Practical Electronics

MAY 1965

PRICE 2/6

FREE inside

2 BLUEPRINTS

* AUDIO OSCILLATOR AND OUTPUT METER
* MICROPHONE MIXER
* SIMPLE SHORT WAVE RECEIVER

PRESENTED FREE WITH
MAY 1965
PRACTICAL
electronics

MICROPHONE

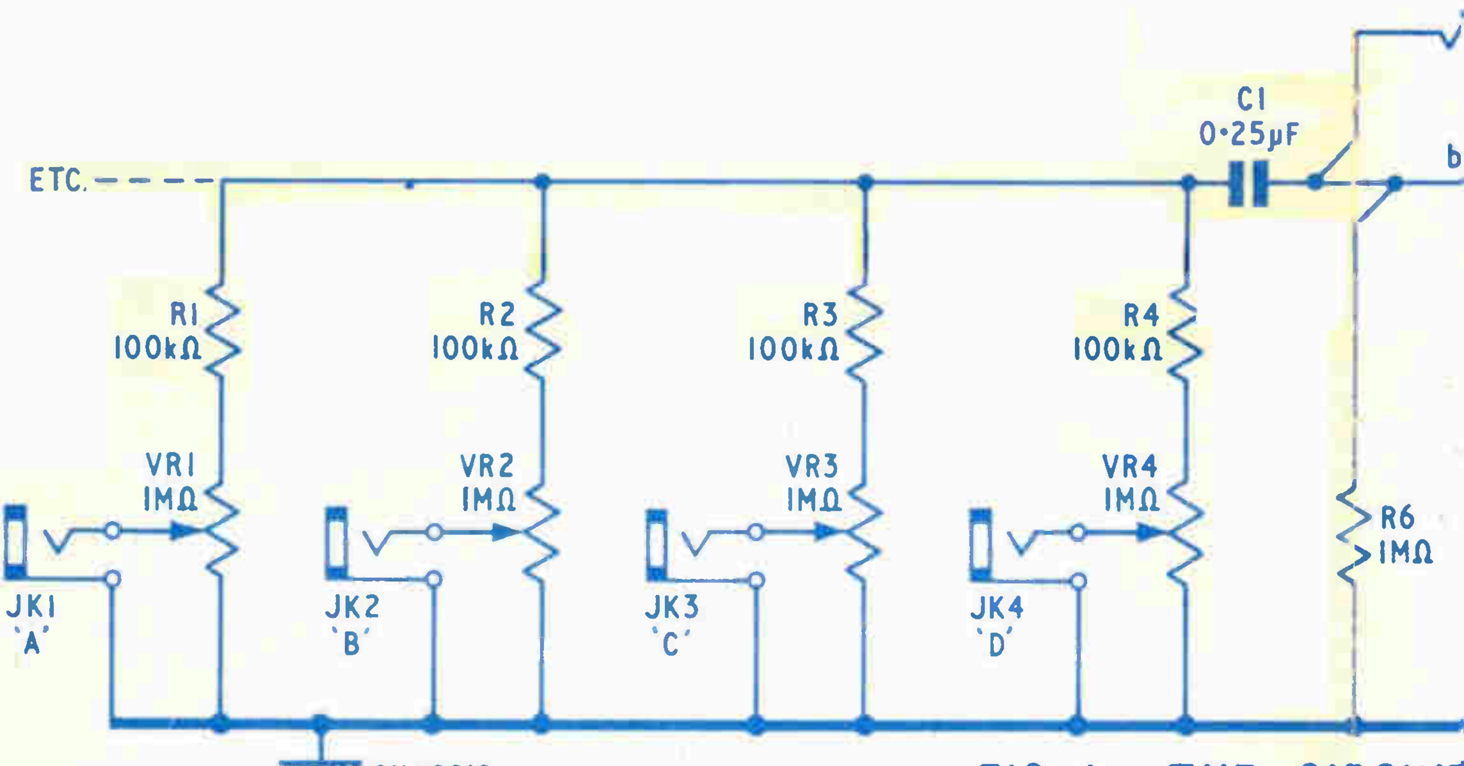
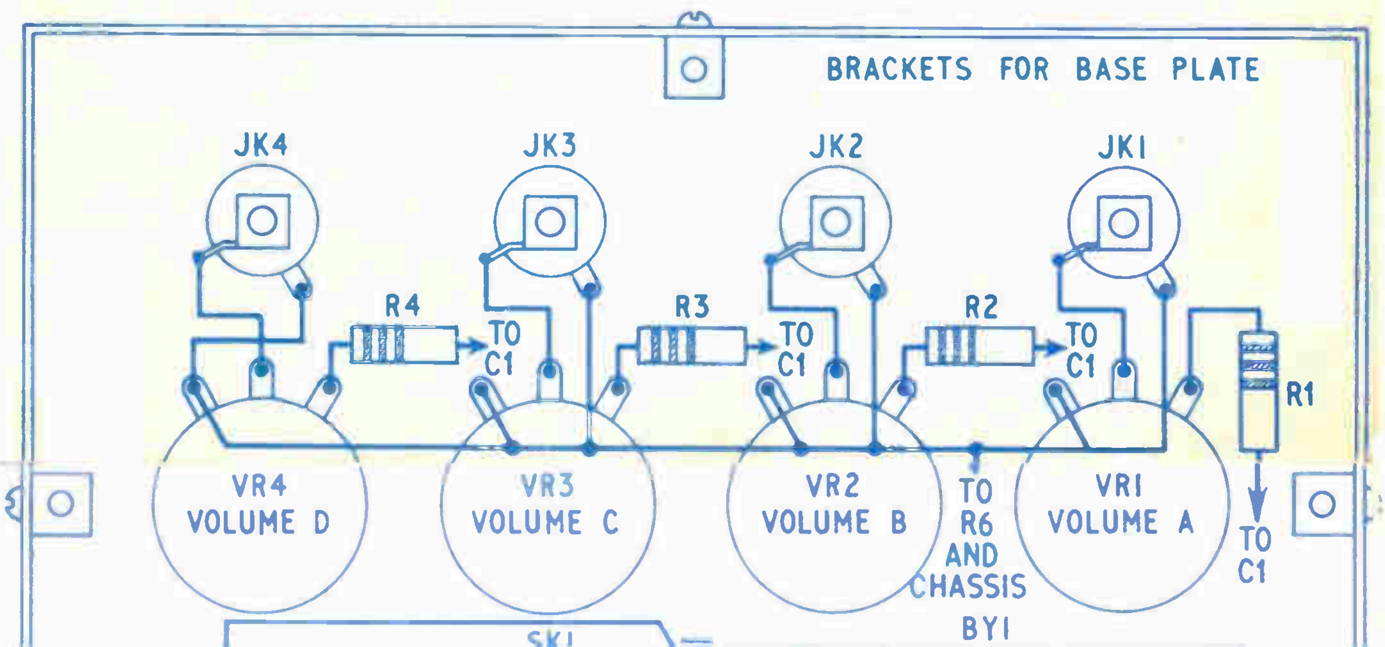


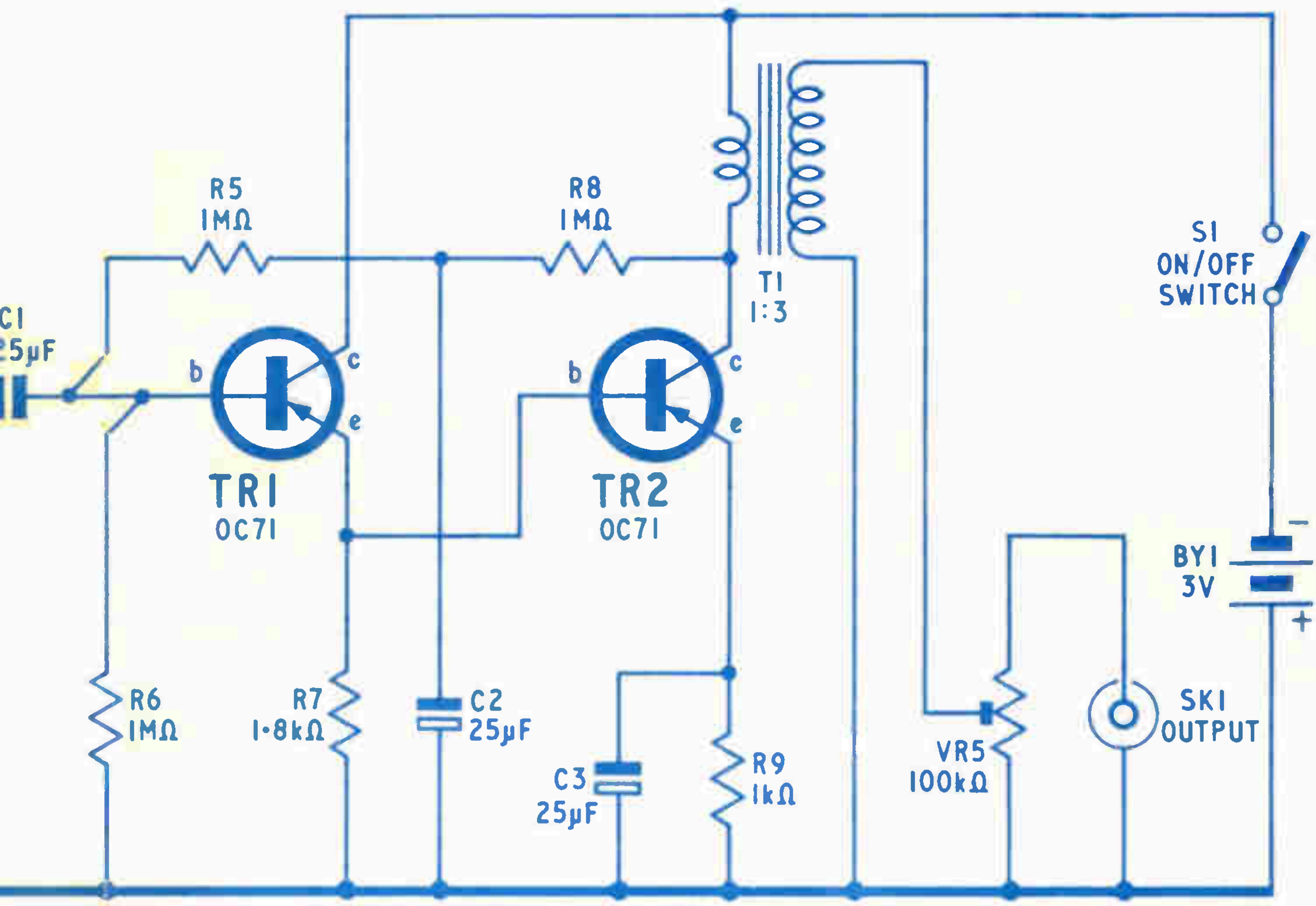
FIG. 1 – THE CIRCUIT



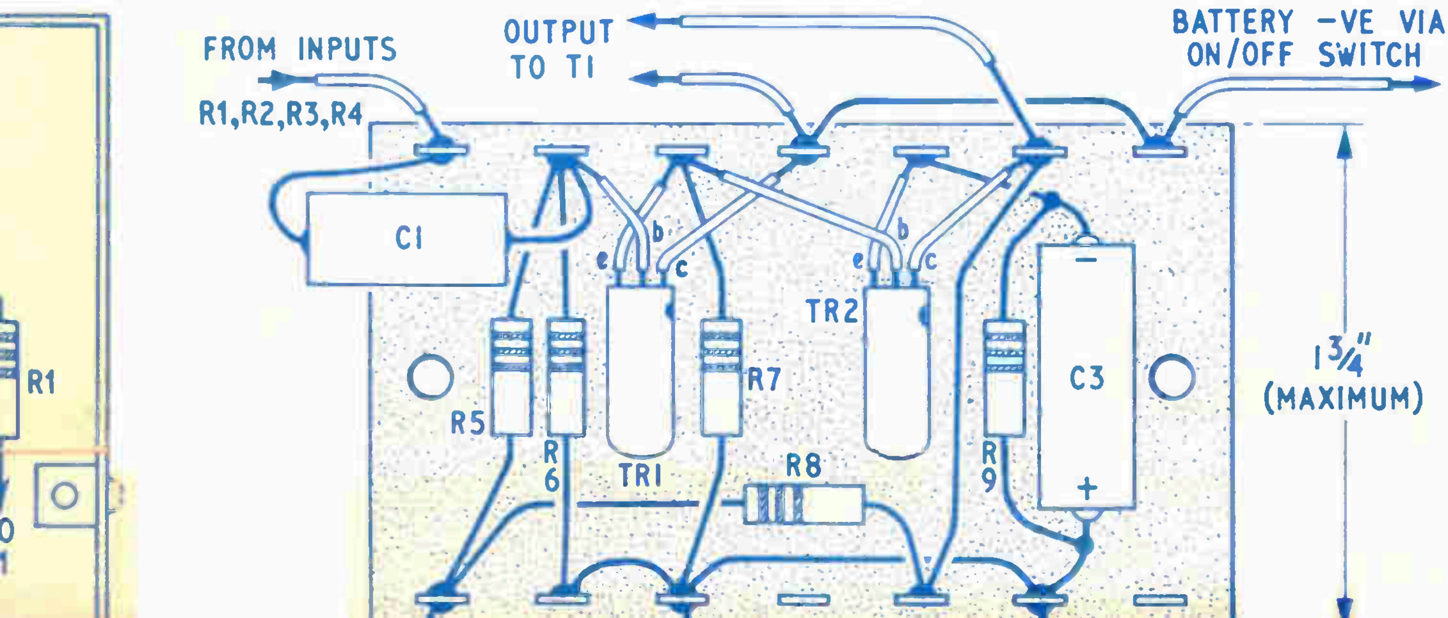
ONE MIXER UNIT

PRICE 5/-

PUBLISHED BY GEO. NEWNES LTD.
TOWER HOUSE, SOUTHAMPTON STREET,
LONDON, W.C.2.



E CIRCUIT DIAGRAM



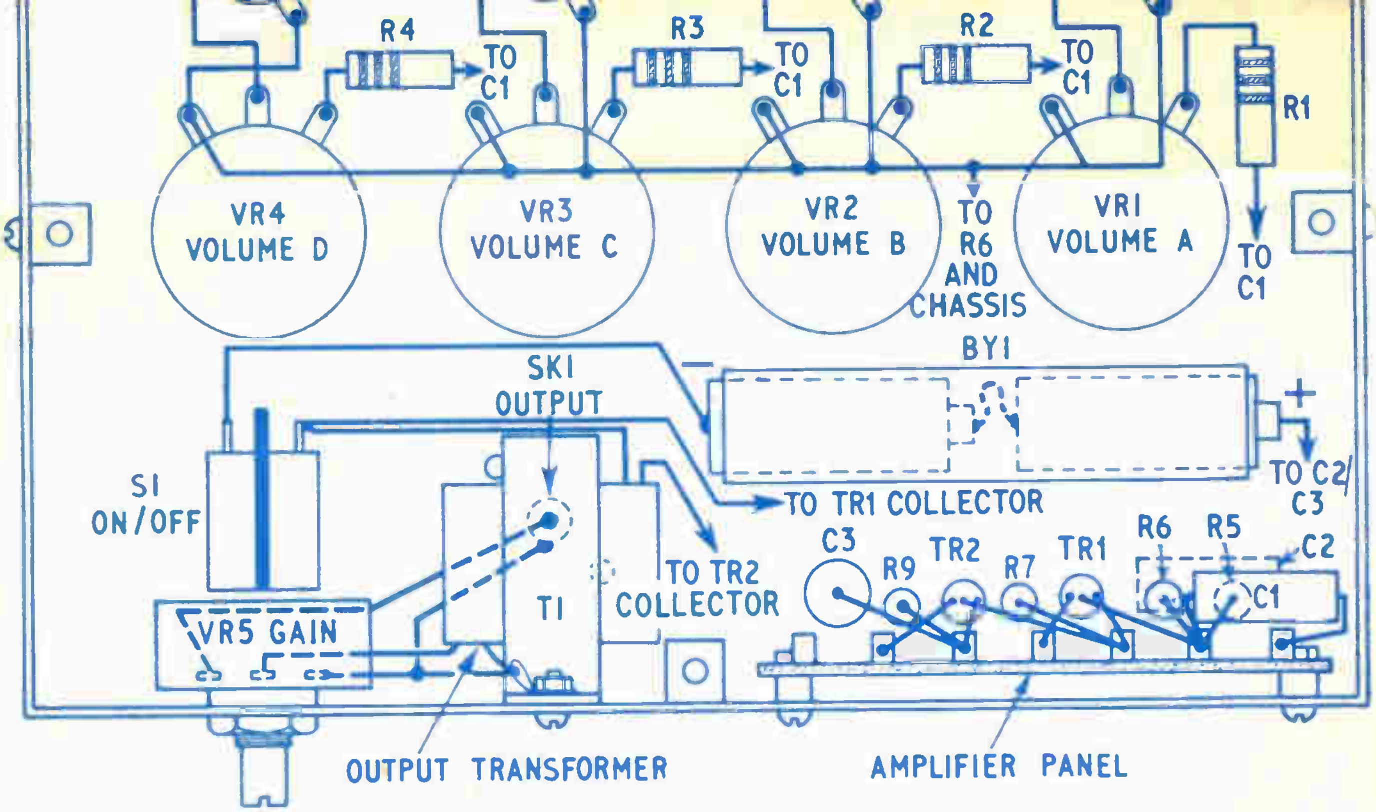


FIG.

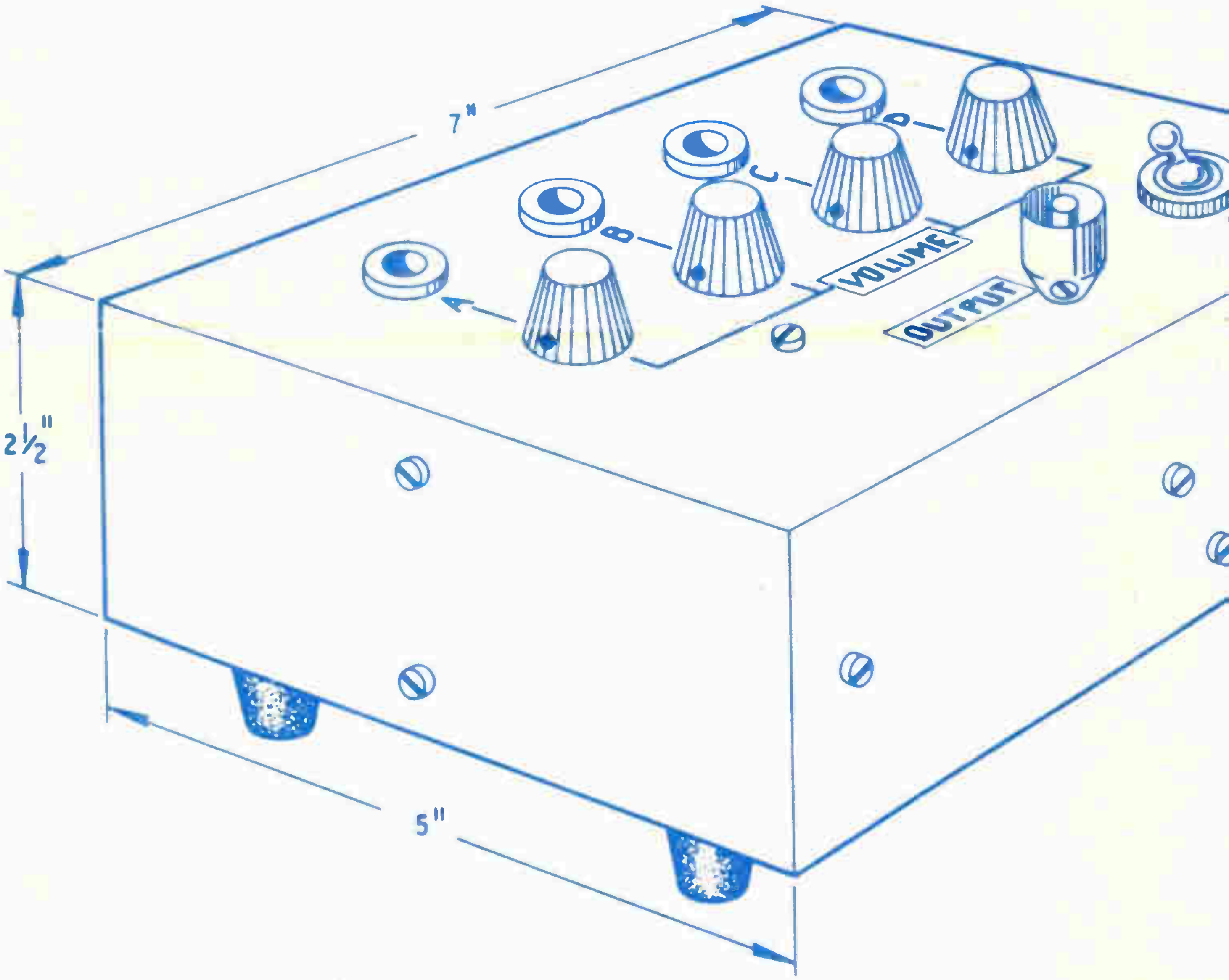


FIG. 4 – VIEW OF COMPLETED UNIT

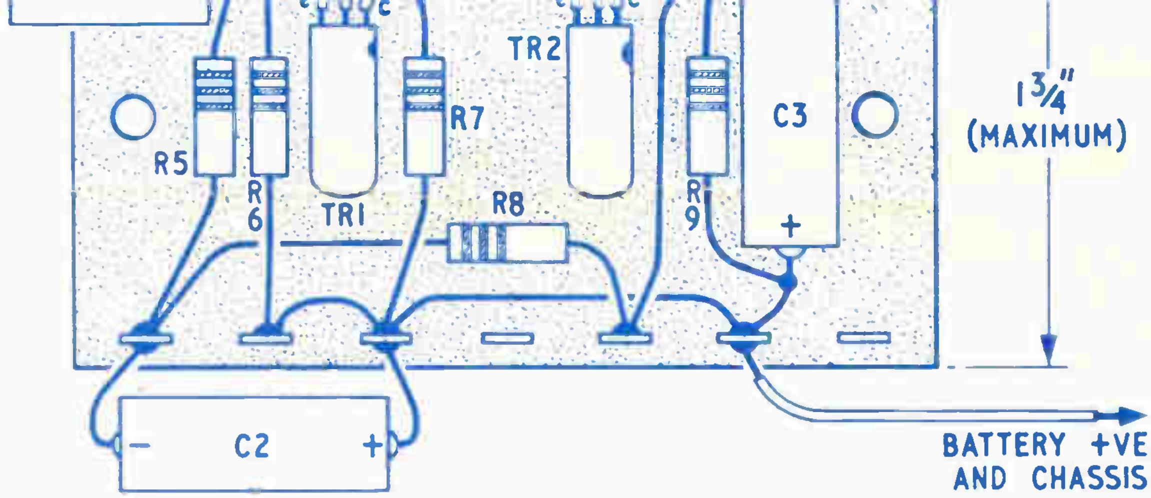
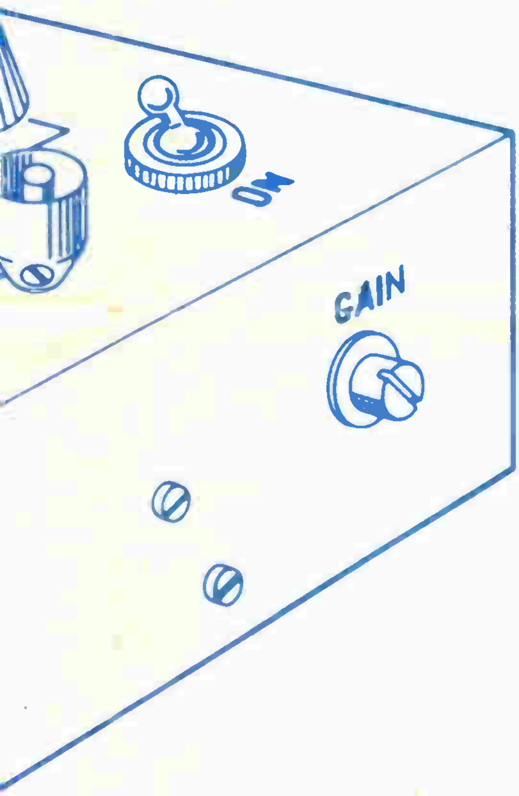


FIG. 3 – AMPLIFIER PANEL WIRING

FIG. 2 – LAYOUT OF CHASSIS
(FULL SIZE)



NIT

COMPONENTS LIST

Resistors

R1	100kΩ	R6	1MΩ H.S.
R2	100kΩ	R7	1·8kΩ H.S.
R3	100kΩ	R8	1MΩ
R4	100kΩ	R9	1kΩ
R5	1MΩ H.S.		

All 10%, ¼W carbon

Potentiometers

VR1-VR4 1MΩ carbon, logarithmic
VR5 100kΩ carbon, logarithmic

Capacitors

C1 0·25μF paper
C2 25μF electrolytic, 25V
C3 25μF electrolytic, 25V

Transistors

TR1 OC71
TR2 OC71

Transformer

T1 Intervalve transformer, 1:3 ratio

Switch

S1 Single pole, on/off toggle switch

Sockets

JK1–JK4 normal 2-contact insulated jack socket (Igranic or Radiospares)
SK1 Coaxial socket

Battery

BY1 3V battery (two 1·5V pen cells)

Miscellaneous

Four matching knobs. Aluminium box 7in × 5in × 2½in, with removable bottom panel. Four small rubber feet

PRESENTED FREE WITH
MAY 1965
PRACTICAL
electronics

AUDIO OSCILLATOR

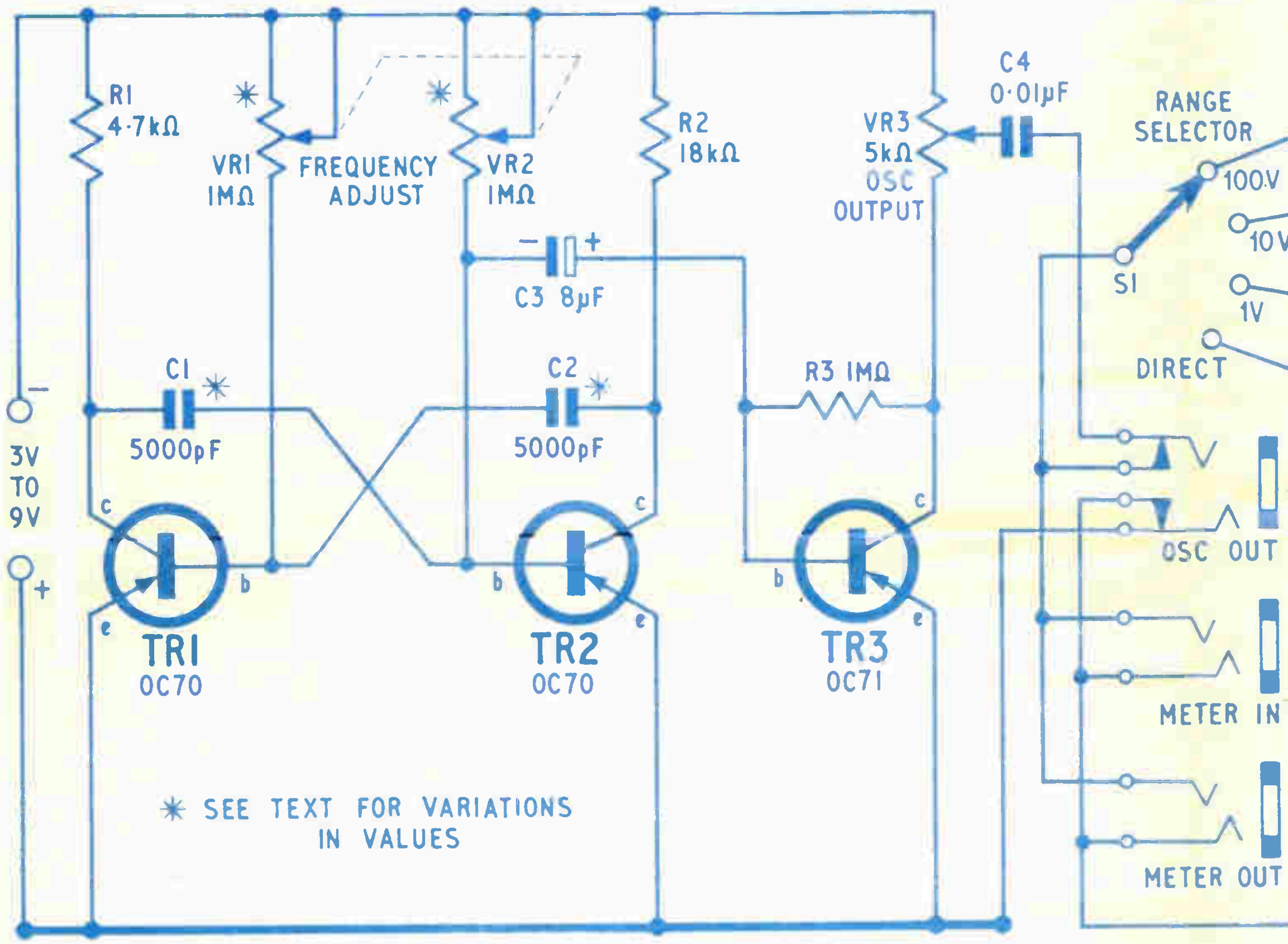
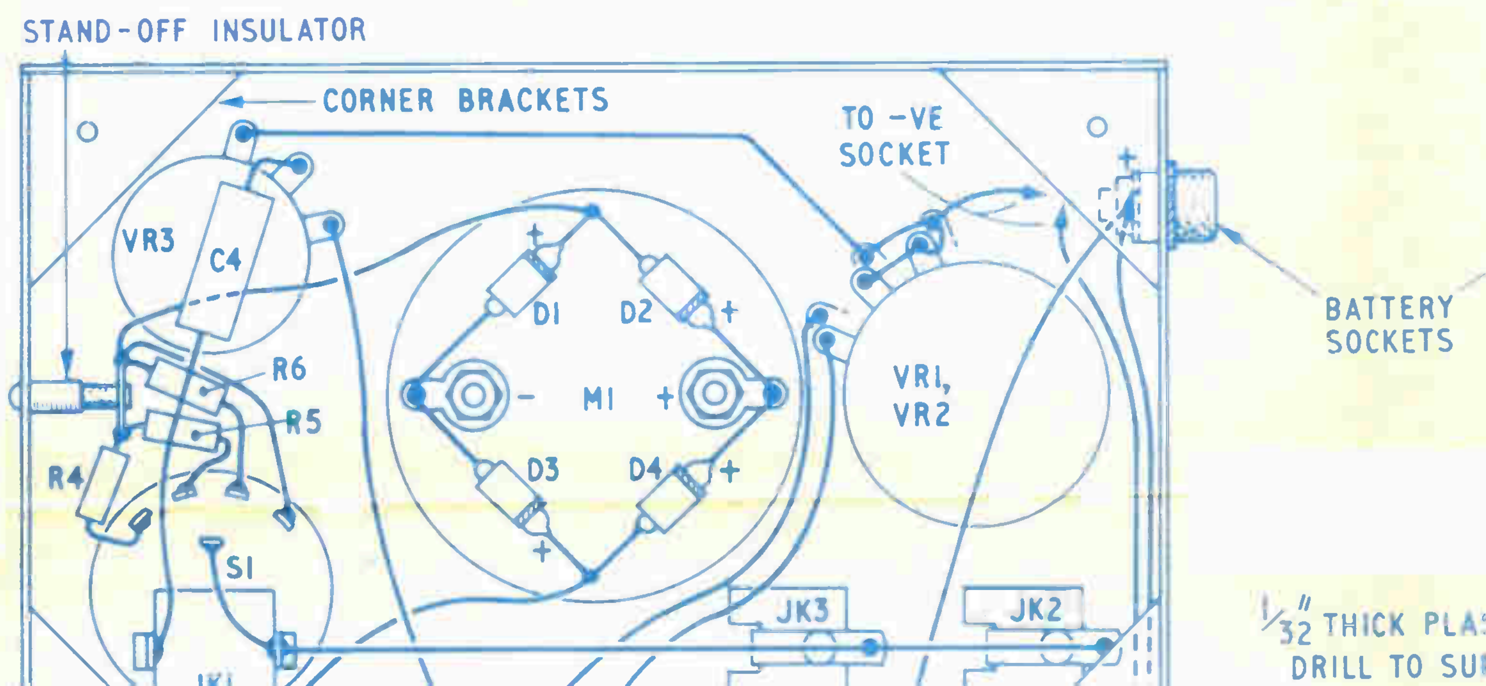


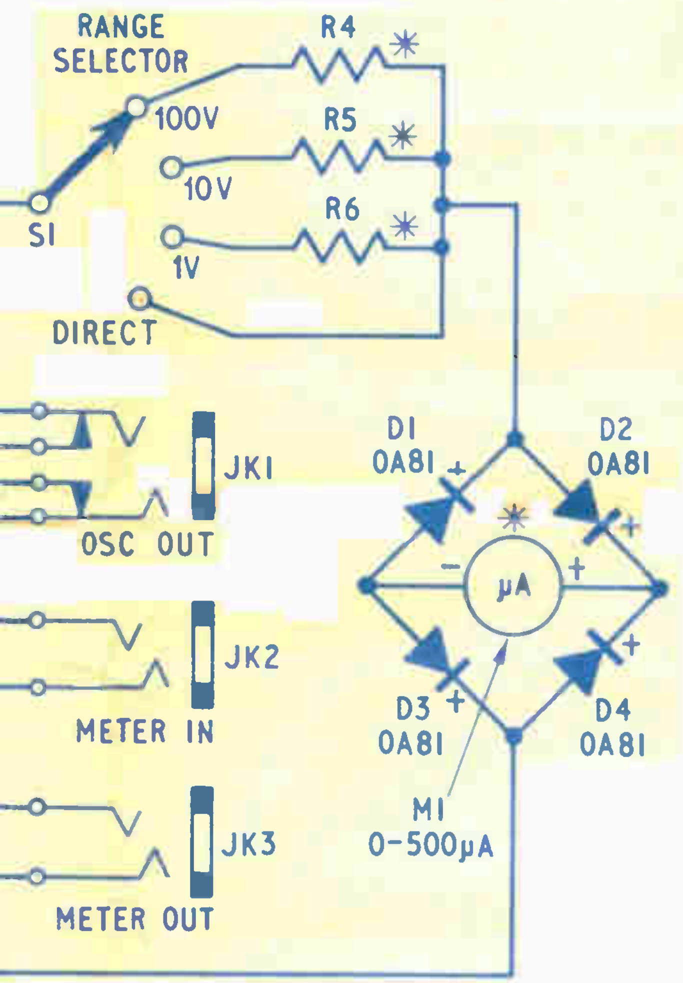
FIG. 1 – THE CIRCUIT DIAGRAM



...ATOR & OUTPUT METER

PRICE 5/-

PUBLISHED BY GEO NEWNES LTD
TOWER HOUSE SOUTHAMPTON STREET,
LONDON, W C 2



COMPONENTS LIST

Resistors

R1 4·7kΩ
R2 18kΩ
R3 1MΩ
R4, R5, R6 } depend upon meter used—see text
All 10%, ¼W carbon

Potentiometers

VR1 1MΩ carbon, linear } ganged
VR2 1MΩ carbon, linear }
VR3 5kΩ

Capacitors

C1 5,000pF silver mica, 5%
C2 5,000pF silver mica, 5%
C3 8μF electrolytic, 15V
C4 0·01 μF Paper

Transistors

TR1 OC70, OC71 or similar
TR2 OC70, OC71 or similar
TR3 OC71, OC72 or OC76

Diodes

D1-4 OA81 germanium diodes (4 off)

Jack Sockets

JK1 closed-circuit, insulated jack } (Igranic or Radiospares)
JK2,3 normal 2-contact insulated jack }

