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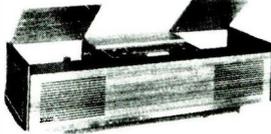
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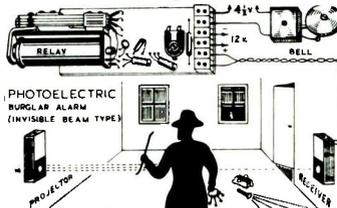
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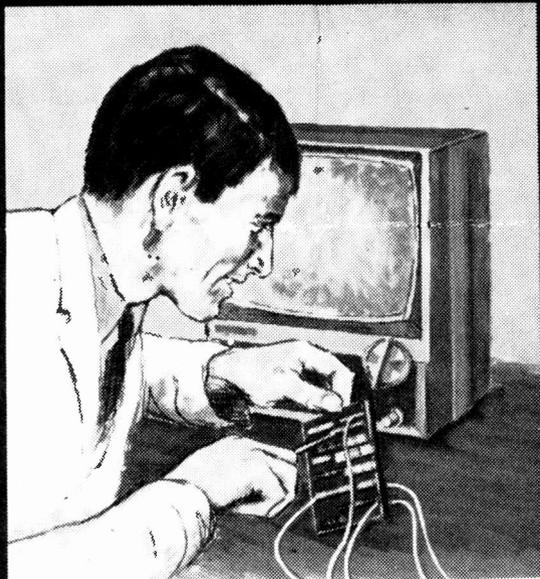
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High stability carbon film. Very low noise. 0.5 watt 5% 4.7 ohms to 2.2MΩ 2d each. 0.5 watt 10% 4.7 ohms to 10MΩ 2d each.

DEVELOPMENT PACK
0.5 watt 5% resistors 5 off each value 4.7Ω to 1MΩ
325 resistors E12 series 50/-
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4 WATT WIRE WOUND RESISTORS 1/6 each.
10% 1-0, 1-8, 2-7, 3-3, 3-9, 4-7, 5-6, 6-0, 6-8, 8-2 ohms.
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200μF	6.4V	20μF	10V	10μF	15V	10μF	25V	50μF	40V
320μF	6.4V	25μF	10V	16μF	15V	16μF	25V	10μF	64V
6.4μF	10V	64μF	10V	25μF	15V	25μF	25V	2.5μF	64V

1/- each, 10/6 doz.

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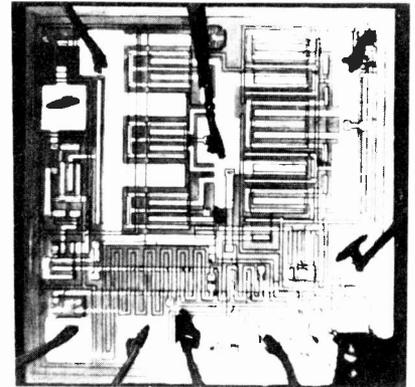
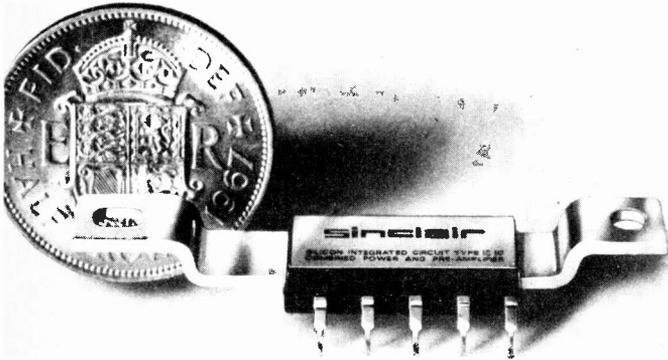
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MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP



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.

SINCLAIR
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 remarkable 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 snags are that one's needs can change and 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 what 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, 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 PZ-6 is stabilised whilst the PZ-5 is not. 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 PZ-5 or PZ-6 unless loudspeakers of very

low efficiency are being used.

In view of the very high performance of a 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 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 into virtually every known type of plinth or cabinet and templates provided enable you to position them. Only holes have to be drilled into the wood of the plinth and they are covered by the aluminium front panel of the Stereo 60. The Project 60 manual gives all the instructions you can possibly want clearly and concisely.

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

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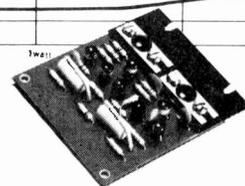
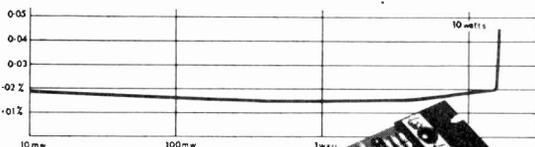
ADVANCED DESIGN MODULES FOR USE AS A TOTAL ASSEMBLY OR INDIVIDUALLY

Z-30 TWENTY-FOUR WATT CONTINUOUS SINE WAVE 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 Project 60 manual.

SPECIFICATIONS

Power output—15 watts continuous sine wave into 8 ohms using a 35 volt supply ; 24 watts continuous sine wave into 3 ohms using a 30 volt supply.
 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.
 Size: $3\frac{1}{2} \times 2\frac{1}{4} \times \frac{1}{2}$ inches.
 Input Impedance: 100 Kohms.
 Damping Factor: >500.



Ready for immediate installation with Project 60 manual

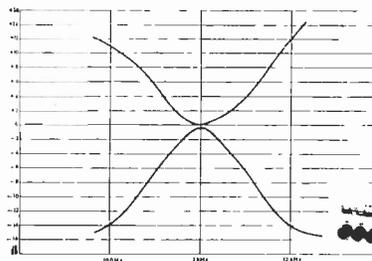
89/6

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.

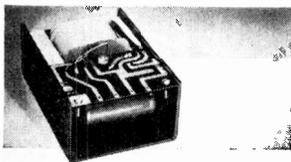
SPECIFICATIONS

- Input sensitivities—Radio—up to 3mV ; Magnetic Pickup—3mV ; Ceramic Pickup—up to 3mV ; Auxiliary—up to 3mV.
- Output—1 volt.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone Controls—TREBLE +15 to -15dB. at 10 KHz: BASS +15 to -15dB at 100 Hz.
- Power consumption 5mA.



Ready for immediate installation

£9. 19s. 9d.



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. 10s. 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.

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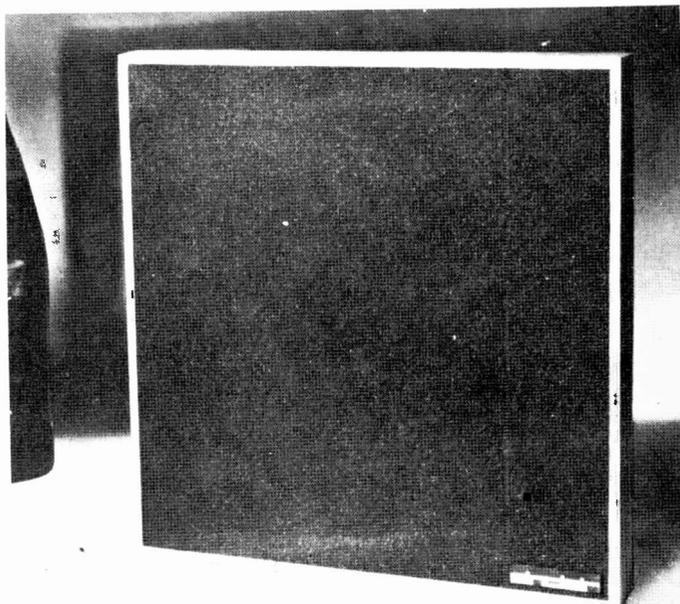
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Q.16

new elegance in an outstanding loudspeaker

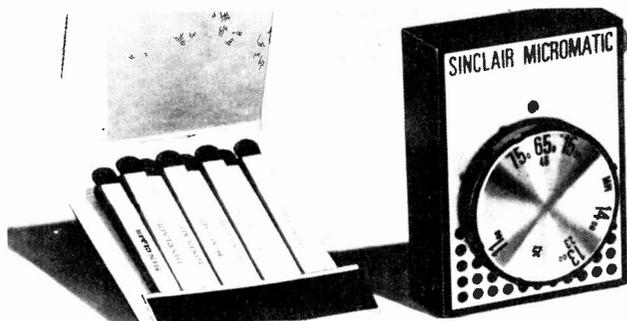
All the superb features which went to make the Sinclair Q.14 have been incorporated in the new Q.16 which gives an exciting new opportunity for you to match your Sinclair equipment with modern decor. Employing the same well proven acoustic system in which materials, processing and styling are used in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

£8.19.6
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SINCLAIR MICROMATIC The world's most successful miniature radio



Specifications

Size: $1\frac{1}{2}$ " \times $1\frac{1}{2}$ " \times $\frac{1}{2}$ " (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.

49/6

Inc. P/Tax

Ready built, tested and guaranteed, with earpiece.

59/6

Inc. P/Tax

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

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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 reception of Radio 1 easy at all times. Vernier type tuning plus the directional properties of the self-contained special ferrite rod aerial 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.

SINCLAIR GENERAL GUARANTEE

Should you not be completely satisfied with your purchase when you receive it from us, return the goods without delay and your money will be refunded in full, including cost of return postage, at once and without question. Full service facilities are available to all Sinclair customers.

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2kW FAN HEATER

Three position switching to suit changes in the weather. Switch up for full heater (2 kW), switch down for half heat (1kW), switch central blows cold for summer cooling—adjustable thermostat acts as auto control and safety cut-out. Complete kit **£3.15.0**. Post and ins. 7/6.

MINIATURE EXTRACTOR FAN



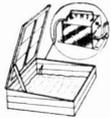
Beautifully made by famous German Company. PAPST System. 230/240 a.c. mains operated, size 3 1/2in. x 3 1/2in. x 2in. Made for instrument cooling but ideal to incorporate in a cooker hood, etc. **65/-**.



SPRING COIL LEADS as fitted to telephones. 4 core 2/6 each, 3 core 2/- each.

QUICK CUPPA

Mini Immersion Heater, 350W, 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. **29/6**, post and insurance 1/6. 12V car model also available.



Be first this year! SEED AND PLANT RAISING

Soil heating wire and transformer. Suitable for standard size garden frame. **19/6** Post and ins. 3/6.

Dynamic microphone 500 ohm, operates speaker or microphone, so useful in intercom or similar circuits. **6/6 ea.**, **£3.10.0 doz.**

Acos crystal microphone. Adjustable stand converts this from hand mic. to desk mic. **19/6 ea.**

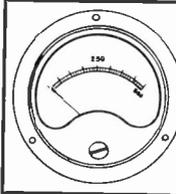
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These units made by the Mullard Group are for operating and controlling d.c. motors and equipment from a.c. mains. Thyristors are used and these supply a variable d.c. resulting in motor speed control and operating efficiency far superior to most other methods. The units are contained in wall mounting cabinets with front control panel on which are fuses—push buttons for on/off and the variable thyristor firing control. 4 models are available—all are brand new in makers' cases: Model 2410 for up to 5 amps **£17.10.0** Model 2411 for up to 10 amps **£27.10.0** Model 2413 for up to 45 amps **£47.10.0** Model 2415 for up to 80 amps **£85.0.0** Note: 2415 is a floor mounting unit.



16 RPM GEARED MOTORS

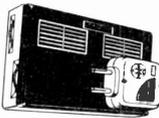
Made by Smith's Electrics, these are almost silent running, but are very powerful. They operate from normal 240V mains and the final shaft speed is 16 r.p.m. **9/6**, post & ins. 2/9.



