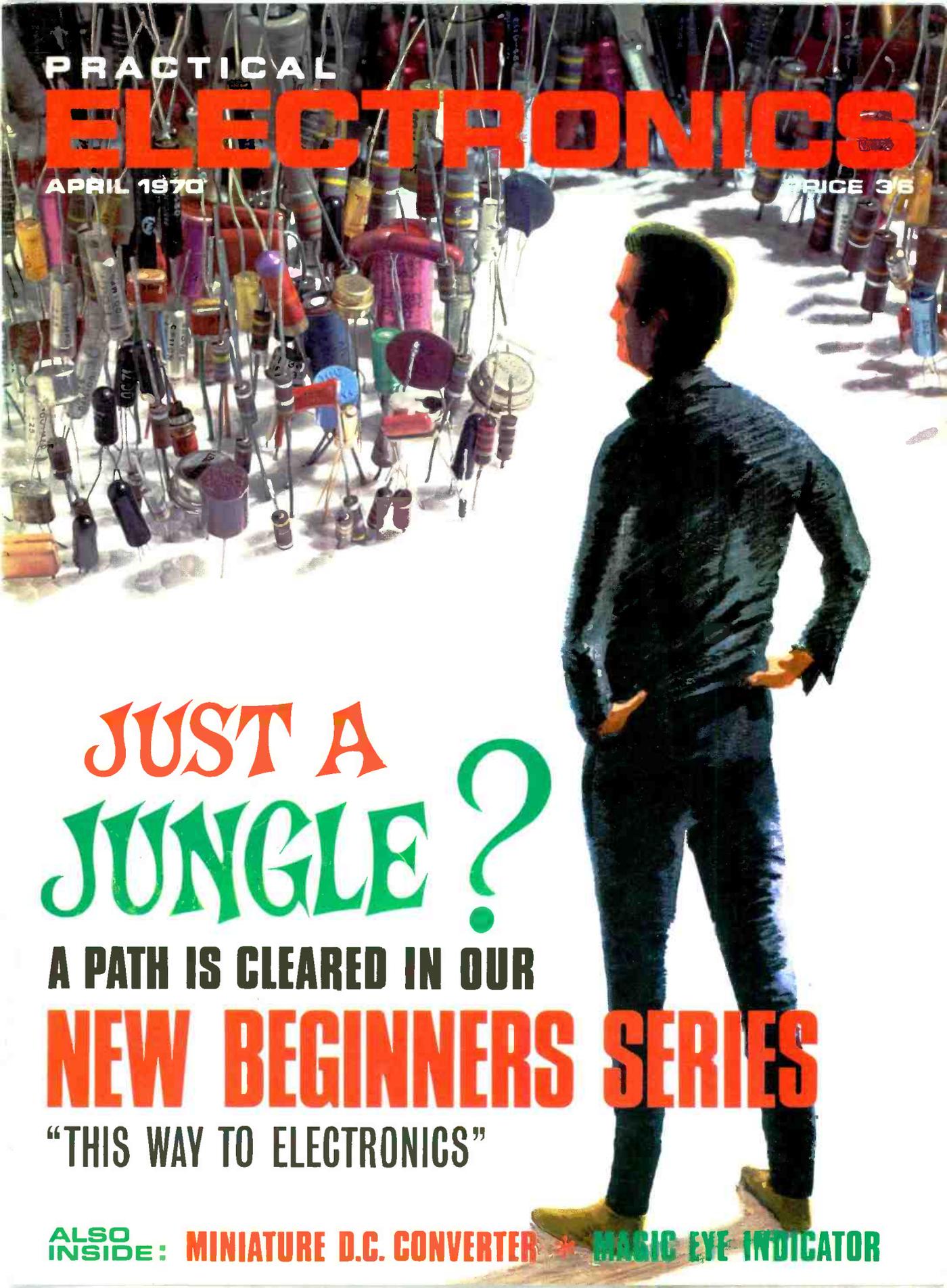


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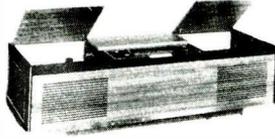
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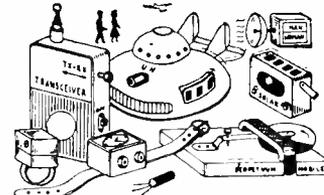
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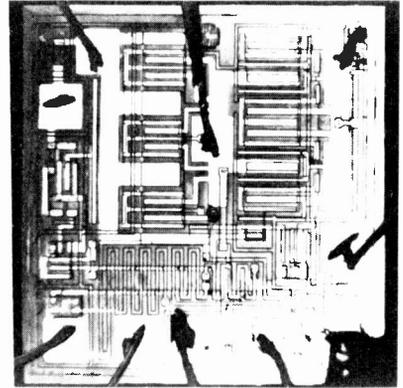
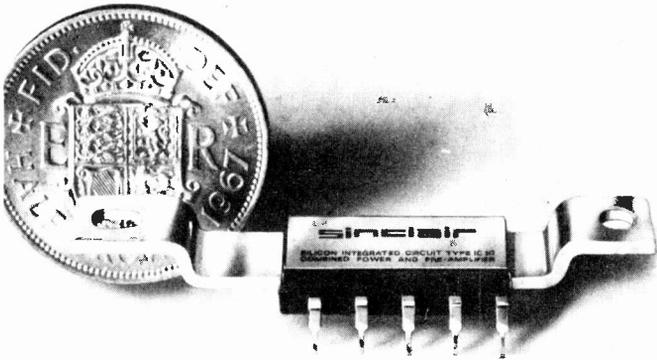
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MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP



the world's most advanced high fidelity amplifier

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

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

■ SPECIFICATIONS

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

■ CIRCUIT DESCRIPTION

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

■ APPLICATIONS

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

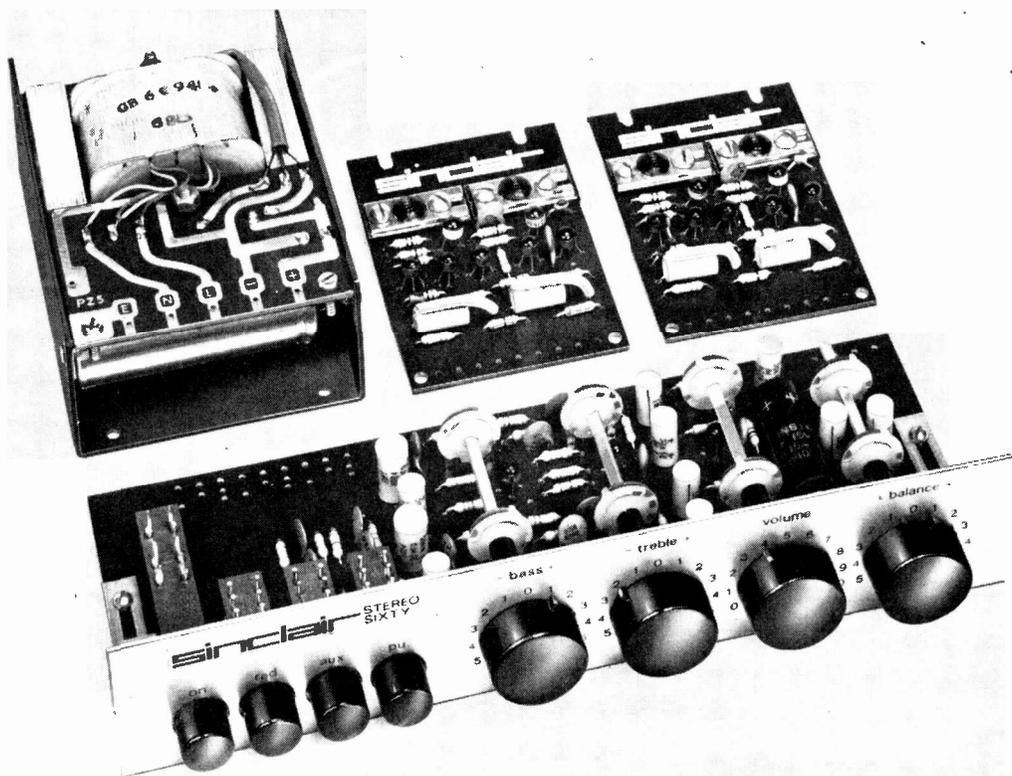
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IC.10 *with IC-10 manual* **59/6**

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Project 60 an exciting alternative

The buyer of an amplifier today has a remarkably wide variety to choose from. It is unlikely that a purchaser would have real difficulty in finding a unit that met all his requirements, although the price might not be as low as could be wished. The only snags are that one's needs can change and that the technically correct amplifier may be physically inconvenient. If you are confident that there is an amplifier available, of the right size and price, which will meet all your needs for the foreseeable future, then that is your best buy. If not, however, we can offer you another possibility which we believe to be an exciting alternative approach. That alternative is **Project 60**.

Project 60 is a range of modules which connect together simply to form a complete stereo amplifier with really excellent performance. So good, in fact, that only 2 or 3 amplifiers in the world can compare with it in overall performance.

The modules are: 1. The Z-30 high gain power amplifier, which is an immensely flexible unit in its own right. 2. The Stereo 60 preamplifier and control unit. 3. The PZ.5 and PZ.6 power supplies. A complete system comprises two Z-30's, one Stereo-60 and a PZ-5 or PZ-6. The power supplies differ in that the PZ-6 is stabilised whilst the PZ-5 is not. This means that the former should be used where the highest possible continuous sine wave rating is required. In a normal domestic application there will not be a significant difference between using either power unit unless loudspeakers of very low

efficiency are being used.

In view of the very high performance of an amplifier system built with Project 60 modules, the cost may seem surprisingly low. There are two reasons for this: Firstly, we are the largest producers of this type of module in Europe and we are able therefore to use highly efficient production methods. Secondly, you are not paying for a cabinet which you may not require anyway.

All you need to assemble your system is a screwdriver and a soldering iron. No technical skill or knowledge whatsoever is required and, in the unlikely event of you hitting a problem, our customer service and advice department will put the matter right promptly and willingly.

Project 60 modules have been carefully designed to fit easily into virtually every type of plinth or cabinet to provide a complete unit of great compactness. Only holes have to be drilled into the wood of the plinth and any slight slips here will be covered completely by the aluminium front panel of the Stereo 60. The Project 60 manual gives all the instructions you can possibly want clearly and concisely.

Perhaps the greatest beauty of the system is that it is not only flexible now but will remain so in the future. We shall shortly be introducing additional modules which will include a comprehensive filter unit, a stereo F.M. tuner and an even more powerful amplifier for very large systems. These and all other modules we introduce will be compatible with those shown here and may be added to your system at any time.

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Z.30 TWENTY WATT R.M.S. (40 WATT PEAK) HIGH FIDELITY POWER AMPLIFIER

The Z.30 is a complete power amplifier of very advanced design employing 9 silicon epitaxial planar transistors. Total harmonic distortion is incredibly low being only 0.02% at full output and all lower outputs. As far as we know, no other high fidelity amplifier made can match this specification, no matter what the price. Thus you can be utterly certain that your Project 60 system will do full justice to your other equipment however good it may be. The Z.30 is unique in that it will operate perfectly, without adjustment, from any power supply from 8 to 35 volts. It also has sufficient gain to operate directly from a crystal pickup. So in addition to its use in a high fidelity system you can use a Z.30 to advantage in your car or a battery operated gramophone for your children, for example. These, and many other applications of the Z.30 are covered in the manual of circuits and instructions supplied with every Z.30 high fidelity power amplifier.

SPECIFICATIONS

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

Output—Class AB.

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

Distortion: 0.02% total harmonic distortion at full output into 8 ohms and at all lower output levels, better than 70dB unweighted.

Signal-to-noise ratio:

Input sensitivity: 250mV into 100Kohms.

Damping factor: >500.

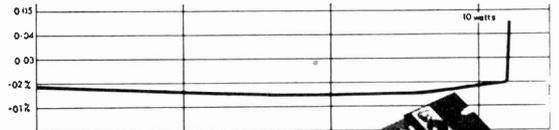
Loudspeaker impedances: 3 to 15 ohms.

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

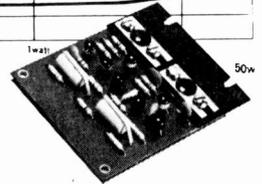
Size: 3½ x 2¼ x ¼ inches.

APPLICATIONS

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



Power versus distortion curve of Sinclair Z.30 amplifier.



Z.30
Built, tested and guaranteed, with circuits and instructions manual

89/6

STEREO SIXTY PREAMPLIFIER AND CONTROL UNIT

The Stereo 60 is a stereo preamplifier and control unit designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout and great attention has been paid to achieving a really high signal-to-noise ratio and excellent tracking between the two channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs. The tone controls are also very carefully designed and tested.

SPECIFICATIONS

• Input sensitivities—Radio—up to 3mV
Magnetic Pickup—3mV; correct to R.I.A.A. curve \pm 1dB; 20 to 25,000 Hz.
Ceramic Pickup—up to 3mV; Auxiliary—up to 3mV.

• Output—250mV

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

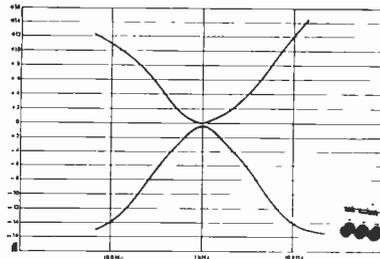
• Channel matching—within 1dB.

• Tone Controls—TREBLE \pm 15 to \pm 15dB at 10 KHz; BASS \pm 15 to \pm 15dB at 100 Hz.

• Power consumption 5mA.

• Front panel—brushed aluminium with black knobs and controls.

• Size 8¼ x 1½ x 4 ins.



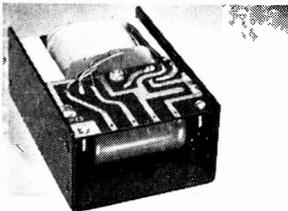
Treble and bass cut and boost curves of Sinclair Stereo Sixty



Ready for immediate installation

£9. 19s. 6d.

SINCLAIR POWER SUPPLIES



PZ-5

30 volts un stabilised—sufficient to drive two Z 30's and a Stereo 60 for the majority of domestic applications.

Price: £4. 19s. 6d.

PZ-6

35 volts stabilised—ideal for driving two Z.30's and a Stereo 60 when very low efficiency speakers are employed.

Price: £7. 19s. 6d.

GUARANTEE

If at any time within 3 months of purchasing Project 60 modules from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

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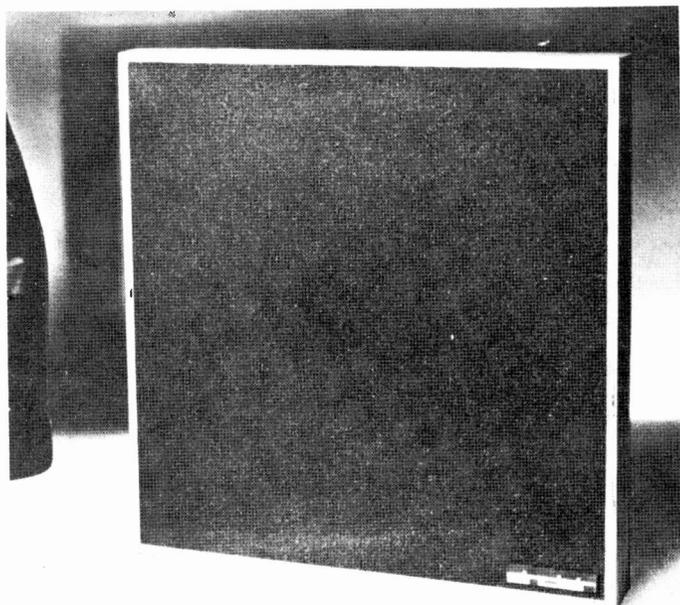
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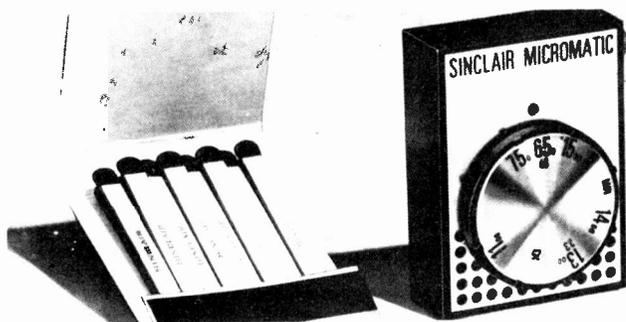


All the superb features which went to make the Sinclair Q.14 have been incorporated in the new Q.16 which gives an exciting new opportunity for you to match your Sinclair equipment with modern decor. Employing the same well proven acoustic system in which materials, processing and styling are used in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

The Q.16 will handle loading up to 14 watts R.M.S. and presents an 8 ohm impedance to the amplifier output. Frequency response extends from 60 to 16,000 Hz. with exceptional smoothness. A specially designed driver system is used in a sealed and contoured pressure chamber to ensure good transient response at all frequencies. Size: $9\frac{3}{4}$ " square \times $4\frac{3}{4}$ " deep from front to back.

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SINCLAIR MICROMATIC The world's most successful miniature radio



Specifications

Size: $1\frac{1}{2}$ " \times $1\frac{1}{4}$ " \times $\frac{1}{4}$ " (46 \times 33 \times 13mm).
Weight incl. batteries: 1 oz. (28-35gm) approx.
Tuning: Medium wave band with bandspread at higher frequency end.
Earpiece: Magnetic type.
Case: Black plastic with anodized aluminium front panel, spun aluminium dial.

Complete kit incl. earpiece, case, solder and instructions in fitted pack.

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Inc. P/Tax

Ready built, tested and guaranteed, with earpiece.

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Considerably smaller than an ordinary box of matches, this is a multi-stage A.M. receiver meticulously designed to provide remarkable standards of selectivity, power and quality. Powerful A.G.C. is incorporated to counteract fading from distant stations; bandspread at higher frequencies makes station separation much easier than with many larger sets. The plug-in magnetic earpiece which matches exactly with the output provides wonderful standards of reproduction. Everything including the batteries is contained within the attractively designed case. Whether you build your Micromatic or buy it ready built and tested, you will find it as easy to take with you as your wristwatch, and dependable under the severest listening conditions.

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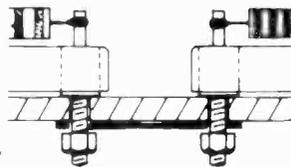
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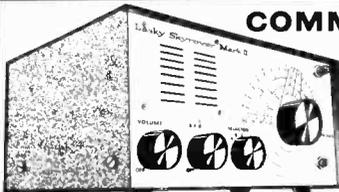
The unit incorporates the renowned Garrard 3000 four-speed autochanger with lightweight tubular pick-up arm fitted with SONOTONE 9TA STEREO CARTRIDGE WITH DIAMOND STYLUS. The beautifully made plinth is finished in richly figured teak veneer with tinted perspex panels in the lid and with attractive charcoal grey "mirror" insert panel on front. All metal trim parts are satin chrome. Black leather grain underside. The lid allows the player to operate automatically when closed and has snap action "stay" when raised. Mains socket and DIN audio output socket are at rear. Overall size 15½ x 7½ x 14in.



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A short wave receiver, exclusive to Lasky's, at a real economy price. Four valve line-up using one each 6BE6, 6BA6, 6AV6 and 6AR5 valves, gives highly sensitive reception and powerful gain. Switch selected SW frequency range cover: 1.5 to 30MHz in three separate band-spread ranges and full AM medium waveband cover in one range 550-1,600kHz. Reduction drive tuning with hair line cursor. Controls include volume on/off BFO, Band selector. Power on indicator lamp. External antenna connections and mains fuse at rear. Internal speaker plus standard 5mm jack socket for phones on front. For 220/240V a.c. mains operation. Strong metal cabinet finished in grey crackle with anodised silver front panel. Size 9½ x 5½ x 5½in. Complete with mains lead and full instructions.

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LASKY'S PRICE £42.0.0 Carriage free

TRIO SP-5D

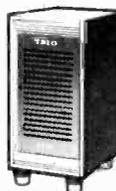
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TTC B-1016

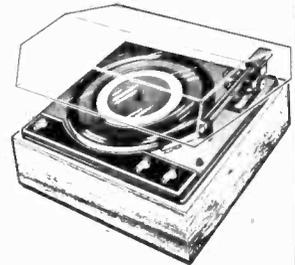
A handy microphone for communications. 6ft retractable lead, special hanger bracket, built in "talk" switch! Imp: 50,000 ohms. Size: 3½ x 2½ x 1½in. **67/6** Post 3/6

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2025 TC complete with stereo cart.	£8 17 6
3000 complete with 9TA 11C stereo cart.	£9 19 6
SL 65B	£15 19 6
1025 complete with stereo cart.	£8 19 6
SL 85B	£40 0 0
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Post on Garrard units: 6/- extra—except AP 75, SL 75B, SL 95B and 401 7/6 extra. Post on bases and covers 6/- extra.

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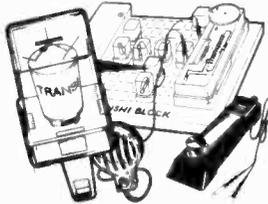
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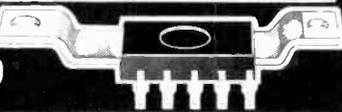
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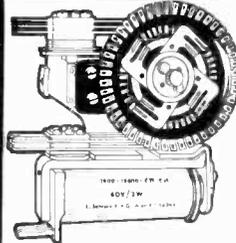
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A compact pygmy relay on an 8-pin base with D.P.D.T. contacts rated to 10A. (Some types are 3 P.D.T. on an 11-pin base.) Quotes for quantities.

RN TYPE	Contacts	Base	Coil Voltage
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235004	D.P.D.T.	8 pin	40V d.c.
215000	D.P.D.T.	8 pin	60V a.c./d.c.
308030	3 P.D.T.	11 pin	60V d.c.
205024	D.P.D.T.	8 pin	24V d.c.
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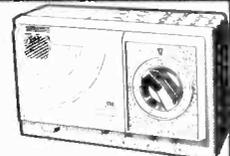
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200μF	6V	20μF	10V	10μF	12V	10μF	25V	50μF	40V
320μF	6V	25μF	10V	16μF	15V	16μF	25V	10μF	64V
6-4μF	10V	64μF	10V	25μF	15V	25μF	25V	2-5μF	64V

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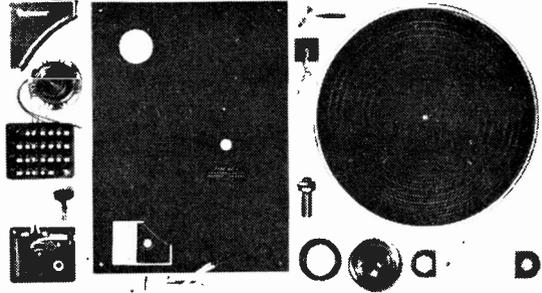
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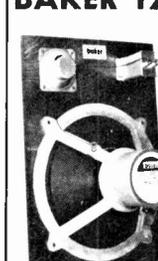
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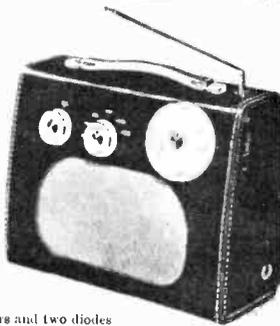
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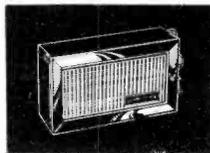


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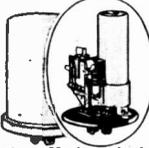
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A crystal controlled heterodyne frequency meter covering 1.7-8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. £5.19.6. Carr. 7/6. or brand new with accessories. £7.19.6. Carr. 7/6.

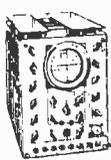
CLASS D WAVEMETERS No. 2

Crystal controlled. 1.2-19 Mc/s. Mains or 12V d.c. operation. Complete with calibration charts. Excellent condition. £12.10.0. Carr. 30/-.

R209 MK II COMMUNICATION RECEIVER

11 valve high grade communication receiver suitable for tropical use. 1-30 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, BFO. Aerial trimmer, internal speaker and 12 V d.c. internal power supply. Supplied in excellent condition, fully tested and checked. £15. Carr. 20/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



An excellent general purpose D/B oscilloscope. T.B. 2 c/s-750 kc/s. Bandwidth 5.5 Mc/s. Sensitivity 33 mV/CM. Operating voltage 0/110/250V a.c. Supplied in excellent working condition. £22.10.0 or complete with all accessories, probe, leads, lid, etc. £25. Carriage 30/-.



MARCONI CT44/TF956 AF ABSORPTION WATTMETER
1 μwatt to 6 watts.
£20. Carr. 20/-.

GEARED MAINS MOTORS



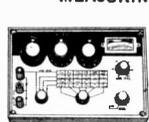
Paralux - type 8D19 230/250V a.c. Reversible. 30 RPM. 40lb in. Complete with capacitor. Excellent condition. 99/6. Carr. 10/-.

TO-2 PORTABLE OSCILLOSCOPE

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



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



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11.1 megΩ. 6 Ranges ±1%. L1 μH - 1 l HENRYs. 6 Ranges -2% C. 10pF ±11.1 mF. d. 6 Ranges ±2%. TURNS RATIO 1:1/1000-1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7 1/2 x 2 1/2 in. £20. P. & P. 6/-.

UNR-30 4-BAND COMMUNICATION RECEIVER

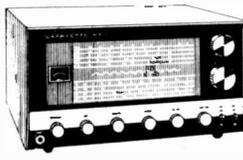
Covering 550 Kc/s-30 Mc/s. Incorporates BFO. Built-in speaker and phone jack. Metal cabinet. Operation 220/240V. a.c. Supplied brand new, guaranteed with instructions. Carr. 7/6

13 gns.



TRIO JR-310 NEW AMATEUR BAND 10-80 METRE RECEIVER.

In stock. £77.10.0.

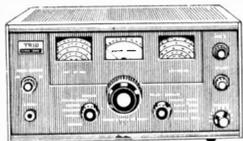


LAFAYETTE SOLID STATE HAGOO RECEIVER

5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 kc/s-400 kc/s and 550 kc/s-30 Mc/s FET front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V a.c./12V d.c. neg. earth operation ● RF gain control. Size 15in 9 1/2in x 8 1/2in. Weight 13lb. EXCEPTIONAL VALUE. £45. Carr. 10/- S.A.E. for full details.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

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



TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER

£69.10.0

TRIO TS 510 AMATEUR TRANSCEIVER

with speaker and mains P.S.U. £212

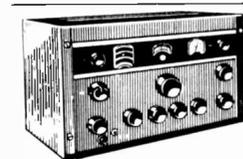
UR-1A SOLID STATE COMMUNICATION RECEIVER

4 bands covering 550 Kc/s-30 mc/s continuous. Special features are use of FET transistors, S meter, built in speaker and telescopic aerial, variable BFO for SSB reception, noise limiter, bandsread control, sensitivity control. Output for low impedance headphones. Operation 220/240 volt A.C. or 12 volt D.C. Size 12 1/2" x 4 1/2" x 7". Excellent value. ONLY £24. Carr. 7/6.



LAFAYETTE HA.800 6-BAND AMATEUR RECEIVER.

£57.10.0. Carr. Paid.



RCA COMMUNICATION RECEIVER AR88D

Latest release by ministry BRAND NEW in original cases. 110-250V a.c. operation. Frequency in 6 Bands. 555Kc/s-32Mc/s continuous. Output impedance 2.5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price £87.10.0. Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

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



TELETON MODEL CR 10T AM/FM STEREO TUNER AMPLIFIER

A new model from Teleton. 31 solid state devices. 4 + 4 watt output. Inputs for ceramic/crystal cartridge. Frequency range AM 540-1600 KHz FM 88-108 MHz. Automatic FM stereo reception. Stereo indicator. Controls: Tuning, function selector, Tone and R & L volume controls. AFC switch. Stereo headphone socket. Size: 13 1/2" x 3 1/2" x 9 1/2" approx. Price £34. Carr. 7/6.

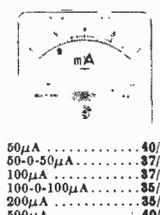


CLEAR PLASTIC PANEL METERS

First grade quality Moving Coil panel meters. Type MR 38P. 1 1/2" in square fronts.

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

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



CRYSTAL CALIBRATORS 'No. 10



Small portable crystal controlled wavemeter. Size 7" x 7 1/2" x 4". Frequency range 500 Kc/s. 19 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. 89/6. Carr. 7/6.

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

10 meg. input 10 ranges: 0-1 / 0-3 / 1-3 / 1-3 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s. 1-2Mc/s. Decibels -40 to +50dB. Supplied brand new complete with leads and instructions. Operation 220V a.c. £17.10.0. Carr. 5/-.



LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

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

TE-65 VALVE VOLTMETER



High quality instrument with 28 ranges. D.c. volts 1.5-1,500V. A.c. volts 1.5-1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. £17.10.0. P. & P. 6/- Additional Probes available: R.F. 35/- I.H.V. 42/6.

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

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

AM/FM SIGNAL GENERATORS



Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20-80Mc/s. AM C.W./FM. Incorporates precision dial, level meter, precision attenuator 1μV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 x 8 1/2 x 9in. Supplied in brand new condition complete with all connectors fully tested. £45. Carr. 20/-.

PLESSEY SL 403A

3 watt Integrated Amplifier Circuit 49/6 POST PAID

EDDYSTONE VHF RECEIVERS MODEL 770R.

19-165 Mc/s. Excellent condition. £150



TE-16A Transistorised Signal Generator. 5 ranges 400 kHz-30 MHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 x Hz modulation. 5 1/2 x 5 1/2 x 3 1/2". Complete with instructions and leads. £17.19.6. P. & P. 4/-.

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Wonderful value and excellent performance combined. Adjustable head-band. 8 ohm impedance. 20-12,000 cps. Complete with lead and stereo jack plug. ONLY 47/6. P. & P. 2/6.



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0/115/230V. Step up or step down. Fully shrouded.

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1,000 W.	£6.10.0.	P. & P. 7/6
1,500 W.	£7.19.6.	P. & P. 8/6
7,500 W.	£15.10.0.	P. & P. 20/-

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush work. Continuous rating. Wide range ex-stock Single hole fixing, zin. dia. shafts. Bulk quantities available.

25 WATT.	10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms.	14/6.	P. & P. 1/6.
50 WATT.	10/25/50/100/250/500/1,000/2,500 or 5,000 ohms.	21/-.	P. & P. 6/6.
100 WATT.	10/25/50/100/250/500/1,000 or 2,500 ohms.	27/6.	P. & P. 1/6.



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

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



A.F. SINE WAVE
20-200,000 c/s.
Square wave 20-30,000 c/s. O.P.
HIGH IMP. 21V.
P/P600Ω 3-V. P/P.
T/P 100 kc/s-300 Mc/s. Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF output and % mod. on R.F. 220/240 V a.c. £32.10.0. Carr. 7/6.

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

TY75 AUDIO SIGNAL GENERATOR



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

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

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER

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



ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.
J1.B. AUDIO SIGNAL GENERATOR. 15 c/s to 50 Kc/s. Sine wave. Output 600 ohms or 5 ohms. £30.0.0.

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TT15. TRANSISTOR TESTER. Full range of facilities for testing PNP or NPN transistors in or out of circuit. £37.10.0. Carriage 10/- per item.

MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0.7-0.9567, B: 8-200, Ico: 0-50 microamps 0-5 mA. Resistance for diode 200 Ω-1 MΩ. Supplied complete with instructions, battery and lead. £5.19.6. P. & P. 2/6.

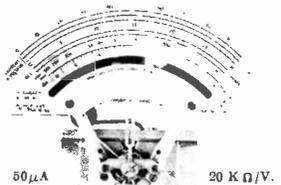


TE11. DECADE RESISTANCE ATTENUATOR

Variable range 0-11dB. Connections: Unbalanced T and Bridge T. Impedance 600Ω (0-1dB - 10) + (1dB x 10) + 10 + 20 + 30 + 40dB. Frequency: d.c. to 200kHz (-3dB). Accuracy: 0-0.5dB. ± indication dB ± 0.01. Maximum input less than 4W (60V). Built in 600Ω load resistance with internal/external switch. Brand new £27.10.0. P. & P. 5/-



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Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multimeter. Brand New and Boxed 69/6. P. & P. 3/6.

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2. For AP75, SL75, SL95. £7.9.6

3. For SP25 etc. to operate with lid in place £8.19.6

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Full range of Garrard accessories available.

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19 transistors, 8 diodes, 11HF music power, 30W at 8Ω. Response 30-20,000 20dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3.15Ω. Separate L and R volume controls. Triple and bass control. Stereo phono to k. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 101 x 9.16 x 7.13/16in. Operation 115/230V. A.C. £24. Carriage 7/6.

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TE-51. NEW 20,000 Ω VOLT MULTIMETER with overload protection and mirror scale. 0-600 12V 1,200V a.c. 0/3-30 60 300 600/3,000V d.c. 0-69A/12 300mA d.c. 0-60K/6 meg. ohm. 92/6. P. & P. 2/6.