Meter

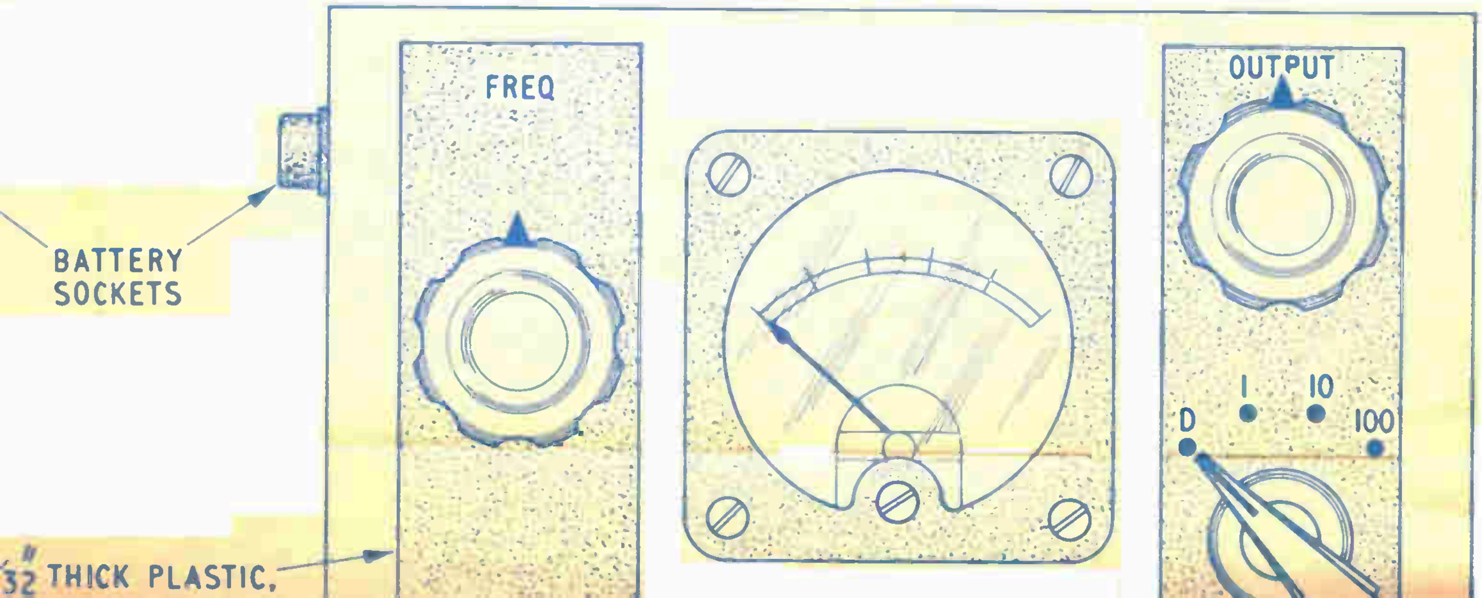
M1 Moving coil, 500μA f.s.d., scaled 0-10

Switch

S1 Single pole, 4 way rotary switch

Miscellaneous

Pair of sockets, one red, one black (Radiospares). Three knobs. Two 7-tag miniature terminal strips. Aluminium sheet for case. Nuts and bolts, rivets, solder tags



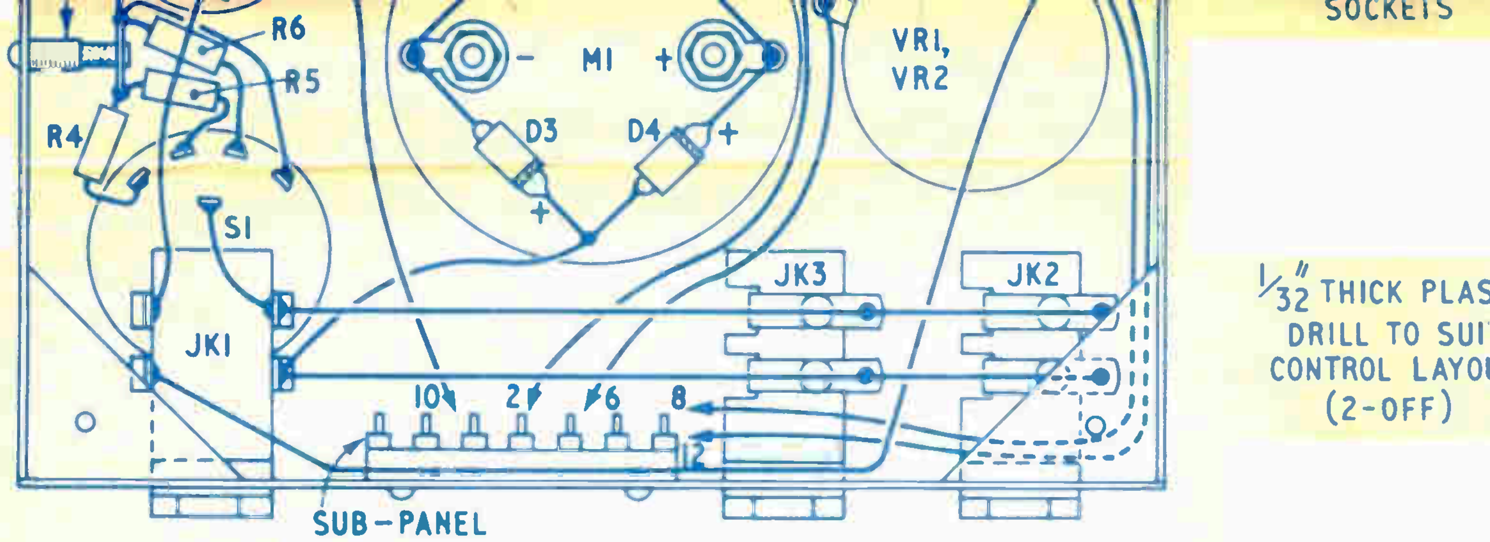


FIG. 2 - VIEW ON UNDERSIDE OF CHASSIS

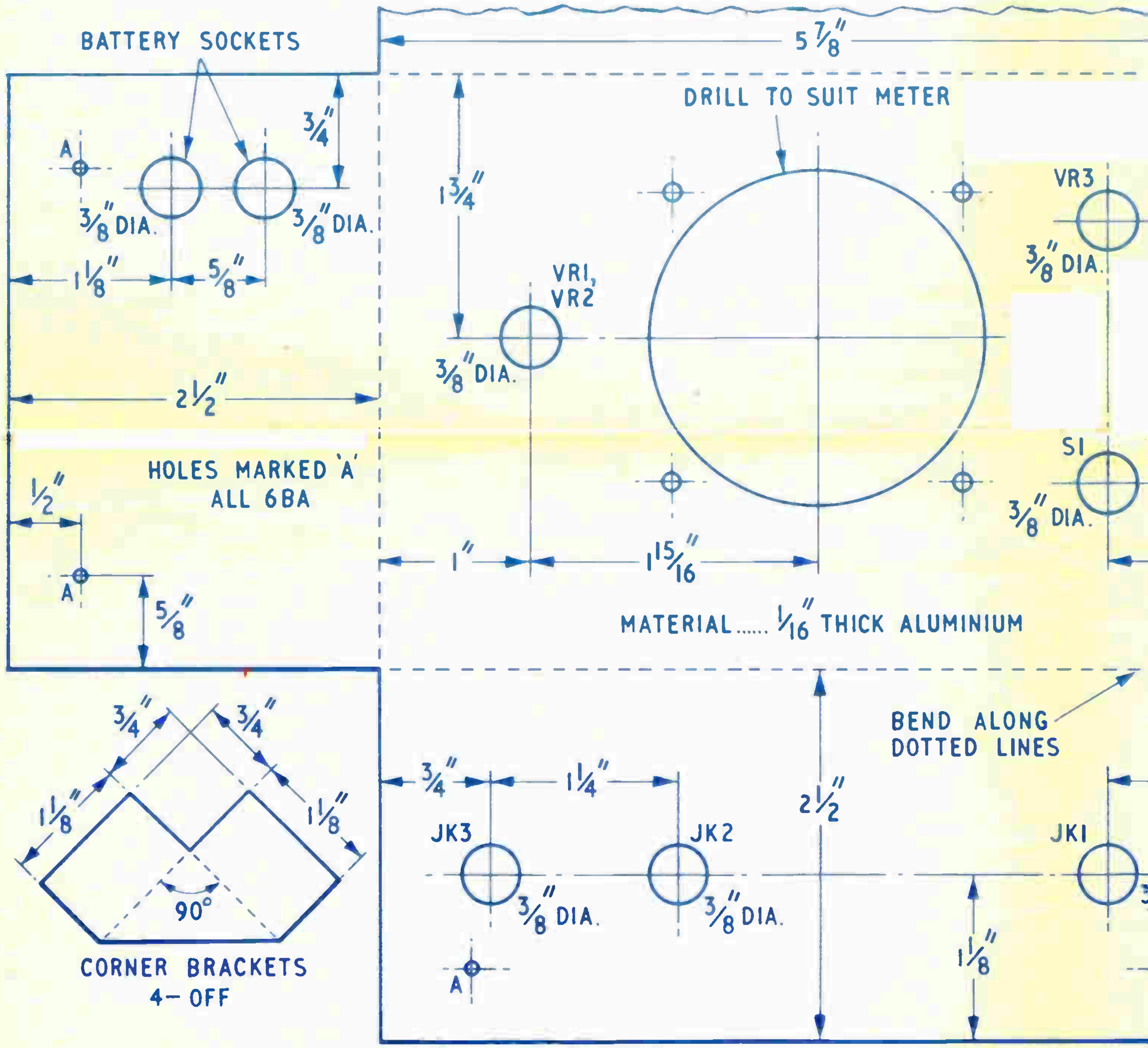


FIG. 4 - CHASSIS DRILLING DETAILS

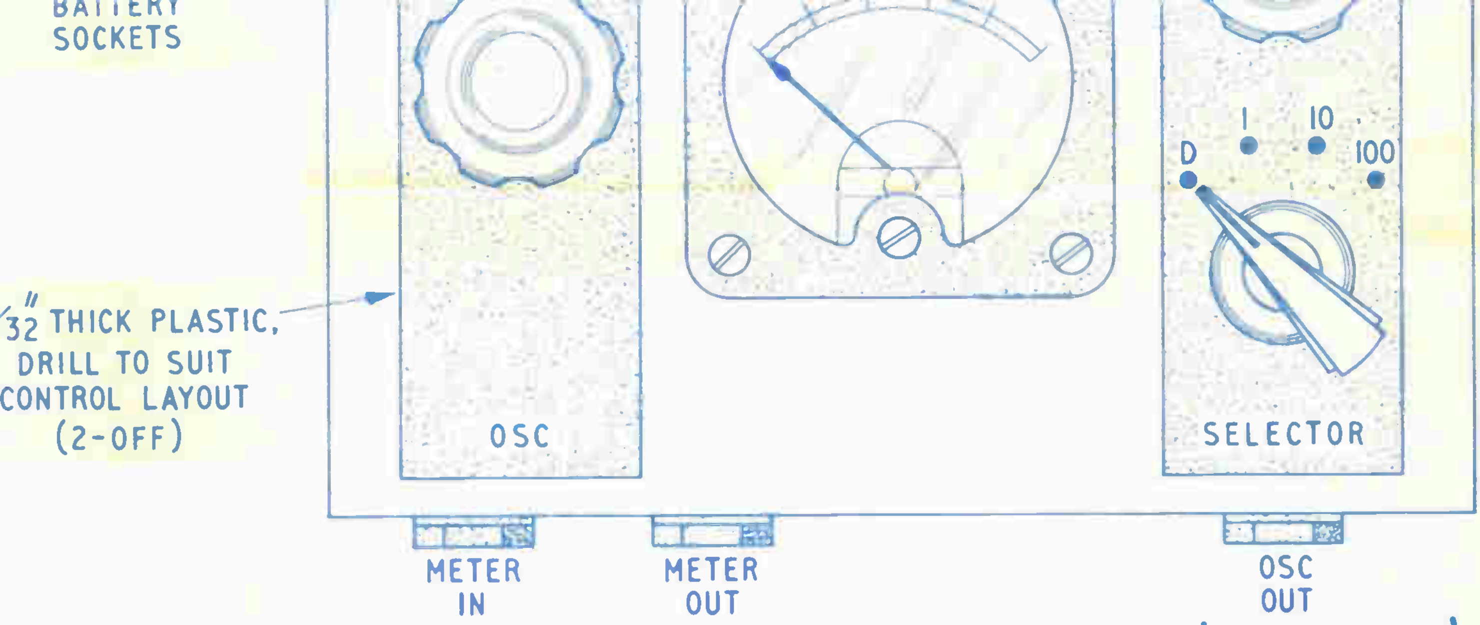
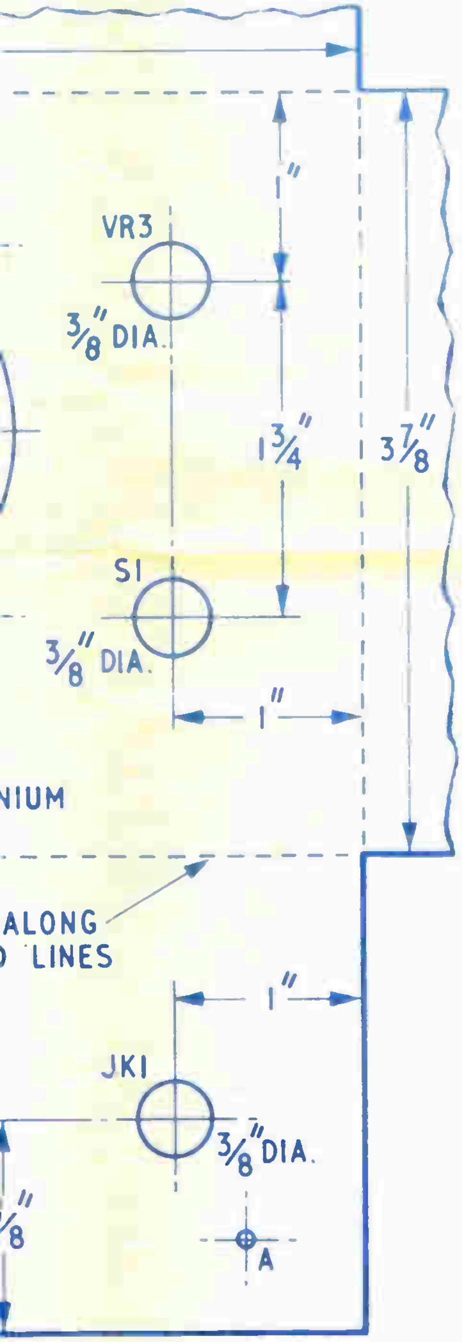


FIG. 3 - VIEW ON TOP OF CHASSIS (FULL SIZE)



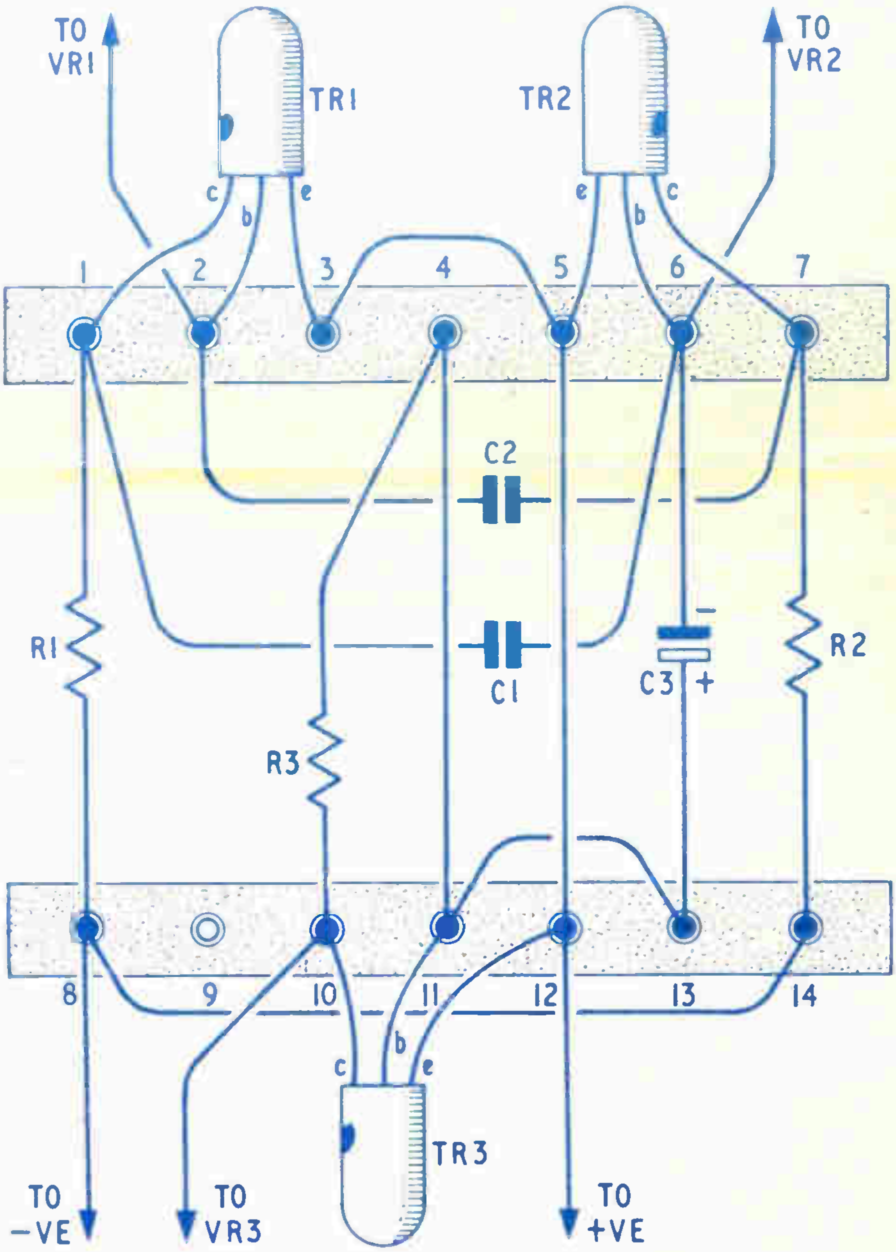
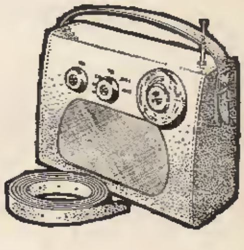


FIG. 5 - SUB-PANEL WIRING

Why NOT BUILD ONE OF OUR PORTABLE TRANSISTOR RADIOS...

BACKED BY OUR SUPER AFTER SALES SERVICE



ROAMER SEVEN Mk III

5 WAVEBAND PORTABLE OR CAR RADIO

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

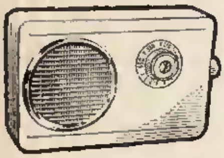
● 9 stages—7 transistors and 2 diodes

Covers Medium and Long Waves, Trawler Band and two Short Waves to approx. 15 metres. Push-pull output for room filling volume from rich toned heavy duty "Celestion" 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 × 4in. approx. The perfect portable and the ideal car radio. (Uses PP7 battery available anywhere.)

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

Parts Price List and easy build plans 3/-

NEW TRANSONA FIVE



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

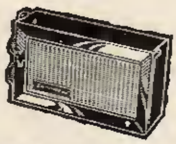
● 7 stages—5 transistors and 2 diodes

Fully tunable over Medium and Long Waves and Trawler Band. Incorporates Ferrite rod aerial, tuning condenser, volume control, new type fine tone super dynamic 2½in. speaker, etc. Attractive case. Size 6¼ × 4½ × 1½in. (Uses 1289 battery available anywhere.)

Total cost of all parts now only **42/6** P. & P. 3/6 *Parts Price List and easy build plans 2/-*

POCKET FIVE

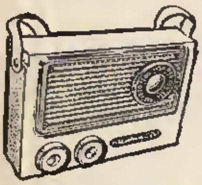
● 7 stages—5 transistors and 2 diodes



Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite rod aerial and fine tone 2½in. moving coil speaker, built into attractive black case with red speaker grille. Size 5¼ × 1½ × 3½in. (Uses 1289 battery available anywhere.)

Parts Price List and easy build plans 1/6 Total cost of all parts now only **42/6** P. & P. 3/-

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 7¼ × 5¼ × 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/-*

COMPONENT BARGAINS

TRANSISTORS

PHILCO MADT Type 2N1727 Maximum frequency of oscillation 150 Mc/s 8/6

PHILCO MADT Type 2N1728 Maximum frequency of oscillation 150 Mc/s 9/6

PHILCO MADT (Micro Alloy Diffused) Type 2N503 Maximum frequency of oscillation over 500 Mc/s 15/-

TUNING CONDENSERS

Air spaced fine quality German manufacture with slow motion drive. 0·0005 with oscillator section .. .. 5/6 Post 1/-

HEADPHONES

High Fidelity miniature magnetic earpieces (2) on slim band with lead and plug. Easily converted to stereo. American manufacture. 100 ohms impedance. Transformers supplied free for higher impedances .. 13/6 P & P 1/6

CYLDON PERMEABILITY TUNERS

Full M.W. coverage. Fitted coupling coil, oscillator coil, ferrite slugs and slow motion tuning with cursor, etc. GIVE AWAY PRICE .. 10/- P & P 1/-

MELODY SIX

"... amazed at volume and performance. has really come up to my expectations". S.G., Stockton-on-Tees.

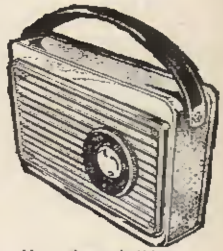
● 8 stages—6 transistors and 2 diodes

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 × 3½ × 1⅞in. approx. with gilt speaker grille and supplied with hand and shoulder straps.

Parts Price List and easy build plans 2/- Total cost of all parts now only **£3.9.6** P. & P. 3/-

TRANSONA SIX

● 8 stages—6 transistors and 2 diodes



This is a top performance receiver covering full Medium and Long Waves and Trawler Band. Push pull output. High-grade speaker makes listening a pleasure. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6¼ × 4½ × 1½in. (Uses PP4 battery available anywhere.)

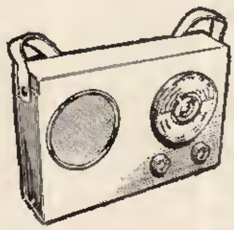
Total cost of all parts now only **59/6** P. & P. 3/6 *Parts Price List and easy build plans 2/-*

ROAMER SIX *NEW!!*

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 three Short Waves. Push pull output. Sensitive Ferrite rod aerial and telescopic aerial for short waves. Top grade transistors, 3-inch speaker, handsome case with gilt fittings. Size 7¼ × 5¼ × 1½in.

★ Extra band for easier tuning of LUX., etc.

Parts Price List and easy build plans 2/- Total cost of all parts now only **£3.19.6** P. & P. 3/6 (Carrying Strap 1/6 extra.)

All components used in our receivers may be purchased separately if desired. Parts price lists and easy build plans supplied free with sets of parts or available separately at fixed prices stated.

RADIO EXCHANGE Ltd.
61a, HIGH STREET, BEDFORD. Phone: 2367

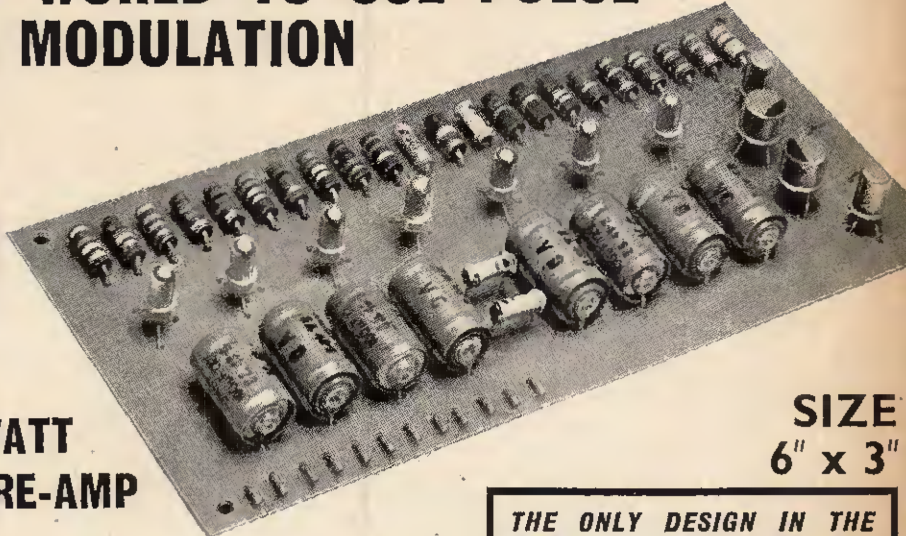
Callers side entrance Barratts Shoe Shop
Open 9—5 p.m.
Sats. 9—12.30 p.m.

A

World-challenging

1 THE ONLY CONSTRUCTIONAL AMPLIFIER IN THE WORLD TO USE PULSE-WIDTH MODULATION

SINCLAIR X-10



SIZE 6" x 3"

INTEGRATED 10-WATT AMPLIFIER AND PRE-AMP

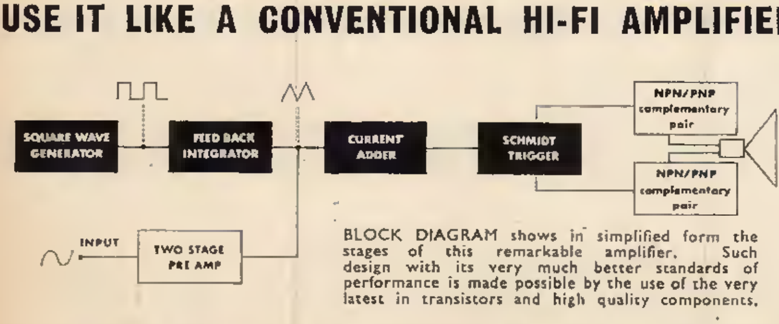
Hi-fi quality for very low cost!

By using pulse width modulation, the Sinclair X-10 integrated amplifier and pre-amp offers the constructor entirely new concepts of amplifier design and performance. Everything, except the tone and volume controls, is contained on the printed circuit board which measures only 6" × 3", and since no heat sink is necessary, the saving in space is enormous. This gives the constructor the opportunity to build a modern sleek hi-fi installation. In performance, the X-10 is a revelation in quality and power. There is no falling off at higher frequencies up to 20 Kc/s, transient response is superb and current consumption for the power output obtained is appreciably less than in comparably rated conventional amplifiers. In fact the X-10 will operate perfectly well from two 6-volt lantern batteries. *The Sinclair X-10 Manual included with every X-10 Amplifier explains how it functions and gives tone control and stereo matching circuits, none of which costs more than a few shillings.*

THE ONLY DESIGN IN THE WORLD TO GIVE YOU ALL THESE EXCITING FEATURES

- ★ Pulse width modulated amplification.
- ★ Eleven transistor circuitry.
- ★ Unique four transistor output stage.
- ★ Input sensitivity of 1mV into 1Kohms. 10 watts peak output into 15 ohms.
- ★ Total harmonic distortion less than 0.1%.
- ★ Choice of tone control system for mono or stereo to match pick-up, micro and radio inputs.
- ★ Integrated pre-amplifier.
- ★ Power requirements—12 to 15 volts, D.C.
- ★ Very easy assembly.
- ★ Hi-fi power and quality, yet measures only 6" × 3".
- ★ An all-British design. Pats. applied for.

USE IT LIKE A CONVENTIONAL HI-FI AMPLIFIER



BLOCK DIAGRAM shows in simplified form the stages of this remarkable amplifier. Such design with its very much better standards of performance is made possible by the use of the very latest in transistors and high quality components.

AVAILABLE FOR BUILDING OR READY BUILT

All parts for building, including 11 transistors, with X-10 Manual and instructions come to **£5.19.6**

Ready built and tested with X-10 Manual **£6.19.6**

X-10 Power Supply Unit (ready built) for A.C. Mains **£2.14.0**

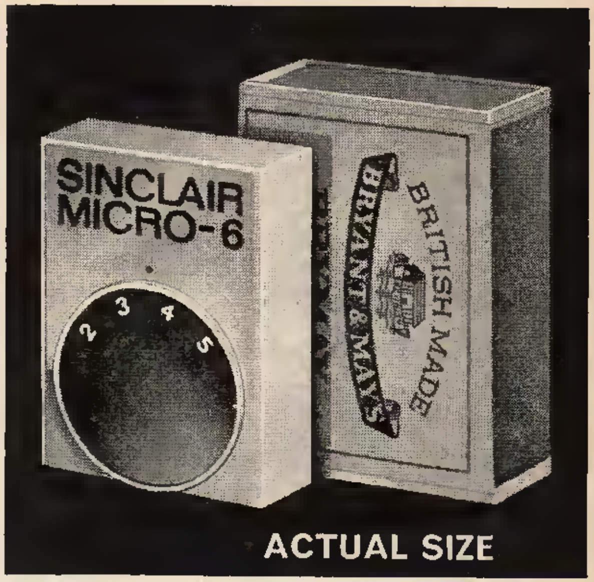
★ *FULL SERVICE FACILITIES ALWAYS AVAILABLE TO SINCLAIR CUSTOMERS*

SINCLAIR RADIONICS LTD., COMBERTON, CAMBRIDGE

Sinclair Designs

② LONG RANGE POWERFUL RADIO

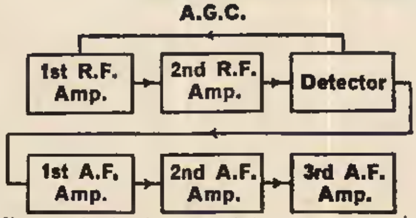
smaller than a matchbox!



SINCLAIR MICRO-6 6-STAGE RECEIVER

IT'S THE SMALLEST IN THE WORLD!
SIZE $1\frac{4}{5}'' \times 1\frac{3}{10}'' \times \frac{1}{2}''$

No transistor set has ever yet compared with the Micro-6 for size, power performance and design, and thousands upon thousands are now in use throughout the world. Everything except the lightweight earpiece is contained within the smart, minute, white, gold and black case. Unique features include bandspread over the higher frequency end of the medium waveband for easy reception of Luxembourg, powerful A.G.C. to counteract fading of distant stations, and vernier type tuning. Quality of reproduction is outstandingly good. Order your Micro-6 now and prove for yourself why it cannot be too highly recommended as an intriguing design to build and a most practical radio to use, and you can build it in an evening.



Six stage circuit using 3 special Micro-alloy transistors (M.A.T.s) provides 2 stages of R.F. amplification, double diode detector and high gain 3-stage A.F. amplifier plus A.G.C. Tunes over the Medium Waveband. Two self-contained batteries give about 70 hours working life.

HAVE IT WORKING IN AN EVENING!

All parts including M.A.T.s, lightweight earpiece and instructions come to **59/6**

MALLORY MERCURY CELL. Type ZM.312 (2 required) each **1/11**
Pack of 6 10/6

*'**Transrista**' black nylon wrist strap* **7/6**

③ SINCLAIR TR750 POWER AMPLIFIER

MEASURES ONLY 2″ × 2″

Another outstanding Sinclair design. Incorporates its own volume control and on-off switch. Used with the Micro-6 or Slimline, the TR750 makes a powerful high quality car portable or domestic radio. 750 milliwatt output into a standard 25-30 ohm speaker for 10mV input. Frequency response from 30 to 20,000 c/s ± 1dB. The TR750 will also make an excellent mono record reproducer (paired for stereo), baby alarm, etc.

All parts for building with instructions come to **39/6** *Ready built and tested* **45/-**

④ SINCLAIR SLIMLIME

The ideal set for beginners

An extra-easy to build pocket radio. Ideal for beginners, yet gives wonderful performance.

Case, parts, earpiece and instructions come to **49/6**

⑤ TRACE THAT FAULT WITH A SINCLAIR MICRO-INJECTOR

This ingeniously designed device generates a test signal at any frequency from 1kc/s to 30Mc/s which is injected via the probe to enable its user to trace faults rapidly and accurately. The case measures only 1.8″ × 1.3″ × ½″. With full instructions.
Parts for building come to **27/6** Ready built and tested **32/6**

⑥ SINCLAIR MICRO AMPLIFIER

Smaller than a 3d. piece!

With a frequency response from 30 to 50,000 c/s ± 1dB and power gain of 60dB (1,000,000 times) makes a broadband R.F. amplifier, A.F. quality amplifier or F.M. transmitter. All parts with instructions come to **28/6**

★ ***TOMORROW'S DESIGNS READY FOR YOU TO BUILD TO-DAY***

To SINCLAIR RADIONICS LTD., COMBERTON, CAMBRIDGE

lease send items detailed below:— £ s. d.

NAME..............................

ADDRESS..............................

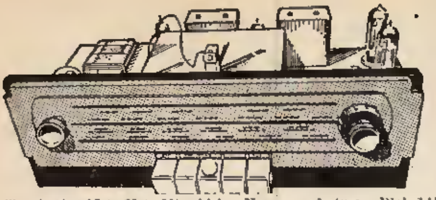
....

TOTAL £

or which I enclose CASH/CHEQUE/MONEY ORDER

USE THE COUPON TO-DAY

Pe 5



BRAND NEW AM/FM (V.H.F.) RADIO GRAM CHASSIS AT £13.13.0 (Carriage Paid)

Chassis size 15 × 6¾ × 5¾in. high. New manufacture. Dial 14½ × 4in. in 2 colours, predominantly cream. 200-250v. A.C. only.
Pick-up, Ext. Speaker, Ae., E., and Dipole Sockets. Five push buttons—OFF, L.W., M.W., F.M. and Gram. Aligned and tested. O.P. Transformer. Tone Control. 1000-1900 M.; 200-550 M.; 88-98 Mc/s. Valves EZ80 rect.; ECH81, EF89, EABC80, EL84, ECC85. 3-ohm speaker required. Speaker 8 × 5in. and Cabinet to fit chassis (table model), 47/6 (post 5/-).
10 × 6in. ELLIPTICAL SPEAKER 25/- to purchasers of this chassis. **TERMS:** (Chassis) **£3.10.0** down and 5 monthly payments of £2.4.0. Cheap Room Dipole for V.H.F., 12/6. Feeder **6d.** per yard. **ALTERNATIVE DESIGN.** L.W. 1000-1900 M.; S.W. (9-15 Mc/s); M.W. 190-475 M.; V.H.F. 87-100 Mc/s; Gram position. Otherwise similar to above chassis. Price **£15.15.0** (carr. paid). **TERMS: £3.10.0** down and 6 monthly payments of £2.4.0. Total H.P.P. £16.14.0. Circuit diagram 2/6.

PUSH-PULL O.P. AMPLIFIER

£5.5.0 (6/- Carr.)

Brand new 200-240 A.C. mains Bass, treble and vol. controls, with valves EZ80, ECC83 and 2-EL84 giving full 8 w. Chassis 12 × 3½ × 3¼in. With o.p. trans for 2-3 ohm speaker. Front panel (normally screwed to chassis) may be removed and used as "flying panel".

AMERICAN BRAND TAPE

FULLY GUARANTEED AT RECORD LOW PRICES

MYLAR BASE

7in. Stand. play, 1,200ft.	12/6
7in. Long play, 1,800ft.	19/6
5in. Double play, 1,200ft.	15/-
5¾in. Double play, 1,800ft.	22/6
7in. Double play, 2,400ft.	25/-
3in. Triple play, 450ft. (Plain white boxes)	12/6
3¼in. Triple play, 600ft. (Plain white boxes)	14/-
4in. Triple play, 900ft. (Plain white boxes)	22/6
5in. Triple play, 1,800ft. (Plain white boxes)	42/6
7in. Triple play, 3,600ft. (unboxed)	75/-

ACETATE BASE

5in. Stand. play, 600ft.	8/-
7 in. Stand. play, 1,200 ft.	11/-
5in. Long play, 900ft.	10/-
5¾in. Long play, 1,200ft.	12/6
7in. Long play, 1,800ft.	15/-

MESSAGE TAPES

3in. Stand. play, 150ft.	3/6
3in. Long play, 225ft.	4/11
3in. Double play, 300ft.	7/6

Postage 1/- per reel (4 or more post free).

"REALISTIC" 'SEVEN'

7 Transistor Superhet. 350 Milliwatt output, 4-inch speaker. All components mounted on a single printed circuit board size 5½ × 5½in. in one complete assembly. Plastic cabinet with carrying handle, size 7 × 10 × 3½in. External socket for car aerial. Ferrite rod aerial. Price for the complete parcel including Transistors, Cabinet, Speaker, etc. and full Construction Data: **£5.19.6.** P. & P. 4/6.
PP9 Battery 3/9. Data and instructions separately **2/6.** Refunded if you purchase the parcel.
Any parts supplied separately.