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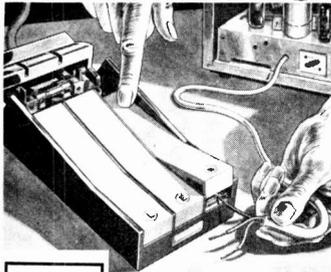
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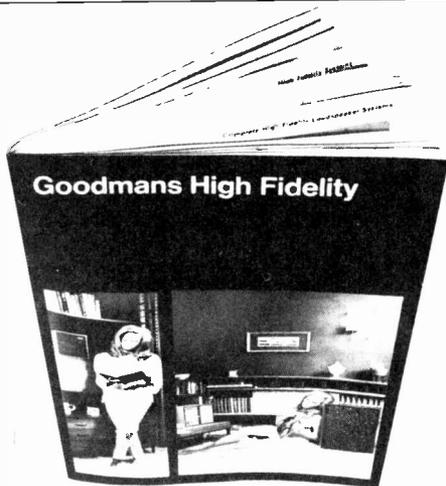
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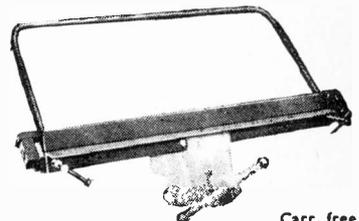
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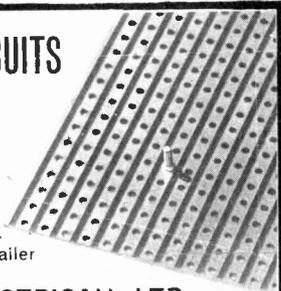
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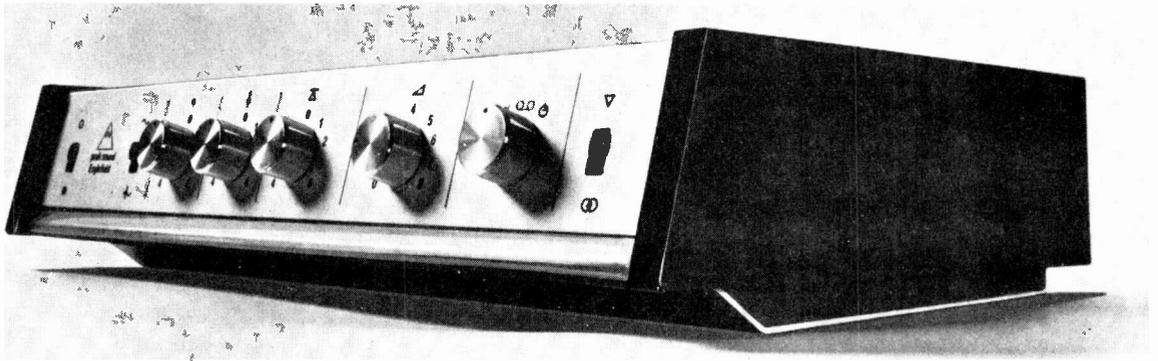
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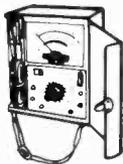
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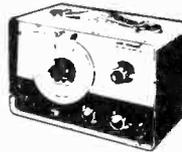
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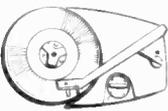
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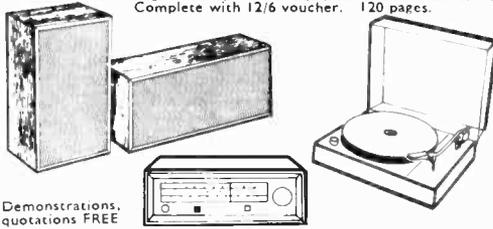


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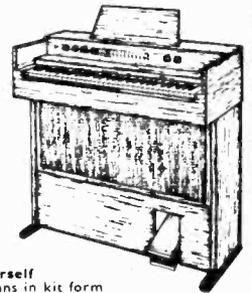


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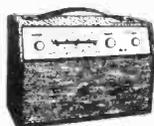
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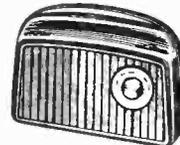


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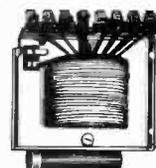
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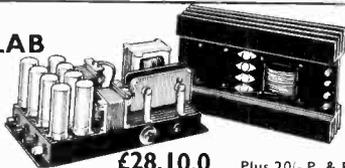
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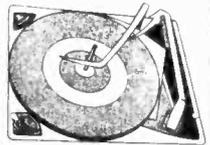
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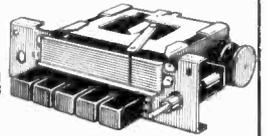
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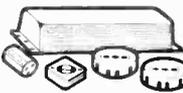


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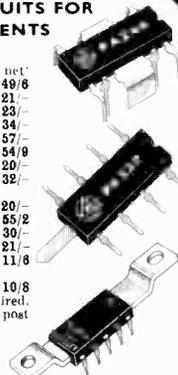
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Sinclair Type IC-10	59/8 net
Fleency SL403A 3W Audio Amplifier	49/8
G.E. Type PA230 Low Level Amplifier	21/-
G.E. Type PA234 1W Audio Amplifier	23/-
G.E. Type PA237 2W Audio Amplifier	34/-
G.E. Type PA246 5W Audio Amplifier	57/-
RCA Type CA3000 D.C. Amplifier	54/9
RCA Type CA3011 Wide Band Amplifier	20/-
RCA Type CA3020 1W Wide Band Amplifier	32/-
RCA Type CA3028A Differential Cascode Amp (120MHz)	20/-
RCA Type CA3029 Operational Amplifier	55/2
RCA Type CA3035 Ultra High Gain Amplifier	30/-
RCA Type SN72708N Operational Amplifier	21/-
G.E. Type SN5306 Darlingon Pair	11/8
G.E. Type D13T1 Programmable Unijunction Transistor	10/8

Add 1/- each to the above i.e.s. for data sheets if required. Data sheets may be purchased separately at 1/8 each, post free. Issued free with SL403A and IC-10 (Data not available separately for IC-10).



1 Watt Amplifier Module type PCM 1

This amplifier unit is a printed circuit module incorporating the popular and well tried PA234 i.e. amplifier. The unit is a COMPLETE AUDIO AMPLIFIER and requires no external components, you simply connect an 18V power supply and a 15 or 16 ohm speaker or headphone, even the supply smoothing capacitor and the output capacitor are included! The overall dimensions, including capacitors, are 2 1/2" x 3" x 1 1/2". The input for 1W output at 1kHz is typically 300mV into 100kohms. This unit is available at only 36/- net, complete with descriptive leaflet or 70/- net per pair.

TRANSISTORS

ACV17	8/8	BC212L	3/9	OC26	9/-	2N1308	9/8
ACV18	4/5	BC213L	3/9	OC28	9/-	2N1309	9/8
ACV19	5/3	BC214L	4/-	OC35	9/-	2N2906	13/-
ACV20	4/6	BCX70	5/4	OC36	9/-	2N2924	4/4
ACV21	4/11	BCX71	10/4	OC71	3/-	2N2926	5/3
ACV22	2/10	BCY72	4/8	OC72	3/9	2N2926	3/-
ACV39	18/-	BD121	18/-	OC75	3/9	2N3053	6/8
ACV40	3/5	BF184	7/8	OC81D	3/-	2N3055	19/6
ACV41	4/4	BF194	7/-	OC170	3/9	2N3702	3/6
ACV44	8/-	BFY50	5/-	OC171	3/9	2N3703	3/3
ASX26	6/2	BFY51	4/6	2N896	4/9	2N3704	3/9
ASX27	8/-	BFY52	5/-	2N897	5/-	2N3705	3/4
ASX28	6/2	B8Y95A	3/11	2N106	3/3	2N3707	4/-
ASX29	8/-	MJ481	27/3	2N132	10/9	2N3708	2/5
BC107	3/3	MJ491	32/11	2N1302	3/11	2N3819	9/-
BC108	3/-	T1P31A	17/-	2N1303	3/11	2N3820	18/9
BC109	3/3	T1P32A	23/-	2N1304	5/-	2N4826	5/11
BC182L	3/2	T1844	1/9	2N1305	5/-	2N4058	4/6
BC185L	2/5	T1849	2/6	2N1306	6/5	2N4059	3/5
BC184L	3/2	T1850	3/9	2N1307	6/5	40408	14/11

DIODES

AA119	3/-	OA391	1/3	1N82A	9/8	1N134	5/3
AA111	2/6	OA202	2/-	1N87A	4/6	1N940	1/-
AA215	3/3	1N34A	4/-	1N914	2/-		
BAV38	3/9	1N60	4/-	1N44	1/8		
OA47	2/-	1N64	4/-	1N131	3/-		

VEROBOARD

	0-1	0-15	
2 1/2in	5in	4/9	4/2
2 1/2in	3 1/2in	4/2	3/5
3 1/2in	5in	5/8	5/6
3 1/2in	3 1/2in	4/9	3/11
1 7/8in	2 1/2in		10/8
1 7/8in	3 1/2in		14/8

PLAIN VEROBOARD

(Uncoppered)
(0-15 in Matrix only)

2 1/2in	5in	3/8
2 1/2in	3 1/2in	3/-
1 7/8in	2 1/2in	7/6
1 7/8in	3 1/2in	9/8
1 7/8in	5in	14/8
Cutter		7/3
Pin Insertion Tool (x1)		9/6
Pin Insertion Tool (0-15)		9/6
Packet of 36 pins (0-1)		3/11
Packet of 36 pins (0-15)		3/11

EDGE CONNECTORS FOR USE WITH VEROBOARD

16 way, 0-15in pitch	4/6
24 way, 0-15in pitch	6/9
24 way, 0-10in pitch	6/9
36 way, 0-10in pitch	8/7

INTERNATIONAL RECTIFIER HANDBOOKS

IRB20 Zener Diode Handbook	16/9
IRB30 Solar Cell and PhotoCell Handbook	16/9
IRB40 SCR Handbook	20/-

PHOTOCELLS

IR CS-120	19/8
Mullard Type ORP12	9/-

ZENER DIODES

1S2030 Series (400mW 3.3V to 15V)	4/8
Z1100-C Series (1W 3.9V to 27V)	7/11

CARBON VOLUME CONTROLS (POTENTIOMETERS)

Linear or log function type are available in the following values 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M. Available in the following types: Single Pots 3/- each. Single Pots with DP switch 5/3 each (log only). Ganged pots 8/6 each. Standard Skeleton pots, linear, horizontal or vertical mounting, available in the following values: 100, 220, 470, 1k, 2.2k to 4.7M. 1/- each.

COMPONENTS CATALOGUE 2/- post free (Inland) P.A.E. 1/6 (Inland), overseas cost (min. 10/-). Cash with order please, discounts may be deducted as follows: order over £5, 10%, order over £10, 15%, excluding net items. Trade orders - net 30 days. Please send S.A.E. with enquiries, CALLERS WELCOME. Open 9.00 a.m.-12.50 p.m. 2.00 p.m.-5.00 p.m. Weekdays and Saturday Mornings 9.00 a.m.-12.50 p.m.



STONE LANE KINVER
STOURBRIDGE WORCS
Telephone KINVER 2099

VARI-STAT THERMOSTATIC SOLDERING IRON



HIGH PRODUCTION MINIATURE MODEL D. 50 WATT

Weight	2 oz.
Heating time	50 seconds
Bit Sizes	1/16", 3/32", 1/8", 3/16", 1/4"
Nickel or Iron Plated	
Voltage	250 to 12 volts
Price	66/-

HIGH PRODUCTION INSTRUMENT MODEL H. 150 WATT

Weight	6 oz.
Heating time	1 min. 45 sec.
Bit Sizes	3/16", 1/4", 3/8", 7/16"
Nickel or Iron Plated	
Voltage	250 to 24 volts
Price	95/-

OTHER VARI-STAT IRONS:

Miniature Model M 50 watt Push-in Bits 1/32" 1/16", 3/32"
Instrument Model B 70 watt Bit Size 11/64"
Industrial Model I 500 watt Bit Size 5/8"

CARDROSS ENGINEERING CO. LTD.

Woodyard Road, Dumbarton
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All mail orders to DEVONIAN COURT, PK. CRES. PLACE, BRIGHTON (Tel 680722)

FANTASTICALLY POPULAR

★ JASON TAPE ★

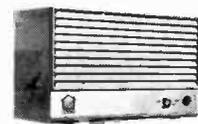
We offer you fully tensilised polyester mylar and P.V.C. tapes of identical quality hi-fi, wide range recording characteristics as top grade tapes. Quality control manufacture. They are truly worth a few more coppers than acetate, sub-standard, jointed or cheap imports TRY ONE AND PROVE IT YOURSELF.