MODEL AS-100D. 100KΩ/VOLT. 5in. mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1,200V a.c. 0/6/30/120/300/600V a.c. 0/10/100/6/60/300mA/12 Amp. 0/2K/200K/2M/200MΩ. -20 to +17dB. £12.10.0. P. & P. 3/6.

MODEL TE-90 50,000 O.P.V. MIRROR SCALE OVERLOAD PROTECTION 0/3/12/60/300/600/1,200V d.c. 0-63/30/120/300/1,200V d.c. 0-63/6/60/500/60A d.c. 16K/160KΩ/1/616MΩ. -20 to +63dB. £7.10.0. P. & P. 3/-.

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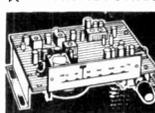
MODEL TE-10A. 20KΩ/Volt. 5/25/50/250/500/2,500 V. d.c. 10/50/100/500/1,000V. a.s. 0/50/1A/2.5 mA/250mA. d.c. 0.6K/6 megohm. -20 to +24dB. 10-0, 100 mfd. 1 0 0-100-1 mfd. 69/6. P. & P. 2/6.

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LAFAYETTE 57 Range Super. 50,000 O.P.V. D.c. Multimeter. 125V-1,000V A.c. Volts 1-5V-1,000V D.c. Current 25µA-10 Amp. Ohms. 0-15 MegΩ dB. -20 to +81dB. Overload Protection. £12.10.0. Carr. 3/6.

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6 TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6 x 4 x 2 1/2 in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money. £6.7.6. P. & P. 2/6. Stereo multiplex adaptors 99/6.

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Each headphone contains a 2in woofer and a 1in tweeter. Built in individual level controls. 8Ω imp. 25-18,000c/s. with cable and stereo plug £5.19.6. P. & P. 2/6.

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COSMOCORD 1-track heads. High imp. record playback 85/- Low imp. erase 20. **MARRIOTT** 1-track heads. High imp. record playback 65/- Low imp. erase 20/- Post extra.

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First grade quality American tapes. Brand new. Discount on quantities.

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7in. 1,200ft. std. acetate	12/6
7in. 1,800ft. L.P. acetate	15/-
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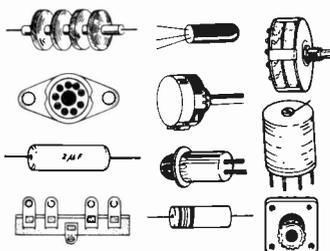
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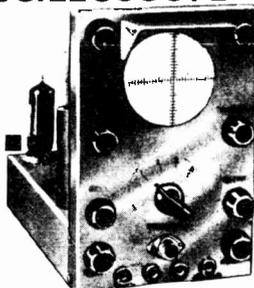
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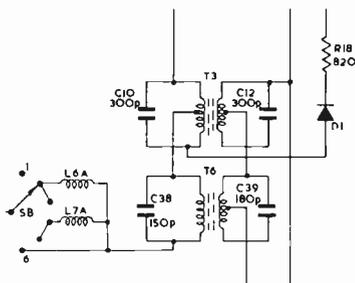
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4 ▶ **CARRY OUT OVER 40 EXPERIMENTS ON BASIC ELECTRONIC CIRCUITS AND SEE HOW THEY WORK . . . INCLUDING . . .**

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DOMESTIC HELP

THE achievements of electronic technology have long been in evidence in every home. Products such as radio, television and hi-fi equipment are an essential part of modern life. Thus in the average household electronics is naturally enough associated first and foremost with entertainment. And there is little reason to suppose this will not always remain so.

This is not to deny that other quite distinctive and immensely important roles for electronic techniques will enter into the domestic scene in due course. Power control is very much a case in point. Electronic methods for controlling electric power have been in use in industrial equipment for a very considerable time, but only during the last six months or so have we seen the emergence, in any consequence, of electronically controlled domestic appliances. Now there are on the market a number of washing machines which incorporate electronic control, giving a smooth drum operation with several spin speeds, without the need for complex mechanical gear boxes.

The advantages of electronic power control are not restricted to washing machines, and we can expect further penetration into the domestic appliance field by electronics. But only in the medium power range, it seems. Immediately one contemplates controlling loads of the order of kilowatts, technical and cost problems arise.

Washing machines (and other medium power appliances such as food mixers, and electric blankets, for instance) can operate satisfactorily with the phase shift method of thyristor operation. But if large loads, such as electric fires, were to employ this method a serious distortion of the mains supply waveform could occur. For this reason the Electricity Council has advised that where large loads are involved an alternative method known as burst-fire operation should be used.

Unfortunately, burst-fire operation is considered too complex and costly for domestic appliances. So the advantages in comfort and economy of a continuously variable heat control over step switching of elements will not be realised, not for a while at any rate.

Even the Gas Industry is coming to recognise the services electronic devices can offer. Already, electric ignition is in common use in gas ovens and fires. The introduction of natural gas poses some new problems, since it is more difficult to ignite by the normal glow coil. A high frequency spark generated by an electronic circuit may be the answer here.

In these behind the scene roles, electronics is giving valuable support to the basic but essential domestic services, and so demonstrating that it is truly a maid-of-all work, and that entertainment is only one of its functions in the home even if, inevitably, the more apparent and glamorous one.

F.E.B.

THIS MONTH

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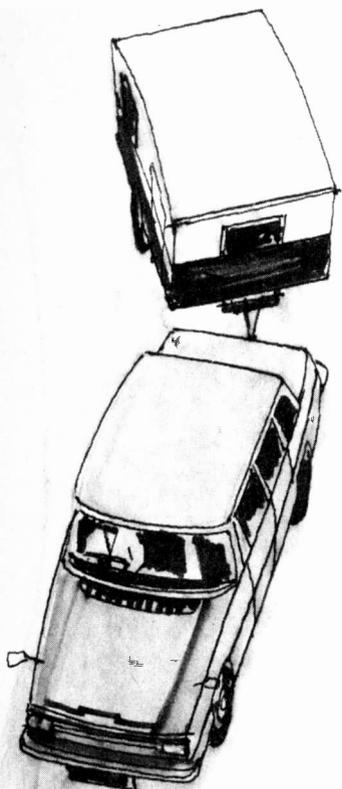
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*Our May issue will be published on
Monday, April 13*

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USE IT IN YOUR CAR, CARAVAN OR BOAT!

EACH year the number of caravans, campers and boat owners continues to grow. With this there is the need for a simple converter to enable electric shavers and other low power appliances—e.g. fluorescent tubes—to be run from a 12V battery. The source of power is usually a car battery, producing an output from the converter of 240 volts. Ideally the 240 volts should be at 50Hz a.c., but as will be seen later there are considerable advantages in making the output d.c.

There are a number of alternatives available for power conversion, namely: rotary converters, vibrator packs and transistorised converters. Rotary converters tend to be inefficient, noisy and large. Vibrator packs have reasonable efficiency but are noisy, bulky and often unreliable. The transistorised converter does not suffer from any of these disadvantages and, provided the power requirements are not excessive, can be physically quite small.

OPERATING FREQUENCY

The operating frequency of the converter governs the inductance requirements of the transformer for a given output power. The lower the frequency the higher the inductance and consequently a larger transformer is needed.

If 50Hz operation is required the transformer must be fairly large and so it was decided to use a higher frequency and rectify the output to give 240 volts d.c. The d.c. output is suitable for most purposes as the majority of shavers are of the a.c./d.c. variety.

Using the transistors and transformer specified the maximum output power is governed by the peak current handling capacity of the AD162 transistors (2 amps) and is about 23 watts with a 12 volt input. The use of larger transistors will increase the output power but this is unlikely to be necessary if the converter is to be used with electric shavers.

The no load current is about 200mA compared with 2 amps for some rotary converters, giving an overall efficiency of approximately 90 per cent. Although the transistors are mounted on aluminium heat sinks their dissipation is low and they should not get hot during use; the same is true for the transformer.

CIRCUIT DESCRIPTION

The circuit (Fig. 1) is of the conventional saturating transformer with feedback type oscillator. As TR1 switches on it is held on by its feedback winding. The magnetising current builds up until a core saturation point is reached, reducing the drive to TR1. This starts to bring TR1 out of saturation, causing a reversal of drive, thus switching it off rapidly and switching TR2 on. The same process happens to TR2 until TR1 is again in saturation. R1 and R2 provide a small forward bias to ensure the oscillator starts under full load.

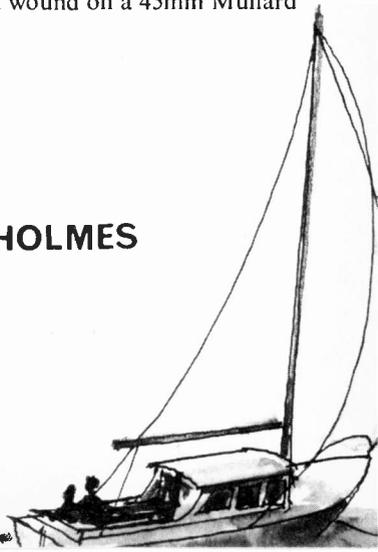
In order to avoid the need for two windings a bridge circuit (D1 to D4) is used to provide the d.c. output. The smoothing capacitor need not be large because of the working frequency. A neon across the output indicates that the unit is functioning. In order to protect the transistors and the car battery in the event of a short circuit the unit is provided with fuses at both input and output. If the shaver takes a very heavy starting current it may be necessary to use anti-surge fuses, although standard 2.5A and 150mA fuses should not blow under full output.

TRANSFORMER CONSTRUCTION

The operating frequency was chosen to be about 1.5kHz, this enabled the primary to be reduced to 42 turns, centre tapped and wound on a 45mm Mullard pot core type FX2243.

MINIATURE CONVERTER

By S. J. HOLMES



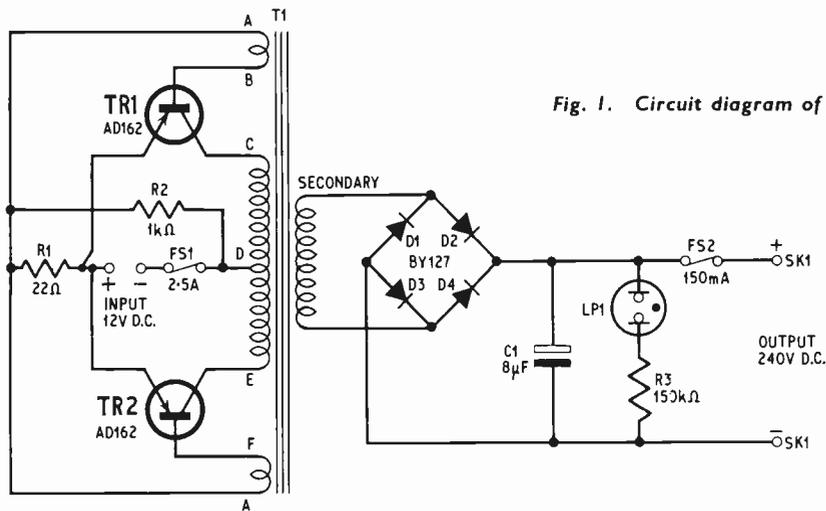
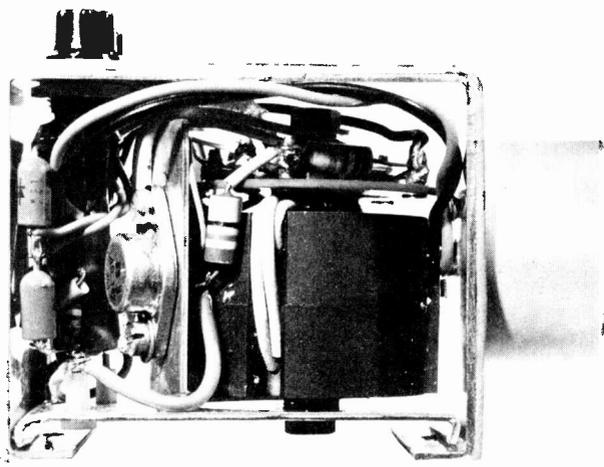
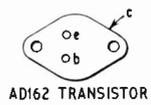


Fig. 1. Circuit diagram of the miniature converter



The complete converter with case removed showing the compact construction

METALWORK

The actual size of the converter may vary according to individual preferences, but it was decided here to reduce the size to a minimum. Cutting and drilling details for the case shown are given in Fig. 2. The transistors are first mounted on the heat sink, using insulating washers, and this is attached to the transformer. The transformer heat sink assembly is then screwed to the chassis by means of the 2B.A. screw through the pot core (Fig. 3). The main purpose of the chassis is to keep the transformer and transistors in a firm position when they are in the case.

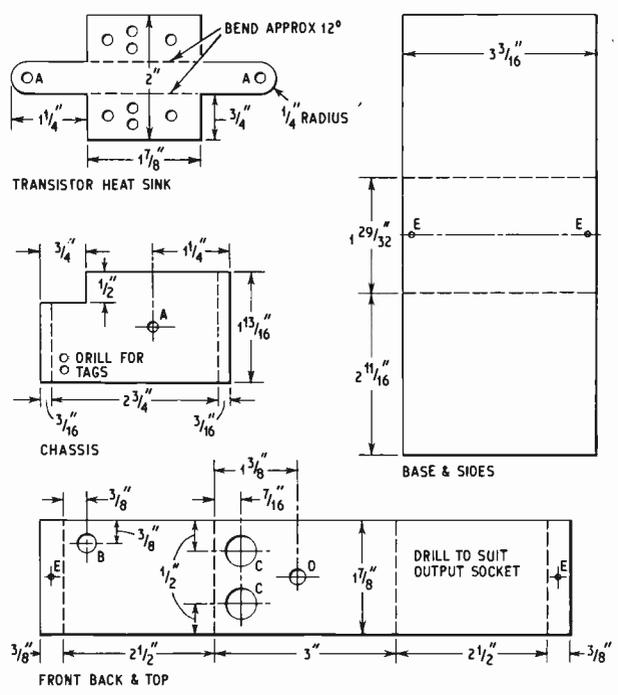
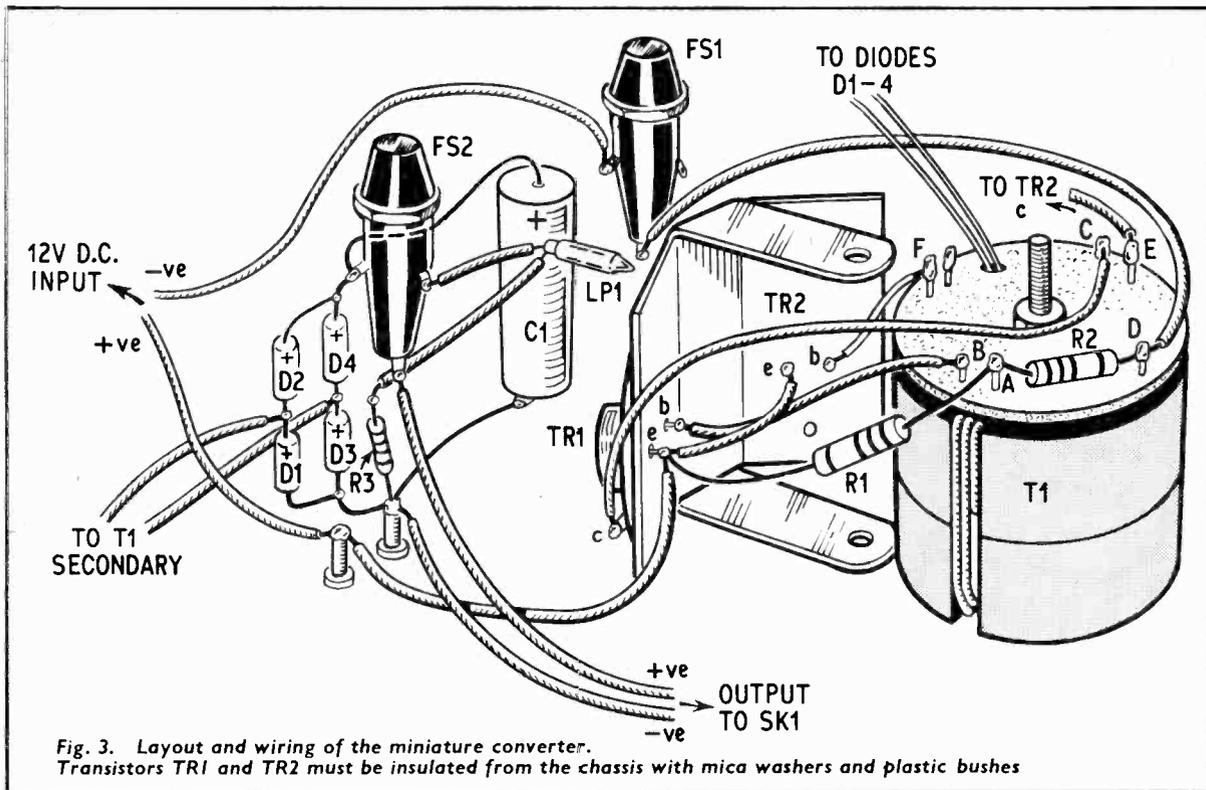


Fig. 2. Chassis cutting and drilling details

Using 21 s.w.g. enamel copper covered wire the winding occupies two layers and so the ends and centre tap may be brought out from the slots in the side of the former. The feedback windings are another four turns centre tapped wound on top of the two primary layers: all windings are in the same direction. After winding, the primary and feedback layers should be varnished and allowed to dry before starting to wind the secondary.

A layer of insulation tape should be inserted between the primary and secondary. The secondary winding consists of 420 turns of 30 s.w.g. enamelled wire wound with insulating sleeving slipped over the start and finish of the winding. The secondary is then given a coat of varnish before a final insulation layer of tape.

The whole pot core assembly is clamped together with the heat sink and chassis by a 2B.A. screw through the centre. A Paxolin tag strip is fitted on one end of the pot core to serve as anchoring points for the transformer leads. A thin coat of varnish on the faces of the core before clamping together will stop any tendency the transformer may have to chatter when working.



COMPONENTS . . .

Resistors

R1 22Ω
R2 1kΩ
R3 150kΩ
All ¼W, 10% carbon

Capacitor

C1 8μF elect. 350V

Semiconductors

TR1, 2 AD162 (2 off)
D1 to 4 BY127 or BY100 (4 off)

Miscellaneous

T1 Mullard pot core FX2243 (Gurneys (Radio) Ltd.,
91 The Broadway, Southall, Middlesex)
FS1, 2 2.5A and 150mA miniature fuses and holders
(2 off)
LP1 miniature wire ended neon
SK1 output socket to suit appliance
Aluminium 18 s.w.g., 7¼in × 8¾in
21 s.w.g. and 30 s.w.g. enamelled copper wire
Small tag strip
Grommet
Fixings

The case is formed by two interlocking "U" shaped pieces of aluminium. The top, front and back are made by bending a 1¼in strip of aluminium as shown, with a ⅜in fold at each end to take the self tapping screws which secure the second "U" section. Before the top section is bent, holes should be drilled for the fuse holders, neon, grommet and output socket.

Once the components have been fixed to the case the chassis with pot core and transistors can be slotted into the "U" shaped top section. The remaining components may be mounted between the anchor points formed by the fuse holder and tag panel on the pot core. Two extra anchor points were found to be necessary and these were formed by two tags on the chassis.

If the self tapping screws are of the right length they will go through the bottom section together with the ⅜in folds and still have enough length to press against the chassis, clamping it in position. Finally, four rubber feet glued on to the unit will prevent the unit from scratching polished surfaces. A strip of rexine glued over the top "U" section before assembly will enhance the unit's appearance.

TESTING

Before the transistors are wired into the circuit their collectors (cases) should be checked with a meter to ensure that there is no short circuit to the heat sink. To avoid any possible shorts to the case when assembled the inner surfaces of the sides of the lower "U" section should be insulated with tape. Before switching on, the wiring should be checked, in particular the polarity of the diodes and smoothing capacitor, together with the polarity of the supply leads.

continued on page 294

APOLLO 13

The target area for the *Apollo 13* moon landing is in a rugged cratered highland known as the "Fra Mauro" formation. It lies a little southwest of the moon's full disc as seen from the earth. The site landing point is just near the crater Fra Mauro (named after a disciple of Saint Benedict) which is about 37 miles wide. Its actual position is 17° 36' west longitude and 3° 48' south latitude. This position is about 110 miles from the *Apollo 12* landing site.

The emphasis on this mission is scientific exploration. The astronauts James Lovell and Fred Haise will collect samples from a fairly wide area and also drill for samples. Similar core sampling tools to those employed on the *Apollo 12* mission will be used.

Lunar experts are of the opinion that the Fra Mauro formation is an upheaval of lava rock from deep inside the moon itself. Thus any material collected could represent the lava that has flowed out in the area.

Basically the experiments carried on this mission will be the same as in the previous one, except that the magnetometer will be replaced by a heat flow experiment. It is planned to insert the measuring unit some 10ft below the surface where it will record the change of temperature level between lunar day and night.

SUB-LUNAR

It is thought in some quarters that because of the nature of the surface rock that there may not be any great change. If this is so, and the level is reasonably below that of the surface, it could mean that lunar colonies will be best located underground. As the emphasis is on scientific exploration, this area has been chosen because of the amount of new data that may be acquired about the interior of the moon.

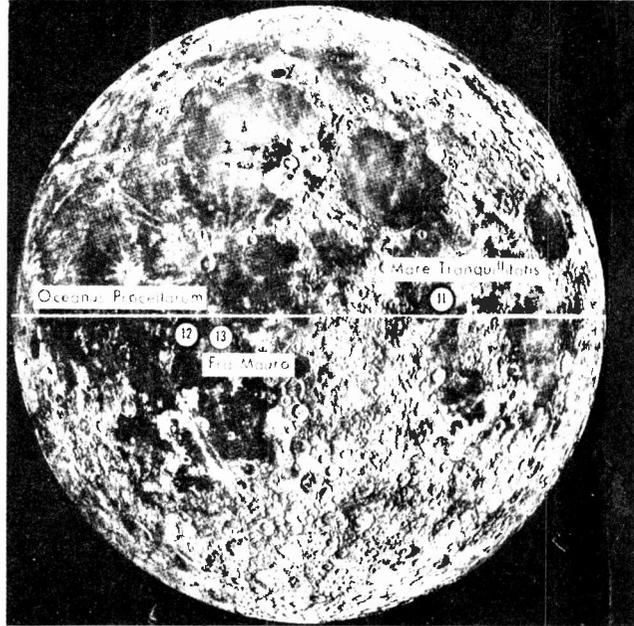
Part of the *Apollo 12* mission was to crash the lunar module on the surface. The module weighed 2.5 tons and impacted with a speed of 3,740 miles per hour. The reverberations forming the shock waves on this occasion lasted half an hour. This was a surprising result. It has been calculated that the shock waves penetrated about six miles into the moon.

As much of the top surface of the moon is thought to be made up of shattered structure and large volcanic blocks of rock, the *Saturn* third stage, which will be crashed to the surface on this mission, will be very interesting. The *Saturn* third stage weighs about 15 tons and will impact at about 5,700 miles per hour.

LONGER WORKING HOURS

The reports of the astronauts Bean and Conrad are very interesting. They say that they were able to work easily and comfortably on their moon

SPACEWATCH



By Frank W. Hyde

mission. They did not tire quickly and could have undertaken more strenuous tasks. They worked easily and did not tire or get hot.

FIFTH "HAM" SATELLITE

Australis-Oscar 5 was launched with *Ito*s for amateur use. It operates on two bands and was built by a group of amateur radio operators in Melbourne University. The craft weighs 39lb; amateurs will be able to train in tracking techniques and conduct propagation experiments.

Four earlier satellites of a similar type, but built by an amateur group in California, have been launched previously and are used widely by "hams".

NEW MULTI-DISH RADIO TELESCOPE

Stanford University (California) is building one of the world's most advanced radio telescopes. It consists of five dishes each 60ft in diameter arranged in a row with a length of some 675ft. The proposed operation frequency is in the X-band. The wavelength which will be used to study special features of some of the radio sources is 3cm.

This arrangement of dishes, with their 15,000 square feet of collecting area, will provide a higher sensitivity and better resolution at this point of the radio spectrum than any other telescope operating. Aligned exactly east and west, the dishes can be steered to give a precise beam of one minute of arc.

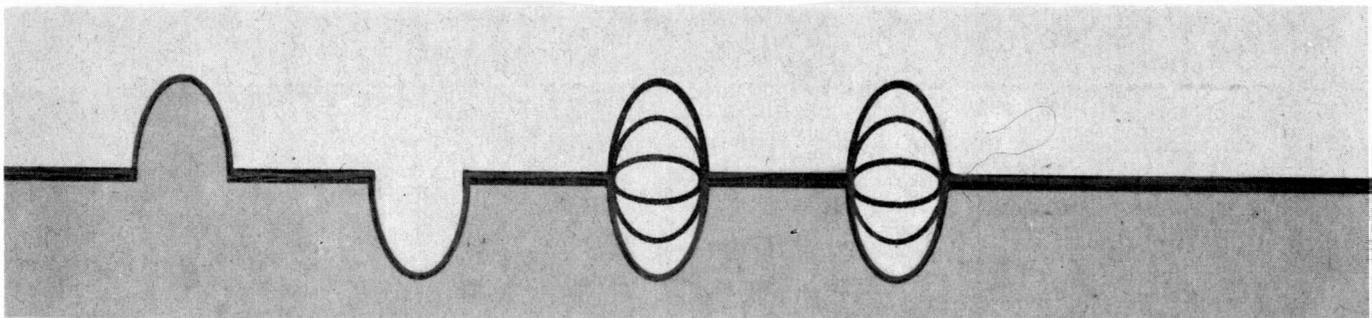
There will be another dish added to the east to complete the interferometer to give a width of 10 seconds of arc. Later it is hoped to have a mobile dish that can be arranged at right angles to the line and thus achieve a pencil beam. About 75 of the known quasars can be studied from this location.

WEATHER SATELLITE

The new world weather satellite, launched on January 23, is another step in the improvement of the accuracy of weather forecasting. Such forecasts are needed to make agriculture more productive, storms and hurricanes less destructive, and air and sea travel safer.

The new satellite, the first of a new series called *Ito*s (Improved Tiro Operational Satellite) is a box shaped spacecraft weighing 682 pounds. The first one is in an orbit of 798 nautical miles. As it is in a near polar orbit every part of the Earth can be viewed daily. It carries four television cameras for daytime pictures of cloud cover, and two infra-red cameras for night-time pictures. Thus the full coverage of the earth can be made every 12 hours.

The satellite also carries a solar proton counter, for monitoring sun flare activity, and a radiometer to measure the heat that the earth absorbs and radiates back into the atmosphere. The satellite was built by RCA Astro-Electronics of Princeton, New Jersey. It will be turned over to the Environmental Science Services Administration (ESSA) after its check out.



BASIC RADAR PRINCIPLES

PART THREE COHERENT PULSED RADAR

By A. FOORD

THE doppler radar described last month consists in essence of a source which is amplified to form the transmitted signal and used as the local oscillator for the received signal. This system is sensitive to small changes in range since it measures the phase changes of the signal return, but it cannot give an absolute measurement of range. This phase sensitive detection is called a coherent system.

The pulsed radar on the other hand uses a non-coherent diode detection system which produces the envelope of the received pulse to give range measurement but little information on small changes of range. Combining the two systems would give information on both range and velocity simultaneously.

One possible arrangement would be to use a system similar to the c.w. system but to pulse the power amplifier. Another way is to use a conventional magnetron, but since this only operates for a short time and has a random starting phase from pulse to pulse, it cannot be used directly as the demodulator reference for the signals. Instead a system like that shown in Fig. 3.1 is used.

COHERENT LOCAL OSCILLATOR

The stable local oscillator output (STALO) is mixed with a sample of the magnetron pulse to produce a reference pulse at i.f., which is amplified and used to phase lock a coherent local oscillator (COHO).

The "coho" is used as the reference c.w. signal source to mix the signal returns down to video. The sequence of events, controlled by the waveform generator, is as in Fig. 3.2.

The "coho" stops oscillating just before the transmitter fires; as the transmitter fires the i.f. sample is applied to the tank coil of the "coho" and the clamp released. The "coho" oscillations build up in phase with the i.f. sample, and are used as the reference for the phase sensitive detector (p.s.d.) which provides a coherently detected video signal output.

A fixed target will give a d.c. output level while a moving target will give a different amplitude output for each transmitted pulse, so that the doppler fre-

quency is sampled at the p.r.f. (Fig. 3.3). When these signals are displayed on an "A" scope they appear as in Fig. 3.4.

EXTRACTING DOPPLER INFORMATION

In practice an "A" scope would be used to determine the range of a target; the target could be gated out and its doppler frequency measured (Fig. 3.5). A variable delay gating pulse is moved in time until it encompasses the selected target.

The output from the gate is the peak of the signal and this is used to charge a capacitor in the "box car" pulse stretcher. This aids the filtering and detection process by eliminating the p.r.f. and its harmonics.

As it stands this doppler frequency output cannot indicate if the target is approaching or receding and the range information can only give this when the target has moved a considerable distance. An offset frequency can be added to the system to provide this information immediately (Fig. 3.6).

For this application the 45MHz reference signal is offset by 300Hz in a single-sideband suppressed carrier modulator before being applied to the p.s.d. For a fixed target the output from the p.s.d. is now 300Hz, for an approaching target the output may be 310Hz (10Hz doppler) while for a receding target the output may be 290Hz, so that the output is no longer ambiguous with direction.

To achieve a reasonable performance the "stalo" requires a stability of 1 part in 10^8 and a specially stabilised klystron with a large cavity has to be used; "coho" stability needs only to be of the order of 1 part in 10^6 .

For this system the transmitter locks an i.f. oscillator with coherent detection at i.f. One other possible system involves r.f. locking and r.f. detection.

MOVING TARGET INDICATION *

Since a non-coherent pulsed radar measures target range and angular position for each scan, moving targets are indicated by their change in position from scan to scan.

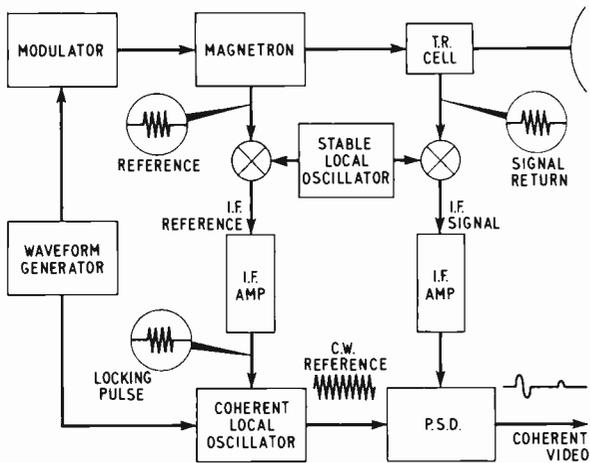


Fig. 3.1. Practical coherent pulsed radar system

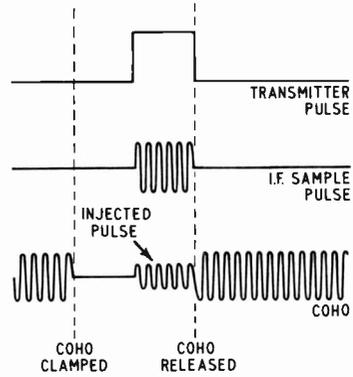


Fig. 3.2. Locking sequence for coherent radar system

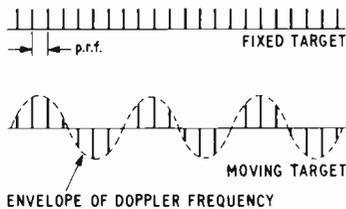


Fig. 3.3. Appearance of stream of received pulses

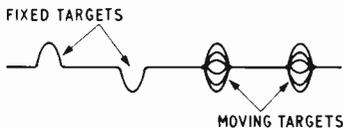


Fig. 3.4. "A" scope display for coherent echoes

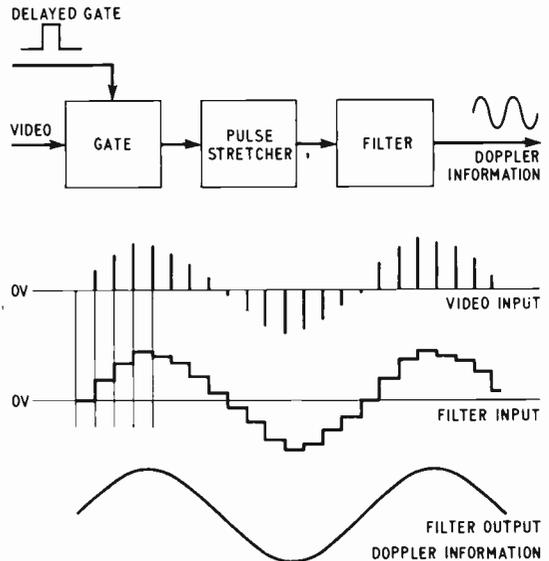


Fig. 3.5. Extraction of doppler information from a selected target

Some assistance in recognising moving targets can be provided by cancelling those echoes due to stationary targets, leaving the display clear of solid masses of "clutter" due to hills or buildings. However the desired moving target echo may have to compete with considerable clutter at a similar range, and the m.t.i. will only be partially effective.