4 TO 5 WATT HIGH GAIN AMPLIFIER TYPE 500A

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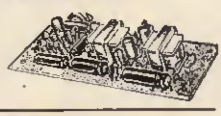

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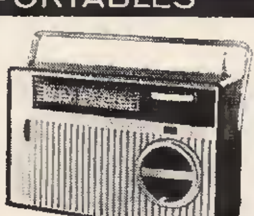

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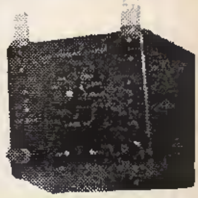

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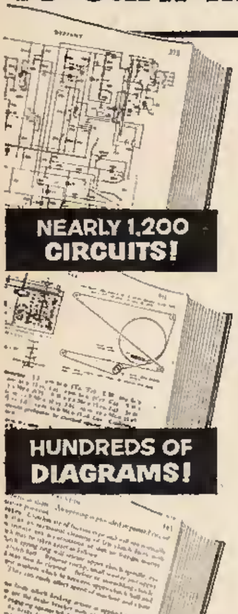

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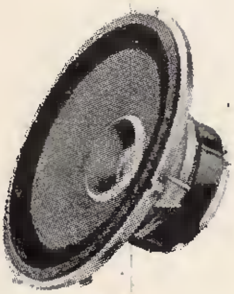

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Bass resonance 38/43 c/s.
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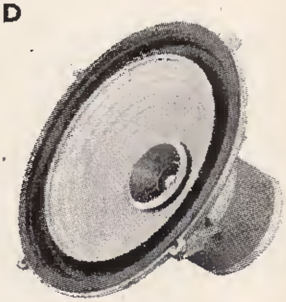

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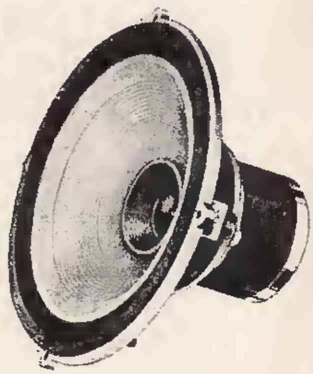

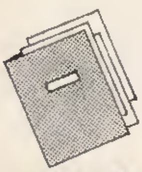

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VOL. 1 No. 7
MAY 1965

Practical Electronics

THE SOUND OF MUSIC

THE art of music has been one of the foremost beneficiaries of electronic science, for the current widespread appreciation of good music can rightly be credited to the influence of broadcasting and sound recording.

In the form of the radio receiver and the record reproducer, electronics made its first entry into domestic service and so added pleasure and enrichment to the lives of millions.

* * *

Through these media music lovers have become acquainted with a repertoire they would otherwise never have heard performed—not even in a whole lifetime of assiduous concert-going. Countless others with no prior musical inclinations who would probably, under other circumstances, never entered a concert hall on their own volition, have, by quite fortuitous listening on various odd occasions, gradually acquired an ear for serious music. This new experience they have then been able to cultivate by selective listening in the comfort of their own home.

* * *

From the earliest days of the radio and the radiogram, as the appreciative home audience grew, many became more discerning in their listening and critical of the shortcomings of the equipment then available. So began a search for the ultimate in sound reproduction.

* * *

The search still continues—but no longer is it a quest pursued by a minority of zealous amateurs and a few manufacturers. A large industry is now in existence to meet this demand for the best in sound reproducing equipment.

This highly specialised audio industry must needs be alert and alive to every new development that may be usefully exploited in the furtherance of their purpose; for not only are these firms subjected to keen competition from their rivals, but they are attempting to sell to a particularly well informed and highly perceptive section of the public.

Products will not be taken on trust, nor will alluring specifications in glossy brochures be accepted unquestioning by the musically minded. The final and decisive test is the effect produced on the aural senses. No mean test either, since the prospective customer is likely to be familiar with the sound of a live orchestra from frequent concert hall attendances and also to have already experienced the capabilities of many high class reproducing systems.

THIS MONTH

CONSTRUCTIONAL PROJECTS

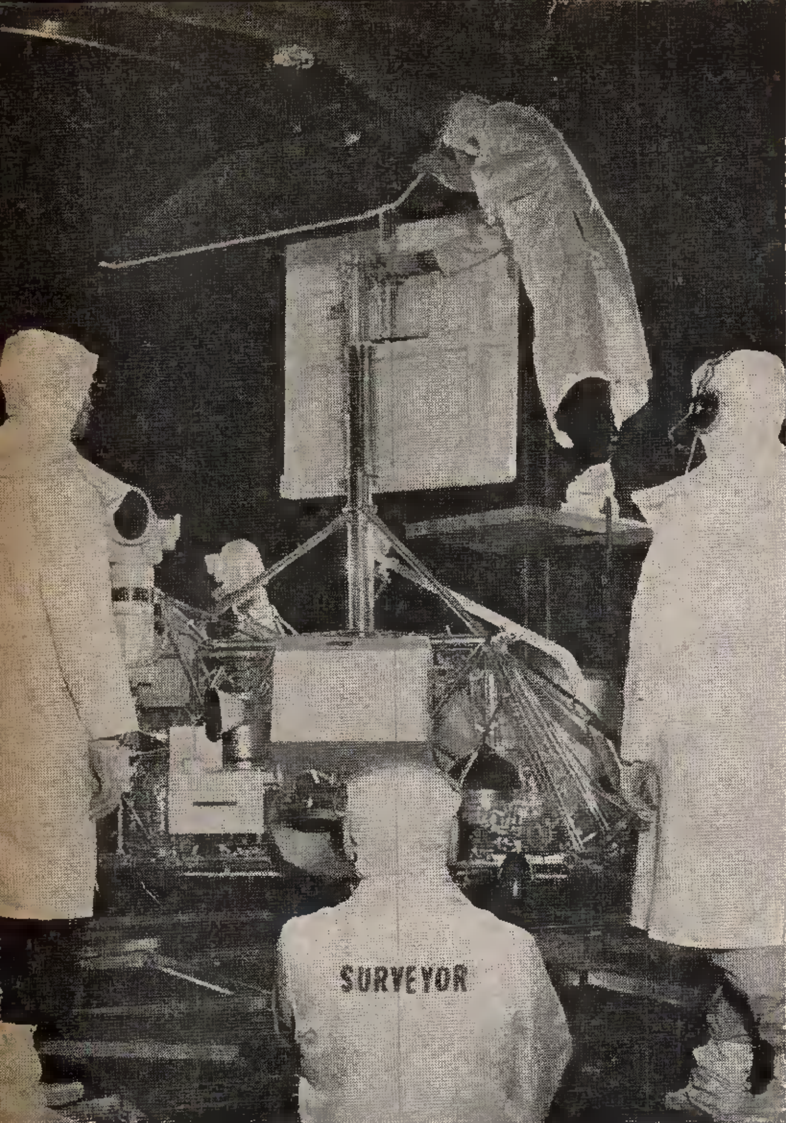
SPECIAL SERIES

GENERAL FEATURES

NEWS AND COMMENT

Our June issue will be published on Thursday, May 13

All correspondence intended for the Editor should be addressed to: The Editor, PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Editorial and Advertisement Offices: PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: Temple Bar 4363. Telegrams: Newnes Rand London. Subscription Rates including postage for one year, to any part of the world, 35s.



Ready for a vacuum chamber test

LUNAR

Before two-legged man sets foot on the moon, a three-legged Surveyor will gingerly dip in a toe — so that a space "first" keeps safety first

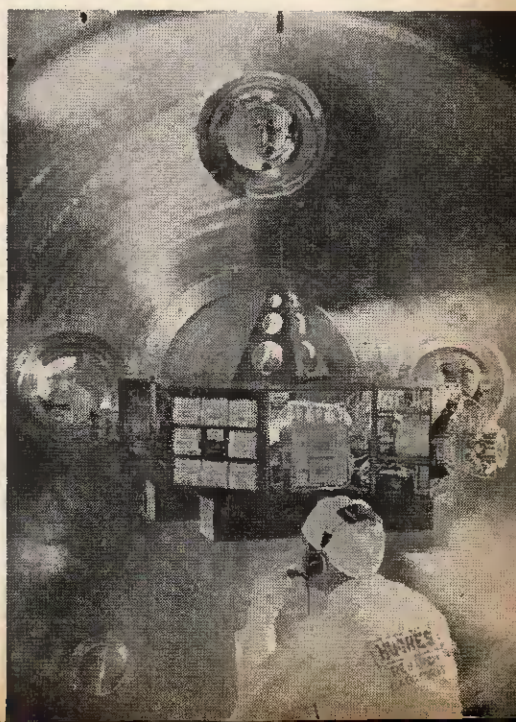
AN UNMANNED Surveyor will soft-land and scrutinise the lunar terrain to determine if it is dusty or crusty before man risks his life learning whether the moon's Sea of Tranquility is truly tranquil or its Sea of Serenity is really serene.

Seven Surveyor spacecraft are being built by the Hughes Aircraft Company at a cost of $230 million for the U.S. National Aeronautics and Space Administration under direction of the Jet Propulsion Laboratory. Some of the vehicles are designed to provide man with his most precise scientific knowledge of the moon's environment before man himself arrives.

The first Surveyor will be launched before the end of this year from Cape Kennedy by an Atlas-Centaur rocket for a 64-hour flight to the moon.

The Surveyor programme is a follow-up to the recent NASA Ranger series that made thousands of close-up photographs of the moon's surface before crash-landing there, and a forerunner to NASA's Project Appollo, which seeks to place men on the moon by 1970.

Besides aiding the manned Apollo programme, Surveyor hopefully is expected to settle the controversy over whether the moon's surface is thin dust over a hard crust or deep dust that could swallow a man or the entire spacecraft quicker than quicksand.



(Right) System of ion engines for station keeping and attitude control. One engine can be seen on the right

(Right centre) Bird's eye view of surveyor being raised into the space chamber

(Extreme right) Close-up view of the ion engine assembly

SURVEYOR...

SOFT LANDING

One of the difficulties is to make Surveyor "settle" on to the moon at 6 to 10 miles per hour (about the speed that a human parachutist hits the ground) instead of crashing, as the Rangers did. It must come in gently without destroying its delicate electronics and remain upright on its tripod landing gear.

To be as certain as possible that this will occur without mishap, Hughes engineers have conducted drop-tests from various heights, plummeting the spacecraft or dummy weights into powder, sand, sawdust, wood shavings and even pop-corn (unbuttered).

The difficult "soft" landing on the moon must be achieved by slowing Surveyor from 6,000 miles per hour to about 3·5 miles per hour, at which time it is dropped in the lunar gravity at an earth speed of 6 to 10 miles an hour. To accomplish this, at 60 miles from the moon the main retro engine and three vernier motors will turn on. After the main decelerating engine of 9,000 lb thrust burns out, the verniers will continue to burn until the Surveyor is about 13ft above the moon, when they too will stop to avoid stirring up moon dust. Then the spacecraft will drop to the moon's surface with a shock no greater than that of a parachutist's legs.

EARLY SUCCESS POSSIBLE

The first four of the seven Surveyor launchings, scheduled to start late this year and continue through 1966, will be engineering flights on which the spacecraft will carry a television camera and engineering equipment to diagnose the performance of its systems during the flight and landing.

Although a full payload of scientific instruments will not be carried until the fifth surveyor flight, even the first spacecraft—provided it lands without accident—could be an outstanding success because:

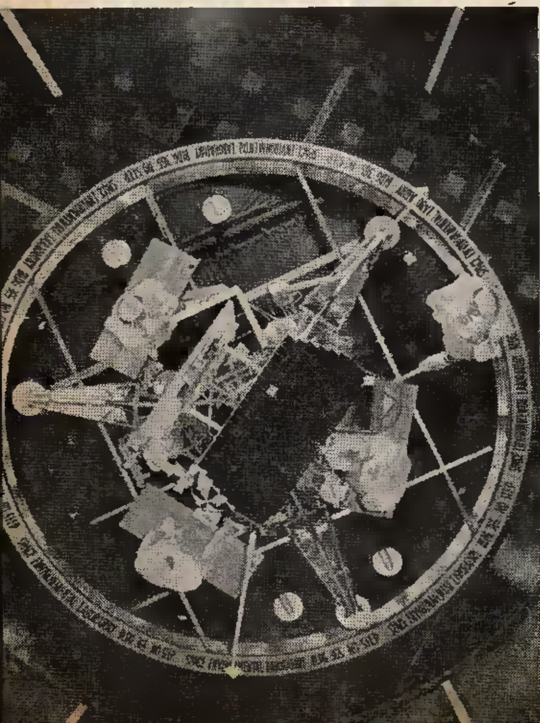
1. Its TV camera can scan the moon's terrain in full circle and also look down at the spacecraft's footpads to see how deeply they stand in dust.
2. The spacecraft's three large footpads, 12ft apart on its tripod legs, contain instruments that can report on landing impact to provide some knowledge of moon's hardness, slope and friction.
3. The Surveyor could respond to commands from Earth, aim its directional antenna at Earth and send back important data.

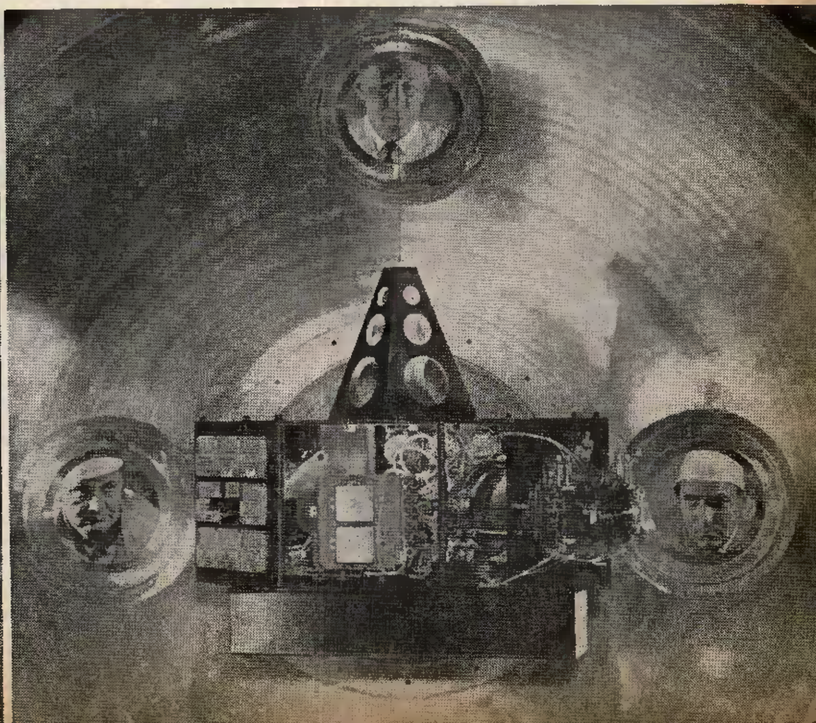
EARTH WILL COMMAND

For the first time on any lunar flight, Surveyor will use the guide star Canopus, as well as the sun, to stabilise itself. When it has landed safely on the moon, Surveyor will depend upon commands from earth to a greater extent than any unmanned spacecraft to date.

Each of the seven Surveyors will measure 10ft in height to the tip of the mast, which houses a solar panel drawing energy from the sun to recharge the batteries (shown in the middle of centre picture below), and a directional antenna that aims at Earth.

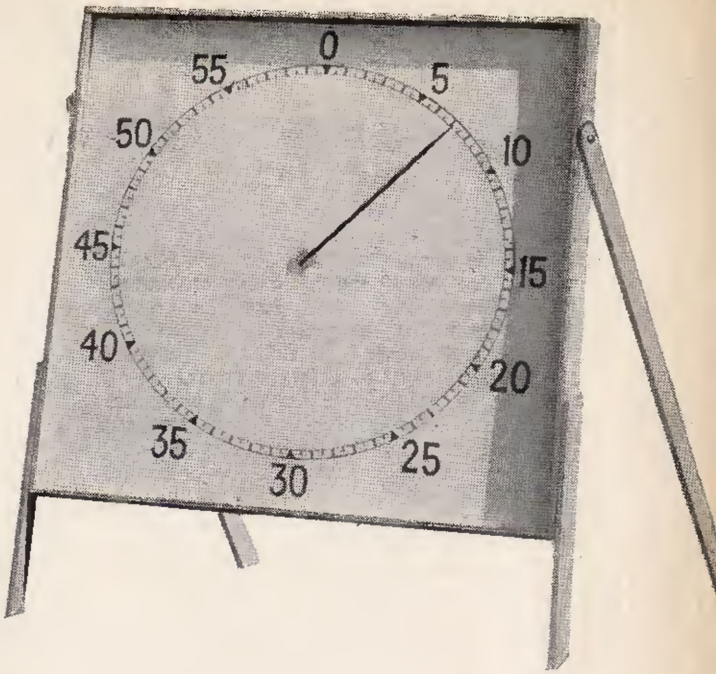
Later Surveyors will carry three TV cameras; instruments to supply information on the moon's surface-bearing strength; a rod that will scoop up samples of the moon's surface to be inspected by the TV camera; a seismometer to detect moonquakes; a device to record the impact of micrometeorites; and an instrument to measure surface chemical elements.





SPORTS EVENTS TIMER

described by J. HILLIER



TIMING competitors to a second, or even part of a second, is necessary in many sporting events including in particular show jumping and car driving tests. The usual method of taking these times consists of manually-operated stop watches. There is much greater interest for the spectators however if a large clock with a sweep second hand can be displayed and started and stopped for each competitor.

This article describes a practical clock consisting of a solenoid-operated escapement controlled by a relay in a simple transistor multivibrator circuit with adjustment for regulating the speed.

WEATHERPROOF UNITS

As space is almost unlimited there is no need to employ miniature components or to pack the parts into the smallest possible space. But as the equipment must be portable and operate out-of-doors in all weather conditions, it should be robust and adequately protected. For these reasons, in the prototype diecast boxes with close fitting lids are used for the two chassis. The larger one houses the electronic timing circuit and the smaller accommodates the escapement mechanism—a ratchet arrangement which moves the sweep hand of the clock.

There are a number of additional refinements which are desirable such as automatic start and stop, quick reset to zero after each competitor, indication of the number of minutes elapsed and such like. It is hoped to deal with some of these circuits in a later article, but it is advisable to get the clock functioning correctly before adding these extra items.

THE ELECTRONIC CIRCUIT

The basic circuit is a simple two transistor multivibrator with the component values chosen so that it operates at about two cycles a second. This gives timing on the sweep hand to half a second. A higher frequency allows even more precise timing to be achieved but it introduces greater problems in connection with the mechanical ratchet arrangement. The principal reason for deciding on half-second timing is because those constructors without the facilities (or the desire) to make the escapement mechanism for the clock can obtain a suitable ex-government component for a few shillings which does the job quite satisfactorily (see components list).

Experiments have shown that the components used in the oscillator circuit are not critical either regarding type or values. However, in view of the importance of the task that the clock has to perform, and bearing in mind the small number of parts involved, it is better to play safe and use only the best.

In the multivibrator circuit the capacitors are paper types and the resistors high stability components rated well above their operating wattage. Transistors are OC72's but any other similar types should be satisfactory.

To provide accurate operation over long periods a separate 9V dry battery (Ever Ready PP9, Vidor VT9 or equivalent) is housed in the box and supplies the power for the multivibrator only. This is better than drawing the supply from the same 12V car battery that is required to actuate the hand mechanism.

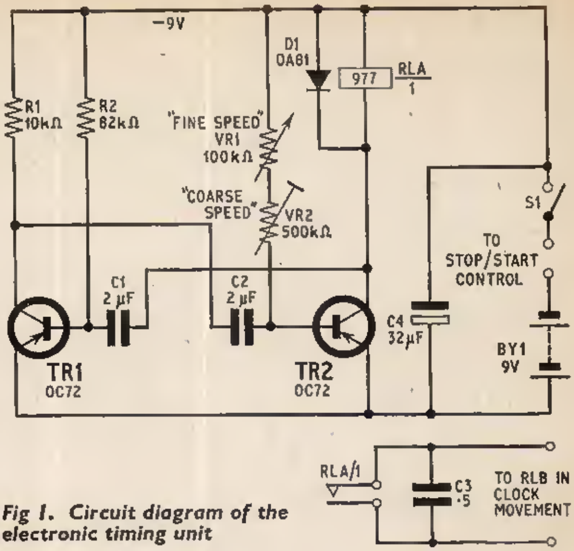


Fig 1. Circuit diagram of the electronic timing unit

COMPONENT LAYOUT

The circuit of the electronic unit is given in Fig. 1 and a suggested component layout in Fig. 2. At the very low frequencies involved layout is not important and constructors can vary this to suit the parts they have in hand.

COMPONENTS . . .

ELECTRONIC UNIT

Resistors
R1 10kΩ R2 82kΩ
5%, ½W, high stability, carbon

Potentiometers
VR1 100kΩ carbon, linear, with switch (S1)
VR2 500kΩ carbon, linear

Capacitors
C1 2μF paper 150V
C2 2μF paper 150V
C3 0·5μF paper 150V
C4 32μF electrolytic 15V

Transistors
TR1 OC72 TR2 OC72

Miscellaneous
BY1 9V battery, PP9 or VT9
D1 OA81 germanium diode
RLA Lightweight relay, 977 ohm coil (B. & R. type B14/12)
S1 Single pole on/off switch—see VR1
Eddystone 845 die-cast box. Five insulated terminals. Snap fasteners for battery. Piece of perforated plastics sheet. Eddystone dial, 1¼in dia., with 0-10 graduated scale. Nuts, bolts, wire and sleeving, etc.

CLOCK MOVEMENT

One ex-government G45 film footage counter (sold by various retailers as lap markers for Scalex cars).

One Eddystone 650 die-cast box

CONTROL UNIT

One push-on, push-off switch

One Eddystone 896 die-cast box

CLOCK

One hardboard sheet 4ft × 4ft
Softwood as follows:
20ft of 6in × ½in
4ft of 3in × ¾in
16ft of 1in × 1in
8ft of 2in × 1in

Adhesive figures

2ft of ⅜in × ⅛in balsa wood for hand

White paint. Nails, screws, nuts and bolts, etc.

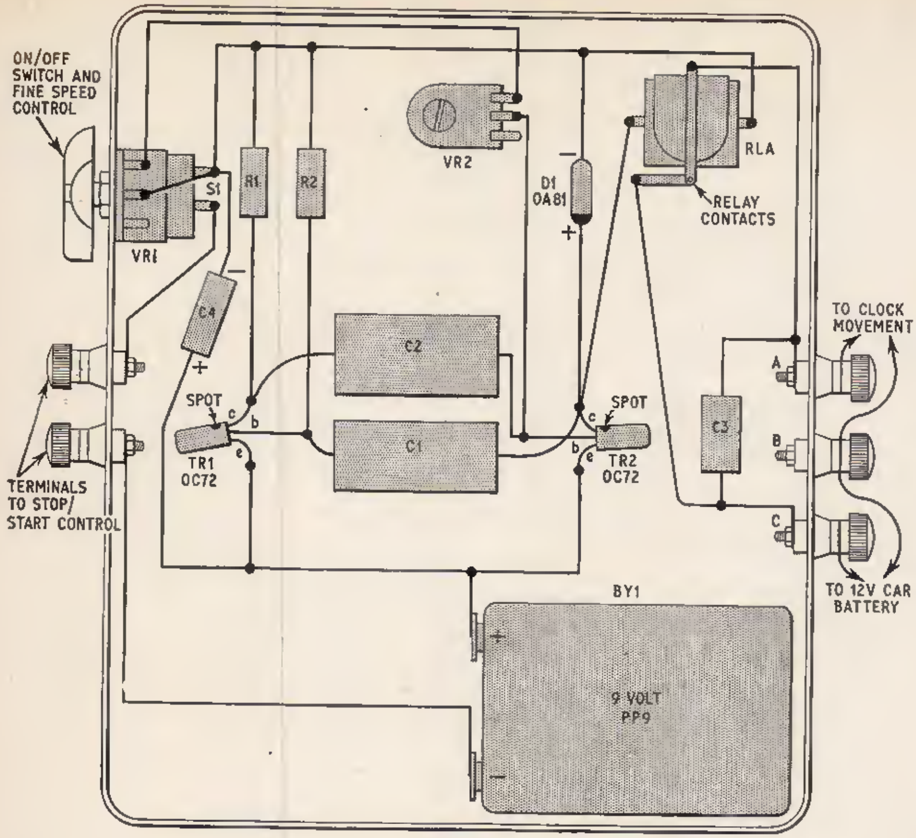
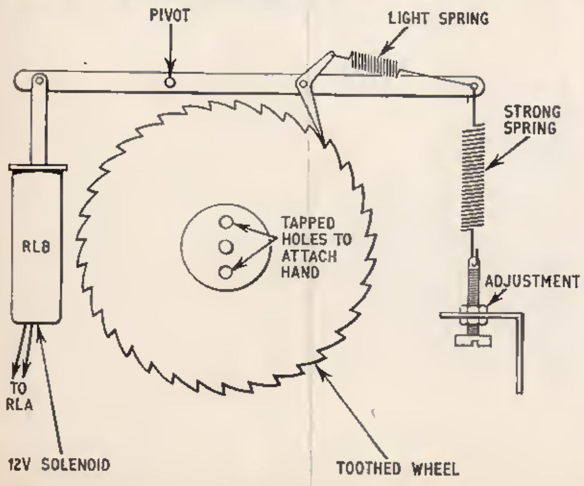
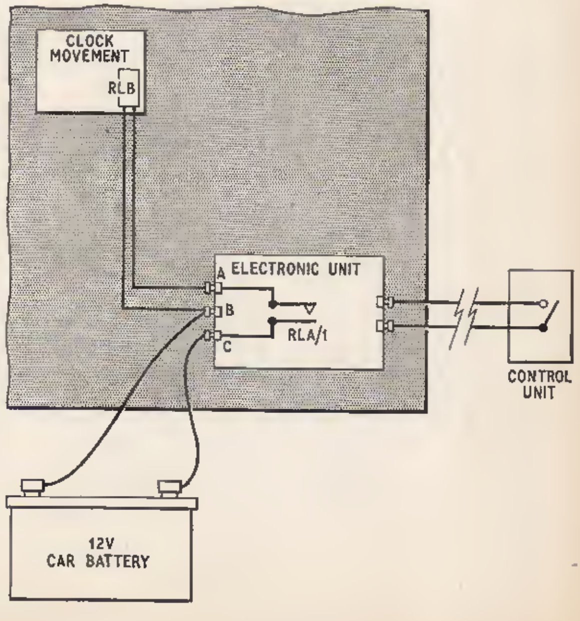


Fig. 2. Details of the com ponent wiring showing positioning of the battery, transistors, relay and pre-set control VR2. Note that VR1 is ganged to the on/off switch

Fig. 4 (right). This diagram shows the interconnections between the various units

Fig. 3 (below). The escapement mechanism which drives the sweep hand of the clock. Note that the toothed wheel must have either 60 or 120 teeth





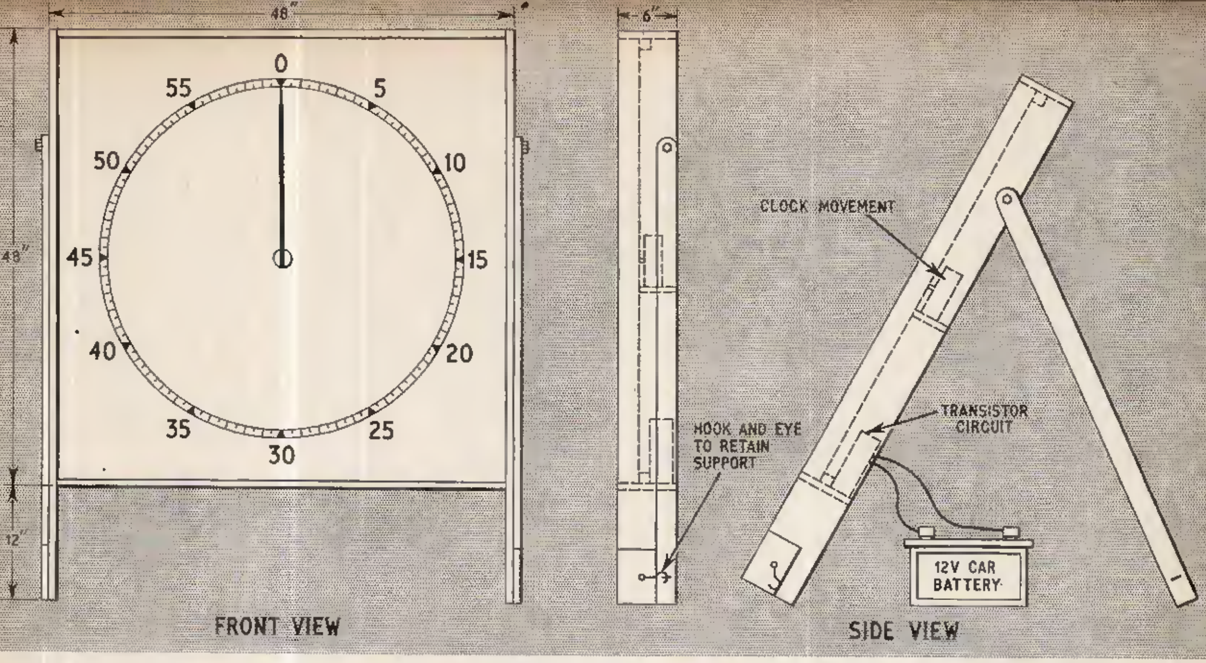
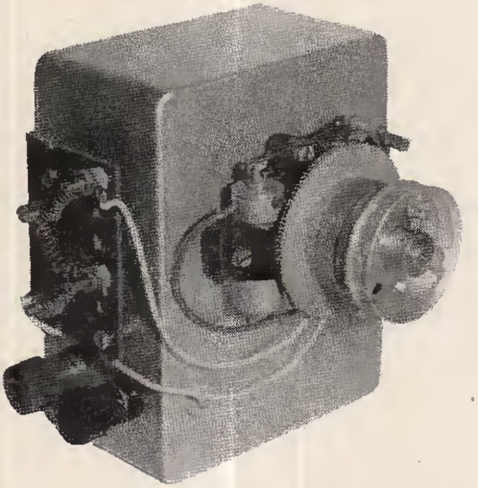


Fig. 5. Front and side view of the complete clock showing the overall dimensions

It will be seen that two variable controls are included. VR1 is ganged to the on/off switch S1 and acts as a fine speed regulator. It is provided with a 0–10 graduated scale so that the correct position to give an exact 60 second sweep can be noted and reset instantly when required. The other control VR2 has a wider range and is preset so that the speed is approximately correct with the fine control set against 5 on the scale. This allows slight adjustment either way to compensate temperature changes, battery voltage variations and other conditions.

The mode of operation is quite simple. As soon as power is applied to the multivibrator it starts oscillating and the relay RLA in the collector circuit of the second transistor opens and closes in time with the oscillations.



Close-up of the ratchet arrangement based on the mechanism used in G45 film footage indicators (the wire wound resistors mounted on the side panel are experimental components only and not normally required)

Each time the relay RLA contacts close the main solenoid RLB actuating the hand movement is energised pulling down the operating lever against the spring pressure—see Fig. 3. As soon as the contacts open the lever is released and as the spring pulls it back to its normal position it moves the hand one division.

When making the escapement it is necessary to include "stops", preferably adjustable, to limit the movement of the operating arm so that the hand is moved only to the extent of one tooth.

As already mentioned, an ex-government piece of equipment can be employed very satisfactorily for this purpose. This is the G45 film footage counter, available from a number of retailers.

DETAILS OF THE CLOCK

The clock itself is made of wood and hardboard, the prototype being four feet square. Originally it was found that when standing in grass the lower figures were obscured so additional side pieces have been added to raise the clock 12 inches from the ground. This can be allowed for when constructing.

The main framework is constructed of 6in × ½in boards cut to length and nailed together. Battens of 1in × 1in are fitted round the inside so as to support the hardboard clockface. The face is given an undercoat and a finishing coat of white paint and then marked out as a clockface numbered 0 to 60. If a large enough compass is not available a piece of string tied to a nail at the centre does the job admirably. An easy method of marking the circles instead of painting is to use waterproof spirit ink. This is available from stationers, in all colours, in small bottles with a felt nib.

Figures may be painted on or, as in the prototype, cut out of self-adhesive "Fablon" or "Contact" and stuck in position. Ready-made self-adhesive figures are also available. To be clearly visible at a reasonable distance the figures should be at least four inches high.

continued on page 488

THE SEMICONDUCTOR . .

PART 4. SIMPLE CIRCUIT DESIGN

BY CHARLES NORMAN

LAST MONTH we proved for ourselves that there is no difficulty about achieving a voltage gain with a transistor. Now look at Fig. 4.1.

One thing you should notice about the circuit is that the emitter is connected to ground and is common to both base and collector circuits. Because of this a transistor connected in this way is said to be connected in the common or grounded emitter configuration. If we accept the analogy between emitter and cathode, this corresponds to a normal triode amplifier which could be called a grounded cathode triode.

If this was a valve amplifier, we could calculate the gain of the stage provided we knew the amplification factor and anode characteristic of the valve. As the input impedance of a valve approaches infinity it throws little or no load on the signal circuit if it is properly biased, and no current flows in the grid-cathode circuit.

But a transistor depends for its operation not on a voltage applied to the input but on the current flowing through it. As a voltage is actually applied, the input current will depend on the input impedance. Consequently, this parameter has an important bearing on stage gain and must be taken into consideration.

CHARACTERISTICS

So, out of the bewildering array of parameters to be found on a complete transistor data sheet, this gives us three characteristics to consider when we calculate gain. These are the current gain (known as β or α')

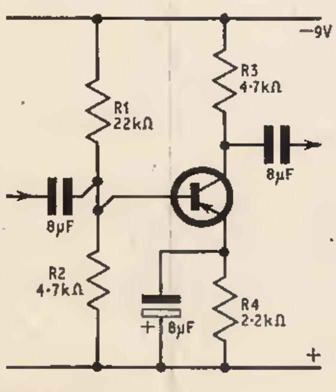


Fig. 4.1. Grounded emitter, or common emitter, connection

the input impedance, Z_{in}, and the output impedance, Z_{out}. For an a.f. transistor the listed data are usually measured at 1,000 c/s with the device working well within its normal range at a temperature of 25°C ambient. They are called the "small-signal" characteristics and should be used for normal calculations. A full transistor data sheet will also contain "large-signal" or d.c. characteristics, maximum ratings, cut-off frequency, average or design centre characteristics and quite a lot more information including a few set of curves, but we need only consider the small-signal characteristics.

COMMON EMITTER

Now let us see how we can use them. The output impedance for a transistor in the common emitter configuration is usually well above 10,000 ohms, often in the region of a megohm. This is useful because the load, R_L is, so far as the signal is concerned, connected in parallel across the output from the collector. As the load is usually much smaller than the output impedance its connection in parallel shunts this and we can say

$$Z_{out} = R_L$$

The output signal voltage will of course be given by

$$v_{out} = I_c R_L$$

where I_c is the collector signal current.

The signal input v_{in} will produce a base current i_b.

$$i_b = \frac{v_{in}}{Z_{in}}$$

If we write this the other way round we get:

$$v_{in} = i_b Z_{in}$$

So voltage gain,

$$\frac{v_{out}}{v_{in}} = \frac{i_c R_L}{i_b Z_{in}}$$

But i_c/i_b (the ratio of output current to input current) is of course β, the current gain of the transistor. So we get

$$\text{Gain} = \beta \frac{R_L}{Z_{in}}$$

Not very complicated really, is it? This is an approximation of course, since it assumes that the output impedance of the transistor itself is so high compared with the load, that it need not be taken into consideration. But it gives the voltage gain within 20 per cent which, as many of the components in the average circuit have a 20 per cent tolerance, is as much as we can expect if we base our calculations on face values.

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You may remember that all transistors made by the same process are very much alike in beta and input impedance. The average low-power germanium transistor in use today has a beta of about 50 and an input impedance of between 700 and 2,000 ohms, giving an average of 1,300 ohms.