Standard Play		Long Play			
3in.	150ft.	2/3	3in.	225ft.	2/9
4in.	300ft.	4/8	4in.	450ft.	5/6
5in.	600ft.	7/6	5in.	900ft.	10/6
5 1/2in.	900ft.	10/6	5 1/2in.	1,200ft.	13/-
7in.	1,200ft.	12/6	7in.	1,800ft.	18/6
Double Play		Triple Play			
3in.	300ft.	4/-	4in.	900ft.	12/-
4in.	600ft.	8/-	5in.	1,800ft.	25/-
5in.	1,200ft.	15/-	5 1/2in.	2,400ft.	34/-
5 1/2in.	1,800ft.	19/6	7in.	3,600ft.	44/-
7in.	2,100ft.	27/-	3in.	600ft.	8/6

Postages 1/- reel.
Post Free less 5% on three reels.
Quantity and Trade enquiries invited.
All mail orders to DEVONIAN COURT, PK. CRES. PLACE, BRIGHTON (Tel 680722)

NEW! ELECTROSTATIC

SMELL KILLER AIR FRESHENER



No moving parts, fans, filters, chemicals. A sealed set of ELECTRODES produces OZONE. OZONE is the most powerful SMELL KILLER/AIR CLEANER known to science. Ozone breaks up the airdrain molecules of smell - completely dispersing all smells - not disguising them. Its EFFICIENCY will amaze you in KITCHENS, LIVING ROOMS, TOILETS, OFFICES, SHOPS, ETC. Less than a 1d a week to run. No maintenance. Fully guaranteed. Portable. 220/40V.

"... you can take it that it's efficient. Putting it through it's paces, it was found to have chased away every vestige of that most pungent smell, fried onions, in under half an hour, leaving the kitchen fresh and sweet smelling..." Peggy Post 4/6 Available from: Briggs. House sense, DAILY MIRROR.

£6. 19. 6

ANDREW STEPHENS (1947) CO. EXPORT
61 DICKSON ROAD, BLACKPOOL. 0253-23755

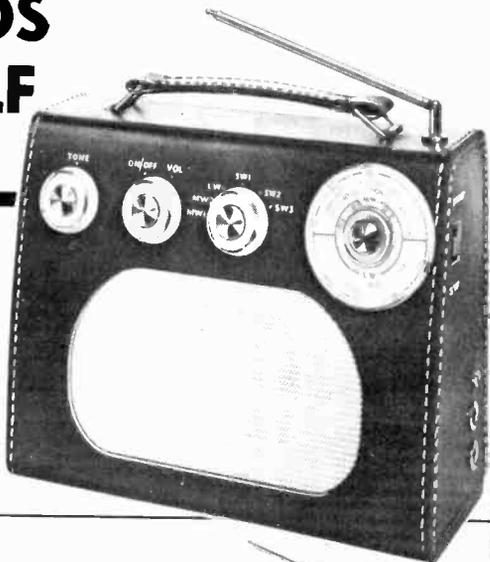
TRANSISTOR RADIOS TO BUILD YOURSELF

Backed by after sales service

NEW! roamer eight mk 1 WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: Medium Wave 1, Medium Wave 2, Long Wave, S.W.1, S.W.2, S.W.3, and Trawler Band. Built in ferrite rod aerial for Medium and Long Waves. 5 section 22in chrome plated telescopic aerial for Short Waves. 5 section 22in chrome plated telescopic aerial for Short Waves. Push-pull output using 600Mw type transistors. Socket for car aerial. Tape record socket. Selectivity switch. Switched earpiece socket complete with earpiece for private listening. 8 transistors plus 3 diodes. Famous make 7 x 4in speaker. Air spaced ganged tuning condenser. On/off switch volume control. Wave change switch and tuning control. Attractive case in rich chestnut shade with gold blocking. Size 9 x 7 x 4in approx. Easy to follow instructions and diagrams make the Roamer Eight a pleasure to build. Parts price list and easy build plans 5/- (FREE with parts).

Total building costs **£6.19.6** P. & P. 7/6



roamer seven mk IV

7 FULLY TUNABLE WAVE BANDS—M.W.1, M.W.2, L.W., S.W.1, S.W.2, S.W.3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for Medium and Long Waves. 5 Section 22in chrome plated telescopic aerial for Short Waves—can be angled and rotated for peak S.W. listening. Socket for Car Aerial. Powerful push-pull output. 7 transistors and two diodes including Micro-Alloy R.F. Transistors. Famous make 7 x 4in P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off control, wave change switches and tuning control. Attractive case with carrying handle. Size 9 x 7 x 4in approx. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build. Parts price list and easy build plans 3/- (FREE with parts).

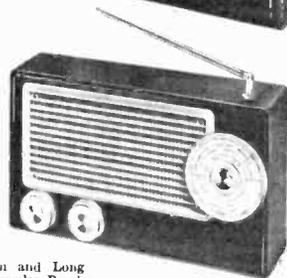


Total building costs **£5.19.6** P. & P. 7/6 Personal Earpiece with switched socket for private listening, 5/- extra.

NEW!

transeight SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case in black with red grille and cream knobs and dial with polished brass inserts. Size 9 x 6 1/2 x 2 1/2in. approx. Tunable on Medium and Long Waves, 3 Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 8 improved type transistors plus 3 diodes. Push-pull output. Ample power to drive a larger speaker. Parts price list and easy build plans 5/- (FREE with parts).



Total building costs **89/6** P. & P. 5/6 Earpiece with switched socket for private listening 5/- extra.

pocket five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE

Attractive black and gold case. Size 5 1/2 x 1 1/2 x 5 1/2in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).



Total building costs **44/6** P. & P. 3/6

transona five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE

Attractive case with red speaker grille. Size 6 1/2 x 4 1/2 x 1 1/2in. 7 stages—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).



Total building costs **47/6** P. & P. 3/9

roamer six

SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case with gilt fittings. Size 7 1/2 x 5 1/2 x 1 1/2in. Tunable on Medium and Long Waves, two Short Waves, Trawler Band plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. (Carrying strap 1/6 extra). Easy build plans and parts price list 2/- (FREE with parts).



Total building costs **79/6** P. & P. 4/6

RADIO EXCHANGE LTD

61a, HIGH STREET, BEDFORD. Tel. 0234 52367

I enclose £..... please send items marked

- | | | | |
|---------------|--------------------------|--------------|--------------------------|
| ROAMER EIGHT | <input type="checkbox"/> | ROAMER SEVEN | <input type="checkbox"/> |
| TRANSEIGHT | <input type="checkbox"/> | POCKET FIVE | <input type="checkbox"/> |
| TRANSONA FIVE | <input type="checkbox"/> | ROAMER SIX | <input type="checkbox"/> |

Parts price list and plans for.....

Name.....

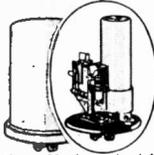
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PE15

* Callers side entrance Stylo Shoe Shop

* Open 10-1, 2.30-4.30 Mon.-Fri. 9-12 Sat.

CAR LIGHT FLASHERS



Heavy duty light flasher employs a condenser discharge principle operating on electro mechanical relay. (As inset.) Housed in strong plastic case. Flashing rate between 60-120 per minute. 12 volt DC operation. Maximum load 6 amps. Size 2 1/16" dia. 4". Supplied brand new at a fraction of original cost. 6/8 each. P. & P. 2/6. (3 for 17/6. P. & P. 4/5).

CLASS D WAVEMETERS



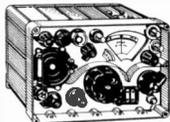
A crystal controlled heterodyne frequency meter covering 1.7-8 Mc/s. Operation on 9V d.c. Ideal for amateur use. Available in good used condition. £5.18.6. Carr. 7/6, or brand new with accessories. £7.19.6. Carr. 7/6.

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. 1-20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, B.F.O. Aerial trimmer, internal speaker and 12 V d.c. internal power supply. Supplied in excellent condition, fully tested and checked. £15 Carr. 20/-.



TYPE 13A DOUBLE BEAM OSCILLOSCOPES



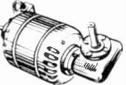
An excellent general purpose D/B oscilloscope. T.B. 2 c/s-750 kc/s. Bandwidth 5-5 Mc/s. Sensitivity 33 mV/CM. Operating voltage 0/110/200/250 V. a.c. Supplied in excellent working condition. £22.10.0 or complete with all accessories, probe, leads, lid, etc. £25. Carriage 30/-.



MARCONI CT44/TF956 AF ABSORPTION WATTMETER

1 μwatt to 6 watts. £20. Carr. 20/-.

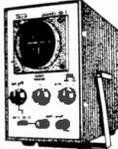
GEARED MAINS MOTORS



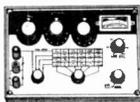
Excellent condition. 99/6. Carr. 10/-.

TO-2 PORTABLE OSCILLOSCOPE

A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 C/s-1 MHz. Input imp. 2 meg Ω. 25 P.F. Illuminated scale. 2in. tube. 115 180 x 230mm. Weight 8lb. 200/240 V a.c. Supplied brand new with handbook. £22.10.0. Carr. 10/-.



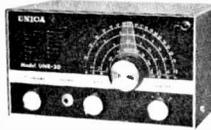
TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1 Ω-11.1 meg Ω. 6 Ranges ±1%. L. 1 μH - 1.1 HENRYS. 6 Ranges ±2%. C. 10pF - 111.0 mF d.c. 6 Ranges ±2%. TURNS RATIO 1:1/1000-1:1/100. 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 5 1/2 in. £20. P. & P. 5/-.

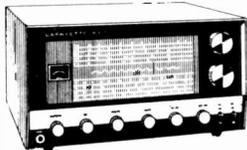
UNR-30 4-BAND COMMUNICATION RECEIVER

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



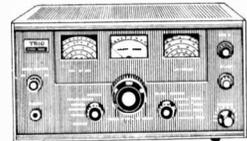
TRIO JR-310 NEW AMATEUR BAND 10-80 METRE RECEIVER.

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 • Fuse 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. Weight 18lb. EXCEPTIONAL VALUE. £45. Carr. 10/- S.A.E. for full details.



TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

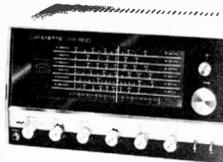
4 band receiver covering 550Kc/s to 30Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW • ANL • Variable BFO • S meter • Sep. bandspread dial • IF 445Kc/s • Audio output 1.5W. • Variable RF and AF gain controls. 115/250V A.C. Mains. Beautifully designed. Size: 7 1/2 10in. With instruction manual and service data. £42 Carriage paid. TRIO COMMUNICATION TYPE HEADPHONES Normally £5.19.6. OUR PRICE £3.15.0 if purchased with above receiver.

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

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

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

Dual conversion on all bands. 2 445 Kc/s mechanical filters. Product detector. Variable B.F.O. 100 Kc/s crystal calibrator. 'S' meter. Slide rule dial. Operation 230V a.c. or 12V D.C. Size 15" x 9 1/2" x 8 1/2". Complete with instruction manual. £57.10.0. Carr. paid. (100 Kc/s Crystal 39/6 extra)



RCA COMMUNICATION RECEIVER AR88D

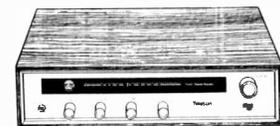
Latest release by ministry BRAND NEW in original cases. 110-250V a.c. operation. Frequency in 6 Bands. 535Kc/s-32Mc/s continuous. Output impedance 2-5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price £87.10.0. Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

A completely new transistorised receiver covering 125-174 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. 75 Ω 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" 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" square fronts.			
500-0-500μA	27/6	50mA	27/6
1mA	27/6	100mA	27/6
10-10mA	27/6	150mA	27/6
2mA	27/6	200mA	27/6
5mA	27/6	300mA	27/6
10mA	27/6	500mA	27/6
750mA	27/6	3V. D.C.	27/6
1 amp	27/6	10V. D.C.	27/6
100μA	37/6	20V. D.C.	27/6
100-0-100μA	35/-	20mA	27/6
200μA	35/-	100V. D.C.	27/6
500μA	40/-		

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

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock Single hole fixing. jin. dia. shafts. Bulk quantities available. 25 WATT. 10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms, 14/6. P. & P. 1/6. 50 WATT. 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, 21/- P. & P. 1/6. 100 WATT. 15/10/25/50/100/250/500/1,000 or 2,500 ohms, 27/6. P. & P. 1/6.

CRYSTAL CALIBRATORS No. 10

Small portable crystal controlled wavemeter. Size 7" x 7 1/2" x 4". Frequency range 500 Kc/s. 10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V D.C. 1.5mA and 12 V D.C. 0.3A. Excellent condition. 89/6. Carr. 7/6.