For a coherent pulsed radar, where doppler information is available, the use of m.t.i. techniques enables the moving target signal to be extracted even if the unwanted clutter signal is 100 times greater than the target signal. M.T.I. is therefore more usefully applied to a coherent pulsed radar.

Since the permanent echoes remain constant from one sweep to the next, whilst the echoes from moving targets vary, subtraction of one sweep from the previous sweep should remove the permanent echoes but leave the moving targets (Fig. 3.7).

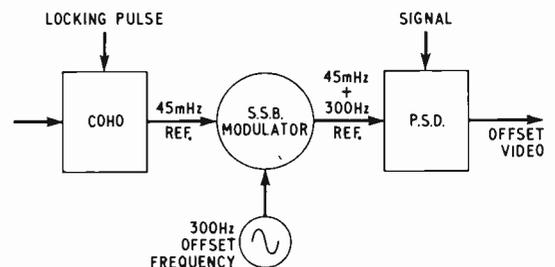
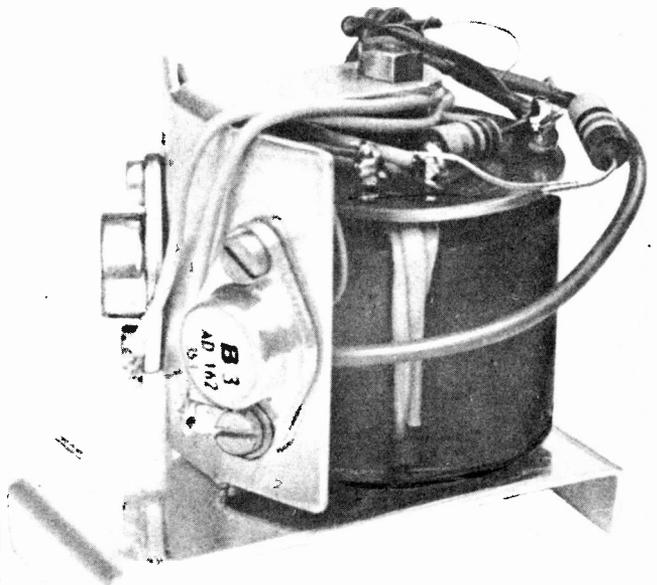


Fig. 3.6. Adding an offset frequency to prevent direction ambiguity

MINIATURE CONVERTER

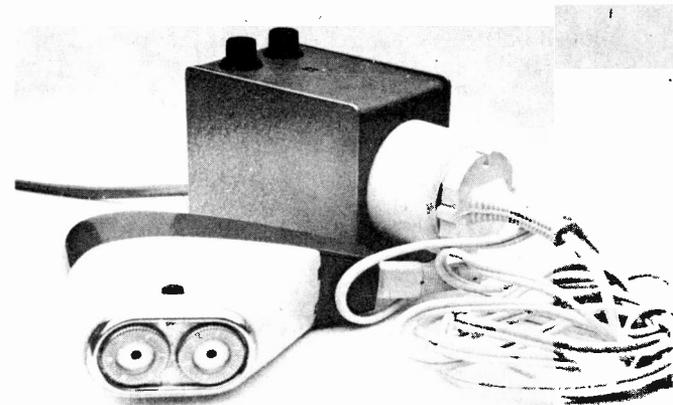
continued from page 290



Transformer T1 before installation, note the tag board to secure the ends of the windings

A meter may be connected across the output (on 250 volt d.c. range) to indicate oscillation, although there will usually be enough vibration in the transformer to show that the converter is working. If there is no output then the phase of the feed-back windings is wrong. The feedback windings may be reversed systematically, i.e. reverse TR1 base and retest; if still not working reverse TR2 base and retest; if the unit still refuses to start reverse TR1 base again. This gives all four combinations.

Once the correct phasing has been found the converter should start under full load. With no load connected the standing current should be about 200mA, while the on load current will, of course, be determined by the shaver used. If the unit is to be used in conjunction with fluorescent tubes the connections to the tube should be reversed from time to time in order to avoid discolouring at the ends. ★



Converter ready for use

Practical Electronics April 1970

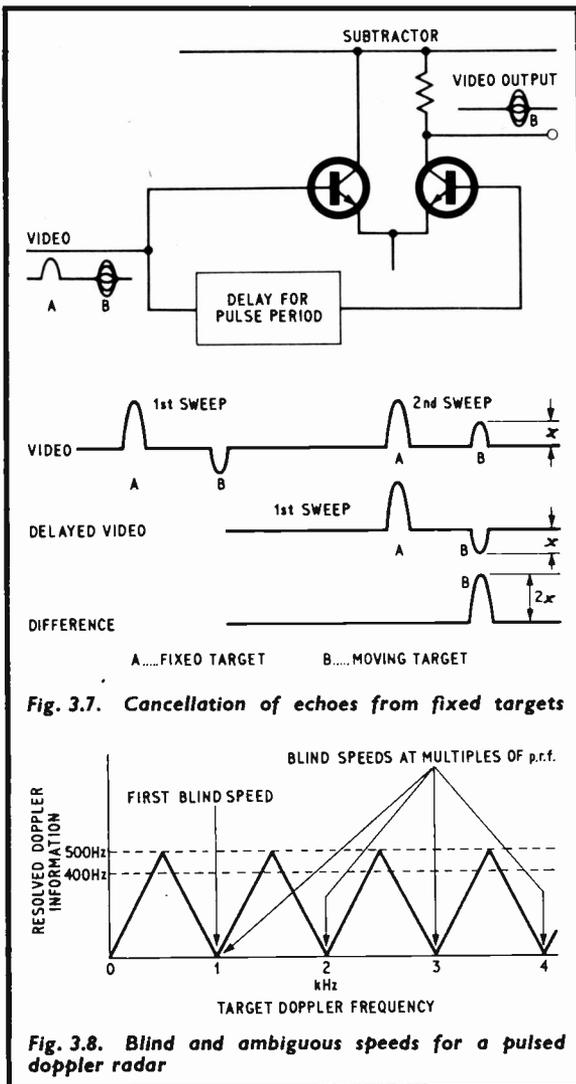
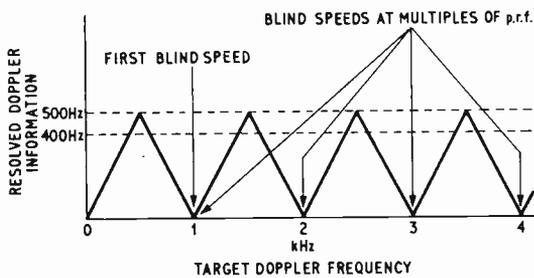


Fig. 3.8. Blind and ambiguous speeds for a pulsed doppler radar



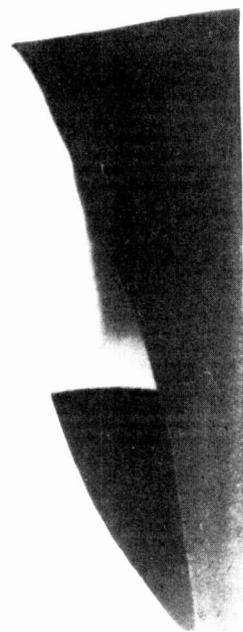
The receiver output is split into two, and one half is delayed by one pulse period and then subtracted from the other half. Possible delay methods include an ultrasonic delay line, or the "writing" of signals on a storage tube and "reading" them off after a delay of one pulse period.

BLIND AND AMBIGUOUS SPEEDS

For a coherent pulsed radar the doppler frequency is measured by discrete pulses (or samples) at the p.r.f. It is one of the axioms of sampling theory that at least two samples in a cycle are required in order to reconstruct a waveform.

If a radar has a p.r.f. of 1kHz then doppler information can only be resolved unambiguously up to 500Hz. This is shown in Fig. 3.8. Doppler frequencies of 1.5kHz, 2.5kHz, and so on, all appear as 500Hz. Doppler frequencies of 400Hz, 600Hz, 1.4kHz, 1.6kHz, and so on, all appear as 400Hz. Any moving target whose doppler frequency happens to be a multiple of the p.r.f. (1kHz, 2kHz, etc.) will be rejected. For a 1kHz p.r.f. and X-band the first blind speed will be 30 knots. ★

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Main amplifier

Distortion

Preamplifier
Main amplifier

Frequency response

Lower—3dB point
Upper—3dB point

Operating voltage

Min. operating load

	SL402A	SL403A
Output power r.m.s.	2W	3W
Input impedance		
Preamplifier	20 M Ω	20 M Ω
Main amplifier	100 M Ω	100 M Ω
Distortion		
Preamplifier	0.1%	0.1%
Main amplifier	0.3%	0.3%
Frequency response		
Lower—3dB point	20 Hz	20 Hz
Upper—3dB point	30 kHz	30 kHz
Operating voltage	+14 V	+18 V
Min. operating load	7.5 Ω	7.5 Ω

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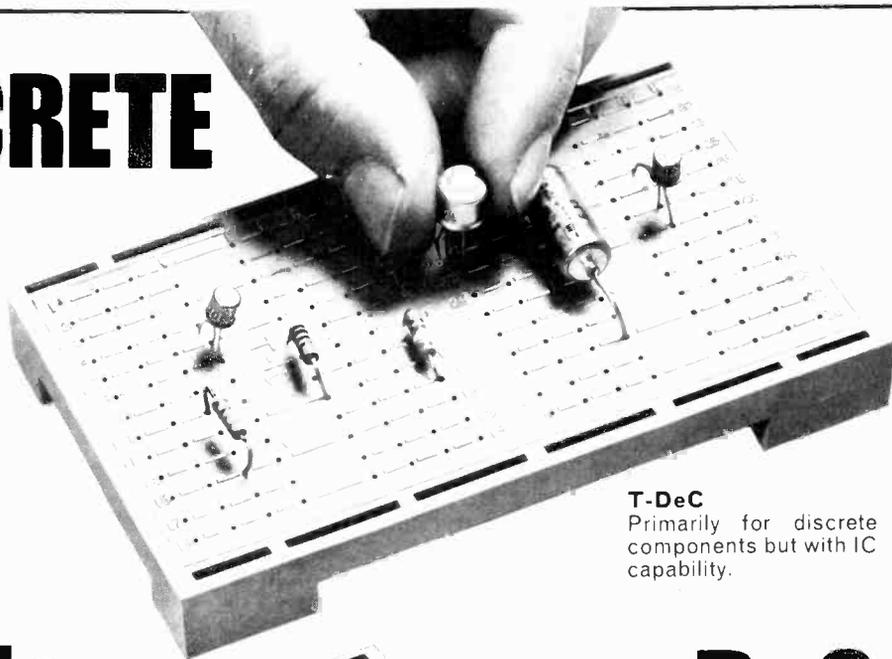
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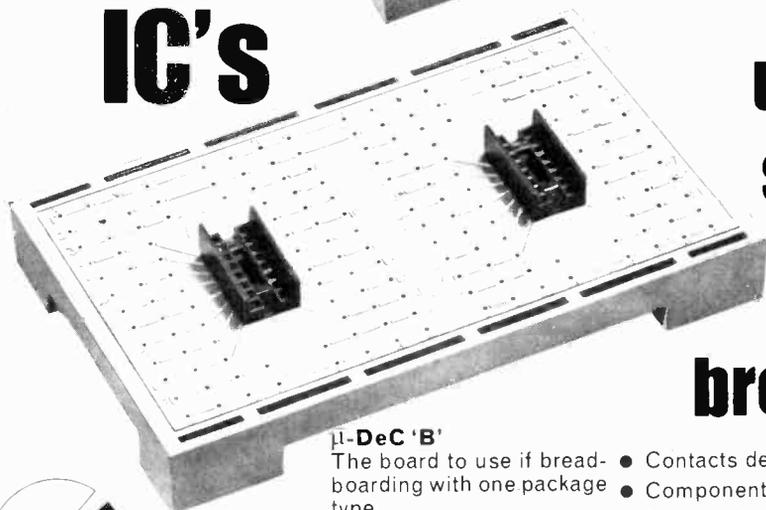
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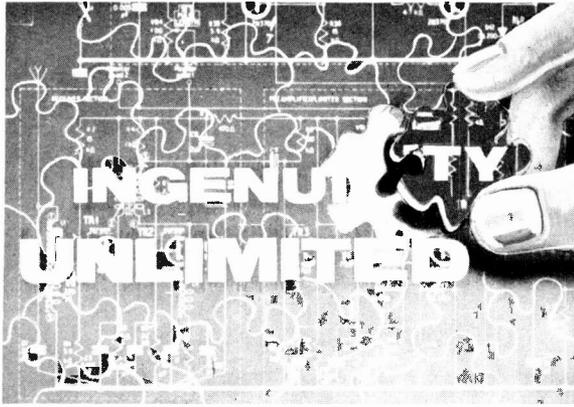
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A selection of readers' suggested circuits. It should be emphasized that these designs have not been proven by us. They will at any rate stimulate further thought. This is YOUR page and any idea published will be awarded payment according to its merit.

GUITAR PICK-UP SYSTEM

LIKE most electric guitar pick-ups, this one is based on Faraday's first law of electromagnetic induction.

In this case the conductors are the steel strings of a guitar, and the magnetic field for each string is produced by several small bar magnets, placed close to them to give roughly equal fields around each string, see Fig. 1.

The magnitude of the e.m.f. produced is too small for most purposes (about 1mV), and the output impedance is very low (less than 1 ohm). Since all the strings are connected in parallel, further amplification is therefore required. A conventional common emitter stage is used, Fig. 2, but with a transformer at the input, to match the strings to the amplifier. A 3 ohm loud-speaker transformer, used in the step-up mode, was found to work very well.

The transistor used was a 2N697 *npn* silicon, but almost any type would do, silicon or germanium, provided that the polarity of the main amplifier power supply matches that of this pre-amplifier.

SOUND MIXER

THE circuit in Fig. 1 shows a simple mixer unit which is very adaptable. The balance control is used to fade out one signal, while another is simultaneously faded in. This gives a more professional touch than simply turning down one signal and then turning up the other, as well as being much simpler to use.

Another possible use is for mixing speech and music for entertainments at dances and parties.

As the mixer consists of only passive components, there is a considerable loss in signal, however, this can be remedied by using a simple audio amplifier. A suitable design incorporating the amplifier is shown opposite.

J. R. Morris,
Chorley.

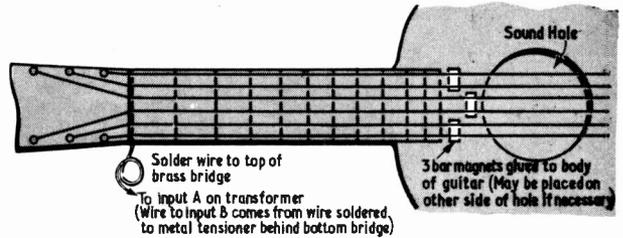


Fig. 1. Position of small bar magnets beneath guitar strings

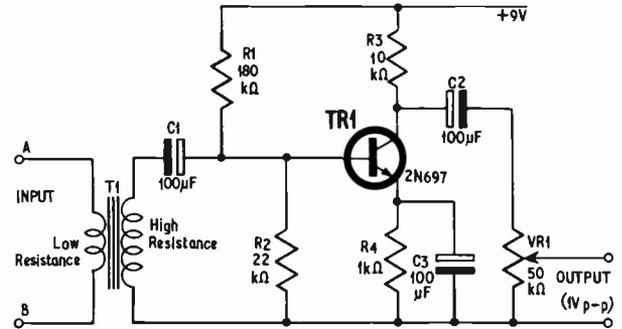


Fig. 2. Circuit diagram for a simple pre-amplifier for the guitar pick-up system

Low noise resistors should be used in the base bias chain if the noise level proves unacceptably high. A volume control is also included so that the pre-amplifier can be fed direct into a guitar amplifier.

This system may be used with any steel stringed instrument, such as a violin or ukelele. It has the advantage that any feedback produced can easily be controlled by touching the particular string which is vibrating and damping it. A large range of bizarre effects can also be obtained by waving a powerful magnet around near the strings while they are being played.

S. Kravis,
Chelmsford.

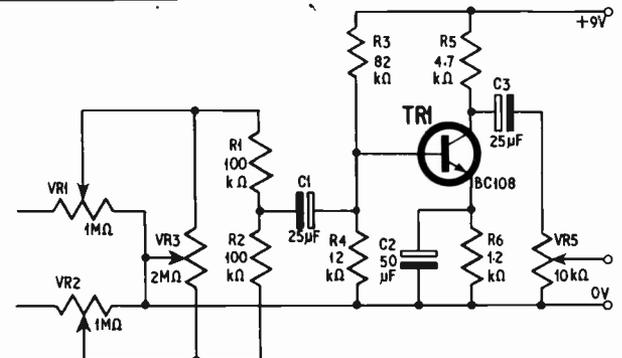
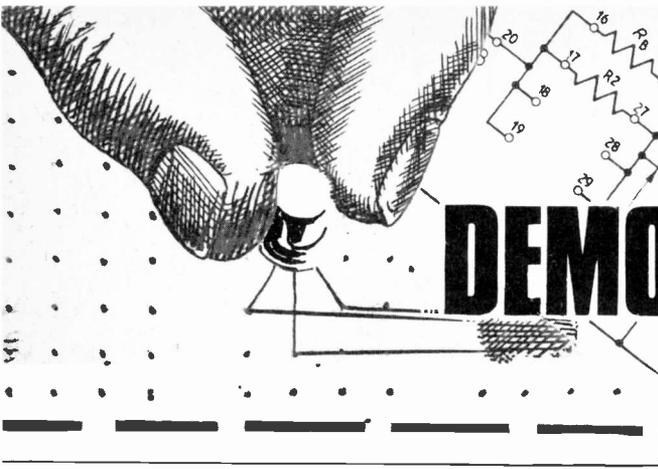


Fig. 1. Circuit diagram of the mixer and audio amplifier



DEMO SWITCHING CIRCUITS

5

BISTABLE MULTI By B. Pounder

THE bistable multivibrator is one of the most important circuits in the whole field of electronics. As one of the basic "building block" circuits in digital computers, there is hardly anything the bistable or a suitable combination of bistables cannot be made to do in switching operations.

The basic circuit is shown in Fig. 5.1. Like the Schmitt trigger, it looks deceptively simple. It is not difficult to derive some approximate equations from which basic designs can be carried out.

SWITCHING ACTION

Suppose that both transistors TR1 and TR2 are conducting, but that for some reason, there is a small increase in the collector current of TR1. This causes the collector voltage to fall because of the increasing potential difference across the collector resistor R1. This fall in collector voltage is transmitted to the base of TR2 via R2.

The falling base voltage of TR2 causes a fall in the collector current of TR2 and a corresponding rise in the collector voltage. But this rise in collector voltage is transmitted back to the base of TR1 so the collector current of TR1 is increased further. This increase is accompanied by an increased drop in collector voltage of TR1, and this is transmitted to the base of TR2.

Obviously, the circuit is naturally regenerative, the initial disturbance being magnified until it is no longer possible for the magnification to increase. This situation is reached when the collector voltage of TR2 has risen to the supply voltage V_{CC} , and the collector voltage of TR1 has fallen to $V_{CE(sat)}$. TR1 is now hard on and TR2 cut-off.

The circuit action could have started with a transient rise in the collector current of TR2 and finished up with TR1 cut-off and TR2 hard on. Thus the circuit possesses two stable states, TR1 on, TR2 off, or TR1 off, TR2 on. Hence the name "bistable".

An obvious application for the circuit is as a "gate" which can be opened by a command or set trigger pulse which switches the on transistor off, and closed by a second command or reset trigger pulse which switches the other transistor off, the other transistor having been turned on when the first is turned off.

DESIGN PROCEDURE

The approximate equations useful in calculating component values are as follows and should be followed in conjunction with Fig. 5.1.

For the conditions shown in Fig. 5.1a, i.e. TR1 is off and TR2 is on,

$$I_{R1} = I_{R2} + I_{c1}; \quad I_{R2} = I_{b2} + I_{R6}$$

$$I_{R4} = I_{R3} + I_{c2}; \quad I_{R3} = I_{b1} + I_{R5}$$

Therefore $I_{R2} = (V_{CC} - V_{be}) / (R_1 + R_2)$

If $R_5 = R_6 \gg R_2 = R_3$

Then $I_{R2} \gg I_{R6}$

and $I_{R2} \approx I_{b2} = I_{c2} / h_{FE}$

Therefore $R_1 + R_2 = (V_{CC} - V_{be}) h_{FE} / I_{c2}$

From Fig. 5.1b

$$V_{b1} = -V_{BB} \left(\frac{R_2}{R_2 + R_6} \right)$$

Let $V_{b1} = 0.5V$ reverse bias to ensure that TR1 is off. Substitution of this value gives

$$R_6 = R_2(2V_{BB} - 1)$$

For satisfactory operation, it can be shown that the following condition must be fulfilled:

$$R_2 < h_{FE} R_1$$

Suppose we wish to demonstrate the circuit by making it switch a 180 ohm relay on and off on command by

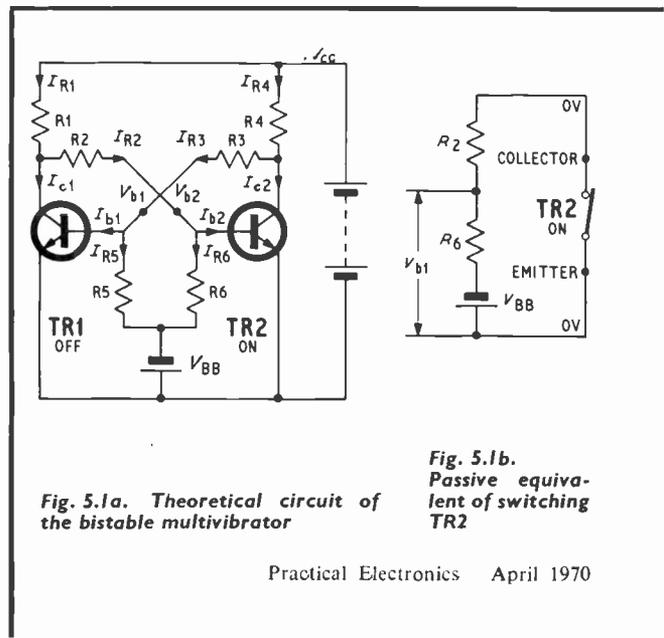


Fig. 5.1a. Theoretical circuit of the bistable multivibrator

Fig. 5.1b. Passive equivalent of switching TR2

DESIGN STEPS (Fig. 5.1)

1. Choose V_{CC} equal to the required output voltage swing. Choose I_{C2}
2. Choose V_{BB} to be between V_{CC} and about $\frac{2}{3}V_{CC}$
3. Calculate $R_1 = R_4 = V_{CC}/I_{C2}$
4. Calculate $R_1 + R_3 = (V_{CC} - V_{be})h_{FE}/I_{C2}$ where h_{FE} can be taken as 20 or 30 and $V_{be} = 0.3V$ for germanium transistors and $V_{be} = 0.8V$ for silicon transistors
5. Calculate $R_2 = R_3 = (R_1 + R_3) - R_4$
6. Calculate $R_5 = R_6 = R_3(2V_{BB} - 1)$
7. Check that $R_6 \gg R_3$
8. Check that $R_3 < h_{FE}R_4$

set and reset pulses. Following through the design procedure, we get the following results.

A 180 ohm relay usually operates at 6V. Hence choose $V_{CC} = 6V$. (step 1)

Also, $I_{C2} = 6/180 = 33mA$ or $0.033A$.

Choose $V_{BB} = 6V$ also. (step 2)

$R_4 = 180$ ohms (given). (step 3)

$R_1 + R_3 = (6 - 0.8) \times 20/0.033 = 3,100$ ohms (step 4)

(We have assumed a silicon transistor is used with $h_{FE(min)} = 20$.)

$R_3 = 3,100 - 180 = 2,920$ ohms. Use preferred value $2.7k\Omega$. (step 5)

$R_6 = 2,700 \times (2 \times 6 - 1) = 29,700$ ohms. Use preferred value $27k\Omega$. (step 6)

Note that $R_6 \gg R_3$. (step 7)

Note that $R_3 < h_{FE}R_4$. (step 8)

BREADBOARDING

The circuit, with suggested S-Dec connections, is shown in Fig. 5.2. The diode shown in the circuit eliminates the possibility of damage to TR2 due to the back e.m.f. generated by the relay coil when the current through it is suddenly switched off. The trigger set and reset pulses are obtained by momentarily short-circuiting the base and emitter leads of the *on* transistor to switch it off.

Alternative component values for the 5mA meter circuit and the bulb circuit are as follows.

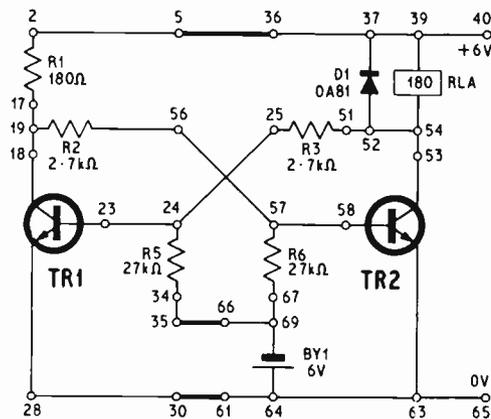
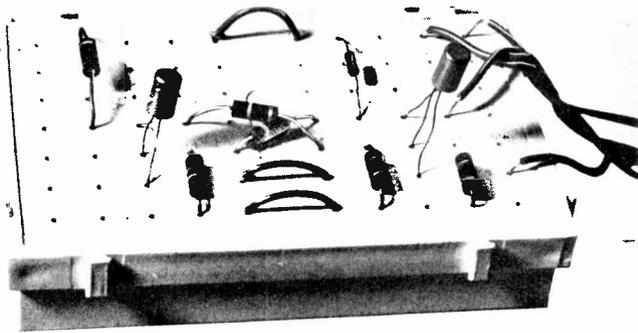


Fig. 5.2. Practical design of the bistable with S-Dec connections



Layout of components on S-Dec for basic bistable in Fig. 5.2

	Bulb Circuit	5mA Circuit
R_4	6V, 100mA bulb	1.2kΩ
R_3		22kΩ
R_6	12kΩ	220kΩ
V_{BB}	6V	6V
V_{CC}	6V	6V

If a relay is not at hand, the circuit can be demonstrated by connecting a voltmeter between the collector and emitter leads of one of the transistors. If this is done, it will be desirable to recalculate the circuit values to operate on a smaller collector current, say 5mA.

Another possibility is to design the circuit with 6V, 100mA bulbs used as the collector resistors R_1 and R_4 . Metal-canned transistors should be used in order to ensure safe operation at 100mA collector current. Some transistors may require heat sinks if the collector current rating is close to the bulb current rating.

EMITTER-COUPLED BISTABLE

In the circuit shown in Fig. 5.3, the V_{BB} power supply has been replaced by a resistor R_7 through which the emitter current of the *on* transistor flows. The voltage dropped by this current across R_7 causes both emitters to be at a positive potential.

Thus if one of the transistor bases is maintained at or near zero potential, that transistor will be cut-off. The use of R_7 to provide negative bias on the base is analogous to the use of a cathode bias resistor in a valve circuit which provides a negative bias on the grid.

The equations from which component values may be calculated are given in the "Design Steps" panel below.

TRIGGERING THE BISTABLE

There are many ways of triggering a bistable by the application of trigger pulses. However, most of the methods have one thing in common; the trigger pulse is applied in such a way as to turn the *on* transistor off rather than vice-versa. To turn the *off* transistor on requires that the trigger pulse is capable of overcoming the reverse bias which is holding the transistor off before it can proceed with the actual switching process.

For simplicity, only one trigger circuit will be used in this article. It utilises collector triggering since the trigger terminals are connected to the transistor collectors.

DESIGN STEPS (Fig. 5.3)

- Step 1. Decide on required output voltage swing V_0 and I_{C2}
- Step 2. Choose V_{CC} and V_e from $V_{CC} - V_e = V_0$
- Step 3. Calculate R_4 from $R_4 = (V_{CC} - V_e)/I_{C2}$
- Step 4. Calculate R_2 from
$$R_2 = \left\{ V_{CC} - (V_e + V_{be}) \frac{2V_e}{2V_e - 1} \right\} [h_{FE}/I_{C2}]$$
- Step 5. Check that $R_2 \gg R_4$
- Step 6. Calculate R_6 from $R_6 = (2V_e - 1)R_2$
- Step 7. Calculate R_7 from $R_7 = V_e/I_{C2}$

Remember, however, that the collectors in a bistable are connected to the bases of the other transistors via cross-coupling networks. Thus a trigger pulse applied to the collector of one transistor is directly coupled to the base of the other. The circuit is shown in Fig. 5.4a.

Suppose TR1 is off and TR2 is on. If a positive-going step is applied to the SET terminal, it is transmitted to D1 and D2 and reverse biases D2. However, D1 will become forward biased so will allow C1 to discharge.

When the SET voltage is reduced as a step to zero, the voltage reduction will be transmitted to D1 and D2 and forward bias D2. A negative-going voltage is therefore applied to the base of TR2 which turns off.

Similarly, the circuit can be made to undergo another transition if a negative-going step is applied to the RESET terminal. Fig. 5.4b shows part of the same circuit but with the diode D1 replaced by resistor R7. Having calculated the component values, it is worth while to check that the saturation collector current can be supplied.

DESIGN

The circuit is easily demonstrated by the use of 6V, 100mA bulbs in place of resistors R1 and R4. In this case, $V_0 = 6V$ and $I_{C2} = 100mA$, so Step 1 is covered. Now proceed as follows.

Choose $V_{CC} = 9V$, so $V_e = 9V - 6V = 3V$. (step 2)

$$R_1 = R_4 = (9 - 3)/0.1 = 60 \text{ ohms} \quad (\text{step 3})$$

$$R_2 = R_3 = \left\{ 9 - (3 + 0.8) \times \frac{6}{6 - 1} \right\} \times [20/0.1] = 890 \text{ ohms (step 4)}$$

(Used preferred value of 820Ω for R2)

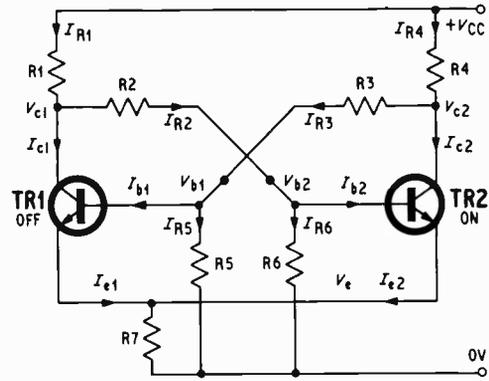


Fig. 5.3. Theory of emitter-coupled bistable

$$R_2 \gg R_4 \text{ as required.} \quad (\text{step 5})$$

$$R_5 = R_6 = (6 - 1) \times 820 = 4,100 \text{ ohms (use } 3.9k\Omega) \quad (\text{step 6})$$

$$R_7 = 3/0.1 = 30 \text{ ohms (use preferred value } 27\Omega) \quad (\text{step 7})$$

The calculations can be checked as follows:

Allowing for the voltage drop across R1 in TR1 under the conditions shown in Fig. 5.3.

$$I_{R1} = \frac{V_{CC} - V_{e1}}{R_1} = \frac{V_{c1} - (V_e + V_{be})}{R_2}$$

$$\text{Hence } (9 - V_{c1})/60 = (V_{c1} - 3.8)/820$$

$$\text{so } V_{c1} = 8.5V \text{ approx.}$$

$$\text{and } I_{R1} = (9 - 3.8)/820 = 5mA \text{ approx.}$$

$$\text{Also, } I_{R6} = \frac{V_e + V_{be}}{R_6} = \frac{3.8}{3.9} = 1mA \text{ approx.}$$

$$\text{so } I_{b2} = 4mA.$$

This base current is roughly 80 per cent of that

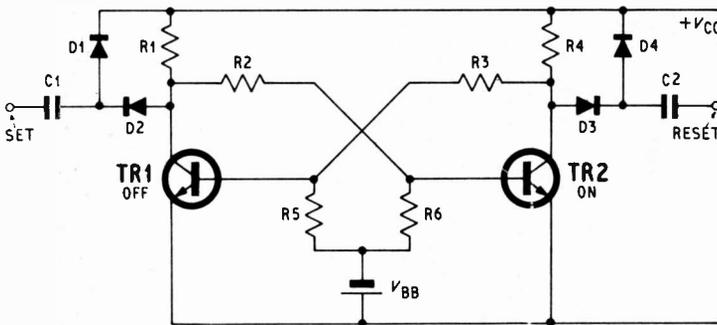


Fig. 5.4a. Trigger inputs to switch the bistable

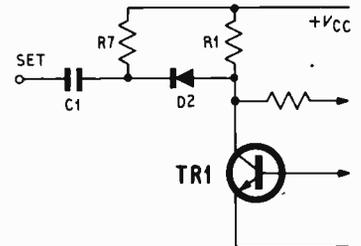


Fig. 5.4b. Diode D1 replaced by a resistor R7

NEWS BRIEFS

Golden Jubilee

THE 50th anniversary of the founding of the Mullard company will be celebrated this year.

It was in 1920 that Mr Stanley Mullard, born in 1883 and still a member of the Mullard Ltd. board, formed The Mullard Radio Valve Company Ltd.—the first venture to bear his name. It occupied floor space rented from his former employers and its initial product was high-power transmitting valves.