The listed characteristics of an OC71 are: beta = 47; Z_{in} in common emitter configuration = 800 ohms; Z_{out} = 12,500 ohms.

You should have noticed that the values of the coupling capacitors are very much higher than those in a valve circuit doing the same job. This is because a transistor operates as a low impedance device, hence the value of the capacitor needs to be higher to pass low frequency currents.

STABILISATION

The resistor in the emitter circuit is very important. It is intended to give an automatic bias in the same way as it would if it were in the cathode of a valve, but it serves another important purpose, i.e., limiting the current through the transistors. The number of current carriers, holes or electrons, in a semiconductor increases with temperature because heat tends to disturb the stability of the electron orbits. The effect of heating the transistor is to set free extra current carriers, so increasing the current and raising the temperature. This sets free yet more carriers and creates a snowball process which causes the current to grow so rapidly that the transistor can be destroyed in a moment.

All this current must flow through the emitter resistance, producing a voltage drop which increases with current. This drop is of course a bias tending to cut off the transistor. So the current is held stable and the transistor does not tend to run away with itself. The resistor by itself would produce negative feedback, so it is by-passed by a large capacitor which takes the signal straight to ground without interfering with the d.c. action of the resistor.

How can we make provision for an input bias current? We could do this by connecting the base via a suitable resistance to the collector supply, but usually a potential divider as shown in Fig. 4.1 is used. This helps to hold the base voltage at a constant d.c. level, and so introduces a further measure of stability. The calculation of these values is complicated, but those given will answer for almost any low power a.f. transistor. If you are making up circuits there is no harm in experimenting, provided that you start with a low bias current and watch the emitter current carefully. Once you get used to them, transistors lend themsleves to experiment even more readily than valves.

GROUNDED BASE

The common emitter configuration is not the only way in which a transistor can be used. In a grounded grid triode circuit, the grid can be connected to ground and the signal applied to the cathode. There seems no reason why the same kind of thing could not be done with a transistor. Fig. 4.2 is the basic circuit of a grounded-base amplifier.

As you can see, it corresponds closely to the grounded grid triode so far as the connections are concerned. The transistor though needs some slightly different mathematics.

To start with, the beta current gain no longer applies. We have seen that only one in fifty of the current carriers from the emitter flow into the base circuit. The remainder cross this thin layer to the collector giving us our β of about fifty. But in the grounded-base configuration all the transistor current must flow in the base circuit instead of in the emitter circuit. And this current must be shared by collector and emitter. If you look carefully at the circuit diagram you will see that this is the only way in which current can flow.

As the current carrying capacities of base-emitter and base-collector circuits are the same, we have only changed the connections, not the transistor. About one carrier in every fifty will flow in the emitter circuit and the rest will go to the collector. So if the base current was, say, 1mA, the collector current could be only about 0·98mA. The ratio of the two currents is called the alpha (α) or current gain of the transistor. Since the current gain is really a small loss, it appears that this connection will not give a voltage amplification.

But if we apply the same reasoning to this as we did to the common-emitter circuit we get:

$$\frac{v_{out}}{v_{in}} = \frac{i_{out}R_L}{i_{in}Z_{in}}$$

But the ratio of input to output is now the alpha current gain,

$$\text{Gain} = \frac{\alpha R_L}{Z_{in}}$$

The input impedance of a transistor in the common-base configuration is much lower than that of the common emitter, but the output impedance is higher. This is logical, since the emitter, into which the signal is fed in a common base amplifier, carries the entire transistor current and must offer a lower impedance than the base. The collector, on the other hand, is separated from the emitter by the grounded base so that its potential can have little effect on transistor current. So the approximation $Z_{out} = R_L$ becomes much more accurate.

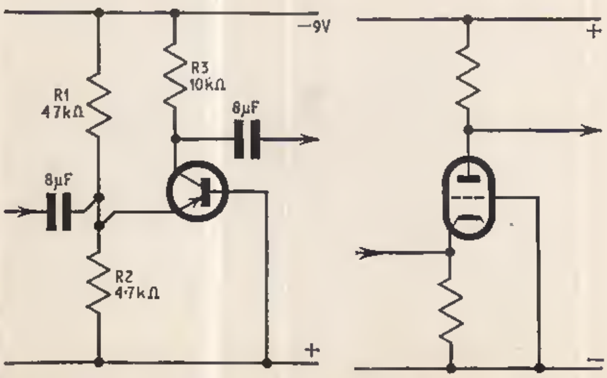


Fig. 4.2. Grounded base transistor and grounded grid triode

On this basis, assuming an input impedance of say 50 ohms, load of 4,700 ohms and α of 0·98, we can calculate the gain of a common-base amplifier.

$$\text{Gain} = \alpha\frac{R_L}{Z_{in}} = \frac{0{\cdot}98 \times 4{,}700}{50} = 90$$

This, for a small load, is a high gain, but the high output impedance of the common-base configuration makes the use of a higher load convenient. Also, we can get a very close approximation by calling alpha unity. So a 10,000 ohm load would give a voltage gain of 200. The secret of course is the ratio of output to input impedance. The output current is very nearly as great as the input current, and so must produce a much greater voltage drop across the high collector load.

The common-base circuit has a more stable gain than the common emitter and is less likely to run away with itself. But its low input impedance is a serious drawback. Imagine connecting 50 ohms across a sharply tuned circuit! So for normal purposes the common-emitter amplifier is more popular.

EMITTER FOLLOWER

The final transistor configuration is the grounded collector circuit, which is sometimes called an emitter follower. It is drawn in Fig. 4.3 with its valve analogy, the cathode follower. Its characteristics differ from those of the grounded emitter and grounded base circuits. The collector, although it is taken to the collector supply line, is of course grounded so far as the a.c. signal is concerned.

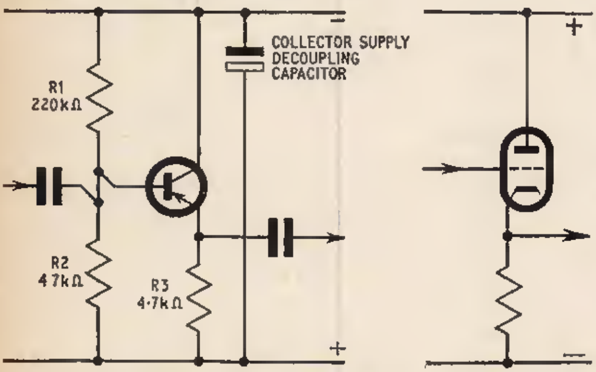


Fig. 4.3. Grounded collector transistor (emitter follower); and grounded anode triode (cathode follower)

As the signal is applied to the collector, which has the highest impedance of all the transistor segments, the input impedance must be high. Conversely, the output is taken from the lowest impedance, the emitter, so the output impedance must be low. The common collector circuit gives a large current gain but its voltage gain is slightly less than unity but, unlike the cathode follower, it does not invert the phase of the signal.

All of this has just scratched the edges of a complex subject, but it is a start. However, readers who have been following this short series will probably have more confidence in making an amplifier. If you made up the diode receiver described in the second article of this series, there is no reason why you should not add a stage of a.f. amplification, using the headphones as collector load.

With a little practice you will find that transistors are just as easy to experiment with as valves. ★

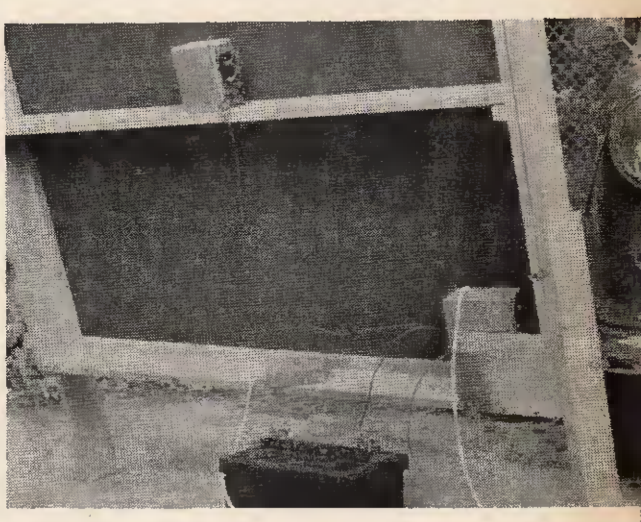
SPORTS EVENTS TIMER

continued from page 483

ESCAPEMENT MECHANISM

A shelf mounted on fixing blocks must be provided at the back of the face to mount the escapement mechanism (or clock movement) for the sweep hand. It is advisable to keep the weight of the moving parts to a minimum and for this reason the hand is made of balsa wood using a strip ⅜in wide tapered to a point and painted black. This has proved to be better than the original hand which was of 18 s.w.g. aluminium and counter-balanced.

Another point learnt from experience is the desirability of keeping the operating solenoid away from the multivibrator relay. For convenience these were originally together on the same box but it was found that the heavy field produced by the solenoid RLB acted on the relay coil and caused a "chattering" effect.



Rear view of the clock showing the units in position and the leads to the 12V car battery which is required to energise the actuating mechanism. The small box houses a press-button switch for remote start and stop

OPERATING THE TIMER

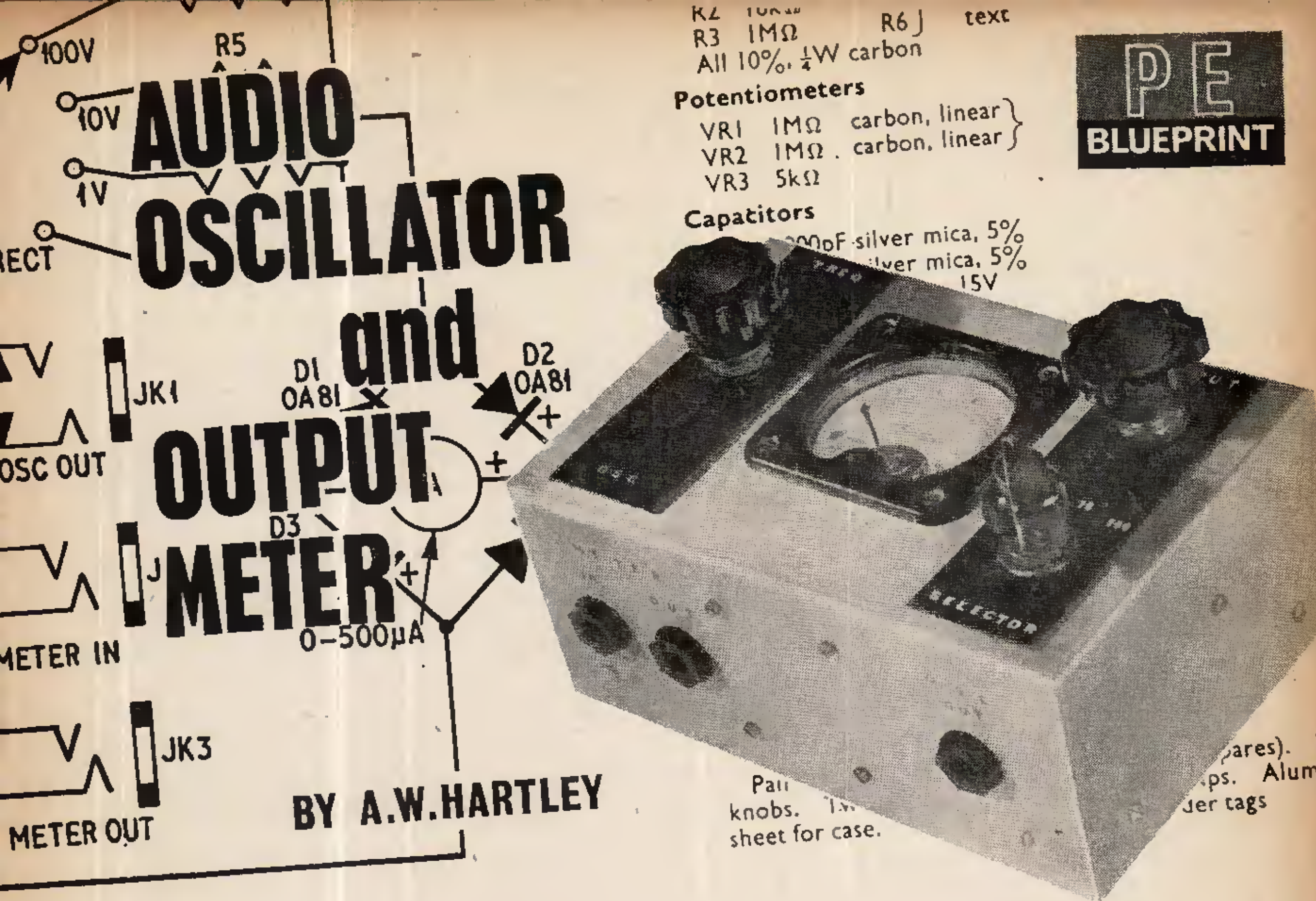
On/off switching can be performed from distances up to 100 yards from the clock, using ordinary twin flex. A push-on/push-off single-pole switch fixed either to a small board or in a small box is the most convenient control to operate and is almost foolproof.

When setting up at the start of a function it is advisable to switch the oscillator on and allow it to run for about 10 minutes. Then check the speed with a stop watch and adjust the fine speed control VR1 so that the hand just completes a circuit in 60 seconds. Note the reading on the fine speed control scale for future reference.

An occasional check with the *same* stop watch during the period of the event is a worthwhile precaution, although in practice this device has been found to maintain extremely accurate time. ★

AUDIO OSCILLATOR and OUTPUT METER

BY A.W. HARTLEY



With the increasing interest of the experimenter in the field of audio, a compact device which will give an indication of the performance of audio amplifiers and other similar equipment and be a useful guide to the location of a fault during trouble-shooting, is always in demand.

The instrument featured on one of the blueprints presented with this issue takes the form of a variable low frequency oscillator and output meter. Before the design was finalised several basic requirements were laid down as desirable features worthy of incorporation in a piece of equipment such as this. These requirements and the reasons behind them are listed below:

(a) The instrument should be fairly small and compact, to make it easily transportable.
(b) In common with modern practice, semiconductors should be used throughout.
(c) As it is not intended to be a precision instrument, a wide tolerance of components can be allowed.
(d) It must be possible to tell when the oscillator is operating, for, depending on the type of transistor used, the cut-off at the top end of the l.f. band will vary.
(e) Provision to be made for using either the oscillator or the meter separately.
(f) The range of the output meter should be variable.

In early experiments with the prototype unit it was intended to incorporate an internal filter to provide an improved waveform at 1,000c/s for checking distortion in audio circuits. To produce a sine wave free of harmonics from the predominantly square wave output of the oscillator would require a selective tuned circuit or bandpass filter. This offers considerable problems to the amateur and, in addition, the inclusion of such a filter would reduce the output level at other frequencies—possibly by as much as 6dB per octave, which would make the instrument unacceptable for its present purpose.

FACILITIES

The facilities available on the present instrument are as follows:

(1) The oscillator frequency is completely variable over the most useful part of the audio range.
(2) With no jacks inserted in the outlet plugs the output of the oscillator is automatically extended to the meter.
(3) The oscillator output level is variable.
(4) By using the METER IN jack and leaving the battery supply to the oscillator disconnected, the output meter may be used separately. (Further isolation may be achieved by inserting a dummy plug in JK1).
(5) The output meter may be used as a level meter when recording from radio, etc. The output of the receiver or pre-amplifier is taken from the extension LS sockets and plugged into the METER IN jack, and connection may be made to the OSC OUT jack for the feeding to the tape recorder.
(6) With the use of an external battery (3V–9V) the oscillator portion of the instrument can be disconnected quickly without having an internal control, and it is then obvious to the user whether the instrument is on or off.

CIRCUIT DESCRIPTION

The circuit diagram appears as Fig. 1 on the blueprint. The audio oscillator is a conventional multivibrator consisting of transistors TR1 and TR2 which are both OC70s.

The capacitors C1 and C2 together with the variable resistors VR1 and VR2 form the time constant circuits which determine the frequency of the oscillations. These are the only components which need be of reasonably close tolerance. The capacitors should preferably be silver mica. The two potentiometers are ganged and form the frequency control.

It will be noted that the moving arm of each potentiometer is linked to the end of the track which joins to the negative supply rail. This ensures continuity of the connection to the transistor collector should the moving arm of the potentiometer develop any intermittency.

The output of the multivibrator is taken from the bottom end of VR2 via an 8μF electrolytic capacitor C3 to the base of transistor TR3, which is used as a straight forward amplifier. A 1MΩ resistor R3 is connected between base and collector of TR3 to improve stability by providing a measure of negative feedback.

VR3 constitutes the collector load, the signal being tapped off through capacitor C4. This variable potentiometer forms the output control.

The common emitter line (which is also the positive battery supply), connects with the normal contact (sleeve) of the closed circuit jack JK1, the output from C4 connecting to the other normal contact (tip) of this jack. The two switching contacts of the jack are connected to the metering circuit with the "tip" contact to the rotor of the selector switch S1. The isolation of the meter circuit is made by breaking the contacts of JK1, and may be achieved by inserting a dummy plug.

METER MULTIPLIERS

The selection of the series multipliers R4, R5, R6 depends on the type of meter chosen. For a meter required for precision measurements the range required would have to be calculated from the formula

$$R = \frac{V - Rm}{I_m} \text{ ohms}$$

where R = multiplier required.
V = voltage reading required for full scale deflection on meter.
Rm = meter internal resistance.
I_m = meter current f.s.d. (in amps).

In addition, another factor would have to be considered. As the meter responds to a rectified alternating current it indicates the mean or average current, which requires further adjustment to the series resistor. However, as precise indications are not required, coupled with the fact that the output is a square wave and the correction factors are only applicable to a sine wave, any correction (including that of the meter resistance) is neglected as this is small with respect to the multiplier used.

In Table 1 values for R4, R5 and R6 are given for three meter full scale deflection readings, the one selected depending of course on the particular meter used.

The bridge connected rectifiers D1-D4 are four germanium diodes, these being used in preference to selenium or copper oxide types from a point of cheapness, availability and better response to the frequencies applied. If several of these diodes are available to choose from, the forward and backward resistance may be measured with an ohmmeter and four selected whose characteristics are similar. This is not essential, but will improve performance.

TABLE 1

Meter f.s.d.	*Direct*	*1V*	*10V*	*100V*
100μA	none	10K (R6)	100K (R5)	1M (R4)
100μA	none	2K (R6)	20K (R5)	200K (R4)
1mA	none	1K (R6)	10K (R5)	100K (R4)

TWO POSSIBLE MODIFICATIONS

Two variations of the present design may be introduced subject to requirements. The first is to incorporate the battery within the case to make the instrument fully self-contained. A clip will be needed to hold the battery, and the potentiometer VR3 should in this case be fitted with an on/off switch to break the battery supply.

The second modification concerns the extension of the frequency range. It may be that a ganged 500 kilohm potentiometer is more easily obtainable than the one specified, and if this is used the value of the two capacitors C1 and C2 should be doubled. This may conveniently be done by substituting a three pole four way switch for S1 instead of the one specified, and mounting two sets of capacitors so they are switched in parallel with C1 and C2, using the selector switch to do this (see Fig. 6).

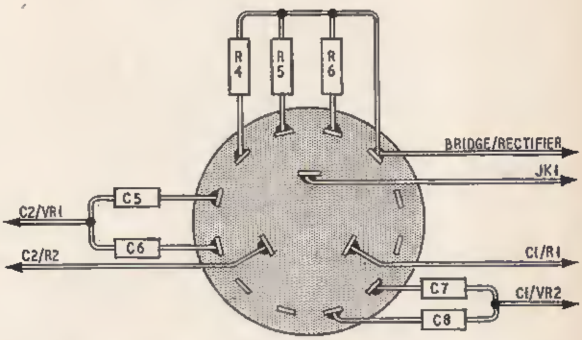


Fig. 6. Connections to S1 for modification described in text.

It should be noted if this modification is carried out and the oscillator used in conjunction with the output meter, the range will change with the change of frequency. The choice of capacitors is a matter of experiment and the results obtained are largely a characteristic of the transistors used in the oscillator.

The use of the output meter in conjunction with the oscillator is most useful for these adjustments, as it can be easily seen when the multivibrator stops oscillating as the frequency increases. The output of the oscillator varies considerably with frequency, so that the use of the output control will ensure that an arbitrary reading is maintained at any frequency within the range.

The range selector provides direct, 1V, 10V, and 100V positions and, depending on the sensitivity of the meter, an output can be obtained on the first three positions.

The choice of transistors does largely determine the performance of the instrument. In the original model TR1 and TR2 were TK40 and VT3 an OC76, but in general the circuit will work with any good a.f. transistors. Similar transistors have been tried in all three positions (OC70), but an OC72 or an OC76 is better in the amplifier.

MECHANICAL CONSTRUCTION

The mechanical construction should commence with the marking out of the chassis as shown in Fig. 4. The actual size of the circular cut-out for the meter will depend on the type used, as also will the holes for the fixing screws.

If an internal battery is to be used the battery sockets are omitted and provision is made for a clip on the inside of the chassis.

Corner strengthening brackets are not normally used on a small chassis such as this, but they do prevent any distortion of the chassis causing wires to break off and also provide useful anchoring points for the securing of the baseplate.

Once the drilling has been completed and before the sides are bent up a line should be scribed on the reverse side of the panel ⅛in in from the outside, to provide for the alignment of the corner brackets. The bending of the sides should preferably be made by using wooden blocks held in a vice.

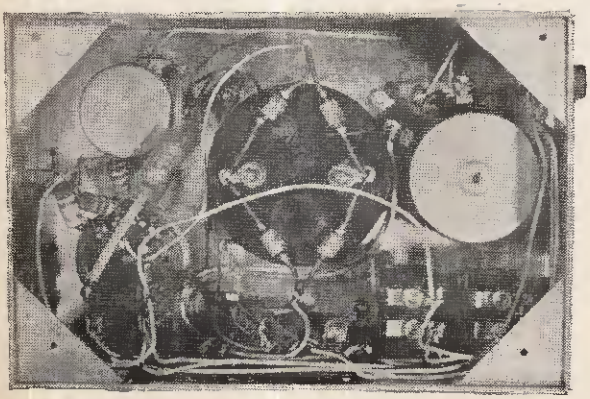
Fold up the sides of the corner brackets and position each in turn so that it is flush with the scribed line, that is ⅛in from the bottom of the panel. With the scriber, mark through the fixing holes from the outside and drill the 6B.A. clearance holes in the bracket. The brackets are fitted to the panel either by aluminium rivets or nuts and bolts.

Some sort of finish can be applied to the outside face of the chassis, either by rubbing down with fine emery cloth or "pickling" in a strong soda solution. In some cases a finish is incorporated in the aluminium sheet during manufacture providing a "stipple" or "stucco" effect, in this case no further work is required.

The base is made to rest just inside the chassis on the corner brackets and is secured by self-tapping screws. In the original model two of the holes were made slightly offset to ensure that the base always went on the same way.

WIRING UP THE SUB-PANEL

The next operation is the wiring of the sub-panel (Fig. 5). In order that the correct spacing between the two tag strips is maintained they are assembled on the outside of the box. The two outside fixing holes on each strip are tapped 8B.A., as it is almost impossible to fasten in with nuts and bolts when the panel is wired. The 8B.A. screws are assembled on the inside of the box to hold temporarily the panel.


Interior view of the completed unit

The wiring is completed, as shown in Fig. 5, with sufficient length of free lead to connect to the external points.

The leads for the transistors should be not less than ½in long and should have small bore sleeving slipped (this may be obtained by stripping off the insulation of a piece of p.v.c. wire).

The completed panel should be removed from the outside of the chassis at this point.

REMAINDER OF WIRING

Wire up the multiplier resistors for S1 (with additional capacitors on S1 if desired) also components VR1/VR2, VR3, JK1, JK2, JK3 and S1 and the battery sockets. The clearance hole for the battery sockets must be sufficiently large to allow the sockets to be located centrally in the holes and locked in this position with insulating washers and locknuts.

Connect up the bridge rectifier as shown in Fig. 2 with the two positive ends (red tip) of the diodes laid together and attached to the solder tag under the positive terminal of the meter. The negative ends should be attached in a similar manner to the other terminal of the meter. The wires at the other ends of each pair of diodes should be bent up about $\frac{3}{16}$in, an external connecting wire being looped in before they are soldered together.

Once this wiring has been completed the sub-assembly is affixed to the inside of the chassis by means of four 8B.A. bolts into the previously tapped holes in the tag strip.

CONTROL PANELS

The insulated control panels are made up and drilled; the holes being slightly under-size to allow trimming by a round file. These panels should be assembled temporarily beneath the lock nuts of the three controls.

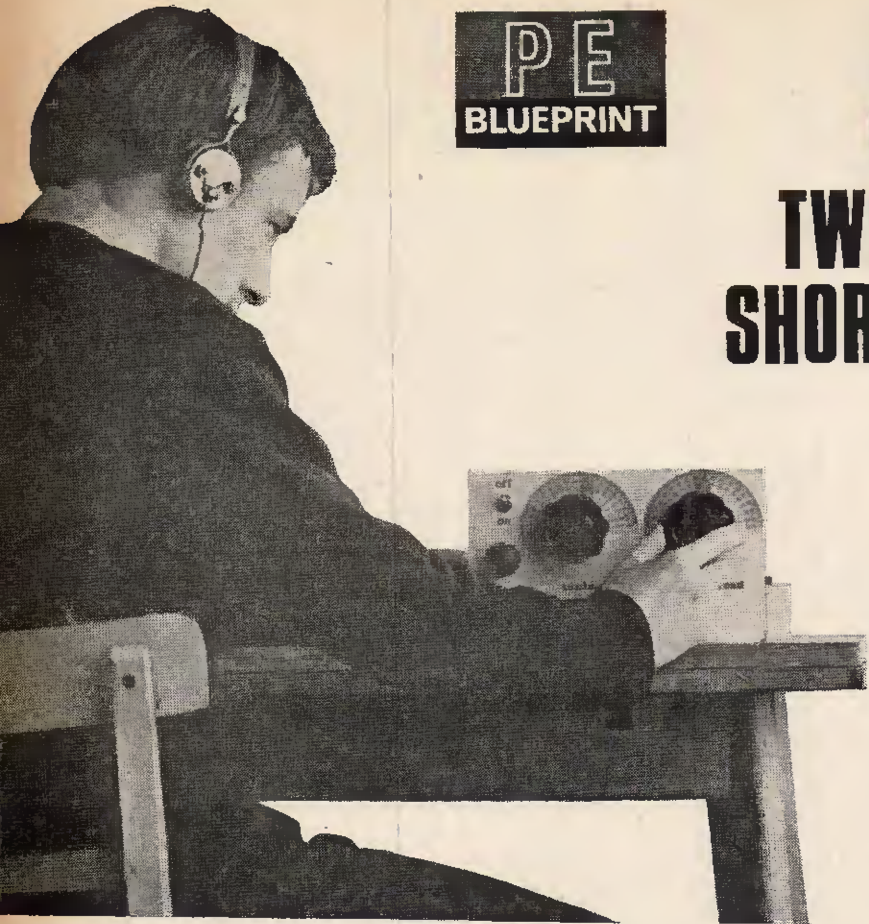
Before the locknuts on the variable controls are finally tightened the two plastic panels should have the lettering applied.

OPERATION

In order to use the instrument connections are made as follows:

Oscillator only (no output indication)	Output at JK1
Oscillator with output indication	Output at JK2
Oscillator check	No jacks in
Meter only	Input to JK2
Input for recording	Input to JK2 Output at JK3

Set the frequency and output controls to approximately mid-position, and the selector switch to 1V position. Connect up the battery supply (between 3V and 9V) to the battery sockets, observing polarity. If no jack plugs have been inserted, the meter should indicate a small reading. Adjust the output control for maximum and the frequency control to that required. The selector switch may have to be reduced to its most sensitive range dependent on the output of the oscillator and voltage of supply. No frequency graduations are shown in connection with the frequency control, as this will vary considerably with choice of transistors and power supply. ★



PE BLUEPRINT

SIMPLE RECEIVER
TWO VALVE SHORT WAVE

by R. E. F. STREET

THE receiver featured on one of the blueprints presented with this issue has been designed especially for the newcomer to radio construction. For this reason it uses a simple circuit—but one which is nevertheless capable of giving excellent results.

The coverage of the receiver is from about 18 metres to 50 or 60 metres (or, expressed in terms of frequency, 16 to 5Mc/s), depending upon the exact components employed. Thus, it covers most of the popular short wavebands including the 20 metre and 40 metre amateur bands (or 20m and 40m, if we use the usual abbreviation "m" for "metre").

CIRCUIT DESCRIPTION

The circuit (see Fig. 1 on the blueprint) uses two identical battery-powered valves; these are 1T4's (other suitable types are CV785, W17, 1F3 and DF91). In a receiver like this, intended for the beginner, mains operation is best avoided because of the danger of shock when in the hands of the inexperienced constructor.

The batteries used here are a 90V (this means 90 volts) type and a 1·5V type, and the risk of shock from these is low.

The output from the receiver is fed to high impedance headphones—this avoids the need for a third valve to feed a loudspeaker and keeps down the battery consumption. The second valve in the circuit (V2) is the detector and is of the regenerative type in which signals are fed back from the anode to the grid to increase the gain by bringing the circuit almost to the point of oscillation. The feedback (or reaction as it is often called) is controlled by varying the screen grid potential by means of VR1.

This particular type of reaction control is not normally used in battery circuits for one main reason —in order to vary the screen-grid potential, a potentiometer must be connected across the h.t. line and this gives rise to a certain amount of wasted h.t. current. In this circuit, the current through the potentiometer (this consists of R5 and VR1 in series) is just over a third of a milliamp (just over 0·0003 amps or 0·3mA). This will not cause the h.t. battery to wear out much more quickly than it would if the usual circuit were used.

The headphones are connected to the anode circuit of V2 via a capacitor C7. This procedure means that there is no direct current (d.c.) flowing through the headphones.

RADIO FREQUENCY STAGE

The main trouble with a reacting detector is that it sometimes radiates appreciable interference when it is actually oscillating, causing howls and whistles on neighbouring receivers. Also, coupling the aerial directly to the detector stage results in "dead spots", where reaction cannot be obtained, at certain points in the tuning range.

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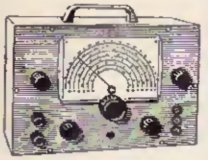

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100mA	22/6	3V D.C.	22/6	15V A.C.	22/6
150mA	22/6	10V D.C.	22/6	50V A.C.	22/6
200mA	22/6	20V D.C.	22/6	150V A.C.	22/6
300mA	22/6	50V D.C.	22/6	300V A.C.	22/6
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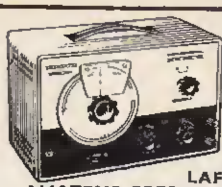

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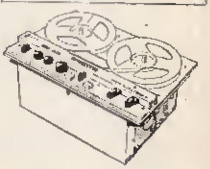

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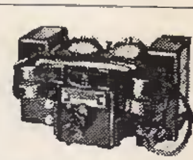

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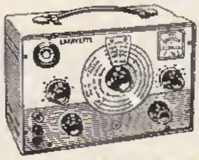

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In this receiver, these two defects are avoided by using a radio frequency (r.f.) stage before the detector. This amplifies the signals from the aerial and feeds them to the detector. Actually, the amplification is not very great and the important function of the r.f. stage is to isolate the detector from the aerial thus preventing radiation of interfering whistles, and the occurrence of "dead spots".

Most simple short wave receivers use plug-in coils to achieve wide coverage. In this receiver, however, this complication has been avoided by using a twin-gang 500pF capacitor in conjunction with one set of coils only which are permanently wired in circuit.

From the beginner's point of view, there is no need to go into more detail concerning the operation of the circuit. More will become apparent when the set has been built and used.

BATTERIES

For the high tension (h.t.) supplies the B126 (Ever Ready) is suggested, although the equivalent in another make is equally suitable.

For low tension (l.t.) supplies the following Ever Ready 1·5V types or their equivalents may be used: AD1, AD4, AD14, AD32, AD34, and AD35. The AD35 is smaller and less expensive than the others, but it will not last as long.

Plugs for the batteries can be obtained from radio component shops and it is a good idea to buy also the aluminium tops which are available for the plugs. These will make it easier to unplug the batteries when required.

It is not essential to buy a proper l.t. battery but it is convenient since this type has sockets on it for connecting the receiver. You can use ordinary 1·5V cells if you wish. An ordinary U2 or equivalent cell will give a good few hours of listening since the current drain of the receiver from the l.t. battery is only 100mA (100 milliamps or 0·1A).

If you use a U2 cell, remember that the zinc case is the negative connection and the brass cap at the top is the positive connection. If possible, solder the wires from the set on to the cell, or make up a spring-clip arrangement for connecting the wires to the cell.

CONSTRUCTION

To simplify construction, the chassis of the receiver is made from wood and hardboard covered in places with aluminium cooking foil. Of course, if you are sufficiently experienced and have the necessary facilities, you can use a conventional form of construction with an aluminium chassis and front-panel. The wood-and-hardboard method has the advantage of ease of working and relative cheapness.

To make the framework for the chassis, a 1 yd length of nominal 2in wide by ½in thick "ramin" or similar softwood will be needed. This is cut to provide two pieces 9½in long and two pieces 6in long. Make sure that you cut the ends "square" or the frame will not fit together very well.

The four pieces of wood are then screwed together as shown in Fig. 6a, using eight ½in No. 4 steel wood-screws.

FRONT PANEL

To make the front panel you will need a piece of ⅛in hardboard 10in by 6in, and you will need another piece the same size for the top of the chassis.

Drill these two pieces as shown in Figs. 8 and 9, shiny side towards you, taking care to sandpaper off any burrs left when the holes have been made. Countersink the holes marked "X".

If the twin-gang tuning capacitor VC1, VC2, you are using has a single-hole or bracket fixing, you will not need to drill the three holes indicated in Fig. 9—these are for the type of capacitor which uses three bolts for fixing. However, if three bolts are to be used, check that they conform to the spacing given in Fig. 9, and if the holes on the front of your tuning capacitor are spaced differently, make the necessary alteration. With the bolt-fixing capacitor, it is very important to make the centre hole in the panel large enough for the capacitor to fit tight against the panel when it is mounted.

Before proceeding further, check that the various parts fit the holes you have made for them. *It is very important that the holes should be the right size now and that you do not have to enlarge them later.*

ALUMINIUM FOIL

The inside of the wooden framework must now be covered with aluminium cooking foil as shown in Fig. 6b. The shape of the foil you will need is also shown—in Fig. 7. Note that on one long side of the framework, you must bring the foil over the top and down the front. The front panel will eventually be screwed to this side of the frame and the foil on it will then be in contact with the foil on the frame.

To glue the foil in position, almost any adhesive can be used including balsa cement.

Foil must also be used to cover the back of the front panel—the side with the cloth-like marks on it, not the shiny side. The underside of the hardboard to be used for the top of the chassis must also be covered with foil.

You will now need to make holes in the foil corresponding to those already present in the hardboard. If you run your finger over the foil, you will see the outlines of the holes formed on the foil and you can then cut it away in the appropriate places. Make sure that you cut the foil away close to the holes, but do not cut away more than is necessary.

ASSEMBLY

The next job is to screw the front panel to the front of the chassis framework; that is, to the side of the framework with the aluminium foil on it. For this, use ⅜in woodscrews and make sure that the heads are below the surface of the front panel when you have done—the holes were countersunk so this should be easy.

You can now mount the various parts on the front panel. The bandspread capacitor VC3 is mounted by a single nut, as are the switch S1/S2 and the potentiometer VR1.

MOUNTING THE TWIN GANG

The twin gang tuning capacitor VC1, VC2 will probably have three holes for fixing it as mentioned earlier. You should use bolts with countersunk heads, but you may have difficulty in obtaining bolts which are short enough. If the bolts are more than about ¼in long, when you screw them up tight to mount the tuning capacitor, the ends which stick through the frame of the capacitor will contact either the fixed plates, thus shorting them out, or the moving plates at some part of their travel. You will thus have to shorten the bolts if you cannot buy the correct length.