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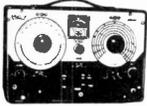
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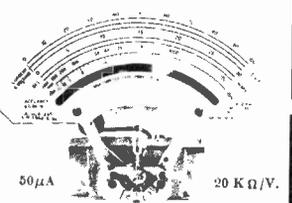


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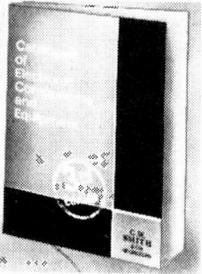
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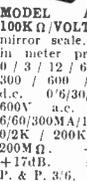
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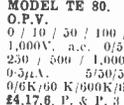
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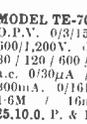
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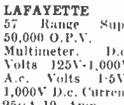
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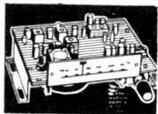


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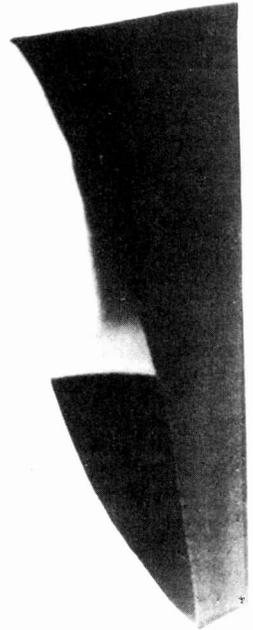
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INFRINGEMENT OF PRIVACY

EVERY kind of technology, and every invention, is potentially a power for good or for evil. The issue is resolved by the motivation of the user. Rational people accept certain rules for human behaviour including good taste and respect for the dignity and rights of others. But it seems such ethical standards count for little with some individuals and organisations when it is apparent that capital can be made or advantage gained through the abuse of technical know how.

Modern electronics can be a frightening power in the wrong hands. Aided and abetted by the latest achievements in this field, the Orwellian nightmare with the omniscient Big Brother watching our every move could arrive long before 1984. Technically it is feasible without a doubt. To a minor and less obnoxious degree a drift in this direction is already discernible, as witness the move towards a national computerised record centre with particulars of every citizen stored therein. Also, in the commercial area, computerised data banks are being established by credit protection agencies. The most intimate facts of a client's private life may be compiled and recorded and so be available at any moment.

Electronic technology has, though, given birth to what seems to be potentially an even more frightening and sinister threat to personal privacy than computer data banks—surreptitious listening, watching, and recording. These spying and snooping activities are particularly disturbing because radio bugging devices and various optoelectronic aids can be used by individuals who are unanswerable for their actions to any recognised authority. Progress in electronic technology will further increase the effectiveness of these devices while making their detection all the more difficult.

It is time this whole seamy "bugging" business was brought into the open and ventilated in public debate. If anything is to be done in outlawing such devices, there is no time to lose. The introduction into the House of Commons last January, by a private member, of a Right of Privacy Bill was therefore a significant initial step.

This Bill sought to protect an individual from intrusion on himself, his home, his family, and business affairs by spying and unauthorised overhearing of words, and the unauthorised recording or copying of documents. The Bill embodied recommendations of lawyers, and the Council of Civil Liberties has welcomed it as "one of the most important reforming measures of this Parliament".

The Bill has come under heavy fire from certain other quarters. Not surprisingly organisations that have a definite vested interest in the use of clandestine spying and snooping equipment, for example, industrial espionage

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*Our April issue will be published on
Monday, March 16*

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Portable and ruggedly constructed, the amplifier features low noise f.e.t. pre-amplifier stages and output protection circuits which make for utmost dependability.

By R. D. PALMER

THIS article describes the construction of an all silicon twin channel 100W power amplifier. This amplifier is suitable for all general purposes requiring high audio power outputs, but can, if desired, be used at more moderate power levels.

Although primarily intended for public address, the power amplifier stages could be used in conjunction with a stereo high fidelity pre-amplifier to provide a high quality output. The integral pre-amplifiers are not suitable for this purpose since there is no provision for the equalisation and selector circuits necessary. They can, however, be used with a variety of different sources, such as crystal microphones; moving coil and ribbon microphones; ceramic and crystal pick-ups; guitar pick-ups; reverberation units, or tuner outputs.

CIRCUIT BLOCKS

In Fig. 1 is given the block diagram of the amplifier. Here a single stabilised power supply is used to power both channels. The output stages are unconditionally stable and feature fool-proof protection circuits safeguarding the output transistors from "second breakdown" under all adverse conditions. The pre-amplifiers each have f.e.t. front ends and independent bass and treble controls.

The two channels can be used completely independently, or a mixing facility can be used to provide the following modes of operation: High and/or low level inputs from one channel to both or either power amplifier inputs, with independent control of each. High and/or low inputs to both channels mixed into both or either power amplifier inputs, with independent control of each.

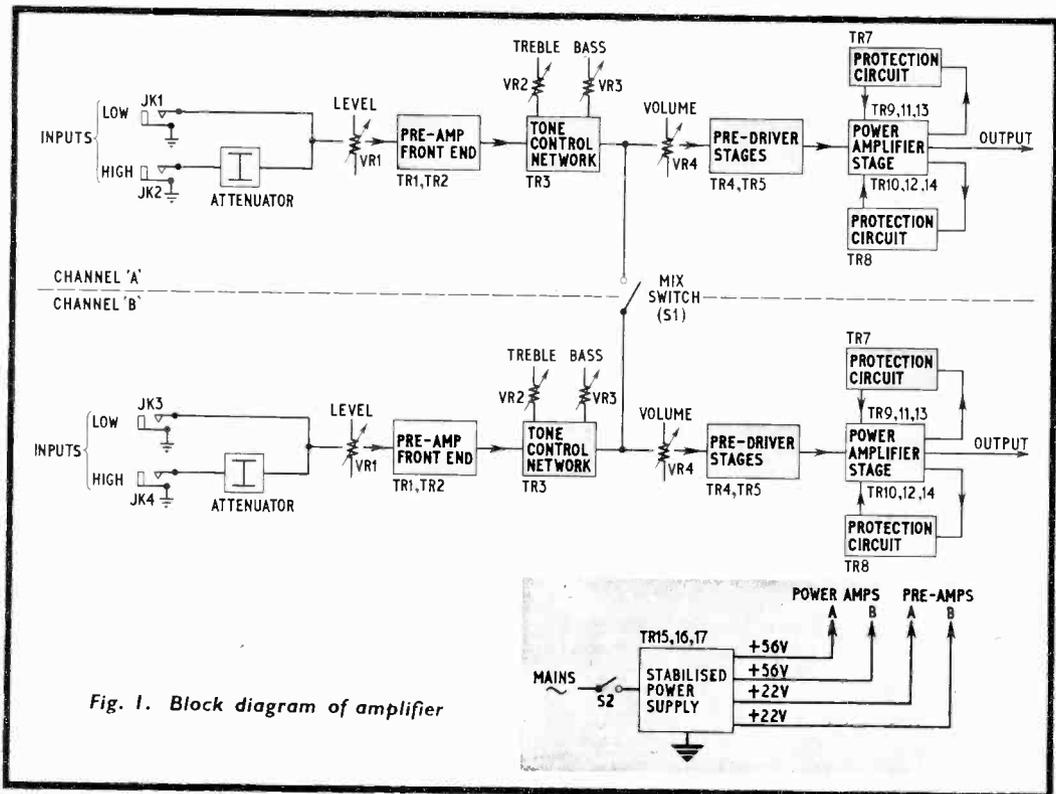
The unit may be built with only one channel, but a modified front end arrangement would then be necessary to provide mixing facilities.

DESIGN PRINCIPLES

The power amplifier is basically a class B transformerless quasi-complementary design. This is derived from the rudimentary circuit shown in Fig. 2. Although the final circuit is more elaborate than this, the basic principles are the same.



50^{PLUS} 50 HIGH POWER AMPLIFIER



SPECIFICATION

Ratings per channel

FREQUENCY RESPONSE	25Hz to 25kHz \pm 3dB
NOMINAL POWER OUTPUT (continuous sine wave)	50W into 5 Ω , 31W into 8 Ω , 17W into 15 Ω
MAXIMUM POWER OUTPUT (continuous square wave)	120W into 5 Ω
TOTAL HARMONIC DISTORTION	0.3% at nominal power outputs 0.2% from 100Hz to 10kHz at 500mW into 15 Ω
DISTORTION (power amplifier only)	0.2% at 50W into 5 Ω 0.03% at 17W into 15 Ω 0.2 ohms
OUTPUT IMPEDANCE	1 Megohm nominal
INPUT IMPEDANCES	500 kilohms nominal
"Low" input	1.2 kilohms
"High" input	
Power amplifier only	
INPUT SENSITIVITY	
"Low" input	1.8mV
"High" input	150mV
Power amplifier only	1.2V
SIGNAL TO NOISE RATIO	55dB at maximum sensitivity (50W into 5 Ω) -80dB with reference to 50W into 5 Ω
RESIDUAL NOISE (power amplifier only)	
TONE CONTROL—bass	\pm 14dB maximum at 100Hz
TONE CONTROL—treble	\pm 18dB maximum at 10kHz



The complementary output transistors, TR2 and TR3, have their bases tied together by the forward biased diodes D1 and D2; their emitters are also connected to form what is often called the "centre rail".

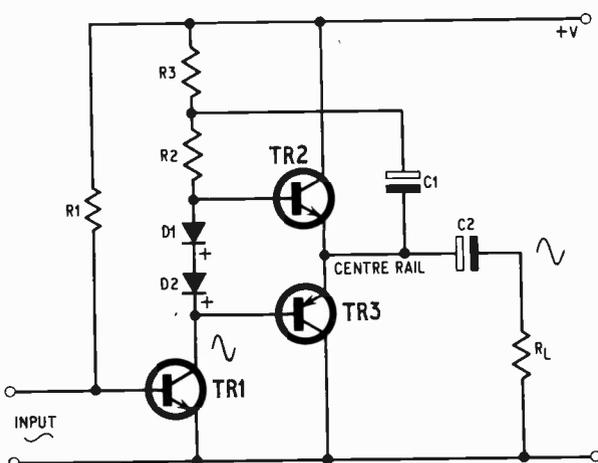


Fig. 2. Basic class B transformerless amplifier

The driver, TR1, is biased by R1 so that the voltage on the centre rail is half that of the supply. The output coupling capacitor C2 blocks this voltage from the load R_L ; it is of sufficiently large value to have a low impedance compared with R_L at the lowest frequencies intended. Thus in this configuration the output transistors act as two emitter follower amplifiers of opposite polarity but with a common input directly coupled to the driver, and a common output capacitively coupled to the load.

When a signal is applied, an amplified version appears at the driver collector. During periods when this goes positive with respect to the half rail voltage, TR3 is cut off and TR2 provides current amplification. When it goes negative with respect to the half rail voltage, TR2 is then cut off and TR3 provides the necessary amplification. Consequently the coupling capacitor C2 is alternately charged and discharged through the load by TR2 and TR3.

PREVENTING DISTORTION

In order to prevent crossover distortion a quiescent bias current is allowed to flow through TR2 and TR3. This enables the output stage to work in class A mode for small signal levels, thereby offsetting the crossover distorting characteristic.

Stable quiescent bias is provided by the voltage drop across the diodes D1 and D2.

In order to prevent the bias diodes introducing even harmonic distortion into the amplifier and to enable the maximum output voltage swing to be attained, the resistor R2 is bootstrapped by C1. This maintains a constant voltage across R2 so that a constant current is maintained through the diodes thereby preventing non-linear current transfer.

An added advantage of bootstrapping is that the maximum open loop gain of the stage is attained.

COMPOUND TRANSISTORS

In a high power amplifier of this type it is impracticable to use single complementary transistors since the high power types needed do not have high enough values of h_{fe} to allow the amplifier to be made efficient and to have a high gain. It is therefore usual to use various combinations of transistors in circuits which behave as single transistors.

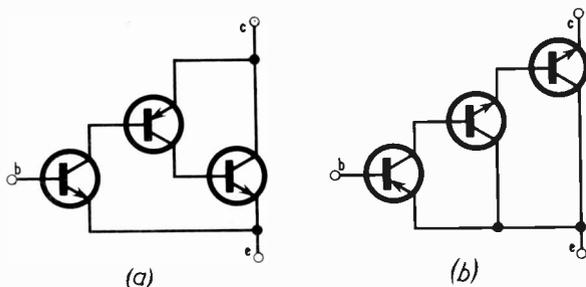


Fig. 3. Compound configuration

These compound configurations have extremely high current gains approximately equal to the product of the h_{re} values of the transistors used. In the final circuit the emitter follower arrangements (a) and (b) shown in Fig. 3 are used to replace the transistors TR2 and TR3 respectively of Fig. 2.

These circuits are particularly suitable for this application since each has an input through a single base-to-emitter junction. This means that the forward base-to-emitter bias voltage is independent of the output transistor junction temperature which makes the circuits stable.

An added advantage is the use of *npn* output transistors, these being cheaper and more readily available than complementary pairs.

