buzz code, when applicable, cancels all numbers that have gone before.

If two consecutive buzz codes apply, as in "MARY" the cancellation is void, so the previous numbers *do* count. In this case the name has two buzz letters R and Y; this provides a handicap in reducing the number of "counting" letters.

Each letter of each christian name is dialled (using the centre dial scale) against the initial letter of the surname on the outer scale. Let us take an example: JOHN PETER BROWN.

First dial J on the centre scale until it aligns with B on the outer scale. Press the button to indicate in the right-hand boxes what is scored. In this example it will be BUZZ (no score). Likewise dial the second letter O against B and score BUZZ again.

The next letter H will score 50 and N will score 60. The second name PETER will score respectively 4, 2, 750, 2, BUZZ. The last letter BUZZ cancels all that has gone before so the rather disappointing result for this example is nil.

Table 1: CODED LETTERS TO SCORE

A = 3	J = BUZZ	S = 40
B = 8	K = 10	T = 750
C = 30	L = 500	U = 7
D = 200	M = 5	V = 250
E = 2	N = 60	W = 6
F = 1,000	O = BUZZ	X = 6
G = 20	P = 4	Y = BUZZ
H = 50	Q = 1	Z = BUZZ
I = 9	R = BUZZ	

Table 2: EXAMPLES OF CODED NAMES

J = BUZZ	R = BUZZ	J = BUZZ	D = 200
A = 3	O = BUZZ	O = BUZZ	A = 3
N = 60	B = 8	A = 3	V = 250
E = 2	E = 2	N = 60	I = 9
T = 750	R = BUZZ		D = 200
	T = 750		
815	750	63	662

M = 5	J = BUZZ	P = 4	F = 1,000
A = 3	O = BUZZ	E = 2	R = BUZZ
R = BUZZ	H = 50	T = 750	E = 2
Y = BUZZ	N = 60	E = 2	D = 200
		R = BUZZ	
8	110	0	202

CASE CONSTRUCTION

The case must be constructed first; it is made in two identical halves 18in × 11in × 2in. The sides are made from planed wood 2in × ½in; 9ft will be needed for the two halves. The top and bottom boards are made from hardboard 18in × 11in.

The bulb compartment is built up on the top by screwing a frame of wood to the hardboard lid. This frame is made from strip wood 1½in × ⅜in and is 10½in long, 9in wide, and 1½in deep.

Each bulb holder (m.e.s.) is screwed to the lid in five rows of four. Holes are drilled adjacent to the terminals of all lampholders for the connecting wires to pass through.

Build up a box around each holder, 1½in deep, so that the light from one box does not leak through to another. Flat pieces of white card are glued on top of each holder to reflect the light upward. It is necessary to bore a hole in the centre of each piece of card so that the bulbs can pass through to be fitted into the holders.

DIAL MECHANISM

Leave this part of the construction for a while and make the dial mechanism. The rotating dialling disc is 6in diameter; 25 finger holes, ½in diameter and $\frac{11}{16}$in between each hole centre, are drilled around the periphery of the dial. It is best to drill these holes before cutting out the final shape of the dial, which might be plywood, s.r.b.p., or hardboard. The centre hole in the dial is drilled to accept a Meccano rod 4½in long. Secure the rod to the dial by using a Meccano face plate with boss.

Next comes the fitting of the 7½in diameter wood disc on top of the case. This has the outer scale of letters of the alphabet, although these letters could be stuck straight on the box after finishing. The centre holes of both the dial and disc are concentric and are 5in from the front (handle) side and 4½in from the left-hand side of the box.

Having assembled the dial, face plate and 4½in rod, pass this rod through the centre hole of the disc and through the case lid. On the inside of the case lid another disc is cut to mount the contact strips, there being 25 copper strips each 1in long and ½in wide bent round the periphery of this disc at equal distances apart. This disc is screwed on to two wood battens 2in × ⅜in × 10in.

Mount four 2in wooden pillars 1in square on the battens as shown so that they are close to the disc. Two braces are mounted on the ends of the pillars, these being Meccano strips arranged so that two holes coincide with the 4½in rod in the centre of the disc. The rod is passed through this hole. Screw the battens to the inside of the lid.

Fit a bossed face plate to the 4½in rod and bolt to it a copper strip made as a wiper to track over the copper contacts.

Going back to the lamp display compartment on the right of the lid, wire the bulbs to the correct copper contacts according to the circuit diagram.

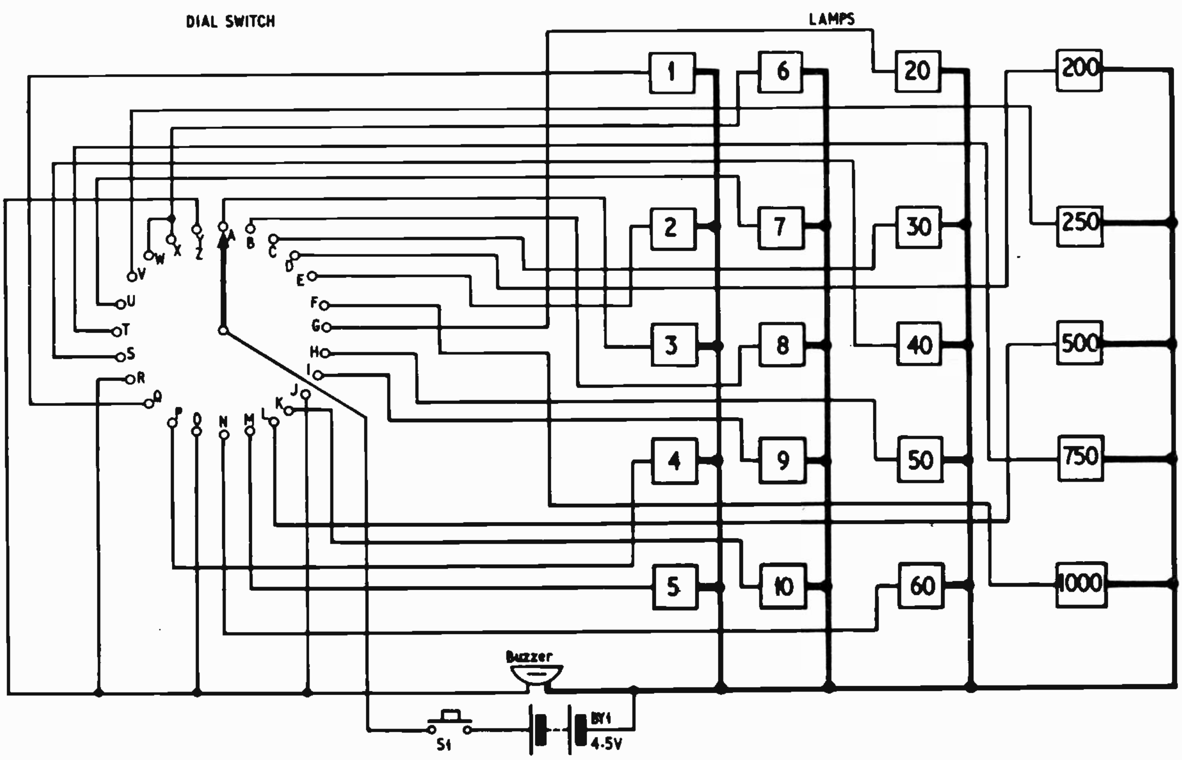
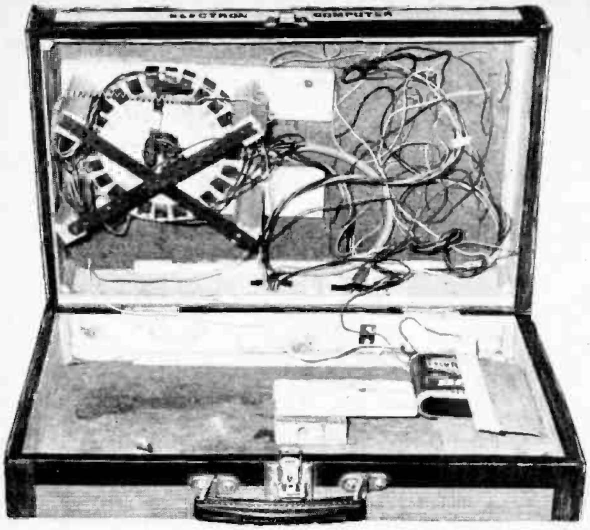
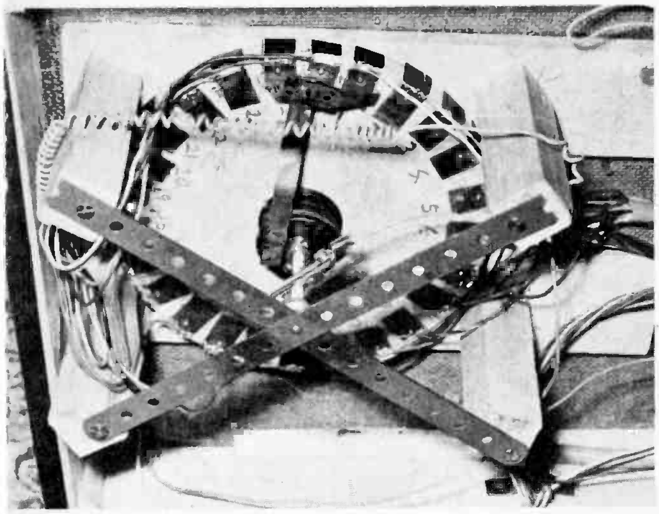


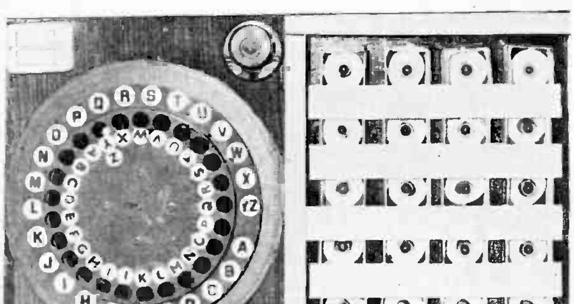
Fig. 1. Complete circuit and wiring of the "Dial-a-name" game



General view of the open case. The dial contacts and wiper are on the left and wiring to the lamps on the right. The $4\frac{1}{2}$V flat pack battery is held firmly in the bottom of the case



Close-up view of the dial switch mechanism. Contact to the wiper is made by the crocodile clip on the metal spindle which is held in position by the coincident holes in the Meccano strips



A rocker switch and buzzer are mounted on top of the case. The lampholders are fitted on the top right-hand side and shrouded by cardboard compartments

COMPONENTS and MATERIALS . . .

CASE

Wood 2in × $\frac{1}{2}$in planed, 9ft long
Hardboard 18in × 11in (2 off)
Attache case handle and fastener
Hinges $1\frac{1}{2}$in long (1 pair)
Decorative adhesive plastics sheet
Quadrant section wood $\frac{3}{4}$in (6ft) for corner strengthening

DIAL ASSEMBLY

DIAL—Sheet s.r.b.p., plywood or hardboard $\frac{1}{8}$in thick, 6in diameter
LETTER DISC—Plywood $\frac{1}{4}$in thick, $7\frac{1}{2}$in diameter
CONTACT DISC—Plywood $\frac{1}{2}$in thick, 6in diameter
BATTENS—Wood strip 2in × $\frac{3}{8}$in (2ft)
PILLARS—Wood strip 1in square (1ft)
CONTACTS AND WIPER—Copper strip $\frac{1}{2}$in wide (3ft)
DIAL ROD—Meccano rod $4\frac{1}{2}$in long (1 off)
BRACES—Meccano strips $7\frac{1}{2}$in long (2 off)
ROD ATTACHMENTS—Meccano face plates (No. 109) $1\frac{1}{2}$in diameter (3 off)
LETTERS—Alphabet transfers or sticky labels (2 off each)

LAMP COMPARTMENT

WOOD FRAME—Wood strip $1\frac{1}{2}$in × $\frac{3}{8}$in (39in)
CLAMP FRAME—Angle aluminium $\frac{3}{4}$in (39in)
LAMPHOLDERS—M.E.S. batten type (20 off)
LAMPS—3·5V m.e.s. torch bulbs (20 off)
LAMP BOXES—White card sheet
COVER—Translucent Perspex sheet $10\frac{1}{2}$in × 9in and transparent non-inflammable acetate sheet $10\frac{1}{2}$in × 9in
MASKING—Black plastics masking tape

MISCELLANEOUS

Buzzer, 4 volt d.c. type
Switch, single-pole on/off push button or rocker
Battery, $4\frac{1}{2}$V flat pack
Wire, p.v.c. covered, single core

The lamp compartment is now covered by a sheet of Perspex, preferably translucent. The number transfers are stuck on the Perspex in the right positions. Black masking tape is stuck down to the Perspex between the numbers. To protect these numbers, fit a sheet of non-inflammable celluloid on top of the Perspex and clamp both in place by screwing an angle aluminium frame round the edge to the wooden frame.

All that remains now is to complete the wiring, including the buzzer and switch. A crocodile clip is used to make contact with the wiper by clipping to the rod. Finish of the complete case by covering with adhesive plastics sheet and fix the letters to the dial and disc. ★

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HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
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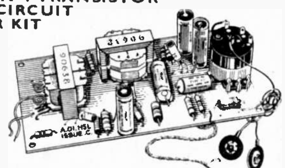

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- Built on printed circuit panel, size 6 x 3in.
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- Output transformer tapped for 3 ohm and 15 ohm speakers.
- Transistors (GET 114 or 81 Mullard OC81D and matched pair of OC81 o/p).
- 9 volt operation.
- Everything supplied, wire, battery clips, solder, etc.
- Comprehensive easy to follow instructions and circuit diagram 1/6 (Free with Kit). All parts sold separately.

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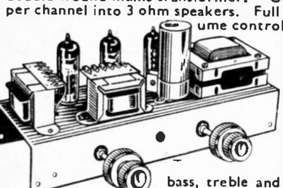

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TWIN TELESCOPIC AERIAL. Two 3-section heavily chromed rods. Closed 12-in. each extending to 32 in. Completely adjustable. Universal mounting bracket, coax lead and plug. Ideal for F.M. or T.V. 12/6. P. & P. 2/6.

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A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 3in. d. x 6in. h. Ready built and tested. **PRICE 69/6.** P. & P. 6/-.
ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. **PRICE 89/6.** P. & P. 7/6.

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Uncut motor board size 14½in. x 12in. clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD Autochanger or Single Player Unit (except AT60 and SP25). Size 18in. x 15in. x 8in. **PRICE £3/9/6.** P. & P. 9/6.

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

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E.M.I. 8 in. x 5 in. with high flux magnet 21/-.
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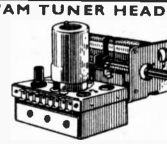

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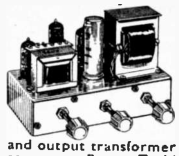

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The HA34 has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc., wired and tested for only **£4.5.0** P. & P. 6/-.

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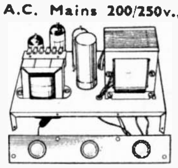
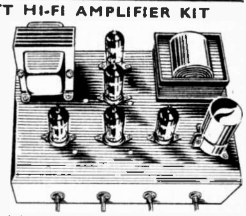


★ Heavy duty double-wound mains transformer with electrostatic screen. ★ Separate Bass, Treble and volume controls, giving fully variable boost and cut with minimum insertion loss. ★ Heavy negative feedback loop over 2 stages ensures high output at excellent quality with very low distortion factor. ★ Suitable for use with guitar, microphone or record player. ★ Provision for remote mounting of controls or direct on chassis. ★ Chassis size only 7½ in. wide x 4 in. deep. Overall height 4½ in. ★ All components and valves are brand new. ★ Very clear and concise instructions enable even the inexperienced amateur to construct with 100% success. ★ Supplied complete with valves, output transformer (3 ohms only), screened lead, wire, nuts, bolts, solder, etc. (No extras to buy.) PRICE 79/6. P. & P. 6/-.
Comprehensive circuit diagram, practical layout and parts lists 2/6 (free with kit).
This kit although similar in appearance to HA34 employs entirely different and advanced circuitry.

10/14 WATT HI-FI AMPLIFIER KIT



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MATCHED PAIR AM/FM I.F.'s. Comprising 1st I.F. and 2nd I.F. discriminator. (465 Kc/s/10.7 Mc/s). Size 1" x 1½" x 2½" H. Will match FM/AM Tuner head on left. 11/- pair. P. & P. 2/-.

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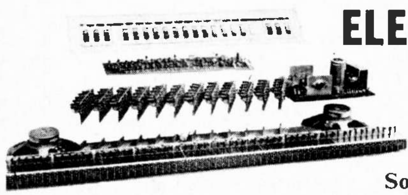

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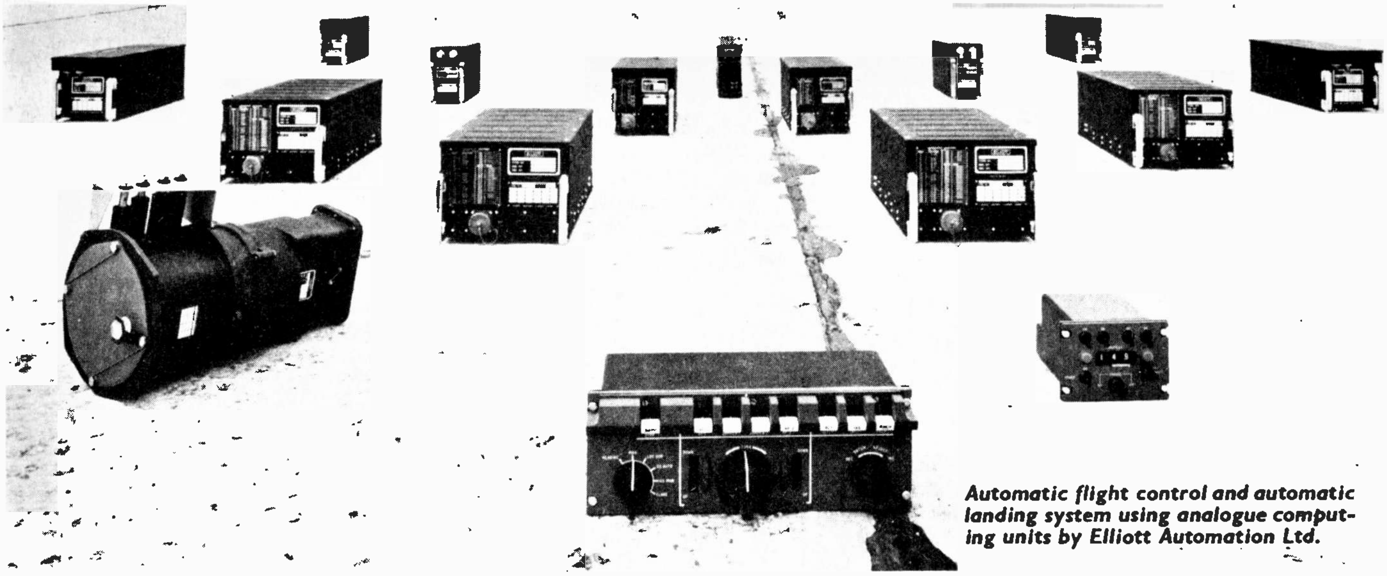
So easy to build, so delightful to play
Suited to all types of music

The Solette. Precision made, pre-tuned units come to you ready to assemble in only 20 hours. Self-contained amplifier and speakers; perfect tone and generous volume, full 5-octave organ keyboard. Five pitches plus solo and melodic bass. Transistorised, portable. Price £118 complete (terms if needed). Details from:

Harmonics (Bromley) Ltd

DEPT. P.E.2, CLARION WORKS, NAPIER ROAD, BROMLEY, KENT. RAVensbourne 2122

★ *Also two-manual and pedal organ kits up to £395.*



Automatic flight control and automatic landing system using analogue computing units by Elliott Automation Ltd.

COMPUTER EVOLUTION

PART TWO

By S. A. HODSON B.Sc.

BASIC ANALOGUE CIRCUITS

In the opening article of this series, the differences between analogue and digital computers were explained, and their early development from simple calculating machines was traced. Now we shall come up to date and look at modern analogue computers and some of their uses.

Two important concepts were described in the previous article. The first of these concepts was that of the "model". It should be obvious that a scale model of a ship or an aeroplane will be a great help in predicting its behaviour when it is built full size.

What may not be so obvious is that, especially in these days of electronics, the model need not be a physical scale model at all, but can be a model made in any medium the modeller likes to use. Of course some media are more direct than others, and it is this that directs the attention to the first means of classification of analogue computers: "Direct" and "Indirect". A scale model of an aeroplane in a wind tunnel is a "direct" computer, whereas an electronic analogue computer, programmed to represent the aeroplane in the air flow, would be an "indirect" computer.

In this case, the electronic computer works by representing the air flow over the aircraft; and it does this by means of mathematical equations that can take into account every bump or curve on its skin. What is perhaps more important is that these equations can be altered to take account of a design change without the aircraft having to be hacked about by a welding torch, in fact the performance of the whole plane can be predicted before hacksaw has touched metal.

These mathematical equations or "functions" as they are more properly called, are the second of the two concepts mentioned above: that of being able to represent any physical occurrence by means of an equation.

COMPUTING MEDIA

There are three main computing media in the field of analogue computing. The first of these is that of mechanics. Scale models are a good example of the direct application of a computing device in this field, while a slide rule serves to illustrate the indirect use of a mechanical device.

The use of the term "computer" about a scale model is not as loose as it may seem. Take for example the case of the model in the wind tunnel. Physical distances and hence velocities have obviously to be scaled, but what about the pressure, the density, and even the composition of the air flowing in the tunnel? These must be scaled too.

A whole science known as "dimensional analysis" has grown up around these scale models, and a lot of time is devoted to the calculation of the correct scaling factors for all the parameters involved in a scale model.

The second medium used in analogue computing is the fluid; here the term fluid includes both liquids and gases, thus embracing the sciences of hydraulics and pneumatics in one term. The fluid medium is mostly commonly used in the direct fashion in scale models of dams and hydroelectric schemes.

It can, however, be used indirectly, and a good example of this is the "electrolytic tank". This device is used mainly in computations involving field theory of one form or another. The details are not important here but the general idea is to have a tank full of an electrolyte and to immerse electrodes in this tank. The arrangement of the electrodes represents the system being investigated, and when they are charged up, the value of the electric field at any point in the electrolyte can be used to calculate the behaviour of the system.

The third, and certainly the most widely used, of the three media that have been mentioned is, of course, that of electronics; and it is the application of this medium that is of interest here.

It should be noted that nearly all the devices described so far can only be used for one purpose. For instance, the model aircraft can only represent one full size machine, any other design will have to have a different model. A computer of this type is known as a "fixed purpose" machine, and as such is limited in its field of operations.

MATHEMATICAL FUNCTION

The great advantage of an electronic computer is that it is a general purpose machine and can be programmed for one job then, when that job is finished, programmed for something entirely different. To achieve this flexibility of operation, the electronic machine works in the realm of the mathematical function, and it is to the explanation of these that the next few paragraphs must be devoted.

Suppose that a capacitor is being charged from a battery, through a resistor. The voltage and current wave-forms will look like Fig. 2.1.

If the graphs of V and I are examined more closely, it will be seen that the actual value of I is directly proportional to the slope of V. That is, near the origin of the graphs, V is sloping upwards quite sharply, and I has a high positive value. As time progresses, V slopes less sharply and the value of I drops away. In mathematical terms this can be expressed

$$I = C\left(\frac{dV}{dt}\right) \qquad (1)$$

where the term dV/dt is used to represent the rate of change of voltage V with time. The operation performed on V to get dV/dt is known as "differentiation". The letter d is an arbitrary symbol of differentiation. Similarly, to get back to V from dV/dt the process used is known as "integration", and may be written thus:

$$V = \frac{1}{C}\int I dt \qquad (2)$$

Two very similar equations can be written to represent the behaviour of an inductor namely:

$$V = L\left(\frac{dI}{dt}\right) \qquad (3)$$

and

$$I = \frac{1}{L}\int V dt \qquad (4)$$

The elongated S sign denotes integration.