From this beginning the Mullard enterprise has developed into one of the UK's biggest electronic component companies. It employs around 17,000 people, over 1,200 of whom are qualified scientists and engineers, in 14 production centres, laboratories, service depots and other ancillary establishments.

During jubilee year production capacity will be substantially expanded by the addition of three new plants at Thornaby (Teesside), Stockport and Bolton.

New Number

THE Institution of Electronic and Radio Engineers have recently changed their telephone number. The new number is 01-637 2771 (10 lines). Previous numbers have been discontinued.

Learning by Computer

A SPECIAL teaching aid, for various subjects for secondary, higher and vocational education, has been developed by ASEA. The system comprises a computer, typewriter, a high speed reader for punched tape and a television type display. Most classrooms are nowadays provided with television sets and these can be connected up to the systems. This means that several classes can study simultaneously the results presented on the screen in the form of, for example, curves obtained as the solution to a problem fed into the pre-programmed computer.

It is also possible to use these small computers in schools as terminals connected to a larger computer system. Teach-aid will therefore be developed so that it can be connected up to large computers of different types for performing calculations according to special programmes.

Certain computer programmes have in fact already been prepared by ASEA. These programmes are primarily intended for such subjects as mathematics, physics, theory of electricity and the theory of control systems. A programme library has also been established. The programmes can be adapted to the curricula laid down by the Boards of Education in different countries.

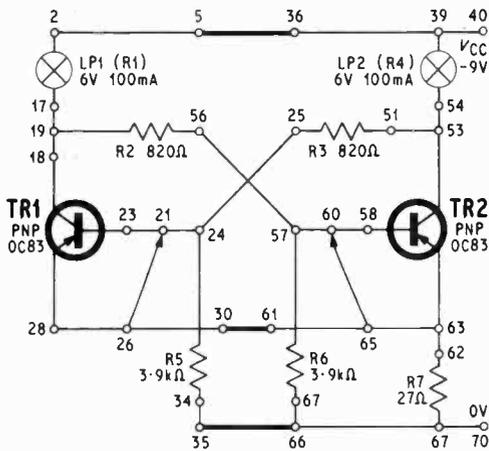


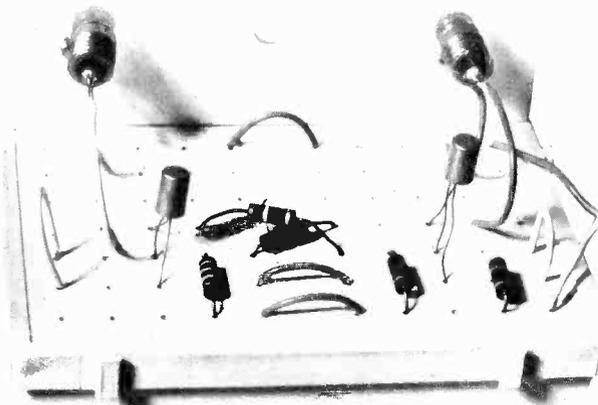
Fig. 5.5. Practical circuit of the emitter-coupled bistable

required to saturate a transistor with $h_{FE} = 20$ at $I_c = 100\text{mA}$. If, as is likely to be the case, the transistors used have h_{FE} slightly in excess of 20, the component values should be satisfactory.

Suggested circuit connections for S-DeC are shown in Fig. 5.5. Note that it is drawn for *pn*p transistors. (*NPN* devices may be used if the supply polarities are reversed at holes 40 and 70.) The transistors should be capable of operating at 100mA collector current. Germanium types such as the OC72 or OC83 will be suitable, but note that the calculation assumed a V_{be} value of 0.8V for silicon types such as OC204.

It is left as an exercise to see what difference, if any, a substitution of 0.3V makes to the component values when calculated for germanium types. As with the previous bistable example, triggering is achieved by shorting the base and emitter leads of the *on* transistor.

To be continued next month



Layout of components on S-Dec of emitter-coupled bistable

POINTS ARISING

P.E. ORGAN (May '69 to March '70)

Parts for the PRACTICAL ELECTRONICS Organ as previously supplied by Kimber-Allen Ltd., should now be ordered from Henry's Radio Ltd., 303 Edgware Road, London, W.12.



MAGIC EYE AUDIO SIGNAL INDICATOR

By M.L. MICHAELIS M.A.

This instrument is a form of audio voltmeter obviating the expense of a moving coil meter. It incorporates a simple audio amplifier with input gain control, driving a magic eye tuning indicator as display device. The green luminous sector of the magic eye vanishes to a simple vertical line for zero signal input. The apex angle of the luminous sector increases in proportion to the peak-to-peak amplitude of the applied audio signal.

The gain control and mains on/off switch are the only manual controls. The unit incorporates its own mains power supply and is thus very simple to operate and cheap to construct. The uses are manifold:

- As a signal tracer
- As a comparative a.f. voltmeter
- As a bridge balance indicator

In addition to full constructional details for the Magic Eye Audio Signal Indicator, this article describes a number of bridge circuits which may be used with this unit for various measurement purposes.

THE complete theoretical circuit of the magic eye bridge indicator appears in Fig. 1. The first section of the ECC83 double triode V1a operates as a conventional audio voltage amplifier which drives the second section of the same valve, V1b. This second triode operates as cathode follower to provide the low source impedance necessary for proper functioning of the d.c. restorer C6, D2, R11.

D.C. RESTORER

This d.c. restorer is necessary because the magic eye V2 must be driven with entirely negative-going signals, i.e. the luminous sector width is zero when the applied voltage between grid pin 1 and cathode of V2 is zero, and the sector width increases in proportion to the negative voltage applied to the grid. A positive voltage applied to the grid produces no definite effect.

To satisfy these drive requirements of the magic eye V2, the d.c. restorer functions as follows. C6 charges via D2 to the peak positive amplitude of an arbitrary waveform appearing at V1b cathode pin 3. C6 attempts to discharge through R11, but the time constant C6.R11 is very long compared to the signal period. Thus a negative d.c. voltage appears across R11, equal to the peak positive amplitude of the signal waveform.

Whenever the signal waveform is momentarily at the peak positive value, this just overcomes the negative d.c. voltage across R11 and the net voltage applied to the grid of the magic eye V2 is zero. At all other instants, the net voltage is negative, reaching its greatest negative value, now numerically equal to the peak-to-peak signal amplitude, when the signal waveform is momentarily at its negative peak. Thus the width of the luminous sector is proportional to the peak-to-peak amplitude of the applied signal, irrespective of the actual waveform.

Any d.c. component of the input signal is blocked by C1, so that response is solely to the a.c. component. R1, R5 and R12 are grid stoppers to prevent parasitic oscillation on sharp transients of applied signals.

The circuit employs a valve amplifier, not a transistor amplifier, because the magic eye V2 already requires a valve-type power supply.

POWER SUPPLY

The h.t. power supply is derived from a half wave rectifier circuit. Any small silicon h.t. rectifier is



suitable for D1. The exact values of the electrolytics C3 to C5, and C7 are not critical.

Do not use mains transformer with a heater winding rated for much higher currents, although up to about 1.5A rating is usable. Higher ratings would mean that unduly high voltages are actually applied to the valve heaters at such low loading. If the available transformer does not possess a centre-tapped heater winding, connect two 5 kilohm resistors in series across the untapped heater winding and earth the centre junction of these resistors to chassis.

CONSTRUCTION

The prototype is housed in an instrument case

measuring 8.75in by 5.75in by 6.25in deep. A shallow chassis bolted to the front panel carries most of the circuit components. The smaller components are wired between a pair of tag strips bolted to the underside of the chassis. Arrangement of the components and wiring is given in Fig. 2 and Fig. 3.

Items mounted directly on the front panel are the mains input plug PL1, mains switch S1, gain control VR1, and the signal input socket SK1.

A small rectangle is cut out of the centre of the front panel and a piece of Perspex is fitted to the rear side to provide a window for viewing the magic eye tuning indicator VR1, and the signal input socket SK1. Cutting and drilling details are given in Fig. 4.

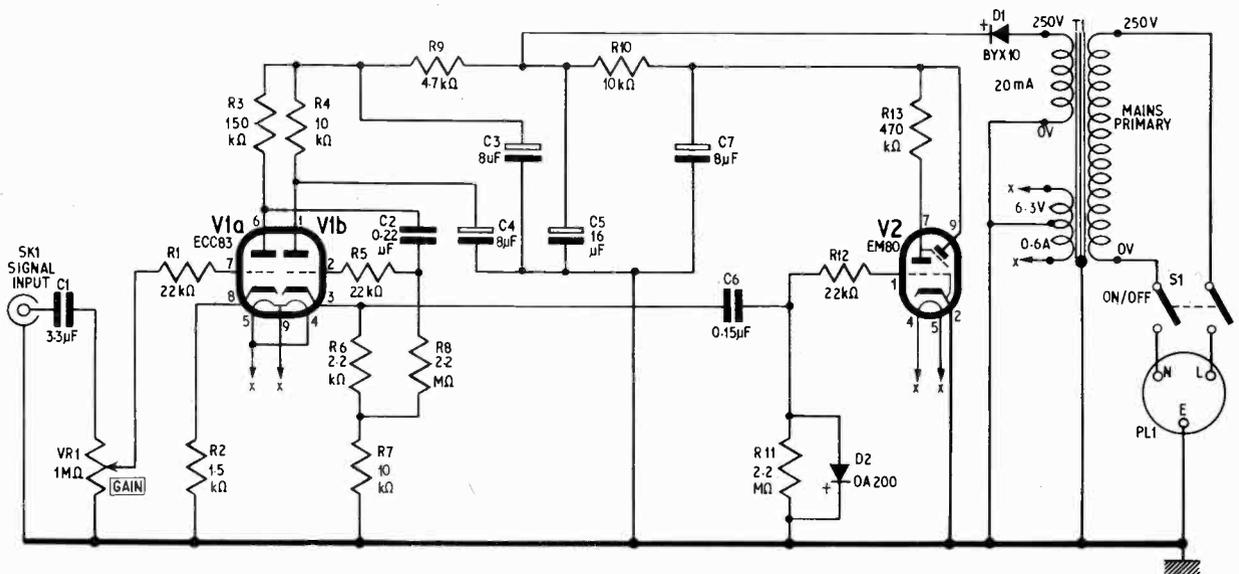
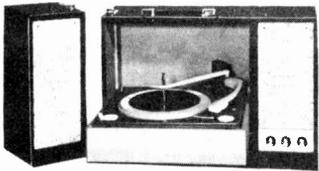


Fig. 1. Circuit diagram of the Magic Eye Audio Signal Indicator

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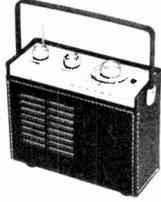
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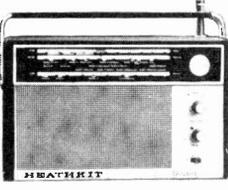
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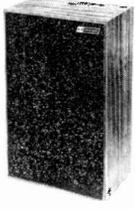
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U39	30 RF Germ. PNP Trans. 2N1303/5 TO-5	10/-
U40	10 Dual trans. 6 lead TO-5 2N2060	10/-
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PERFORMANCE

To express the sensitivity of this instrument, we may define three display sector sizes as follows:

- (1) Smallest conveniently observable signal, equal to audio voltage required to double the residual width of luminous line for zero signal
- (2) Half-size sector signal, equal to audio voltage required to produce a luminous sector angle equal to the angle of remaining dark sector.
- (3) Full sector signal, equal to audio voltage required to extend the luminous sector over the entire screen, leaving only two very narrow dark lines.

The luminous sector angle increases in approximately linear proportion up to (3), beyond which point large further increases of signal amplitude cease to exert any appreciable effect.

With the gain control VR1 at maximum, the necessary peak-to-peak input signal amplitude was measured for the prototype to be:

- 20mV for sector size (1)
- 300mV for sector size (2)
- 600mV for sector size (3)

These sensitivity figures were found to be valid without detectable changes for any frequency from 20Hz to 20kHz, sinewave or squarewave, thus presumably also for any arbitrary waveform as justified theoretically above.

To define the bandwidth, we adjust the input voltage at some medium frequency, e.g. 500Hz, for full sector size according to (3), and then increase or decrease the signal frequency, without changing the signal amplitude, until half sector size is obtained according to (2), showing that the 6dB points of the passband have been reached.

These 6dB points were found to be dependent on waveform and gain control setting. The lower 6dB point lies at one or two Hz for all normal waveforms and all settings of the gain control. With the gain control at maximum, the upper 6dB point lies at about 65kHz for waveforms approximating to sinusoidal, or at 120kHz for waveforms approximating to square, whilst with the gain control at half-way setting, the 6dB point lies at 20kHz irrespective of waveform.

SIGNAL TRACING

Evidently the smallest conveniently detectable audio signal is some 5mV r.m.s., so that the sensitivity of this unit is ample for signal tracing in all types of audio circuits right back to the anode or collector of the first stage following a microphone or tape deck input. Some form of pre-amplifier will be required for measuring the outputs of microphones or tape decks directly, but the sensitivity of the instrument as it stands is fully adequate for direct observations of the output from a crystal pick-up, most other kinds of pick-up, and a.m. or f.m. detectors.

Using an ordinary diode detector probe as found among standard oscilloscope accessories, the instrument can be used for tracing modulated i.f. and r.f. signals, right back to the aerial input circuit when using strong local stations or a signal generator. The choice of diode probe is in no way critical, any type made for a nominal oscilloscope input impedance of about 1M Ω being suitable. The magic eye bridge indicator may be connected directly to the a.m. detector output or to the loudspeaker output as indicator for aligning superhets.

The maximum safely acceptable input signal amplitude is about 50 to 100 volts peak-to-peak, regardless of the gain control setting. The latter must of course be reduced accordingly for proper display of

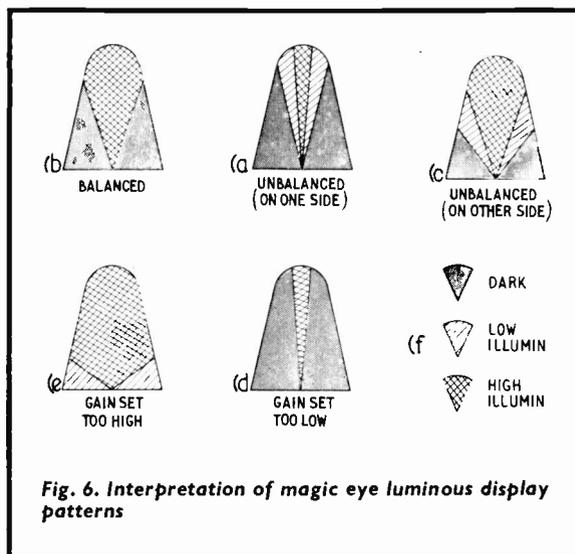


Fig. 6. Interpretation of magic eye luminous display patterns

the larger voltages in this range. If still larger audio voltages must be examined, use a conventional 10:1 ratio oscilloscope probe obtainable from any dealer stocking oscilloscopes. The impedance rating should be about 1M Ω oscilloscope input, but is not critical here. Voltages up to about 1kV peak-to-peak can then be examined. The 10:1 probe is also necessary to reduce capacitive loading when tracing signals in very high impedance audio circuits, or in tuned circuits which are sensitive to detuning (electronic pulse circuits, TV scan circuits, etc.).

COMPARATIVE AUDIO VOLTAGE MEASUREMENTS

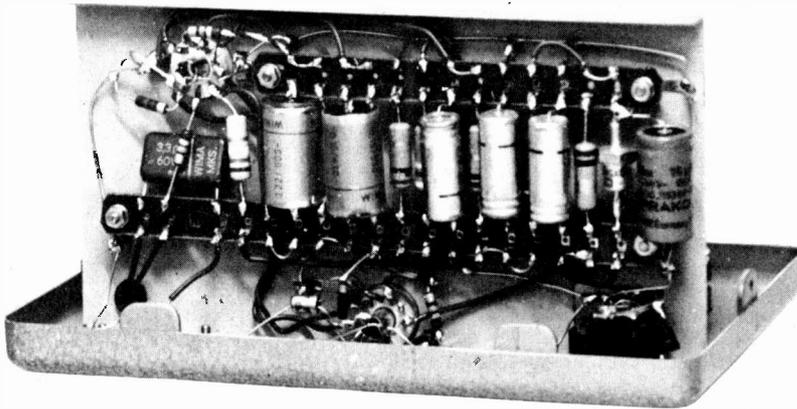
The sensitivity figures quoted in the section on performance enable rough assessments to be made of the peak-to-peak amplitude of any applied audio signal, from the gain control setting and observed sector size. It is possible to calibrate the gain control in terms of peak-to-peak signal amplitude required for half-sector size. The latter is readily observable by virtue of the symmetry present when the luminous and dark sectors possess equal angles. This generally permits ± 10 per cent accuracy, or better with care, in assessing a.f. signal amplitudes.

Still better comparative measurements are possible by using a small cable adapter fitted with a switch or push button to alternate between the audio signal and an adjustable 50Hz signal from a mains transformer. The 50Hz reference signal is varied until actuation of the switch or push button produces no change in the luminous sector size. The 50Hz reference voltage can then be measured with an ordinary multimeter whose readings need only be correct at 50Hz mains frequency.

USE AS BRIDGE BALANCE INDICATOR

This instrument is equally satisfactory as balance indicator for various types of conventional bridges for R, C and L measurements and for the novel type of split phase bridge for electrolyte conductivity measurements described in the August 1969 issue of PRACTICAL ELECTRONICS.

For signal tracing, including balance indication in conventional bridges and comparative audio voltage measurements, the number of voltage inverting amplifier stages in the unit would be immaterial, since the d.c.



Underside view of prototype unit

restorer always ensures display of the peak-to-peak value. However, the published split phase conductivity bridge delivers a train of positive half-cycles of a sinewave, whose peak equality is the balance criterion. It is undesirable to have the d.c. restorer diode conducting here, so these peaks must be the negative ones in the waveform applied to the d.c. restorer.

Consequently we need an odd number of voltage inverting amplifier stages—a single one in the present unit. As long as the split phase bridge is not balanced, we obtain two overlapping luminous sectors of different angles. These coincide to a single sector at balance. This balance criterion is quite sharp, although not nearly as sharp as with the described double bright-edge raster oscilloscope display in the cited article. When using the magic eye bridge indicator with the split phase bridge, do not turn up the gain control more than necessary. Quite a small luminous sector gives the sharpest assessment of sector coincidence (see inset sketches on Fig. 6).

For conventional bridges, the purpose of the balance indicator is merely to detect when no, or negligible, signal is present. At all other points of off balance for the bridge, an appreciable signal will be present and indicated as corresponding luminous sector. Thus good maximum sensitivity is required for a satisfactory balance indicator in a conventional bridge.

In this sense, the instrument here described is at least as good as sensitive headphones, and superior thereto because it does not require ambient silence, and visual assessments are clearer than aural ones. For normal operation in a conventional bridge, a low gain setting is used when still far off balance, turning up to maximum gain as the balance point is approached.

CONVENTIONAL BRIDGE TYPES

Fig. 7a shows the generalised four-arm bridge. The arms may be arbitrary impedances composed of R , C and L and designated Z_1 to Z_4 . The audio voltage source is applied across one diagonal, and the balance indicator is connected across the other diagonal. It is generally immaterial which diagonal is used for which purpose, so that if the impedances are arranged such that the bridge is balanced (no signal indicated by balance indicator), it is still balanced if the audio source and the balance indicator are interchanged.

THE WHEATSTONE BRIDGE

Fig. 7b shows the Wheatstone bridge, in which all four impedances are simple resistors. This sketch also shows convenient forms of connections for a practical set up, applying analogously for the other bridges, (c) to (e) too. T may be any small audio or intervalve type transformer. The ratio is not critical but should not be too great. If dealing with only low impedances in the bridge, connect the winding with the smaller number of turns across the bridge diagonal. If low and high impedances are encountered in the bridge, connect the largest winding across the bridge diagonal.

The audio source may be taken from a low voltage secondary winding of a mains transformer for the Wheatstone bridge, but for the other bridges, especially if the arms contain small C or L values, a higher frequency is preferable. Neither amplitude nor frequency are critical, so that if an audio signal generator is not available, a radio or tape recorder is usable.

A single balance criterion, expressed in the two alternative forms shown, suffices for the Wheatstone bridge. In general, it is immaterial which one of the four resistors is the unknown one to be determined, which pair of the remaining three is selected in definite ratio to establish the range factor, and thus which fourth resistor is the calibrated variable one.

For example, R_1 may be the unknown one, R_4 a fixed standard resistor, R_2 chosen as a decimal multiple or submultiple thereof to establish the range factor (switch to select various values of R_2), and R_3 is the calibrated variable resistor.

OTHER DERIVATIVE BRIDGES

The possible variants of the general bridge of Fig. 7a are legion. We will select only three particularly useful ones for simple practical work, without making any claims to be comprehensive.

As soon as we introduce capacitors and inductances, we generally need two independent balance conditions which have to be satisfied simultaneously to obtain zero signal in the balance indicator diagonal. The reason for this is that resistive (R) and reactive (C and L) voltages or currents are in phase quadrature, thus vectorially independent and the bridge must be balanced separately for each quadrature component. Consequently two variable calibrated components must be *mutually* adjusted for balance, which considerably complicates the search for the true balance point.

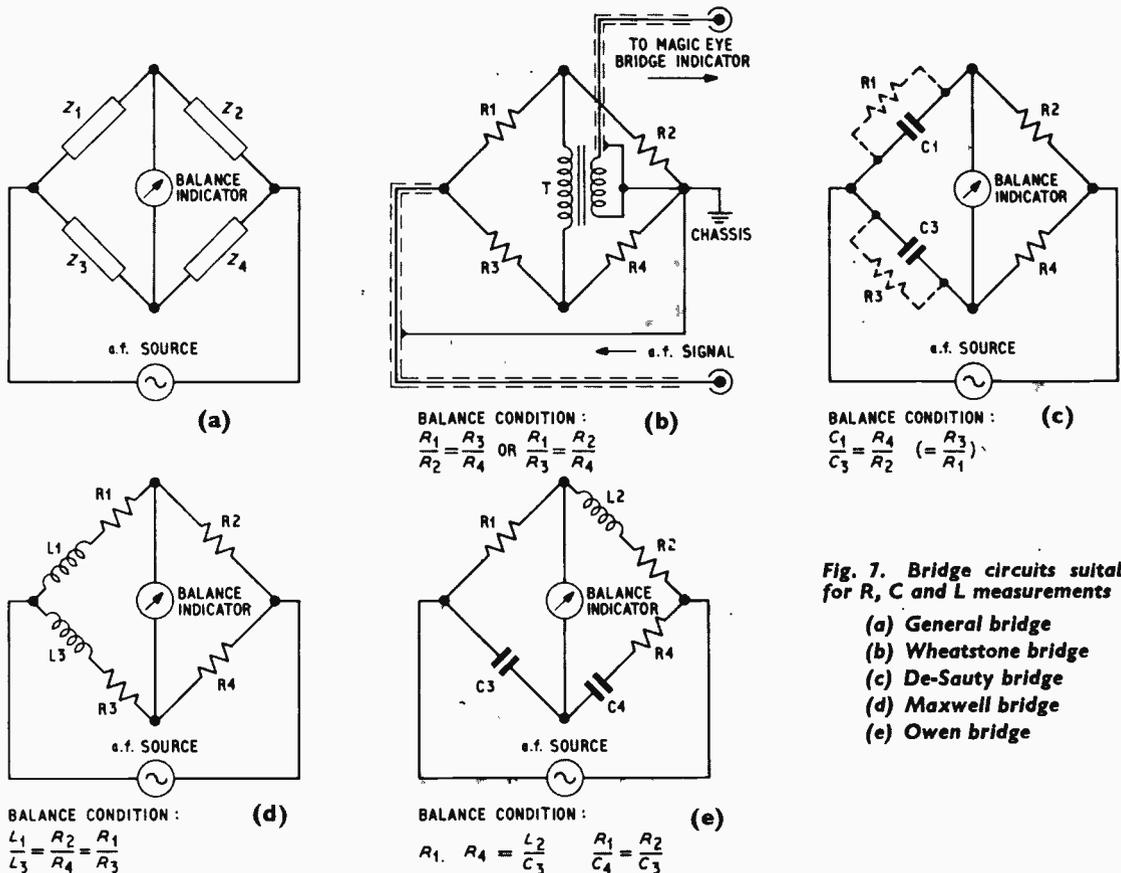


Fig. 7. Bridge circuits suitable for R, C and L measurements

- (a) General bridge
- (b) Wheatstone bridge
- (c) De-Sauty bridge
- (d) Maxwell bridge
- (e) Owen bridge

THE DE-SAUTY BRIDGE

Fig. 7c shows the De-Sauty bridge for measuring capacitances. As long as the capacitors possess negligible leakage (time constants $C_1 \cdot R_1$ and $C_3 \cdot R_3$ very long compared to the period of the audio drive waveform), so that R_1 and R_3 may be neglected, this bridge degenerates to one with a single balance criterion. It is immaterial which capacitance arm contains the unknown capacitor. The other one then contains a switch selecting various accurate fixed capacitors to determine the range. One of the resistors is a fixed standard, the other one a variable resistor calibrated directly in capacitance values.

The bridge is extremely useful for making reasonably accurate checks of small capacitors from about 1,000pF up to tens of microfarads, using a 50Hz source. Measurements are possible down to about 100pF with higher audio frequencies, the lower limit being set by confusion due to stray capacitances which are generally about 30pF in an arbitrarily set-up bridge. If the capacitor to be measured leaks, the second balance criterion with respect to R_3 and R_1 must be satisfied too.

THE MAXWELL BRIDGE

The Maxwell bridge shown in Fig. 7d is the counterpart of the De-Sauty bridge for inductances. It is unusual to find inductances with such a high L/R ratio that R_1 and R_3 may be neglected, so this bridge normally

does not degenerate to one with only a single balance criterion.

In a typical practical arrangement, L_1 is the unknown inductance and R_1 its own inherent d.c. resistance. A range switch selects various standard L_3 , whose d.c. resistances are smaller than those of any unknown coils L_1 likely to be encountered. R_3 is a variable resistor for one balance criterion, R_2 a variable resistor for the other balance criterion and R_4 a fixed standard resistor. The practical difficulty with this bridge arrangement is that R_2 and R_3 have about the same effect on the balance point, so that mutual adjustment is difficult.

THE OWEN BRIDGE

The Owen bridge (shown in Fig. 7e), is easier to balance because R_2 affects the balance point more strongly than R_1 . Thus to establish balance, vary R_2 until minimum signal is shown on the balance indicator, and then adjust R_1 for zero signal (repeat for fine zero adjustment if necessary).

The bridge can be switched for L or C measurements. R_1 may be a fixed standard resistor, C_4 a fixed standard capacitor, R_4 a variable resistor calibrated in inductance values and C_3 various values selected by the range switch, for inductance measurements. The same range switch with the same C_3 values can serve for capacitance measurements, whereby C_4 is the unknown component and R_2 is a variable resistor calibrated in capacitance values.



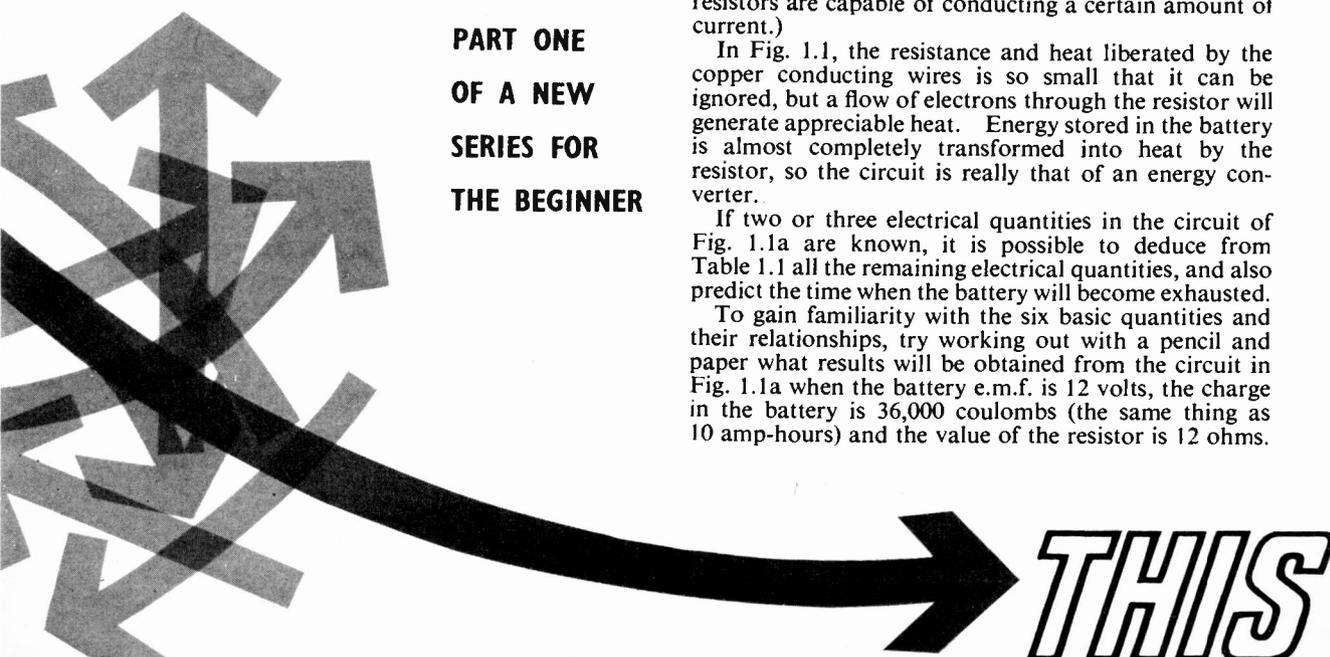
ELECTRONICS is not really new, it has been growing up slowly for more than a hundred years. In 1835 Roschenschold published his discovery that an electric current would only flow in one direction through certain solids; he had unwittingly stumbled upon the solid-state or semiconductor diode, and a device for controlling the motion of electrons.

Dramatic progress in radio communications, from about 1900 onwards, tended to overshadow further developments in electronics, and the thermionic valve diverted attention away from solid-state devices.

Electronics really came into its own following the Second World War. There was an enormous proliferation of electronic devices, and semiconductors began to compete with valves.

It is only natural that electronics, like any other specialised subject, has slowly acquired a "language" of its own. However, with just a smattering of school science, and some fairly simple maths, the intelligent electronics tourist can soon pick up the patois and begin to appreciate at least some of the scenery. This series of articles is intended to satisfy a need for a "phrase book" and general guide to electronic theory.

The first part must essentially begin with basic electric currents and the influences of simple components to control these currents. Later parts will progress through more complex devices (using semiconducting materials) to functional circuits.



**PART ONE
OF A NEW
SERIES FOR
THE BEGINNER**

ELECTRICITY AND ELECTRONS

The general phenomena arising from a surplus or deficiency of electrons (negatively charged particles) in atoms is called static electricity. When electrons are made to drift from atom to atom, this constitutes an electric current.

A *conductor* is a body or substance which readily permits a flow of electrons, while an *insulator* is a body or substance which does not allow such a flow. More about electrical conduction later.

Electrons are far too small to be examined individually, and are too numerous to count, but an electric current can be studied by making use of its effects on components and materials.

Large populations of electrons in motion will cause appreciable heat to be developed in a poor conductor (a resistance), and will also generate a magnetic field. Heat and magnetism in turn can be made to deflect the pointers of measuring instruments. It then remains to find out what aspect of electron behaviour the instrument is actually measuring.

SIX BASIC QUANTITIES

The display panel opposite sets out the six basic quantities used to assess functions of electricity, with quantities in bold capitals and their associated units in bold small letters. Symbols appear inside brackets, and it is important not to confuse the symbol of a quantity with that of its measured unit.

RELATIONSHIPS

The electrical quantities listed can be arranged in a number of ways to tell us what is happening, and what is likely to happen in an electrical circuit. A very important set of relationships is given in Table 1.1.

To see just how these relationships work in practice, it is instructive to apply them to a simple circuit consisting of a car battery, a switch, and a resistor, which are linked together in series by copper conducting wires of negligible resistance, as in Fig. 1.1. (Resistance is a comparative term. All conductors will exhibit some resistance at normal temperatures, and all resistors are capable of conducting a certain amount of current.)

In Fig. 1.1, the resistance and heat liberated by the copper conducting wires is so small that it can be ignored, but a flow of electrons through the resistor will generate appreciable heat. Energy stored in the battery is almost completely transformed into heat by the resistor, so the circuit is really that of an energy converter.

If two or three electrical quantities in the circuit of Fig. 1.1a are known, it is possible to deduce from Table 1.1 all the remaining electrical quantities, and also predict the time when the battery will become exhausted.

To gain familiarity with the six basic quantities and their relationships, try working out with a pencil and paper what results will be obtained from the circuit in Fig. 1.1a when the battery e.m.f. is 12 volts, the charge in the battery is 36,000 coulombs (the same thing as 10 amp-hours) and the value of the resistor is 12 ohms.