To shorten a bolt, place a large nut on it and screw it up to the head of the bolt. Grip the nut in a vice or in a pair of pliers and saw off the unwanted part of the bolt using a small hacksaw. Finally, reverse the bolt in the vice or pliers and use a screwdriver to unscrew it from the nut. This procedure makes sure that if you damage the bolt when you saw a piece off it, unscrewing the nut will restore the thread quite well. If you do not use a nut, it will be difficult to hold the bolt in the vice or pliers without damaging its thread and you may have a job to screw a nut on it when you have sawn it.

When you have mounted the tuning capacitor VC1, VC2, make quite sure that the three fixing bolts do not get in the way of the moving plates nor short out the fixed plates.

CONNECTIONS TO METAL FOIL

Here, one point must be noted carefully. Owing to the fragile nature of aluminium cooking foil, it is necessary to check carefully that all the metal parts mounted in contact with it do in fact make good electrical contact. Examine the tuning capacitor and the bandspread capacitor and also the solder tags which are fastened to the hardboard chassis and front panel to make sure that they are tightly contacting the aluminium foil.

SOCKETS FOR WANDER-PLUGS

The sockets for the wander-plugs can be fixed to the chassis using red for the two aerial sockets and for one of the headphone sockets (the one to be connected eventually to C7). Use black sockets for the earth and the other side of the headphones. The two valveholders can also be mounted—you will need soldering tags underneath the mounting bolts as shown in Fig. 2.

MAKING THE COILS

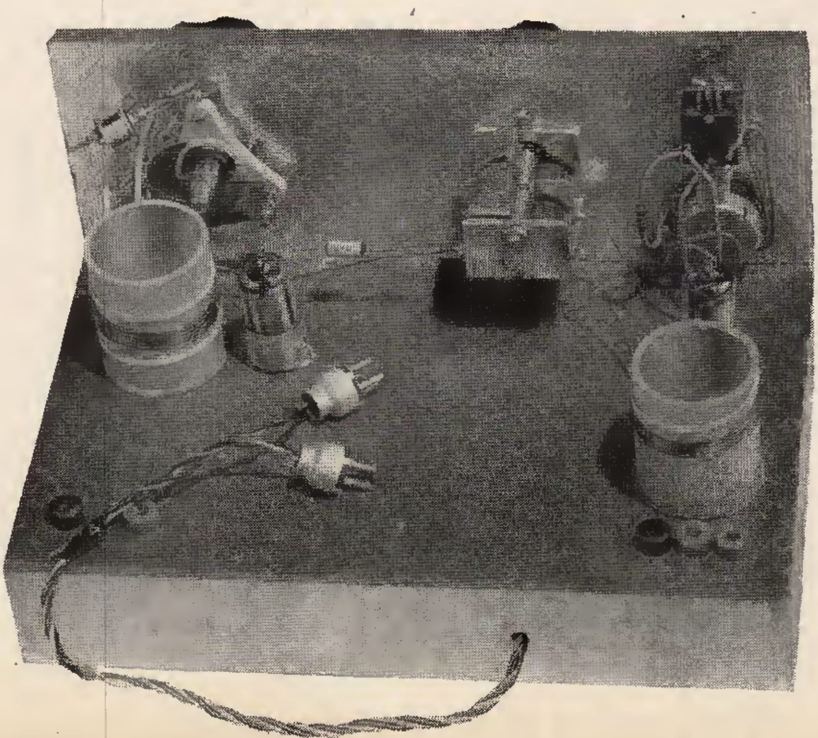
For the coils, obtain a length of cardboard tubing about 1½in in diameter. This diameter tubing is found in the rolls of paper sold for kitchen use. Cut off two 2in lengths of the tubing using a small saw such as a coping-saw to give neat edges. A sharp knife can also be used, but great care should be taken or cut fingers will result.

Cut out two cardboard discs the same size as the cardboard tubing and make an ⅛in hole in the centre of each. Glue one on each 2in length of tubing, using balsa cement, etc.

FIRST COIL, L1, L2

The first coil to make is L1/L2. Measure 1¼in from the base of the coil former (that is the end with the disc attached) and make two holes as shown in Fig. 3. Leaving a 5in length of wire for connecting later, wind on six turns of the 22 s.w.g. enamelled copper wire, spacing each turn from those next to it by an amount equal to the diameter of the wire or a little more. Note the method of threading the wire through two holes in the coil former at each end of the winding to secure the turns in position. To keep the spacing between the turns from altering, secure them to the coil former with balsa cement at one or two points.

Now wind on four turns of 34 s.w.g. double cotton covered (d.c.c.) copper wire in the same direction as the previous winding and spaced about ⅛in from it.



The turns of this winding should be close together—it should be "close-wound". Leave 10in ends on this winding for connection later.

SECOND COIL, L3, L4, L5

To wind L3/L4/L5, measure ½in up from the base of the coil former and make the two holes for securing the end of the wire. See Fig. 4. Leaving a 10in length of wire for connecting, wind on four turns of 34 s.w.g., d.c.c. wire close-wound. Leave 10in at the other end for connecting.

Then, $\frac{3}{16}$in from this winding, wind on in the same direction six turns of 22 s.w.g. enamelled wire leaving 5in ends for connecting. The turns of this winding should be spaced from one another (as were those of L2) by a distance about equal to the diameter of the wire. The winding will occupy a length of about ⅜in.

Next, $\frac{3}{16}$in from the top of L4, wind on five turns of 34 s.w.g. wire (d.c.c.) in the same direction. These turns should be close-wound and 10in ends should be left for connecting later.

CHECK THE WINDINGS

It is important that the turns on L1 should be wound in the same direction as those on L2. The turns on L3 should be wound in the same direction as those on L4 and L5, too. Use the diagrams of the coil-winding (Figs. 3 and 4) to check the coils you have made.

When the coils are complete, mount them on the chassis, passing the securing bolts through the holes in the discs at the bottom of the formers. Use a washer on each bolt to prevent the heads of the bolts from being pulled through the cardboard when they are tightened.

Now that all the parts have been mounted, the wiring can be carried out as shown in Figs. 2 and 5. Use insulated wire of the single strand type throughout and put sleeving on the cotton covered leads from the coils, and also on the bare leads of the capacitors and resistors.

Note that TC1 is a "concentric" type of trimmer. It is held in position by soldering its long centre pin to an "earthy" tag on VC3.

BATTERY LEADS

Leave the battery connecting leads until last. For these, you will need four plastic covered pieces of flex about 18in long—one red, two black, and one clear or transparent. These can be made by unravelling pieces of coloured twin bell-flex (obtainable from chain stores). Twist all four leads together to form a cable and then connect their bared ends separately to the tag strip near to V1 as shown in Fig. 2. Thread the leads through the hole in the rear runner of the chassis, and, about four inches from the ends of the leads, separate them into pairs—red and black; white and black. Connect these leads to the battery plugs as shown in Fig. 5 and Fig. 10.

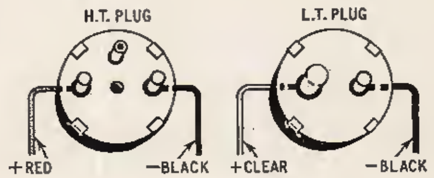


Fig. 10. Details of battery plug connections

All of the wiring should now be completed. It must then be checked very carefully against the wiring diagrams Figs. 2 and 5 and the coil diagrams Figs. 3 and 4.

Be quite sure that you have wired up the battery connections correctly. Check the h.t. wiring and make quite sure it is correct. If by chance you connect the h.t. incorrectly and it is applied across the filaments of the valves, they will be ruined at once.

TESTING

Switch off S1/S2 and connect the l.t. battery (1·5V). Switch on S1/S2 and look carefully at the two valves. The filaments should be glowing, but you may need to be in a darkened room to see the glow which is not at all bright.

Switch off again and plug in the h.t. battery and the headphones, which must be of high impedance (2,000 to 4,000 ohms). Turn the tuning capacitor (VC1, VC2) and the bandspread capacitor (VC3) to their mid-way positions. Turn the adjustable top of TC1 as far clockwise (almost) as it will go. Turn the reaction control VR1 fully anticlockwise. (It does not matter at this stage whether or not the various controls have knobs fitted since the aim is just to see if the set works.)

Plug in an aerial (to either of the two aerial sockets) and an earth too, if one is available. Now switch on and there should be a click in the headphones. Turn up the reaction control VR1 and eventually there should be a whistle or hissing in the headphones. You may also hear a station, but if not, move the tuning or bandspread capacitor a little. Once that you have heard that the set works, switch off again.

If the set does not work, check all your wiring and connections carefully once more, making quite sure that the metal parts which are supposed to be in contact with the aluminium foil on the chassis are really in contact with it.

TUNING SCALES

The next job is to make the front panel look neat and to provide a scale for each of the tuning controls. In the prototype, this was done by covering the front panel in thin white card. Scales were made for the tuning knobs from ordinary protractors as used in schools and sold for about 7d. each at the moment.

It is necessary to cut out semi-circles in the protractors so that they can be fitted in position on the front panel without the fixing nuts of the controls getting in the way. It is possible to drill holes initially in the protractors and then use a fine toothed fretsaw to remove the small piece of material. Great care must be taken when preparing the protractors since the material used cracks easily. If drilling is carried out, it must be done with the protractors on a solid surface to prevent cracking—a small piece of wood is ideal. The edges of the hole can be neatened up using a *blunt* penknife, but, even so, care is necessary to prevent cut fingers and damaged protractors.

Two countersunk holes should be made in each protractor so that they may be bolted to the front panel after the white card has been glued to it. The holes should be in a position where they will later be hidden by the control knobs.

These four holes are the only ones which you have to make in the front panel after you have fixed the foil in position. Place the protractors in their correct places and use the holes in them to mark the four that must be drilled. Remove the valves and be careful when drilling that you do not damage the tuning capacitors. Take care also to keep the dust out of them as you drill.

FIXING THE KNOBS

The knobs used on the two tuning controls should preferably be of the same type for good appearance, and as large as possible. They also need to have a pointer fitted. You can buy knobs with pointers but you can add plastic pointers to ordinary knobs by gluing them on the underside.

When you fix the knobs on to the spindles, turn the tuning capacitor to maximum capacity (vanes fully meshed) and turn the knob to read a little more than 180 degrees on the protractor before you tighten the grub-screws. When you turn the tuning capacitor to minimum capacity, the knob should read a little below 0 degrees. Do the same sort of thing with the other knob, but set the pointer exactly to 180 degrees with the bandspread capacitor fully meshed. The pointer will then read 0 degrees with the plates as open as possible.

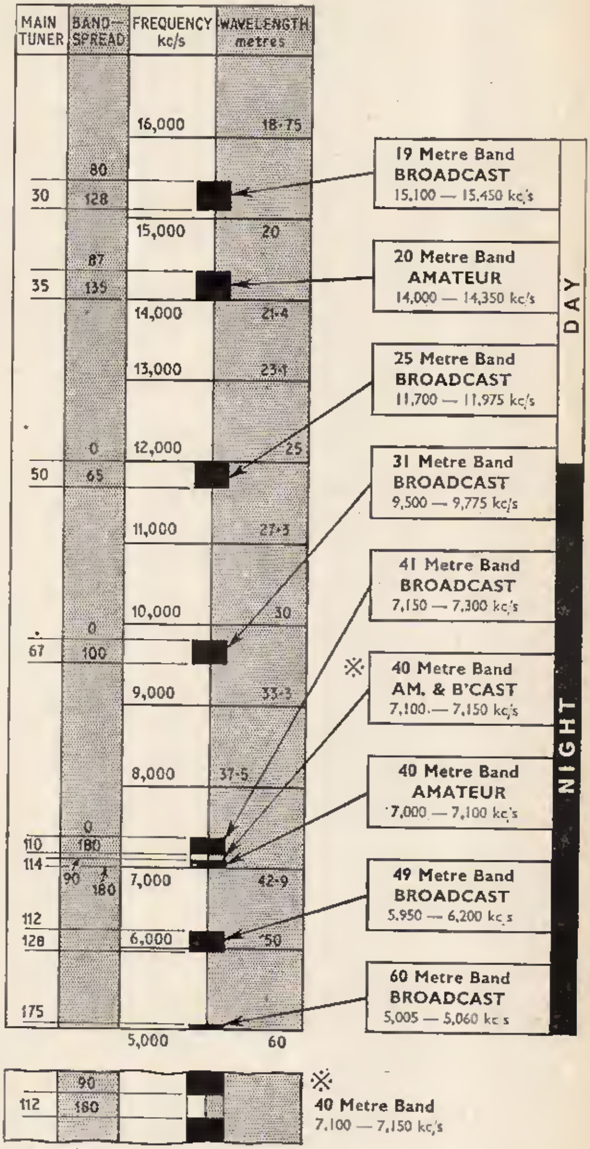


Fig. 11. This chart shows the approximate tuning range of the simple Short Wave Receiver.
The well known bands used by broadcasting and amateur stations are shown. Calibration points for the main tuner and the bandspread control are provided here as a general indication. These readings will vary somewhat for each individual receiver.
Log the dial readings for each station heard. When a sufficent number of stations have been identified it will be possible to compile a calibration chart such as given in the two left hand columns of our illustration.
In daylight, the higher frequencies (shorter wavelengths) are the more active. With oncoming darkness as night approaches, the lower frequencies (longer wavelengths) become usable for long distant transmissions.

USING THE SET

Plug in the batteries and switch on. Make sure that the aerial, earth and headphones are plugged in too. Set the bandspread capacitor to 90 degrees (half-way) and the tuning capacitor to, say, 135 degrees (rather more than half-way to maximum capacity) Switch on and turn up the reaction control until some sound is heard—you may have to move the tuning capacitor a little. The best time to try the set out for the first time is in the evening when there are more stations to hear.

As you gradually turn up the control there will be a point where a whistle or hiss is produced. The aim in using the receiver should be always to keep the reaction control in such a position that if you turn it up just a little more, the whistle or hiss will be heard. The detector (V2) is then at its most sensitive —it is said to be "on the threshold of oscillation". If you do not keep the reaction control at this point, you will only hear strong stations.

You must remember that the reaction control will require continual adjustment as you alter the tuning of the receiver. The best setting varies according to the position of the tuning capacitors.

ADJUSTING TC1

To adjust TC1 for optimum results, tune the bandspread capacitor to the half-way position (90 degrees) and the main tuning capacitor to the position of maximum capacity (vanes fully meshed). Unscrew TC1 (anticlockwise) as far as it will go, and turn the reaction control nearly full up. Switch on the receiver and screw TC1 clockwise until you hear the reaction whistle or hiss. You should now find that reaction is obtainable over the whole of the tuning range of the receiver. If not, screw up TC1 a little more. You should aim at keeping TC1 set as far anticlockwise as possible provided that you can get reaction over the whole tuning range of the set.

TUNING

The tuning capacitor should be used to select the band on which you want to listen, with the bandspread capacitor set to 90 degrees. Then, tuning the bandspread capacitor will enable you to tune the receiver over the band you have selected. The operation is really quite simple.

If you have a 500pF tuning capacitor, this works out at about (500/180)pF or 2·8pF per degree of rotation. With a 15pF bandspread capacitor, the variation in capacity is only about (15/180)pF per degree of rotation which is 1/12pF per degree. Thus, if you move the tuning capacitor 2 degrees, the capacity changes by about 5·6pF. To get the same capacity change by moving the bandspread capacitor, you would have to move it about (5·6 ÷ 1/12) degrees which is about 67 degrees. Thus, if two stations were only 2 degrees apart on the tuning capacitor, they would be nearly 70 degrees apart on the bandspread capacitor.

The bandspread capacitor therefore spreads out the stations in a given band making them easier to tune—hence the name.

AERIALS

The best type of aerial for this receiver is the "longwire" which consists of a long wire suspended horizontally as high as possible. It should be about 50ft to 100ft long including the downlead. Egg-type insulators should be used to suspend the aerial from its guy ropes and the wire and rope should be threaded around each insulator in such a way that if the insulator should break, the aerial will not fall down. The correct way is easily seen if you examine the insulator carefully.

EARTH CONNECTION

In many areas, the addition of an earth will not greatly improve signal strength.

There are two ways of achieving an earth connection. If there is a cold water pipe in the room where the radio will be used, a copper earth clip can be fixed to the pipe. The alternative is to bury a copper spike or plate about 18in deep in the ground and connect a wire to it. The copper can be surrounded by earth and then small stones and finally more earth. If it is not in a position where there is much rain, it should be watered now and again to keep the earth moist and maintain a good connection between earth and copper.

The main point about earth leads is to keep them as short as possible. This is one reason why it is not good to use the earth pin of mains sockets for the earth connection to a receiver like this one.

CHOICE OF AERIAL SOCKETS

On the receiver, there are two sockets for the aerial, one going to a coupling coil L1 and the other to the "top" of L2 via a 47pF capacitor C1. When using the receiver, use the aerial socket which gives the best results from the station to which the set is tuned.

★

PE BLUEPRINT

4 CHANNEL INPUT 3 VOLT BATTERY 2 TRANSISTORS 1 OUTPUT

THE OCCASION often arises when a number of microphones are required to be used in conjunction with a common power amplifier. For example, the author was asked recently to provide such a set-up for a local dance band. The amplifier used at the time had provision for two inputs. Although this was satisfactory up to a point there were limitations.

Two obvious limitations come to mind: the system is not flexible and hence individual control and balance of instruments or groups is not easily obtained. Furthermore, if the loudspeaker is mounted in the amplifier cabinet, the microphones have to be at a distance to avoid acoustic feedback.

The ideal arrangement is to provide a means of linking four microphones to a power amplifier, with a separate volume control for each microphone. The following details describe a mixer which will give these facilities at a very modest outlay. It is possible to convert the unit for up to six channels but with certain limitations which will be described later.

CIRCUIT

Fig. 1 on the blueprint sheet shows the circuit diagram of the complete mixer. The unit can be made entirely self contained by incorporating its power supplies (battery) within the case. Only two transistors are used, TR1 being directly coupled to TR2. Temperature stabilisation is maintained by R5, R6, and R8.

The stopper resistors (R1, R2, R3, and R4) are connected in series with the four inputs to avoid interaction between the inputs when dissimilar microphones are used. If these resistors are not inserted in circuit the volume control of one channel may interfere with the volume from the other three.

The circuit is shown with four input networks but up to six can be employed. If more channels are added, the input impedance will be reduced due to the shunting effect of the volume controls; interaction then becomes even more of a problem. The combined signals are fed into the base of TR1, which is connected as an emitter follower. The low impedance output from TR1 is directly coupled to TR2 base.

The output signal passes through an inter-stage transformer to provide a high impedance output for feeding either a valve or transistor power amplifier. The transformer is not critical but a reasonable quality component is recommended to maintain a good frequency response. A master volume control is inserted between the transformer and the output line and allows the overall gain to be adjusted to avoid overloading the main amplifier input.

The 3 volt battery connections are soldered *in situ*. The current taken is less than 1mA and the battery gives a considerable life approaching its normal "shelf" life.

MICROPHONE

COMPONENTS

Little needs to be said about the components since they are all readily available from many dealers who advertise in the magazine.

A further point on the transformer which is worth mentioning is its physical size. While a miniature type might be quite adequate, it is recommended that for reproducing quality music signals it should be a little larger to give low and high frequency reproduction. This is why an intervalve transformer with a 1:3 step-up ratio is quoted in the components list. It should be of reasonable size to be accommodated in the chassis (see Fig. 2 on the blueprint).

The chassis has been made 2½ inches in depth for this purpose and can be obtained ready made from H. L. Smith's of Edgware Road and other suppliers.

The knobs can be selected according to the constructor's own choice. Those shown in our cover photograph are from the new aminoplastic range by Bulgin.

CONSTRUCTION

Construction of the mixer should present no problems provided that the elementary rules are followed in wiring the transistor circuits. The chassis top becomes the front panel for the controls and jacks. The underneath can be fully enclosed by fixing an aluminium plate, thus completely enclosing the wiring and components, and screening them from extraneous hum sources.

The main part of the amplifier is wired on a small tag board, as shown in Fig. 3 on the blueprint, which is subsequently mounted in the chassis when the drilling and assembly is completed. Only five connections are then necessary to couple the amplifier to the other chassis components.

Note that the output socket SK1 in Fig. 2 is mounted behind the transformer, hence the dotted wiring. A soldering tag is fitted under one of the transformer fixing screws to connect the battery positive side of T1 secondary to chassis. If the jacks are insulated, make sure that provision is made for connecting the screen terminal to battery positive, the tag strip, and the chassis.

Make certain that the battery is connected the right way round, otherwise irrepairable damage to the transistors may result. In the prototype two 1·5 volt pen cells were used. These can be obtained as one battery contained in a common cardboard tube. To avoid intermittent connection between the two cells it is worth soldering a small piece of wire between them as shown in Fig. 2 on the blueprint.

The coaxial output socket is mated with its complementary plug for coaxial connection to the power amplifier. Screened or coaxial cable up to about 50 feet long can be used without introducing too much loss in signal strength or quality.

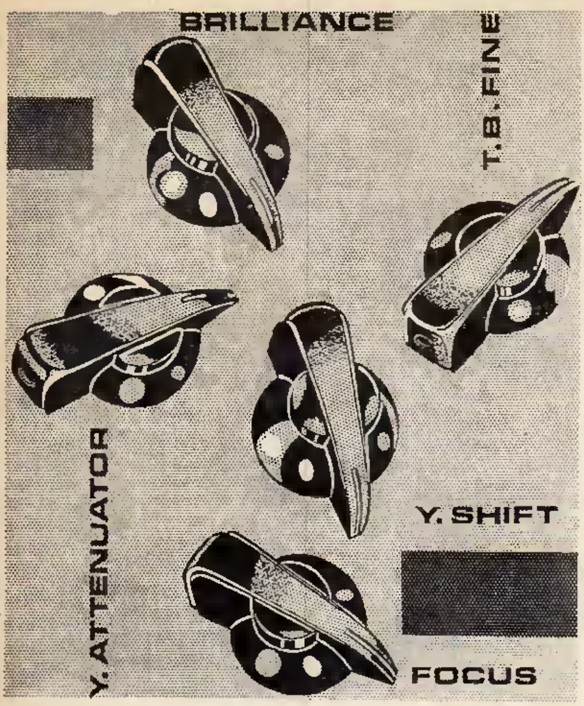
When completed, four knobs are fitted to the volume controls and a different style knob for the master gain control. To avoid incorrect setting of the master control it may be an advantage to saw a screwdriver slot in the spindle (see Fig. 4) and so dispense with the knob.

Four small rubber feet are fitted to the base plate to protect polished furniture and absorb any vibration which may be caused by the musicians beating out the rhythm on the floor.

Finally a word on microphones. Any high impedance crystal or dynamic microphone can be employed; low impedance microphones should be connected via the usual step-up matching transformer. ★

MIXER UNIT

BY BRIAN . L . PHILLIPS



INEXPENSIVE OSCILLOSCOPE

PART THREE

By P. Cairns

After completing the construction as described in last month's article, all wiring should be re-checked to ensure that it is in accordance with the circuit diagram. Particular care should be taken when checking the h.t. and e.h.t. circuit wiring.

The testing and setting up procedure will now be described.

Set the oscilloscope controls as follows: X shift, Y shift, focus, brilliance, astig., time base fine, X gain, and Y gain all at approximately half scale.

The Y attenuator should be set to position 1 (X1) and a short circuit link connected across the Y input sockets.

Set the time base switch (S5) to position 2 and the sync control (VR6) to zero, the cal. switch (S2) off and the sync switch (S4) to the internal position.

Now switch on the oscilloscope.

The neon V2 gives indication when the h.t. supply is present, and after a short period the time base line should appear horizontally across the tube face. When this appears set the brilliance to a reasonable viewing level and adjust the focus for as fine a trace as possible. With the focus correctly adjusted the trace should be under one millimetre thick.

CHECKING THE TIME BASE

Now reduce the X gain to zero, thus reducing the time base line to a spot. This spot should be centred on the screen by means of the X and Y shifts; these controls will move the spot horizontally and vertically respectively. The X gain is then increased once more until the time base line just overlaps each side of the screen.

The time base switch should now be switched through positions 1 to 4 and the fine control swung over its entire range at each position. The trace length may vary slightly between ranges but this can be easily compensated for by the appropriate adjustment being made on the X gain.

On the slowest range on both time base controls the trace should appear as a spot travelling from left to right across the tube face as the time base scan here is about 100ms/cm, the spot taking over half a second to scan the tube face. No flyback sweep should be visible and as the tube is of relatively short persistence little or no afterglow will be visible.

CHECKING THE X AMPLIFIER

Having checked that the time base is working satisfactorily on all ranges, set X gain to zero and then the time base switch to position 5 (X Amp.). Now inject an external signal of between one and ten volts into the X input sockets. The internal calibration can be used for this purpose by simply connecting a shorting link between the cal. output socket and the X input socket, the earth return being internal to the oscilloscope.

The cal. switch is then switched on. After centring the spot by means of the X shift, the X gain should be increased to maximum, when the injected signal will appear as a horizontal line on the screen whose length will be dependent upon the amplitude of the injected signal. If the internal cal. is used whose output is one volt peak to peak, the line should be about 1·25cm long with maximum X gain as the X amplifier has a maximum sensitivity of approximately 800mV/cm.

Having ensured that the X amplifier and associated circuit are working correctly, reset the time base switch to position 2, the X gain to zero, recentre the spot if necessary by means of the shift controls, and then increase the X gain until the time base line is again just over one screen diameter in length.

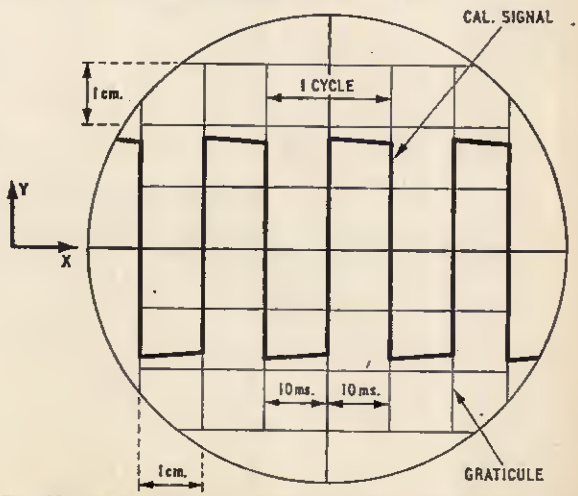


Fig. 12. Square wave calibration signal as viewed on the oscilloscope

ADJUSTING THE SIGNAL TRACE

The short circuit link can now be removed from the Y amplifier and a signal injected into the input. Again the internal cal. signal may be used, the cal. output being linked to the Y input socket and the cal. signal switched on. The Y gain should then be adjusted until the signal amplitude occupies about three centimetres of the screen height. The time base fine control is then adjusted until about two or three complete cycles of the square wave occupy the screen width. At the same time the sync control is also increased from zero until the trace is locked steady and does not tend to "run" across the screen.

In practice it will always be found an advantage to adjust the fine time base control and the sync control simultaneously to achieve optimum and positive synchronisation.

The screen trace should now appear as in Fig. 12, assuming that the internal cal. signal is being used. The slight slope on the upper and lower edges is due to the l.f. response of the Y amplifier and is not a function of the signal. No over- or undershoot should be present nor should any of the corners be rounded, all corners and edges should be sharp and clean cut. (Such defects would be due to incorrect h.f. compensation and in this case C13 and C15 would be the most likely offenders. However, no such troubles should normally be encountered.)

The signal can be examined in more detail if required by simply increasing the time base speed until only one or less cycles occupy the screen width (the sync control being readjusted to suit, of course). The trace can also be expanded by increasing the X gain which at maximum should give at least the equivalent of six screen diameters, i.e., the signal is "stretched" in a horizontal direction by a factor of six. By such methods very small portions of a composite signal may be expanded to large dimensions for more detailed analysis.

THE BASE CALIBRATION

Referring back to the trace as previously described and as shown in Fig. 12, such a trace may be used for time, as well as amplitude or voltage, calibration.

With each pulse or half cycle occupying exactly 1cm as shown, the time base calibration at that point is 10ms/cm, i.e. as the cal. signal is derived from the 50c/s mains, one cycle of this frequency is equivalent to 20ms and therefore each half cycle equals 10ms.

If the time base is expanded until one half cycle occupies say 4cm the time calibration is then 2·5ms/cm. Faster time base speeds can be calibrated by means of an audio oscillator, e.g. if a signal input to the Y amplifier of 5kc/s is set so that one cycle occupies exactly 1cm, the time base calibration is then 0·2ms or 200μs/cm.

The approximate ranges of sweep speeds covered by the time base is shown in the specification given in the first article of this series.

In some instances a slight non-linearity at the start or finish of the time base scan may be noticed, particularly on the slower sweep speeds. This can easily be offset by increasing the X gain slightly until the non-linear portion of the trace "falls" outside the tube diameter.

ASTIGMASTISM ADJUSTMENT

Before going on to the Y amplifier, the preset astigmatism control (VR1) may be set up.

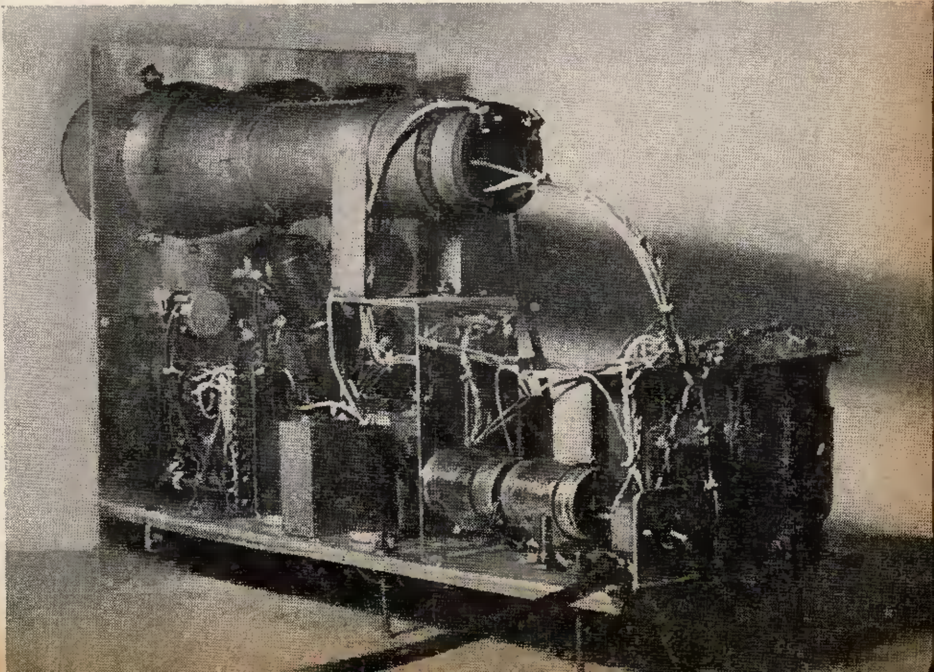
With the oscilloscope set up as just described and with a trace similar to Fig. 12 on the screen, connect a d.c. voltmeter between the slider of VR1 and the chassis. This preset control is then adjusted to give a voltage of about 260 on the meter.

The focus control should then be adjusted to give optimum focus over the whole of the trace in both horizontal and vertical directions.

The purpose of the astig. control is to give optimum focus over the whole useful screen area which is usually achieved when the A3 voltage is near in value to the deflection plate voltages.

The astig. control should then be varied by a reasonable amount above and below the figure quoted, the focus being adjusted at each setting until the best results are obtained. The object is to get an equally fine focus at both the edges and centre of the trace

An incorrectly adjusted control could show up as a slightly defocused trace at the edges with a very fine focus in the centre, or a fine focus on the vertical edges of the trace and slight defocusing on the horizontal edges, or vice versa. The best compromise between



A general view of the inexpensive oscilloscope. This completed assembly should be housed in a case made either of plywood or aluminium sheet. Ventilation holes should be provided along the top and bottom edges of the side panels these extremes should be found by experimenting with the astig. and focus controls.

Once the astig. is set it should seldom require any further adjustment. Any change in focus necessary due to a change in brilliance is compensated for by adjusting the focus control in the normal manner.

It may be mentioned at this point that the centre portion of the tube is normally used for signal analysis and measurement as a certain amount of defocusing occurs at the extreme edges in all but the most expensive tubes. This is principally due to the curvature of the glass which becomes more pronounced at the edges of the screen and is unavoidable.

X AMPLIFIER CALIBRATION

We now come to the calibration of the Y amplifier. While the method to be described uses the internal cal. signal, any external signal in the audio range may be used—provided the output level is known or is measurable.

The output level of the cal. signal should be one volt peak to peak, the accuracy depending principally upon the divider network R4, R5, R6. The signal level can be checked by connecting a low range d.c. voltmeter of the multirange type between the cal. output and one of the common earth sockets. With the cal. switch on this should read 0·5 volts, this being the average voltage of a one volt peak to peak square wave having a 1:1 mark space ratio.

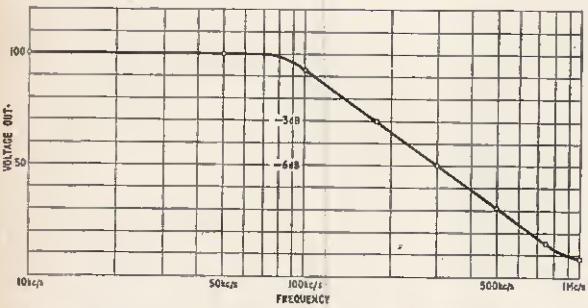


Fig. 13. This curve shows how the response of the Y amplifier falls of at the higher frequencies

The oscilloscope is set up again to the same conditions as previously described with a trace similar to that in Fig. 12 and the Y attenuator still being in position 1 (x1).

The Y gain is now adjusted until the peak to peak amplitude of the signal occupies exactly 5cm. This point can now be marked on the Y scale as 200 or 0·2 (the scale being Y sensitivity in millivolts or volts per centimetre).

The signal amplitude can now be reduced by means of the Y gain to exactly 2·5cm peak to peak, this point being marked on the scale as 400 or 0·4. This method is continued until the main points of the scale are calibrated; e.g., 2cm = 500 or 0·5. 1cm = 1,000 or 1. 3·3cm = 300 or 0·3, etc. The intermediate points can be calibrated later if required.

The measurements can be carried out by means of the graticule or with a fine pair of dividers. Once this scale is calibrated these sensitivity factors may be increased by the various attenuation factors obtainable by means of the Y attenuator.

For example, if a signal is measured with an amplitude of 2·5cm with the Y gain reading 300mV/cm and the Y attenuator set in position 4 (×30) then the actual peak to peak voltage would be (300 × 30) × 2·5 = 22·5 volts. If the signal is a sine wave this can be converted to r.m.s. value if required by dividing by $2\sqrt{2}$ = 7·95 volts r.m.s.

As the Y calibration is carried out on the basic amplifier (position 1 on the attenuator) any inaccuracy on the other ranges will be simply due to the tolerance of the attenuator resistors, and as 5 per cent high stability types are specified any such errors are reduced to practicable proportions.

Another advantage of the attenuator is that the various multiplying factors choosen (×3, ×10, ×30, etc.) correspond to very near 10dB steps, this often being of use when taking characteristics on audio power amplifiers.

As previously mentioned, the Y amplifier has quite a good frequency response but when working up at the h.f. end of the characteristic the Y gain calibration will become increasingly inaccurate. To help offset this a typical frequency response curve for the amplifier is shown in Fig. 13. Though this curve will tend to vary somewhat between amplifiers due to differences in tube capacitance, valves, wiring, and stray circuit capacitance, etc., it will give an approximate value of any correction factor which may be required at the h.f. end of the amplifier characteristic.

The gradual fall off in h.f. response also shows that the amplifier is correctly compensated and will have a good square wave response. An over compensated amplifier will have a pronounced "hump" at the h.f. end of its characteristic.

VOLTAGE READINGS

A final test worth carrying out is to check the voltages at various points in the circuit and also the h.t. current drain. A complete list of all the relevant voltages together with the conditions under which they were taken is given in Table 1.

Table 1
VOLTAGE READINGS

All voltages are with respect to earth and measured on AVO Model 8 (20,000 ohms/volt). Measured under following conditions: no signal input, time base on fastest sweep speed, brilliance, focus and astig. controls set for normal viewing brightness and optimum focus, X and Y shift controls in mid position.