SECOND BREAKDOWN

The output transistors are required to dissipate large amounts of power well within their capabilities, but under misuse, such as short circuited output or highly reactive load conditions, could easily be destroyed, even though they may be operating below their maximum power dissipations.

This is due to a phenomenon known as "second breakdown" caused by lateral current instability through the transistor when operating at relatively high voltages and current. It has its greatest effect under d.c. conditions, but falls off with increasing temperature and frequencies; the breakdown caused is usually permanent.

PROTECTION CIRCUITS

The amplifier is protected by two circuits similar to the one shown for the protection of a single transistor in Fig. 4. The function of this circuit is to prevent the power transistor operating point from crossing the protection locus (shown on the graph Fig. 5 by a dotted line), and moving outside the Safe Operating Area (SOAR) curve. This curve represents the limiting conditions within which safety from second breakdown, under specified conditions, is guaranteed.

The action of the protection circuit is as follows. When the voltage on TR1 base reaches approximately 0.6 volts, it clamps the base of the power transistor TR2. This occurs when the summation of currents through R3 and R4 produce a voltage of approximately 0.73 volts across R1 and R2.

The diode D1 is used as a non-linear resistor to generate the curved portion of the protection locus to correspond with the SOAR curve when the V_{ce} is high. It also provides temperature compensation for the circuit.

The protection locus is displaced from the SOAR curve for the derating necessary at the maximum junction temperature expected. It is also displaced from the 5 ohm resistive load line to allow for the elliptical paths described by the transistor operating point when driving reactive loads.

THE COMPLETE CIRCUIT

The complete circuit diagram for one channel of the amplifier is shown in Fig. 6. The two channels, A and B, are identical, both being powered by a single regulated supply.

INPUTS

The high and low inputs to the amplifier are made through sockets JK2 and JK1 respectively. JK2 feeds the T network R2, R3, and R4. The resistor R1 is simply to prevent excessive attenuation of the "High"

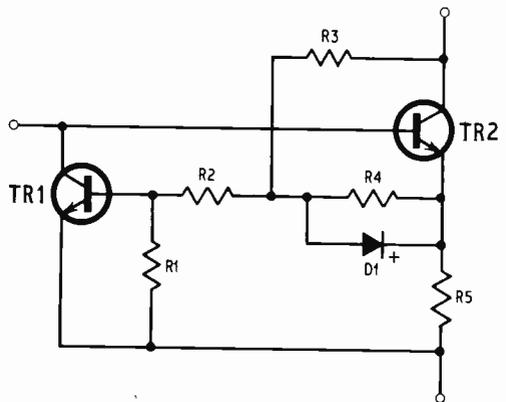


Fig. 4. Amplifier protection circuit

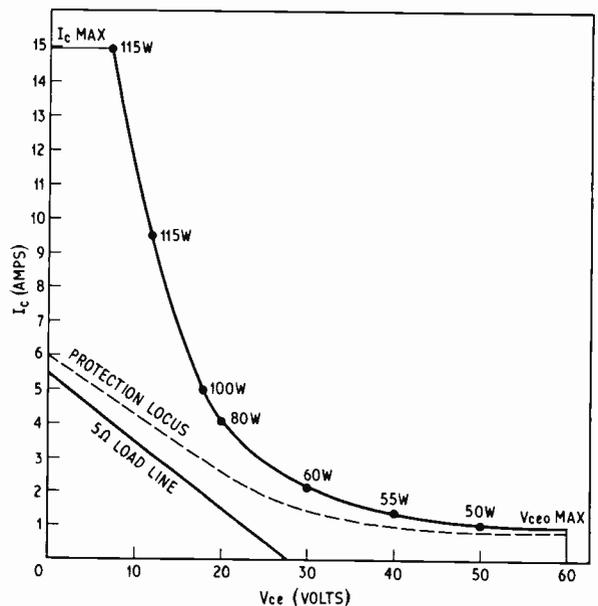


Fig. 5. Graph showing safe operating area

input by a low source impedance input into JK1 when they are in simultaneous use.

Variable attenuation of both inputs into the front end is provided by the level control VR1.

F.E.T. PRE-AMPLIFIER

The front end of the amplifier consists of a common source f.e.t. pre-amplifier formed by TR1, R5, R6, and C1. The f.e.t. used is an N-channel junction gate, depletion mode type. It is self-biased by R5 which is decoupled by C1.

The gate is protected against breakdown by the silicon diode D1 which effectively behaves as an open circuit at normal input levels but conducts when the voltage on the f.e.t. gate exceeds 0.6 volts.

Further amplification is provided by TR2 in the second stage. Here the gain is limited by negative feedback introduced into the emitter by R9.

TONE AND VOLUME CONTROLS

The third stage consists of the bass and treble controls, VR3 and VR2, in combination with a modified Baxandall circuit.

COMPONENTS . . .

AMPLIFIER (2 REQUIRED)

Resistors

R1 270k Ω	R17 2.2k Ω
R2 470k Ω	R18 22k Ω High stab
R3 2.2M Ω	R19 22k Ω High stab
R4 22k Ω	R20 2.2k Ω
R5 3.3k Ω High stab	R21 100k Ω High stab
R6 3.3k Ω High stab	R22 2.2k Ω High stab
R7 1M Ω High stab	R23 1k Ω
R8 3.3k Ω High stab	R24 100k Ω High stab
R9 100 Ω High stab	R25 15k Ω High stab
R10 6.8k Ω	R26 2.2k Ω
R11 6.8k Ω	R27 100 Ω
R12 6.8k Ω	R28 4.7k Ω
R13 1.8k Ω	R29 4.7k Ω
R14 1M Ω	R30 680 Ω
R15 3.3k Ω	R31 4.7k Ω High stab
R16 2.2k Ω	R32 4.7k Ω 5% High stab

R33 4.7k Ω 5% High stab	R41 1k Ω 5% High stab
R34 680 Ω	R42 1k Ω 5% High stab
R35 1k Ω 5% High stab	R43 180 Ω
R36 1k Ω 5% High stab	R44 0.14 Ω see text
R37 680 Ω	R45 0.14 Ω see text
R38 39k Ω 5% High stab	R46 5.6 Ω
R39 39k Ω 5% High stab	R47 100 Ω 5W wirewound
R40 180 Ω	

All 10%, $\frac{1}{4}$ watt carbon except where otherwise stated

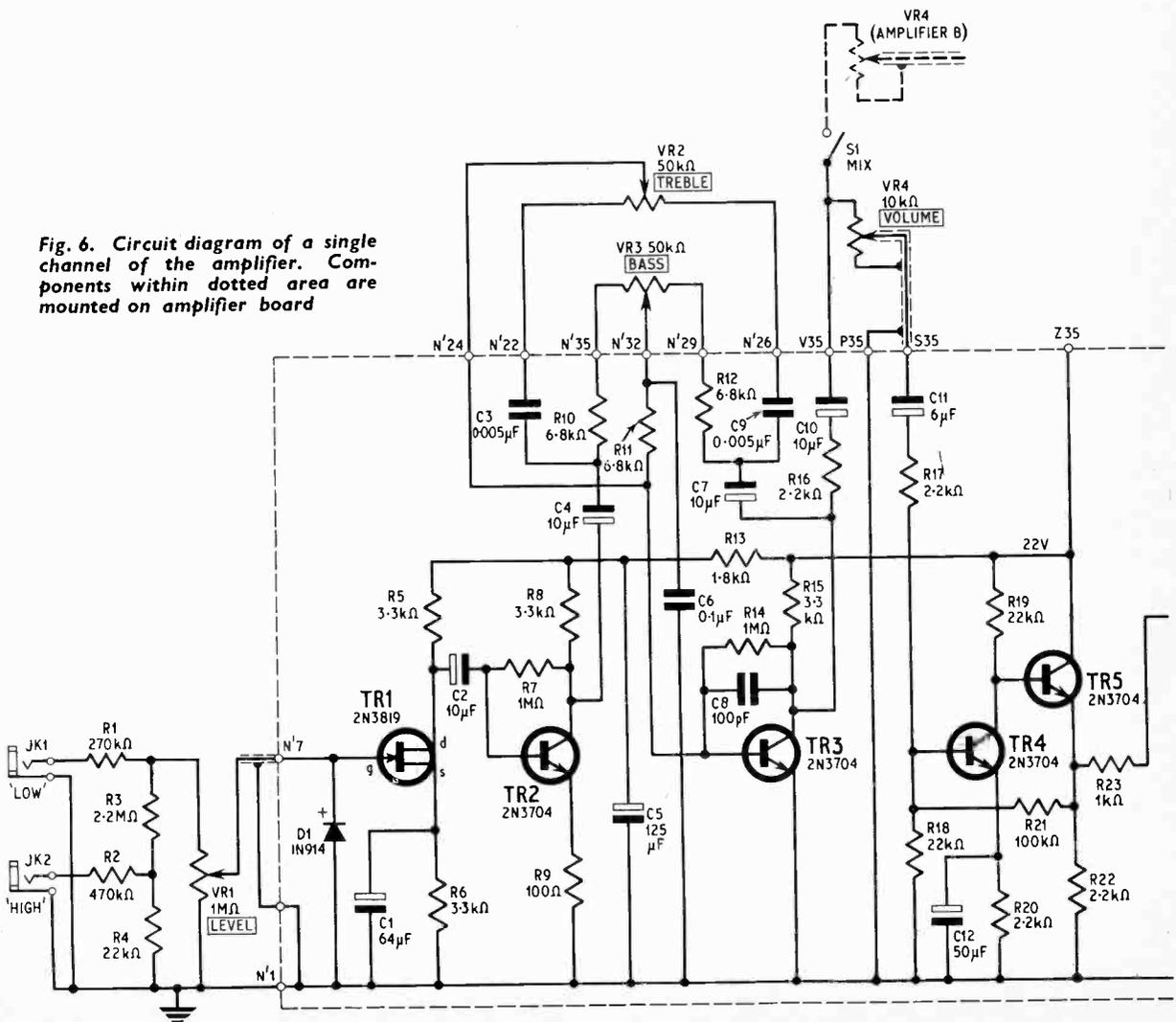
Potentiometers

VR1 1M Ω log carbon	VR5 500 Ω	} miniature horizontal presets
VR2 50k Ω linear carbon	VR6 500 Ω	
VR3 50k Ω linear carbon		
VR4 10k Ω log carbon		

PRE-AMPLIFIER

PRE-DRIVER

Fig. 6. Circuit diagram of a single channel of the amplifier. Components within dotted area are mounted on amplifier board



Capacitors

- C1 64 μ F elect. 15V
- C2 10 μ F elect. 15V
- C3 0.005 μ F paper
- C4 10 μ F elect. 15V
- C5 125 μ F elect. 15V
- C6 0.1 μ F polyester
- C7 10 μ F elect. 15V
- C8 100pF polystyrene
- C9 0.005 μ F paper
- C10 10 μ F elect. 15V

- C11 6 μ F elect. 15V
- C12 50 μ F elect. 15V
- C13 32 μ F elect. 50V
- C14 20 μ F elect. 25V
- C15 330pF polystyrene
- C16 8 μ F elect. 50V
- C17 0.1 μ F polyester
- C18 0.1 μ F polyester
- C19 2,000 μ F elect. 50V

- TR11 40362 (RCA)
- TR12 40361 (RCA)
- TR13 2N3055
- TR14 2N3055

Diodes

- D1-D6 1N914

Sockets

- JK1-JK2 Standard jack sockets
- JK3-JK4 4mm insulated sockets

Transistors

- TR1 2N3819 (Texas)
- TR2 2N3704 (Texas)
- TR3 2N3704 (Texas)
- TR4 2N3704 (Texas)
- TR5 2N3704 (Texas)