THIS

It should be possible to arrive at the following answers by taking any of the several paths of exploration offered by Table 1.1, and jointly consulting the list of quantities given earlier. Energy in the battery will be 432,000 joules, heat liberated by the resistor during the life of the battery 103,075 calories, flow of charge or current 1 amp, rate of energy dissipation or power 12 watts, and time taken for the battery to become exhausted 36,000 seconds or 10 hours.

RESISTANCE NETWORKS

A current can be increased or reduced by changing the value of resistance in a circuit. Indeed, the interrelationship of electrical quantities means that wholesale changes can be brought about, merely by adjusting a single quantity, such as resistance.

Looking again at the circuit in Fig. 1.1a, if two more 12 ohm resistors are wired in series with the first resistor (Fig. 1.1d) the resulting total resistance will be 36 ohms, the current will be reduced to $\frac{1}{3}$ amp, and the charge in the battery will last three times longer.

On the other hand, if these two extra 12 ohm resistors are wired in parallel with the first (Fig. 1.1d), the total resistance will be reduced to 4 ohms, current will be trebled to 3 amps, and time taken for the battery to discharge will be 3-3 hours.

If a selection of resistors were wired to a special switch, which connected them in series or parallel in the circuit in Fig. 1.1b, a whole range of heat outputs would be readily available, ranging from a great heat for a short time to a small heat over a long period, with intermediate steps, according to the resistance values and wiring arrangement.

Table 1.1: ELECTRICAL RELATIONSHIPS

CHARGE (COULOMBS)	$Q = \frac{W}{E} = I \times t = \frac{E \times t}{R} = \frac{P \times t}{E}$
CURRENT (AMPERES)	$I = \frac{W}{Q \times R} = \frac{E}{R} = \frac{P}{E} = \sqrt{\left(\frac{P}{R}\right)}$
ENERGY (JOULES)	$W = Q \times E = P \times t = E \times I \times t = I^2 \times R \times t$
POWER (WATTS)	$P = \left(\frac{W}{Q}\right)^2 \times \frac{1}{R} = E \times I = I^2 \times R = \frac{E^2}{R}$
RESISTANCE (OHMS)	$R = \frac{W}{Q \times I} = \frac{E}{I} = \frac{P}{I^2} = \frac{E^2}{P}$
E.M.F. (VOLTS)	$E = \frac{W}{Q} = I \times R = \frac{P}{I} = \sqrt{(P \times R)}$

CHARGE (Q). An amount of electricity. A surplus or deficiency of electrons. Practical unit the **coulomb (C)**. A negative charge of 1 coulomb corresponds to an excess population of approximately six trillion (6×10^{18}) electrons.

CURRENT (I). The movement of electrons or CHARGE. Practical unit the **ampere or amp (A)**. One amp is a flow of 1 coulomb per second.

ENERGY (W). The work done by a flow of electrons, in terms of heat, light, mechanical effort, etc. Practical unit the **joule (J)**. One joule equals 0.2386 calories, or the work done by a force of 1 newton acting through a distance of 1 metre.

POWER (P). The rate of doing work or delivering ENERGY. Practical unit the **watt (W)**. One watt is equal to 1 joule per second or 0.00134 horsepower.

RESISTANCE (R). Property of a material to resist or slow down a flow of electrons, and convert their kinetic energy into heat or light. Practical unit the **ohm (Ω)**. A resistance of 1 ohm will dissipate 1 watt when a current of 1 amp passes through it.

ELECTROMOTIVE FORCE or E.M.F. (E), also called **VOLTAGE** and **POTENTIAL (V)**. The force which moves electrons. Practical unit the **volt (V)**. One volt is needed to push a current of 1 amp through a resistance of 1 ohm.

Quite often the practical units used to measure electricity are either too large or too small for the job in hand, and they have to be prefixed for multiples or sub-multiples of one thousand; see Table 1.2.

Table 1.2: UNIT PREFIXES

Prefix	Value
pico—($\mu\mu$ or p)	One million millionth (10^{-12})
nano—(n)	One thousand millionth (10^{-9})
micro—(μ)	One millionth (10^{-6})
milli—(m)	One thousandth (10^{-3})
kilo—(k)	One thousand times (10^3)
mega—(M)	One million times (10^6)
giga—(G)	One thousand million times (10^9)
tera—(T)	One million million times (10^{12})

Examples are: picofarad ($\mu\mu F$ or pF), nanovolt (nV), microamp (μA), millihenry (mH), kilowatt (kW), and megohm (M Ω).

WAY TO ELECTRONICS

FIG. 1.1. RESISTANCE

THE RESISTANCE OF ANY MATERIAL IS PROPORTIONAL TO THE RESISTIVITY FACTOR OF THE MATERIAL AND ITS LENGTH, AND INVERSELY PROPORTIONAL TO ITS CROSS-SECTIONAL AREA

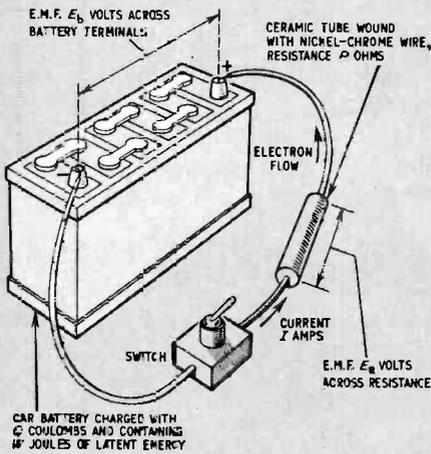


Fig. 1.1.a. A heavy duty battery connected in series with a switch and resistor. Electron flow is shown by the arrows. Conventional current flow, based on positively charged particles, is in the opposite direction

Fig. 1.1.b. The diagram in Fig. 1.1.a can be redrawn in simple terms using a symbol for each component and straight lines for wires. This is called a theoretical circuit diagram. The switch is shown normally open, or "off". The resistor could be replaced by a 12V lamp to show that current flow is heating the filament when the switch is closed

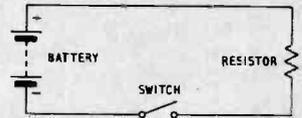


Fig. 1.1.c. This graph shows that when the switch is closed the e.m.f. across the resistor increases instantly and remains at almost battery voltage until the switch is opened again

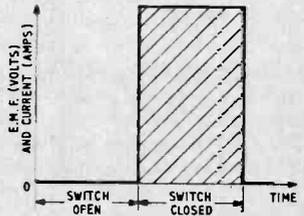


Fig. 1.1.d. The total resistance of any number of resistors connected in SERIES is equal to the sum of each resistance added together: $R_{TOTAL} = R_1 + R_2 + R_3$, etc.



The total resistance of any number of resistors connected in PARALLEL is

$$R_{TOTAL} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \text{, etc.}$$

(All units in ohms)

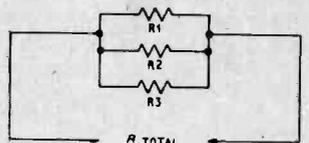


FIG. 1.2. VOLTAGE OR POTENTIAL DIVIDERS

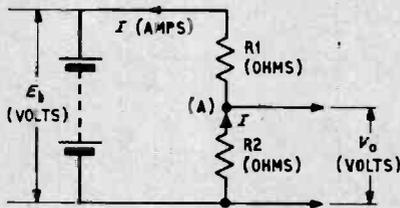


Fig. 1.2a. Potential divider using two fixed value resistors in series. The output voltage available across one of these is $V_o = I \times R_2$. The current through the potential divider is $I = E_b / (R_1 + R_2)$ (E_b and V_o are in volts; I in amps; R_1 and R_2 ohms)

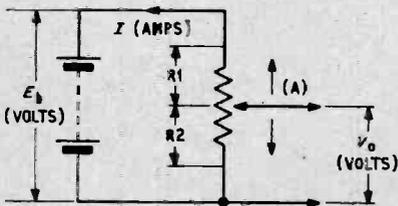


Fig. 1.2b. Potential divider where the two fixed resistors are replaced by one resistor with a movable wiper arm to provide an output voltage V_o of any amount between zero and the battery voltage. This component is called a potentiometer and is sometimes referred to as a rheostat, volume control, or variable resistor

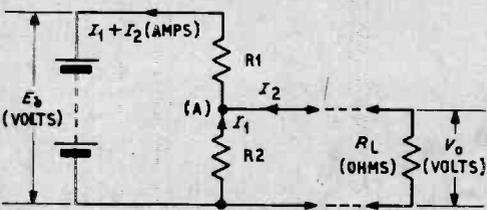
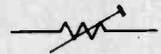


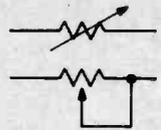
Fig. 1.2c. The output of the above two circuits is usually connected to a load of some kind which can be represented by a resistance R_L . The output voltage V_o across the load will now be less than it was in Figs. 1.2a and 1.2b because R_L shunts R_2 .
 $V_o = I_2 \times R_L = I_1 \times R_2$
 (V_o is in volts; I_1 and I_2 in amps; R_1 , R_2 , and R_L in ohms)

CIRCUIT SYMBOLS

VARIABLE RESISTOR

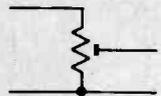


(Preset screwdriver control)



(Knob control)

POTENTIOMETER



(Preset screwdriver control)



(Knob control)

FIG. 1.3. CAPACITANCE

THE CAPACITANCE BETWEEN TWO SETS OF PARALLEL METAL PLATES IS PROPORTIONAL TO THE AREA OF OVERLAP OF EACH PAIR OF PLATES, THE NUMBER OF PAIRS OF OVERLAPPING PLATES, AND THE DIELECTRIC CONSTANT OF THE INSULATING MATERIAL BETWEEN THE PLATES. IT IS INVERSELY PROPORTIONAL TO THE DISTANCE BETWEEN TWO PLATES

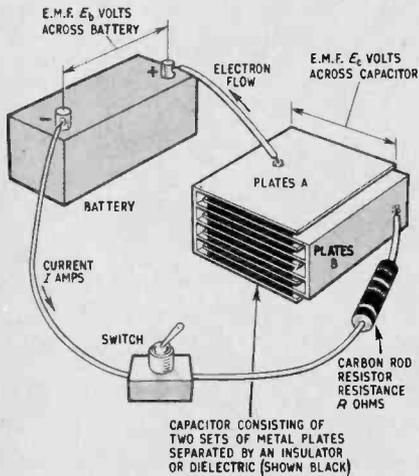


Fig. 1.3a. A battery connected in series with a switch, a current limiting resistor, and a capacitor. For simplicity the capacitor is shown with flat plates interleaved with a dark area of insulating material (or dielectric) between each pair

Fig. 1.3b. The diagram in Fig. 1.3a can be redrawn in simple terms using a symbol for each component. The switch is shown normally "off"

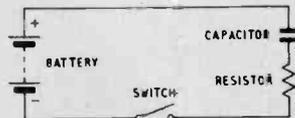


Fig. 1.3c. This graph shows that when the switch is closed the voltage across the capacitor rises exponentially to almost the battery voltage while the current rises instantly and declines exponentially as the voltage rises

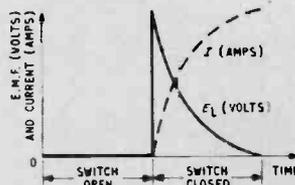
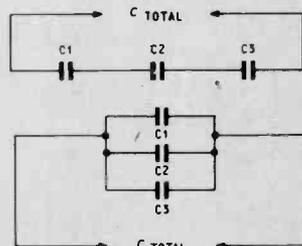


Fig. 1.3d. The total capacitance of any number of capacitors in SERIES is

$$C_{TOTAL} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}, \text{ etc.}}$$

The total capacitance of a number of capacitors in PARALLEL is

$$C_{TOTAL} = C_1 + C_2 + C_3, \text{ etc.}$$



CIRCUIT SYMBOLS



FIXED VALUE CAPACITOR



VARIABLE CAPACITOR (Knob control)



VARIABLE CAPACITOR or TRIMMER (Preset screwdriver control)

POTENTIAL DIVIDER

Apart from series and parallel combinations, there is another important configuration called a potential or voltage divider, see Fig. 1.2. The potential divider is widely used for reducing or dividing voltages or currents by known amounts.

In Fig. 1.2a, the fixed divider network consists of two resistors wired in series across a battery, with an output taken from across one of these resistors. By calculating suitable values for R_1 and R_2 , any voltage between zero and battery volts E_b can be made available.

A continuously variable adjustment between zero and E_b volts can be obtained if the divider has a sliding contact which moves along a resistance track; this arrangement is variously called a potentiometer, volume or gain control, variable resistor and so on, depending on the use to which it is put. The variable divider circuit is given in Fig. 1.2b.

In the examples given in Fig. 1.2a and 1.2b, the dividers reduce the e.m.f. to be supplied to the output (V_0), but until a load is connected, no current flows in the output wires. Current merely flows through R_1 and R_2 and back to the battery. Most practical dividers usually end up having some sort of load on their outputs, which can be represented by a plain resistance, R_L in Fig. 1.2c.

Even a voltage measuring instrument can take some current, and a heavier load, such as a flashlamp bulb, will place a considerable load on the divider output.

So, the current originally passing through R_2 is now divided into I_1 and I_2 through R_2 and R_L . The output voltage V_0 is also modified and reduced, because the relationships between electrical quantities in the circuit of Fig. 1.2c must be maintained; refer again to the calculations for voltage, current, and resistance in Table 1.1 and the formulae in Fig. 1.1d.

$$V_0 = I_2 \times R_L = I_1 \times R_2$$

CAPACITANCE

It is appropriate now to add two more electrical quantities to the previous list, namely capacitance and inductance. The basic quantities again being in bold capitals and the measured units in bold small-letters.

CAPACITANCE (C). The property of two conductors, separated by an insulator, to store an electric charge. Practical unit the **farad (F)**. One **farad** will store 1 coulomb on application of 1 volt.

INDUCTANCE (L). The property of a current carrying conductor to oppose a change of current, due to an associated magnetic field. Practical unit the **henry (H)**. The amount of energy stored in the magnetic field associated with 1 **henry** is $\frac{1}{2}$ joule for a current of 1 amp.

FIG. 1.4. INDUCTANCE

THE INDUCTANCE OF ANY COIL OF WIRE IS PROPORTIONAL TO THE SQUARE OF THE NUMBER OF TURNS OF WIRE, THE SQUARE OF THE MEAN DIAMETER OF THE COIL, THE LENGTH OF THE COIL, AND THE MAGNETIC QUALITIES OF THE CORE MATERIAL

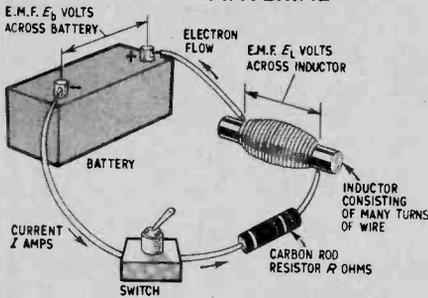


Fig. 1.4a. A battery connected in series with a switch, a resistor, and an inductor (or coil). The inductor usually consists of several turns of thin insulated wire, sometimes with a core of air or ferrous material

Fig. 1.4b. The diagram in Fig. 1.4a using symbols for components

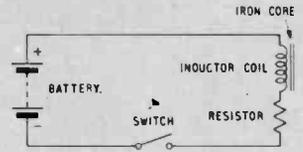


Fig. 1.4c. This graph shows that when the switch is closed the current through the coil rises exponentially, while the voltage rises instantly and declines exponentially as the voltage rises

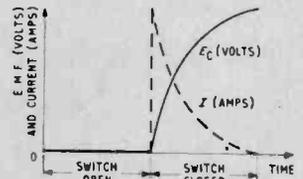
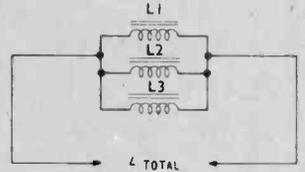


Fig. 1.4d. The total inductance of any number of inductors in SERIES is $L_{TOTAL} = L_1 + L_2 + L_3$, etc.

The total inductance of any number of inductors in PARALLEL is

$$L_{TOTAL} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}, \text{ etc.}}$$



CIRCUIT SYMBOLS

- FIXED VALUE INDUCTOR
- FIXED INDUCTOR WITH IRON CORE
- FIXED INDUCTOR WITH CORE OF FERRITE MIXTURE
- VARIABLE INDUCTOR WITH ADJUSTABLE CORE

In the circuit in Fig. 1.3a, the capacitor shown consists of two sets of interleaved metal plates A and B, each set being insulated from the other. The presence of an insulator prevents any significant flow of electrons between the two sets of plates, and yet the capacitor seems to conduct a current in certain circumstances.

To see how this can be, we will assume that the switch in Fig. 1.3a is off, leaving the resistor and plates B disconnected from the battery negative terminal. Because plates A are wired directly to the battery positive terminal, they will be deficient in electrons. For the purposes of this exercise we will also assume that plates B have been discharged and are in the same condition as plates A, with an electron deficiency.

When the switch is closed, electrons will rush through the resistor to the electron starved B plates, consequently power will be dissipated for only an instant in the resistor. The graph in Fig. 1.3c shows that the current rises very rapidly to maximum as the switch is closed, then declines slowly as the concentration of electrons on plates B begins to build up (dotted line).

However, the e.m.f. across the capacitor works the opposite way, rising slowly from zero towards maximum (as shown by the solid line). Note that when the process has been completed, plates A are still deficient in electrons, and there has been no actual flow of electrons through the insulator, but there was a short-lived current through the resistor.

After plates B have been fully charged with electrons, the capacitor is capable of delivering a charge to a resistor which may be connected across A and B. In many ways a capacitor behaves like a small battery.

INDUCTANCE

It has been established that there is a close relationship between electron motion and magnetic attraction. If a current flows through a wire a magnetic field is set up around that wire.

To make this magnetic field of useful magnitude, several wires are placed together and all fed with an e.m.f. The easiest way is to use one wire and wind it several times around a former. The greater the wire thickness and number of turns, the stronger will be the magnetic field and "inductance" of the coil.

A core of iron or other ferrous mixture can be placed inside the coil of wire to increase the inductance. This is shown in Fig. 1.4b.

However, the magnetic field can generate a small opposing current in the wire which will rapidly increase for an instant when the core is removed. The magnetic field collapses and generates an e.m.f. across the coil for a short time. The inductor opposes a change of current, and stores electrical energy.

When the switch is closed in the circuit in Fig. 1.4a, the e.m.f. across the inductor builds up very rapidly to maximum before slowly declining, while current begins a slow growth from zero towards maximum. Clearly, the action of an inductance has points of similarity with that of a capacitance. Current and voltage trends for both can be compared by examining the graphs in Fig. 1.3c and Fig. 1.4c.

Part two next month will deal with the differences between electrical conduction in solids, liquids, and gases, and will also introduce that important semi-conducting device—the diode.

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2	4µF	25	4d			46	20/4	275	1/-		
3	4µF	4	4d			47	250	50	2/-		
4	6µF	6	4d			48	500	25	1/6		
6	64µF	9	4d			49	400	15	1/-		
7	20µF	6	4d			50	400	2.5	3d		
11	8µF	6	4d			51	64	275	1/9		
16	32	150	9d			52	32/32	350	2/6		
17	64	2.5	3d			53	8/8/8	275	1/9		
18	100/200/200/50	275	7/6			54	500	6	6d		
19	50/80	300	3/-			55	64	25	1/3		
21	24	275	1/-			56	25	6	3d		
22	10	25	3d			57	100	9	6d		
23	125	2.5	3d			58	400	50	2/-		
25	16/32	350	2/6			59	400	30	1/6		
26	32	275	1/6			60	500	4	3d		
28	75/75/75/75	150	2/6			61	150	30	1/6		
30	12.5	40	9d			62	64/32/8	275	2/6		
32	3,000	35	7/6			64	40	6.4	3d		
33	3,000	15	3/-			67	30	6	3d		
34	3,000	30	7/-			68	100/100/50	275	5/-		
35	250	70	2/-			69	50/50/50	350	4/-		
36	2,500	9	2/-			70	40/40/20	275	2/-		
38	750	12	1/9			71	400	6.4	3d		
39	100µF	275	2/6			72	320	6	10		
40	30µF	10	3d			73	32/32	275	2/6		
42	16µF	50REV	2/-					25			
43	16/16	275	1/-								
44	16	275	1/-								

Total:—

RESISTORS. EXCELLENT QUALITY. MAINLY 5%. 7/6 per 100 of any one value.

2/- per dozen of any one value. Smaller quantities 3d each. Tick the values required.

13 ohms	220 ohms	1.5k Ω	3.6k Ω	7.5k Ω	22k Ω	39k Ω	62k Ω	130k Ω	560k Ω	1.8M Ω	7.5M Ω
22 ohms	470 ohms	1.8k Ω	4.3k Ω	10k Ω	24k Ω	43k Ω	75k Ω	360k Ω	620k Ω	3.6M Ω	8.2M Ω
36 ohms	560 ohms	2.2k Ω	4.7k Ω	16k Ω	27k Ω	47k Ω	82k Ω	430k Ω	1.2M Ω	5.1M Ω	9.1M Ω
47 ohms	750 ohms	2.4k Ω	5.6k Ω	18k Ω	30k Ω	51k Ω	91k Ω	470k Ω	1.5M Ω	6.2M Ω	10M Ω
91 ohms	1k Ω	3.3k Ω	6.8k Ω								

Total:

SILVER MICA/CERAMIC/POLYSTYRENE CONDENSERS. 10/- per 100 of any one value. 3/- per dozen of any one value. Smaller quantities 6d each. As available. In following values. Tick those required.

2pF	5pF	12pF	25pF	50pF	80pF	135pF	180pF	250pF	680pF	1,000pF	2,500pF
3.9pF	6pF	15pF	27pF	58pF	82pF	140pF	190pF	330pF	800pF	1,100pF	2,700pF
4pF	8pF	18pF	30pF	62pF	100pF	158pF	200pF	500pF	820pF	1,500pF	3,000pF
4.7pF	10pF	22pF	39pF	72pF	125pF	170pF	240pF	600pF	900pF	2,200pF	6,200pF

Total:

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0.15 µF 6d ea. 160V		
0.22 µF 6d ea. 160V		
0.27 µF 6d ea. 160V		
1 µF 1/- ea. 125V		

Total:

25% discount lots of 100 per type.
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S.T.C. 3/4 (400V), 2/6 ea., 24/- doz, £7/10/- 100.
BYZ 13 or 19 (6A), 2/6 ea., 24/- doz, £7/10/- 100.

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THE whole "news complex" occupies a six-floor spur built on to the Television Centre at White City.

The News installation includes studios, telecine and video-tape areas, a film processing section, film workshops, cutting rooms, and of course, newsrooms, offices, etc. The basement contains an underground car park for news operational vehicles.

The installation is primarily for the 625-line 50-field PAL colour standard but pictures can be originated on NTSC 525-line 60-field standards directly or via a converter.

Sub-Central Apparatus Room

On the first floor is the sub-central apparatus room in which the many communications facilities required by the News Service are controlled. This room has its own genlocking equipment and pulse generators as well as feeds from the main Television Centre pulse chains. It also supplies all technical areas in the Spur with sound, vision, pulses, and communications facilities, and also co-ordinates the output of news sources in the Spur with other areas in the Television Centre and with the external switching centres of the simultaneous broadcast network. Facilities also exist for remote control of the camera at the Parliamentary Studio. The first photo (*above*) shows the control desk in the sub-central apparatus room.



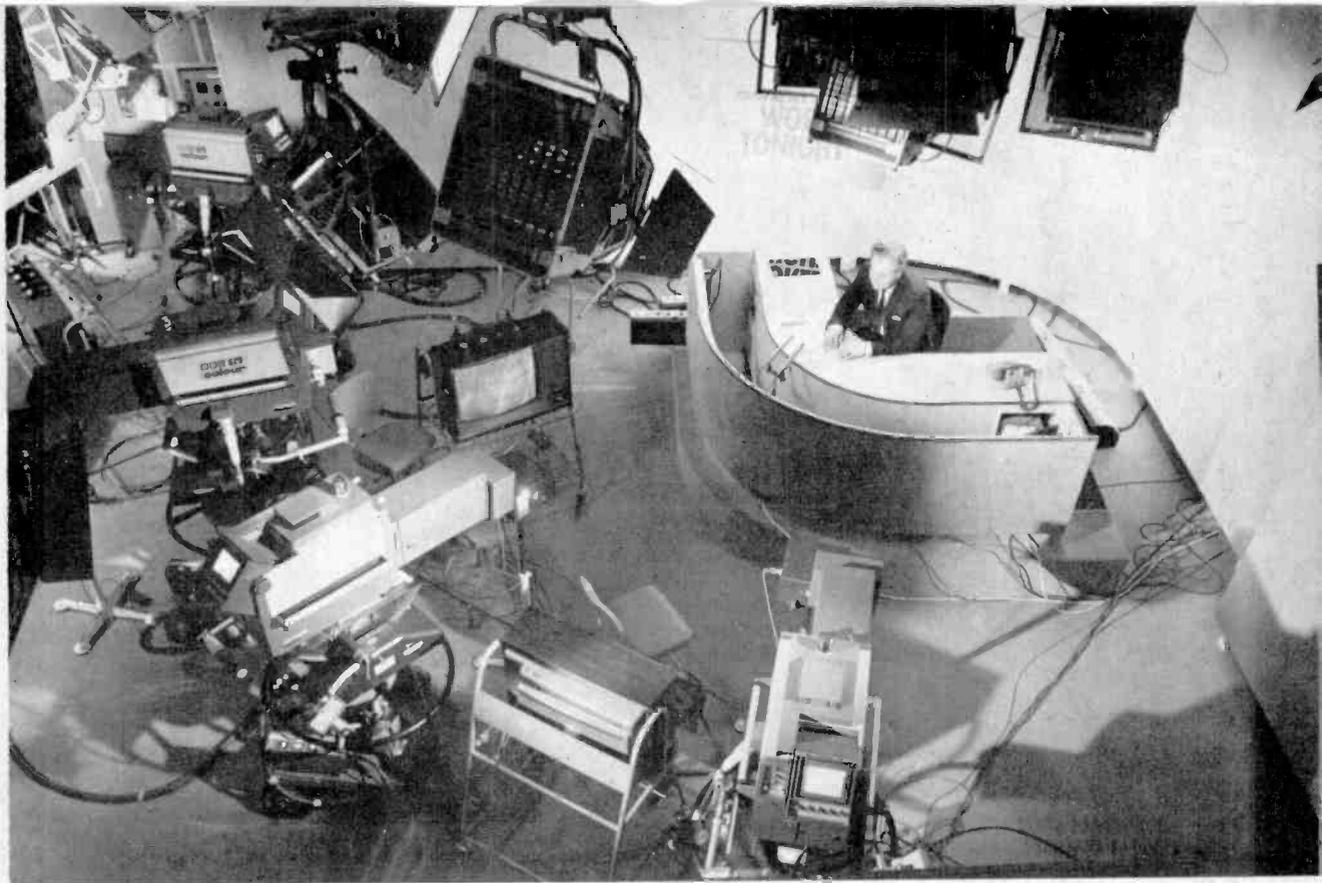
Video-Tape and Film Processing

The third floor contains video-tape and film processing areas and the senior engineering offices.

A large Telecine area is on the fourth floor. This area is equipped with nine 16mm colour machines, two of which are multiplexed to deal with 8mm and super 8mm film. There are also two 16mm monochrome telecines.

One of the two telecine control desks is shown in the photo (*right*).

The electronic method of reviewing film is used.



The Studios

The sixth floor can be described as the output floor. In addition to a large newsroom it has two studios each equipped with four remotely-controlled Marconi colour cameras, see photo (above).

There are two large control rooms, one for each of the studios, separated from the studio by a glass partition. The control rooms are divided into raised islands, one of which is for the sound mixer and his disc and tape machines. The island is partially screened by glass which gives some acoustic isolation but enables the sound mixer to keep in touch with control-room operations, an essential requirement in constantly-changing News programmes.

Another island supports the editorial desk and on the floor level is the production section containing vision mixer, productions assistant, senior television engineer, and secretarial positions.

The remaining island houses the vision control and lighting console.

The vision control positions have full remote control of the studio cameras. There are in each studio four panels each enabling up to 20 pre-set camera shots to be adjusted after which information on these shots can be fed into a ferrite-core memory store in the vision apparatus.

Newsroom

The large Newsroom has communications facilities, teleprinters, and a permanently installed monochrome camera. In addition two colour cameras, one on remote control, can be installed in the Newsroom if required. The photo (left) shows newsreader facing vidicon "news-flash" camera.

Captions, either opacity or transparency, are originated in a special control room equipped with a monochrome micro scanner. This is used for inlaying the sub-titles in the "News Review for the Deaf" programme and includes a colour synthesiser enabling a two-tone monochrome caption to be reproduced in two colours.





50^{PLUS} 50 HIGH POWER AMPLIFIER

By R. D. PALMER

IN LAST month's issue the first part of this article provided design details of the complete amplifier and component assembly and wiring of two amplifier boards.

In this second part the output stage sub-assemblies and power supply unit will be presented, as well as chassis layout and interwiring details.

OUTPUT TRANSISTORS

The output transistors TR13 and TR14 and R44, R45, R46 and C18, for both channels, are mounted on extruded aluminium heatsinks type 10D.

Prior to mounting the components, the heatsinks must be drilled as shown in Fig. 10 making sure that all burrs are removed afterwards. They should then be cleaned and sprayed with an aerosol matt black paint after first having masked the transistor mounting area.

The transistors are then bolted on with the appropriate insulating kits. To ensure a low thermal resistance, silicone grease should be smeared over the insulation washers.

RESISTOR WINDING

Resistors R44 and R45 are made by bifilar winding 25in of 30 s.w.g. or 36in of 28 s.w.g. enamelled copper wire over the body of any 1 watt resistor. This gives the required value of 0.14 ohms \pm 5 per cent.

To secure these windings Araldite should be applied.

The component layout for the heatsinks of both channels is given in Fig. 11. Wiring details of these are given later.

THE POWER SUPPLY

The power supply is of a series regulated type, the circuit of which is shown in Fig. 12. A regulated supply is necessary to maintain the correct working voltage for the two power amplifiers and to prevent excessive intermodulation and hum which would otherwise occur at high output levels.

An added advantage of this circuit is that mains input voltage adjustment by transformer tapings is not necessary over a range of about \pm 10 per cent of the nominal input voltage.

The specifications of the power supply are as follows:

Output voltage	56 volts
Maximum continuous output current	5 amp
Maximum peak output current	12 amp for duration of 5 milliseconds

The transformer provides a 50 volt output under no load conditions; this being rectified by the bridge D7-D10 and smoothed by C20. The voltage at this point attains 70 volts under no load conditions since C20 charges up to the peak value of the rectified input.

The series regulator transistor TR17, and TR15 are in Darlington pair, emitter follower configuration, biased by R48.

DIFFERENTIAL AMPLIFIER

A differential amplifier, formed by TR16 and the associated components, senses any difference between the voltage on VR7 and the reference voltage across the series diodes D11 and D12. Output changes cause

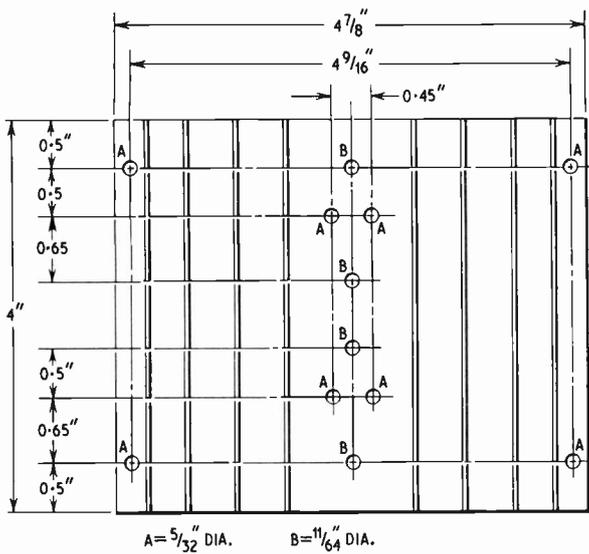


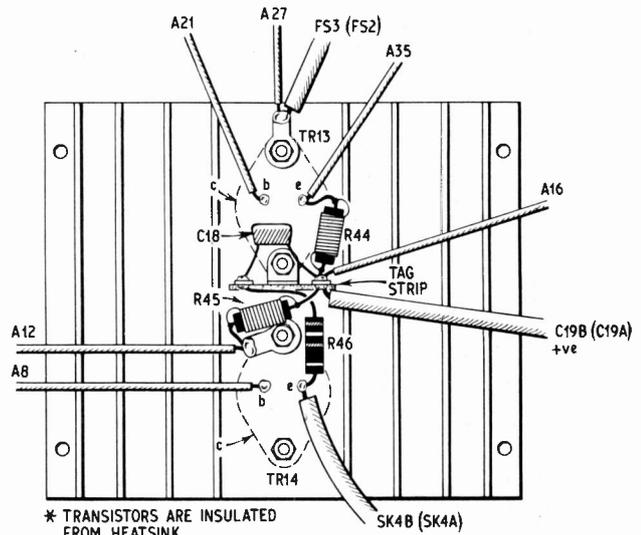
Fig. 10. Drilling details for the type 10D heatsinks, three of which are required

TR16 to shunt R48 and reduce the voltage at the base of TR15 and hence stabilises the line voltage.