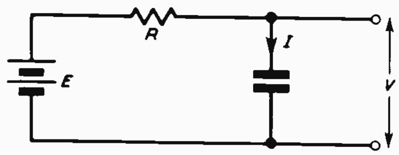
No apology is made for starting at such an elementary point in the theory of functions, since these equations are by far the most important in the realm of analogue computing. It is in fact possible, with these four equations to set up solutions to the most complex differential equations imaginable.

Just as it is possible to differentiate V once and obtain dV/dt, it is equally possible to do it again and end up with d^2V/dt^2.

An easy way of understanding this is to consider a car travelling along a road, and to let the distance it has covered be x miles. Then if x were to be differentiated dx/dt would be obtained which is the velocity of the car in miles per hour. A further differentiation would give d^2x/dt^2 which is its acceleration, in miles per hour per hour, and so on. In just the same manner integration may be performed again and again.

In all these examples the function "time" t has been involved and the differentiations and integrations that have been performed have been done with respect to time. Any computations done with respect to time in this manner would be known as "real time" computations.

A great deal of analogue computing is done with respect to time, although, as will be seen, it need not always be real time that is used. In some cases it is very convenient to use "half time" or "quarter time". This gives a very powerful method of speeding up what may be a tedious calculation.



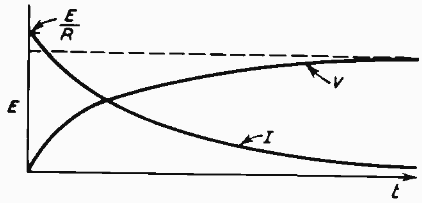


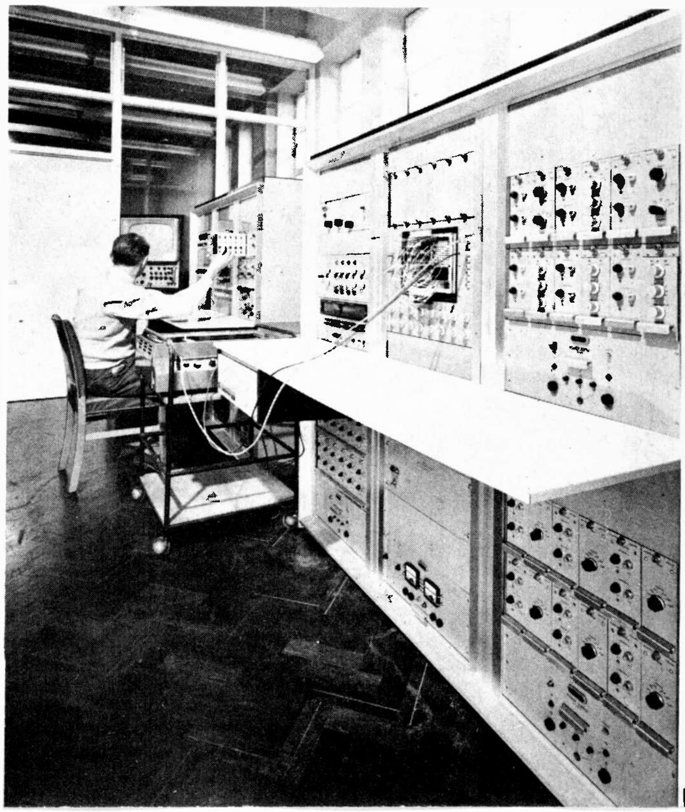
Fig. 2.1. Capacitor charging circuit with voltage and current waveforms

Having described the basic formulae involved in calculus (this is the term used to describe integration and differentiation), it is possible now to turn to the differential equation, which forms the basis of all computations performed on an analogue computer. The general form of such an equation is:

$$a + bx + c\left(\frac{dx}{dt}\right) + d\left(\frac{d^2x}{dt^2}\right) + e\left(\frac{d^3x}{dt^3}\right) + \ldots = 0 \qquad (5)$$

This looks positively frightening, and as it stands, has no solution. However, if it is broken up into its separate terms, it will be seen that each term is no more than one differentiation of the previous term with a different constant attached. When all the terms are added together they might, for instance, represent the flow of air across an aircraft's wing surfaces, or, in a simplified form, they might, as has already been seen in previous equations, represent the behaviour of a capacitor or an inductor.

Solartron analogue computer in use in the electrical and mechanical research laboratories at the University of Sheffield



OPERATIONAL AMPLIFIER

To turn now to the actual hardware involved, the basic linear computing unit is the "operational amplifier" (see Fig. 2.2). The amplifier has a very high gain, and its input current is assumed to be zero.

If this is the case, then $I_1 = I_2$, putting this in another form gives

$$\frac{V_1 - V_g}{Z_1} = \frac{V_0 - V_g}{Z_2} \qquad (6)$$

Now if the gain of the amplifier is in the thousands or even millions, then V_g can be neglected in comparison with V_1 and V_0, and this equation becomes

$$\frac{V_1}{Z_1} = \frac{V_0}{Z_2}$$

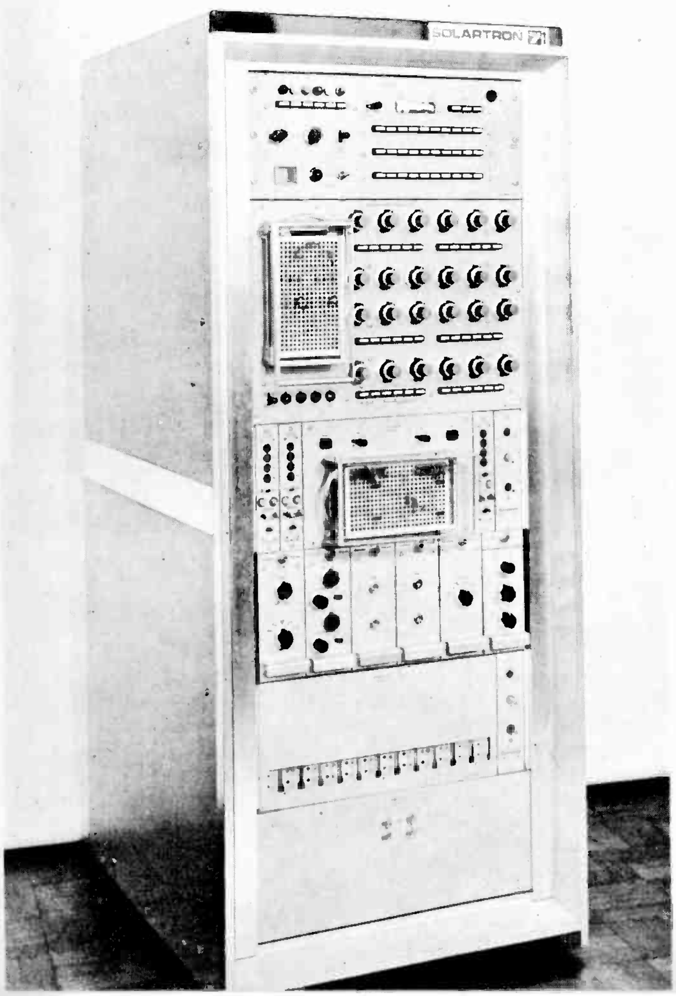
or

$$\frac{V_0}{V_1} = \frac{Z_2}{Z_1} = G$$

where G is the "closed loop" gain of the unit as a whole. Thus the gain of this device can be controlled at will by the user simply by juggling with the two impedances Z_1 and Z_2.

Suppose now that Z_1 was a resistance of 10kΩ and Z_2 a resistance of 100kΩ, then the gain G would be 10 and the output voltage V_0 would be 10 times the input voltage V_1. This is a simple way of multiplying a variable voltage by a constant. In fact it has performed one of the operations required to form equation **5**.

The patch board and analogue control panel on the Solartron basic 24 amplifier equipment



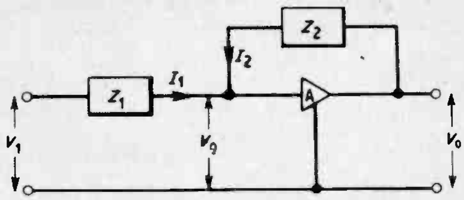


Fig. 2.2. Basic operational amplifier

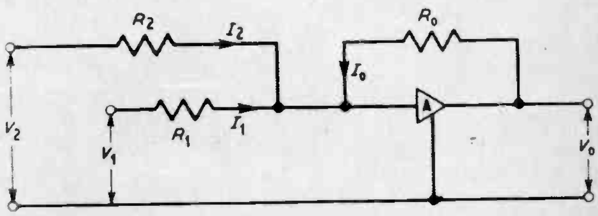


Fig. 2.3. Two inputs fed into a basic amplifier

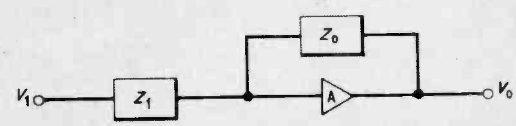


Fig. 2.4. Simplified diagram of an operational amplifier

In the above diagrams A is normally prefixed with a minus sign to denote 180 degrees phase shift

If the input voltage were to represent dx/dt, and $Z_2/Z_1 = c$, then the output voltage will be $C(dx/dt)$; one of the terms in equation **5**.

Consider now what would happen if two inputs were added on to a basic amplifier, as in Fig. 2.3.

Now, using the same assumptions as before,

$$I_0 = I_1 + I_2$$

then

$$\frac{V_0}{R_0} = \frac{V_2}{R_2} + \frac{V_1}{R_1}$$

therefore

$$V_0 = \left(\frac{R_0}{R_2}\right) V_2 + \left(\frac{R_0}{R_1}\right) V_1$$

but R_0/R_2 and R_0/R_1 can be varied independently of each other, and hence it is possible to add two variables together. For instance:

Let

$$V_1 = 1 \quad \text{and} \quad R_0/R_1 = a$$

and

$$V_2 = x \quad \text{while} \quad R_0/R_2 = b$$

then $V_0 = a + bx$, which are the first two terms of equation **5**. It is easy to see how this technique can be extended to accomodate any number of inputs with different multipliers for each one. The only thing that remains now is to be able to differentiate and integrate electronically. Once this is possible, the whole of equation **5** will be constructed from just one input.

The only type of amplifier that has been dealt with so far is that in which the two impedances, Z_0 and Z_1 (see Fig. 2.4) were both resistances.

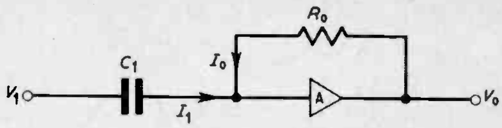


Fig. 2.5. Z_1 is represented by a capacitor

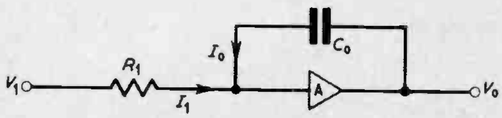


Fig. 2.6. Z_1 is represented by a resistor and Z_2 by a capacitor

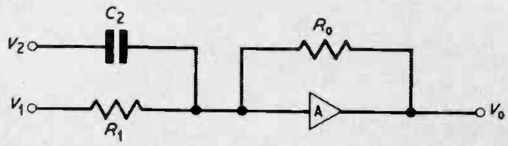
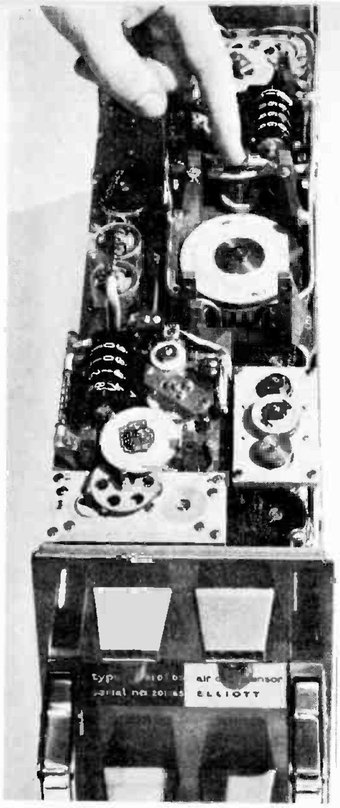


Fig. 2.7. A differentiator C_2 and scaler R_1 are combined

In the above diagrams A is normally prefixed with a minus sign to denote 180 degrees phase shift



Elliott air data analogue computer for aircraft. Signals from the aircraft's sensors are converted for use in flight control

It may have been noted that, in Fig. 2.4, no earth or zero voltage line has been drawn. This is a matter of convenience, and provided that all voltages given on a diagram are given with respect to earth, then no confusion should arise. This makes the drafting of large, more complex circuits, a very much less tedious task.

Having described the results of calling Z_0 and Z_1 resistances, consider now what would happen if one of them, say Z_1, were to be a capacitance, leaving Z_0 as a resistance, as in Fig. 2.5.

Assuming, as before, that the amplifier draws no current at its input, then $I_0 = I_1$
hence, using equation **1**

$$\frac{V_0}{R_0} = I_1 = C_1\left(\frac{dV_1}{dt}\right)$$

or

$$V_0 = R_0 C_1\left(\frac{dV_1}{dt}\right)$$

This means that the output of this type of operational amplifier is directly proportional to the differential of the input. It is now that the possibilities of such an amplifier begin to make themselves felt. Given, say, x in equation **5**, and this may be the distance that a car has travelled as read from its trip-meter, then solely by using a train of differentiators, as in Fig. 2.5, dx/dt, and all the further derivatives of x, may be found. This gives the speed of the car at any one point; also, its acceleration, its rate of change of acceleration, and so on.

Supposing Z_0 and Z_1 were to be interchanged, making Z_0 a capacitance, and Z_1 a resistance, as in Fig. 2.6.

In this case

$$I_0 = I_1 = \frac{V_1}{R_1} = C_0\left(\frac{dV_0}{dt}\right) \qquad (7)$$

Now, remembering that, to get from dV_0/dt to V_0, it is necessary to integrate, it is possible to integrate both sides of equation **7**, and get

$$C_0 V_0 = \int\left(\frac{V_1}{R_1}\right)dt \quad \text{or} \quad V_0 = \frac{1}{C_0 R_1}\int V_1 dt$$

The dt is included to show that the integration has been performed with respect to time.

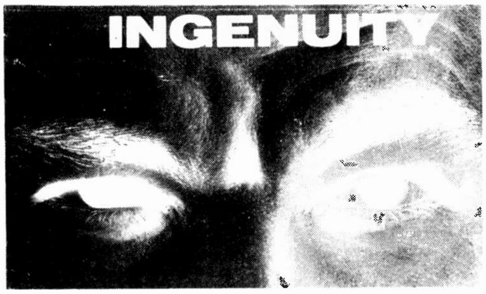
Not only is it possible to differentiate and multiply with an operational amplifier, it is also possible to integrate.

The flexibility of these units is such that they can be mixed up together to give more complex results without having to use large quantities of hardware. For instance, Fig. 2.7 shows how a differentiator and a scaler can be mixed together. This dodge can save two operational amplifiers straight away.

It may have been noticed that nowhere in the preceding paragraphs is an inductor mentioned.

The reason for leaving out the inductor is that in practical circuits for this purpose they are never used. Capacitors are cheaper, smaller, easier to obtain, and more stable than inductors. Furthermore, there just isn't any need for them, since all the functions that are needed can be performed using capacitors alone.

In the next article it is intended to describe how these methods are put to use in practical analogue computers; types of d.c. amplifier that can be used; setting up for computation.



UNLIMITED!

In THIS feature we hope, from time to time, to be able to publish suggestions submitted by some of our readers on the possible improvement of projects previously described in PRACTICAL ELECTRONICS; short contributions on other subjects may be included. The aim is not to find fault or undermine the abilities or knowledge of our contributors. It may well be that the original article is *par exellence* but it could be improved or adapted to suit individual requirements. The views expressed by readers are not necessarily those of the Editor.

AUTOMATIC SWITCHING OF TAPE RECORDERS

There are, of course, alternatives to the method (January 1967 issue) of automatically switching tape recorders. One, basically with less components—and no transistors—is shown in Fig. 1. This unit is simply interposed between the mains supply and the tape recorder. RLA is a Carpenter miniature polarised relay of the twin coil, each-side-stable variety (such as the 5c9, which has 1,600 ohm coils). Coil (b) is connected so that closure of the watch contacts pulls the relay armature "in". It will, of course, remain "in" after the watch contacts have opened again.

Coil (a) is connected so that the circuit completed by the tape foil moves the armature "out". So long as the armature is "in" RLB is energised, completing the mains circuit to the tape recorder. Although, normally, the unit will not be used a vast number of times, the loads switched by the watch contacts and RLA contacts are each inductive and it would be desirable to suppress arcing by wiring a resistor (50–100 ohms) and a capacitor (0·05–0·1μF) in series across each pair of contacts as shown.

Provided the recording period is to exceed the period of closure of the watch contacts (about 35 minutes) a very short piece of tape foil will result in switching off the mains supply to the recorder. One of the short self-adhesive metallic tabs available from some photographic dealers, fixed temporarily to the back of the tape, will do the job simply and conveniently if the tape deck contacts are suitably arranged. Motor over-run will take the tab past the contacts so that the unit ceases to draw current.

For shorter recordings, a good electrolytic capacitor (say 200μF) in series with coil (b) of RLA will allow a "pulse" (whilst the capacitor charges through the coil) to move RLA armature "in", after which only a minute leakage current will flow—not enough to prevent the foil tab moving the armature "out" again at the required time. Obviously the leakage current will continue to flow only until the watch contacts open.

Since the unit draws current only during the period of watch contact closure or the period of the recording—whichever is the longer—consideration could well be given to battery operation, dispensing with a step-down transformer which would continue to be "alive". Either way, the d.c. operating voltage is dictated by RLB: the Carpenter relay of the type mentioned, when in good mechanical adjustment, is capable of operation on less than half a volt and little more than a quarter of a milliamp—which means that each coil could have a quite large series resistance, if desired, to keep consumption to a minimum.

If operation via a transformer and rectification is preferred, the circuit of Fig. 2, which uses an additional relay, has the advantage of shutting off the mains supply to both transformer and tape recorder at the end of the recording. Operation is fairly obvious. Depressing the push-button or microswitch (of the biased-off type) closes the mains circuit to the transformer. Rectified low voltage then energises RLC through RLA contacts, and RLC contacts preserve the mains supply to the transformer when the push-button is released.

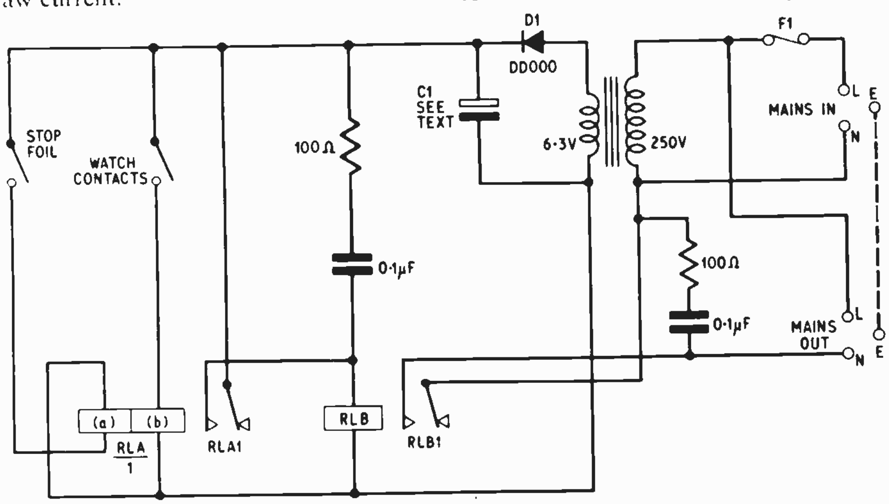


Fig. 1. Simple tape recorder switch using a Carpenter relay

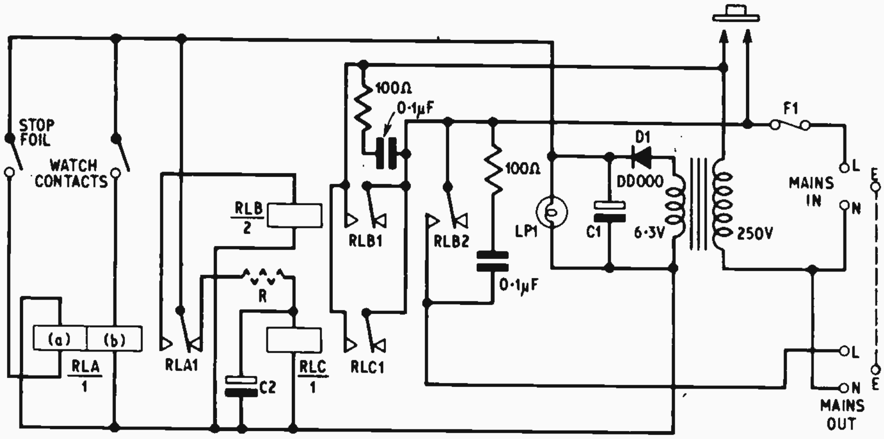


Fig. 2. Improved version of circuit in Fig. 1 to switch off the mains supply at the end of recording

The pilot lamp (which also has another function mentioned later) indicates that the unit is set.

When the watch contacts close, RLA contacts change over, energising RLB in place of RLC, but discharge of the capacitor in parallel with RLC delays its de-energisation long enough for its function to be taken over by RLB, thus preserving continuity of the mains circuit. RLB's second pair of contacts complete the mains supply to the tape recorder.

When the deck contacts are bridged by the foil tab and RLA changes over again there is a fraction of time during which its armature is between its side contacts, touching neither. RLC is already de-energised, and RLB is immediately also de-energised so that the mains circuits to both the transformer and the tape recorder are opened. However, the fraction of time is very small indeed and if sufficient charge remains long enough on the reservoir capacitor C1, RLC will again energise—restoring the mains supply to the transformer, though not, of course, to the tape recorder. During the changeover, RLA (via the foil tab) will briefly take some current from C1 but it will be very little; the pilot lamp will take much more.

On completion of the changeover, C2 presents a temporary virtual short to C1, after which there *may* be some remanent charge on both capacitors at something less than maximum voltage) draining rapidly away via the pilot lamp and RLC coil. If the capacitance of C1 is chosen to be no greater than is necessary to obviate relay chatter, the probability is that all will be well—so long, at least, as the lamp doesn't fail.

There is a simple way of making sure: a resistance R, will make RLC slow to close without disturbing its slow-to-open function—provided RLC, C2 and R all have fairly high values. A little experimenting with alternative values of C and R, with the pilot lamp removed, should quickly ensure satisfactory operation. If necessary, a bleeder resistance can be fitted across C1. Remarks, in respect of Fig. 1, concerning short recordings and inductive loads clearly apply also to the circuit of Fig. 2. All relays should be capable of operating at the supply voltage (6·3V) and have heavy duty contacts.

If the tape recorder to be used has a three-core mains cable, the earth line can obviously also be used as a connection between the control unit and the "earthed" contact of the pair on the deck which are bridged by the tape foil. This leaves a single line connection to be made (e.g. by banana plug) to the insulated deck contact.

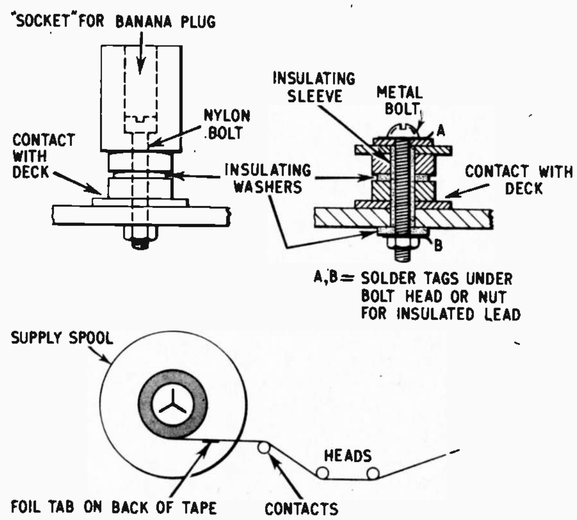


Fig. 3. Insulation of the tape guide and position with respect to the heads

Any rectifier diode rated at about 12V 0·5A will suit for D1.