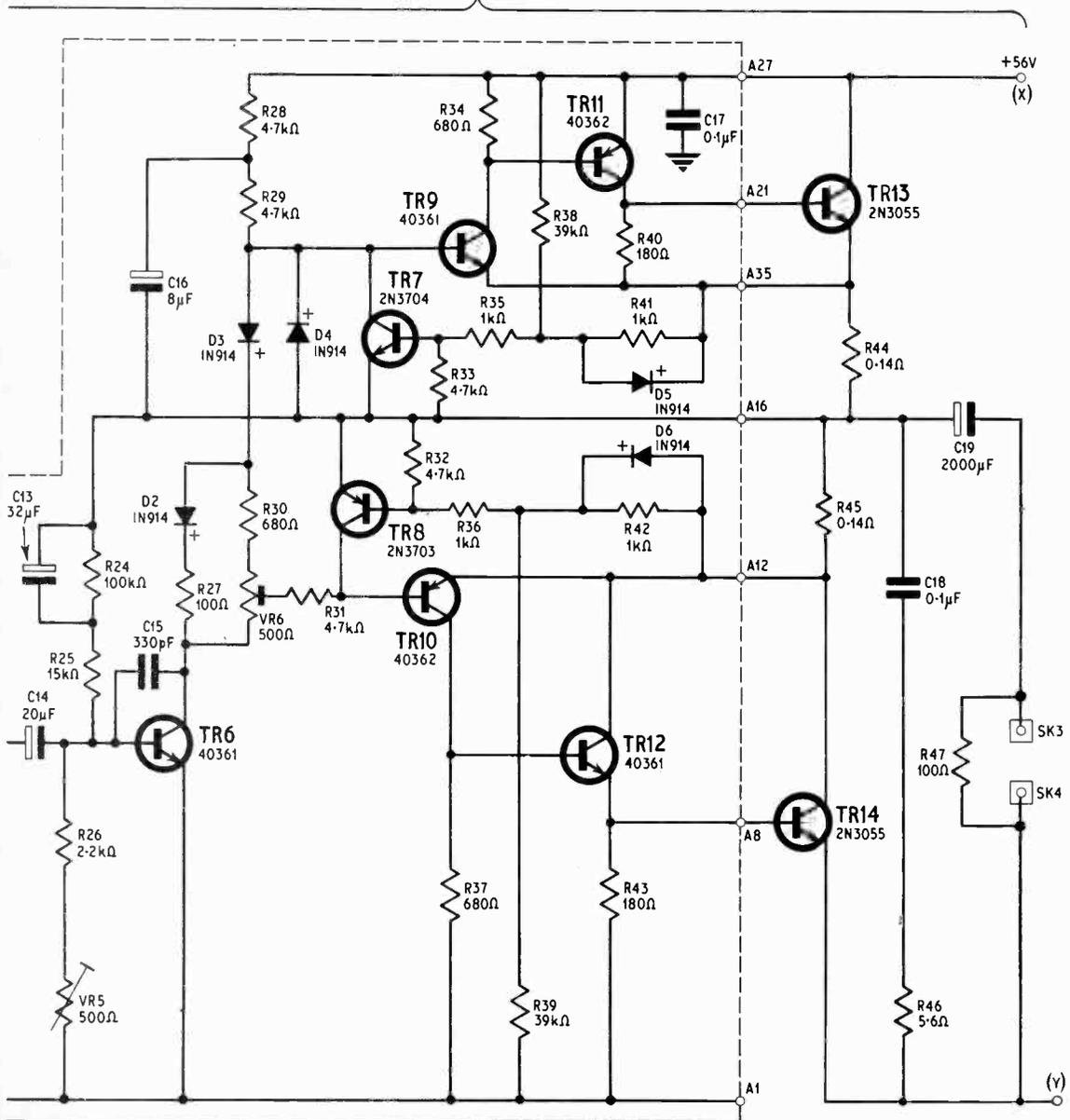
- TR6 40361 (RCA)
- TR7 2N3704 (Texas)
- TR8 2N3703 (Texas)
- TR9 40361 (RCA)
- TR10 40362 (RCA)

Miscellaneous

- Perforated s.r.b.p. sheet 0.1in matrix—Lektrokit chassis plate no. 4—LK141
- Wiring pins—Lektrokit LK3011
- TO5 heatsinks (2 off)

(maximum ripple current rating at least 3.2A)

POWER AMPLIFIER



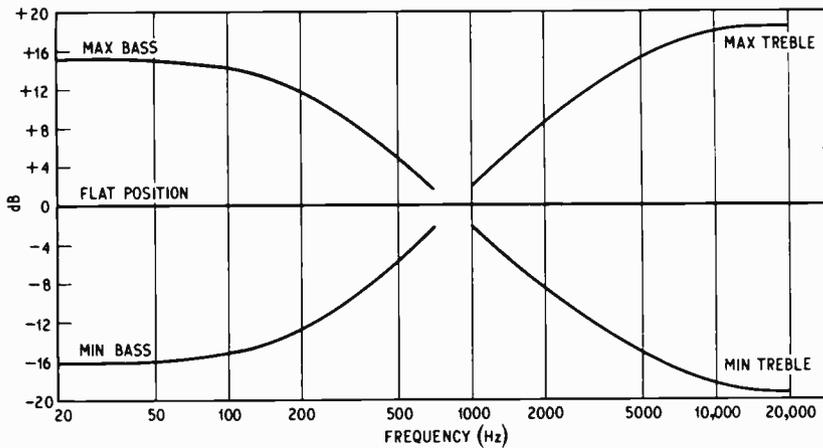


Fig. 7. Response curves of tone controls

This stage provides any necessary bass and treble cut or lift required, but is unusual as it has a very wide range of control at the extremes, making it useful for special effects. Its response curves are shown in Fig. 7. With the controls set in the central or "flat" position, the stage has a gain of approximately unity.

The output from this stage to the pre-driver stage is attenuated by the volume control VR4. Connecting the two independent channels at this point is the "Mix" switch S1. This switch enables the output from one front end to be fed to both power amplifiers via their respective volume controls, or for the inputs to the separate front ends to be mixed into one or both of the power amplifiers.

PRE-DRIVER STAGE

The pre-driver stage acts as a buffer between the medium output impedance of the volume control and the comparatively low input impedance of the power amplifier. It also provides further gain for the pre-amplifier. This is achieved with a directly coupled circuit where TR4 functions as a conventional common emitter amplifier and TR5 as an emitter follower.

Stable bias and negative feedback are provided by R21 and the necessary buffering between the pre-driver output and input of the power amplifier by R23 and C14.

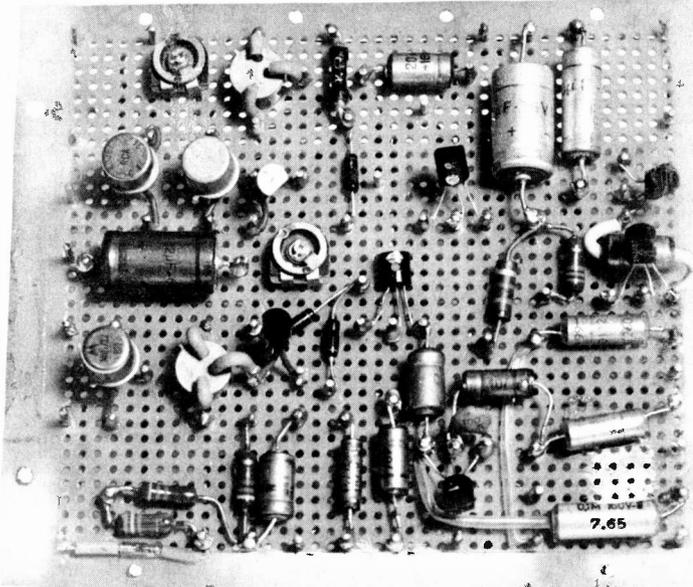
The tone control and pre-driver stages are both powered from the 22 volt rail.

POWER AMPLIFIER

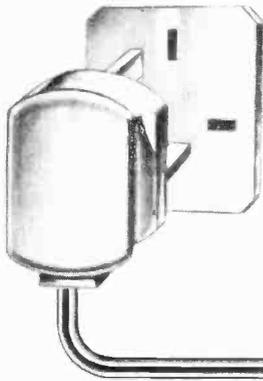
The power amplifier section possesses all the features previously described; in addition to these, certain refinements are necessary to complete the design.

In all power amplifiers feedback is used to stabilise the d.c. biasing and to reduce the distortion introduced by the amplifier. Here R24, R25 and C13 form a feedback loop from the centre rail to the base of the driver TR6; thus the bias is stabilised by feedback through both these resistors. The centre rail voltage itself is set by adjustment of VR5.

Capacitor C13 is primarily a protective component since when the amplifier is switched on, the long time constant of C13 and R25 allows the centre rail voltage to rise very slowly, thereby preventing damage which might be caused to the loudspeaker if the centre rail voltage was suddenly applied to C19, the output coupling capacitor.



Topside of a completed amplifier board. It is important that none of the TO5 transistor cases are allowed to contact wiring pins as these are common to the collectors.



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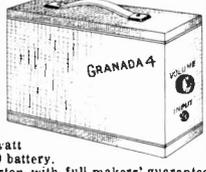
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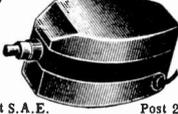
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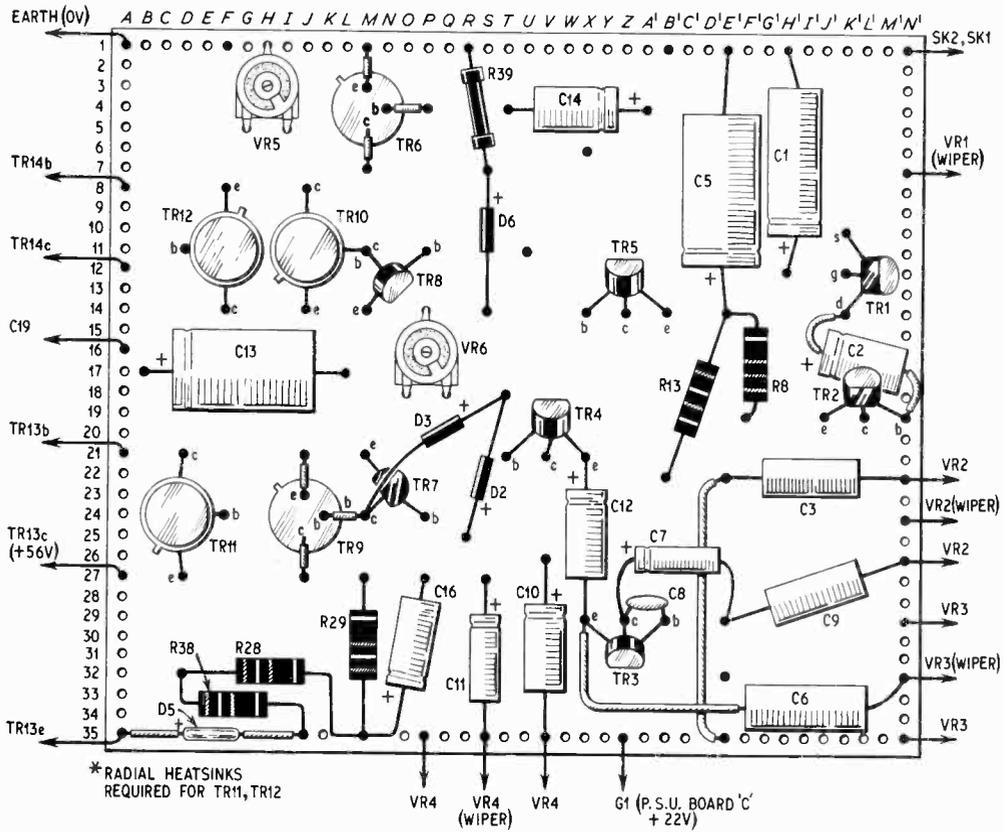


Fig. 8. Topside layout and wiring for an amplifier board. Two such boards are required for both channels