Valve	*Anode*	*Cathode*
V1	—	325V
V4b	220V	1·6V
V5a	245V	} 21·5V
V5b	245V	
V6a	115V	5V
V6b	310V	150V
V7a	315V	150V
V7b	215V	12V
V8a	190V	} 19·5V
V8b	190V	

C.T.R. (V3):
Grid −660V Anode 2 −380V Anode 3 260V

H.T. (junction L1/R2): 315V

E.H.T. (junction C7/VR3): −750V

Calibration Unit Supply (junction R5/S2): 11V

Total H.T. current 45mA

While the voltages shown were measured on an AVO Model 8, 20,000 ohms/volt instrument, a meter of lower impedance can be used providing the necessary correction is allowed for.

The voltage levels listed are not in any case the criterion as the individual voltages will vary between instruments due to differences in component tolerances, h.t. level, valve efficiencies, etc. They are provided here principally as a guide when fault finding or servicing.

With all the above tests satisfactorily completed the oscilloscope may be considered ready for use and should prove invaluable in all aspects of amateur experimental work. While the many and varied uses to which an oscilloscope may be put, together with its few limitations, is beyond the scope of this particular article, the variety of applications for which it can be used will increase as the operator becomes more familiar with the various controls and test procedures involved. The advantages of the oscilloscope in all branches of electronic work are immense, and once the operator becomes fully conversant with the various techniques involved, he will find it an invaluable, and even indispensable, instrument.

MAINS TRANSFORMER

The Radiospares "Heavy Duty" type mains transformer meets the requirements of this oscilloscope *without any modification*. If a "normal" type mains transformer with only two 6·3V windings is used it is then necessary to wind on one additional heater secondary. The information in the components list (p. 331, March issue) should be amended accordingly.

ALTERNATIVE TUBE TYPES

A type 3BP1 c.r. tube is used in the author's original model. If either of the alternatives are used the minor differences in specification and the difference in base and pin connections should be noted.

The pin connections of the 3EP1 and 3GP1 tubes are identical and are shown in Fig. 11.

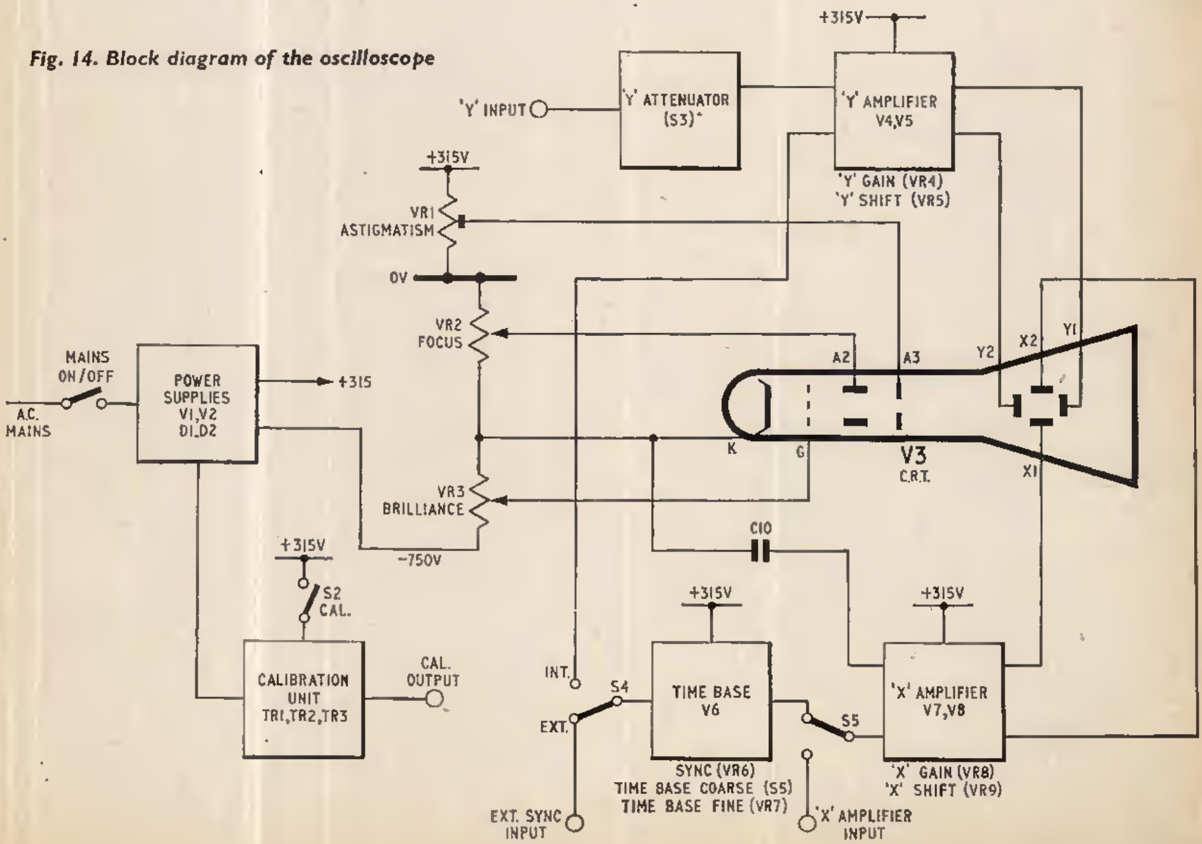
3EP1—The Y plate sensitivity will be decreased by about 8 per cent. The X plate sensitivity will be decreased by about 10 per cent. These slight differences will be automatically compensated for when the instrument is calibrated. The specification and circuit should therefore remain unchanged.

3GP1—The Y plate sensitivity will be increased by about 6 per cent. The X plate sensitivity will be increased by about 20 per cent. It may be necessary to increase the value of R15 by about 20 per cent (up to 390 kilohms) to allow for the lower value of A2 voltage required by this tube. The minor difference in Y sensitivity will be compensated for when the instrument is calibrated. The only difference in specification will be an increase in the X sensitivity of about 20 per cent, i.e. 7X trace expansion instead of a 6X trace expansion. The only circuit change may be R15 which can be increased should the correct focus not be obtained.

TUBE ORIENTATION

In order to obtain proper aligment of the trace it may be necessary to rotate the 3EP1 and 3GP1 tubes slightly away from the position indicated in Fig. 11 (p. 415, April issue). Once this adjustment has been performed, lock the base clamp to secure the tube. ★

Fig. 14. Block diagram of the oscilloscope



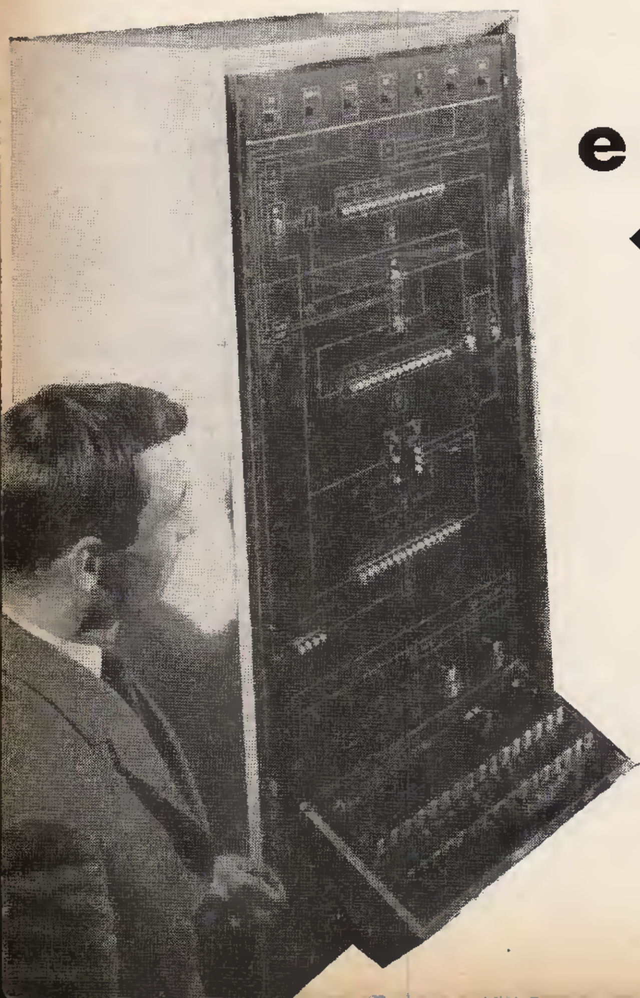
ELECTRONORAMA

HIGHLIGHTS FROM THE CONTEMPORARY SCENE

Microwave Cooking

THE principle of cooking or heating by microwaves, that is radio waves at the frequencies used in radar, has been established and used for some time. The application of this principle to catering in terms of providing the customer with quickly served, appetising, varied and hygienic meals has however only recently been achieved, and so far only significantly in the U.S.A. Microwave heating, which has been developed over the last 15 years by the Raytheon Company, can be used for the reheating of pre-cooked deep frozen foods or complete meals in a matter of seconds.

The secret behind the microwave oven, as in radar techniques, is a magnetron tube, a pulse operated device consisting of a cylindrical cathode surrounded by a solid cylindrical anode containing resonant cavities. An electromagnet is placed around the anode to provide a magnetic field through the magnetron. The frequency of oscillation is determined by the resonant frequency of the cavities.



electronics

Training Computer

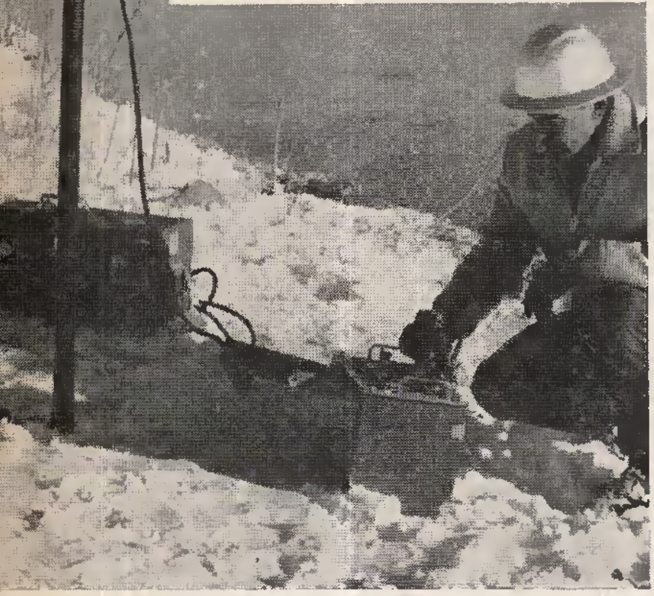
NOW THAT there is a large number of computers in operational use a problem has arisen in training students and operators. There is a growing demand for personnel to operate and maintain these massive electronic "brains". Elliott Automation have been working in collaboration with the Battersea College of Advanced Technology to produce a training computer which, it is hoped, will help to teach students the basic principles of computer technology and prepare them for operational activities.

The kit for a basic machine comprises a set of "Minilog" logic elements and a set of diagrams. It operates at clock frequencies of either 1c/s or 5kc/s and "one shot" operation is also available. All arithmetic operations are performed in serial form on word lengths of 16 bits (binary digits) and data is read in or out in parallel via switches and lamps. The training computer is capable of performing addition, subtraction, shift, negation, multiplication and transfer. Other configurations in logic can be done by interchanging connections and plug-boards.

It is expected that students will first be given a theoretical appraisal of how computers work which can then be demonstrated on the machine. The instructor can insert faults for the student to correct. He can remove entire logic sections, leaving the student to reconstruct the machine from a plug-in board, suitable components and a performance specification. In this way the student will have been given experience of the basic problems.

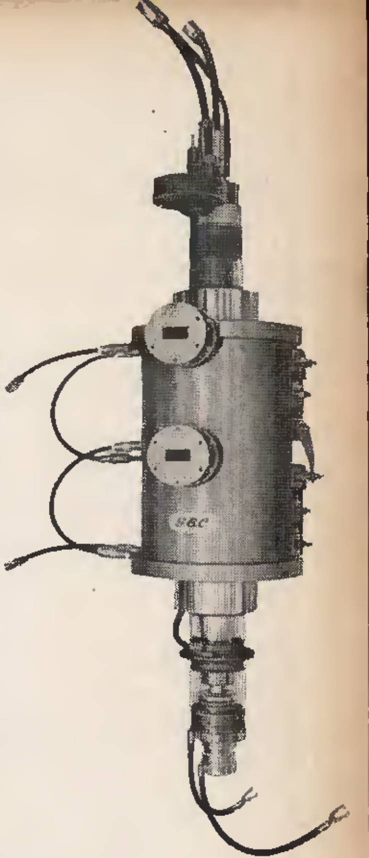
Boon to Builders

Probing the ground for moisture content to see if it is suitable for building purposes has hitherto been an expensive operation—often requiring the drilling of numerous 50ft deep holes. Now a new nuclear device which measures radioactivity at depths of only 15in is doing the same job at a tremendous saving. The detector—called a "Scaler"—records the speed of neutrons. When neutrons pass through water they collide with hydrogen atoms and slow down—the slower the reception of the neutrons, the more moisture is in the soil. Currently, the device is in extensive use in Colorado.



Largest T.W.T. ▶

One of the features of The M-O Valve Company exhibit at the eighth international electronic components show held in April at the Porte de Versailles in Paris, was the display of the world's largest travelling wave tube specially designed for satellite communication ground stations. This tube, type TWC827, is a water cooled C-band travelling wave amplifier giving a minimum operating power output of 8kW at a frequency of 6,300Mc/s with 60Mc/s bandwidth and wide tuning range. The tube uses a coupled-cavity slow wave structure of a type which gives high gain.

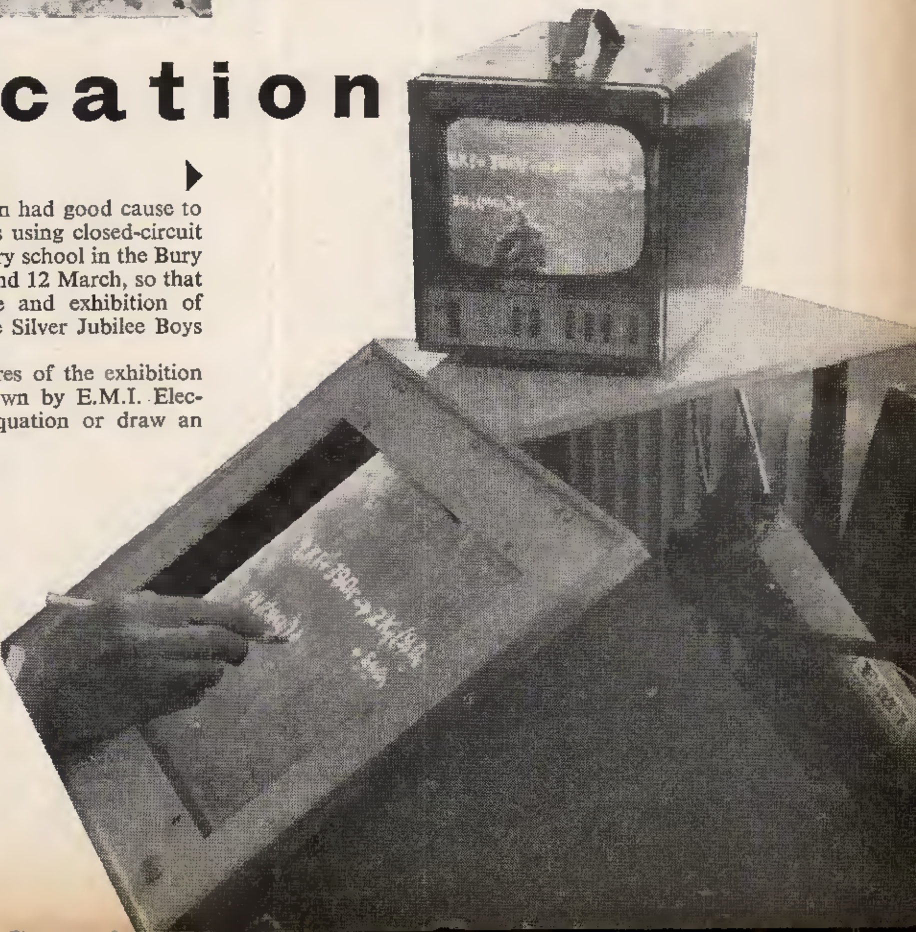


in education

Electronic Blackboard ▶

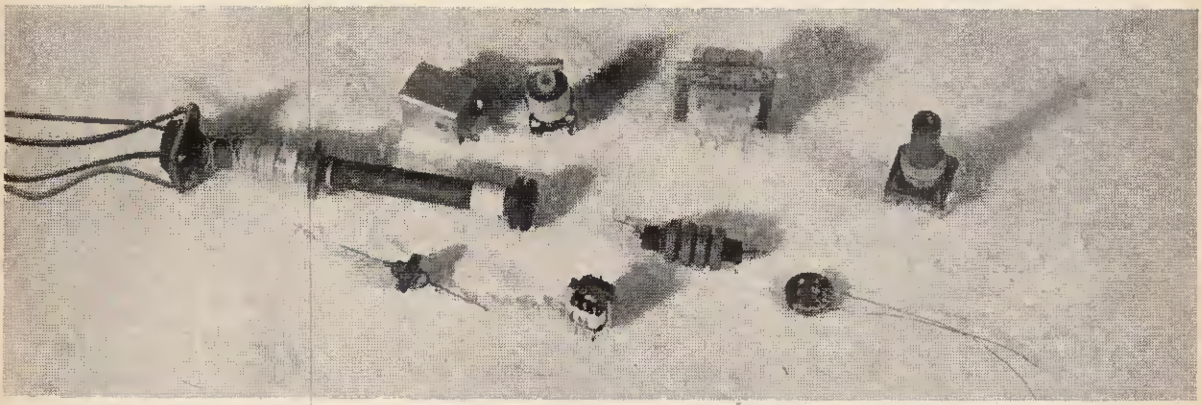
Thousands of Suffolk schoolchildren had good cause to approve the current trend towards using closed-circuit television as an aid to teaching. Every school in the Bury St. Edmunds area was closed on 11 and 12 March, so that 600 teachers could attend a course and exhibition of audio-visual aids to education at the Silver Jubilee Boys and Girls Schools.

One of the most interesting features of the exhibition was an "electronic blackboard" shown by E.M.I. Electronics. A teacher can write an equation or draw an illustration on the plastic screen without turning his back on the class, and the picture is simultaneously shown on television screens throughout the school or in several schools. Diagrams, maps and other illustrations of suitable size can be prepared beforehand then transmitted in quick succession during a lecture. Attention can be drawn to specific details of the illustration by a pointer or the teacher's finger, which will also be televised.



BEGINNERS start here... 7

An Instructional Series for the Newcomer to Electronics



Shown here are a number of small inductors and transformers such as are commonly used in transistorised equipment.

The components in the rear half of the photograph are, reading from left to right, as follows: ferrite aerial as used in portable transistor radios; intermediate frequency (i.f.) transformer with iron dust core, and its screening can; audio frequency (a.f.) transformer with laminated iron core; and another i.f. transformer.

In the foreground, left to right are the following: radio frequency (r.f.) inductor or "choke" having an inductance value of about 2.5 millihenrys; miniature a.f. transformer with laminated iron core; r.f. choke of about 20 millihenrys—this form of construction with sectional windings is used to minimise self-capacitance effects; and finally a ferrite ring with single winding, this is used in computer "memory" circuits.

So far in this series we have met the resistor and the capacitor. It will be recalled that these are the names for components or parts which are designed to make use of the properties of *resistance* and *capacitance*, respectively. There remains one other basic electrical property, this is *inductance*. In fact there are two kinds of inductance, self-inductance and mutual inductance, and both occur through the action of magnetic fields produced when an electric current passes through a wire or other conductor.

The component that makes use of self-inductance is called an *inductor*. It may be a simple coil of wire, or it may be wound in a certain peculiar fashion, and may or may not have an iron core.

The component that utilises the mutual induction effect is called a *transformer*. Again, this may be simple or complex in construction, but essentially it consists of two (or more) windings in close proximity to each other.

ELECTRO-MAGNETISM

Surely it is remarkable, but just as surely taken for granted nowadays, that the flow of electric current produces a magnetic field; and that a *moving* magnetic field, in turn, makes current flow in nearby conductors.

The first effect was noticed by accident, but the reverse effect was carefully thought out, and tested by experiments, by the scientist M. Faraday back in the last century.

The experiments to be described later will enable you to study the formation of an electric current by moving magnets to and fro. Notice that no current is obtained if the magnetic field is steady.

Of course, instead of the permanent magnet, the field can be produced by a current flowing in a coil. This current can then produce a further current in a separate coil nearby, see Fig. 7.1.

Coiling the conductor concentrates the magnetism from each turn, and forms a strong field. Also, using an iron bar or magnetic core makes a strong increase in the magnetic effect—in an analogous way to the dielectric increasing the electric field in a capacitor.

The "induced" current in the second coil only flows when a *moving* field links with the turns of wire, but it is not necessary to move the first coil, as in the case of the magnet, because if the current in it is turned on and off, then the field builds up and collapses in sympathy—in other words moves. Thus currents flow in the second coil in sympathy.

Obviously you will see already the importance of alternating current in electronic devices—it is changing rapidly all the time.

The above linking of circuits with a magnetic field is called *mutual induction*, and the circuits are said to be magnetically coupled. Mutual induction is used in transformers; it is also used in induction heating, where the strong, rapidly changing fields round a coil induce currents into a nearby metal so that it becomes red- or white-hot. This is useful when the metal part to be heated is inside a vacuum tube, see Fig. 7.2.

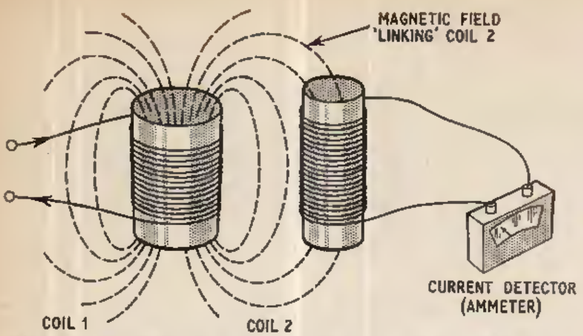


Fig. 7.1. The "lines of force" representing the field produced by the current in the first coil, link with the second coil. If the field moves relative to this coil then currents are set up in it. The amount of linking of the field is called the degree of coupling between the coils

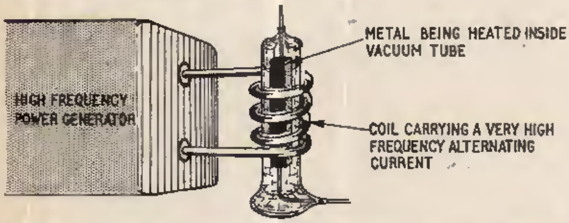


Fig. 7.2. The high frequency current flowing in the coil produces a rapidly changing magnetic field, which causes large currents to flow in the metal placed in the centre of the coil and these "eddy currents" as they are called, make the metal hot

This induction effect is also used in the "magnetic memory matrix" units in some computers. These consist of a large number of tiny rings of a magnetic material called a "ferrite" in which the magnetic field can go round, as it were, in a clockwise direction or an anticlockwise one. Conductors link these rings as shown in Fig. 7.3. Pulses of current sent in at the right points set the magnetic fields in the rings into a pattern of clockwise and anticlockwise circulation. Clockwise would correspond to "0" and the other way to "1". Computers usually count up to "1", i.e. the *Binary System*, so here is a whole pattern of information held for an indefinite time, and ready to be extracted later by currents induced into conductors (when the fields are made to change over to the other direction).

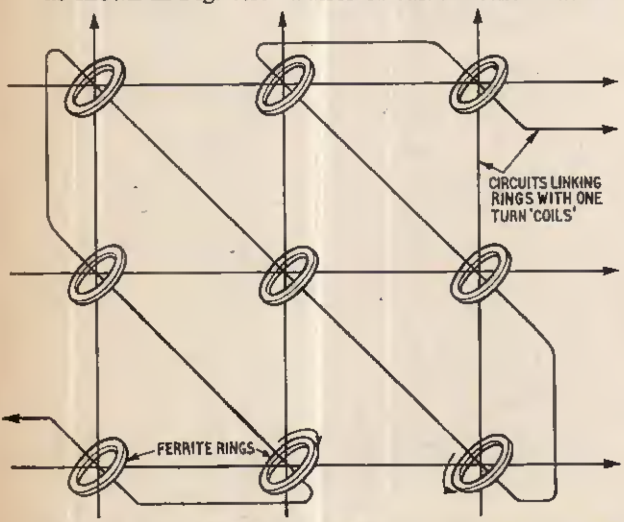


Fig. 7.3. The leads linking the ferrite rings are one turn coils, and when a pulse of current passes through both a horizontal and vertical wire at the same time, the field is switched in the appropriate ring. The field can be in one of the two directions indicated by the arrows. The diagonal wire is the "readout" circuit. It conveys a pulse to the computer whenever a ring has its field direction changed

AN INDISPENSABLE EFFECT!

Consider all the rows of tiny magnets—all varying in strength—which are on the surface of a piece of magnetic recording tape with "signals" on it. As the tape moves past the "playback" head, the magnetic field variations induce small currents in the coil on the head.

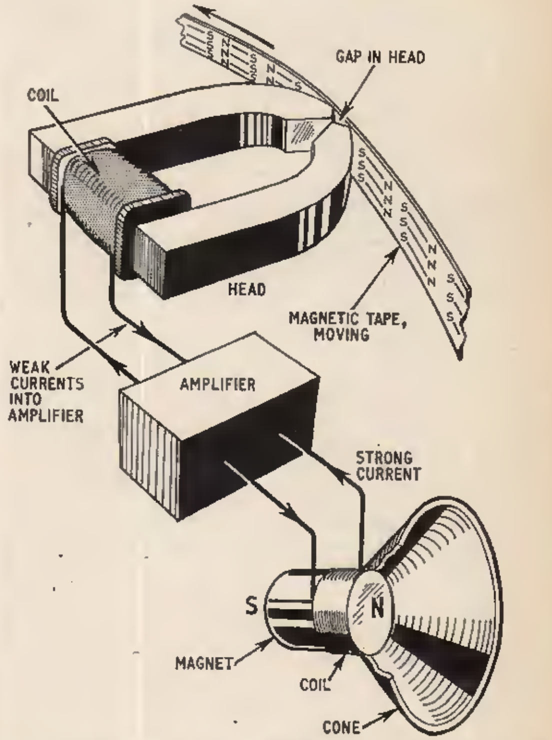


Fig. 7.4. The moving magnetised tape induces small currents into the coil wound onto the head. After amplification the sound is radiated by the vibrating cone of the loudspeaker

These currents, changing in sympathy with the music or speech are amplified greatly by the valves or transistors in the equipment and then fed through the coil of a moving coil loudspeaker. This coil is between the poles of a strong magnet and the currents flowing in it form another varying magnetic field. The forces between the fields push and pull the cone in sympathy with the music or speech variations—and sound waves are radiated to our ears. This chain of events is illustrated in Fig. 7.4.

We could go on listing the vast number of devices using effects similar to the above! But, may we encourage you, the reader, to think about the operation of these other things—the principles are all the same; for instance the small magnet moved by the stylus of a magnetic gramophone pick-up. . . .

Audio TRENDS...

A Commentary on Sound Reproducing Equipment by Clement Brown

AUDIO provides an absorbing field of study, especially if the aim is to secure high quality performance. It is rewarding for you, the amateur constructor, who can develop the skills which will enable you to economise while building or extending a home music system.

In *Audio Trends* particular attention will be paid to developments which you can exploit or adapt, and this will be supported by technical background information. Here, the aim is to deal with the questions: "Why is it done this way?" and "What will it mean in terms of performance?"

But remember that in every audio system there are items which you must, as it were, take on trust. Although you may acquire skills in audio electronics—possibly adding a bonus in the shape of cabinet work, if you are so inclined—there is little you can contribute when it comes to pick-up cartridges, loudspeaker drive units and other precision made items.

Such products will be discussed in these columns, partly because you will have to choose from a wide variety. There is an additional good reason: by studying the characteristics of these products—many are now of professional calibre—you can obtain an impression of major trends in audio.

TRANSISTORISED AUDIO

First a look at transistors. They have come to stay in high fidelity equipment and they offer a number of advantages.

Transistorised audio has some features in common with radio. Although portability is not required, the trend to more compact equipment is most certainly welcome. Facilities need not be sacrificed as size comes down. Look at some amplifiers in the medium-price range—for instance the Leak Stereo 30 and Truvox TSA100. Cool operation is an advantage: one worries less about special ventilation. Improved robustness is another point.

Very small transistor amplifiers, and particularly sub-assemblies using printed wiring, are of special value for experimental purposes.

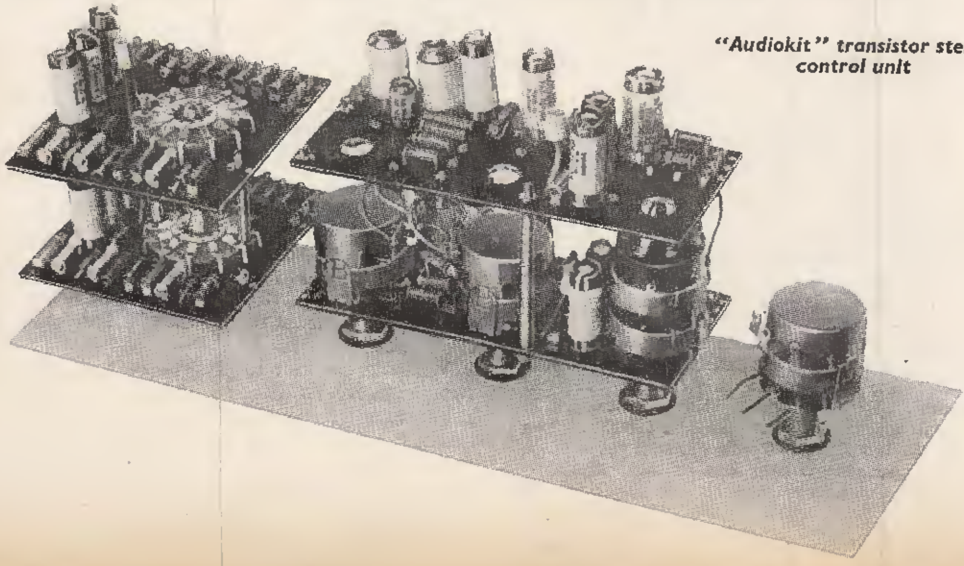
Those who favour kits are catered for by a number of firms. To mention one example the Martin Electronics Ltd. *Audiokits* enable ambitious equipment to be assembled at moderate cost.

Components manufacturers often help the constructor to exploit new developments. By consulting such specialists one can learn a lot about typical applications of transistors.

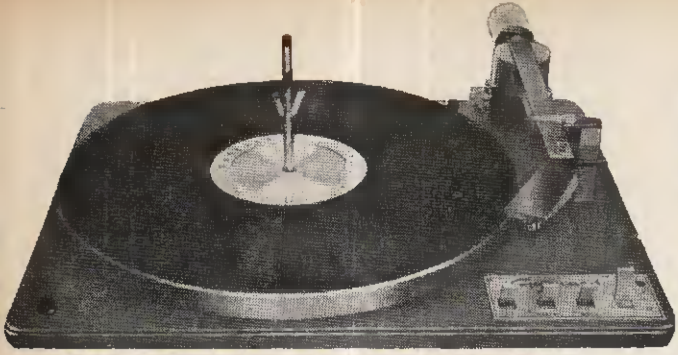
TAPE RECORDING

Next a few words about the ways in which tape can be associated with home music systems. Many enthusiasts, especially those who regard tape recording as a hobby, use portable machines. A multi-speed recorder of good quality is very suitable; it can be plugged into an amplifier for recording or replay, and can just as easily be disconnected for service elsewhere.

Right from the start of tape recording as we now know it, there has been some support for an alternative method—the relatively complicated one of using a tape deck (just the mechanical parts) and adding to it the circuits needed for response equalisation, amplification and so on. Home constructors can make many contributions if this plan is followed.



"Audiokit" transistor stereo control unit



Garrard Lab 80 transcription turntable

In the last year or two, however, there has been increased interest in a third method. A few manufacturers offer machines which incorporate bias oscillator, pre-amplifiers and indeed all that is needed for recording and replay. An audio output is provided but power output stages and speakers are omitted, since an existing audio installation provides these in good measure.

Truvox are well known for this approach. Several of these "tape units" are featured in their current range. Another example is the Bang and Olufsen Beocord 1500, made in Denmark. It is based on the already familiar model 2000 but has no output amplifiers or mixing facilities. This new stereo model, priced at 89 gns., has meters for recording level indication.

RECORD TURNTABLES

Not so very long ago the audio enthusiast was able to complain that, compared with the wide variety of amplifiers and speakers available, there was a sadly restricted choice of disc equipment—particularly turntables. And home construction was normally out of the question in view of the kind of engineering involved. However, the position has been changing for the better.

At the "budget" end of the range there is now the Deccadec, marketed by Decca for 15 gns. For this modest sum you are offered a robust single-play turntable (made by Garrard) which is fitted with an arm of up-to-date design plus the Deram head (an item which has been improved since its first appearance). This unit is also now included in a complete Decca stereo outfit which totals 73 gns.

Things have also been moving on the transcription quality front. Garrard's model 401 turntable is for those who can afford not to compromise in their record playing. This model does not yet supersede the famous 301 studio unit, which is still being marketed. Then there is the Lab 80: this, too, is of the transcription type, but it includes a pick-up arm and can be made automatic in operation by inserting a special centre spindle. Exports have claimed most of the output, but we should now see more of them in the U.K.

But the wider choice in top-quality turntables is really due to the increasingly international nature of audio. New models from Europe have included the PE33, made by the West German firm Perpetuum-Ebner. Like most continental units it includes a pick-up arm. It sells at a little over £40.

Also in the over £40 range are the fine Elac units, such as the Miraphon 17H and the Miracord 10H.

Yet another example is the Jobo 2800, made in Holland. This unit, like some other advanced studio quality turntables, has a built-in stroboscope, illuminated by neon lamps. But it is distinctly unusual in that it has a non-metallic turntable platter.

So the choice is widened, most of all at the costly end of the scale. This brings us to a final important point which often worries, or is misunderstood by, the amateur enthusiast. Can one do without this sort of outlay on a turntable—a relatively uninteresting link in the chain?

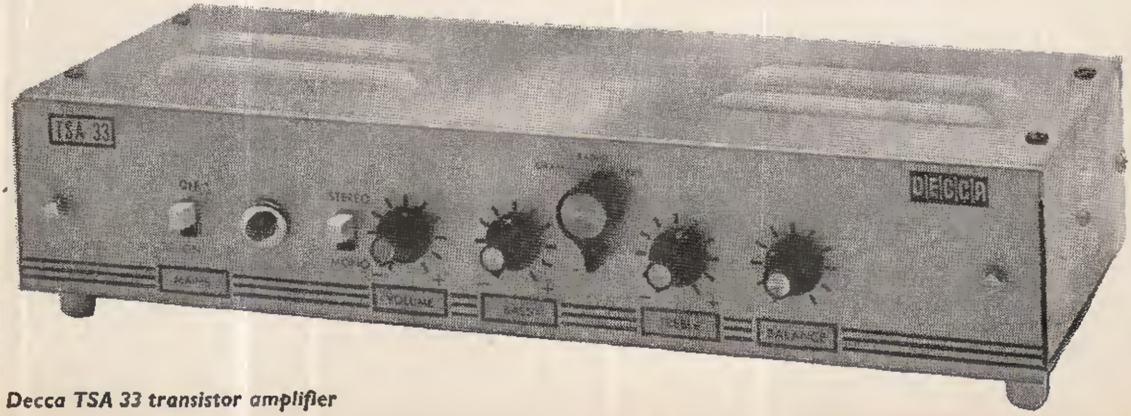
The answer is that high class engineering cannot be provided cheaply. The music loving audiophile, once he becomes more discerning—and more demanding—wants to *forget* about the turntable. It must unfailingly perform its simple task without causing any audible interference.

Speed fluctuations must be small—virtually non-existent—and no background noise must be generated. Studio quality is required: the term means what it says. This, plus long-term reliability, costs money.

Above all, the amateur should remember that a consistent level of quality must be maintained right through the audio system. If you plan to settle for a modest installation—stereo at well under £100—a cheaper turntable may well suffice.