N.B. Reference to removable self-adhesive foil tabs assumes use of a deck contact assembly similar to those in Fig. 3, which are easily made up. If separately mounted contacts are used, the length of stop foil spliced into the tape should be only marginally longer than the distance between them.

N. G. Dix,
London, W.1.

We would stress that neither this system nor the original system (January 1967) are immune from the possibility of "flats" occurring on the rubber capstan roller if this is mechanically held engaged while the recorder is not running.

SIMPLE SITAR

In the "Simple Sitar" (*Ingenuity Unlimited*, March issue) there should be a resistor 220kΩ between TR1 base and the negative supply line. R1 on the published circuit should be 4·7kΩ and R2 220kΩ. The battery voltage is 9V.

FUEL SAVER TIME SWITCH

I HAVE a solid fuel central heating boiler with a mains driven combustion air fan normally controlled by a thermostat. The arrangement as supplied wastes fuel overnight or goes out if the thermostat is set low due to the long waits between "fan on" phases when no heat is abstracted from the primary circuit. To cure this I found that a thirty second puff every half-hour would keep the fire alive without wasting heat. I modified the *Time Switch* (October 1966).

The basic time switch was used to control a power transistor with a 9V relay (with heavy duty contacts) in the collector circuit. The delay period was extended by substituting a 1,000μF at C1 and a 10MΩ resistor at R2 and a recycle delay (to keep the relay closed for periods of up to a minute) arranged by discharging C1 through a 100kΩ preset potentiometer switched in by the relay.

Commercial units quoted for the same duty were priced in the £10 region. My switch cost £4 complete with 9V d.c. supply from a mains power unit.

The same system, with slight variations, might be used for intermittent feeds, sampling devices, lighting displays, fountains and the like.

C. Mattingly,
Wormington,
Worcs.

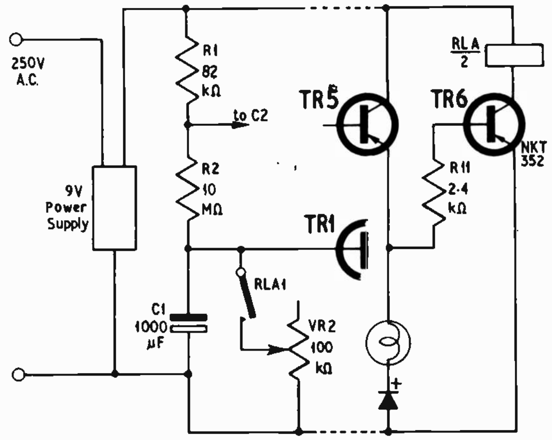


Fig. 1 (above). Modified parts of the original Time Switch circuit

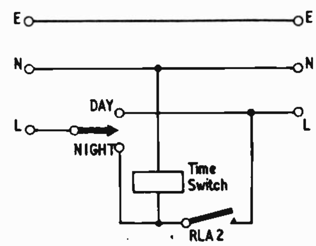


Fig. 2 (right). Mains supply is fed via the "day night" switch and RLA2 to the air fan

THERMAL DELAY

IF THE *Car Burglar Alarm System* in your February issue is wired as shown, when the system is switched off, the mercury switches S1 and S2 will short-circuit the door switch whilst the car is in motion, and thus will flash the interior light.

This can be avoided by inserting a single-pole changeover switch S4 into the circuit as shown in Fig. 1.

It must be remembered when wiring in S4 that there can be up to four door switches; make sure that it is connected correctly.

As it is possible for the alarm to be set off accidentally, the owner may return to find a flat battery.

Fig. 1 also shows a modification to overcome this difficulty.

The system is operated in the conventional manner with mercury and door switches. When the alarm has been set any interference with the car will sound the horn for 30 seconds after which the alarm will reset itself. If the interference continues the alarm will not reset but continue sounding until manually restored.

When the concealed switch S3 is operated the two relays RLA and RLB are connected in series with the door and mercury switches.

When the circuit is completed via S1, S2, or the door switches, RLA operates and holds in via RLA1, relay RLB is a thermal delay relay which will take 30 seconds to operate. The car horn will sound via RLA2 for 30 seconds until RLB operates and RLB1 disconnects the relay circuit. RLA and RLB will release, if S1, S2, or the door switches are operated still. Relay RLA will reoperate and the horn will continue to sound. If the source of interference is removed RLA will not reoperate, thus avoiding the nuisance of flat batteries or having to attend to false alarms.

The thermal delay relay recommended is the P.O. type (Fig. 2). This can be mounted on the PO 3000 type relay, thus if RLA is the PO 3000 type relay the unit will take up very little room.

This thermal relay can be adjusted to give a delay of 10 seconds to 60 seconds in operate lag, the release lag is 1–15 seconds depending on the operate lag and the ambient temperature.

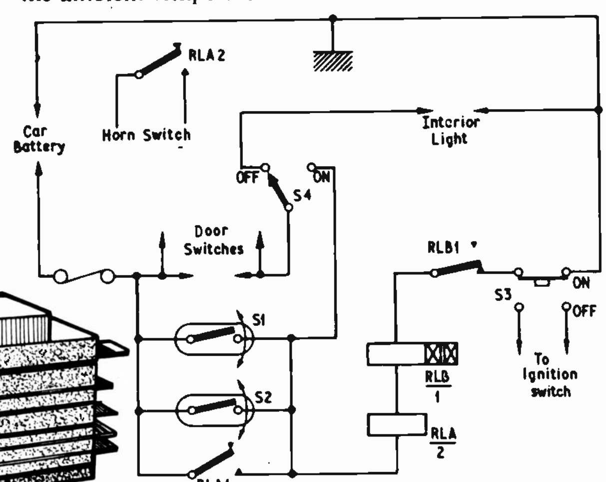
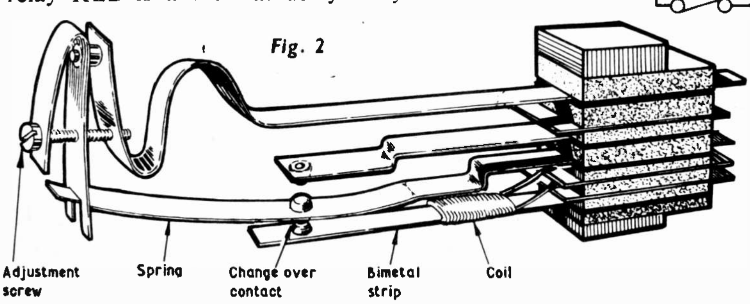


Fig. 1



P. Heal,
Acton,
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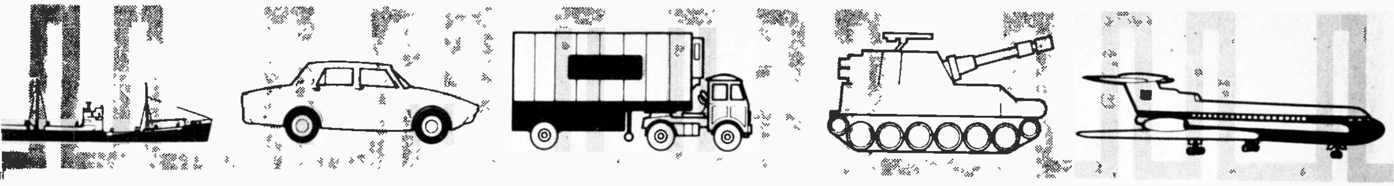


MODEL CONTROL

PART ONE

The short series in PRACTICAL ELECTRONICS on Miniature Model Control gave constructional details of a transmitter, receiver, and three amplifiers designed specifically for use in small models.

Sufficient information was given to allow the reader to construct and put into operation the basic units of equipment, to the point where a single or multiple on-off function could be obtained in response to a push-button command from the transmitter.

The next stage described here is conversion of a switched function to mechanical operation of various controls within the model itself.

An ideal form of model control system is one where angular rotation of potentiometer spindles at the transmitter is faithfully reproduced by a like rotation of corresponding powered shafts in the model, which are linked to functions such as steering, or engine speed. The majority of existing systems only approximate to this ideal, for the very good reason that a "full house" proportional outfit is rather expensive, and may use as many as 60 or 70 transistors. Nevertheless, it is surprising what can be done with very simple equipment and a skilful operator, particularly in the field of miniature models.

STEERING

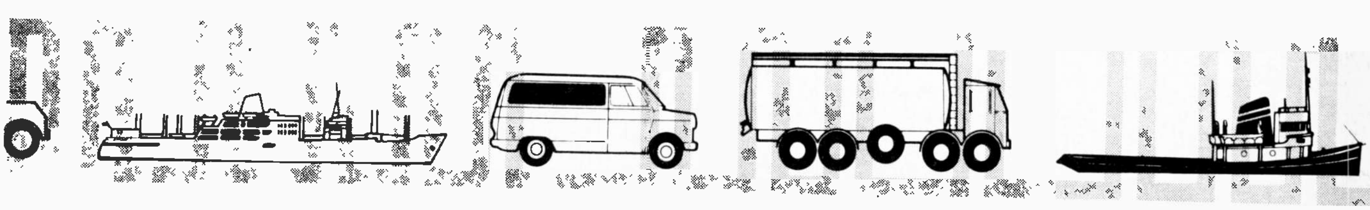
The ability to point the model in any desired direction can be claimed as the prime requirement, and it is possible to achieve interesting results with steering alone. Other controls, such as stopping and reversing, can be added later.

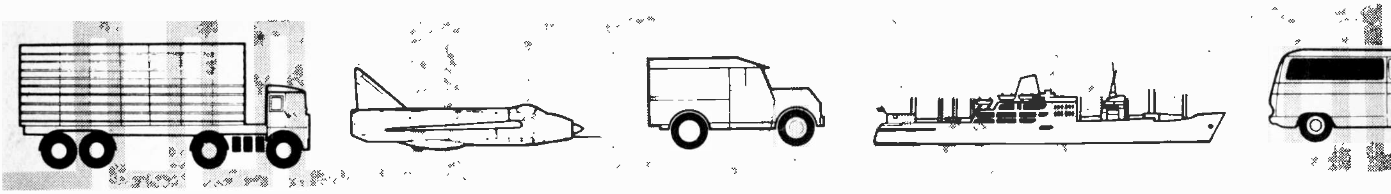
Before going on to a description of an integrated steering unit it would be as well to explain first the action of the clockwork escapement. The illustration of Fig. 1 may help to make clear the sequence of events, which is common to all four-arm escapements, including rubber powered ones.

Referring to Fig. 1, when a pulse is applied to the electromagnet by brief closure of the reed switch in the amplifier module, the latch will move down, releasing arm 1 of the rotor. The rotor is then free to move quickly under power, and drive the crank round, but the top of the latch has moved inwards and blocks the path of approaching arm 3, now on its downward journey. Thus, the rotor stops just before the crank has reached its full control position.

When the pulse ceases the latch is pulled back by its spring against the top stop, releasing arm 3. The bottom of the latch just has time to move in and stop arm 4 when arm 3 is released, and the crank attains full control position.

Therefore, with a single input pulse of indeterminate length, the escapement has unlatched, moved under power to the next position, and relatched on cessation of pulse, ready for the next command to be given. From this it will be clear that a four-arm escapement can provide positive positioning of its crank with the minimum fuss and bother at the transmitter end, and





INSTALLATIONS

By D. BOLLEN

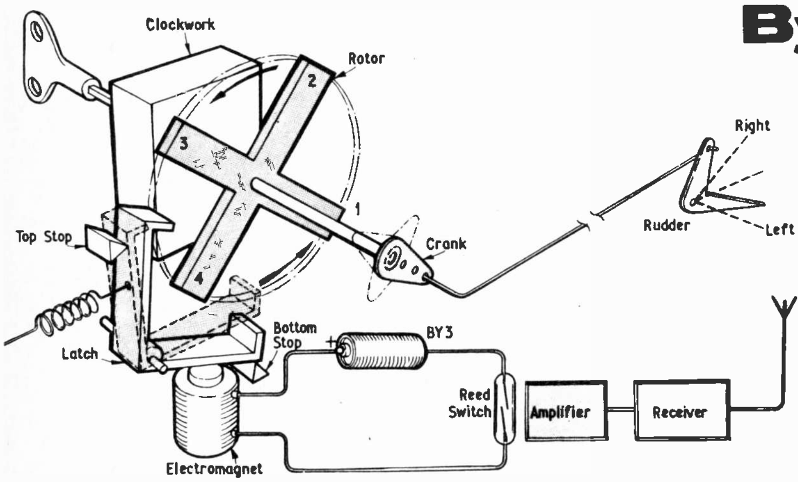


Fig. 1. Simple four-position sequential escapement — pulse operated

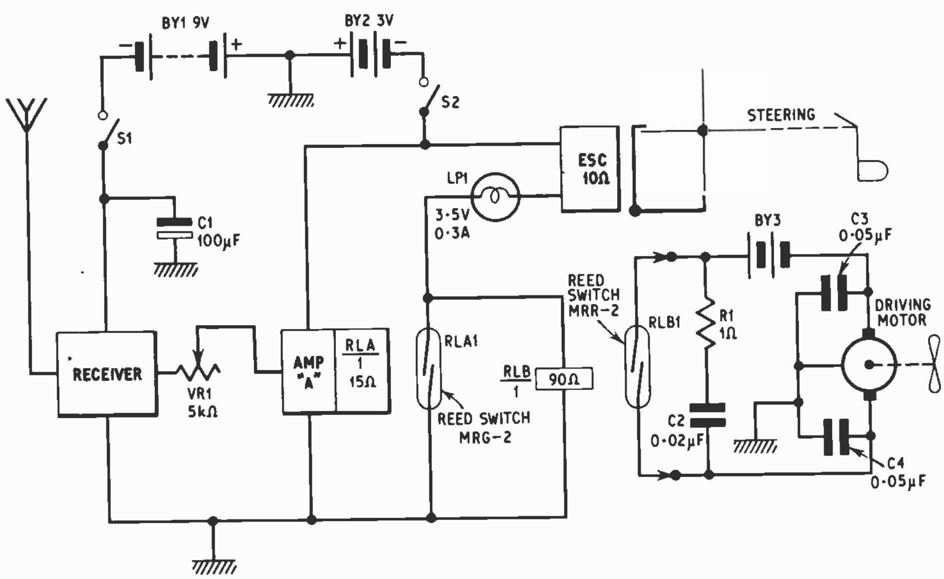
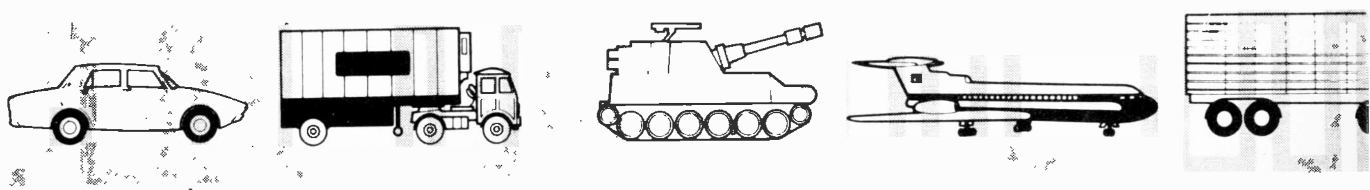
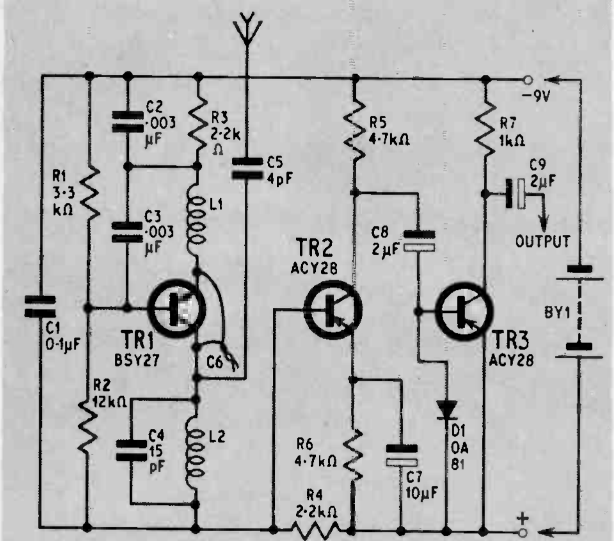


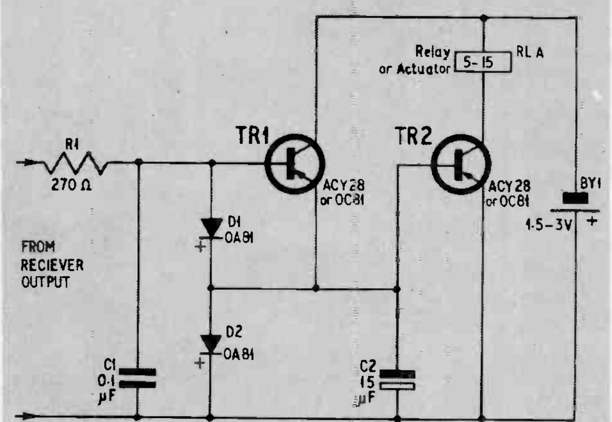
Fig. 2. Addition of stop-start circuit to steering unit



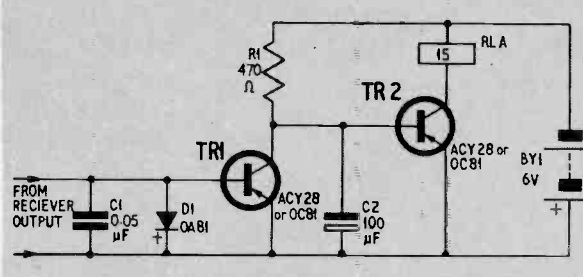
RECEIVER



AMPLIFIER "A"



AMPLIFIER "C"



These three circuits are reprinted from the previous series on *Miniature Model Control*. The Transmitter and Amplifier "B" will be given in Part Two

power is only taken from the battery for the duration of the pulse (typically 300–400mA).

It is only necessary to remember the simple sequence *right, neutral, left, neutral* to make the model go straight ahead or to left or right. Two or three fast pulses in succession will cause the escapement virtually to skip positions. Intermediate steering alignment can be approximated by fast work on the transmitter button, so that the escapement only remains at full right or left for a very brief time, sufficient to "twitch" the model in the desired direction; this is where the skill comes in.

The "Rising" Mark 1 four-arm escapement used with the prototype is manufactured by Rising and Schulz, Whissendine, Rutland, and can be obtained from many model shops. There is enough crank power available for a small boat or aeroplane, and the escapement has even been employed by the author to turn the steering wheels on a model car weighing over one pound. The clockwork motor will yield more than 150 complete revolutions of the crank on one winding.

INTEGRATED STEERING UNIT

The integrated steering unit, shown in the photographs, was made with the Receiver and Amplifier "A" module. Being only 3⅝in long, this unit is small enough to fit inside electrically powered model boats, cars, and tanks. All-in weight, including batteries, is 4 ounces, making the unit suitable for fairly small model aeroplanes. The main reason for having an integrated unit is that it can be quickly transferred from model to model, thus avoiding unnecessary duplication and expense.

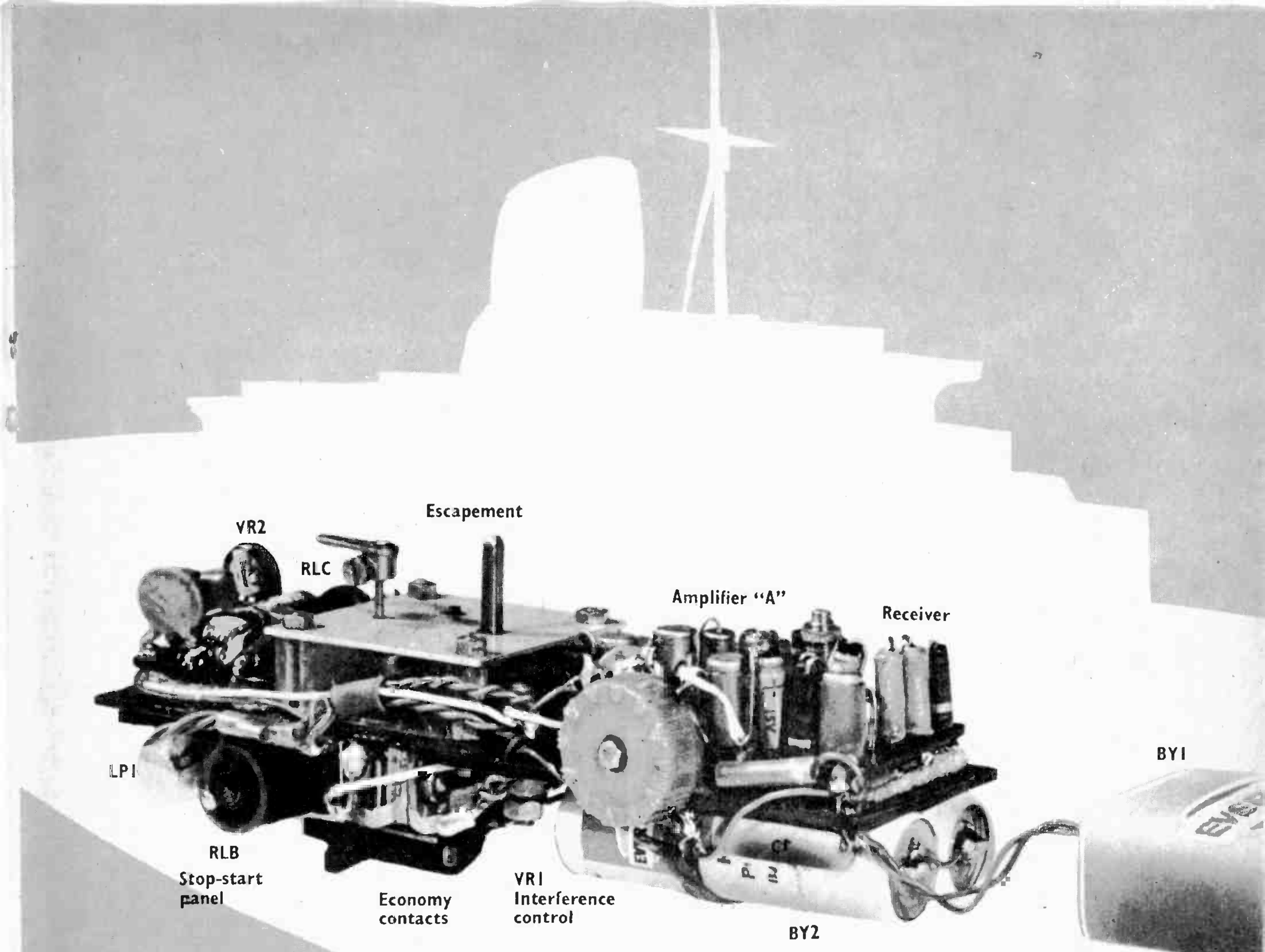
Propulsion motors tend to radiate considerable electrical interference, due to sparking on the brushes. One remedy is to wire two 0·05μF capacitors from the brush holders to the metal body of the motor, but even then interference may still be experienced, especially when the Receiver is positioned close to the propulsion motor.

Looking at the circuit in Fig. 2, interference control VR1 has been introduced between the Receiver output and Amplifier "A" input. If interference does cause spurious triggering of the escapement, VR1 can be backed off to just past the point where triggering ceases. There may be some slight loss of range, but not enough to prove troublesome.