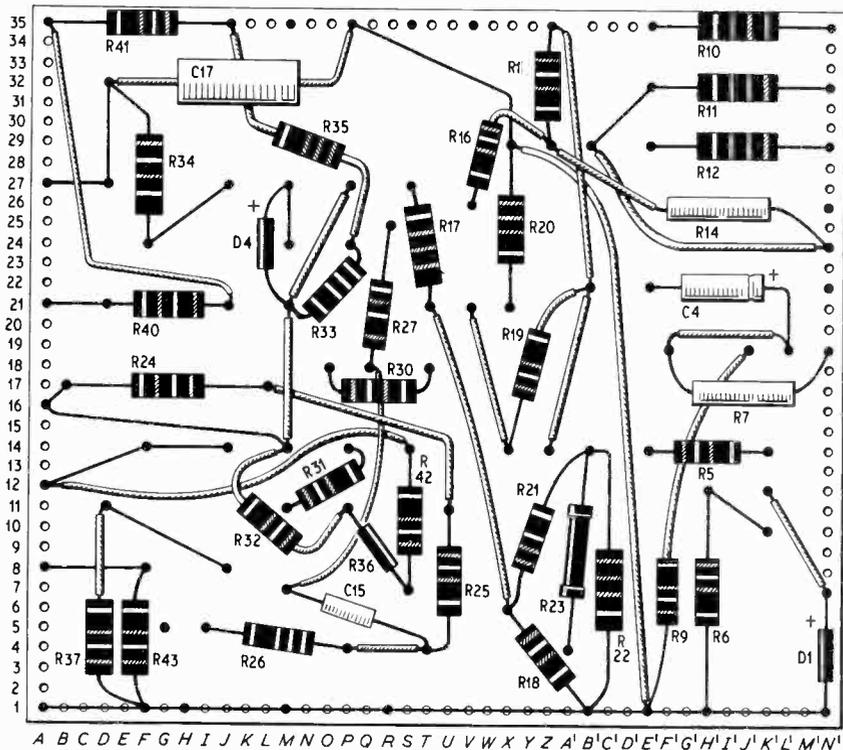
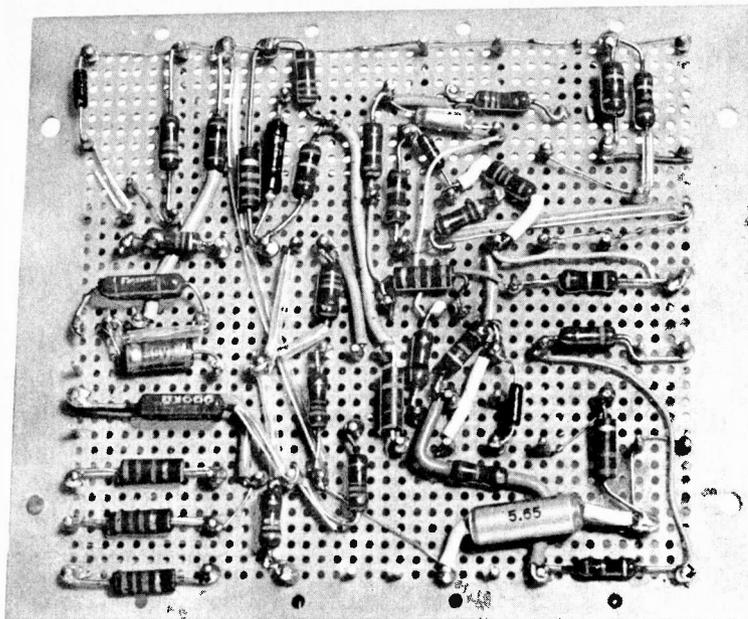


Fig. 9. Underside layout and wiring of the board



Underside of a completed amplifier board

Resistor R47 across the output socket is also a protective component since it allows C19 to charge up to centre rail voltage in the event of no load being present when the amplifier is turned on.

QUIESCENT CURRENT

The quiescent current bias is set by VR6 and stabilised by D2 and D3; R27 and R30 limit the range of this potentiometer.

The current sensing resistors in the protection circuit, R44 and R45, stabilise the quiescent current since they provide negative feedback into the "emitter" leads of the complementary compound transistors TR9, TR11, TR13 and TR10, TR12, TR14.

Protection against second breakdown is provided by TR7 and TR8. These transistors limit the output transistors TR13 and TR14 to excursions within the graph previously shown in Fig. 5.

When the overload is marginal, TR7 and TR8 simply clamp the bases of TR9 and TR10 respectively, but under severe overload conditions large excursions occur at the base of the driver caused by the lack of negative feedback when the output swing is being limited.

Overload rectification by the base emitter junction of TR6 produces asymmetrical clipping which causes C19 to become discharged by TR14, since TR6 is held in saturation for increasingly longer periods.

This process takes about a second or so depending on conditions and is marked by the fact that the output rapidly degenerates until it is but a severely distorted signal of small amplitude. This condition is maintained until the overload is removed or the input to the amplifier reduced.

To prevent TR9 being destroyed by reverse biasing of its base emitter junction at the onset of an overload, the diode D4 is connected from its base to the centre rail. TR10 is also protected under these conditions against excessive base current by the insertion of R31.

H.F. STABILITY

In order to make the amplifier stable at high frequencies, the capacitor C15 is inserted across the base and collector of the driver TR6, and C18 and R46 are placed across the output. Without the insertion of

C17 at the 56 volt rail there is a possibility of radio frequency oscillations developing due to the inductance of the wires and the high cut-off frequencies of the transistors.

It will be noted that separate 0 volt lines are used for TR14 and the rest of the power amplifier and pre-amplifier; this is to prevent the voltages set up in the output stage interfering with the front end and small signal stages.

CONSTRUCTION OF AMPLIFIER BOARD

The majority of the components for each channel are mounted on a single perforated s.r.b.p. board, these are shown in the circuit diagram enclosed by the dotted line. They are attached to both sides of the board by wiring pins inserted through the holes. The layout for the upper and lower sides on the board are shown in Figs. 8 and 9 respectively.

First the pins should be inserted into the board at the appropriate positions illustrated in the diagrams. They should then be wired with the various connecting links shown with bare tinned copper wire, which should be sleeved where shown. The fixed resistors and capacitors can now be fitted to the underside, VR5 and VR6 pre-sets having been previously inserted through the upperside.

When soldering, care should be taken so as not to burn the sleeved links. To prevent this the use of silicone rubber sleeving is recommended.

The remainder of the passive components should be attached to the upper side before mounting the transistors. No special precautions are necessary when mounting the transistors other than their leads should be sleeved and care should be taken in orientation. Once completed the board should be carefully checked with the wiring diagrams.

Finally, clip on the TO5 heatsinks on to TR10 and TR12. Make certain that the cases of the TO5 transistors do not touch the wiring pins or each other as they are connected to their collectors.

Next month: Further constructional details and power supply.

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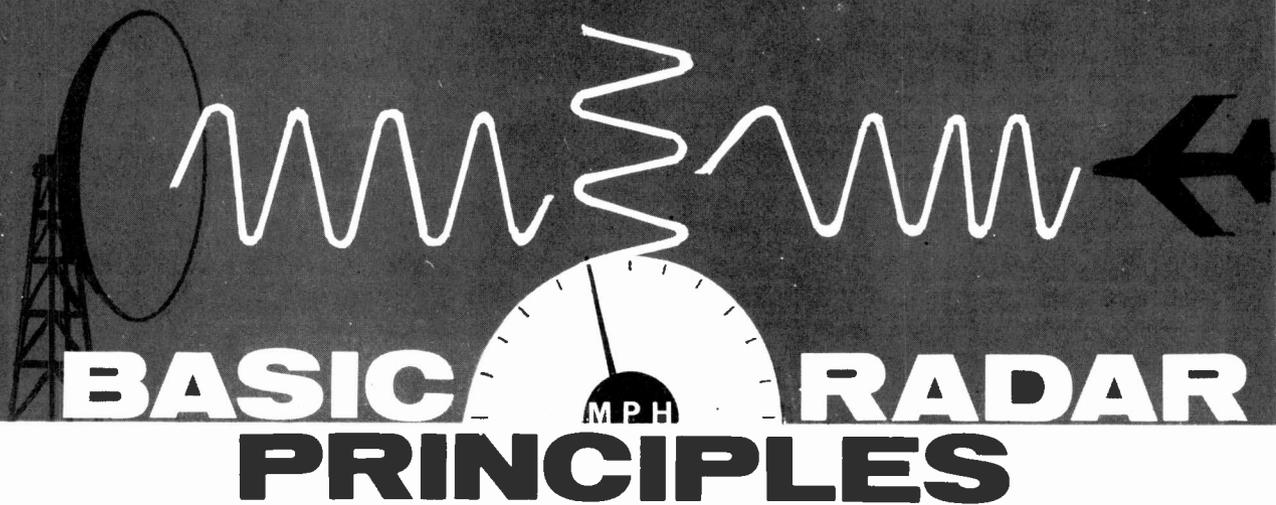
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BASIC RADAR PRINCIPLES

PART TWO · DOPPLER RADAR

By A. FOORD

FOR some specialised applications pulsed radar may not be able to give the results required, and c.w. radar has to be used instead. This involves the transmission of a continuous unmodulated stream of radio waves.

As with pulsed radar a reflected signal will be obtained from any object in the path of the beam. The bearing and elevation of this object can be determined from the aerial position for a maximum reflected signal, but a straightforward c.w. radar can give no indication of range, and is therefore used to give velocity measurements for a known single target.

DOPPLER EFFECT

The traditional explanation of the Doppler effect involves the observation that the pitch of a train's whistle seems to alter noticeably as the train passes a listener. If the train is stationary the note heard is constant, when the train is moving however, the frequency of the note will sound higher than the actual (stationary) note if the train is approaching, but lower if it is receding.

For an approaching train each successive peak of the sound wave is emitted from a point which is slightly closer to the listener, and the previous peak, than would normally be the case for a stationary train. This effect shortens the wavelength and increases the frequency of the note.

Conversely, for a receding train each successive sound peak is emitted from a point further away from the listener, and so the wavelength is increased and the frequency decreased.

This difference in frequency depends on three things:

1. The relative velocity between the object and the observer;
2. The frequency of the transmission;
3. The propagation velocity of the wave.

This applies for all wavelengths from sound through radio and radar wavelengths to light, provided the correct constants are used.

For an object approaching a c.w. radar set the received signal returns will be higher in frequency than the transmitted signal, and lower for a receding object.

SHIFT FREQUENCY

If the transmitted signal is F_0 and the received signal F_r , then the doppler shift frequency f is the difference between these two frequencies and is given by:

$$f = \frac{2v}{c} F_0$$

where

f = Doppler shift frequency in Hertz.

F_0 = transmission frequency in Hertz.

v = relative velocity between object and radar in miles per hour.

c = velocity of radio waves in miles per hour
($186,000 \times 60 \times 60$)

If the transmitter frequency is 10,000MHz and the velocity of an approaching object is 100 m.p.h., then the Doppler shift frequency is:

$$f = \left(\frac{2 \times 100}{186,000 \times 60 \times 60} \right) 10,000 \times 10^6 \text{Hz}$$

$$f = 3.2\text{kHz.}$$

Transmitter freq.	Target velocity	Doppler freq.
10,000MHz	100 m.p.h.	3.2kHz

As an easily remembered approximation this represents a Doppler frequency of 30Hz per 100MHz per 100 m.p.h.

Since the object is approaching, the frequency of the reflected signal is:

$$F_r = F_0 + f = 10,000\text{MHz} + 3.2\text{kHz.}$$

If the object were receding, then the frequency of the reflected signal would be:

$$F_r = F_0 - f = 10,000\text{MHz} - 3.2\text{kHz.}$$

RADIAL VELOCITY

If the object is not travelling in a straight line towards or away from the radar then the actual change in frequency caused by the Doppler effect depends not on the actual velocity of the object, but on its velocity relative to the aerial.



Fig. 2.1a. Basic principle of Doppler radar, where the object is moving directly towards, or away from, the radar.

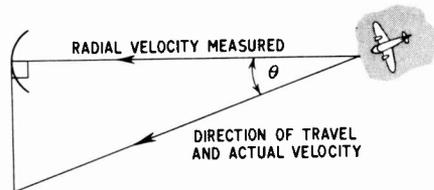


Fig. 2.1b. How the actual velocity of the object can be calculated, if it is moving at an angle to the aerial, from radial velocity and θ

In Fig. 2.1a, where the aircraft is travelling towards the radar, the measured radial velocity will be the true velocity of the aircraft.

In Fig. 2.1.b, where the aircraft is travelling at an angle to the aerial, the measured radial velocity towards the aerial is less than the true velocity along the direction of the aircraft flight. Since in this case the aerial will be tracking the aircraft, the actual velocity can be calculated from the radial velocity and the angle θ .