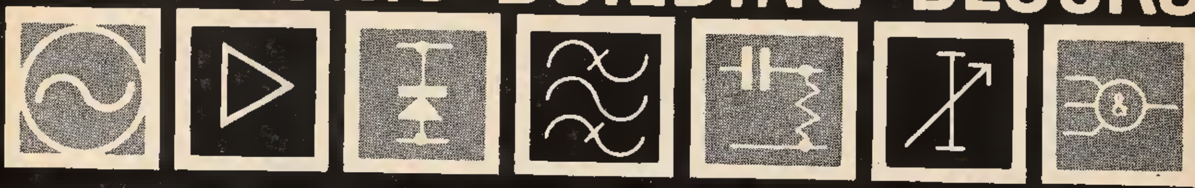
If you are more ambitious in the first place, or if you plan to modify and extend an existing outfit, a transcription unit is essential. Otherwise, disappointment is likely to follow. It is a simple, basic consideration, but mistakes are often made.

In the next article we will return to other aspects of disc reproduction, with a look at some recent products.



Decca TSA 33 transistor amplifier

ELECTRONIC BUILDING BLOCKS



PART TWO

by R. A. DARLEY

FOLLOWING last month's preview of the type of units which will be described in this series, we deal in more detail this month with passive networks, including attenuators and CR circuits.

ATTENUATORS

The simplest version of the passive attenuator is the potentiometer. As shown in Fig. 2.1, the input is connected across the total resistance and the required proportion taken from the variable arm. This is the arrangement that is generally used as a volume control. As the exact amount of attenuation provided is of little importance, the control is usually left uncalibrated.

If a precise amount of attenuation is required, a simple switched potential divider network of the type shown in Fig. 2.2 may be used. It is important to note, however, that this circuit is designed to be fed into an infinite impedance, or at least one that is very large compared with the total resistance of the divider.

When designing an attenuator of this kind, the first step is to decide what its input impedance is to be, and this value then dictates the total value of the resistance chain. Next, the values of the individual resistances are determined, and here the design is carried out in a number of steps, there being as many of these steps as there are attenuator switched positions. In each of these steps, the circuit is considered to consist of an upper and a lower half only. An example follows.

In the circuit shown in Fig. 2.2, it was decided that the input impedance, and therefore the total resistance of the chain, should be 600 ohms. Two attenuator positions, not including the zero attenuation one, were required, these being ÷10 and ÷100. The values for the greatest amount of attenuation are always determined first. For the ÷100 position, it is clear that the lower arm must contain one hundredth of the total resistance of the chain, giving 6 ohms. This gives the value for R3, and leaves the remaining 594 ohms in the upper arm. The values for the ÷10 position are next calculated, and it is found that here 60 ohms are needed for the lower arm. In this case, however, the lower arm consists of resistors R2 and R3. As the value of R3 has already been determined as 6 ohms, R2 must $= 60 - 6 = 54$ ohms. The upper arm (R1) must contain the remaining 540 ohms. This simple procedure may be carried on to give as many steps as are required.

It is often found that in practical circuits of this type small fixed or trimmer capacitors are wired in parallel with the resistors. These serve to give a degree of high frequency compensation or correction to the overall circuit with which they are used.

In many cases an attenuator is required to be terminated by a fixed load of some mind, and here the potential divider mentioned above is of little use. Instead, one of the many versions of the so-called matched resistance attenuators must be used.

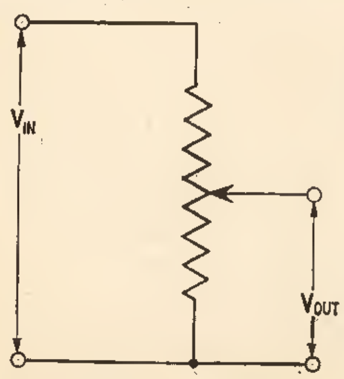


Fig. 2.1 (left). Simple passive attenuator or potentiometer

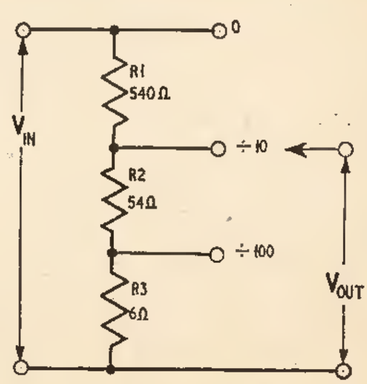
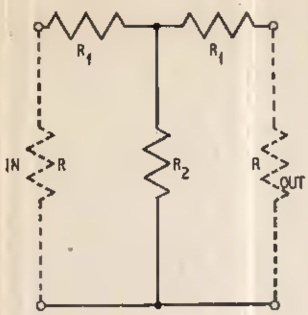


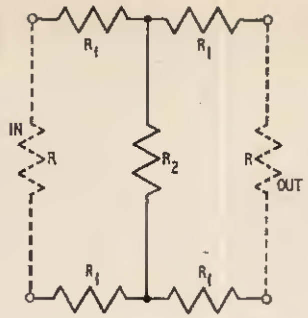
Fig. 2.2 (right). Switched potential divider network



$$R_1 = R\left(\frac{a-1}{a+1}\right)$$

$$R_2 = R\left(\frac{2a}{a^2-1}\right)$$

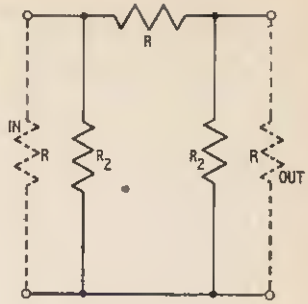
Fig. 2.3a. 'T' type



$$R_1 = \frac{R}{2}\left(\frac{a-1}{a+1}\right)$$

$$R_2 = R\left(\frac{2a}{a^2-1}\right)$$

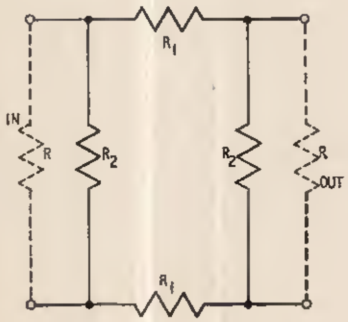
Fig. 2.3b. 'H' type



$$R_1 = R\left(\frac{a^2-1}{2a}\right)$$

$$R_2 = R\left(\frac{a+1}{a-1}\right)$$

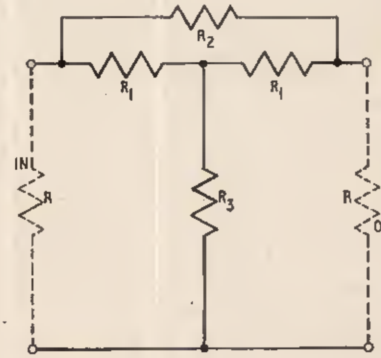
Fig. 2.3c. 'π' type



$$R_1 = \frac{R}{2}\left(\frac{a^2-1}{2a}\right)$$

$$R_2 = R\left(\frac{a+1}{a-1}\right)$$

Fig. 2.3d. 'O' type



$$R_1 = R$$

$$R_2 = R\,(a-1)$$

$$R_3 = R\left(\frac{1}{a-1}\right)$$

Fig. 2.3e. 'Bridged-T' type

NOTE: In Figs. 2.3a. to 2.3e, 'a' $= \dfrac{V_{in}}{V_{out}}$

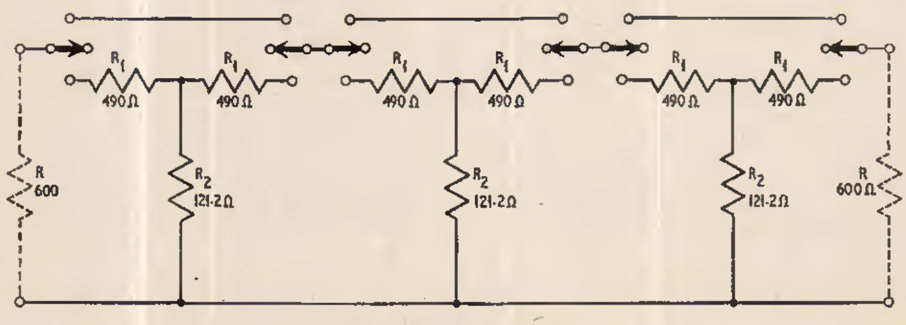


Fig. 2.3f. Three-stage 'T' type

MATCHED RESISTANCE ATTENUATORS

Many pieces of electronic equipment are designed to be driven from a particular impedance source. If the value of this impedance is altered, the working characteristics of the equipment will be upset. If, therefore, the input is fed via an attenuator, it is essential that the attenuator should have the same output impedance in all switched positions. Similarly, the input impedance of the attenuator may also be required to remain constant. As a general rule, the input and output impedances of the attenuator are required to be the same.

A large number of circuits have been developed to meet these requirements, and a few of them are illustrated in Fig. 2.3, together with their essential design formulae.

There is not a great deal to choose from between the performance of these attenuators; the range of circuits just gives a choice of ways of carrying out the same basic function, in much the same way as a bolt or nut can be made with any one of several alternative types of thread, or a mains plug with any one of a range of pin arrangements!

Fig. 2.3a shows the circuit of the "T" type attenuator. In all of these circuits the input and output impedances are represented by dotted resistors. The value of these is very important and should be adhered to, otherwise the calibration of the attenuator will be meaningless. In each of the circuits shown in Fig. 2.3 only one stage of a complete attenuator network is shown. Each one is designed to work from, and into, a particular impedance. It can be seen, therefore, that any number of the same type of attenuator can be wired in series providing that they all have the same impedance. An example of this is shown in Fig. 2.3f, where a three-stage "T" type, with input and output impedances of 600 ohms and attenuations of 0, 10, 100, or 1,000, is illustrated. Each stage is, in this case, identical. The formulae given in Fig. 2.3 only apply for circuits in which the input and output impedances are the same.

DIFFERENTIATING CIRCUIT

The simple circuit shown in Fig. 2.4, consists merely of a capacitor and resistor wired in series. The output is taken from between their junction and the input fed across the two ends. This is rather similar to a potential divider circuit, but in this case the degree of attenuation depends on frequency as well as component values. If phase effects are ignored, the capacitor C can be regarded as a resistor which increases in value as frequency falls, and decreases in value as frequency rises. Thus, the attenuation of the circuit increases as the frequency applied to the input falls. As this is the type of arrangement used to couple the output of one amplifier to the input of the following stage, it can be seen that this simple differentiating circuit sets a natural limit to the low frequency response of the complete amplifier. The low frequency end of the response curve of an existing amplifier can usually be improved by increasing the value of the coupling capacitors, this measure having no adverse effect on the actual operation of the complete circuit.

This voltage divider effect is not the only function of the CR circuit. We can put the circuit to one of good use as a time delay device.

TIME CONSTANT

Fig. 2.5b shows the voltage that results from wiring the circuit of Fig. 2.5a and closing S1. At the moment of switch-on, C acts as an effective short circuit and the full battery voltage is applied across R; a current of V_R thus flows in the circuit. As this current flows the capacitor begins to "charge-up" in a manner similar to that of an accumulator; the input voltage is thus "split" between C and R, so that the voltage across R decreases, as does the current and, therefore, the "charging" rate of the capacitor. The voltage across R continues to fall as C "charges-up", but at a progressively slower and slower rate as more and more voltage is "lost" across the capacitor. Eventually, the voltage across R decreases to almost zero.

The voltage across the capacitor rises, and that across the resistor decreases, in an exponential fashion. The most important thing about all this is that, since the graph follows a strict mathematical law, it is possible to predict the voltage appearing at a given moment after switch on, given certain essential information. The three most important factors are the values of resistance and capacitance used, and the time delay in question. It is found that the voltage across R falls by approximately two-thirds in a time of CR seconds, i.e., $T = CR$ seconds, where C is measured in farads, and R in ohms. Alternatively, R may be measured in megohms and C in microfarads.

A further sequence of operations using the CR circuit can now be considered. Fig. 2.5c shows the circuit rearranged with another switch, S2, wired across the input. This switch is ganged with S1 in such a way that when S1 is closed, S2 is open, and vice versa.

If S1 is closed, S2 will open, and the circuit will operate in the manner that has just been considered. The voltage across the resistor will be at maximum at "switch-on" and then decay as previously explained. Fig. 2.5d illustrates the voltages that will appear at the input, across the resistor, and across the capacitor. Note that the sum of V_R and V_C must equal V_{in}.

Consider now what happens if the capacitor is allowed to charge fully (or near enough), and S1 is then made open circuit and S2 short circuit across the input.

The capacitor is charged up to V_C, which is equal to the input voltage first applied; S2 shorts to give a discharge path for the circuit, with the top (positive) end of C connected to the lower end of the resistor, i.e. the voltage polarity across R is reversed, as shown in the V_R curve. The voltage across R now decays from this negative maximum to zero in the normal way, that is, exponentially. If, after the capacitor has fully discharged, the switches are again changed over, the cycle will repeat, as is shown in Fig. 2.5d.

Note that in practice the same results can be obtained by shorting S1 out and leaving S2 permanently open circuit. A square wave or pulse generator can be connected across the input, the generator output impedance providing the necessary discharge path with zero volts applied. There are certain limitations, however, which we shall now consider.

EFFECT OF CR VALUES ON SQUARE WAVE OR PULSE INPUTS

In the circuit which we have just considered, it was stipulated that the capacitor should be allowed to be fully charged or discharged before any change over of switching took place. In other words, the circuit's time constant ($T = CR$) was very short compared to the length of time for which any switch position was maintained. Consider now the effects that different

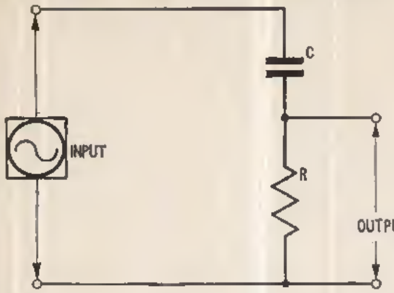


Fig. 2.4. Simple differentiating circuit

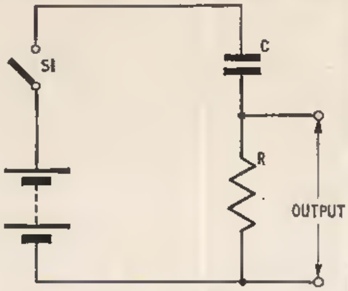


Fig. 2.5a. CR circuit with battery across input

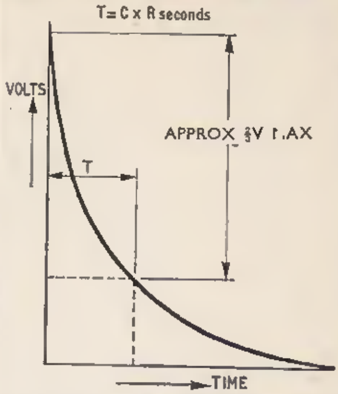


Fig. 2.5b. Resultant voltage across R when SI is closed

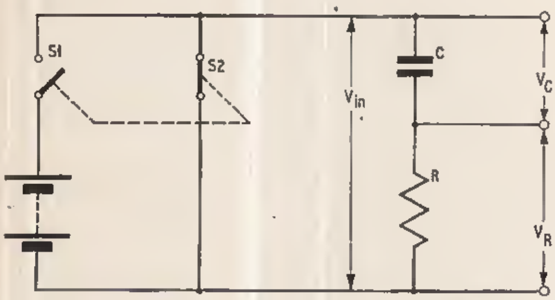


Fig. 2.5c. Circuit rearranged with two switches across the input

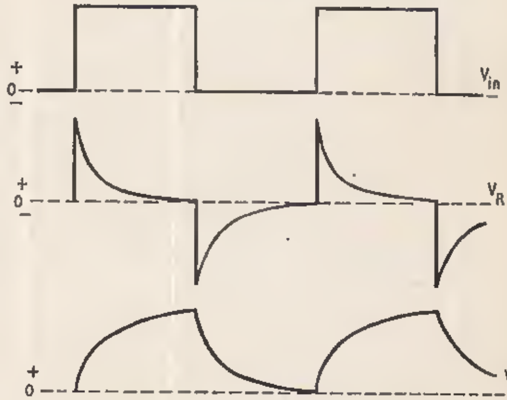


Fig. 2.5d. Shows the voltage that will appear across the input, the resistor and the capacitor

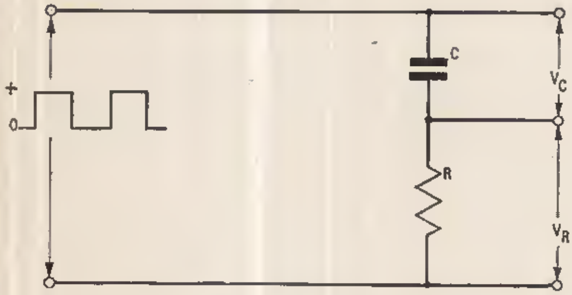
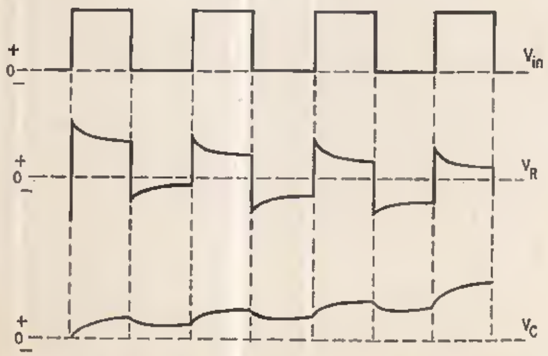
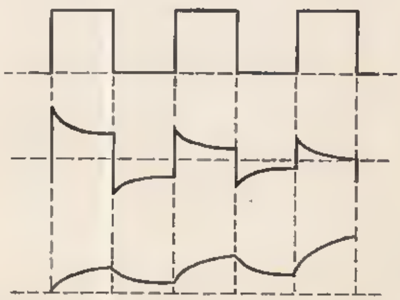


Fig. 2.6a (left). Square wave applied to input of CR circuit

Fig. 2.6b (below, left). Waveform obtained if the time constant is very large compared with the pulse duration

Fig. 2.6c (below). Shows the waveforms that result if the time constant is the same as the duration of the pulse





time constants will have on an applied square wave.

Fig. 2.6a shows the familiar CR circuit, in this case with a square pulse generator connected across the input. If the time constant of this circuit is very large compared with the length of the applied voltage period, the waveforms shown in Fig. 2.6b are obtained. Note that, in the examples which we are considering here, the applied square pulse is positive.

Referring to the voltage appearing across the resistor, the action is as follows: at the commencement of the first pulse the full voltage is developed across the resistor, and then it falls off exponentially. By the time the pulse cuts off this voltage has decayed by only a small amount from the applied value. With zero voltage applied and a discharge path provided through the generator, the voltage across the resistor swings negative by the amount by which it decayed when the pulse was on. This discharge voltage again falls exponentially towards zero, but the pulse switches on again before zero volts is reached; the resistor is thus still slightly negative when the new pulse voltage arrives. This new pulse will, on arrival, result in the full applied voltage again being developed across the resistor, but not in a positive direction. At the end of this pulse the resistor voltage again swings negative by the sum of the amount of decay and the amount by which the voltage was negative at the start of the pulse. This value is greater than the negative swing after the first pulse. This negative swing becomes progressively greater with each pulse applied, until eventually the amount of negative swing becomes the same as the amount of positive swing, and the waveform varies symetrically about zero.

The actual output waveform resulting from this circuit is very similar to the input one, and will become progressively more similar as the time constant is increased. The most important effect of the long time constant circuit in this application is to convert an all positive square pulse to one that swings symetrically about the zero voltage point, without destroying the basic waveform, i.e. it serves to shift the d.c. voltage level.

Fig. 2.6c shows the waveforms that result if the time constant is made the same as the period of the applied pulse. Here again the d.c. shift takes place, but in this case it is accompanied by considerable distortion of the applied pulse.

While all the CR circuits shown in this article have been referred to as "differentiating" circuits, true mathematical differentiation of the square wave is approached only in the case of the circuit with the very short time constant.

EFFECT OF CR VALUES ON OTHER WAVEFORMS

With most waveforms other than the sine wave the CR circuit will cause some degree of distortion of the applied signal, the degree of distortion depending on the time constant employed. In many cases this distortion will be undesirable (as in the case of CR coupling between stages of an amplifier) and component values should be chosen to keep it to a minimum. Generally, the longer the time constant employed, the lower is the distortion.

In other cases distortion may be desirable, perhaps as a method of wave shaping, and again the component values must be carefully chosen to give the best results.

In the case of the sine wave virtually no distortion of the waveform is caused by the circuit's time constant. The only important effect is the degree of attenuation which depends on the frequency of operation.

Next month we will see the effect of using a diode to provide wave shaping.

Contributed Articles

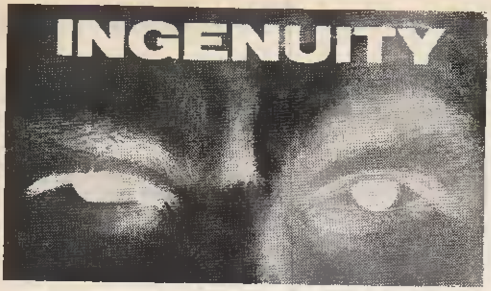
The Editor will be pleased to consider for publication articles of a theoretical or practical nature. Constructional articles are particularly welcome, and the projects described should be of proven design, feasible for amateur constructors and use currently available components.

Intending contributors are requested to observe the style in our published articles with regard to component references on circuit diagrams and the arrangement of the components list.

The text should be written on one side of the paper only with double spacing between lines. If the manuscript is handwritten, ruled paper should be used, and care taken to ensure clarity, especially where figures and signs are concerned.

Diagrams should be drawn on separate sheets and not incorporated in the text. Photographic prints should be of a high quality suitable for reproduction; but wherever possible, negatives should be forwarded.

The Editor cannot hold himself responsible for manuscripts, but every effort will be made to return them if a stamped and addressed envelope is enclosed.



UNLIMITED!

INGENUITY is a valuable quality which, when you come to think about it, is the essence of research and development in any field. Electronics is no exception to this. Ingenuity thrives on constructive criticism of ideas, and suggestions for improvement.

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 excellence* but could be improved or adapted to suit individual requirements.

We hope that this series will provoke discussion, stimulate thought and further improve our general knowledge on electronic techniques.

Following on the "Magic Boxes" epic last month we are devoting the entire article in this issue to modifications to the "Immersion Heater Economy Circuit" published in our February issue. We have ideas and material for the near future. However, we must emphasise that, whilst limited space does not permit us to publish all your letters, the original authors will be given every opportunity to reply. The views expressed by readers are not necessarily those of the Editor.

IMMERSION HEATER ECONOMY CIRCUIT

MOST OF the letters received on the "Immersion Heater Economy Circuit" suggested that, whilst it may well provide an economy in fuel consumption there was room for further economy on the circuit itself. The remainder of the comments speak for themselves.

SKILLED JOB

I was interested in Mr. Levett's article but think that it is unnecessarily complicated. Also, non-standard adjustment of relays is a skilled job requiring special tools.

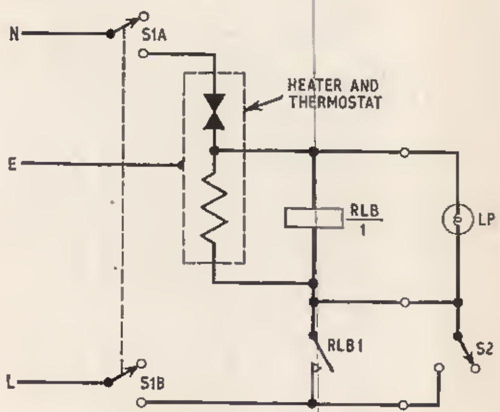
The attached circuit is based on his idea but uses only one relay—the one with the 250 volt coil.

Operation of S2 energises the heater, the lamp and the relay which remains locked on by its own contact. S2 may then be switched off without switching off the heater. When the thermostat operates the heater lamp and relay will be switched off and will remain off until S2 is operated once more. This achieves the one-shot operation of Mr. Levett's circuit but if normal operation is required S2 should be left in the ON position and the lamp would then indicate when the heater was actually on.

The second lamp is not really necessary because, if S2 was operated and the lamp did not come on, it would indicate that the temperature was sufficiently high to open the thermostat provided, of course, that S1 was always left in the ON position.

S2 and the lamp could be one of the commercially available immersion heater switch units wired with 3-core cable to a remote point. Normally the cable would only be required to carry the heater current for a few milliseconds but it should be capable of carrying it indefinitely in case of failure of the relay contact.

A. H. Stewart,
North Harrow,
Middlesex.



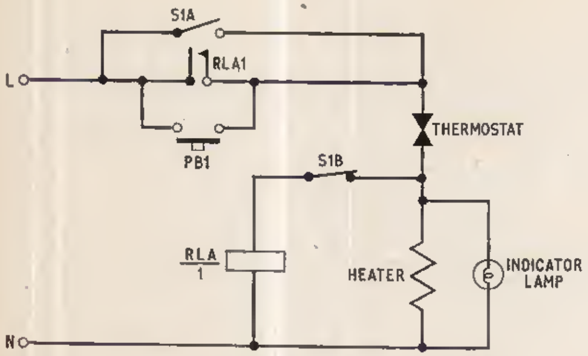
A. H. Stewart's circuit is simplicity in itself and very good. The cable mentioned should be as is used to wire the heater to the mains.

The 1 amp fuse in my circuit was intended as part of the "fail safe" mechanism and would blow if part of the control circuit became faulty. Remember, I noted that the unit and controls should be built upon thick s.r.b.p. (paxolin) or plastic and mounted in an earthed metal box.

A.M.L.

ABUNDANCE

If a housewife requires an abundance of hot water she has to keep pressing the one-shot button. This I think she would probably forget just as much as she would forget to switch off a conventional immersion heater. I respectfully suggest that the following circuit would be cheaper and more practical.

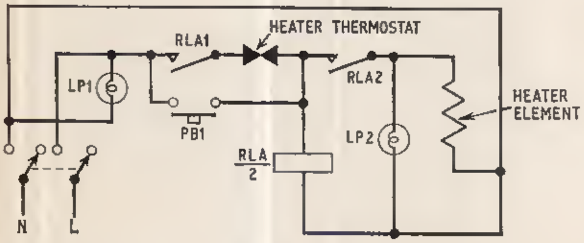


The circuit shows S1 in the "one shot" condition with the thermostat cold. The circuit operation is as follows:

One shot: Push PB1; relay RLA is operated through the thermostat contacts and S1B. Contacts RLA1 close holding the circuit on until the thermostat contacts open, when RLA releases and breaks the heater circuit.

Continuous Operation: Switches S1A and S1B are ganged as a double pole changeover switch. When S1 is operated S1A closes and S1B opens. The relay circuit is broken by S1B and the heater is connected to the mains by S1A. The heater will function according to the action of the thermostat in the normal way until S1 is changed back to the normal one-shot position.

S. H. Bassford,
East Molesey,
Surrey.

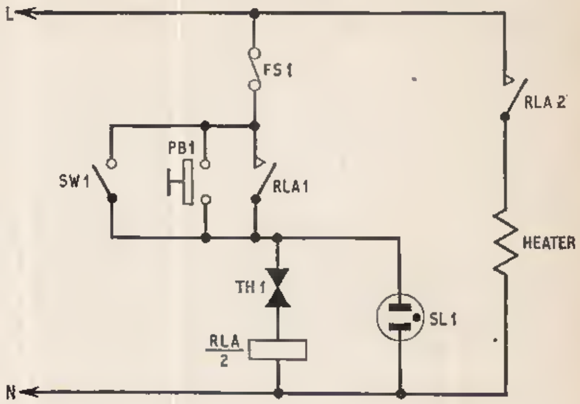


EARTH FAULT . . .

There seems to have been some unnecessary trouble taken with your Immersion Heater Economy Circuit. I should like to point out that if an earth short should occur on the neutral side of the element the heater will stay on. I am enclosing a circuit of my own which seems to be more suitable. The reason for contacts RLA2 is to take the heater load off PB1.

J. Wells,
Bromsgrove,
Worcestershire.

S. H. Bassford and J. Wells managed to fall into a little trap. I regret that the push button will NOT take 15 amp, even for a very small fraction of a second. In fact, it would probably explode with disastrous results. A solution would be to use a microswitch rated at 15 amp. Incidentally, the term "micro" refers not to the physical size of the switch, but to the very small mechanical movement required to change from state to state.—A.M.L.



FIRST CLASS

I regard Alan M. Levett's idea for a single shot immersion heater economy circuit as a first class idea. However, I cannot solve how he determined the necessity for all those relays, capacitors, diodes, etc. From a safety point of view, it is very unwise to place the thermostat in the neutral line of the heater because if an earth fault developed on the neutral end of the immersion heater element it would, if not discovered, boil itself to destruction.

The circuit I would suggest uses only one 15A 240 volt a.c. relay with two sets of heavy duty make contacts. In all immersion heaters I have seen, it is possible to bring out both thermostat leads. Therefore it is advantageous to place the thermostat in the low current relay line, thus reducing contact burning. Mr. Levett's circuit is for all time a one shot, therefore I have inserted a switch across the push button so that at choice, one shot or normal operation can be achieved.

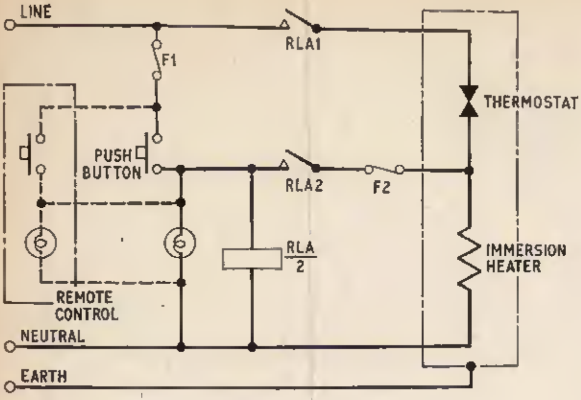
R. Twelves,
Wantage,
Berkshire.

R. Twelves produced an excellent circuit. However, I fail to see his remark about contact burning, for he has a relay contact in the heater circuit. The thermostat, which he has removed from the heater circuit, was designed to take 15 amp without burning.—A.M.L.

. . . DANGEROUS

I should like to point out that in Mr. Levett's circuit, the 1A fuse will not protect the control circuit (including the suggested remote controls) against earth faults, which is a dangerous condition. Here is my suggestion.

Peter A. Collier,
Whitley Bay,
Northumberland.

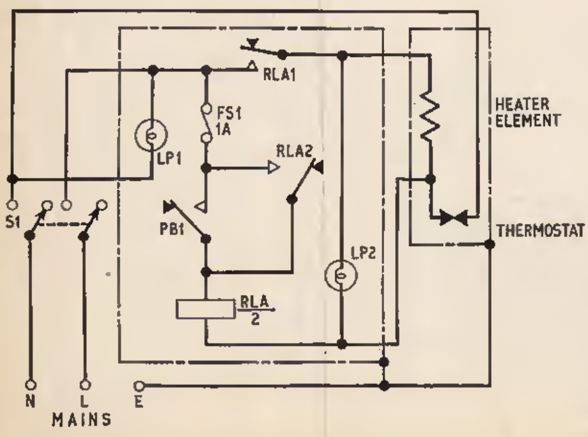


Should contact RLA2 in Peter A. Collier's circuit beat RLA1, then the heater current will be drawn through F1, push button, RLA2, and F2. This means that F1 and F2 will be blown and the push button burnt. This could be avoided by adjusting the relay so that contact RLA1 makes before RLA2. The adjustment of relay contacts is not at all difficult, and only requires time, care and patience.

In actual fact, I did have a very good reason for the circuit containing two relays. With the relay I used in the heater circuit, I found that there was very great contact bounce due to the massive size of the armature, and this did not give a positive operation as I would have liked. As will be noticed, the push button is disconnected after operation, through RLA1 and the relay held in by RLA2, RLA3 switching the main heater relay. As RLA was a low voltage type, some form of voltage drop had to be used. Capacitors were selected as heat is not dissipated to such a great degree. The diode only secures a d.c. voltage across this relay.—A.M.L.

DESIRED RESULTS

I read with interest your article describing a relay circuit for immersion heater control. Unless I have missed the point the circuit seemed to be unnecessarily complex. I believe the simple circuit attached would give the desired results.



In operation from cold the push button PB1 is depressed energising relay RLA, which is held on by contacts RLA2. Contacts RLA1 are now closed allowing current to be passed through the heater and to lamp LP2. When the circuit is broken by the thermostat, switch S1, or mains failure, relay RLA is de-energised releasing the contacts.

F. Pearce,
Biggleswade,
Bedfordshire.

F. Pearce produced another excellent circuit, and I think that his comments have been answered above.
A.M.L.

LAST WORD . . .

The general comment in the letters published was that of damage to the heater due to an earth short. Should an earth fault develop in the heater, how much better for it to indicate its presence, for it MUST be replaced, as in such a condition it would constitute a danger to life. In the event of the system boiling, it will be found that the plumbers have already provided a safeguard in the expansion pipe of the hot water system.

If a continuous supply of hot water were required, it would seem rather an extravagance to fit a one shot device to save fuel. In this case, the best and greatest fuel saving would be in a well lagged hot water storage tank and hot water system. Even with a completely lagged tank, it will be found that the airing cupboard is still warm enough for the job.

A.M.L.

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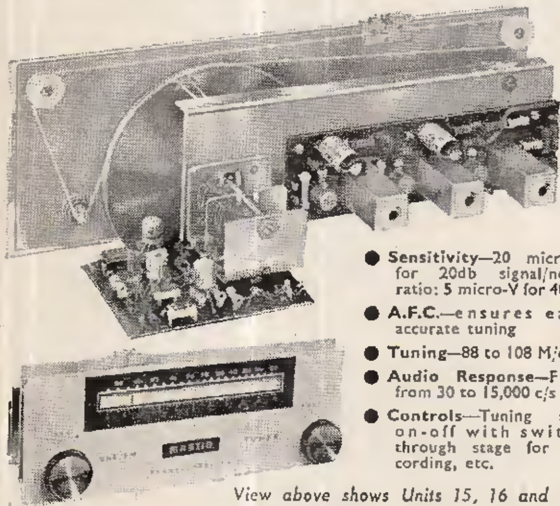

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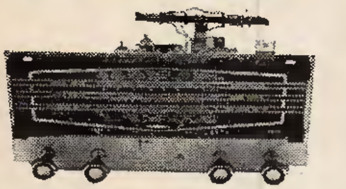

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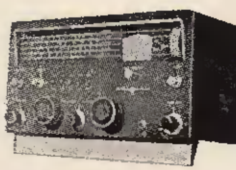

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Reclaimed Tubes. 6 months guarantee, 14in. Mullard and Mazda, 17/-, carriage 10/-. 17in., 30/-, carriage 10/-.

NEWS BRIEFS

The Roding Boys' Society

After a season in which exhibition work figured prominently, the Roding Boys' Society is planning a series of projects; one is the electronic test equipment bay, which is nearly operational. When this is set up it will be a calibration and laboratory standards centre for all amateurs in the East London area—especially boys and beginners.

Membership of the group still remains difficult to expand, because of the small premises. There are usually one or two vacancies, but exceptionally keen lads are always made welcome whatever the accommodation difficulties.

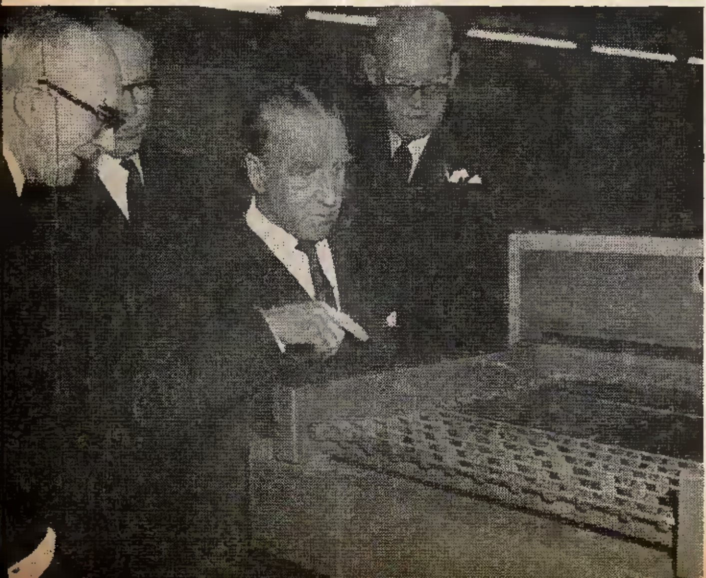
Papers read to the Society in recent times have included: "Why street lights are usually yellow or blue (gas discharge tubes)", "The electromagnetic spectrum", and "Polarisation of electromagnetic waves". (The latter won David Moerel a prize at the R.S.G.B. Exhibition.)