VR1 also serves as an accessible connection for a pair of high impedance headphones, which are used to monitor Receiver operation and tone signal from the Transmitter.

Miniature model control receivers do not normally incorporate extensive supply decoupling but, when powered by low impedance Deac type rechargeable batteries, stability is adequate. However, if high gain transistors have been employed in the Receiver circuit there may be instability when it is coupled to a small layer built primary battery, such as the PP5. A simple cure for this instability, which lowers the effective battery impedance, is to wire a sub-miniature 100μF capacitor between the negative supply rail and earth. This is shown in the photograph on the underside of the mounting panel alongside BY2.

The steering unit, receiver and amplifier "A" modules are fixed to a mounting board by means of rectangular pieces of foam plastic, held in place with spots of glue. Although quite firm, the foam will absorb vibration from the propulsion motor, and guard against fatigue of soldered joints.



In the event of a very severe jolt, the modules will break free, and this avoids damage to delicate components. The crank can be attached either to the top of the output spindle (as shown in the photograph) or underneath close to the rotor.

High power cells are recommended for BY2 (for example, HP7), and are slung below the mounting board and held with a rubber band. Although a small box equipped with spring contacts could be made up to take the cells, soldered connections are more reliable. Pairs of cells can be quickly taped together and soldered, and it does not take long to connect such a battery to a set of miniature screw terminals on the mounting board. In the pulsed mode, the HP7 will give a surprisingly long life, and battery replacements are infrequent.

BY1 is not fixed to the mounting panel, but is used as ballast to trim the model. Similarly, switches S1 and S2 (Fig. 2) should be conveniently mounted on the outside of the model. BY1 is held by a rubber band, and the two switches can be attached to a sub-panel, designed for quick removal.

If the layout has been well arranged, it should be possible to transfer the integrated unit in a few minutes to another model. One further practical point; the linkage to the rudder or steering can be a piece of wire with a 90 degree bend at the end, to drop into one of the holes in the crank. This is prevented from jumping out again by a short length of tight sleeving slipped on the end of the wire.

STOPPING THE PROPULSION MOTOR

Having constructed and used the integrated steering unit, the enthusiast may wish to introduce other functions, such as "stop–start" and "slow reverse". One virtue of the unit form of construction is that changes can be made without dismantling the original modules.

The only real headache is in finding a bit more space in the model to take extra circuits and batteries. If the intention is to equip one particular model only, better use of available space can be made if the sub-units are dispersed, instead of being assembled in integrated form. It is amazing how much can be stowed away in a tiny model if circuits are built on individual panels less than 1 in square.

The stop–start control can be readily added to the steering unit at the expense of a space measuring 1in × 1in × ½in, and no extra batteries will be needed. Furthermore, this motor control can be used without any modification to the simple single tone transmitter.

To make the propulsion motor stop, it will be necessary to hold down the tone button on the transmitter. It may seem the wrong way round to keep the model stationary with a continuous tone, but the reason for this becomes apparent when it is considered that the model spends most of its active time going forward, and that stopping is only used for manoeuvring or in an emergency.

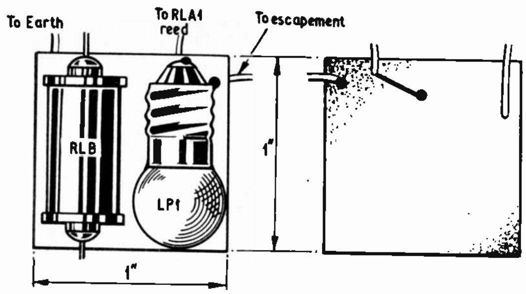


Fig. 3a. Stop-start panel topside and underside

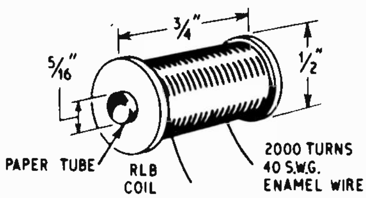
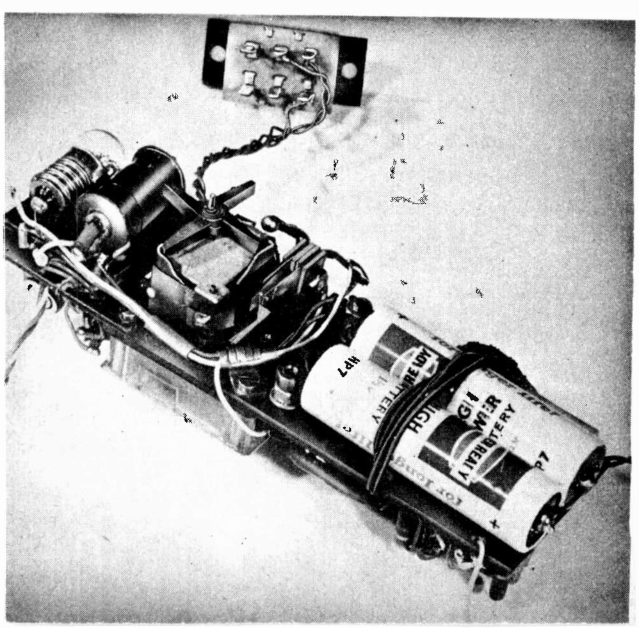


Fig. 3b. Construction details of RLB coil

"Stop-start" circuit details are included in Fig. 2. The bulb LP1 is introduced as a battery economiser. If the escapement is to be held on for long periods it will draw a continuous current of some 300mA, but with the bulb in series this is reduced to approximately 150mA. The resistance of a cold filament is much lower than that of a hot filament, therefore, a heavy initial current will flow through the escapement coil when RLA1 contacts close.

Before the bulb has time to warm up, the escapement latch is quickly pulled in, then the bulb glows and the current is reduced. The glow of the bulb is also a clear indication of correct circuit operation, and can be very usefully employed on single-handed range checks.

Unfortunately, although an attractively simple arrangement, the bulb does tend to slow down escapement speed and if pulses are sent in rapid succession, the bulb warms up and escapement current temporarily drops to a point where the latch is no longer pulled in. A preferred form of economy circuit will be given later.



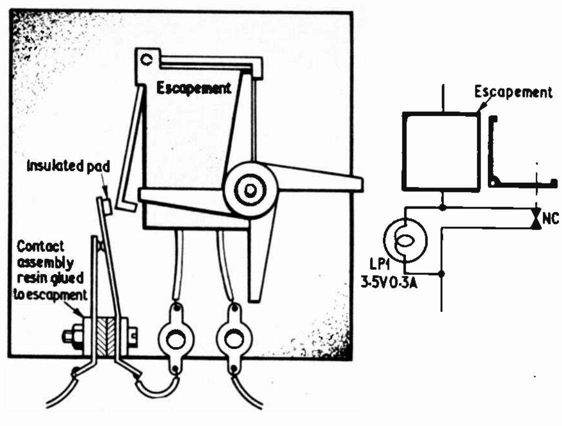


Fig. 4. Fitting economy contacts to the escapement

OPERATION OF "STOP-START" CIRCUIT

Since relay coil RLB (Fig. 2) is wired across the reed switch RLA1, a current will flow through this when RLA1 contacts are open. This is sufficient to close reed switch RLB1 and set the propulsion motor going. RLA1 contacts will therefore remain closed when there is no signal, but a continuous tone from the transmitter will hold them open.

R1 and C2 suppress the arc across the reed switch contacts when switching a heavy load; motor interference suppression capacitors C3 and C4 are also shown. Only the body of the motor is connected to a common earth point, and both brushes are left floating relative to earth. R1, C2, C3, and C4 should be mounted close to the propulsion motor, as permanent fixtures in the model.

"Stop-start" panel details are given in Fig. 3. The unit is very simple indeed, and can be mounted directly on the steering unit. RLB coil is wound with 2,000 turns of 40 s.w.g. enamelled wire, and bobbin constructional details are given in the inset diagram.

REED SWITCH RATINGS

A point well worth considering, which is related to size of model and equipment, is the current rating of miniature and sub-miniature reed switches. Miniature model electric motors have a high stalling current rating, sometimes well in excess of 1A, but the miniature reed switch, depending on type and contact material, has a typical long-life rating of 0·5A. If absolute dependability is called for, the switch rating should not be exceeded.

Although there is no reason why larger armature relays should not be used in bigger models, the reed does offer exceptional reliability and compactness, and an expected life of 100 million operations when not overstressed. Some standard size reeds, encapsulated in 2in glass envelopes, are capable of handling as much as 3A, and can be wound with exactly the number of turns and gauge of wire as a miniature reed in the same circuit. A bobbin for a standard reed need only be 2in long by $\frac{3}{8}$in dia. for a 90 ohm coil.

When a heavy current is to be switched it is recommended that larger reeds are used, either to replace the miniature reed or as slave relays. Reed switches were carefully chosen for the circuits given here, bearing in mind cost and current loading. The type numbers in the circuits are for Hamlin switches, and these are obtainable direct from Flight Refuelling Ltd., Industrial Electronics Division, Wimborne, Dorset.

No hard and fast rules can be laid down when so much depends on individual application, but it is sometimes better to retain miniature reeds and replace the motor in the model with a low consumption propulsion unit, where high current is a problem. This will also bring a bonus in model operating time due to lower battery drain. A suitable motor for small boats or cars is the Microperm 2000, which has a stall current of 400mA, a running current of about 150mA, and measures 1in × 11/16in diameter case size.

ECONOMY CONTACTS

For a very fast escapement speed with good "hold-on" economy, a set of contacts can be added to an escapement, as shown in Fig. 4. The contacts are normally closed when the escapement coil is not energised. When the latch moves, the contacts open and place LP1 in series with the escapement coil, roughly halving the current consumption. As before, the bulb will light up and can be employed as an indicator.

REVERSING THE PROPULSION MOTOR

Up to this point operation has been confined to one channel, using a modulated carrier only. It is possible to employ the unmodulated carrier virtually as a second channel for a separate function.

Amplifier "C" was originally intended for a 6V supply, but will work on a 3V source if an extra component is added. It may be remembered, from the earlier article, that Amplifier "C" is biased off by noise from the receiver. When a plain carrier is received, the amplifier switches on its relay, but does not respond to modulation.

Equally, Amplifier "A" does not respond to plain carrier, so there are two interaction free channels when both amplifiers are incorporated in a single unit.

The modified Amplifier "C" circuit is shown in Fig. 5. Enough free space exists on the amplifier panel to take not only the extra feedback capacitor C3, but a sub-miniature pre-set potentiometer VR1 and a 15 ohm relay coil identical to that used for Amplifier "A".

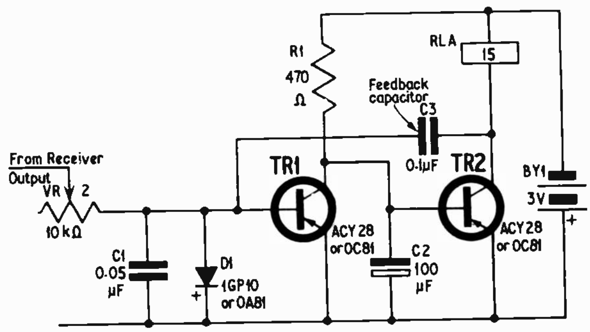


Fig. 5. Modified version of Amplifier "C" to operate from a 3V battery

Amplifier "C" panel, together with the "stop-start" unit, are attached to the "free" end of the escapement, opposite the Receiver and Amplifier "A". The complete control unit is 4¼in long and weighs 5 ounces.

REVERSING CIRCUIT OPERATION

Fig. 6 gives the complete circuit. A changeover reed relay RLC has been introduced as a simple means of reversing the propulsion motor. BY3 is the main propulsion battery and the smaller battery BY4 is switched in by RLC1 to provide slow reverse when a plain carrier is received. As before, the motor is switched off by RLB1.

Pre-set VR2 allows Amplifier "C" to be trimmed for optimum results without the necessity for altering the value of C1 in Fig. 5 and, at the same time, acts as a series resistor so that the signal from the receiver is equally shared by both amplifiers.

Note the economy contacts on the escapement in Fig. 6, and the new values of suppressor resistors in the motor circuit. The reeds of RLB and RLC can be coupled to the motor circuit with a B7G plug and socket or similar midget connector.

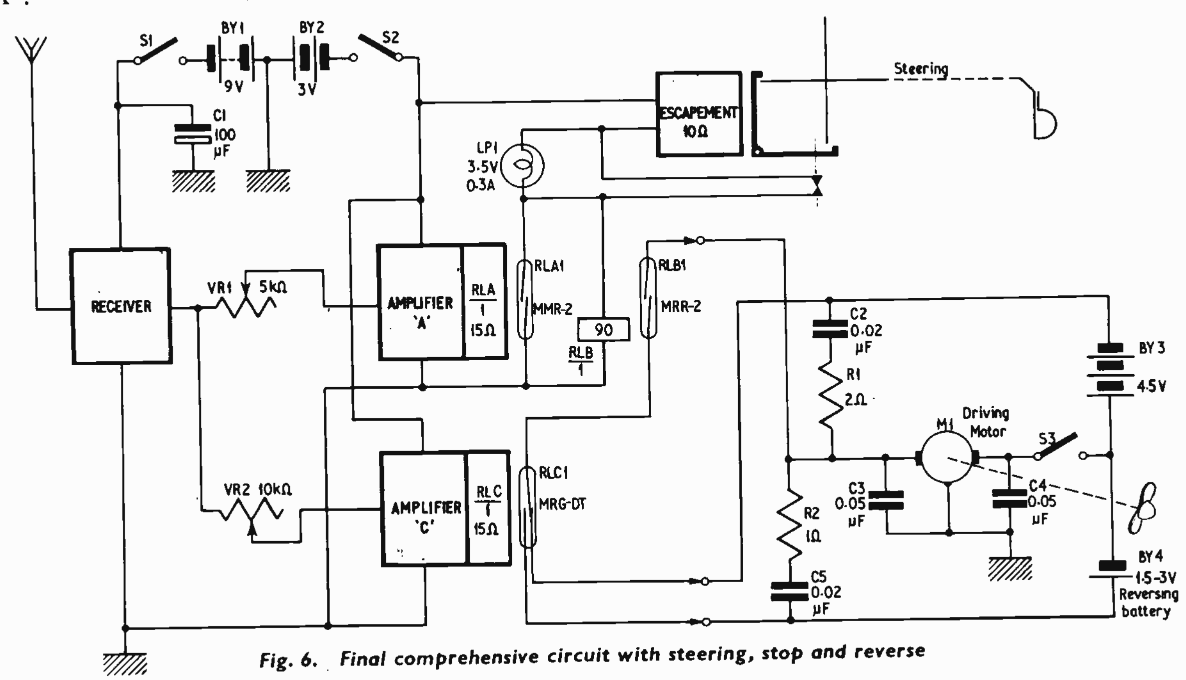


Fig. 6. Final comprehensive circuit with steering, stop and reverse

SETTING UP

Connect a pair of headphones via a 0·1μF capacitor between VR1 and earth. Set VR1 to its mid-position and close S1; the hiss from the Receiver should be audible. Check that the Receiver is responding correctly to a tone signal from the transmitter to the limits of range. Retune the Receiver if necessary and slightly advance VR1.

Next, switch on S2 and see if the escapement functions, and does not skip a position when the transmitter button is pressed. It is a good plan to set a small electric motor running close to the receiver to see if there is any interference. If the escapement starts operating of its own accord, back off VR1.

When "stop–start" is included, see that this functions correctly when RLB1 is coupled to a running electric motor. The bulb should light when the transmitter button is held down.

For Amplifier "C" the following procedure is adopted. Having first ensured that steering and stopping circuits are responding well to the transmitter, connect Amplifier "C" to S2 and connect VR2 to the receiver output. Advance VR2 until RLC just operates then back off VR2 slightly. The correct setting is when a very slight noise is just audible from RLC reed switch. A loud noise will denote that the reed contacts are opening and closing spontaneously.

This may be checked with an ohmmeter or a bulb and battery. Key the transmitter button with modulation switched off. If all is well, RLC will change over its reed contact to the reverse position.

Test the plain carrier range, which should be slightly more than half the distance obtained with tone signals. A table of current consumption figures is given as a guide for setting up.

OTHER INSTALLATIONS

It is hoped that the information given here will enable the reader to equip a model, and devise alternative arrangements, with different amplifier and reed switch combinations. For example, if the transmitter is modified to give two tones, at 1kHz and 5kHz, tuned Amplifier "B" can be placed in parallel with Amplifiers "A" and "C" to provide an extra channel, assuming that two more pen cells are added in series with BY2 to give the 6 volts necessary for Amplifier "B".

Table I. CURRENT CONSUMPTION

	No signal (mA)	Tone (mA)	Carrier (mA)
BY1 Receiver	4	5	4·5
Amplifier "A"	2	150	zero
Escapement with economiser	zero	150	zero
RLB	30	zero	30
Amplifier "C"	7	5	150
BY2 total	39	305	180

The frequency determining ladder network in Amplifier "B" circuit (January issue) is tuned by capacitors C1, C2, C3. If 0·02μF capacitors are used, the amplifier will respond to a 5kHz tone. A 0·02μF low frequency blocking capacitor should also be added in series with the Amplifier "B" input resistor. As Amplifier "A" cuts off sharply above 2kHz there will be no interaction between "A" and "B" channels.

The circuit diagram of the transmitter and Amplifier "B" will be reprinted in Part Two of this article.

A motorised servo can be used in place of an escapement and the wiring diagram supplied with a new servo will show how to couple to various forms of amplifier output. Although bigger than an escapement, a sequential servo works in a similar manner and its greater crank power is suited to bigger or heavier models.

Several readers have queried the r.f. chokes used in the transmitter and receiver circuits. The prototype chokes were not, in fact, home wound. They were taken from valve type i.f. transformers. There is now available an excellent 97mA 1mH sub-miniature choke, scarcely bigger than a ½ watt resistor and this has been successfully used in both circuits. Manufactured by Painton, the choke is now available from Electroniques (Prop STC) Ltd., Edinburgh Way, Harlow, Essex, with the code number 58–10–0023–10.

Meetings . . .

INSTITUTION OF ELECTRICAL ENGINEERS

LONDON

Date: May 19
Title: Colloquium on "Advances in Measurements Brought About By Recently Introduced Semiconductor Devices"
Time: 9.30 a.m.
Address: I.E.E., Savoy Place, London, W.C.2

Tickets must be obtained from the Secretary, Savoy Place, London, W.C.2

Date: May 24
Title: The Postal Service and the Electronics Engineer
J. Piggott and T. Pilling
Time: 6 p.m.
Address: I.E.E., Savoy Place, London, W.C.2

SOCIETY OF ELECTRONICS AND RADIO TECHNICIANS

GLASGOW

Date: May 19
Title: Computers—A. Coppell (I.B.M.)
Time: 7.30 p.m.
Address: Y.M.C.A. Club, Bothwell Street, Glasgow

INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS

LONDON

Date: May 24
Title: Symposium on "Television Network Switching at the Post Office Tower"
Time: 5.30 p.m.
Address: 8–9 Bedford Square, London, W.C.1

READING

Date: May 23
Title: Astronomical Instrumentation
Prof. P. B. Fellgett
Time: 7.30 p.m.
Address: J. J. Thomson Physical Laboratory, University of Reading

THE ELECTRONIC ORGAN

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

VIBRATO: ELECTRONIC AND MECHANICAL METHODS

Modern instruments rely greatly on the use of vibrato. This is partly because vibrato is an essential ingredient of romantic music; partly because it enhances the effect of certain tone qualities which would otherwise sound very dull and monotonous; and partly because it is a fashion or symbol of the times.

The word *vibrato* is of comparatively recent origin. It covers a multitude of sins because it can be frequency modulation, amplitude modulation, or a bit of both. Strictly speaking vibrato is equivalent to the tremulant on a pipe organ, first applied by the French; the word tremulant is a corruption of their expression *tremblant*. Because pipes are very sensitive to pressure changes, the device as normally fitted shakes the wind supply to certain selected ranks of pipes and this causes a considerable change in pitch, though not so much in volume. The effect is very agreeable if carefully used and when produced electronically, vibrato should give an equivalent result.

In some instruments only the volume is varied cyclically, and this is described as *tremolo*; an expression of Italian origin, intended to refer to the human singing voice. It is not so effective on organs as vibrato.

METHODS AVAILABLE

We can introduce the vibrato effect in two ways; either something can be done to the circuit to alter its characteristics as required; or a mechanical device can be applied to a loudspeaker to produce the desired result.

On account of the stability in tuning so easily attained with transistor generators, it is not always easy to swing the oscillators to the required extent. Further, in a frequency divider organ, all notes down to the lowest will be modulated, and as the frequency of vibrato commonly lies between 5 and 6Hz, pedal notes of 16ft pitch may be so modulated. This produces a most objectionable effect.

An alternative electrical method is to use a phase shift circuit following the generators, a necessity if these are of the vibrating reed or gear driven iron wheel type, since generators cannot be made to go off pitch. In such phase shift circuits, the pass band can be so adjusted that the bass is not modulated.

The last method, mechanical control of the sound waves, is the most effective from a truly musical point of view. Although only recently becoming popular, and heralded by some makers as a new invention, it is the oldest type of vibrato and was actually used in reed organs over 100 years ago! The forerunner of the present methods was the Everett Orgatron of 1935, whilst John Compton took out a patent for a rotating horn loudspeaker in 1936. Today, Donald Leslie's design is widely used in various forms, although the rotating unit devised by Jerome Markowitz in 1940 is a standard part of the American Allen organs; and more recently, there is the Compton Rotofon—an almost identical arrangement.

The foregoing represent all the means at present in use, although some ingenious alternatives have been proposed. So let us examine them in turn.

ELECTRONIC METHODS

In the majority of types of electronic organs which are likely to interest readers of this magazine, a Hartley type of oscillator is used as a prime oscillation generator. Although we will deal with transistor methods exclusively so far as the Practical Electronics organ is concerned, it must not be forgotten that there are thousands of valve organs in existence; therefore we show one transistor and one valve circuit in this article.

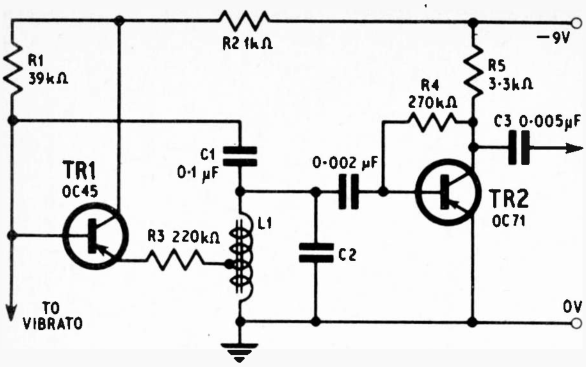


Fig. 7.1. Typical Hartley oscillator tone generator, with buffer and shaping stage to drive dividers

Because a transistor is substantially current operated, it is harder to produce a large change in the bias than in the case of a valve; and the "slope" of a transistor is entirely different from that of a valve. In Fig. 7.1 is shown a popular type of Hartley oscillator for organs. Other types vary only in detail. Differing voltages, etc. are merely due to the use of different kinds of transistor.

The base is the most sensitive element to modulate, so we find a connection which is normally floating, that is, not connected to anything, but which may be connected to a varying voltage supply through a high resistance which will not divert current from the oscillating circuit. Since the circuit shown delivers only a few volts to the load, it is possible to alter the frequency by injecting a few volts into the existing base bias. But this will very much depend on the kind of transistor used. It has long ago been found that there is an optimum value for the frequency of vibrato so produced, and this is about 8Hz. Many people prefer a slower rate of modulation, consequently vibrato oscillators are adjustable for frequency.

It is most important that the vibrato waveform be as sinusoidal as possible, otherwise harmonics may be injected into the oscillator proper and also, the swing must be equal either way. A sine wave vibrato is therefore desirable. This also has the merit that the rise and fall of the sound is truly continuous and is not held up at all during a cycle as can happen with a square wave multivibrator. The phase shift RC oscillator is widely used to provide the vibrato modulation but this kind of oscillator requires high gain transistors.