The pre-set potentiometer VR7 is used to set this voltage.

TRANSFORMER IMPEDANCE

The series regulator transistor would not be able to handle the high power dissipated if the transformer had a very low output impedance, since the voltage on C20 would maintain its value and produce a very large current. Thus it is necessary that the transformer should have an output impedance not less than 1.5 ohms. If it is less than this, a ballast resistor must be inserted in series with the winding to make up the difference. It should be rated at 25 watts per ohm used.



* TRANSISTORS ARE INSULATED FROM HEATSINK

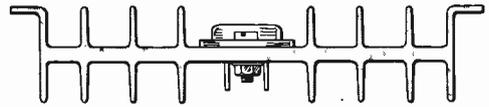


Fig. 11. Component and wiring layout for the heatsink mounted output transistors and associated circuitry of amplifier B. The amplifier A heatsink assembly is identical. For this, thick wire routing is given in parentheses

If in any doubt as to the internal impedance of a particular transformer, the supplier should be consulted or the constructor should measure it for himself.

CAPACITOR RATING

The smoothing and reservoir capacitors C22 and C20, should each have a maximum ripple current rating of not less than 5 amps r.m.s. at 100Hz at 25 degrees centigrade. Again any doubt should be resolved with the supplier.

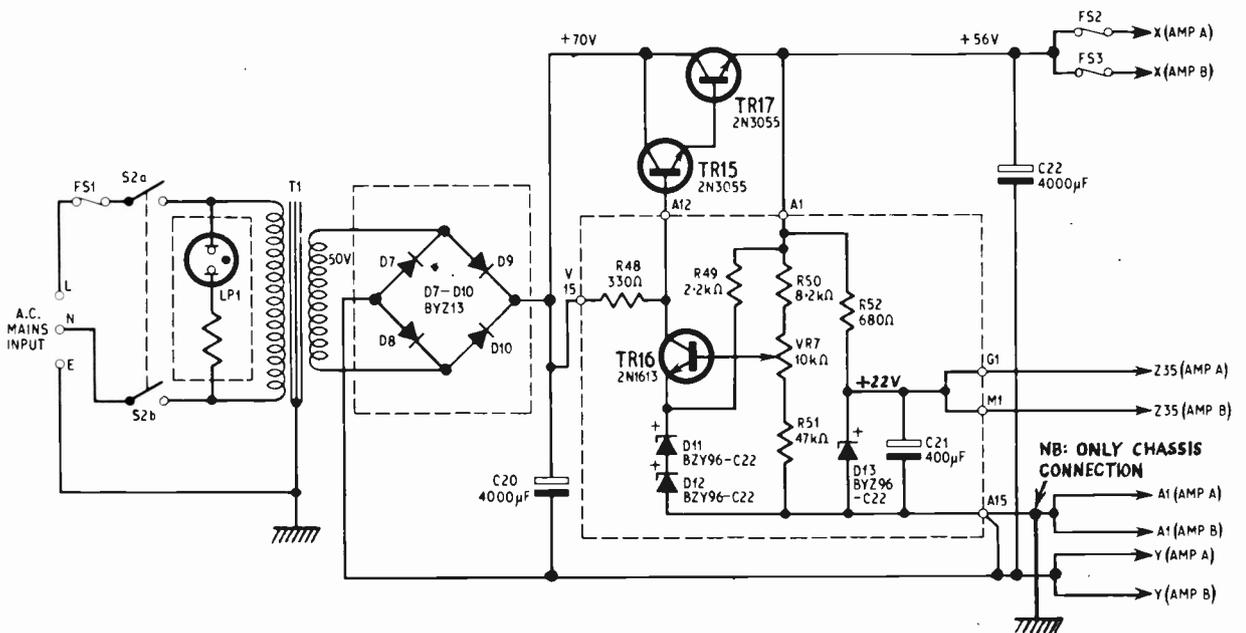


Fig. 12. Circuit diagram of power supply C. Board mounted components are enclosed within dotted lines

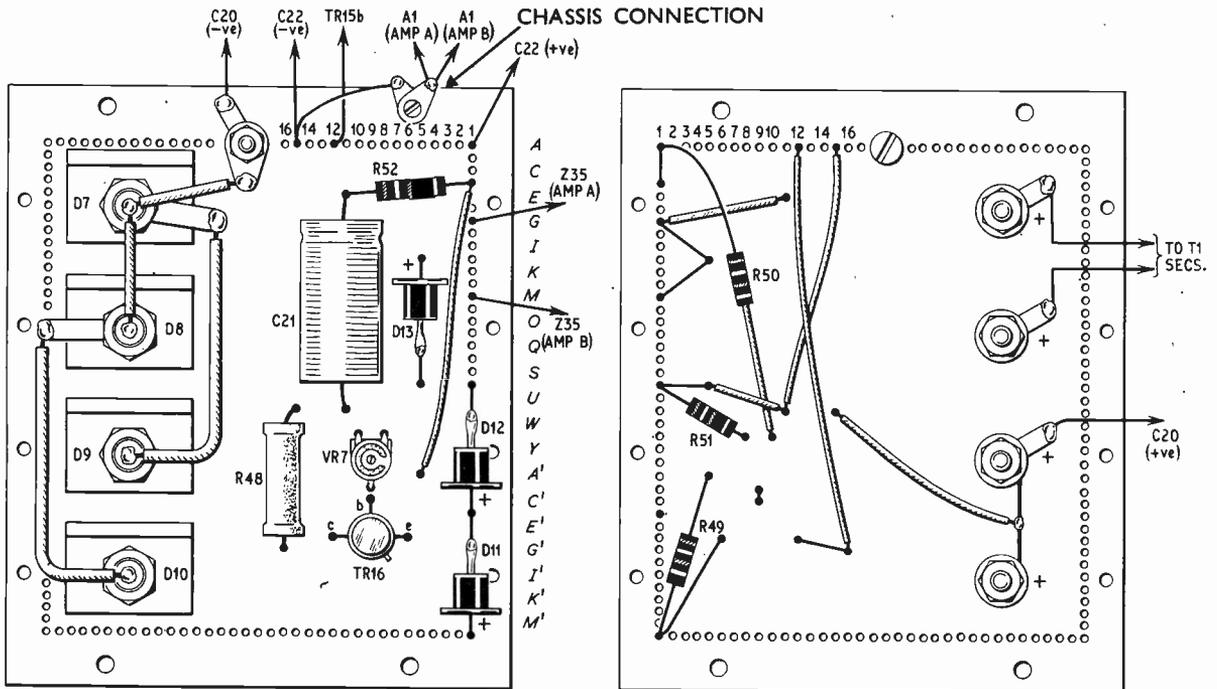


Fig. 13. Component and wiring layout for power supply C

COMPONENTS . . .

POWER SUPPLY UNIT

Resistors

R48 330Ω 1W R50 8.2kΩ R52 680Ω 2W
 R49 2.2kΩ R51 4.7kΩ

All ½ watt, 10% carbon except where otherwise stated

Capacitors

C20 4,000μF 75V elect. (see text)
 C21 400μF 25V elect.
 C22 4,000μF 60V elect. (see text)

Transistors

TR15 2N3055 TR16 2N1613 TR17 2N3055

Diodes

D7-D10 BYZ13 (Mullard) (4 off)
 D11-D13 BZY96-C22 1.5W Zener diodes (3 off)

Switch

S2 Double pole mains on/off

Transformer

T1 Mains transformer: pri. 0-240V; secondary 50V at 6A. MT107AT (G. W. Smith Ltd.)

Fuses

FS1 3A cartridge fuse and holders
 FS2 } 3A cartridge fuses (2 off) and twin holder
 FS3 }

Miscellaneous

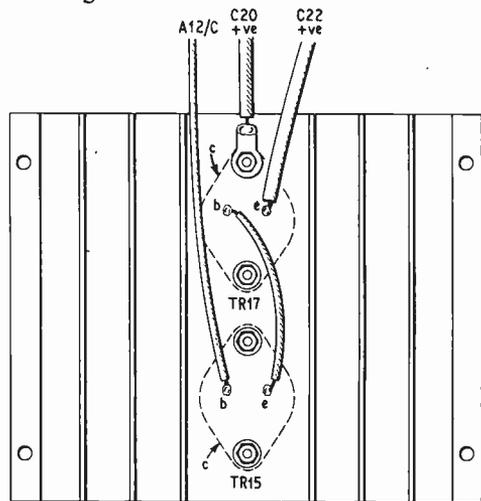
Lektrokit chassis plate No. 4—LK141, 20 wiring pins, type 10D heatsink, TO5 radial heatsink, LPI—mains neon, Aluminium case 15in × 7in × 9in. Type Y (H. L. Smith & Co. Ltd., 287/289 Edgeware Road, London, W.2). Rubber feet, knobs, 6B.A. × ½in hexagon spacers (12 off), 2 chrome handles

Alternative capacitors up to 6,000μF with working voltages up to 150 volts can be used providing they meet the ripple current requirement.

In order to provide the reference voltage a single 43 volt, 5 watt Zener diode may be used instead of the two, 22 volt 1.5 watt Zener diodes D11 and D12.

POWER SUPPLY BOARD

All the components in the power supply circuit except for the two large electrolytics, TR15 and TR17 (and of course the transformer) are mounted on perforated s.r.b.p. board. Component layout and wiring are shown in Fig. 13.



* TRANSISTORS ARE CONNECTED DIRECTLY TO HEATSINK

Fig. 14. Component and wiring for power supply transistors. The heatsink MUST be insulated from the chassis. Heatsink drilling details are given in Fig. 10

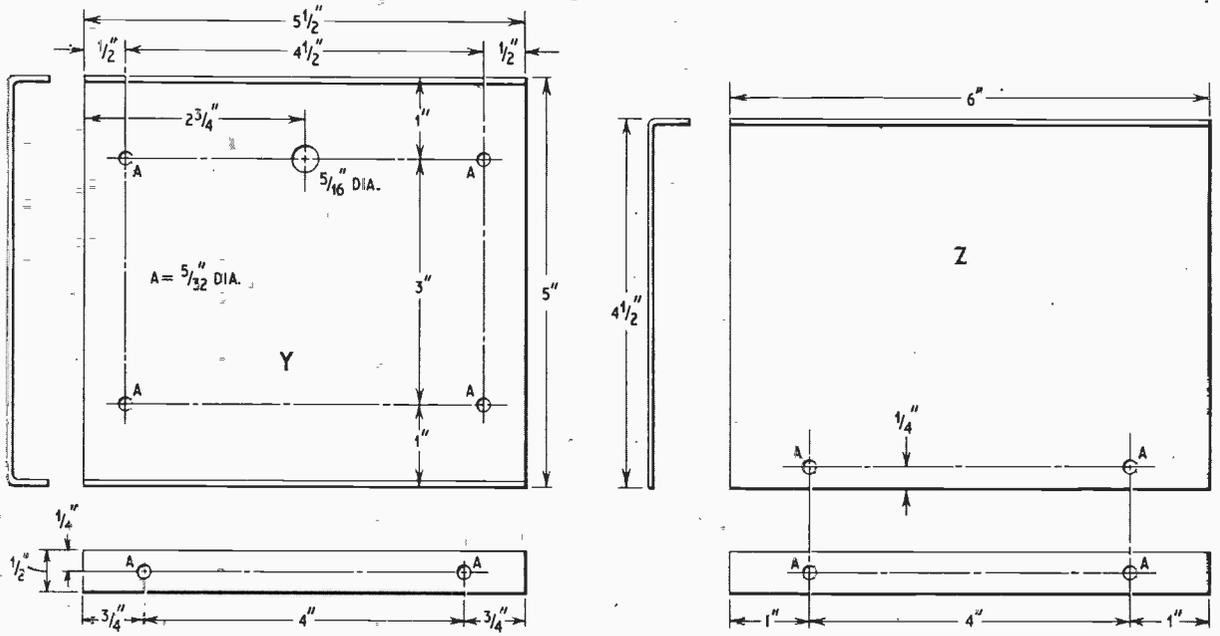


Fig. 15. Drilling details of the 18 s.w.g. aluminium sub-chassis plates X, Y and Z

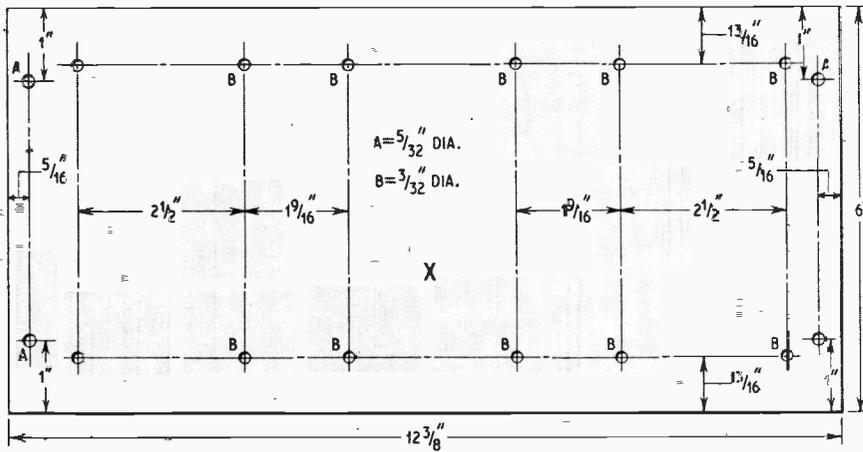
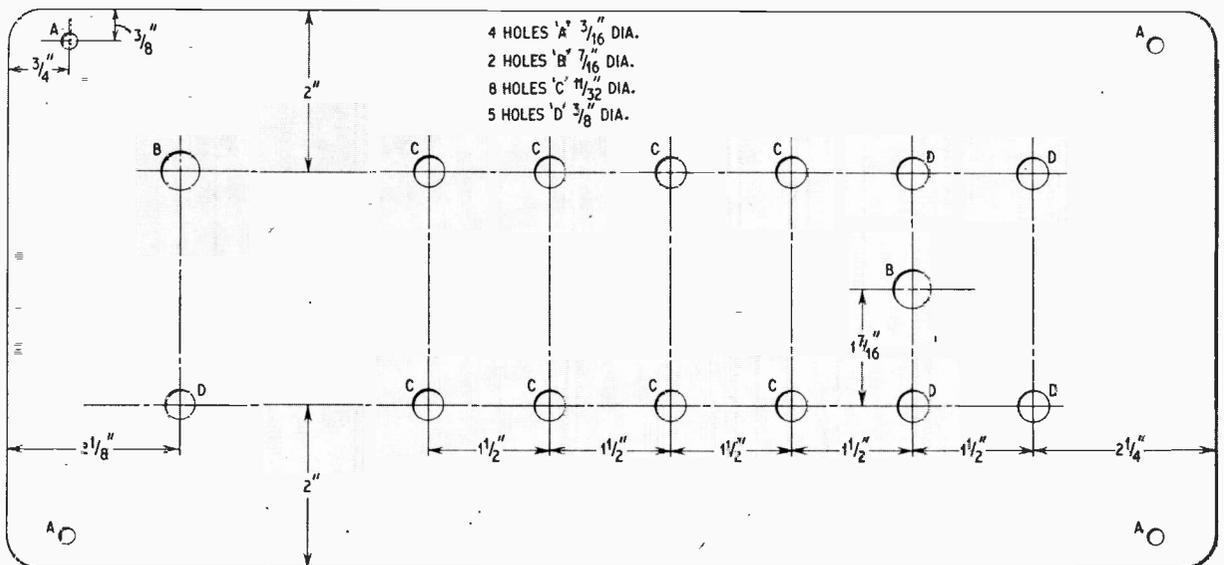


Fig. 16 (below). Drilling details for control panel



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 2N1613 4/8d. 2N3011 9/1d. 2N3053 6/2d. 2N3055 15/9d. 3N140 15/3d. BFY50 4/8d. BFY51 3/9d. BSY27 18/- BSY95A 3/3d. C407 4/6d. CA3012 18/3d. CA3014 25/6d. CA3020 25/9d. OA200 1/9d. OA202 1 11d.



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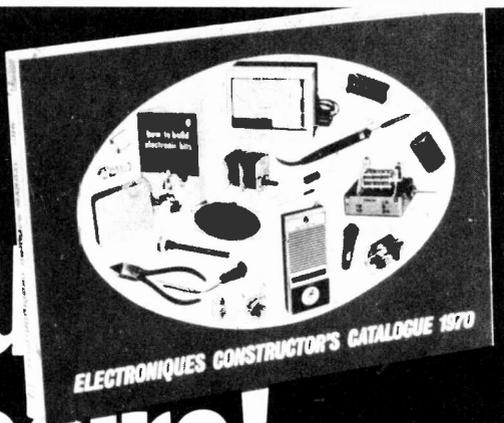
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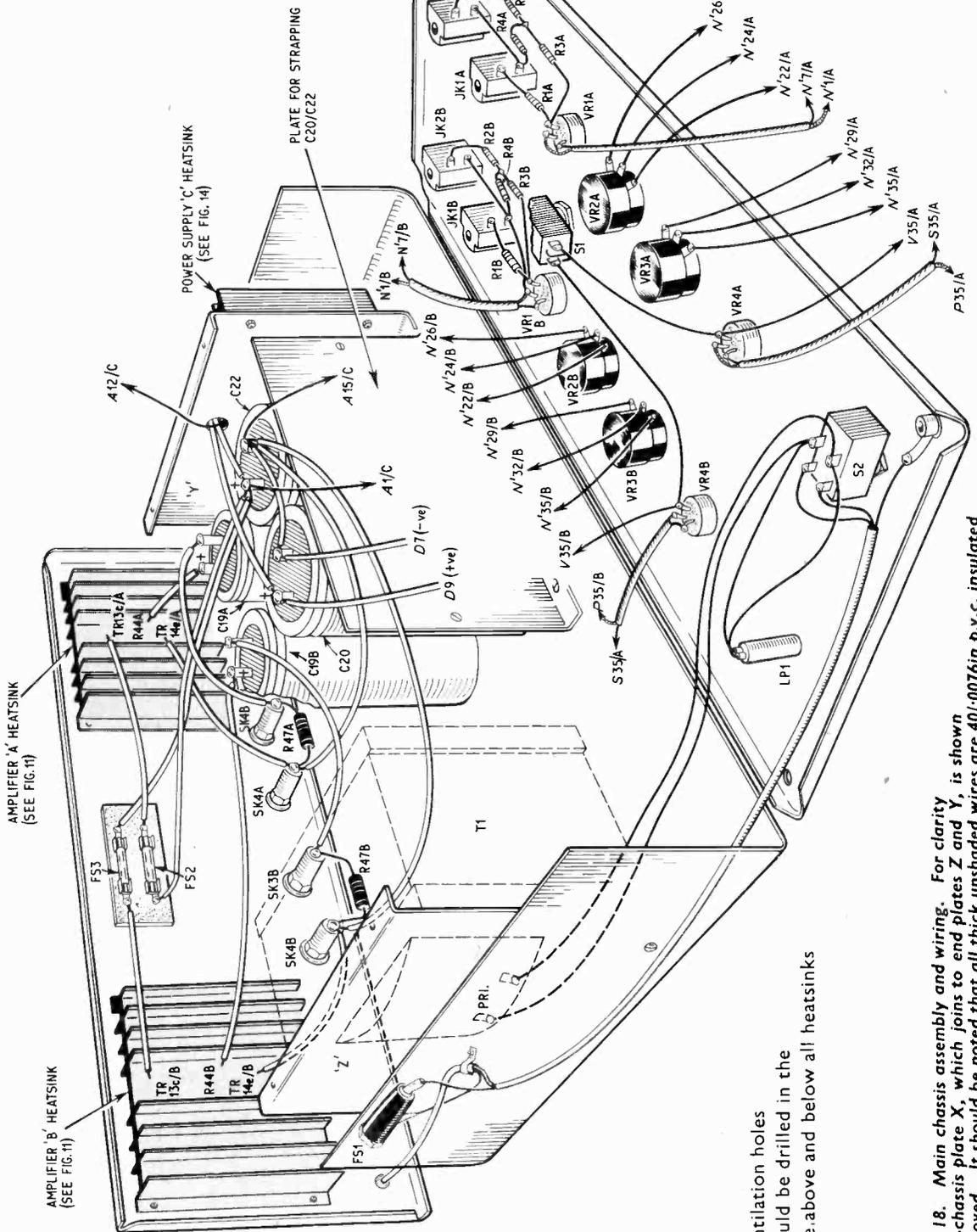
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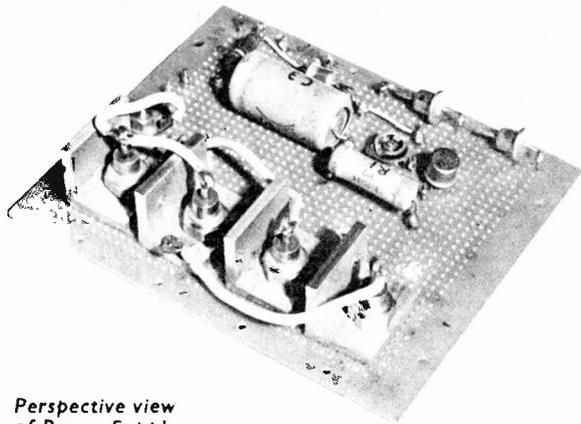
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Fig. 18. Main chassis assembly and wiring. For clarity sub-chassis plate X, which joins to end plates Z and Y, is shown removed. It should be noted that all thick unshaded wires are 40|-0076in p.v.c. insulated



Perspective view of Power Supply Board. Note the diode heatsinks

MOUNTING THE HEATSINKS

The amplifier heatsinks are mounted inside the back panel. Since the transistors are insulated they are connected directly.

Before mounting the power supply heatsink, flying leads should be attached as shown in Fig. 13. These leads are drawn through the centre hole of end plate Y and the heatsink attached using 4B.A. nylon bolts and insulating washers.

The small components of the main chassis back panel should now be attached and the underside rubber feet bolted on.

WIRING UP

Initial wiring should be carried out according to Fig. 18. It should be noted that all thick unshaded wires are 40/0076in p.v.c. insulated which are necessary for carrying the high output circuit.

Flying leads from the front control panel should be 9in long as they will all terminate at the upper plate of the sub-chassis. The power supply and amplifier boards mounted on this plate are shown in outline in Fig. 17.

The plate should now be connected to plates X and Y in the sense indicated and wires attached to the pins as shown. With soldering completed the wiring should be tidied up by tying in cableforms with nylon cord. This will ensure reliability.

TEST AND SETTING UP PROCEDURE

Extreme care should be taken when making tests as an accidental short circuit across the power supply will result in the instantaneous destruction of TR17. A short elsewhere might cause even more expensive damage to the amplifier circuitry.

First remove FS2 and FS3, then proceed as follows:

(1) Switch on and measure the potential at the collector of TR17 collector; this should be about +70 volts.

(2) Set the voltage on pin A1 of the power supply board to +56 volts by adjusting potentiometer VR7.

(3) Check the +22 volt output at either pins G1 or M1.

(4) Switch off and connect a 100 ohm, 5 per cent, 5 watt resistor across the terminals of FS2 fuse socket. Across this connect the multimeter set to a high voltage range. Now check that the volume and quiescent current controls of amplifier A are turned fully anti-clockwise.

(5) Switch on and wait a few minutes for the coupling capacitors to charge. Set the multimeter to a lower range after the voltage drops to zero, then set VR6 for a reading of 1.5 volts.

This represents a quiescent current through the output transistors of about 12mA.

(6) Switch off and remove test resistor from FS2 socket, and replace fuse.

Switch on and set the centre coil voltage, measured at pin A16 on amplifier A board, to 28 volts, by adjusting the pre-set potentiometer VR5.

(7) Repeat operations (4), (5) and (6) for amplifier B.

With the satisfactory completion of these tests, the amplifier is now ready for use.

LOUDSPEAKER ARRANGEMENTS

In order to obtain the maximum power it is necessary that the amplifier be correctly loaded. This can be done by using parallel and series arrangements of loudspeakers as shown in Fig. 19, or a suitably rated matching transformer to obtain the required load impedance of 5 ohms.

When using horn type speakers, the bass control must be turned down to restrict the bandwidth at low frequencies. If this is not done, damage may be caused to the pressure units.

The concluding article will include a voltage table and a fault finding schedule.

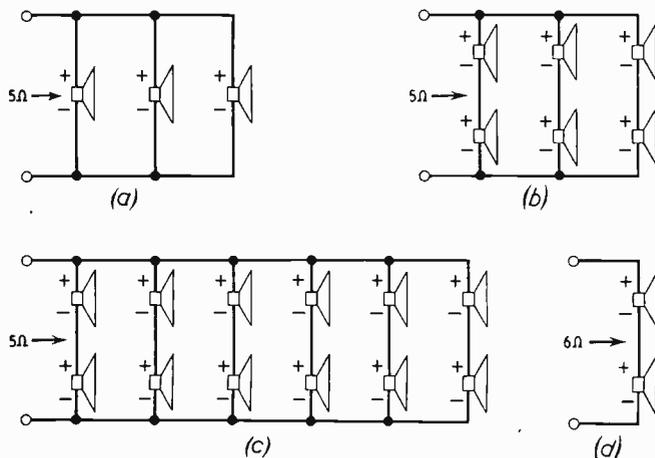


Fig. 19. Some possible loudspeaker arrangements for each channel.

Impedances "looking in" are indicated:

(a) 3 speakers, each of 15 ohms and rated at 20 or 25W.

(b) 6 speakers, each of 7.5-8 ohms and rated at 10 or 12W.

(c) 12 speakers, each of 15 ohms and rated at 5-6W.

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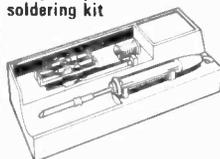


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PHILIPS TRIMMER

0-30pf an old design but one which has never been bettered. 1/- each, 10/- doz. 24.0.0 per 100.

PP3 BATTERY ELIMINATOR

Run your small transistor radio from the mains—full wave circuit—made up ready to wire into your set and adjustable high or low current. 8/6 each.

TOGGLE SWITCH

3 amp 250V with fixing ring. 1/6 each 15/- doz.

DRILL CONTROLLER

Electrically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. 19/6 plus 2/6 post and insurance. Made up model 27/6 plus 2/6 p. & p.

230 VOLT SOLENOID

1in stroke. size 2 1/2in 2in 1 1/2in. 14/6, postage 2/6.

13 AMP FUSED SWITCH

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

MICRO SWITCH

5 amp. changeover contacts. 1/6 each 18/- doz. 13 amp model 2/- each or 21/- doz.

ISOLATION SWITCH

20 amp. D.P. 250V. Ideal to control water heater or any other appliance. Neon indicator shows when current is on. 4/6. 48/- per dozen.

SUPPRESSOR CONDENSER TCC

0-1 mfd. 250V a.c. working metal case with fixing lug. 1/9 each 18/- doz.

15/20 AMP CONNECTORS

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

MAINS MOTOR

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

0-0005mFd TUNING CONDENSER

Proved design, ideal for straight or reflex circuits 2/6 each. 24/- doz.

250V a.c. working condensers for power factor correction, motor starting etc. 3-5 mfd. 8/6 each, 6-5 mfd. 8/6 each, 8 mfd. 9/6 each.

3 amp battery charger kit comprises copper backed circuit board, 3 amp mains transformer, regulator resistors and smoothing condenser 20/6 inc. wiring diagram, post & ins. 4/6.

VARIAC CONTROLLERS

With these you can vary the voltage applied to your circuit from zero to full mains without generating undue heat. One obvious application therefore is to dim lighting. We offer a range of these, ex-equipment but little used and in every way as good as new. Any not so, will be exchanged or cash refunded. 2 amp £12.19.6. 5 amp £7.19.6. 8 amp £12.19.6. 10 amp £15.19.6. Note some of these are panel mounting types.



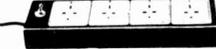
HOUR COUNTERS

If you wish to know how long your equipment has been switched on then this is what you need. Counts running time up to 999 hours. 30c's mains operation. 49/6 plus 3/6 post and insurance. Resettable type 69/6 plus 3/6 p. & i.



24 HOUR TIME SWITCH

Mains operated. Adjustable Contacts give 2 on/off per 24 hours. Contacts rated 15 amps, repeating mechanism so ideal for shop window control, or to switch hall lights (anti-burglar precaution) while you are on holiday. Made by the famous Smiths Company. This month only 39/6 with Perspex cover, plus 3/6 postage and insurance, a real snip which should not be missed.

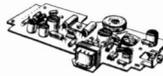


DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 13 amp sockets and on/off switch with neon warning light in metal box. Takes standard 13 amp fused plugs. Supplied complete with 7 feet of heavy cable. 39/6 wired up, ready to work plus 4/6 post and insurance.

1 WATT AMPLIFIER & PREAMP

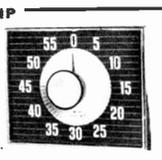
5 transistors—highly efficient, made for use with tapehead G4 but equally suitable for microphone or pick up—limited quantity 29/6. Full circuit diag. also shows tape controls 6/-.



THIS MONTH'S SNIP

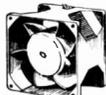
1 HOUR MINUTE TIMER

Made by famous Smiths company, these have a large clear dial, size 4 1/2 x 3 1/2in, which can be set in minutes up to 1 hour. After preset period the bell rings. Ideal for processing, a memory jogger or, by adding simple lever, would operate micro-switch. 22/6.



VARYLITE

Will dim incandescent lighting up to 600 watts from full brilliance to out. Fitted on M.K. flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob 23/6.



MINIATURE EXTRACTOR FAN

Beautifully made by famous German Company. PAPST System, 230/240 A.C. Mains operated, size 3 1/2in. x 3 1/2in. 2in. Made for instrument cooling but ideal to incorporate in a cooker hood, etc. 65/-.



STANDARD WAFER SWITCHES

Standard Size 1 1/2 water—silver plated 5 amp contact standard 1/2in spigule 2in long—with locking washer and nut.

Poles	2 way	3 way	4 way	5 way	6 way	8 way	10 way	12 way
1 pole	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
2 poles	8/6	8/6	8/6	8/6	8/6	8/6	8/6	8/6
3 poles	8/6	8/6	8/6	8/6	8/6	8/6	8/6	8/6
4 poles	8/6	8/6	8/6	8/6	8/6	8/6	8/6	8/6
5 poles	8/6	8/6	8/6	8/6	8/6	8/6	8/6	8/6
6 poles	8/6	8/6	8/6	8/6	8/6	8/6	8/6	8/6
7 poles	8/6	8/6	8/6	8/6	8/6	8/6	8/6	8/6
8 poles	10/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
9 poles	10/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
10 poles	10/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
11 poles	10/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
12 poles	10/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6

15, 30 & 100 WATT HI FI SPEAKERS

FULL FI 12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address. Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Cone Moulded fibre—Freq. response 30-10,000 c.p.s.—specify 3 or 15 ohms—Mains response 60 c.p.s.—Chassis Diam. 12in.—12in over mounting lug—Baffle hole 11in diam.—Mounting holes 4, holes 1/2in diam, on pitch circle 1 1/2in diam.—Overall height 3 1/2in. A 66 speaker offered for only £3.19.6 plus 7/6 p. & p. Don't miss this offer. 15in 25 watt £7.19.6 18in 100 watt £19.10.0.



3kW TANGENTIAL HEATER UNIT

This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only need control switch. 79/6. Postage and insurance 6/6. Don't miss this.



Where postage is not stated then orders over £3 are post free. Below £3 add 2/6. Semiconductor add 1/- post. Over £1 post free. S.A.E. with enquiries please.



MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 3/6 each. 36/- dozen, your assortment.

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. 10/- post free.

BLANKET SWITCH

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



COPPER CLAD ELEMENT

1250W—4ft long but bent to L shape, ideal for overhead heater—just mount reflector above. 12/6 each, plus 4/6 post. 26 doz. post free.

HEAT & LIGHT LAMP

275W internally mirrored bulb, with b.c. end for plugging into lamp holder. 19/6 each plus 4/6 post and insurance.

TUBULAR HEAT & LIGHT LAMP

Philips 300W 29/6 plus 4/6 post and insurance.

ELECTRIC CLOCK WITH 25 AMP SWITCH

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



THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouses, airing cupboard. Has spindle for pointer knobs. Quickly adjustable from 30-80°F. 9/6 plus 1/- post. Suitable box for wall mounting. 5/- P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnaces, ovens, kiln, immersion heater or to make flume-act or fire alarm. 8/6 plus 2/6 post and insurance.

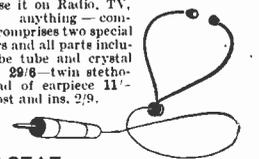
Type "D". We call this the Ice-stat as it cuts in and out at around freezing point. 2/3 amps. Has many uses one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16 x 10) is wound round the pipes. 7/6. P. & P. 1/-.

Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. 7/6, plus 1/- post.

Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50 to 150°F. Price 18/- plus 2/- post and insurance.

RADIO STETHOSCOPE

Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal capsule. 25/6—two stethoscopes instead of expensive 11/- extra post and ins. 2/9.