All boys whether members or not, will be welcome to a lecture at the Science Museum on 24 April. The Society will meet at 10 a.m. at South Kensington Underground Station.

The Camp will again be held in August this year, and the Society hopes to carry out further observations as before. Inquiries regarding the Society should be addressed to the Leader, K. L. Smith, B.Sc., 82 Granville Road, London, E.17.

Rapid Growth of S.E.R.T.

In the ten weeks that application forms have been available the Society of Electronic and Radio Technicians has received 479 applications for membership. The Membership Committee has held two meetings and recommended the election of 137 Members, 188 Associates and 41 Students, a total of 366. The Society has established nine local sections, eight of which are running regular meetings. Further details of membership and meetings should be addressed to The Secretary, Society of Electronic and Radio Technicians, 33 Bedford Street, London, W.C.2.



Course on Electronic Musical Instruments

Here is something new for readers interested in learning more about electronic musical instruments. The Department of Musical Instrument Technology at the London College of Furniture will hold a course on "Electric and Electronic Musical Instrument Technology". The course, which starts on Monday, 13 September 1965, will take one year to complete, and is open to applicants of 16 years or over who have obtained four passes at "O" level G.C.E., two of which must be in science and mathematics.

The course is designed to train students as service engineers on all types of electric or electronic musical instruments, with particular emphasis on guitar amplifiers and electronic organs. Students need not be musicians but such an interest is obviously desirable. Apart from the training in electronics, special emphasis will be made on the relationships of musical tone, harmonic structure and their electronic counterparts.

Full details of the course can be obtained from The Secretary, M.I.T., London College of Furniture, Pitfield Street, London, N.1.

Audio Fair

The 1965 International Audio Festival and Fair will be held as usual at the Hotel Russell in London from 22 to 25 April. A record number of exhibitors will be there with many new products on view. The Hotel's rooms have been hired for demonstrations of manufacturers' products while the ground floor will house the usual array of booths.

Reading Computer

A pattern recognition device has been developed at the Kaunas Polytechnic (Lithuania) which automatically reads numerical data off typewritten pages and feeds them into an electronic computer.

Existing computers, although extremely efficient in mathematical calculations, process control and even chess playing, cannot recognise hand-written or printed numerals and letters, drawings and other graphic material.

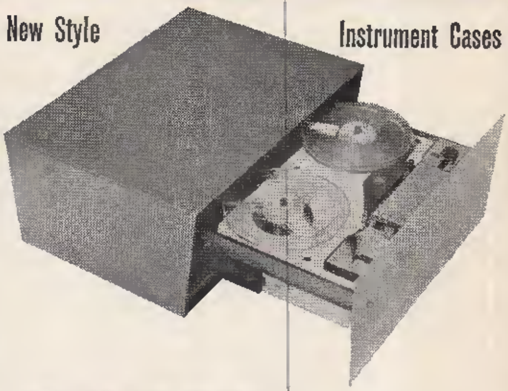
The new device can recognise typewritten numerals on a paper tape moving at a rate of up to three metres per second. The tape can be fed into the field of vision of the device either manually or mechanically. Once in the field of vision, a numeral is scanned by a photo-diode converter, the so-called matrix. The resultant signals are processed by associative elements similar to those used in analogue computers. The elements convert the signals into voltage pulses which present each numeral in a binary code. The rate of input into the computer is a thousand numerals per second.

Back to School

Mr Marples, "shadow" Minister of Technology, has been taking a 23 day applied course in computers and automation and has visited leading British firms. Picture shows Mr Marples watching a computer circuit board on an automatic etching machine at English Electric-Leo-Marconi, Kidsgrove, Staffordshire. With him (left) are Sir Gordon Radley, chairman of the company, Mr W. E. Scott, managing director and Mr M. F. Delahunty. Mr Marples also saw the production of magnetic tape decks and high speed printers as well as computers and development work on their application to advanced automation schemes.

NEW PRODUCTS

New Style Instrument Cases

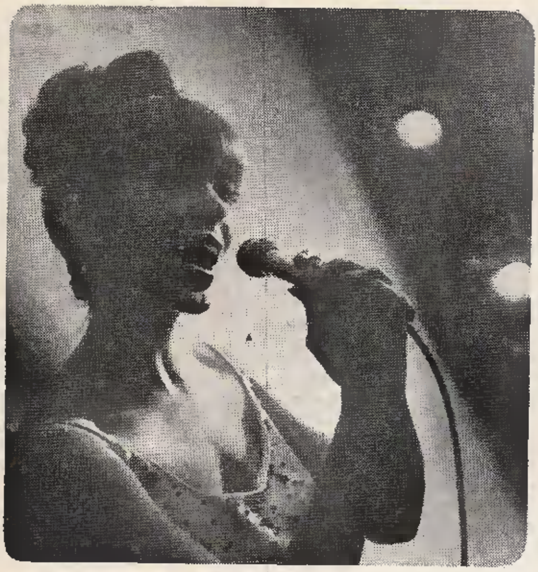


West Hyde Developments Ltd., 1, New Park Road, Harefield, Middlesex.

For readers who are looking for something new in cabinet design for their domestic or other electronic equipment, West Hyde Developments have introduced a range of steel instrument cases which on some models are fitted with slides and runners similar to those used in filing cabinets. A tape deck, record player or electronic equipment can be mounted on the slides so that it can be either shut in out of sight or drawn forward to gain access.

The cases are painted in hammer finish blue with white panels and boast a neat contemporary appearance. The panels are protected by a strippable coating to avoid damage during drilling and to facilitate easy and clear marking out. They are made in a wide variety of sizes from 5in high × 7in wide × 5in deep overall at 35s. 0d. to 7in high × 16in wide × 12in deep overall (fitted with slides) at £5 19s.

Our photograph shows a tape recorder mounted in a cabinet type 16127S.



New Ribbon Microphone

Standard Telephones & Cables Ltd., Electromechanical Division, West Road, Harlow, Essex.

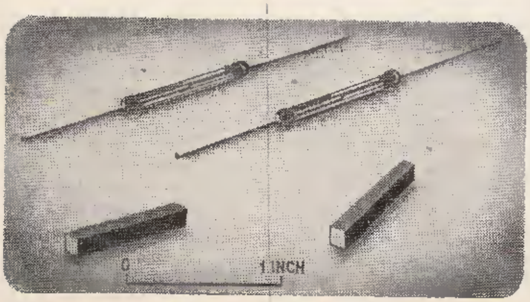
A new high quality tubular ribbon microphone shown at the 1965 Public Address Exhibition recently is designed specially for close talking—this should prove ideal for some of today's weak voiced pop singers!

The microphone gives a narrow cardioid directional sound pick-up. A spherical woven wire wind shield is fitted and a tubular bass chamber also serves as a handle.

The approximate price of the ribbon microphone is around £25.

Miniature Dry Reed Switches

Cockrobin Controls, 36, Villiers Avenue, Surbiton, Surrey.



A new range of miniature dry reed switches are available from Cockrobin Controls.

These dry reed switches consist essentially of a pair of contacts sealed in glass capsules and are operated by the presence of a magnetic field produced by permanent or electromagnets.

The switches do not require physical contact and can be situated a short way from the operating device according to the strength of the magnetic field produced.

These switches have already been used for automatic signal control on model railways and enterprising readers will no doubt find many similar applications as they develop new ideas. The relays cost 3s. 6d. each and small bar magnets are available at 1s. 6d. each.

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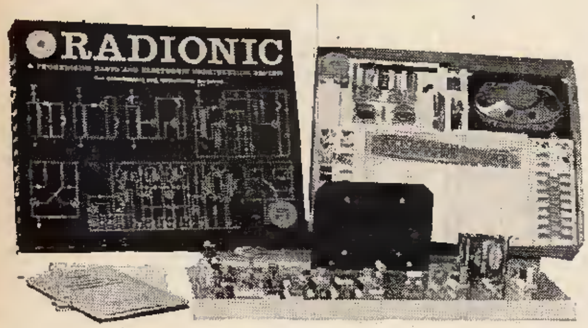
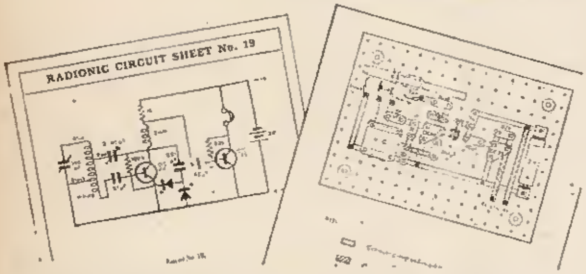


A No. 4 SET and 6-TRANSISTOR SUPERHET



Theoretical Circuit — Practical Layout

Our new 'E' Series of basic electronic circuits is also available separately.

Unique and brilliantly simple. Hundreds of educational establishments—Universities, Technical Colleges, Schools, the Armed Forces—are already using Radionic for electronic instruction. Enthusiastic owners range from 9 to 82 years of age.

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No. 2 Set	**£6 - 19 - 6d.**	**20 Circuits (Earphone)**
No. 3 Set	**£10 - 19 - 6d.**	**22 Circuits (7" × 4" Loudspeaker output)**
No. 4 Set	**£14 - 19 - 6d.**	**26 Circuits (include 6 Transistor and reflex superhets)**

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Tel.: CRAWLEY 28700 — Trade Enquiries Invited

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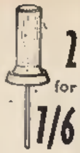

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New, inexpensive photo-conductive cells act as light sensitive resistors that increase conductivity with increased light. 1,000 times more sensitive than selenium cells with greater reliability, and can easily be built into a wide range of simple circuits. Typical uses include: automatic light controls, exposure meters and many other devices. Requires simple low power source from battery or mains transformer. Two types available: **Type 1:** Max. voltage 200 v. Output 0·5 watt. Sens. range 400–800 mu. 10/- post free. **Type 2:** Max. voltage 150 v. Output 0·15 watt. 8/6d. post free. **Both types have a resistance range of 5 megohms at zero to 500 ohms at 1,000 lux. Sensitive range is 400–800 mu. Supplied with specification, instructions and typical circuits.**

Make a wonderful range of inexpensive devices with DRY REED SWITCHES

Can be actuated by permanent or electromagnets to provide excellent basis for a wide range of inexpensive devices such as burglar alarms, limit switches, door bell switches, etc. Tremendous reliability factors and a working life of about 100 times that of microswitches and the uses to which they can be put is limited only by imagination. Each switch supplied complete with specification, instructions and ideas information. **SUITABLE MAGNETS 1/- extra.**

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2 WATT GRAM AMPLIFIER—just connect to any crystal pick-up and 8-ohm speaker for above average output with excellent tonal quality. 1-megohm potentiometer recommended for vol. control. Compact, high quality unit. 30/-. P. & P. 1/-.

CODE PRACTICE OSCILLATOR—simply connect with morse key, any P.M. speaker and any 1½–6v battery. Fully transistorised and assembled on rigid board size 2 × 1¾in. 12/6. P. & P. 1/-.

BURGLAR ALARM — needs only 8-ohm loudspeaker, switch and microswitch (or reed switch and magnet) to complete. Operation of sensing switch trigger upward screaming syren to give instant alarm. For home or motor car protection. 30/-. P. & P. 1/-.

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Type 2: Max. pull 18oz. Stroke ⅛" to ½". Size 2⅛" long, Bolt diam. 5/16". 14/6. P. & P. 1/-.
Type 3: Max. pull 26oz. Stroke ⅛" to ¾". Size 2 11/16" long (bolt in) × 1 5/16" wide × 1 13/16" high, Bolt diam. ½". 27/6.
Type 4: Max. pull 26oz. Stroke ⅛" to 1½". Size 3 3/16" long (bolt in) × 1 9/16" wide × 1 13/16" high, Bolt diam. ½". 32/6. P. & P. 1/6. **SEND FOR SOLENOID LIST.**

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DETACHED PARTICLES
By John Valence

COLOUR CONUNDRUM

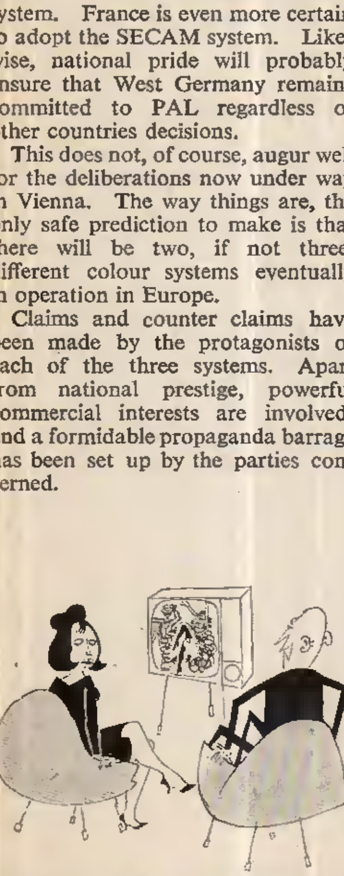
Between division bells, a group of M.P.s have paid a rapid visit to Paris recently to look at the native colour television in action. This demonstration was arranged specially for their benefit by the French Broadcasting Authorities who are naturally most eager to promote the SECAM system for European use.

Coming soon after the recent spot of bother over an aircraft named (hopefully) *Concord* (theirs' spelt with an e) any cross-channel wooing is to be greatly applauded. Unfortunately colour television is hardly likely to provide the basis for a general reconciliation!

By all accounts the British half of the *Entente Cordiale* seems committed to the American NTSC system. France is even more certain to adopt the SECAM system. Likewise, national pride will probably ensure that West Germany remains committed to PAL regardless of other countries decisions.

This does not, of course, augur well for the deliberations now under way in Vienna. The way things are, the only safe prediction to make is that there will be two, if not three, different colour systems eventually in operation in Europe.

Claims and counter claims have been made by the protagonists of each of the three systems. Apart from national prestige, powerful commercial interests are involved, and a formidable propaganda barrage has been set up by the parties concerned.



£250 for colour tele, and what do we get? Black and White Minstrels!

RCA have carried out demonstrations of the NTSC system in Moscow. Here they were greatly concerned to refute the criticism that NTSC is unsuitable for long distance transmission over line or microwave links. To this end they were assisted by the BBC who provided the latest in network correcting equipment. I see that it was claimed that observers were unable to distinguish between a picture fed over 6,000 kilometres of network prior to transmission and a picture that was transmitted direct.

MORE CONTROLS

One remaining criticism of NTSC is that the viewer has two extra controls to manipulate as opposed to receivers for SECAM and PAL.

In replying to this criticism, RCA takes a side swipe at SECAM, by saying that colour controls are equally necessary with this system—but that they are very difficult to provide!

Personally I think RCA goes a bit too far in trying to make a virtue out of these viewer colour controls. They say that because of physiological differences, it is seldom that any two people see colours in exactly the same way, and it is (they conclude) therefore important that individuals be allowed to adjust the hue and colour saturation to suit personal tastes.

Surely this is a fallacious argument? Who is going to be the arbiter of colour balance in the family circle?

Surely *less* variables are to be welcomed so far as the viewer is concerned. From personal observation I would estimate that the greater number of viewers do not know how to set the contrast and brilliance for optimum picture on an ordinary black and white set! How then are they supposed to discriminate in terms of colour hue?

Colour balance is the concern of the producer or the technicians at the originating end, unless I am greatly mistaken.

Besides, do the TV Companies really want to be held responsible for introducing discord into the domestic scene? Dad may favour a peaches and cream complexion for the leading lady, while mum may insist that the handsome rugged hero be deeply tanned. And, come to think of it, why put further encouragement the way of that irritating pest, the knob twiddler.

ACTION STATIONS!

I am under fire. A heavy salvo received just a while ago was fired not from Portsmouth or Devonport, but from the peaceful countryside of Surrey. A. B. Taylor (those initials must be significant) strongly resents my posing the question concerning the vulnerability of aircraft carriers. He champions these vessels as extremely important mobile bases—particularly vital now when we seem to be losing some of our overseas land bases.

Well, we are all entitled to our opinions of course. Mine, I must make clear are strictly lay so far as matters maritime are concerned.

FAMOUS BOOK

The one tenuous link I can claim with the Navy is as a one-time reader of the Admiralty Handbook of Wireless Telegraphy. Indeed I have a sentimental attachment to a battered copy of this classical work which has found permanent quarters in my bookcase.

So well served are we nowadays with textbooks covering all aspects of electronic engineering that it is hard sometimes to realise that 25 years ago "The Admiralty" was the only comprehensive textbook available. And its use was not limited to the Senior Service, of course. In those pre-radar days, when "electronics" was represented by W/T or R/T, "The Admiralty" provided the basis for technical training courses in that up-and-coming Service — the R.A.F.

Perusing those yellowing pages now one steps back into the period of coexistence between spark and valve; when "tonic train" was the term for a modulated wave; and when a jar meant one nine-hundredth of a microfarad as well as a measure of liquid refreshment. Northern readers please note.

Readout—
A SELECTION FROM OUR POSTBAG

Extract one Digitron

Sir—Congratulations to Mr. Locke on his really novel digital clock in the March issue. I had thought of making such a device myself, but had dismissed the idea as being too expensive using purely electronic division—I had not thought of doing it mechanically; this is obviously the best way for producing a digital clock at low cost.

However, I feel that Mr. Locke has rather wasted about 35s. using a digitron for the tens of hours indication. After all, it is only indicating a figure one when it comes on at all, and surely an ordinary neon lamp could be used. An ideal lamp is the Hivac 23L which is a miniature wire-ended neon with longer electrodes than usual, about ⅝in long in fact; this would make a very good figure one when mounted vertically, and at a cost of probably not more than half a crown.

D. Sharp,
B.Sc. (Eng.) Grad.I.E.E.,
Southgate,
N.14

Further light on the OC71

Sir—With reference to your article describing a Print Recorder and the use of a modified OC71, Mr. K. W. Collins of Mullard Ltd. is, of course, correct in suggesting the OCP71 for this purpose.

He misses the point, however, that the average young experimenter cannot afford the thirty odd shillings to buy the OCP71, but can afford the odd shilling or so for the OC71.

OC71s do work quite well as photo transistors, particularly if the opaque filling can be cleared from the junction by means of a centrifuge. The writer has successfully used a "spin dryer" for this purpose. Under laboratory conditions, the OC71 has been centrifuged at 250g with no ill effects.

As with all germanium devices, the characteristics of OCP71 alter with temperature, and the dark current increases by approximately 12 per cent per 1°C rise. Compensation is necessary if the device is used in equipment having a higher ambient temperature than 40°C and may be achieved by wiring a GD5 or similar diode between the base and emitter of the OCP71—the negative point of the diode to the base of the photo transistor. Should much higher ambient temperatures have to be tolerated, then a silicon photo diode should be used—these devices are often fitted with a small focusing lens, but are unfortunately too expensive for the average experimenter.

H. N. Kirk,
G3JDK,
Rotherham,
Yorks.

Home made turret tags

Sir—I note that a number of circuits used in Practical Electronics mention the use of turret tags; for economy, the following alternative method is used by myself.

I drill the insulating board and countersink the hole on the reverse side to accept ⅛in brass shoe rivets. When these are cut off and tinned, they are perfect turret tags. The pin should be a tight fit in the hole through the board. However, as soon as a connection is made the pin cannot possibly fall out.

This method also offers great scope with insulating boards, from Paxolin to laminated glass fibre and even Perspex.

I have successfully used this method in constructing circuits and have found it extremely satisfactory.

J. G. Little,
Pembrokeshire,
Wales.

Novice licences?

Sir—I read your "73 Page" with great interest and congratulate you on an electronics magazine for all types of enthusiasts.

I am the secretary and organiser of a petition (which is to be sent to the P.M.G. this year) on behalf of the "British Novice Radio Society" which has, at present, over 170 members. Apart from the names and addresses of supporters such as listeners and licensed amateur stations, we also have support from K. W. Electronics Ltd. and Mosley Electronics Ltd.

I appeal to you for support and submit my name and address for publication in your magazine in the hope that your readers will not only find this aspect of amateur radio interesting, but also contact me to give their support.

M. R. Wadsworth,
G-10891,
48 Estoril Avenue,
Wigston Magna,
Leicester.

Two band radio tuner

Sir—I am interested in the article written by A. Sydenham (Two Band Radio Tuner) and I would like to make it. However, I should like to align it with a signal generator, but when I came to read this part I found that there were no frequencies for when the gang is open or closed and that it did not say anything about a generator.

P. Cook,
Coalville,
Leicester.

Suitable frequencies for signal generator alignment of the Two Band Radio Tuner are 560kc/s and 1,500kc/s, with the gang capacitor fully engaged and disengaged respectively.

At the low frequency end of the band, the core of T1, together with L2, should be adjusted for maximum output, whilst at the high frequency end, the two trimmers should be used. The operations should be repeated several times for optimum results.

On the long waveband, 200kc/s should occur at about mid-scale and with L1 set for maximum gain normally. Conditions on this band have to be something of a compromise, at the band ends at any rate, due to the particular circuitry used.

It should be noted that the values of C1 and C12, as shown in Fig. 2, should be transposed.

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The pre-paid rate for classified advertisements is 1/- per word (minimum order 12/-), box number 1/6 extra. Semi-displayed setting £3.5.0 per single column inch. All cheques, postal orders, etc., to be made payable to PRACTICAL ELECTRONICS and crossed "Lloyds Bank Ltd." Treasury notes should always be sent *registered post.* Advertisements, together with remittance, should be sent to the Advertisement Manager, PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, WC2, for insertion in the next available issue.

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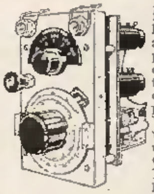

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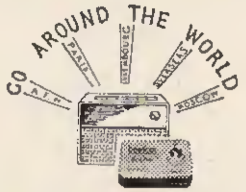

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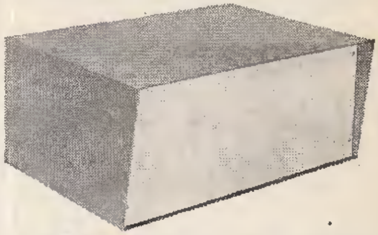

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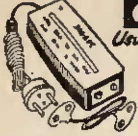

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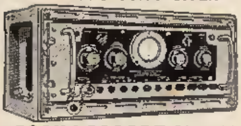

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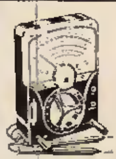

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12SK7	5/-	85A1	25/-	DK91	5/-	ECF82	7/6
12SY7	6/-	85A2	8/6	DK92	9/-	ECF86	10/-
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19AQ5	5/-	150B2	12/-	DL92	5/-	ECH35	13/-
20F2	15/-	150B3	8/-	DL93	4/-	ECH42	8/-
20L1	14/-	807	9/-	DL94	5/6	ECH81	6/-
20P1	14/-	811	20/-	DL95	6/6	ECH83	7/6
20P3	12/-	832	20/-	DL96	6/6	ECL80	6/6
20P4	14/-	954	5/-	DM70	5/-	ECL82	7/6
20P5	12/-	955	3/-	DY86	8/-	ECL83	9/-
25A6G	5/-	956	2/-	E88CC	14/-	ECL86	8/6
25C5	10/-	957	5/-	E90CC	12/-	EF36	4/6
25L6GT	8/-	958	4/-	E91H	12/-	EF37A	8/-
25Z4G	7/-	959	8/-	E92CC	7/-	EF39	6/-
25Z5	7/6	2050	12/6	E180CC	8/-	EF40	9/-
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29C1	20/-	6060	6/-	EB41	5/-	EF55	8/-
30C15	10/-	6080	25/-	EBC33	7/-	EF80	5/-
30C17	12/-	6146	27/6	EBC41	7/-	EF83	10/-
30C18	10/6	A2293	15/6	EBC81	6/6	EF85	6/-
30F5	9/-	AC/TH1	10/-	EBF80	6/6	EF86	7/-
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EL86	7/6	PC97	9/-	R17	8/-	UCL83	10/-
EL90	6/-	PCC84	6/6	R19	7/-	UF41	7/6
EL91	2/6	PCC85	7/-	RL18	12/6	UF42	8/-
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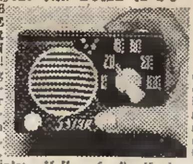

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QUALITY RECORD PLAYER AMPLIFIER

A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs 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 2½in. d. x 5½in. h. Ready built and tested. **PRICE 69/6.** P. & P. 3/6.

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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.

BRAND NEW CARTRIDGE BARGAINS!

ACOS 71-5. Single sided Crystal Cartridge for Stereo and L.P. records. Complete with diamond stylus and universal mounting bracket. List price £2.6.4. Our price 18/6. P. & P. 1/-.

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Separate switching actions at intervals up to 6 mins. Each switch action designed for current loading up to 15 amps at 250v. Suitable for photo timer, sequence switching ops, etc., etc. Brand new and unused. Offered at fraction of true value. OUR PRICE 10/- each. Post Free. 2 for 17/6. Special quotations for quantity.

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5 in., 12/6; 6½ in., 15/-; 8 in., 21/-; 10 in., 25/-; 12 in., 27/6; (12 in. 15 ohm, 30/-). 10 in. x 6 in., 26/-.

Latest type E.M.I. 13½ x 8 in. with high flux ceramic magnet, 11,000 gauss. Aluminium centre cone. 10 watts, 50 c/s to 10 Kc/s., 42/-.

P. & P. up to 6 in., 1/6; over 6 in., 2/6 per speaker.

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ACOS CRYSTAL MIKES. High imp. For desk or hand use. High sensitivity, 18/6. P. & P. 1/6

TSL CRYSTAL STICK MIKE. Listed at 45/-. Our price. 18/6. P. & P. 1/6.

TRANSISTOR DRIVER and O/P TRANSFORMERS. (Tapped 3 ohms and 15 ohms output). Plus 4 suitable Transistors giving approx. 1 watt output, 25/-. P. &. P. 2/6.

MATCHED PAIR OF 2½ WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stack size 1¾ x 1¼ x ⅞ in. Output trans. tapped for 3 ohm and 15 ohm output. 10/- pair plus 2/- P. & P.

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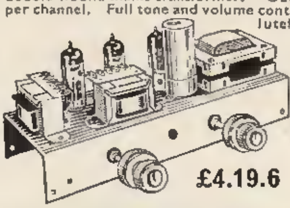
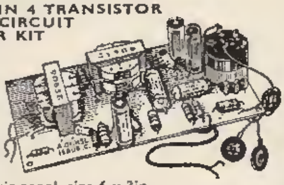
STEREO AMPLIFIER

Incorporating 2 ECL82s and 1 EZ80, heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.



BARGAIN PRICE ONLY £4.19.6 P. & P. 5/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1



● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel, size 6 x 3in. ● Generous size Driver and Output Transformers. ● 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. **SPECIAL PRICE 45/-.** P. & P. 2/6. Also ready built and tested, 52/6. P. & P. 2/6. A pair of TA1s are ideal for stereo.

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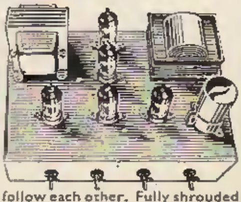
B.S.R. MONARDECK (Single speed) 3¾in. per sec., simple control, uses 5¾in. spools, £6/15/- plus 5/6 carr. and ins.

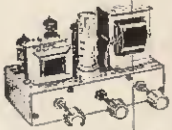
COLLARO STUDIO DECK 3 motors, 3 speeds push button control. Up to 7in. spools £10/10/- P. & P. 5/6. (Tapes extra on both.)

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86, and EZ80 rectifier. Simple instruction booklet 1/6. (Free with parts.) **All parts sold separately.** ONLY £6/19/6. P. & P. 6/6. Also available ready built and tested complete with std. input sockets, £8/15/-. P. & P. 6/6.

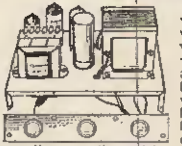
3-VALVE AUDIO AMPLIFIER MODEL HA34



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in. w. x 4in. d. x 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume. controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls.

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. 5/-.

HSL 'FOUR' AMPLIFIER KIT. A.C. Mains 200/250v., 4 watt, using ECC83, EL84, EZ80 valves.



★ 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 7½in. wide x 4in. deep. Overall height 4¾in. ★ 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. 5/-.

Comprehensive circuit diagram, practical layout and parts list 2/6 (free with kit).

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● F.M. tuning head by famous maker. ● Guaranteed non-drift. ● Permeability tuning ● Frequency coverage. 88-100Mc/s ● OA81 balanced diode output ● Two I.F. stages and discriminator. ● Attractive maroon and gold dial (7 x 3in. glass). ● Self powered, using a good quality mains transformer and valve rectifier. ● Valves used ECC85, two EF80s, and EZ80 (rectifier) ● Fully drilled chassis. ● Size of completed tuner 8 x 6 x 5½in. ● All parts sold separately. Set of parts if purchased at one time **£5/19/6**, plus 8/6 P.P. and ins. Circuit diagram and instructions 1/6 post free. **Mark II Version as above** but complete with magic eye, front panel and brackets, **£6/12/6.** P. & P. 8/6.

Mark III Version as Mark I but with output stage (ECL82) and tone control, £7/7/-. P. & P. 8/6.

Handsome Metal Cabinets. Choice of Black, or Green. To fit Mark I, 25/-. P. & P. 2/6. To fit Mark II, 17/6. P. & P. 2/6.

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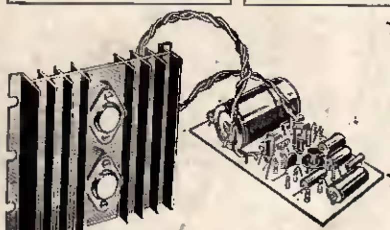

★ **10 watt Power Amplifier** (For 15/16 ohm SPEAKERS)

BUILT **£5.19.6** P.P. 2/6

★ **10 watt Power Amplifier** (For 3 to 5 ohm SPEAKERS)

BUILT **£5.10.0** P.P. 2/6

★ MAINS UNITS 59/6 for one amplifier, or 69/6 to power 2 amplifiers.

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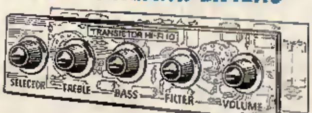
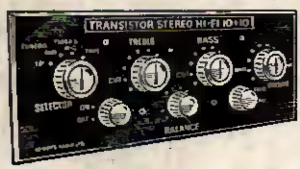
● Mono full function pre-amplifier with 8 input positions. Low noise, high quality. 1½mV sensitivity. Gives 10 watts with one power amplifier or 20 watts with two amplifiers. Size: 9 × 2½ × 2in.

BUILT **£5.10.0** P.P. 2/-



★ Dark Brown with Gold panel plate 8/6.



● **STEREO PREAMPLIFIER**

Two channel version of above. For use with two power amplifiers. For 10 + 10 watts output.
Size: 9 × 3½ × 1¾in.

PRICE BUILT **£10.19.6** P.P. 3/6

★ Dark Brown with Gold Front Panel 12/6.

● MULTI-INPUT PREAMPLIFIER

Simplified preamplifier for use with one or two power amplifiers, 8 inputs.

PRICE BUILT **65/-** P.P. 1/6

★ Front Panel Plate 6/6.

All the above preamplifiers can be used with any valve or transistor power amplifier requiring 250mV or full output. They can be operated with two 9 volt batteries in series or from the power amplifiers.
All preamplifiers and power amplifiers are designed for high gain low distortion with excellent quality.

20 WATTS PEAK MUSIC POWER PER CHANNEL

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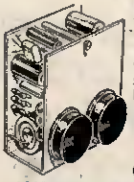
TWO PACKAGED TRANSISTOR QUALITY AMPLIFIERS



4 WATT and 1½ WATT

● 6-Transistor printed circuit designs. Push-pull output for 3 to 5 ohm speakers. Can be battery operated. 6mV into 1 Kohm sensitivity. Response 40 c/s to 15 kc/s. Outputs are 1½ watts and 4 watts RMS. Can be used with above preamplifiers for mono or stereo in any application requiring a low distortion low cost amplifier.

OVERALL SIZES 2½ × 2 × 1¼ inches.

● 4 watt version operates from 12 to 18 volts. PRICE BUILT **79/6** P.P. 1/6

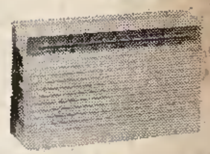
● 1½ watt version operates from 9 to 12 volts. PRICE BUILT **65/-** P.P. 1/6

★ CIRCUITS AND DETAILS ON REQUEST ★

"REGENT 6" MW/LW POCKET RADIO

NEW! ● 6 TRANSISTOR SUPERHET

Covers all Med./Long Waves



A new printed circuit Pocket Radio design. Features 6 matched transistors and diode with push-pull 'Cleartone' speaker output, geared tuning, Hi-flux speaker, etc. Fitted phone socket, separate wave-change switch. Easy to follow building instructions. Moulded two-tone cabinet size 5" × 3" × 1¼". All parts sold separately and guaranteed. After sales service.

CIRCUIT AND DETAILS ON REQUEST.

★ Total cost to build **85/-** P.P. 2/- (Battery 2/6 extra)

ALL TRANSISTOR CAR RADIO

● 1 HOUR TO BUILD WITH PRE-ASSEMBLED CHASSIS AND PANELS

THE "ROADSTER"

6-Transistor 3 diode med. and long wave superhet design. Features double tuned IFTS, AVC, permeability tuning with geared drive. Push-pull car filling volume. Full tuning on both wavebands. A high sensitivity printed circuit professional design to fit any type of vehicle. Case size 7 × 4 × 2 in. For 12 volt positive earth or dry battery. All parts available separately. After sales service and guarantee.

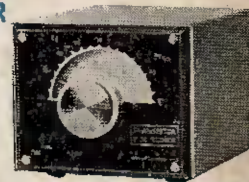
● TOTAL COST TO BUILD **£8.19.6** P.P. 3/6

● 7 × 4 inch Hi-Flux speaker with baffle and car fixing kit 20/- extra

★ CIRCUIT AND DETAILS ON REQUEST

VHF TRANSISTOR FM TUNER

● HIGH STABILITY — HIGH SENSITIVITY ●



Features 5-Mullard transistors with 4 diodes, compact printed circuit, high gain, low distortion, superhet design. Full tuning from 87/105 Mc/s with geared tuning. AVC and AFC. 9 volt 9 mA operation. 50 dB S/N. Output up to 1 volt audio. Easy to build and align. Overall size in cabinet 3½ × 2¼ × 4in. All parts sold separately.

After sales service and guarantee.

● TOTAL COST WITH FRONT PANEL To Build **£6.19.6** P.P. 2/6

★ CIRCUIT AND DETAILS ON REQUEST (Cabinet Assembly 20/- extra)

● New 6-Transistor FM design with factory pre-built units, horizontal tuning, AFC, etc. Leaflet on request. Total cost to build **£12.17.6**

'CONVAIR' PUSH-BUTTON PORTABLE/CAR RADIO

● UNBEATABLE FOR PERFORMANCE AND DESIGN ●

Printed circuit 6-Transistor 2-Diode superhet radio with full tuning on medium and long wave bands. Quality push-pull output up to 1 watt. Attractive portable cabinet, size 10 × 7 × 3½in. with horizontal slow motion tuning dial and push button wave change. Easy to build with superb performance. All parts sold separately. After sales service and guarantee.

● TOTAL COST OF ALL PARTS To Build **£7.19.6** P.P. 3/6

(Batteries 6/- extra)

★ CIRCUIT AND DETAILS ON REQUEST

★ The finest portable available.

BUILD A QUALITY TAPE RECORDER

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TWO TRACK **£26** P.P. 8/6 FOUR TRACK **£30** P.P. 8/6

★ DETAIL LEAFLET ON REQUEST ★

● SINCLAIR X10 in stock

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800 VALVES AND TUBES
500 QUARTZ CRYSTALS

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