BRIDGED-T CIRCUIT

A very successful circuit is the tuned bridged-T shown in Fig. 7.2. This was originally described in the Wireless World for December 1962 by Mr F. Butler, and can be adjusted to give the frequency for vibrato modulation as shown in the diagram.

One point to note with this circuit is that the feed resistors form part of the oscillator proper, so all must be wired up (probably 12) before tuning. Advantage can be taken of this arrangement to vary the degree of vibrato for different oscillators if desired by raising or lowering the value of these resistors until the effect is judged most pleasing. There is provision for altering both the amplitude and the frequency, and since this latter is very low, the controls can be brought out to the console stop panel without trouble. The effect of this oscillator on the signal from a tone oscillator is shown in Fig. 7.3.

Turning now to the kind of circuit which follows a tone system, which in itself is not made to alter in pitch or volume, and is therefore applicable to any kind of electrical tone source, it is found virtually impossible to achieve the same simplicity circuit-wise and the simplest arrangement is given in Fig. 7.4. Unfortunately valves are required for this purpose, but there seems little reason why the circuit should not be transistorised. Filters are shown in the output stage to remove the switching transient and also to attenuate the bass.

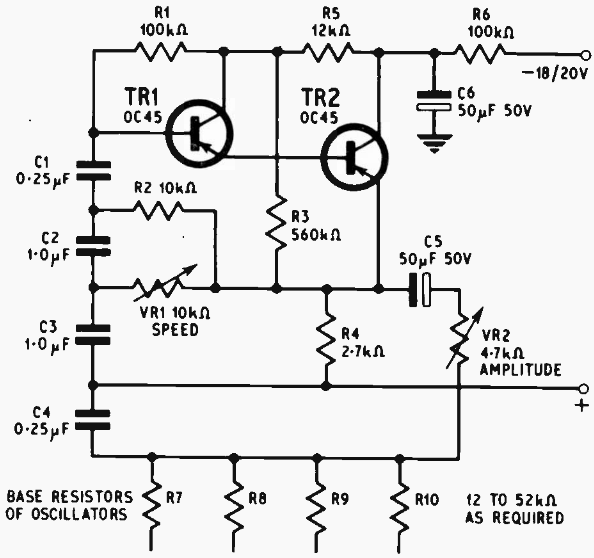


Fig. 7.2. Bridged-T vibrato sine wave oscillator

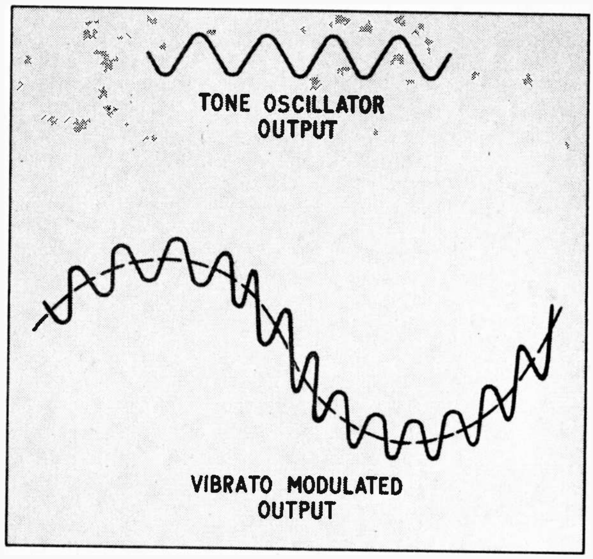


Fig. 7.3. Effect of vibrato circuit of Fig. 7.2 on tone oscillator waveform

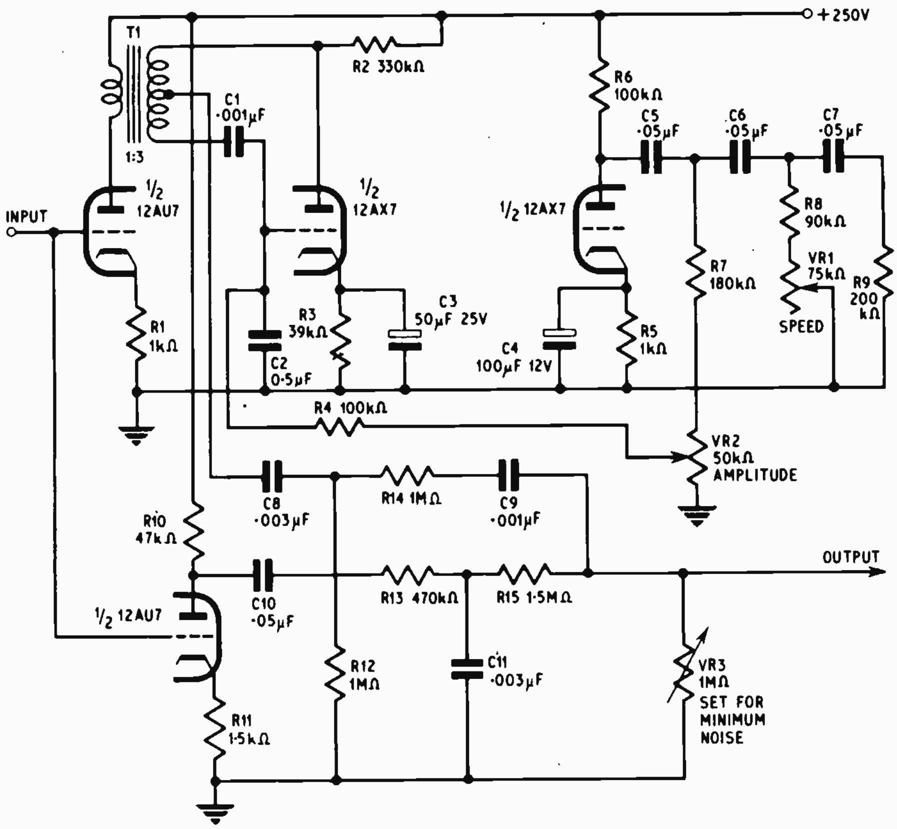


Fig. 7.4. Vibrato circuit suitable for following tone generators of any kind

Such vibratos have been used by Wurlitzer, Kinsman, and Schober, and have the merit that any signal not to be so treated need not be connected to the unit. Thus, one manual need not have vibrato, nor the pedal department, even with a common generator.

MECHANICAL METHODS

Mechanical means for modulating the tone always involve some device which alternately opens and closes the direct radiation path from a loudspeaker. The earliest types used flat paddles revolving in front of a cone, as in Fig. 7.5. This scheme is still very effective, but has the drawback that the vane might stop in such a position that the sound was blocked off. Experimenters who have not tried this very simple idea might like to investigate. The effect is very pleasing, improving of course as the frequency rises. The difference between the fixed rate of rotation and the frequency source will then be greater, since the effect is based on Doppler's theory which states that:

f (frequency at point of observation)

$$= \frac{V}{V - V_s} \cdot f_s$$

where V = velocity of sound in the medium (air)

V_s = velocity of source

f_s = frequency of source

Unless the vane is shaped to fit the cone, the degree or extent of the vibrato will not be great; and of course some part of the cone will always be exposed and not modulated. Therefore other ideas were investigated.

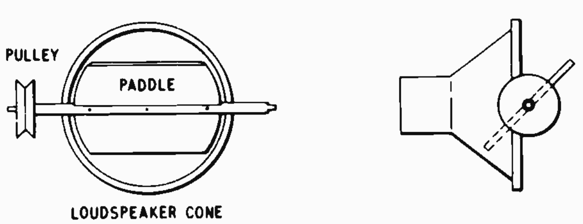


Fig. 7.5. Rotating paddle vibrato system

ROTATING SPEAKERS AND BAFFLES

Since tremulants are always most effective at the upper frequencies, early attempts involved rotating horn loudspeakers. This does away with the difficult problem of a baffle and ensures a high degree of cut off as the horn turns away. However, current must be fed into the circuit by some means and in the first attempts, slip rings proved troublesome. Then, to extend the response of the loudspeaker further down the scale, the size became a problem. This was solved in the Leslie devices, which are as numerous as they are varied.

Two basic types exist; one which rotates a small loudspeaker without a baffle; and one in which the speaker is stationary and a shaped baffle rotates above or below the cone. A baffle is generally used in this arrangement. The small units which themselves rotate are fed with the signal from a transformer with a

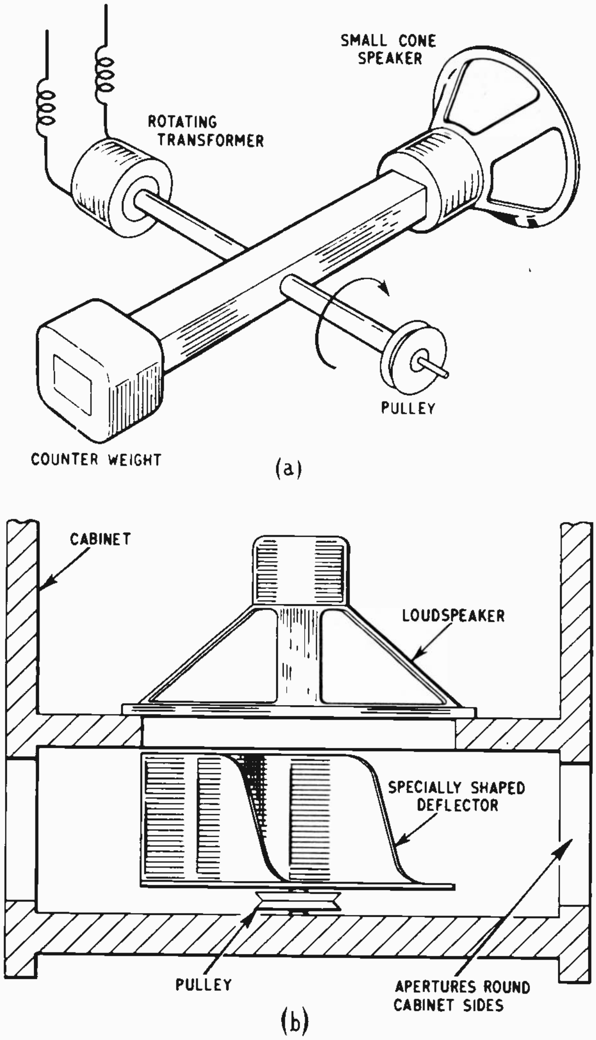


Fig. 7.6. Illustrating the principle of, (a) small and (b) large, Leslie speakers

rotating winding; in the case of the larger units, connections are of course normal. Driving motors may have more than one speed, since except for the American Allen, a.c. motors are used and the speed is not so easily controlled.

Taking the Leslie units first, both patterns are shown in a basic form in Fig. 7.6. The smaller units (Fig. 7.6a) turn rather fast, but produce a very complex radiation pattern which is most effective on high notes. The larger units (Fig. 7.6b) are more generally effective, and some makers fit them inside the console. One obtains true modulation of both pitch and volume, and this is why they sound better than any electrical means of tone modulation. But why they should be so expensive is a mystery.

A rather different approach is taken by the Allen organ company and also the Compton organ company. Here we find several loudspeakers mounted on a circular baffle which must be of large size. This assembly is rotated as a whole inside a large box open at the back and there is no real attempt to make an airtight seal between the rotor and the case. Current is fed in by slip rings. Several channels can be wired

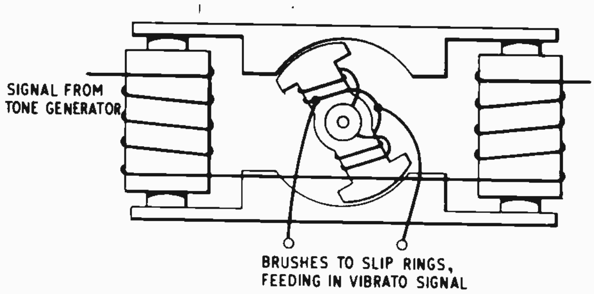


Fig. 7.7. Early Constant Martin tremulant device

into the unit, and because of the large arc described by the loudspeakers, the sound appears to move from side to side rather in the manner observed with a pipe organ when near at hand.

Apart from the main use as a vibrato device, it is found that if the baffle is turned very slowly, the spread of sound has a spacious quality which imparts a suggestion of a large room. Used with reverberation of the right kind it is therefore a useful adjunct to the organ, but it is not effective unless of large size. Of course, electrical vibrato can be added to any of these mechanical devices, when all kinds of effects become possible.

AN EARLY DEVICE

An early attempt to introduce modulation after the tone generators was made by Constant Martin, who used the ingenious little device shown in Fig. 7.7. The signal from the generators passed through the "field" coils on its way to the amplifiers, whilst the vibrato voltage passed through the armature windings, and so was superimposed on the main signals. A small motor drove the armature. ★

Book review

BASIC PRINCIPLES OF ELECTRONICS AND TELECOMMUNICATIONS

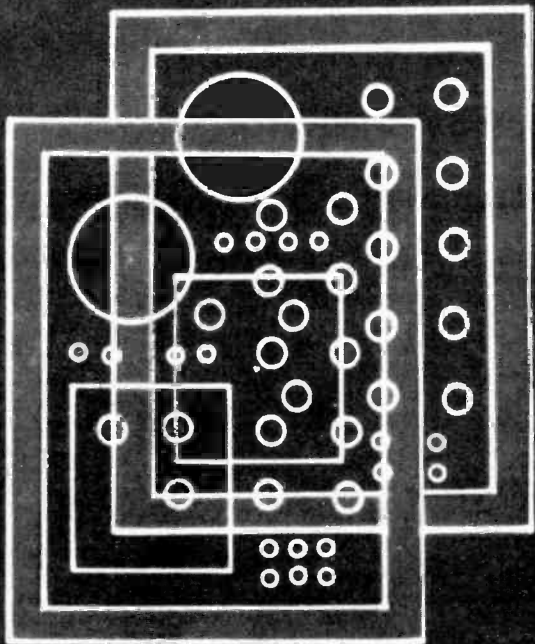
By M. D. Armitage
Published by George G. Harrop and Co. Ltd.
390 pages, 5½in × 8¾in. Price 30s

THIS is the second edition of a popular textbook first published in 1961. Completely revised and with a considerable amount of additional text, this book must be a natural choice for the second-year technical student intending to cover the "Principles A" syllabus of the City and Guilds of London Institute's Telecommunications Technicians' Course (No. 49).

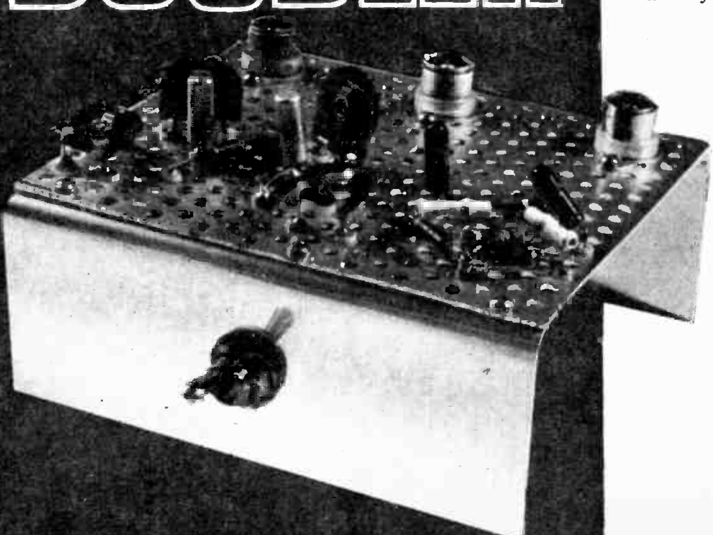
As a class work adjunct, or as a tutor text, for those who might sit this examination as external candidates, this will prove more than adequate in covering the syllabus requirements.

Liberally illustrated and with numerous worked examples, each chapter is completed with a set of questions, many of them from part C.G.L.I. examination papers, and answers which are contained at the back of the book.

G.M.H.



C.R.O. TRACE DOUBLER



Any conventional single beam oscilloscope can be quickly and easily converted to dual trace or multiple trace at low cost.

Trace doubling circuits, or "chopping" circuits as they are sometimes called, are by no means new in this application. Most modern oscilloscopes with two or more beams usually employ two quite independent electron beam sources or else resort to the cheaper method of beam chopping.

The chopping method involves deflecting a single beam up and down on the screen by using an internally produced high frequency square wave signal. If the square waves have 1 : 1 mark/space ratio, two distinct horizontal traces are seen instead of one on the screen for low sweep rates.

With switchable internal electronic circuitry these two traces are modulated with the two separate input signals to produce the dual trace effect. For purposes requiring a multiple beam oscilloscope, where measurements of voltage, frequency or phase of several different waveforms are required simultaneously, the enterprising amateur having only a single channel must either use more expensive equipment or resort to modifying his own oscilloscope, an often tedious if not difficult task.

LOW VOLTAGES

The transistor trace doubler described here is suitable for testing transistor circuitry where only low voltages are employed. There is no reason, however, why the circuit could not be adapted for higher input voltages as long as suitable calibrated attenuators are used.

The single circuit shown in Fig. 1 was found to have a frequency response from d.c. up to 50kHz with no relative phase shifts between signals over that range. Upon examination of the circuit it will be seen that its dynamic response to input signals is in fact only determined by the characteristics of the oscilloscope used.

Facility for trace separation also makes it possible for d.c. components of either input signal to be measured.

The unit shown will divide one channel into two channels. Two such units will provide four channels, when used on a dual beam oscilloscope, and it has been found possible to produce as many as four channels on a single beam oscilloscope, providing that they all operate on the same chopping frequency.

Where there is a need for viewing several different output signals of high output impedance, it was found to be possible using this unit where the current availability was very low.

By B. L. Welsh

THE CIRCUIT

The circuit, containing four transistors, is basically a free running multivibrator producing two sets of negative square waves with a 1 : 1 mark/space ratio, and each in antiphase with the other. The remaining two transistors form a pair of electronic "gates" or low resistance switches.

Each of these transistors has its base negatively biased by one of the square waves from the multivibrator so that it is alternately forward biased, or else forms a high resistance path to earth.

The two input signals are separately applied to the two emitters of the *pnp* transistors, each wired with its emitter as a collector. The two signals are fed via two 5 kilohm potentiometers which are used as gain balance controls. These two signals are alternately shorted to earth at the chopping frequency.

Trace separation is provided by negative d.c. bias on each of the two emitters via two 10 kilohm potentiometers. The emitters of the two transistors are joined together via a pair of 4·7 kilohm resistors with a centre-tap output. These provide the load. The output signal is taken from this point and fed to the oscilloscope.

With the components used the multivibrator frequency was found to be nominally 5–7kHz but jumped to 33kHz when loaded with the circuitry. This provides the unit with a higher frequency response.

ACTION OF THE GATES

In the absence of any base voltage, the first gating transistor can be regarded as a reverse biased diode. Any signal appearing on its emitter is presented with a high impedance to earth via this transistor.

At the same time, however, a negative voltage appears on the base of the second gate transistor, from the antiphased output of the multivibrator. As this voltage is higher than the standing d.c. emitter voltage on gate two, this transistor becomes forward biased and consequently has a low impedance to earth via its emitter.

As there are now two alternative paths to earth, the input signal on the emitter of the first gate now goes via the lowest resistance path to the earth; this is via the second gate.

Current flows through the two 4·7 kilohm resistors and the voltage output is detected as shown, between these two resistors.

As the two d.c. voltages on each gate transistor base are 180 degrees out of phase, the signals appearing

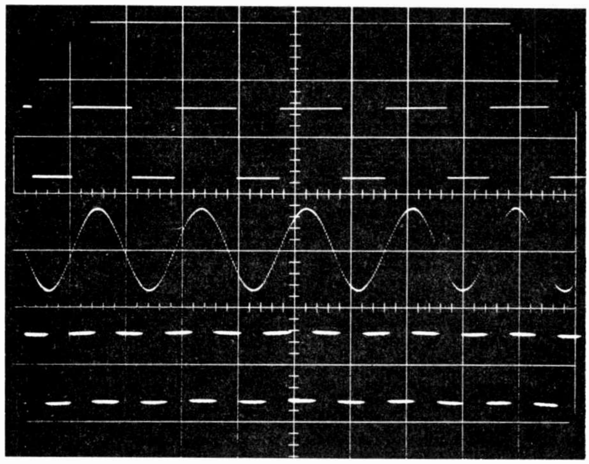


Fig. 2. Top beam direct and d.c. coupled; middle (sine wave) and lower beams a.c. coupled. Very slight differentiation of the lower square wave is just apparent

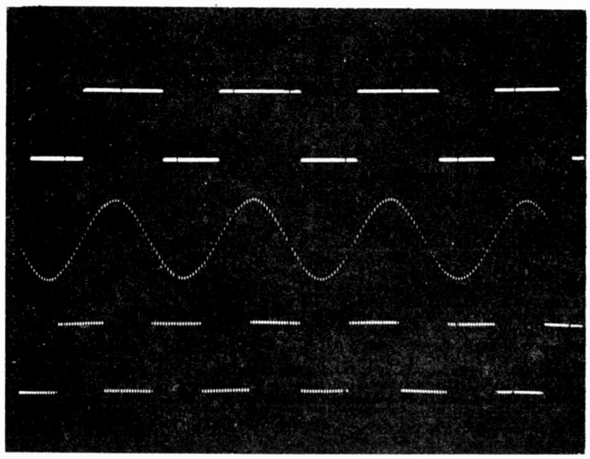
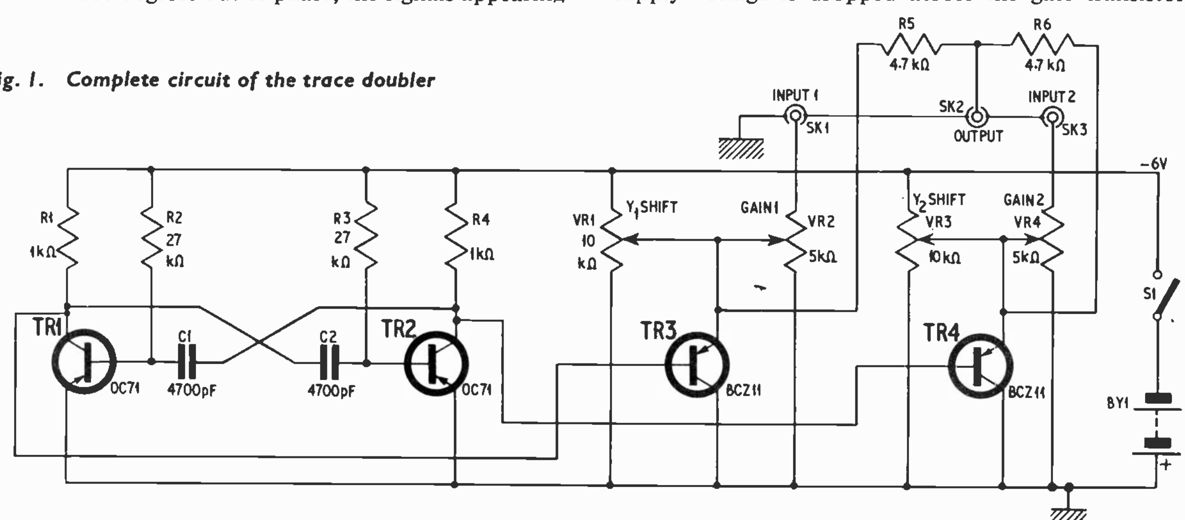


Fig. 3. A square wave and sine wave are injected into the chopper. Both 'scope beams are d.c. coupled

at the two inputs will be alternately shorted to earth, thus producing the switched signal beam at the output.

If Y_1 or Y_2 is at the end of its track, then the whole supply voltage is dropped across the gate transistor.