BECKASTAT

This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 12A loading. Will save its cost in a season. 19/6. Post and insurance 2/9.



MAINS TRANSFORMER SNIP

Making a power pack for amplifier or other equipment? These transformers have the normal mains primaries (230/240V) and isolated secondaries two types (1) 12V 300mA at 8/6; (2) 15V 500 mA at 8/6.

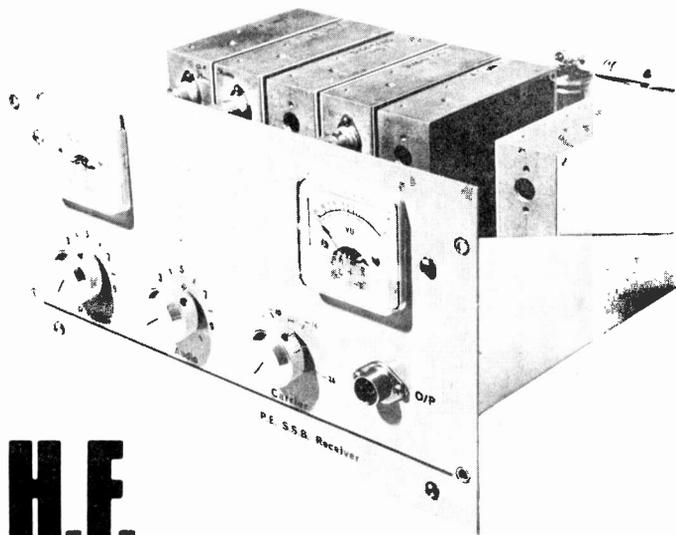


ELECTRONICS (CROYDON) LTD

Dept. PE, 266 London Road, Croydon CRO 2TH
Also 102/3 Tamworth Road, Croydon

THE Main Chassis Assembly is the interconnecting and control unit for all the modules described earlier in this series of articles and brings together the following assemblies to form the overall receiver:

- (a) The R.F. Module
- (b) The First I.F. Module
- (c) The Sideband Filter Module
- (d) The Second Oscillator Module (36MHz)
- (e) The A.F. Module
- (f) The Third Oscillator Module (2MHz)
- (g) The Power Supply Unit
- (h) The Power Supply Board
- (i) The R.F. Attenuator



P.E. WIDEBAND H.F. COMMUNICATIONS RECEIVER

By R. HIRST S.T.C. LTD. PART SEVEN MAIN CHASSIS ASSEMBLY

The main cable form running underneath the chassis assembly distributes the positive 24 volt supply, the positive 12 volt supply and the negative 12 volt supply to the appropriate units. Also in this cable form are the control wires which link up with the controls mounted on the front panel. The front panel presents all the manual controls and visual indication of the signal strength and audio levels. The output socket is also mounted on this front panel for easy access.

CONTROLS

There are three manual controls which alter the gain of the various portions of the overall receiver. The "R.F. Gain" (VR1) controls the level of the input signal which is fed to the R.F. Unit and applies a d.c. voltage to the R.F. Attenuator. This d.c. voltage varies in level depending upon the setting of the control.

The "Audio" control (VR2) controls the audio output level at the output socket. The final control marked "Carrier" (VR3) controls the gain of two stages in the i.f. amplifiers. All three of these controls reduce the sensitivity of the receiver when they are set in the fully anti-clockwise position.

MECHANICAL ASSEMBLY

The main chassis unit consists of an Imhoff BC 511 chassis and a 1690C cabinet and front panel. Holes are drilled in the chassis and front panel as indicated in the appropriate diagrams (Figs. 7.1 and 7.2). The meters and controls can then be mounted on the front panel and the panel bolted to the main chassis. The Power Supply Unit and the Power Supply Board should be fixed to the main chassis and all the front panel wiring put in at this stage (Fig. 7.3 is the interconnection circuit diagram for the main chassis), otherwise it will

be difficult to wire up the controls once the modules have been mounted. A wiring diagram for components mounted on the front panel is shown in Fig. 7.4.

At this stage the R.F. Attenuator and the separate smoothing capacitor C114 should be fitted, both of which are located underneath the main chassis. The Main Chassis Assembly is now ready to receive the modules each of which is held in position with two screws accessible from underneath the chassis. Individual earth tags should be mounted under one of these fixing screws to ensure that the units are earthed at these points. The earth pin of the modules are connected to their respective earth tag. A wiring diagram for the module interconnection is shown in Fig. 7.5. *An important point to note is that in the case of the A.F. Module, the screened lead going to the output socket should under no circumstances be earthed, as this carries the supply for the A.F. Module.*

WIRING

All the connecting leads should be kept as short as possible, and where the chokes L12 and L13 are fitted (Fig. 7.5.) they should be placed as close as possible to the a.g.c. pins of the first and second units. These chokes in conjunction with C130 and C131 give further decoupling to the d.c. control line which adjusts the basic gain of the receiver.

It may well be, if the wiring of the modules and receiver has departed from the specified layout, prudent to run two separate leads from the slider of the "Carrier" control VR3, one to the R.F. Module and the other to the First I.F. Module, using screened lead and thus avoiding any stray pickup. This point to the receiver is very sensitive and is prone to picking up any strong R.F. signal that may be floating around the set,

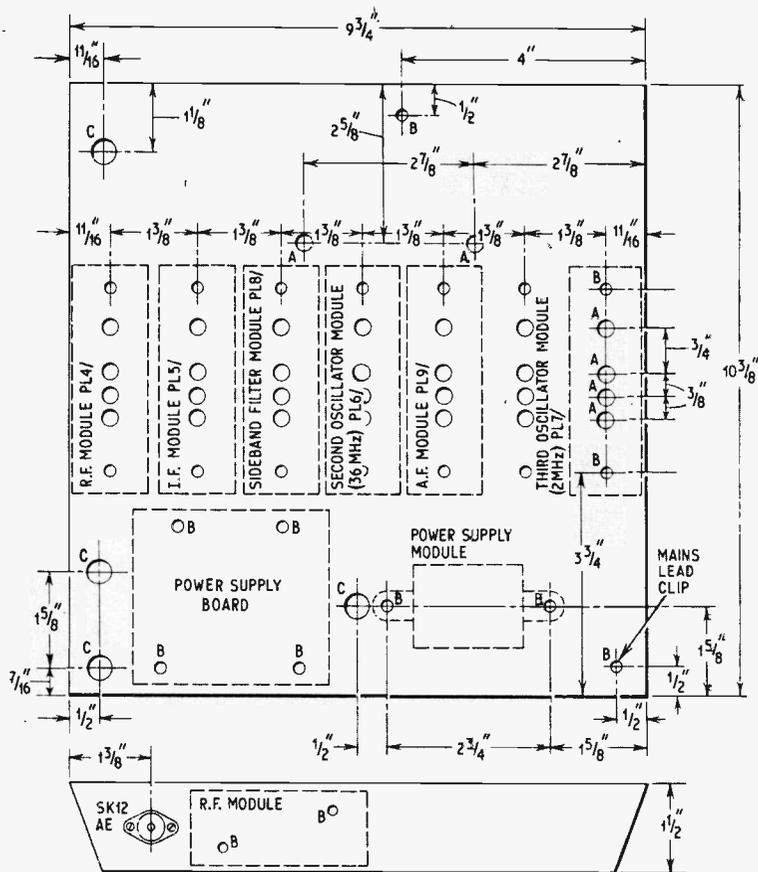


Fig. 7.1. Chassis drilling details. Positions for holes not dimensioned must be taken from the relevant components

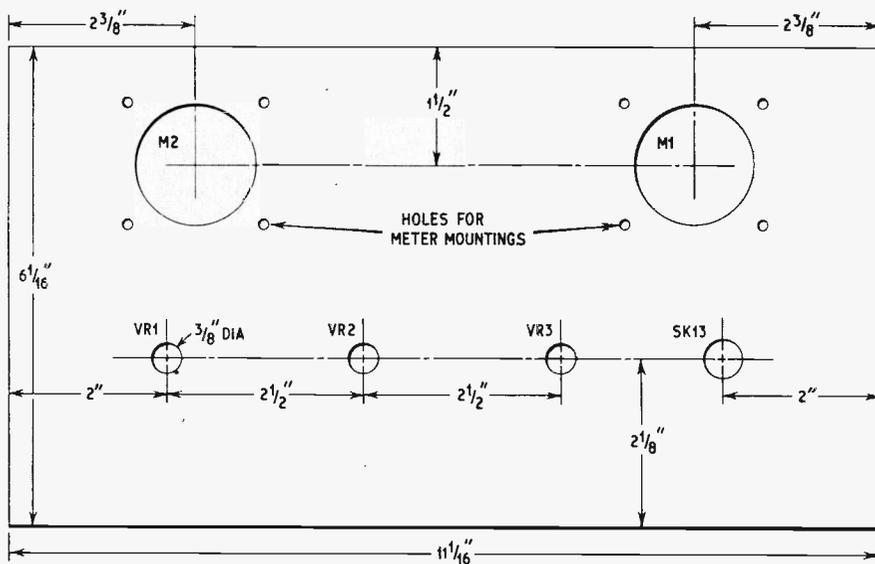
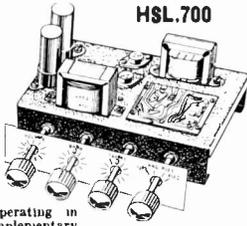


Fig. 7.2. Front panel drilling details

MONO TRANSISTOR AMPLIFIER

A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated preamplifier assembled on special printed sub panel.



HSL 700

AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for a.c. mains 200-240v. Controls: bass, treble, volume/on/off. Function selector for P.U.I., P12, tape, radio. The HSL 700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9 1/2 x 4 1/2 in. high.

Sensitivity—P.U.I.—50mV/v. 26K input impedance. P12—110mV/v, 1 meg input impedance. Tape—110mV/v, 1 meg input impedance. Radio—110mV/v, 1 meg input impedance.

Output power measured at 1Kc—6.2 watts RMS into 3 ohms, 5.8 watts RMS into 15 ohm. Overall frequency response 30c/s—18Kc/s: Continuously variable tone controls: Bass, +8db to -12db at 100c/s. Treble, +10db to -10db at 10Kc/s.

The HSL 700 has been designed for true high fidelity reproduction from radio tuner, gramophone deck and tape recorder preamp. Supplied ready built and tested, complete with knobs, attractive anodised aluminium front, escutcheon panel, long spindles (can be cut to suit your housing requirements) full circuit diagram and operating instructions.

OUR SPECIAL PRICE **£7.19.6.** P. & P. 7/6.

LOUDSPEAKER BARGAINS

5in 3 ohm 16/-, P. & P. 3/-, 7 x 4in 3 ohm 21/-, P. & P. 4/-, 10 x 6in 3 ohm 27/6, P. & P. 8/-. E.M.I. 8 x 6in 3 ohm with high flux magnet 26/-, P. & P. 4/-. E.M.I. 13 1/2 x 8in 3 ohm with high flux ceramic magnet 42/-, (15 ohm 45/-), P. & P. 6/-. E.M.I. 13 x 8in, 3 or 15 ohm with two inbuilt tweeters and crossover network 4 gns, P. & P. 6/-.

BRAND NEW. 12in 16W H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5.10.0.** P. & P. 7/6. Guitar models: 26w **£6.0.0.** 35w **£8.0.0.**

E.M.I. 3in HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohm 15/- each; 15 ohm 18/6 each. P. & P. 2/6.

13in "EA" TWIN COME LOUDSPEAKER 10 watt peak handling, 3 or 16 ohm, 27/6, P. & P. 6/-.

35 OHM SPEAKERS

3in 14/-, P. & P. 2/6; 7 x 4in 21/-, P. & P. 4/-.

80 OHM MOVING COIL SPEAKERS

High Flux Magnet 2 1/2" dia. 12/- each. P. & P. 1/6.

BALANCED ARMATURE EARPHONE

Approx. 70 ohm impedance. Can be used as ultra sensitive mike or speaker. ONLY 8/6. P. & P. 1/6

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

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE 21/-. P. & P. 1/6.

HIGH IMPEDANCE DYNAMIC STICK MIKES. High sensitivity. 39/6, P. & P. 2/6.

FTE MICROSWITCHES 5/P. C/O. Lever roller action. Rating 250v. AC in push. Size approx. 1" x 1" x 1/4". 4/- each. P. & P. 1/6 (6 or more post free).

HOYWELL MICROSWITCHES 5/P. C/O. Push-button action. Rating 250v. AC in 15 amps. Size approx. 1 1/2" x 1 1/2" x 1/2". 5/- each. P. & P. 1/6 (6 or more post free).

TELESCOPIC AERIALS WITH SWIVEL JOINT. Can be angled and rotated in any direction. 12 section Heavy Chrome. Extends from 7" to approx. 56". Maximum diameter 1 1/2". 10/- each. P. & P. 1/6. 6 section Lacquered Brass. Extends from 6" to approx. 22 1/2". Maximum diameter 1 1/2". 5/- each. P. & P. 1/6.

TRANSFORMER BARGAINS!

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternates secondary 330-0-330V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V, at 2 amps full wave. Size 3inL x 3 1/2inW x 3inD. Price **32/6.** P. & P. 6/-.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9-0-9 at 500mA. 11/-, P. & P. 2/6. Pri. 200/240V. Sec. 12-0-12 at 1 amp. 14/6, P. & P. 2/6. Pri. 200/240V. Sec. 10-0-10 at 2 amp. 27/6, P. & P. 3/6. Tapped Primary 200-220-240V. Sec. 21-5V at 500mA. 12/6, P. & P. 2/6.

BRAND NEW! PARMKO MAINS TRANSFORMERS. Primary 110v-250v secondary 330-0-330V. 100mA at 6-3v, at 2 amps, 8-3v, at 2 amps and 6-3v, at 1 amp. Conservatively rated. Fully impregnated Electrostatic screen. Suitable for vertical or drop through mounting. Overall size 4 1/2 x 3 1/2 x 3 1/2 in. Weight 8 lb. Limited number only at 27/6, P. & P. 8/-.

Open all day Saturday
Early closing Wed. 1 p.m.
A few minutes from South Wimbledon
Tube Station

SPECIAL OFFER !!

Your opportunity to acquire a first class HI-FI LOUD-SPEAKER SYSTEM at an extremely moderate price! Beautifully made teak finish enclosure with most attractive Tigran front. Size 16 1/2" high 10 1/2" wide x 6" deep. Fitted with E.M.I. Ceramic Magnet 13" 8" bass unit, two H.F. tweeter units and crossover. Power handling 10 watts. Available 3 or 15 ohm impedance.

OUR PRICE WHILE LIMITED **8 Gns.** Carriage 10/-

STOCKS LAST

TRANSISTOR STEREO 8 + 8 MK II

Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts per 3 pull output per channel (16W mono). Integrated pre-amp. with Bass, Treble and Volume control. Suitable for use with Ceramic or Crystal cartridges. Output stage for use with speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy! Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Freq. response ± 3 dB. 23-2000c/s. Bass boost approx. to $+12$ dB. Treble cut approx. to -16 dB. Negative feedback 18dB over main amp. Power requirements 25V at 0.6 amp.

PRICES: AMPLIFIER KIT **£10.10.0.** POWER PACK KIT **£3.0.0.** CABINET **£3.0.0.** All above Post. Also available STEREO 10+10. All about 10 watts per channel. PRICES: AMPLIFIER KIT **£12.** POWER PACK KIT **£3.10.0.**

Circuit diagram, construction details and parts list (free with kit) 1/8. (S.A.E.).

Official stockists of all PEAK SOUND HI-FI EQUIPMENT

including the P.W. DOUBLE 12 STEREO AMPLIFIER as featured in Practical Wireless April, May and June 1969 issues. Component pack as specified. Total cost **£23.5.6** plus P. & P. 11/-. (Excluding metalwork, knobs, plugs and sockets and fuses.)



SPECIAL PURCHASE!

E.M.I. 4-SPEED PLAYER

Heavy 8 1/2 in. metal turntable. Low flutter performance 200/250 V shaded motor (90 V tap). Complete with latest type lightweight pick-up arm and mono cartridge with 1/6 styli for LP/76. ONLY 68/-, P. & P. 6/6.

QUALITY RECORD PLAYER AMPLIFIER MK II

A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, E280 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm impedance. 12v/76. Fully built and tested. PRICE 75/-, P. & P. 6/-. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE 97/6, P. & P. 7/6.

DE LUXE QUALITY PORTABLE R/C CABINET MK II

12v cut motor board size 14 1/2 x 12 1/2 in. clearance 2 in. below, 5 1/2 in. above. Will take above amplifier and any H.F. R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 x 15 x 8 in. PRICE 79/6, P. & P. 9/6.

3-VALVE AUDIO AMPLIFIER HA34 MK II

Designed for Hi-Fi reproduction of records. A.C. Mains operation. 12v/76 built on plated heavy gauge metal chassis, size 7 1/2 in. w. x 4 in. d. x 4 1/2 in. h. Incorporates ECC83, EL84, E280 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4 1/2 watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4.15.0.** P. & P. 6/-.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **79/6.** P. & P. 6/-.

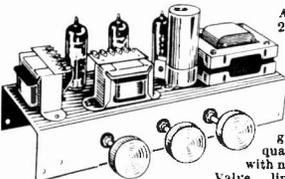
BRAND NEW TRANSISTOR BARGAINS. GET 15 (Matched Pair) 15/-, V15/10p, 10/-; OC71 5/-; OC76 6/-; AF117 2/6; 2G339 (NPN) 8/-.

Set of Mullard 6 transistors: OC44, 2-OC45, AC128D, matched pair AC128 25/-; ORP12 Cadmium Sulphide Cell 10/6. All post free.

YVNAH AND BEKINE SPEAKERS AND CABINET FABRICS app. 5 1/2 in. x 5 1/2 in. usually 25/-, 15" x 15" yd. length. P. & P. 2/0 (min. 1 yd.). S.A.E. for samples.

POWERFUL COMPACT MOTOR for 6-9v. Battery operation approx. 25mA. Made originally for "Staar" and "Greencoat" record player decks. Built in constant speed device. Ideal for models, etc. Overall size approx. 1 1/2" x 1 1/2". 7/6 each. P. & P. 1/6. (3 or more Post Free).

DE LUXE STEREO AMPLIFIER



A.c. mains 200-240 volts. Using heavy duty fully isolated transformer with full wave rectification giving adequate smoothing with negligible hum.

Valve line up: 2 x ECL82 Triode Pentodes. 1 E280 as full wave rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11 in. w. x 4 in. x. Overall height including valves 5 in. Ready built and tested to a high standard. Price **8 gns.** P. & P. 8/-.

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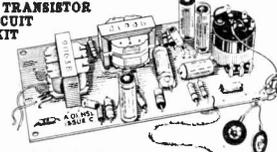
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Type TA1
● Peak output in excess of 11 watts.
● All standard British component.
● Built on printed circuit panel size 6 x 3 in.
● Generous size Driver and Output Transformers.
● Output transformer tapped for 3 ohm and 15 ohm speakers.
● Transistors (GET114 or 81 Mullard AC 128D and matched pair of AC128 o/p). ● 9 volt operation.
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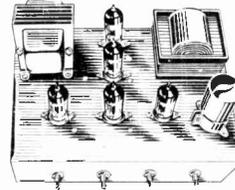
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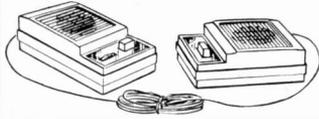
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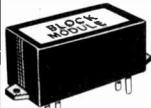
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Tape pre-amp E1312, as above.

Mic. pre-amp E1313, as above.
Power amplifier E1314: input, 1,000 ohms; gain, 20db, 300M/W; power, 9-volt d.c.

Electronic organ, tonR osc. E1315: tone freq., 200-1kHz; output, 80M/W; power, 9V; current, 15M/A.

Dual flasher E1318: flasher time, 1/4 secs; power, 6V; current, 150M/A; lamp, 6V 150M/A.

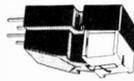
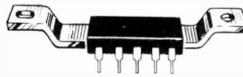
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Ceramic cartridge diamond styli.

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10 watts. 13in x 8in + two 2.2in tweeters and crossover. All wired and ready for use. This ever-popular 450. In 3-8-15 ohm imp.

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Designed to clean the heads on all cassette machines.

11/6 Plus 1/- P. & P.

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A now famous brand of tape. 7in 2,400ft, 25/-; 7in 1,800ft, 21/-; 7in 1,200ft, 13/8; 5 1/2in 1,200ft, 15/-; 5 1/2in 1,800ft, 22/6; 3in 600ft 9/9; 5in 900ft, 12/8; 5in 1,200ft, 16/-; Please note the postage and packing is FREE.



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Emitape 3in 175ft in EMI case **5/-** EACH

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A complete speaker system IN KIT FORM. We supply a modern styled teak finish cabinet with black front. Overall dimensions: 14in x 9in x 9in. Made to a very high standard. A 6in EMI woofer. A 3in tweeter. A crossover network. Acoustic wadding. Output terminals, wire and fixing hardware. Specification: Max. power, 10 watts; frequency, 65-20kHz; imp 3-8-15 ohms.

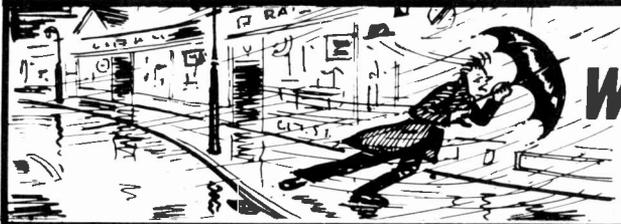
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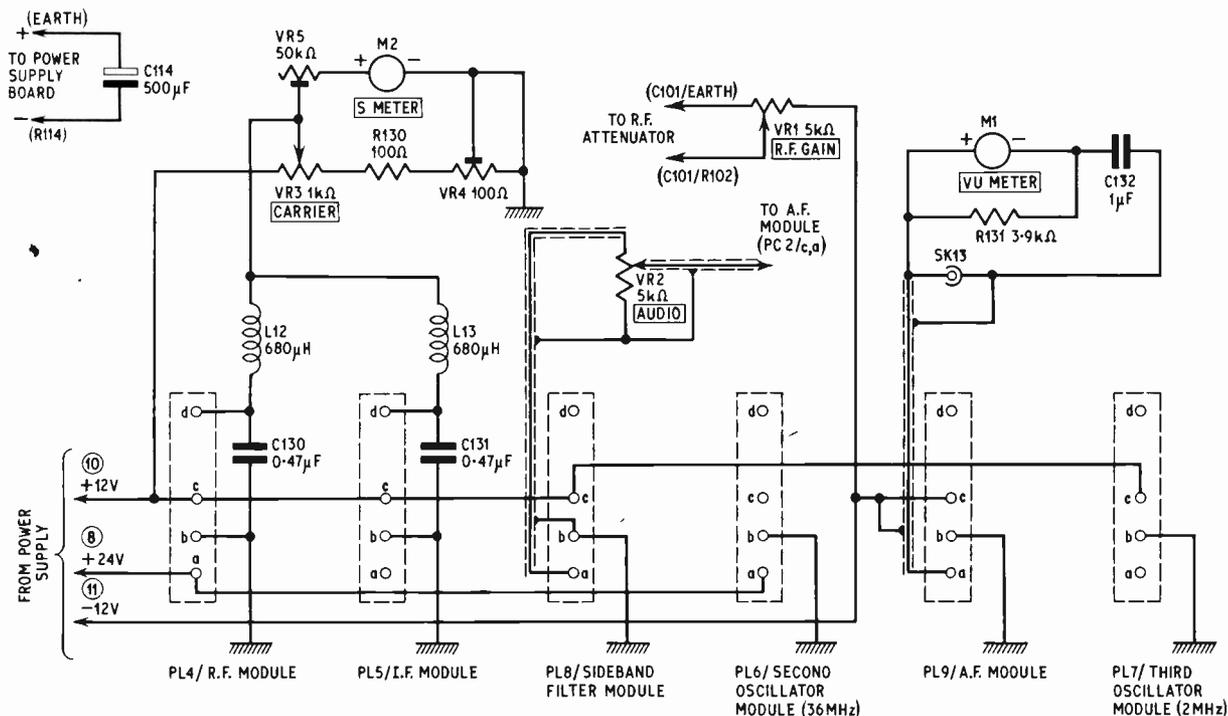


Fig. 7.3. Module and control interconnection circuit for the receiver main chassis

so care should be taken in keeping any leads that may be associated with the Second and Third Oscillator Modules well away from this area. Interconnections between the various sockets on the modules are shown in Fig. 7.6.

SETTING UP INSTRUCTIONS

Equipment required

- (a) Multimeter
- (b) Signal Generator with an output of 2MHz to 30MHz and a stability of better than 2 parts in 10^6

giving an output of at least 1 millivolt into 50 ohms.

(c) Signal Generator or Single Spot Oscillator having a range of 36MHz to 64MHz with a stability of better than 1 part in 10^6 giving an output of at least 0.7 volts into 50 ohms.

PROCEDURE

Before switching on the main chassis of the receiver, check all connections to see that they are correct. Once assured that the receiver is wired up correctly, switch on and check the d.c. levels at the appropriate

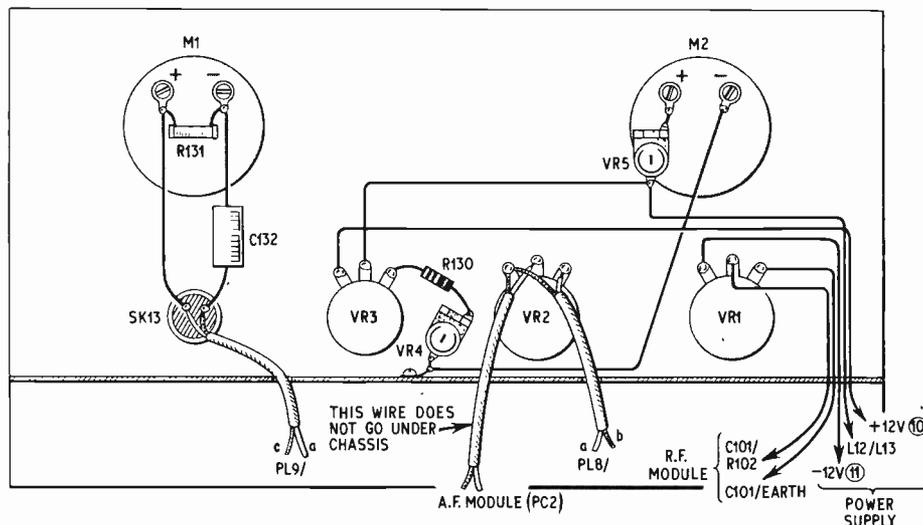


Fig. 7.4. Control and meter wiring diagram

Table 7.1.
MAIN CHASSIS D.C. VOLTAGES

Connection	Voltage	Connection	Voltage
PL4 (a)	+24V	PL7 (a)	0V
(b)	Earth	(b)	Earth
(c)	+12V	(c)	+12V
(d)	Variable	(d)	0V
PL5 (a)	0V	PL8 (a)	Audio
(b)	Earth	(b)	Earth
(c)	+12V	(c)	+12V
(d)	Variable	(d)	0V
PL6 (a)	+24V	PL9 (a)	Audio
(b)	Earth	(b)	Earth
(c)	0V	(c)	-12V
(d)	0V	(d)	0V

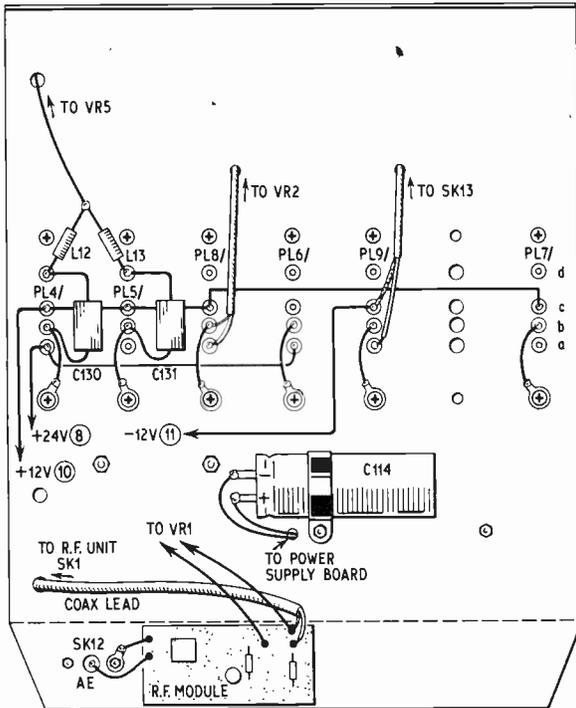


Fig. 7.5. Module wiring diagram

points to see that they correspond with those given in Table 7.1. Once these are correct proceed as follows:

Set the "Audio" control to 6 and the "R.F. Gain" and "Carrier" controls to maximum sensitivity condition (i.e. fully clockwise). Apply the local oscillator signal set to 36MHz, at a level of 0.7 volts, to SK2 on the R.F. Module. Inject a signal into the aerial socket SK1 at a level of 1 millivolt; with the frequency at 2.001MHz a 1kHz tone should be heard at the output. Both the generators should be set to within 10Hz of the specified frequency. If some warbling is heard it

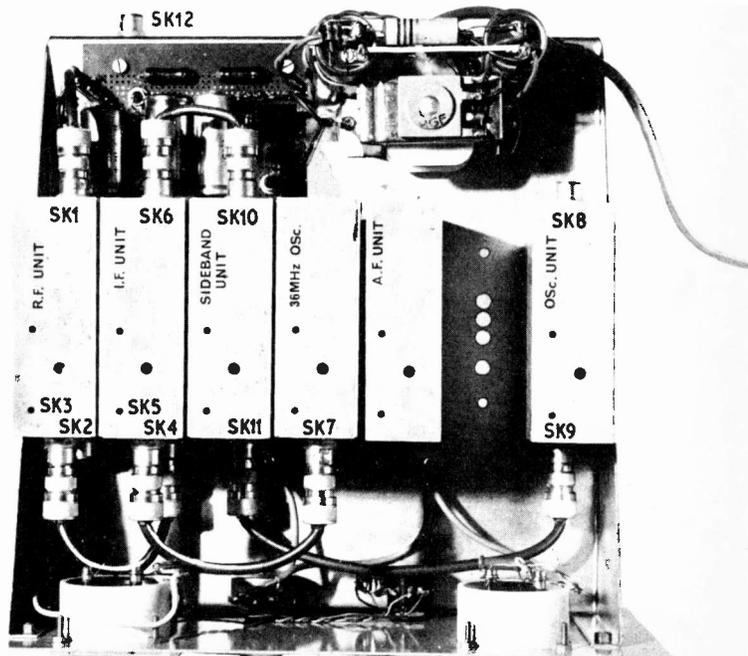
could well be that the generators are not stable enough or have not had time to warm up to their correct operating characteristics.

Reduce the level of the 2.001MHz signal to 10 microvolts and adjust VR4 for maximum audio gain as indicated on the front panel V.U. meter (M1). It may be necessary to reduce the "Audio" control during this operation to keep the pointer within the confines of the scale. Having adjusted VR4, set the "Audio" control back to 6 and increase the 2.001MHz aerial input signal level to 100 microvolts. Adjust VR5 so that the S meter (M2) reads 9dB. These last two adjustments must be made with the "Carrier" control in its fully clockwise condition.

Connect SK1 to the R.F. Attenuator unit and put the input signal at a level of 10 microvolts into SK12, with the signal set at 2.001MHz. The audio output should not be less than -6dB on the V.U. meter. To produce 1 milliwatt in the earphones when the V.U. meter reads 0dB, the earphones should be 1 kilohm impedance; under no circumstances should a load of less than 15 ohms be placed across the output socket SK13.

Next month: First Oscillator Unit

Fig. 7.6. Interconnection of coaxial sockets on the modules



COMPONENTS . . .

Resistors

- R130 100Ω ¼W carbon
- R131 3.9kΩ 1W wirewound

Capacitors

- C130 0.47μF polyester
- C131 0.47μF polyester
- C132 1μF polyester

Variable Resistors

- VR2 5kΩ linear
- VR3 1kΩ linear
- VR4 100Ω skeleton preset
- VR5 50kΩ skeleton preset

Miscellaneous

- L12, 13 680μH choke (Painton 2 off)
- M1 VU meter MR45P (-20/0+3 VU)
- M2 S meter MR45P (50-9+40dB)
- SK12 coaxial aerial socket
- SK13 socket to suit earphones
- Main chassis, Imhoff BC 511
- Cabinet and front panel, Imhoff 1690C
- 3 knobs
- Coaxial wire
- Coaxial plugs (12 off)
- Earth tags and fixings

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RESISTORS

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99	100 up
C	1/4 W	5%	100 Ω-220k Ω	E12	18d	16d	15d
C	1/2 W	5%	4.7 Ω-330k Ω	E24	2.5d	2d	1.75d
C	1 W	10%	4.7 Ω-10M Ω	E12	2.5d	2d	1.75d
MO	1/4 W	5%	4.7 Ω-10M Ω	E24	3d	2.5d	2.25d
C	1 W	2%	18 Ω-1M Ω	E24	9d	8d	7d
WW	1 W	10%	4.7 Ω-10M Ω	E12	6d	5d	4d
WW	1 W	10%	0.22 Ω-3.3 Ω	E12	15d all quantities		
WW	3 W	5%	12 Ω-10k Ω	E12	15d all quantities		
WW	7 W	5%	12 Ω-10k Ω	E12	15d all quantities		

CODES: C = carbon film, high stability, low noise. MO = metal oxide, Electroil TR5, ultra low noise. WW = wire wound, Plessey.
VALUES: E12 denotes series: 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2 and their decades. E24 denotes series: as E12 plus 1.1, 1.3, 1.6, 2, 2.4, 3, 3.6, 4.3, 5.1, 6.2, 7.5, 9.1 and their decades. Prices are in pence each for quantities of some ohmic value and power rating, not mixed values. (Ignore fractions of one penny on total resistor order.)