Fig. 1. Complete circuit of the trace doubler

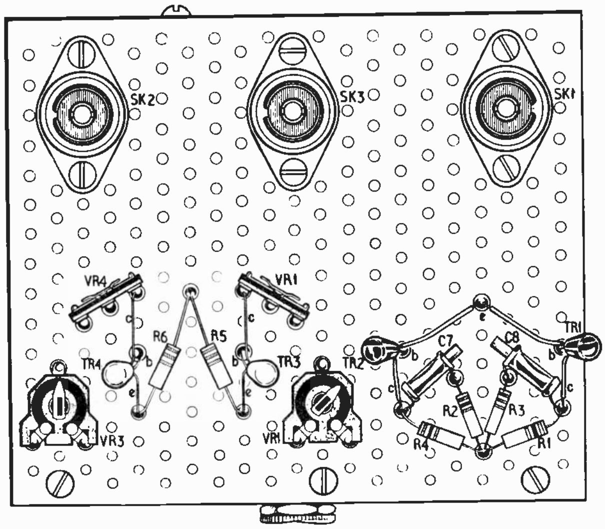


As long as this is less than 9V the transistors are perfectly safe. Excessive current for this case can produce burning on the end of the resistive tracks of either of the 10 kilohm potentiometers. This could, however, be eliminated by making the potentiometers 5 kilohms each with a 5 kilohm fixed resistor in series. This would give a slightly lesser degree of trace separation, but would protect the potentiometers.

COUPLING

For looking at square waves when using the unit, the output has to be d.c. coupled to the oscilloscope input amplifier, as a.c. coupling will produce differentiation (only slight) of the square wave.

Three traces of signals on a Tetronix 502A Oscilloscope are shown.



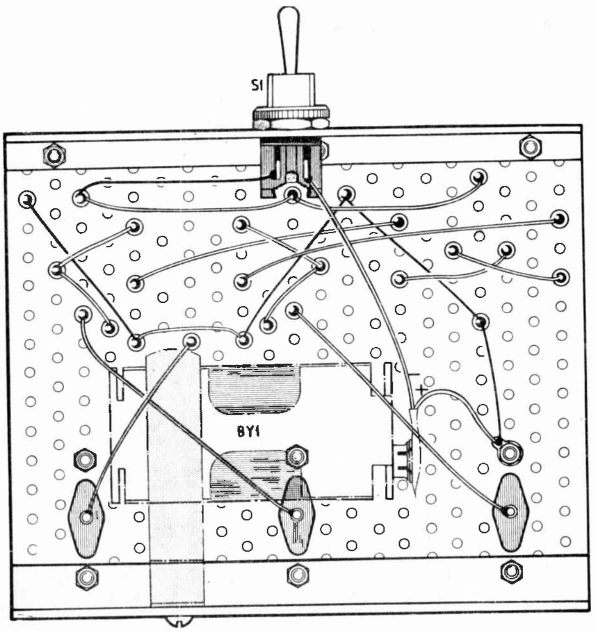


Fig. 4. Top and underside views of the chassis plate

COMPONENTS . . .

Resistors
R1, R4 1kΩ (2 off) wirewound 5% 5W
R2, R3 27kΩ (2 off) } metal oxide 2% 1W
R5, R6 4·7kΩ (2 off) } (Radiospares)

Potentiometers
VR1, VR3 10kΩ (2 off) } miniature preset
VR2, VR4 5kΩ (2 off) } skeleton types

Capacitors
C1, C2 4,700pF

Transistors
TR1, TR2 OC71
TR3, TR4 BCZ11

Switch
S1 Single-pole on/off toggle switch

Battery
BY1 6 volts (4 pen light cells in plastics container)

Miscellaneous
Lektrokit chassis plate No. 7 and Sealectro "cloverleaf" terminals (Home Radio (Mitcham) Ltd)
SK1–3 Plugs and sockets coxial (3 of each)

In each case, the two lower signals displayed are chopped, the upper being the remaining beam of the oscilloscope. This top beam is displaying a square wave of about 1kHz frequency. The middle beam is displaying a sine wave of similar frequency and the lower beam a square wave, again of similar frequency.

In Fig. 3 a square wave as well as a sine wave is injected into the chopper to show that the degree of intermodulation between the two differing shapes is only slight.

The chopping frequency on the lower two traces can be seen, but if this is a criterion, the time constants of the multivibrator can easily be changed to produce minimal chopping signal from appearing on high frequency signals.

All three input signals to the oscilloscope are produced from different isolated sources. If it is required to measure phase shift between signals, it can be seen that by putting two identical signals into each channel of the chopper, no phase shift within the device is present, thus it may be possible to measure direct time differences between signal phases.

The author successfully cascaded two such choppers, one into the other, so that simultaneous display of four signals on a dual beam 'scope was achieved. The output of the first chopper can be fed into the second chopper as one of the two inputs.

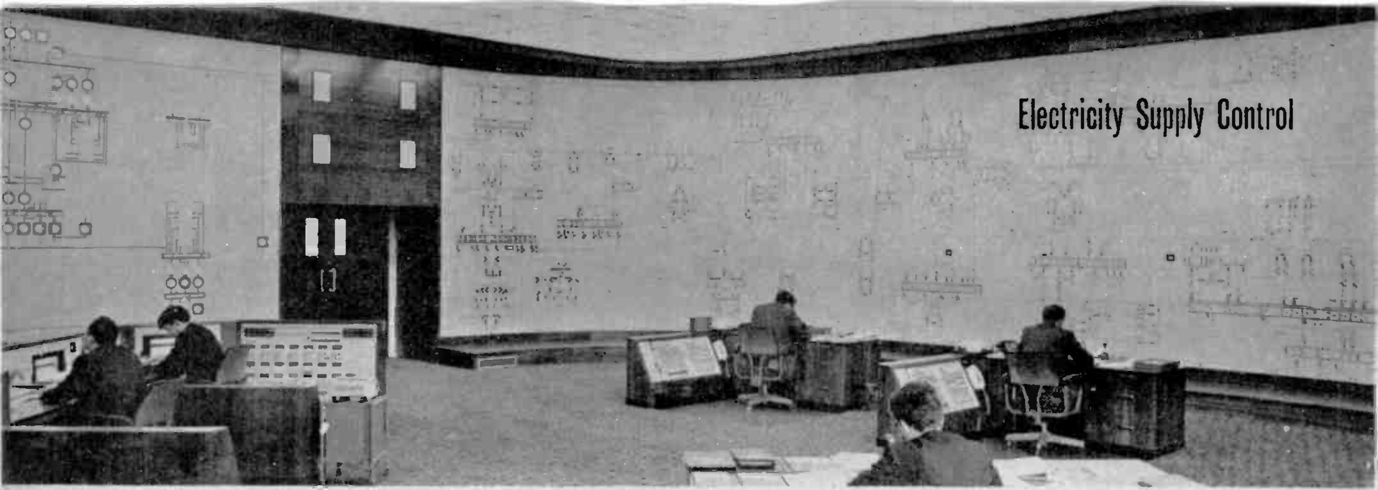
CONSTRUCTION

The circuit was constructed using standard electronic components readily available, and wired together on Lektrokit chassis plate no. 7 with Sealectro cloverleaf press-fit terminals (see page 414 for full instructions). No care was taken to screen all of the connections, although it would be advisable where very small signals from high output impedance sources are used.

If more than two channels are needed two such units can be used together, but intermodulation will occur between the two different chopping frequencies that would be produced. This can be eliminated by using the one multivibrator to drive as many gates as are needed, via a suitable emitter follower, to match the low input impedance of each set of switches.

The transistors BCZ11 are *pnp* silicon types. Germanium types are not suitable in this part of the circuit.

★



Electricity Supply Control

A NEW control centre (above) for the Central Electricity Generating Board at Manchester, this is the first to operate under a three-tier grid control system, and will cover an area from Lancaster to Aberystwyth with a maximum controlled output of 5,480 megawatts. Plessey were responsible for the installation of the control centre.

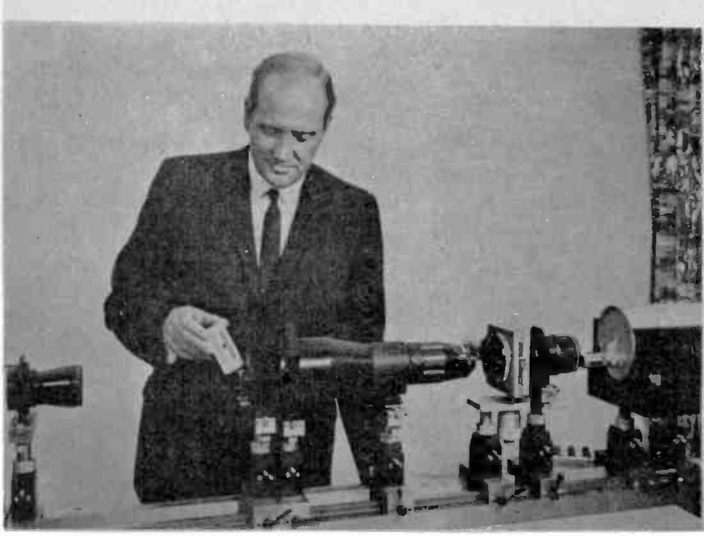
Above right, we show a close-up view of two electro-hydraulically controlled governor valves, which replace conventional mechanical governors on an A.E.I. 300 megawatt turbine-generator at the West Thurrock power station. The new system incorporates an electrical speed sensing unit, from which a frequency signal is obtained and processed to provide a speed error signal. This is added to a reference voltage to control the governor valves.

Precision Measurement Machine Wins Award

THE Council of Industrial Design has given an award to Ferranti for their co-ordinate inspection machine size 4, a photo-electric control system for measuring component holes and surfaces in two directions to an accuracy of $\pm 0{\cdot}001$in over 24in.

Movements of a probe are measured by an optical grating system whose light pulses are sensed by photocells and translated into a digital readout display.

ELECTRONORAMA

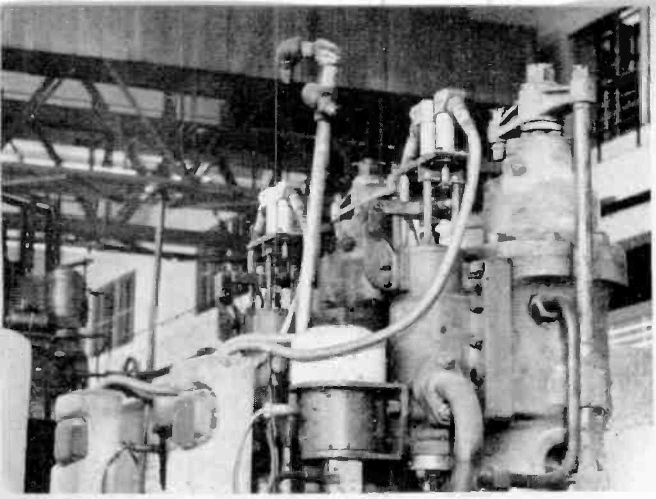


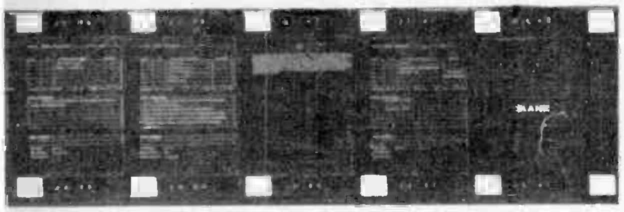
Laser Image Comparison and Display

A FUTURISTIC concept of banking facilities was shown to the Press recently by the National Cash Register Company. The idea is to use holography (a means of detecting and displaying three-dimensional images using a laser beam) to match the shop customer's signature on a credit card to that on his bank account some distance away. It is thought that all shopping using cash can then be replaced by credit card holography systems.

Our picture on the left shows a credit card being inserted into a holograph unit. A photographic reproduction of the signature can be displayed on a terminal unit.

On the right, a laser is used for demonstrating microprinting. Impulses generated by touching the keys of a typewriter keyboard causes the laser beam to form microscopically small characters on a photosensitive plate. The characters can then be printed out by normal photographic means.



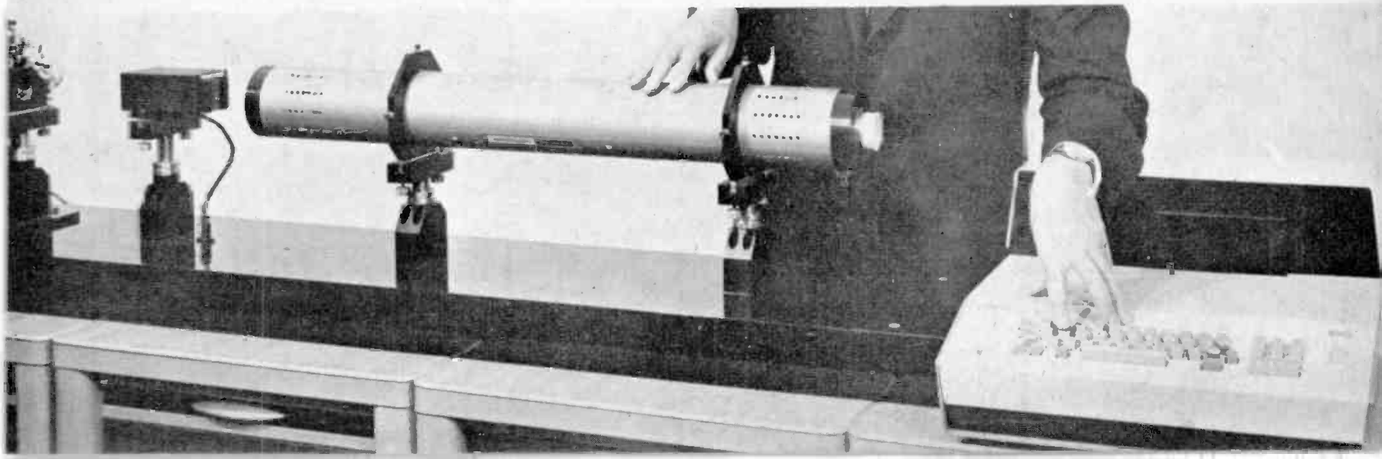


Our title strip above shows a print of a plate that has been subjected to a laser fed image of book pages. The image has been magnified eight times.

FACE Computer Armament

THE interior of the Royal Artillery's new Battery Command Post showing the Field Artillery Computer Equipment (FACE) is shown above. The computer, an Elliott 920B, is on the left and the operator's console is to the right of the automatic typewriter.

Having FACE, which will be issued on the scale of one per battery, will make the Royal Artillery the first arm of any European army to have computers in the forward battle area.



Field Effect TRANSISTORS

PART TWO

By G. B. Clayton, B.Sc., A.Inst.P

THE electrical characteristics and the theory of operation of f.e.t.s were considered last month; in this article some of the circuitry appropriate to f.e.t.s will be considered. It is not the purpose of the article to suggest that the f.e.t. is superior to the ordinary bipolar transistor, indeed arguments on the relative merits of various devices, like the valve transistor controversy that raged in the early days of transistors, are valueless without first clearly formulating a criterion of superiority.

If one adopts the criterion that the "best" device to use is the one that enables the desired circuit performance to be achieved with the minimum financial expenditure, the greater cost of f.e.t.s will usually favour the use of bipolar transistors, except in certain special circumstances, however, the price of commercially available f.e.t.s is falling so that they may eventually be used in preference to bipolar transistors.

F.E.T.s AS AMPLIFIERS

The f.e.t. like the bipolar transistor is a three terminal device and may be used as an amplifier in three different ways depending upon which of its terminals is made common to both input and output circuits.

The three amplifier configurations are called, common source, common gate and common drain analagous to common emitter, common base and common collector amplifiers respectively. The common gate circuit has a low input impedance and therefore offers no real advantages over bipolar transistor circuits, it will not be considered further.

Only junction gate f.e.t.s will be discussed here; insulated gate f.e.t.s are only just coming out of the development stage and are rather expensive.

COMMON SOURCE AMPLIFIER

A simple self-biased common source amplifier using a *p*-channel f.e.t. is illustrated in Fig. 10. An *n*-channel device would, of course, require a positive voltage supply rail. Readers familiar with valve circuits will notice the close resemblance to a common cathode valve amplifier.

Resistor R_s acts in a manner similar to the cathode resistor in a valve amplifier, source current flowing through R_s being used to produce the desired gate-source biasing voltage. R_s is bypassed by capacitor C_s to prevent degenerative feedback. The magnitude

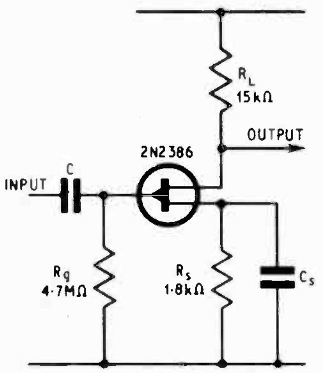


Fig. 10. Simple common source amplifier

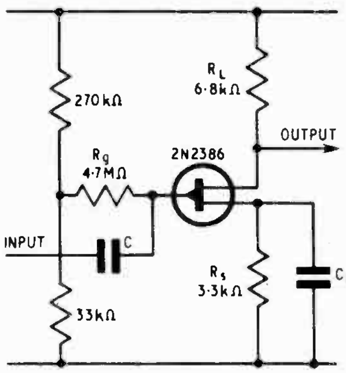


Fig. 11. Common source amplifier with bias

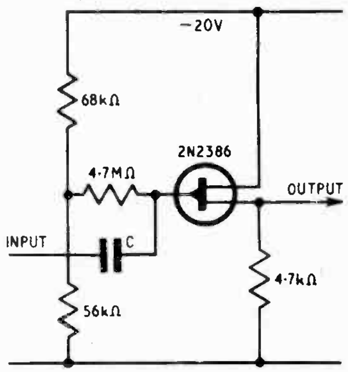


Fig. 12. Common drain amplifier

of the gate resistor (R_g) used should be such that the leakage current which flows through the reverse biased gate junction does not seriously affect the biasing at the highest working temperature.

A circuit giving greater stability of operating conditions is shown in Fig. 11, the method of bias stabilisation being similar to the technique used for stabilising common emitter amplifiers. This method of biasing is preferable for higher temperature working or for compensating for variations in f.e.t. characteristics.

Voltage gains of about 10 are typical for common source amplifiers and because of their high input impedance, the frequency response down to low frequencies may be obtained without the use of very large values of coupling capacitor (C).

Response at high frequencies is limited by a fall of input impedance and a consequent loading of any signal source feeding the amplifier. This is due to the capacitance that exists between gate and source (C_{gs}) and gate and drain (C_{gd}). These capacitances are quite small (C_{gs} = 10pF and C_{gd} = 20pF are typical values for currently available f.e.t.s), but the effective input capacitance of the amplifier due to C_{gd} is increased because the signal voltage at the drain is 180 degrees out of phase with the input voltage applied to the gate (the familiar Miller effect). The effective input capacitance is given by the equation

$$C_i = C_{gs} + C_{gd}(1 + A)$$

where A is the voltage gain of the amplifier. Substitution of typical values gives a value of about 230pF for the input capacitance. Thus at a frequency of 10kHz the input impedance will have fallen from its low frequency value of R_g to about 70 kilohms because of C_i. Input capacitance may be reduced at the expense of loss of gain by using smaller values of load resistance. If the load of a common source amplifier is reactive feedback through C_{gd} can cause instability if no neutralisation is used.

COMMON DRAIN AMPLIFIER OR SOURCE FOLLOWER

This amplifier is analogous to the valve cathode follower and the bipolar transistor emitter follower. It is not phase inverting and is characterised by a high input impedance, low output impedance, and voltage gain less than unity, it is very useful for impedance transformation when f.e.t.s are used with bipolar transistors.

An example of a common drain circuit is shown in Fig. 12. The effect of C_{gs} on the input capacitance is reduced in this type of circuit because the signal output voltage at the source varies in phase with the input signal applied to the gate. The effective input capacitance is, given by the equation $C_i = C_{gd} + C_{gs}(1 - A)$ and with A almost unity the input capacitance is not much greater than C_{gd}.

In order that the gain should approach unity the source resistance should be as large as possible. The relatively large voltage drop and power dissipation occasioned by the use of a large source resistance may be overcome by replacing it with a bipolar transistor as shown in Fig. 13. The effective source resistance is then the large dynamic resistance seen looking into the collector of this transistor. The quiescent current is set by the choice of the emitter resistance R_e.

AMPLIFIERS USING F.E.T.s WITH BIPOLAR TRANSISTORS

The outstanding low level characteristics of f.e.t.s are high input impedance and low noise, they are therefore

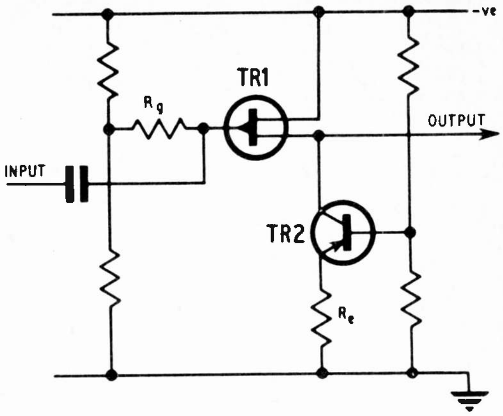


Fig. 13. Common drain amplifier using bipolar transistor instead of load resistor

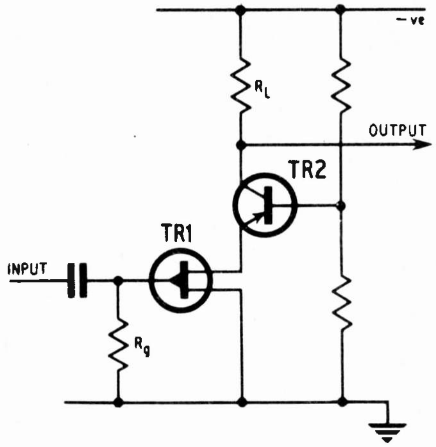


Fig. 14a. Common source amplifier driving a common base pnp transistor amplifier

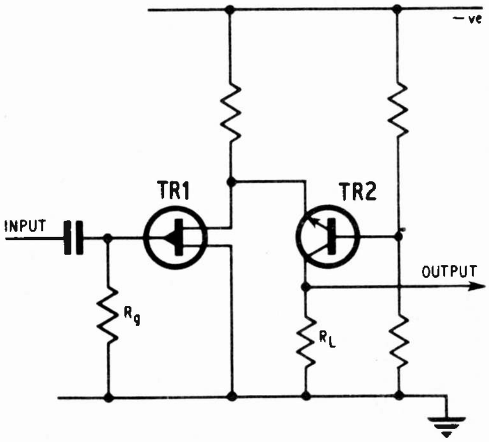


Fig. 14b. Common source amplifier driving a common base npn transistor amplifier

most useful at low level high impedance points in electronic circuits, for example, as a preamplifier for use with a high input impedance transducer. Once the impedance level has been reduced it is more economical to use conventional transistors for further amplification.

Many interesting compound connections of f.e.t.s and bipolar transistors are possible; some increase the bandwidth of the f.e.t. by reducing the effects of inter-electrode capacitance.

An f.e.t. common source or common drain stage may be used to drive any configuration of second stage making six possible circuit configurations. In Fig. 14 a common source amplifier is directly coupled to a common base amplifier, two versions of the circuit are shown. The voltage gain of the common source amplifier is small since it feeds the low input impedance of the common base amplifier. The low voltage gain gives a comparatively small effective input capacitance. The f.e.t. gives a very high current gain. If a large value resistance is used in the collector circuit of the bipolar transistor, high overall voltage and power gains are possible.

The circuit features a great amount of isolation between output and input making it suitable for use as a high frequency tuned amplifier if a tuned load is used instead of the load resistor. The breakdown voltage of currently available f.e.t.s is not large but quite large values of supply voltage can be used with the circuit of Fig. 14a. In this circuit the f.e.t. experiences only the voltage applied to the base of the bipolar transistor.

The effective input capacitance of a common drain amplifier, with gain close to unity, is little greater than C_{gd}, it may be reduced to an even smaller value using the type of circuit shown in Fig. 15.

In this circuit transistor TR3 drives the drain of the f.e.t. in phase with the signal applied to the gate, thus reducing the effective value of C_{gd}. The lower end of the gate resistor is also driven in phase with the signal applied to the gate, thus reducing the current through this resistance and increasing its effective magnitude.

Effective input impedances of many hundreds of megohms are possible; the input capacitance would be less than 1pF. Input capacitance is in fact usually determined by "strays". The circuit is basically a common drain amplifier, so its gain is less than unity.

Another type of compound connection with high effective input impedance, but which can have a voltage gain greater than unity, is shown in Fig. 16. It is sometimes referred to as a "bootstrapped source follower".

The drain of the f.e.t. drives the base of the *npn* transistor whose collector drives the source of the f.e.t. and the lower end of the gate resistor in phase with the input signal. With the component values shown the circuit was found to have a voltage gain of eight and a maximum signal output amplitude of 4 volts. Table 1 shows the input impedance for a wide frequency range.

F.E.T. MULTIVIBRATORS

Field effect transistors can be used in multivibrator circuits in a manner similar to bipolar transistors, but if high speed switching and high pulse frequencies are to be used bipolar transistors give better performance. However when repetitive waveforms and timing circuits having periods of several minutes are required the f.e.t. has a marked advantage.

The maximum timing resistance that can be used with a bipolar transistor is determined by the base current required by the transistor. Because of the high input impedance of an f.e.t. very high values can be used; long time constants can be obtained in monostable and astable circuits without the need for very large capacitance values.

A circuit for a free running multivibrator published by Semitron is shown in Fig. 17. It is said to have a frequency of one cycle per minute.

A field effect timer circuit using a monostable multivibrator is shown in Fig. 18. In the stable state of the circuit transistors TR1 and TR2 are both conducting;

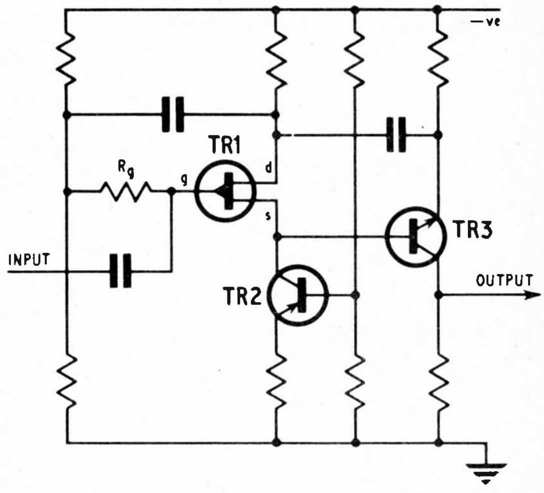


Fig. 15. High input impedance amplifier

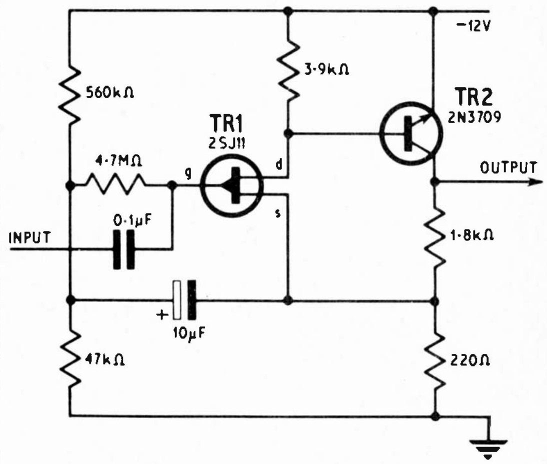


Fig. 16. Boot-strapped source follower

Table I. INPUT IMPEDANCE OF CIRCUIT IN FIG. 16

Frequency	5Hz	1kHz	5kHz	10kHz
Input impedance Z_i (MΩ)	26	26	19	8
Frequency	20kHz	40kHz	100kHz	
Input impedance Z_i (MΩ)	3·1	1·6	0·67	

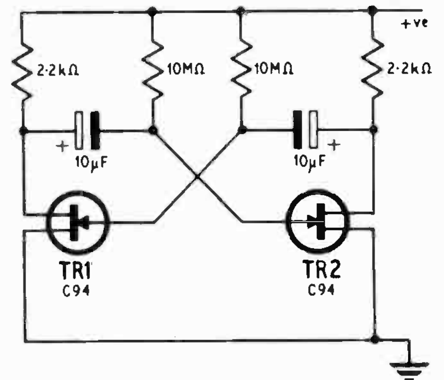


Fig. 17. Very low frequency free running multivibrator

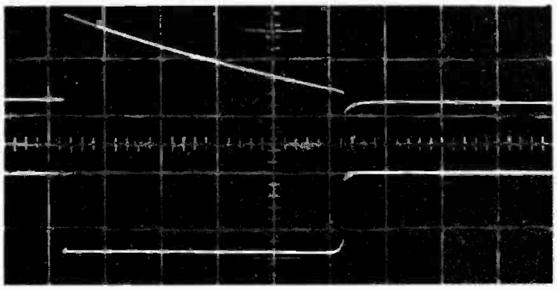


Fig. 19. Gate waveform (top) 5V/cm. TR2 collector (bottom) 5V/cm. Time 0·5 second per centimetre. (Refer to Fig. 18)

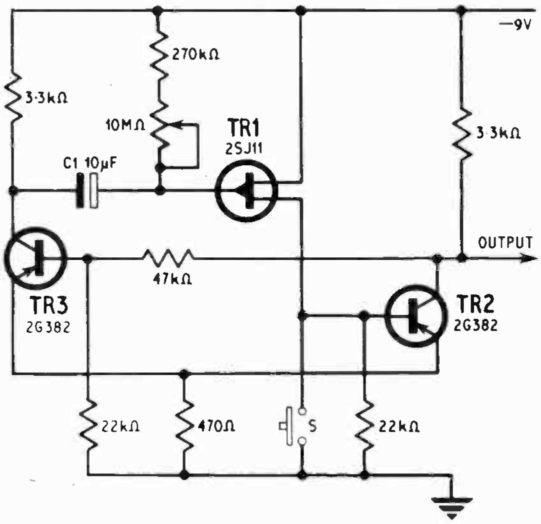


Fig. 18. Field effect timer circuit

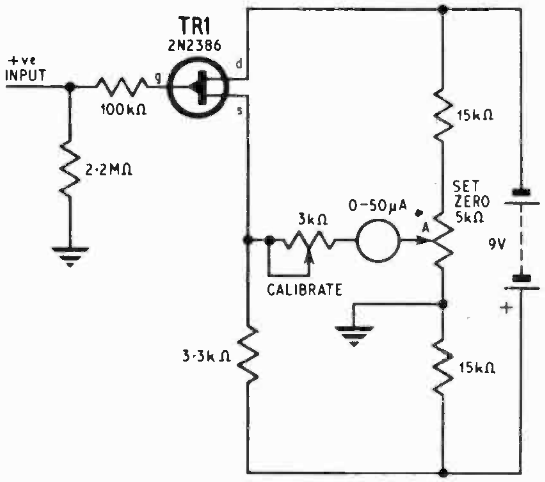


Fig. 20. Simple f.e.t. voltmeter

TR2 is saturated. Transistor TR3 is held cut off by the voltage across the 470 ohm emitter resistor and the potential divider connecting the collector of TR2 to the base of TR3. When the switch S1 is momentarily closed the current through TR2 stops and TR3 suddenly conducts. This causes a sudden change in TR3 collector voltage which is communicated to the gate of f.e.t. TR1 by the capacitor C. TR1 is cut off and this state is maintained until C discharges sufficiently to bring TR1 into conduction again when a regenerative action returns the circuit to its stable state. The waveforms at the gate of TR1 and at the collector of TR2 are shown in Fig. 19. The time delay is proportional to the time constant *CR*, with the values shown the delay is variable between 3 and 90 seconds.

F.E.T. VOLTMETER

The high input impedance of an f.e.t. may be utilised in the construction of high input resistance electronic voltmeters. The circuit of a simple f.e.t. voltmeter is shown in Fig. 20. With no input voltage applied the potentiometer VR1 is adjusted to bring the potential of the point A to the same potential as the source of the f.e.t. so that no current flows through the meter. The VR2 calibration control is adjusted to give full scale deflection of the meter when 0·5V is applied to the input. The basic sensitivity of the instrument is then 4·4 megohms per volt; it is a simple matter to make it read higher voltages by using a suitable input multiplier. The reading of the meter is very stable provided no violent fluctuations in temperature take place and the instrument is extremely useful for measuring direct voltages at high impedance points.

F.E.T.s AS VOLTAGE CONTROLLED RESISTORS

The drain characteristics of an f.e.t. in the non-pinched-off region (low values of drain voltage) are almost linear and their slope is dependent on the magnitude of the gate voltage. In this region the f.e.t. acts as a variable resistor; the gate voltage determines the resistance between source and drain. Interesting applications of an f.e.t. operated in this way are possible.

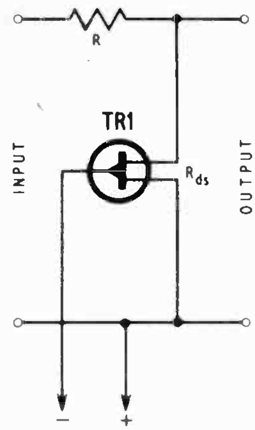


Fig. 21. Voltage controlled attenuator

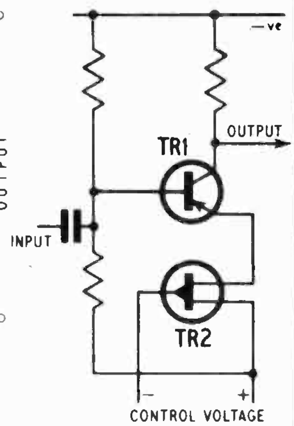


Fig. 22. Voltage operated gain control

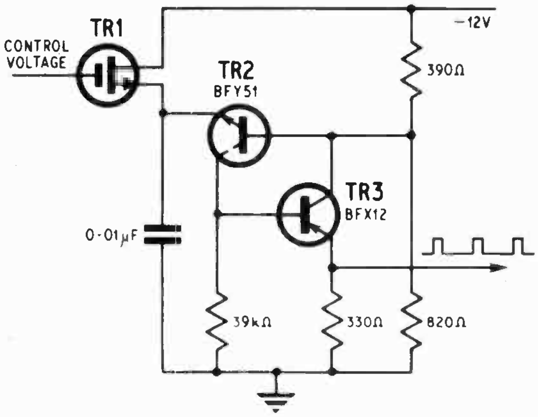


Fig. 23. Voltage to frequency converter

A simple voltage controlled attenuator is shown in Fig. 21. The attenuation ratio is given by

$$N = \frac{R_{ds}}{R + R_{ds}}$$

where R_{ds} is the source drain resistance. The range of attenuation obtainable is dependent on the range over which R_{ds} can be varied and this is a property of the particular f.e.t. in use.

In the circuit of Fig. 22 an f.e.t. is used as a voltage operated gain control. The f.e.t. is used as the emitter resistance of a common emitter amplifier introducing negative feedback. The amount of negative feedback and hence the gain of the amplifier is determined by the value of R_{ds}.

A Mullard circuit using an f.e.t. in a voltage-to-frequency converter is shown in Fig. 23. An insulated gate f.e.t. is used in this circuit although a junction gate f.e.t. could be used in the same way. The f.e.t. is used as the resistive element in a CR *npn-pnp* relaxation oscillator, changing the input voltage to the gate of the f.e.t. alters the effective timing resistor and varies the frequency of oscillation. ★

the 73 page by Jack Hum G5UM

Two-Plus-Three

Most short wave listeners keep in the radio room a copy of *The Callbook* to enable them to identify the stations they hear on the amateur bands. But besides functioning as a radio-station directory *The Callbook* can be a source of interesting and at times surprising information. Properly studied, it will in fact reveal a fascinating cross-section of amateur radio history when it is remembered that all two-letter callsigns printed in it are (with a few exceptions in the G4 block) of pre-war origin, while all G3-plus-three callsigns are post-war. And of course all the G6-plus-three and G8-plus-three special u.h.f.-only licences are post-1964, which was the year in which these "Television" and "Sound Licence B" permits came into issue.

What also becomes evident from a study of the pattern of British amateur transmitting licences is that there exists, in contrast to the overwhelming preponderance of G3-plus-three allocations, a small corpus of callsigns in the G2-plus-three series (yes, we said "G2"!), a fact which has prompted many newcomers to amateur radio to ask: What is the special significance of these calls, and why did the series start in the G2AAA block only to peter out somewhere down the G2HAA block? And why are there so few of them?

Which brings us back to the point where we left off last time, and to a word or two about what was once known as the "artificial aerial" transmitting permit.

That Unroyal Road

Before the war there was no royal road to the acquisition of a transmitting licence, as has been amply demonstrated in the last two instalments of *The 73 Page*. It was certainly not possible then, as it is today, to obtain "a ticket" more or less upon request after passing a Radio Amateurs' Examination: the R.A.E. hadn't been thought of then! No, the procedure which the aspirant to transmitting facilities had to follow was to prove to the licensing authority that the "wireless experiments" on which he was engaged were such that would justify the need to transmit.

It was perhaps not surprising that a majority of applicants said they had experiments with radiating aerials in mind!

Nevertheless, whatever line of experiment was put forward, our (generally young) hopeful would almost certainly not be granted full transmitting authorisation straight away, but—much more likely—would be allocated what was known as the artificial aerial (or A.A.) licence. Its purpose: to enable the newcomer to gain experience with the setting up of transmitting equipment on a non-radiating basis, output being fed not to an outside aerial but to a non-radiating artificial aerial—which today we would call a dummy load.

Although derided in some quarters, the A.A. licence system did offer the very practical advantage of allowing the would-be transmitting amateur to master the problem of generating stable r.f. power on the short waves without making himself a nuisance to others with unintended swishes and blurps. It served also the incidental useful purpose of helping to cool the heels of the over-enthusiastic by compelling them to serve a probationary period before going on the air. (Today's cynics have been heard to say that judging from the poor quality of some of the signals and operating standards that infest the amateur bands of 1967, it is a pity that the probationary period is no longer the law. "Some of 'em ought to be on probation in a different sense!" growled one.)

"No 'G', Lad"

Up to the time of the war in 1939 artificial aerial permits were allocated in the Figure 2-plus-Three-Letter sequence, e.g. *2AHL*. Significantly, the national prefix was not included as part of the callsign as it is today. After all, the A.A. licensee, forbidden to radiate beyond the confines of his home, had no need for national identification. The purpose of his holding his 2-plus-three callsign was to send it to himself!

One young hopeful, proud possessor of a brand new "Two-plus-Three" callsign, asked for it to be published in the radio press of the day complete with the prefix "G". Within a mail or two he found himself pulled up smartly by the G.P.O. licensing authority with a reminder that he couldn't—and shouldn't—use "G" until he had earned his full ticket. The lad survived the reproof, and went on to mount the staircase of St Martin le Grand to take his morse test in the fullness of time.

Six well-known callsigns in the G2-plus-three series are shown on these QSL report cards. All were issued before the war but none of the holders transmitted on the air until after it. Left to right: G2AHL is General Manager of the Radio Society of Great Britain; G2BLA is a noted ornithologist besides being a radio amateur; G2CDX is Chairman of the Cambridge Radio Club; G2DHV is a Major who travels much on the Continent and holds several overseas callsigns as well as his British one; GM2FNF, a farmer, is one of the few transmitting men on the Isle of Arran; and G2HIF is a leading member of the Radio Club associated with the Atomic Energy Authority

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1uf.	..15V.	4uf.	..25V.	20uf.	..6V.	100uf.	..6V.
1uf.	..40V.	4uf.	..100V.	20uf.	..9V.	100uf.	..10V.
1uf.	..50V.	5uf.	..6V.	20uf.	..15V.	100uf.	..12V.
1uf.	..350V.	5uf.	..25V.	25uf.	..6V.	100uf.	..15V.
1·25uf.	..16V.	5uf.	..50V.	25uf.	..12V.	150uf.	..12V.
2uf.	..3V.	5uf.	..70V.	25uf.	..25V.	150uf.	..25V.
2uf.	..9V.	6uf.	..12V.	25uf.	..30V.	200uf.	..3V.
2uf.	..10V.	6uf.	..15V.	30uf.	..6V.	200uf.	..4V.
2uf.	..15V.	6·4uf.	..40V.	30uf.	..10V.	200uf.	..16V.
2uf.	..70V.	8uf.	..3V.	30uf.	..15V.	250uf.	..2·5V.
2uf.	..150V.	8uf.	..6V.	32uf.	..1·5V.	250uf.	..9V.
2·5uf.	..16V.	8uf.	..50V.	32uf.	..25V.	250uf.	..15V.
2·5uf.	..25V.	10uf.	..6V	40uf.	..3V.	320uf.	..2·5V.
3uf.	..3V.	10uf.	..10V.	40uf.	..6·4V.	500uf.	..4V.
3uf.	..12V.	10uf.	..12V.	50uf.	..6V.	500uf.	..25V.
3uf.	..25V.	10uf.	..25V.	50uf.	..9V.	640uf.	..2·5V.
3·2uf.	..6V.	12·5uf.	..4V.	64uf.	..2·5V.	750uf.	..18V.
3·2uf.	..6·4V.	12·5uf.	..40V.	64uf.	..9V.	1000uf.	..6V.
3·2uf.	..40V.	16uf.	..16V.	64uf.	..10V.		
3·2uf.	..64V.	16uf.	..30V.	64uf.	..16V.		

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MARKET PLACE

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

AUDIO FAIR

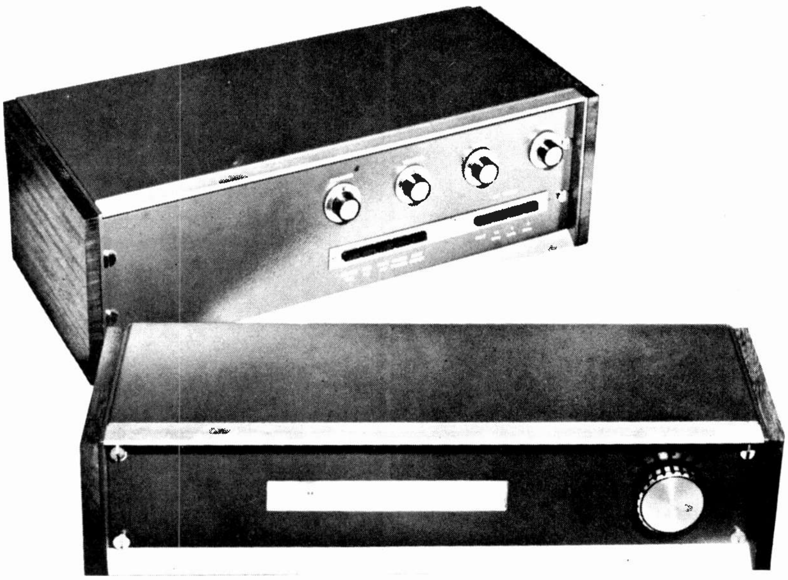
At this year's Audio Fair two companies which made an instant impact were **SGS-Fairchild Ltd.** and **Ferranti Ltd.**, both first time exhibitors in this show.

The full matched set of semiconductors in the AF11 package comprises six transistors for operation at 57 volts and three diodes.

The AF12 consists of seven transistors and one diode; details of a 30 watt amplifier using these are available.

A suitable pre-amplifier design is available for both amplifiers and full details are available from SGS-Fairchild Ltd., Planar House, Walton Street, Aylesbury, Bucks.

An impressive demonstration of audio equipment using silicon planar epitaxial transistors was Ferranti's contribution to the fair. All the pieces of equipment were designed by the Applications Laboratory of the Ferranti Electronics Department and a very good comprehensive 47-page brochure is issued containing all the circuit diagrams, components lists and design notes.



Ferranti pre-amplifier and f.m. tuner

SGS-Fairchild gave details of the AF11 and AF12 "packaged" kits of matched sets of six and seven silicon planar transistors and diodes suitable for building 20 and 30 watt power amplifiers respectively.

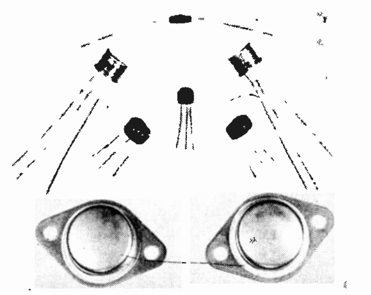
The AF11 package is supplied with full circuit and component details for an amplifier having a guaranteed power output of 20W into 15 ohms. Frequency response is 20Hz to 50kHz (—3dB). Harmonic distortion is less than 0·1 per cent and the sensitivity (for maximum output) is 450mV.

The amplifier incorporates design features such as a stable and reliable direct coupled series output circuit, obviating the need for driver and output transformers. Square wave response is said to be excellent, with very fast rise time and no trace of "ringing".

The brochure is entitled "Ferranti High Fidelity Audio Designs", price 5s 0d, and contains chapters on a wide range transistor phase shift oscillator, pre-amplifiers, 7 to 150 watt amplifiers, power supplies, tape recorder pre-amplifiers and amplifiers, tape record level indicator, tape bias/erase oscillator and an f.m. tuner designed to accept BBC stereo broadcasts. For details of where to obtain copies readers should write to Ferranti Ltd., Gem Mill, Oldham, Lancashire.

Ferrograph Co. Ltd., announced that all Ferrograph microphones are now supplied complete with stands.

Whilst still on the subject of the Audio Fair, in next month's Audio Trends, Clement Brown will be dealing with some of the exhibits in more detail.



The AF12 Semiconductor pack from SGS-Fairchild

CONSTRUCTORS' AIDS

Surplus or misplaced solder can be speedily removed with a desoldering suction pump, price 65s 0d, from **Henri Picard & Frère Ltd.**, 34/35, Furnival Street, London, E.C.4.

Suction is created by a sprung piston, which is released by pressure on a button catch, the solder being sucked through a pointed nozzle and ejected on the return of the piston. This seems rather expensive for a form of "cycle pump".

A new range of double-sided 0·1in matrix Veroboards have just been introduced by **Vero Electronics Ltd.**, of Chandlers Ford, Hampshire.

These new boards should be ideal for producing prototype "lash-ups" before finalising the intended designs. No special sockets for "breadboarding" are required and only a spot-face cutter is needed to break the copper strips.

It is strange the number of times faulty readings, malfunctions and general bad performance in pieces of equipment can be traced to dirt. In most cases it is found that the equipment is very delicate, and rather than risk serious damage by

Desoldering Suction Pump imported by Henri Picard & Frère

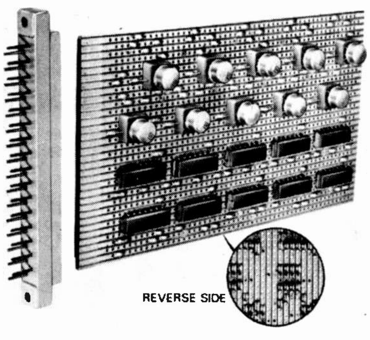
attempting to clean it, one tends to give a few "puffs" to blow any loose grit clear. This procedure may work the first time but over a period of time the accumulation of dirt, grease and oils tends to solidify and no amount of blowing will shift the waste.

Now a contact cleaner, type CO, is available from **Corrosion Abolition Ltd.**, Camey House, Horton Road, West Drayton, Middlesex. This cleaner is packaged in aerosol cans and dissolves most types of waste and does not damage the base material. The cleaner will penetrate the smallest crack or surface opening and the force from the spray blows away the dirt particles, leaving the contact clean.

A product that retailers, designers and constructors will find useful is the new Electroluminescent Numerical Indicator from **Thorn Bendix Ltd.**, Great Cambridge Road, Enfield, Middlesex, the new name for Thorn Special Products who have merged their interests with Bendix Corporation of the U.S.A.