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

CARBON TRACK POTENTIOMETERS: Double wiper ensures minimum noise level
 Long plastic spindles. each

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Single gang log: 4k Ω, 10k Ω, 22k Ω, etc. to 2.2M Ω	each	2/6	Dual gang log: 4k Ω, 10k Ω, 22k Ω, etc. to 2M Ω	each	8/6
Any type with 1/2 amp double pole mains switch: extra	each	2/3	Log/Anti-log: 10k Ω, 47k Ω, 1M Ω only	each	8/6
			Dual anti-log: 10k Ω only	each	8/6

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NEW PLESSEY INTEGRATED CIRCUIT POWER AMPLIFIER, Type SL403A. Only 48/- nett. Operates with 18V power supply. Sensitivity 20mV into 20k Ω, 3W into 7.5 Ω Application data with two or more. P.E., Nov. 69. Stereo Amplifier kit less metalwork £11.18.2 net complete.

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

SINCLAIR IC10 Integrated Circuit Amplifier and Pre-amplifier. This remarkable monolithic integrated circuit amplifier and pre-amp is now available from stock. The equivalent of 13 transistor/18 resistor circuit plus 3 diodes and the first of its kind ever. It is d.c. coupled and applicable to an unusually wide range of uses as detailed in the manual provided with it. As advertised, post free 59/6 net.

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MEDIUM ELECTROLYTICS. Axial leads: Values (µF/V): 50/50 2/-; 100/25 2/-; 100/50 2/6; 250/25 2/6; 250/50 3/9; 500/25 3/9; 1,000/10 3/-; 500/50 4/6; 1,000/25 4/6; 1,000/50 6/-; 2,000/25 6/-; Small electrolytics, axial leads: 5/10, 10/10, 25/10, 50/10, 1/- each; 25/25, 47/25, 100/10, 220/10, 1/3 each.

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2N2926V	2/3	BC148	3/3
2N2926G	2/3	BC149	4/3
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R. M. Marston

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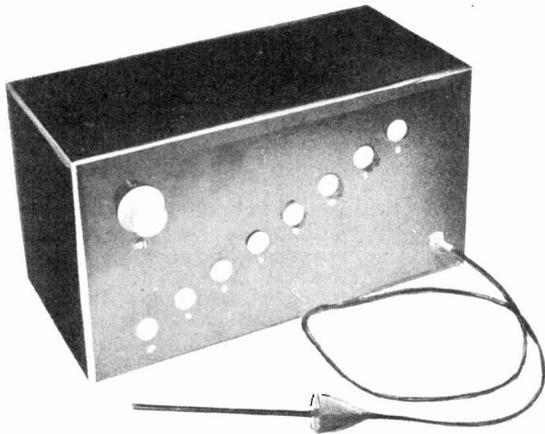
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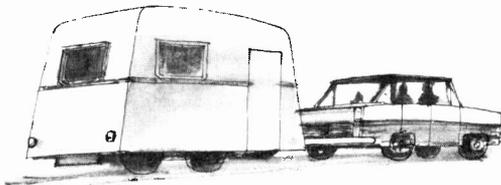
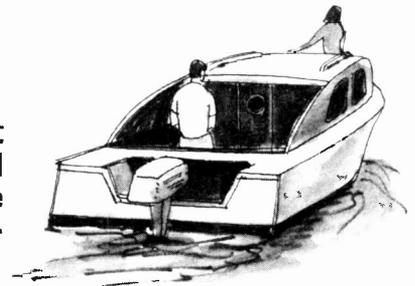


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A novelty single octave electronic musical instrument for learning rudimentary tonic sol-fa. This compact melody maker is self-contained and is simple to play using a touch probe. An instrument that will appeal to young and old both for novelty and some serious applications.

MARINE TACHOMETER

A tachometer for the boat enthusiast. This instrument has been designed for 2 stroke outboard motors and will accurately indicate the r.p.m. of the outboard. Its use will prevent "cavitation"—saving petrol—and safeguard the engine.



CAR CONVERSION FOR TOWING

This article describes the electrical conversion of a car for towing and gives constructional details of an electronic device to repeat indicator signals on the tow. A warning light system is also given and the two units can be used on any 12V car system.

Plus of course PART 2 "THIS WAY TO ELECTRONICS"

PRACTICAL
ELECTRONICS

MAY ISSUE
ON SALE
APRIL 13

Readout—

A SELECTION FROM OUR POSTBAG

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

Unqualified success . . .

Sir—I was most interested in the letter from Mr E. A. Bromfield (P.E. February 1970) headed "Academic Barrier".

I have been in various branches of the Electronics Industry since the year 1920 and have four inventions to my credit. Two were applicable only to the guided weapons work upon which I was engaged and were put on the secret list. They were manufactured and used by my employers. The other two, the Fairey Safety Ohmmeter and the Fairey Voltage Detection Meter have been used widely all over the World and in respect of which Royal Letters Patent were granted.

In view of this, I certainly consider that I am entitled to be classed as an engineer even though I do not hold a degree.

It would be most interesting to hear Mr Bromfield's opinion on this matter.

J. C. Baker,
Bristol.

who is probably doing exactly all that is required of him at present. But at some future date, I cannot see why all engineers shouldn't be expected to be qualified.

After all, an academic qualification has no destructive properties, but leaves the inventive mind still inventive but with a useful grasp of analytical methods with which to probe and prove the limitations inherent in any idea. This is usually noticeably lacking in semi-professional inventions.

As for your point of view that some people do not wish to be, or cannot attempt to become qualified, I have very little sympathy. In the case of personal hardships involved in becoming qualified, I would put my own record against anyone's, and I have as little sympathy for someone who doesn't wish to become qualified as I do for an athlete who doesn't wish to train.

In any field of human endeavour the introduction of a basic training programme has always improved performance, not diminished it. Did England win the Jules Rimet trophy by simply "having a bash"?

M. A. Stewart,
Dundee.

. . . of trained engineers

Sir—Your editorial on the "Non-Registered Engineer" and your reply to Mr Bromfield's letter on this subject, tempt me to make a few observations of my own.

The main theme of your argument is, that the fairly large body of non-qualified engineers make a really worthwhile contribution in the sphere of original invention. In the first place, how many people in the engineering industry are required to be technical innovators? Not many.

Also, if the record of inventions of the non-qualified engineers are placed alongside those of the qualified research workers, I fail to see how anyone can describe the contribution of the former as significant.

I share your concern that it is grossly unfair to attempt to dismiss the existing non-qualified engineer

Bad taste!

Sir—It is with reluctance that I feel obliged to write to an excellent magazine with a complaint.

In the February 1970 issue the critic of Roland Worcester's book "Electronics" displays remarkably bad taste by questioning the validity of the claim that this author is an authority in the field of electronics. Could it be that the critic feels he is a greater authority? Strangely, he does not add his full name after the critique but merely the initials "M.K."—a pseudonym. Using M.K.'s own argument, one is led to wonder whether he is in fact qualified to make criticisms of the book. A book which, though it doubtless has its faults, is excellent value for money and attempts to cover a much wider field than any comparable work.

Stephen J. Waller,
Belvedere,
Kent.

Your Throw

Sir—After I built my Stockmarket game, I constructed a very simple, relatively inexpensive electronic die. Perhaps your readers would be interested in the circuit.

I used a Raytheon CK8754 Datavue numerical indicator tube (\$5.60) operated by a simple half-wave power supply and a 24 position rotary switch. Incidentally, a Burroughs B5440 or a National NL840 tube could have been used just as well; they are all about the same. I am sure that there are comparable readout tubes available in England.

I removed the detent (click-stop) mechanism from the rotary switch so that it rotates continuously with little friction. On the shaft of the switch I installed a tuner type flywheel to provide coasting inertia. A suitable flywheel is available from Electroniques, Edinburgh Way, Harlow, Essex, catalogue number 4522. The switch shaft is also fitted with a large knob.

Every four contacts on the 24 position switch are connected to one of the cathodes of the numeral indicator tube. For example, the first four switch contacts go to the number 1 cathode. The next four switch contacts are wired to the number 2 cathode on the tube, and so on.

To use this electric die, all I do is spin the switch shaft and the flywheel causes the switch to spin to a random stop after a few rotations. The result is that a number from 1 to 6 is illuminated in the readout tube. The number is random of course, depending on how fast the switch is spun, etc. The switch should be the shorting (make-before-break) type. This type of switch results in a more positive change.

I mounted the whole thing in a 5 × 3 × 2in metal box. This electro-mechanical approach is the cheapest way to have an electronic die. Using the driver-decoder circuits made for these readout tubes was out of the question because of their cost and complexity.

Ken Greenberg,
Chicago,
U.S.A.

Since the Electronic Stockmarket Game was published many ideas for a dice (or "die" as some prefer to call it) have been received. Some, like the example described above, are semi-electronic, and others are entirely electronic. We hope shortly to publish full details of a few of these all electronic dice designs.

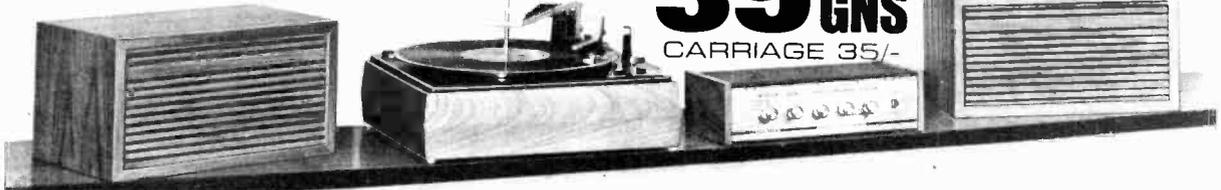
Although it is not possible to publish all ideas submitted, (a certain amount of similarity or duplication inevitably occurs) we do thank all those who sent in their ideas on this subject.—Ed.

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TELETON SAQ203E STEREO AMPLIFIER



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A small but powerful amplifier designed for stereo hi-fi reproduction. Incorporates 16 transistors and diodes. 10 watts per channel music power. Inputs for Gram (Magnetic and Crystal), Tuner and Auxiliary. Tape Record output. Controls: Volume, Balance, Bass, Treble. Stereo/Mono slide switch. Stereo headphone socket. Attractive teak cabinet with brushed aluminium front panel. List Price £28.7.0

"NOVA" 505 TRANSISTOR STEREO AMPLIFIER



A superb stereo amplifier offering every facility for the hi-fi enthusiast. Output 6 watts per channel. Frequency response 40-20,000Hz ± 3dB. Inputs for Radio, P.U. Ceramic, P.U. Magnetic Tape. Separate bass and treble controls, Volume and Balance Controls. Mono/Stereo Switch. Also features headphone socket and tape output. Teak case with attractive illuminated front panel. Size 14 1/2" x 8 1/2" x 2 1/2". a.c. 200/250V.

WONDERFUL VALUE AT ONLY **18 gns.** Carr. 10/-

PREMIER STEREO SYSTEM "FOUR"

Teleton SAQ203E Amplifier (as above)	£23.2.0
Garrard SP25	£11.19.6
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Teak base and cover	£5.10.0
Pair of 3-Unit Hi-Fi Enclosures fitted E.M.I. Speakers	£26.5.0
Total cost if purchased separately	£73.16.0

PREMIER PRICE **65 GNS.** Carr. 35/-

PREMIER STEREO SYSTEM "TWO" 45 GNS.

As system 'ONE' above but with Garrard SP25. Carriage 35/-.

VERITAS V-149 MIXER

Battery operated 4-channel audio mixer providing four separate inputs. Size 6 x 3 x 2in. suitable for crystal microphone, low impedance microphone with transformer, radio, tape, etc. Max. input 1.5V, max. output 2.5V, gain 6dB. Standard jack plug socket inputs, phono plugs output. Attractive teak wood grain finish case. Mono Model 59/6 Stereo Model 69/6 P. & P. 2/6.



PREMIER STEREO SYSTEM "THREE"

Nova 505 Amplifier (as above)	£18.18.0
Garrard SP25	£11.19.6
Sonotone 9TAHCD	£2.15.0
Teak base and cover	£5.10.0
Pair of 3-Unit Hi-Fi Enclosures fitted E.M.I. Speakers	£26.5.0
Total cost if purchased separately	£65.7.8

PREMIER PRICE **55 GNS.** Carr. 35/-

SANYO M48M CASSETTE TAPE RECORDER

A truly compact lightweight recorder size 8 x 4 1/2 x 2 1/2in. 5 transistors and 1 diode. AC Bias. 2 1/2in. speaker. Record level indicator. Earphone socket. Complete with carrying strap, remote control microphone with pouch and tape cassette. Output 300mW. Operates on 4 U11 batteries.



PRICE **£21** P. & P. 7/6

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A must for all tape users! Tape heads become permanently magnetized with constant use; this leads to background noise that prevents perfect recordings. Simply applied to recording head the V313 leaves head free of magnetism. Cleans any tape head in seconds. P. & P. 1/6

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Complete with battery and 50ft connecting wire. Compact size, two way call system. Ideal for home, office, factory, etc. **65/-** P. & P. 4/-



FOUR STATION INTERCOM. Master unit and 3 slaves. Ideal for office and home. Complete with battery and connecting wire **£7.19.6.** P. & P. 5/6.

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C60 (60 min.)	7/6
THREE FOR 21/-	
C90 (90 min.)	12/6
THREE FOR 38/-	
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Removes unwanted deposits from delicate tape heads. Fits all cassette recorders. P. & P. **11/6** 1/-

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TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped—attractively boxed.

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SP6 5' 600' P.V.C.	8/6	SP7 7' 1200' P.V.C.	12/6
LPS 5' 900' P.V.C.	10/-	DT7 7' 2400' POLYESTER	25/-
DT5 5' 1200' POLYESTER	15/-	TT7 7' 3600' POLYESTER	50/-

TAPE SPOOLS 3' 1/-, 5', 5 1/2', 7' 1/0. TAPE CASES 5', 7' 2/6. Post and Packing 3' 1/-, 5', 5 1/2' 1/6, 7' 2/- (3 reels and over Post Free.)



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AF181	8/6	BSX78	6/6	NKT301	16/-	TIS47	3/3	2N1307	5/-	2N3906	7/6	BY121	6/6	
AF186V	9/-	BSY27	4/-	NKT302	11/-	TIS48	3/6	2N1308	7/-	2N4037	15/-	BY123	5/6	
AF186G	9/-	BSY29	5/6	NKT303	10/-	TIS49	3/6	2N1309	7/-	2N4058	4/6	CG42	4/8	
AF239	7/6	BSY32	5/6	NKT305	9/6	TIS50	5/6	2N1406	34/6	2N4058	5/-	CG63	2/6	
AFY19	22/6	BSY36	5/6	NKT351	8/-	TIS51	4/-	2N1507	4/8	2N4059	5/-	CG64	2/6	
AFZ11	8/-	BSY37	4/6	NKT352	7/6	TIS52	4/-	2N1613	5/6	2N4060	5/-	CG61	2/6	
AFZ12	10/-	BSY38	4/6	NKT401	17/6	TIS53	6/6	2N1671A	2N4061	4/6	CG62	2/6		
ASV26	5/-	BSY95A	6/6	NKT402	24/-	TIS60	6/6		2N4062	4/6	CG2	2/6		
ASV27	6/-	BSV41	5/6	NKT403	15/-	TIS61	7/-	2N1711	6/6	2N4284	3/-	EA403	3/6	
ASV28	6/-	BSV70	8/6	NKT404	12/6	SW30C	18/-	2N1893	10/6	2N4285	3/-	EC401	5/6	
ASV29	6/6	BTX39/600	120/-	NKT405	15/-	U23AAA	5/-	2N2147	17/-	2N4286	3/-	EC402	4/8	
ASZ21	7/6		120/-	NKT406	15/-	V205	20/-	2N2152	27/6	2N4287	3/-	EB383	3/6	
AUY10	30/-	BTX40/600	120/-	NKT451	12/6	V405A	9/3	2N2148	14/6	2N4288	3/-	GEX45/1	4/-	
ATZ10	4/6		120/-	NKT452	12/6	XA102	6/6	2N2160	12/9	2N4289	3/-	GJ3M	4/6	
B2M	12/6	BTY87/150R	31/-	NKT453	10/-	XA702	15/-	2N2243	26/-	2N4290	3/-	OA9	3/8	
B3M	2/9	CI06F1	9/6	NKT613F	5/-	ZE1277	15/-	2N2368	5/-	2N4291	3/-	OA10	6/6	
BC107	2/9	CI11	19/-	NKT674	5/-	ZT22	19/-	2N2369	5/-	2N4292	3/-	OA47	1/6	
BC108	2/9	CI11E	12/-	NKT675	5/-	ZT86	27/6	2N2369A	5/6	2N4871	6/9	OA70	1/6	
BC109	2/9	CI11E	12/-	NKT676	5/-	ZT2270	19/6	2N2432	67/-	2N5027	10/6	OA73	1/6	
BC113	5/-	C400	9/-	NKT677F	5/-	40250	12/6	2N2484	8/-	2N5028	11/6	OA79	1/6	
BC115	6/6	C426	8/3	NKT703	8/-	40309	9/6	2N2613	7/6	2N5029	9/6	OA81	1/6	
BC116	8/-	C444	9/8	NKT713	7/6	40310	13/-	2N2614	4/-	2N5030	8/6	OA85	1/6	
BC118	5/-	CI31T	10/-	NKT713	7/6	40310	13/-	2N2646	10/-	2N5172	3/-	OA90	1/6	
BC125	11/-	CI102	6/6	NKT713	7/6	40310	13/-	2N2711	6/-	2N5174	10/6	OA91	1/6	
BC126	11/-	CI113	4/-	NKT10339	4/6	6/6	40314	10/6	2N2712	6/-	2N5175	10/6	OA95	1/6
BC134	5/-	GET114	4/-		6/6	40314	10/6	2N2713	5/6	2N5176	9/6	OA200	2/6	
BC135	6/-	GET120	6/-		6/6	40315	10/6	2N2904	8/6	2N5232	5/6	OA202	2/6	
BC136	8/-	GET880	9/-		6/-	40316	13/-	2N2904A	8/-	2N5249	13/6	SD19	7/6	
BC137	8/6	GET887	4/-	NKT10429	40317	11/-	40319	15/-	2N2905	10/6	2N5250	13/6	TD716	12/-
BC138	3/3	GET889	6/6	NKT10519	40320	10/6	2N2905A	8/-	2N5251A	9/6	2N5305	7/6	IN44	4/6
BC140	2/9	GET890	4/6	NKT10519	40320	10/6	2N2924	8/-	2N5305	7/6	IN40	4/6		
BC147	2/9	GET896	4/6	NKT16229	40324	12/6	2N2924	4/-	2N5306	8/-	IN64	4/6		
BC148	3/3	GET897	4/6		40326	10/6	2N2925	3/6	2N5309	12/6	IN82A	9/6		
BC149	3/3	GET898	11/-		40329	7/6	2N2926	2N5354	5/6	IN87A	4/6			
BC154	12/-	GEX45/1	3/-	NKT20329	40329	7/6	2N2926	2N5355	5/6	IN191	5/6			
BC167	3/6	MAT100	5/6	OC20	11/-	40344	8/-	Green	2N5355	5/6	IN191	5/6		
BC168	3/6	MAT100	5/6	OC20	19/6	40347	9/6	2N2926	2N5356	10/6	IN194	1/9		
BC169	3/9	MAT120	5/6	OC22	8/-	40348	14/6	Yellow	2N5356	29/6	IN4001	2/6		
BC182L	3/6	MAT121	5/6	OC23	8/-	40360	11/6	2N2926	3N128	18/6	IN4005	5/6		
BC183L	2/6	MJ400	21/6	OC24	8/-	40361	12/-	Orange	3N140	19/6	IN4007	5/6		
BC184L	3/6	MJ420	22/6	OC25	7/6	40362	14/-	2N2926	3N141	21/6	IN4148	1/9		
BC212L	3/9	MJ421	22/6	OC26	6/6	40370	8/6	Brown	2N3142	16/6	IS113	4/6		
BCY10	10/6	MJ430	20/6	OC28	12/-	40406	16/-	2N3011	12/6	3N143	19/6	IS44	1/9	
BCY12	12/6	MJ440	21/6	OC29	9/6	40408	14/6	2N3016	39/6	3N152	22/-	IS130	2/6	
BCY30	5/6	MJ480	20/6	OC36	12/6	40467	16/6	2N3055	5/-	5S001	10/6	IS131	2/6	
BCY31	5/6	MJ481	27/-	OC41	4/6	40468A	16/6	2N3054	12/6	2S002	12/6	IS132	3/6	
BCY32	10/-	MJ490	22/6	OC42	4/6	40602	9/9	2N3055	15/-	2S003	12/6			
BCY33	4/-	MJ491	19/6	OC43	4/6	2G301	3/6	2N3133	6/-	2S004	15/-			
BCY34	5/-	MPF102	8/6	OC44	3/6	2G302	3/6	2N3135	6/-	2S005	15/-			
BCY38	10/-	MPF103	7/6	OC45	3/6	2G306	8/6	2N3136	6/-	2S006	15/-			
BCY40	5/-	MPF104	7/6	OC70	2/6	2G339A	5/-	2N3235	28/6	2S012	25/6			
BCY42	4/-	MPF105	8/-	OC71	3/6	2G371	3/6	2N3234	27/6	2S012A	22/6			
BCY43	4/-	MPS3638	6/6	OC72	4/6	2G371B	3/6	2N3391A	6/-	2S017	15/6			
BCY54	7/6	NKT0013	9/6	OC75	4/6	2G374	5/-	2N3392	5/-	2S018	17/6			
BCY70	4/6	NKT121	11/-	OC76	2/6	2G378	7/6	2N3393	5/-	2S019	19/6			
BCY71	8/-	NKT122	8/-	OC77	5/6	2G381	5/-	2N3394	4/9	2S104	12/6			
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BCZ11	7/6	NKT127	5/6	OC82	5/-	N2217	7/6	2N3404	7/6	2S203	10/-			

Complete stereo system — £29.10.0

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

Type 1 SPECIFICATION:— Impedance 10 ohms. It incorporates Goodmans high flux 6" x 4" speaker and 2 1/2" tweeter. Teak finish 12" x 6 1/2" x 5 1/2". 4 guineas each. 7/6d. p. & p.
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Duetto Integrated Transistor Stereo Amplifier **£9.10.0**
plus 7/6d. p. & p.

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

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



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



The Classic

Teak finished case

£9

Plus P. & P. 7/6

SPECIFICATION: Sensitivities for 10 watt output at 1KHz into 3 ohms. Tape Head: 3mV (at 32 i.p.s.) Mag. P.U.: 2mV. Cer.P.U.: 80mV. Tuner: 100mV. Aux. 100mV. Tape/Rec. Output. Equalisation for each input is correct to within +2dB (R.I.A.A.) from 20Hz to 20KHz.

Tone Control Range: Bass: 13dB at 60Hz. Treble: +14dB at 15KHz. Total Distortion: (for 10 watt output) < 1.5%. Signal Noise: < -60dB. A.C. Mains 200-250V. Size 12 1/2in long, 4 1/2in deep, 2 1/2in high. Built and tested.



THE RELIANT Mk. II SOLID STATE GENERAL PURPOSE AMPLIFIER

£6.16.0 Plus P. & P. 7/6

In teak finished case

SPECIFICATION: Output: 10 watts into a 3 ohms speaker.

Inputs: (1) for mike (10mV). Input (2) for gram. radio (250mV) individual bass and treble control.
Transistors: 4 silicon and three germanium. **Mains input:** 220/250 volts. Size: 10 1/2" x 4 1/2" x 2 1/2in. Mk. I £5.15.0 plus 7/6 P. & P. Less teak finished case.

THE ELEGANT SEVEN Mk. III (350mW Output)

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

Price £5.5.0 Plus P. & P. 7/6.

Circuit 2/6. Free with parts.



THE DORSET (600mW Output)

7-transistor fully tunable M.W.-L.W. Superhet portable with baby alarm facility. Set of parts. The latest modulated and pre-alignment techniques makes this simple to build. Sizes: 12" x 8" x 3 1/2in.
MAINS POWER PACK KIT: 9/6 extra.



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Circuit 2/6. Free with parts.



The Viscount INTEGRATED HIGH FIDELITY TRANSISTOR STEREO AMPLIFIER

£14.5.0

Plus P. & P. 7/6

SPECIFICATION: Output: 10 watts per channel into 3 to 4 ohms speakers (20 watts monaural). Input: 6-position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All inputs 100mV into 18M ohms. Frequency Response: 40Hz-20KHz ± 2dB. Tone Controls: Separate bass and treble controls. Treble 13dB lift and cut (at 15KHz). Bass: 15dB lift and 25dB cut (at 60Hz). Volume Controls: Separate for each channel. A.C. Mains Input: 200-240V, 50-60Hz. Size: 12 1/2" x 6 1/2" x 2 1/2in teak-finished case. Built and tested. P. & P. 7/6.
Viscount Mark II for use with magnetic pick ups specification as above. Fully equalised for magnetic pick ups. Suitable for cartridges with minimum outputs of 4mV/cm/sec. at 1Kc. Input impedance 47k. 15 gms. plus 7/6 P. & P.

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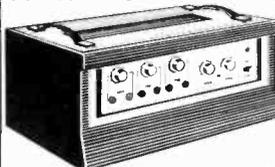
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TECHNICAL SPECIFICATIONS: 3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The volume controls for each channel are located directly above the corresponding input sockets. **SENSITIVITIES AND INPUT IMPEDANCES:** Channels 1 & 2 4mV at 470K. These 2 channels (4 inputs) are suitable for microphone or guitars. Channels 3 & 4 300 mV at 1M. Suitable for most

high output instruments (gram, tuner, organ etc.). Input sensitivity relative to 10w output. **TONE CONTROLS ARE COMMON TO ALL INPUTS.** Bass Boost +12dB at 60 Hz/s. Bass Cut -13dB at 60 Hz/s. Treble Boost +11dB at 15 KHz/s. Treble Cut -12dB at 15KHz/s. With bass and treble controls central -3dB points are 30Hz/s and 20 KHz/s. **POWER OUTPUT:** For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For sine wave 38.5 watts rms. Nearly 80 watts peak. Total distortion at rated output 3.2% at 1KHz/s. Total distortion at 20 watts 0.15% at 1KHz/s. Output to match into 8 or 15 ohms speaker system. **NEGATIVE FEED BACK** 20dB at 1KHz/s. **SIGNAL TO NOISE RATIO** 60dB. **MAINS VOLTAGES:** Adjustable from 200-250V. A.C. 50-60Hz/s. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.

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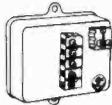
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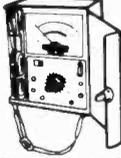
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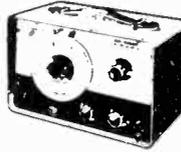


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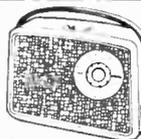
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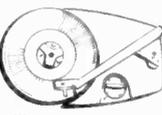
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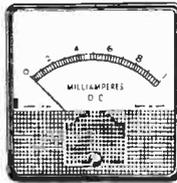
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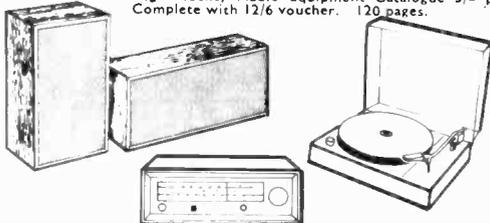


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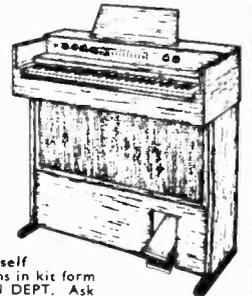
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2N2540	4/6	2N5030	8/6	AF179	11/6	BFX68	13/6	MJ440	19/6	OC205	8/6
2N2613	7/9	2N5172	3/6	AF180	12/6	BFX68A	13/6	MJ480	20/6	OC207	7/6
2N2614	7/6	2N5174	10/6	AF181	8/6	BFX84	8/6	MJ481	22/6	OC208	10/6
2N2645	6/-	2N5175	10/6	AF239	7/6	BFX85	10/6	MJ490	27/6	ORP12	12/6
2N2646	11/6	2N5176	9/6	AF279	16/6	BFX86	8/6	MJ491	29/6	ORP60	10/6
2N2696	6/6	2N5232	5/6	AF280	16/6	BFX87	10/6	M1800	43/6	ORP61	10/6
2N2711	6/6	2N5234	5/6	AF211	5/6	BFX88	5/6	MJE340	15/-	P346A	4/6
2N2712	6/6	2N5245	12/6	AS526	5/6	BFX89	12/6	MJE520	19/6	TIP31A	19/6
2N2713	5/6	2N5246	12/6	AS527	8/6	BFX92A	12/6	MJE521	19/6	TIP32A	22/6
2N2714	6/6	2N5249	13/6	AS528	5/6	BFY10	4/6	MPF102	8/6	TIS34	17/6
2N2865	12/6	2N5249A	13/6	AS529	5/6	BFY11	4/6	MPF103	9/6	TIS43	8/6
2N2904	8/6	2N5265	62/6	AS536	5/6	BFY12	4/6	MPF104	7/6	TIS44	2/6
2N2904A	8/6	2N5266	37/6	AS537	5/6	BFY13	4/6	MPF105	8/6	TIS45	3/6
2N2905	8/6	2N5274	52/6	AS550	5/6	BFY17	4/6	MPS5638	6/6	TIS46	3/6
2N2905A	8/6	2N5305	7/6	AS553	5/6	BFY18	4/6	NKT0013	9/6	TIS47	3/6
2N2906	6/6	2N5306	8/6	AS554	5/6	BFY19	4/6	NKT124	8/6	TIS48	3/6
2N2906A	8/6	2N5307	7/6	AS562	5/6	BFY20	12/6	NKT125	5/6	TIS49	3/6
2N2907	6/6	2N5308	7/6	AS563	3/6	BFY21	8/6	NKT126	5/6	TIS50	3/6
2N2923	4/6	2N5309	12/6	AS572	5/6	BFY24	9/6	NKT128	5/6	TIS51	4/6
2N2924	4/6	2N5310	8/6	AS579	3/6	BFY25	5/6	NKT135	5/6	TIS52	4/6
2N2925	3/6	2N5354	5/6	AS586	6/6	BFY26	4/6	NKT137	6/6	TIS53	6/-
2N2926	3/6	2N5355	5/6	AS520	7/6	BFY29	10/6	NKT210	6/-	TIS60	6/6
2N2927	3/6	2N5356	6/6	AS521	7/6	BFY30	10/6	NKT211	6/-	TIS61	6/6
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2N2929	3/6	2N5366	10/6	BC107	3/6	BFY43	12/6	NKT213	6/-	ZTX108	3/6
2N3011	12/6	2N5367	11/6	BC108	3/6	BFY50	4/6	NKT214	4/6	ZTX109	3/6
2N3014	6/6	2N5450	7/6	BC109	3/6	BFY51	4/6	NKT215	4/6	ZTX300	4/6
2N3053	6/6	2N5005	15/6	BC113	6/6	BFY52	4/6	NKT216	7/6	ZTX301	4/6
2N3054	12/6	2N5020	37/6	BC115	6/6	BFY53	5/6	NKT217	8/6	ZTX302	5/6
2N3055	15/6	2N5102	6/6	BC116	12/6	BFY56A	11/6	NKT219	6/-	ZTX303	5/6
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700	12-24	2 c/o	12/6
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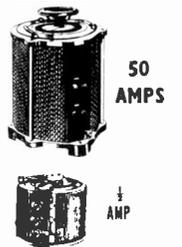
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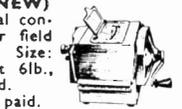
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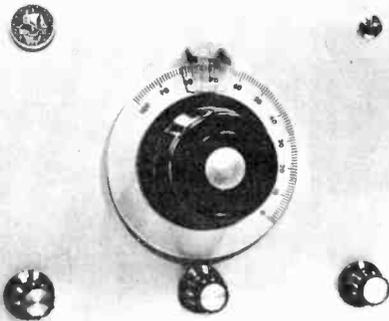
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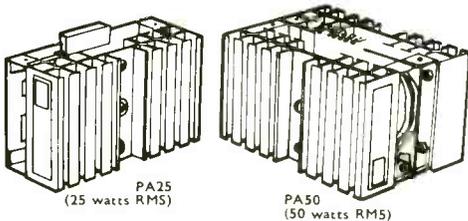
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