By applying the principles of the electroluminescent lamp in carefully designed segments, it has been possible to produce a neat numerical indicator that will produce all numerals from 0 to 9 and the letters A,C,E,F,H,J,L,P and U. In addition the letters G,I,O and S may be lit by using the figures 6,1,0 and 5 but the possibilities of confusion should be considered before use.

The use of such a light source allows it to be placed directly behind a translucent face, thus eliminating numeral distortion sometimes encountered in conventional indicators with stacked numerals. Also the viewing angle, without distortion, is 160 degrees.



New Veroboard from Vero Electronics

The life of the indicator is not adversely affected by switching on and off, there being no filament or vacuum, and should give many thousands of hours' service. These indicators are housed in either a clear or green polycarbonate case measuring 2⅜in by 1$\frac{13}{16}$in and has a maximum overall thickness of $\frac{9}{32}$in.

Also available from the same company is a new midget relay type RA. The relay is a four pole change-over unit with contact ratings of 3 amps at 115 volts a.c. It has standard a.c. and d.c. coils with nominal coil voltages ranging from 6 to 115 volts. The operating time is 9 to 11 milliseconds and the release time 3 to 6 milliseconds.

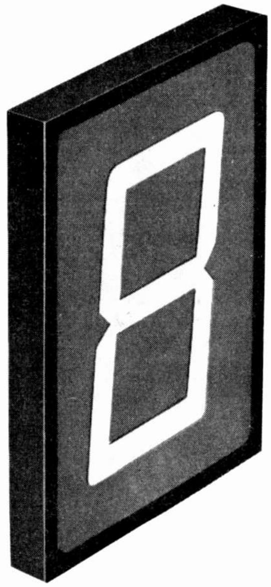
LITERATURE

The new 1967 Electronics Catalogue from **dca Electronics Ltd.**, 28 Uxbridge Road, Ealing, W.5, contains a very large list of test equipment, receivers, amplifiers, and Radiospares components. The price of the catalogue is 1s 6d including postage, separate price lists of valves and transistors are available free of charge.

CO Contact Cleaner by Corrosion Abolition Ltd.

An enlarged list of semiconductors and diodes is just one of the many additions to the new 1967 Henry's Radio Catalogue. A useful item in the 206 page catalogue is a list of transistor alternatives. The price of the catalogue is 7s 6d plus 1s 0d postage. But this can be offset by the use of five free vouchers each worth 2s. These vouchers are only usable on orders over £1 and should be used as per the instructions given in the catalogue. Copies are obtainable from Henry's Radio Ltd., 303 Edgware Road, London, W.2.

A good components catalogue for the "den" is the Arthur Sallis (Radio Control) Ltd., 1967/68 Mail Order Catalogue No. 17, price 3s 0d. Practically any piece of model control equipment can be obtained direct from stock as well as a large amount of general electronic equipment.



Electroluminescent Indicator marketed by Thorn Special Products

It was noticed, whilst shopping for components, that all recognized **International Rectifier** distributors are passing on to the public "Pocket Cross Reference Guides". These guides list encapsulated silicon rectifier assemblies and 1·3A silicon diodes with easy cross reference to I.R. equivalents. These guides should prove useful in the selection of diodes and rectifiers. If any readers are unable to locate their nearest I.R. dealers they can write direct to International Rectifier at Hurst Green, Oxted, Surrey, who will notify them of the nearest agent. We are told that supplies are limited.

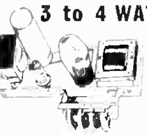
Three brochures on careers in computers have just been published by **English Electric-Leo-Marconi** to coincide with a major recruiting drive aimed at increasing the company's sales and sales support staff. Particular stress is laid in the new brochures on the fact that it is not necessary to have had a narrowly directed training in the past in order to enter the computer field.

The three brochures are entitled "Careers in Computers", a 20-page publication describing in detail the opportunities now available in research, production, engineering, marketing, systems programming, bureau services and operations research; "Careers in Computers for Arts Graduates"; and "Opportunities for School Leavers". Copies are available from English Electric-Leo-Marconi Computers Ltd., Portland House, Stag Place, London, S.W.1.

POCKET MULTI-METER

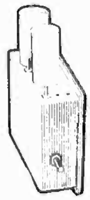
Size 3⅞ × 2⅛ × 1⅜in. Meter size 2⅛ × 1⅜in. Sensitivity 1000 O.P.V. on both A.C. and D.C. volts. 0·15, 0·150, 0·1000. D.C. current 0·150mA. Resistance 0·100k Ω. Complete with test prods, battery and full instructions, 42/6. P. & P. 3/6. **FREE GIFT** for limited period only. 30 watt Electric Soldering Iron value 15/- to every purchaser of the Pocket Multi-Meter

3 to 4 WATT AMPLIFIER



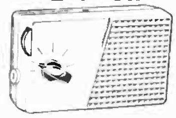
3-4 watt Amplifier built and tested. Chassis size 7 × 3¼ × 1 in. Separate bass, treble and volume control. Double wound mains transformer, metal rectifier and output transformer for 3 ohms speaker. Valves ECC81 and 6v6. £2.5.0 plus 5/6 P. & P. The above in Kit Form, £1.14.6 plus 5/6 P. & P.

CYLDON U.H.F. TUNER



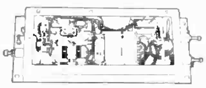
complete with PC.88 and PC.86 Valves. Full variable tuning. New and unused. Size 4½″ × 5½″ × 1½″. Complete with circuit diagram. 35/- plus 3/6 P. & P.

NEW Transistorised SIGNAL GENERATOR



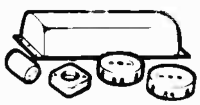
Size 5½″ × 3½″ × 1½″. For IF and RF alignment and AF output, 700 c/s frequency coverage 460 Kc/s to 2 Mc/s in switched frequencies. Ideal for alignment to our Elegant Seven and Musette. Built and tested. 39/6. P. & P. 3/6.

TRANSISTOR INVERTOR



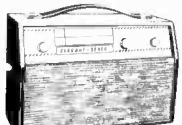
50 v. D.C. Input. Output 240 v. A.C. 40 watts incorporating transformers, choke, condensers and 2 Mullard OC28 in solid 16 gauge Aluminium Case. Size 15″ × 6″ × 2¼″ by famous manufacturers. 19/6 plus 7/- P. & P.

40W FLUORESCENT LIGHT KIT



Incorporating GEC Choke size 8¼″ × 1¾″ × 1¾″, 2 bi-pin holders, starter and starter-holder. 11/6. P. & P. 5/6.
Similar to above: 80 W. Fluorescent Light Kit incorporating GEC Choke size 11¾″ × 1¾″ × 1¾″, 2 bi-pin holders, starter and starter holder 17/6. P. & P. 6/6.
Twin 40 W Choke instant start for 2 × 2 ft. tubes 17/6. P. & P. 5/6.

Special offer
ELEGANT SEVEN mk IIa



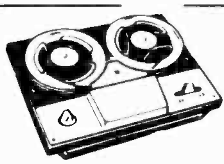
SPECIAL OFFER. 7″ × 4″ P.M. Speaker at no extra charge. Power supply kit to purchasers of 'Elegant Seven' parts, incorporating mains transformer, rectifier and smoothing condenser, A.C. mains 200/250 volts. Output 9v. 100 mA. 7/6 extra.

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

ONLY
£4.4.0
Plus 7/6 Post & Packing

★ De luxe grey wooden cabinet size 12¼″ × 8½″ × 3½″. ★ Horizontal easy to read tuning scale printed grey with black letters, size 11½″ × 2″. ★ High 'Q' ferrite rod aerial. ★ I.F. neutralisation on each separate stage. ★ D.C. coupled push pull output stage with separate A.C. negative feedback. ★ Room filling output 350mW. ★ Ready etched and drilled printed circuit board back printed for foolproof construction. ★ Fully comprehensive instructions and point to point wiring diagrams. ★ Car aerial socket. ★ Fully tunable over medium and long wave, 168-535 metres and 1250-2000 metres. ★ All components, ferrite rod and tuning assembly mount on printed board. ★ Parts list and circuit diagram 2/6, free with parts.

BSR *Tape deck*



AC 200/250 v., tape speed 3¾ twin track.

Special price £5.19.6
Post and packing 7/6

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By Famous Manufacturer

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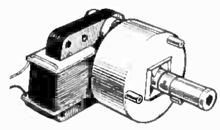
£14. 14. 0
P. & P. £1

Type E MOTOR



Small A.C. mains motor 230/250 volts complete with gearbox, 6 r.p.m. Price 15/- plus 4/- P. & P. Similar to above motor but without gearbox. Price 9/6 plus 3/- P. & P.

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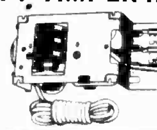
250 v. P.I.V. 750 milliamps. Six for 7/6, Post paid.

TRANSISTORISED 1½ WATT AMPLIFIER



comprising 2AC 128, 20C 75 and 2 AA129 separate bass and treble volume controls. Complete with Power Supply AC mains 240 v. Size 7½″ × 3¼″ × 2″. Price 50/- plus 2/6 P. & P.

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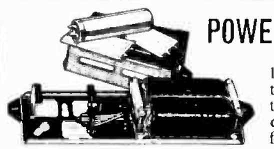

A.C. MAINS 200-250 V
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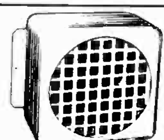
5¾″	L.P. 1200ft.	11/6	5¾″	T.P. 2400ft.	32/6
7″	L.P. 1800ft.	18/6	7″	T.P. 3600ft.	42/6
5¾″	D.P. 1800ft.	18/6	4″	T.P. 900ft.	15/-

P. & P. on each 1/6, 4 or more post free



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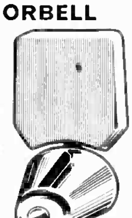
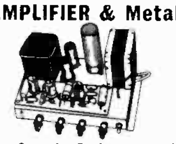
AC Mains 230/250v complete with pull switch. Size 6″ × 6″ × 4″. Price 27/6 plus 5/- P. & P.

GEC DOORBELL



Complete with mains transformer 240v AC and illuminated bell push. Price 12/6 plus 5/6 P. & P.

8-WATT 4-VALVE PUSH-PULL AMPLIFIER & Metal RECTIFIER



Size 9″ × 6″ × 1½″. A.C. Mains, 200-250 v. 4 valves. For use with Std. or L.P. records, musical instruments. All makes of pick-ups and mikes. Output 8 watts at 5 per cent of total distortion. Separate bass and treble lift control. Two inputs, with controls for gram. and mike. Output transformer tapped for 3 and 15 ohm speech coils. Built and tested. £4.4.0. P. & P. 11/-. 8″ × 5″ Speaker to suit. Price 14/6 plus 1/6 P. & P. Crystal Mike to suit 12/6 plus 1/6 P. & P.

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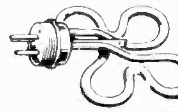

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AC127	2/6	OC139	2/6
AC128	3/–	OC140	5/–
ACY17	5/–	OC170	2/6
AF114	4/–	OC171	4/–
AF115	3/–	OC200	5/–
AF116	3/–	OC201	8/–
AF117	4/–	2G301	2/6
AF118	3/6	2G303	2/6
AF119	3/6	2N697	5/–
AF178	10/–	2N706	5/–
ASY66	2/–	2N711	10/–
BCZ11	5/–	2N1302	4/–
BFY50	15/–	2N1303	4/–
BSY25	10/–	2N1304	5/–
BSY26	5/–	2S303	2/6
BSY27	5/–	POWER TRANSISTORS	
BSY28	5/–	OC20	10/–
BSY29	5/–	OC23	10/–
BSY95A	5/–	OC25	8/–
GET102	2/6	OC26	5/–
GET114	2/6	OC28	7/6
NKT213	2/6	OC36	10/–
OC41	2/6	DIODES	
OC44	2/6	AAY42	2/–
OC45	2/6	OA10	2/–
OC71	2/6	OA70	1/9
OC72	2/6	OA79	1/9
OC73	5/–	OA81	1/9
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C6.	5—Sil. recs., ¾ amp, 100/200PIV ..	15/–
C9.	2—100/60V, sil. trans., 200 Mc/s, ZT84/86	15/–
C14.	2—3 watt planar, 2N1613, 2N1893 ..	15/–
C15.	4—Sil. trans., in the 2S300 series ..	15/–
C16.	1—Sil. power 85 watts, 2S721 series ..	15/–
C17.	2—60v. 160 Mc/s TO-18, 2S103/4 ..	15/–
C18.	1—2N1132 sil. planar, pnp trans. ..	15/–
C20.	3—Germ. NPN trans., 2N1302/4/8 ..	15/–
C21.	3—Germ. pnp trans., 2N1303/5/7/9 ..	15/–
C22.	1—300 Mc/s trans. ASZ21, Mullard ..	15/–
C23.	1—35 amp sil. rec., 100PIV, stud ..	15/–
C25.	2—Power trans., germ., OC28/29 type	15/–
C27.	4—800PIV, 500mA, sil. recs., STC ..	15/–
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C29.	1—200 Mc/s low noise trans., AFZ12 ..	15/–
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C31.	4—Sil. recs. 800 PIV, ¾ amp	15/–
D1.	25—¼W hi-stab. resistors mixed ..	5/–
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D4.	2—Sil. recs., Sub. min., 400/600PIV 400mA	5/–
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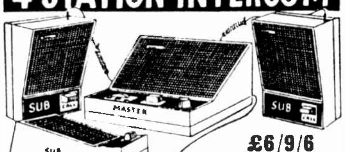

£6/9/6

Solve your communication problems with this **4-Station Transistor Intercom** system (1 master and 3 Subs), in de-luxe plastic cabinets for desk or wall mounting. Call/talk/listen from **Master** to **Subs** and **Subs** to **Master**. Ideally suitable for Business, Surgery, Schools, Hospital, Office and Home. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. and other accessories. P. & P. 6/6.

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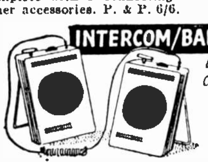

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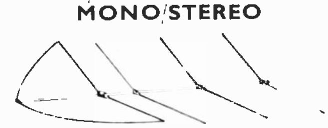

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JOHN VALENCE

NEW MANAGEMENT

From America, a county one particularly associates with the all-powerful business tycoon, comes a message of another wind of change. This message was delivered right here in Croydon, England, last month by Robert G. Chollar, Vice-President of the National Cash Register Company of the U.S.A.

For 1 hour 30 minutes Mr Chollar literally held the stage during a demonstration of NCR's long range research and development programme. The aim was to give businessmen from Britain and other countries "a preview of the advanced systems that will shape the future role of management".

An accomplished speaker plus an exceedingly well produced demonstration of some exotic electronic equipment made quite an impression on those present. If there were any complaints, it was that the range of equipment and systems demonstrated was perhaps too large for a single occasion. But if one suffered a little mental indigestion trying to absorb details of the different techniques on show, the desired effect was obviously registered on the audience ". . . that the information revolution is underway, and cannot fail to have a profound effect in business management circles".

I suspect that another, but less exhilarating, message was that day delivered to our own electronic engineering industry. The visual evidence of actual equipment soon to go into production is rather different to reports one may read about projected developments taking place over the other side of the Atlantic.

Tycoons of the British electronics and computer industry had better get the message—fast! Croydon could well prove to be the jumping off point for another large scale invasion of our markets.

LASERS AND HOLOGRAPHY

And what exactly, are these new aids to management, that are destined "to replace the overrated attribute of intuition". Perhaps the most exciting are based upon applications of the laser and that even more recent technique called holography.

The laser figures prominently as a communications link, both for speech and for transmitting data from a computer in an on-line banking system.

A specific example of holography in use is the identification of signatures on credit cards. This promises to be a vital component of any "cashless' or "chequeless" society.

The equipment demonstrated how when a credit card is inserted into a machine a photograph of the bearer is located in a central file. This picture is then projected onto a screen and so the identity of the bearer can be confirmed.

The NCR demonstration also included microprinting by laser beam. This beam, focused down to an infinitesimal spot, is controlled by a typewriter keyboard. Microscopically small characters are formed on a light sensitive plate. Thus a large amount of information can be recorded in a small space. Retrieval and reproduction on enlarged scale can be performed at will.

One of the original members of the cashless society

BACK TO BASICS

The armed forces have to be prepared for even the ultimate catastrophe overtaking their electronics.

During a demonstration of FACE (Field Artillery Computer Equipment) it was stated that previously it had taken several months to train an artillery team to carry out the laborious calculations involved before each "shoot". Now the use of FACE meant that an operator could be trained to the requisite standard in just one week.

Nevertheless, a high ranking R.A. officer reassured one rather apprehensive inquirer, the army will continue to provide a certain amount of basic training in triangulation and other relevant sciences for its R.A. crews. Thus, as this officer explained, in the unlikely event of complete electronic failure the crew would be able to perform the essential basic calculations on a slide rule and back of an old envelope! So the shooting would continue—albeit a trifle less accurate than before!

ODD JOTTINGS

Come to think of it, that "old envelope" must have played a significant part in the affairs of man from time to time. How much literature, art, or music would have been lost for ever if that humble item had not been present in the pocket of some genius at the vital moment.

As for the world of science, we might still be waiting for the laser but for the fact that Charles Townes had an inspiration while sitting on a park bench in Washington D.C., way back in 1951.

Speedily he made some calculations on the back of an old envelope. The result suggested a new approach in his experimental work on the production of centimetric waves. This lead to the invention of the maser, which as you know was the forerunner of the laser.

So, you budding geniuses, never discard all your old correspondence. You never know when the Muse will descend.

Readout—
A SELECTION FROM OUR POSTBAG

Radiation counter

Sir—With reference to my article *Radiation Counter* in the March 1967 issue. I would draw readers' attention to an error on the e.h.t. circuit Fig. 3.

The base bias resistor (R16) should be shown connected to the negative supply rail and not the collector of the transistor as it appears in the magazine. I would think that the latter configuration would severely damp the oscillatory circuit, however the effect on its performance could only be found by experiment (it may in fact work like this). This error also renders the underside wiring diagram Fig. 5 incorrect.

P. F. Bretherick,
Eastcote,
Ruislip,
Middlesex.

Surprise flash

Sir—In your article *Photoflash Slave Unit* in the March 1967 issue, you suggest adapting an extension lead by reversing the wires to one of the connectors to ensure that the slave unit may be connected to an electronic flashgun with polarities on its trigger lead connector opposite to those required on the slave unit connector. While this is perfectly satisfactory electronically, it should be pointed out that the better quality extension leads have connectors with all metal casings. Adapting such an extension lead would result in the casing of one connector having a polarity opposite to that of the other connector. Touching both connectors with the flashgun switched on would result in one's fingers being effectively shorted across the flashgun's trigger capacitor, which may be charged to a potential of up to 250 volts. While this would constitute no danger to a normal healthy person, the element of surprise might cause the equipment to be dropped, with somewhat disastrous results!

With this in mind, perhaps a better method of ensuring correct polarity would be to use an extension lead with moulded plastic connectors. As the insides of these connectors are not accessible without destroying the casing, the lead itself would have to be cut and reconnected in reverse, the join naturally requiring careful insulation. This would result in only the actual connecting points of the two connectors having opposite polarities. The chances of touching both these at the same time are only small. However, if metal-cased connectors are employed on the flashgun trigger lead and the slave unit itself the effectiveness of this is reduced considerably.

The most satisfactory arrangement would be to utilise some of the unoccupied space in the slave unit case by fitting a switch to reverse the connections between the slave unit's connector and the thyristor.

A. W. Hawkins,
Lowestoft,
Suffolk.

Quick-blip

Sir—I have been taking this journal for quite a time and have been particularly pleased with the articles on Radio Control by Mr D. Bollen. I hope you will persuade him to do some more of this type of article. . . .

My other request is this, could your contributors give general parameters of transistors used in their articles as well as the alternatives. I would like to make up a lot more of the gear described but am often unable to get the transistors listed in the materials lists. Our local dealers have never heard of some of the transistors specified and even famous makes such as Mullard are difficult to obtain. Given some details of the transistors used, one could try and find alternatives among those available locally.

H. C. Wells,
Como,
Western Australia.

We have twisted Mr Bollen's arm and the first part of a new article starts on page 432 this month.

Hot point

Sir—It is with horror that I realise that no emphasis has been placed on the ease with which f.e.t.s can be destroyed. I have in mind all those unsuspecting enthusiasts who are contemplating the building of your Integrated Stereo Amplifier (December 1966 issue), in which I note there is no protection of the f.e.t. from lethal transients. The transistor in question, a 2N3819, has a maximum rating of 20 volts gate to any other electrode. Unlike an ordinary transistor, it will be permanently destroyed if any breakdown occurs, and even touching the gate with a finger may cause this if the body has some stray capacity to the mains. After my first disaster, I adopted the following procedure:

Before the transistor is ever brought near mains, batteries, or soldering irons, a length of fine wire (about 36 s.w.g.) is wound round the three leads to short them to each other, and kept in place until construction is complete, and a pair of catching diodes installed. These diodes are reverse biased and connected between the gate and the appropriate voltage sources to limit the range of voltage applied to the gate. In the case of the Stereo Amplifier, one is connected to earth (anode end) and the other (cathode end) may be taken to the drain electrode. These catching diodes must be silicon, type OA200 being suitable, and will protect the transistor against transients which can occur when plugging in external signal sources.

James M. S. Hutchinson,
University of Bradford,
Bradford, 7.

While your comments are entirely justified, it must be said that I have designed quite a few circuits for the practical constructor that do in fact contain field effect transistors and have yet to be informed of anyone who has had the misfortune to liquidate one. As long as common sense is used in the handling of these devices, they are quite as tame as the bipolar transistor. As you will no doubt appreciate there was a great deal of trepidation in soldering transistors without a heatsink in the early days, but standard soldering procedure would in fact have caused no trouble at all.

However, do not misunderstand me, there is a real danger of field effect transistor and possibly one of the more pertinent points would be in ensuring that the soldering iron is isolated from the mains earth. No doubt this comment will draw criticism from some people as safety is all a matter of degree.—R.H.

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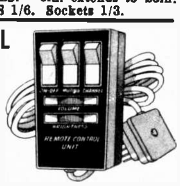

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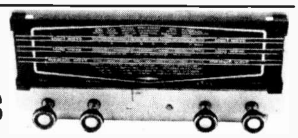

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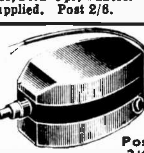

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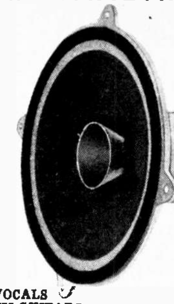

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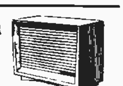

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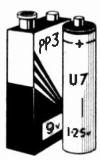

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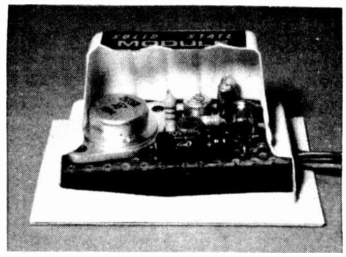

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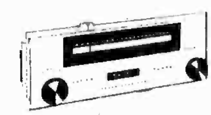

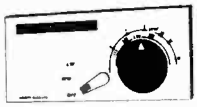

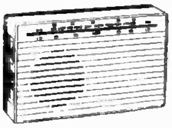

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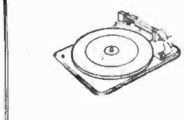

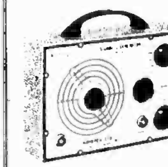

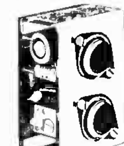

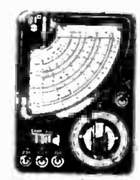

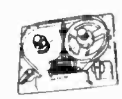

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