BASIC MIXER

A simple block diagram is shown in Fig. 2.2 where the c.w. energy is transmitted at a frequency F_0 and after reflection from a target returns to the receiver at a frequency F_r . The received signal is amplified and

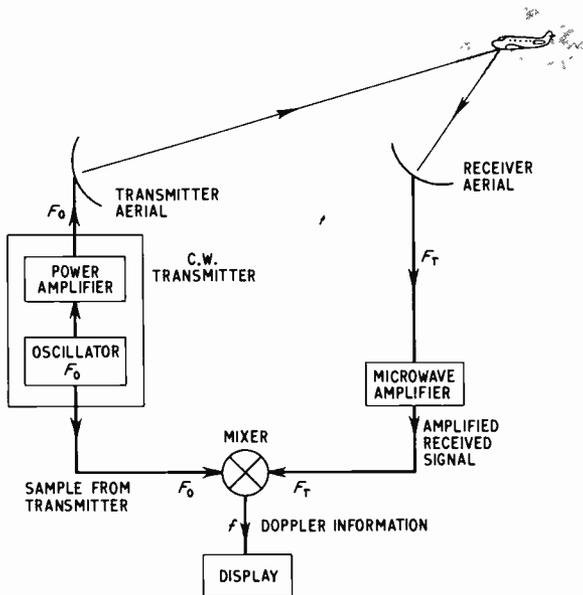


Fig. 2.2. Block diagram for a simple Doppler radar

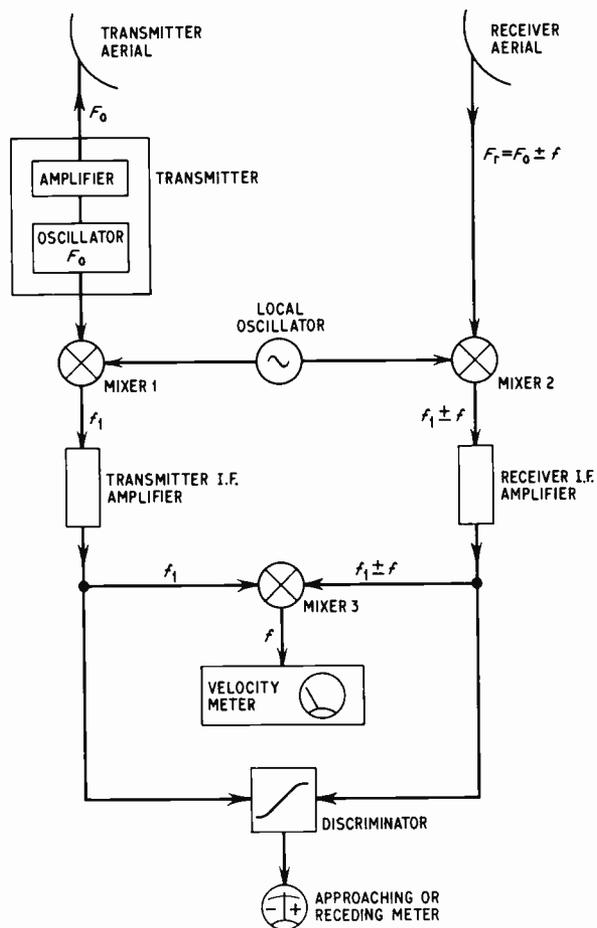


Fig. 2.3. Block diagram for a practical superhet Doppler radar

mixed with a sample from the transmitter to obtain the difference frequency f , which is amplified and fed to a frequency counter to determine the object velocity, or to a display unit to show the presence of a moving target.

For a stationary object there will be no doppler output, but even for a moving target this system cannot decide if the target is approaching or receding since the mixed output will be the same for either case.

It is difficult to measure the transmitted and received frequencies directly, to decide if the received signal is higher or lower than that transmitted, because of the very small percentage difference.

The system just described relies on the microwave amplification of the received signal up to a level suitable for mixing and amplification at audio frequency. Low noise microwave amplifiers are expensive and bulky or have a poor dynamic range, so that microwave mixing down to audio, with or without previous microwave amplification, would only be used for short range equipments where the noise figure is not important.

Using the superhet principle, a far better practical system can be employed and is shown in Fig. 2.3.

I.F. AMPLIFICATION

The sample of the transmitted signal is mixed with a local oscillator to produce an i.f. which is amplified and applied to the third mixer. The received signal is

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NEWS BRIEFS

Export Orders by Computer

THE Board of Trade have recently announced the proposed introduction of a new computerised scheme for export intelligence. The scheme, which will use the existing Board of Trade ICL 1905E computer on a night shift, has been designed to provide a fast interchange of information between foreign and British firms.

At present the Board of Trade publish a daily Export Services Bulletin listing export opportunities. The Computerised Export Intelligence system will supersede the bulletin and provide highly specialised information to firms where required. The computer can be programmed to select not only defined products, but the countries to which a British firm wishes to export.

It is hoped that more than 10,000 British firms will join the scheme which will be self-supporting.

Scandinavian Flights

SCANDINAVIAN air travel, at present around 4½ million persons per year, is expected to rise to around 20 million in the next decade, while air cargo will also greatly increase in volume. To prepare for this expected boom Scandinavian Airlines have just installed a SASCO II system at their computer centre in Copenhagen.

Claimed to be the largest real-time installation in Europe, the heart of the system comprises three new UNIVAC 494 computers, each with 131W core store.

Applications handled by SASCO II include passenger reservations and remote load control. The latter, used to control the take-off weight of aircraft, involves the on-line recording of data relating to passengers, baggage, cargo, mail and fuel to be carried on each flight.

Batch processing applications already in operation or scheduled for the near future include crew control, material supply, an integrated accounting system, passenger sales and revenue statistics, traffic operation and planning statistics, maintenance and overhaul planning and catering planning.

It is expected that the new system will provide a better service at an economic cost during the period of expansion.

Versatile Computer

THE introduction of the Ferranti ARGUS 600 digital computer at £1,700 is claimed to be the cheapest digital computer available in the U.K. The new computer is aimed at the large but virtually untapped low-cost computer and control system markets for which existing, more powerful digital systems are not economically viable.

The ARGUS 600 is ideally suited for use as a central processor in a variety of small system configurations, such as the control of production machines, traffic lights, warehouse conveyor systems, batch production processes and hospital management services.

Being completely compatible with large digital computers, it can be linked directly or over telephone lines.

—PRACTICAL ELECTRONICS—A PRICE INCREASE—

With effect from next month, the price of PRACTICAL ELECTRONICS will be increased from 3s to 3s 6d.

It is greatly regretted that this has become necessary. Unfortunately rising costs of production permit no other course of action.

There will be no change in our editorial policy, of course. We shall continue to present the most up-to-date ideas and designs for home constructors, as well as feature articles highlighting significant developments in electronic technology.

mixed with the local oscillator, amplified at i.f., and also applied to the third mixer. The output from the third mixer will be the required Doppler signal.

The amplification now takes place at i.f. rather than at microwave frequency and the second mixer is the main source of receiver noise, but this will be lower than in the previous case.

To determine if the object is approaching or receding the two i.f. signals are compared in a frequency discriminator which indicates this. The discriminator has to decide if the received i.f. signal is greater or less than the transmitter i.f. signal; the Doppler information is now a much greater percentage of the signal, 1kHz in 45MHz rather than 1kHz in 10,000MHz, and this does not present any problems.

Next month's article will describe coherent pulsed radar using the Doppler effect.

To be continued

INFRINGEMENT OF PRIVACY

continued from page 203

companies and private detective agencies, have raised strong opposition. But more disturbing and of serious concern was the attack made upon this Bill by the Press Council and subsequently echoed by most of the national newspapers. While acknowledging the serious threat to the individual's privacy from electronic spying devices, many newspapers are chiefly concerned that their own investigations are in no way impaired by legislation to ban such devices.

The unearthing and publication of unsavoury facts is often in the public interest, but is there to be no limit to the way such information is obtained? Privacy cannot be violated simply on the basis that something of vital importance *may* be revealed. Only properly authorised bodies like the police and security services should be permitted the use of surreptitious spying equipment—but subject to statutory safeguards. In combating criminal or treasonable activities, such methods can be justified. If the press is claiming the same right in pursuit of its everyday business, then it is asking too much. This is tantamount to demanding the right of entry into every private dwelling and to open every bureau and search all personal documents, upon whim.

Newspaper men will throw their hands up in horror at this suggestion. But because modern technology allows this spying to be carried out often without obvious and brutal physical intrusion, the offence to human rights is no less real. In fact, it is all the more despicable because of its very surreptitious nature. Not a broken pane or forced lock to warn the victim that his most intimate affairs have been pried into by strange anonymous eyes or ears. This is perhaps the most frightening aspect of all. Those who feel it their right or duty to employ hidden bugging and snooping devices should pause and consider that they themselves could be subject to this kind of investigation at any time—if these devices are not outlawed.

It would be foolish to imagine that the act of declaring such devices illegal will eliminate the problem. But it would be the first important step, and would make the moral and ethical position quite clear. And it would allow the victim to obtain redress in the courts.

We cannot just sit back and condone this abuse of electronics.

F.E.B.

PE ORGAN PART 11

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

IN THIS final article of the series, circuits for single note manual sustain and vibrato are included. To realise the capability of the instrument, guidelines for the selection of pitch combinations are provided.

USE OF REVERBERATION

It is often said that the building makes the organ, and this is very true; but we are really referring to the majestic sounds of the large pipe organ in saying this, where reverberation rounds off the massive concentration of sound.

In the cinema, there is no reverberation with an audience present. So if we had a room of not less than 3,000 cubic feet, we would have the best conditions for this particular organ. It is more likely that we will have about half that figure, and if this is so, or less, then

a little artificial reverberation will enhance the results.

SPRING REVERBERATOR

Since we are not dealing with any great degree of power, we can apply a spring reverberator quite well. This is really a coiled transmission line, the rate of propagation being determined by the length of the line and to some extent by the density of the line material.

Most spring units use far too heavy a gauge of material, so that if the line is over-driven, the spring takes a long time to settle down and may actually chatter. However, if carefully used, the simple spring lines are quite effective down to about 100Hz.

One such device is available from Henry's Radio Ltd. or Harmonics Ltd. of Bromley, Kent. The author has not actually tried this unit, but from the published specification it appears to be a close copy of the small Hammond spring unit, and could be directly connected in the mixer output; but since it uses a low impedance magnetic driver in place of the crystal which was common at one time, it would be more effective if coupled to this output by a transformer stepping down from 8 kilohms to 15 ohms.

The output from the unit can go direct to the input of the manual amplifier. Thus there would be reverberation on both manuals. It must be stressed that this should be kept to the minimum acceptable level and a very small amount is much more realistic with this type of organ in a small room.

SPRING LINE MOUNTING

Spring delay lines tend to be microphonic and they should be wrapped in foam plastic or some similar material to prevent the sound waves from the loudspeaker from exciting them. They are also extremely susceptible to mechanical shock, so can be suspended on cords to isolate them physically from the organ frame.

There are many other electro-mechanical or electro-acoustic reverberation systems but under the designed conditions of use for this organ, a spring unit of the type described should be quite satisfactory.



ADDITIONAL CIRCUITS AND PLAYING TECHNIQUE

MANUAL SUSTAIN GATE

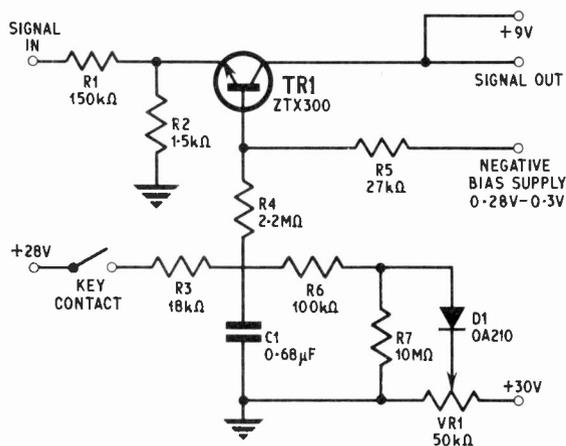


Fig. 11.1. Circuit of manual sustain gate, one of which is required for each organ note. See Fig. 9.5. for power supply taps

Resistors

R1	150kΩ
R2	1.5kΩ
R3	18kΩ
R4	2.2MΩ
R5	27kΩ
R6	100kΩ
R7	10MΩ

All 10%, ½ watt carbon

Capacitors

C1	0.68μF polyester
----	------------------

Potentiometers

VR1	50kΩ carbon
-----	-------------

Transistors

TR1	ZTX300
-----	--------

Diodes

D1	OA210 (Mullard)
----	-----------------

MANUAL SUSTAIN

The introduction of pedal sustain in Part Nine naturally leads to the question of manual sustain, but this is more difficult since a sustain circuit is required for each note.

This becomes quite complicated and costly and really a similar effect can be obtained from reverberation. However, as a matter of technical interest we show in Fig. 11.1 a circuit for this purpose.

The advantage of using a transistor for keying is that there is no distortion of the waveform as is encountered with diodes. The cut-off is better defined and there is no leakage, and of course there are no key clicks, so very simple contacts can be used. In this connection it should be noted that the resistance key switches specified for this organ could not be used with transistor (or diode) keying.

OPERATION OF SUSTAIN CIRCUIT

One transistor is required for every note of every pitch, so in some cases it is customary to key the bottom octave by direct contacts (using gold wires) and by transistors for the rest of the compass.

Thus, the signal voltage would be keyed for 13 notes and the forward conductive d.c. voltage would be keyed for the remainder, the signal voltage being permanently connected to the transistors.

Now the signal is fed through R1 to the transistor. The bias supply of about 0.28 to 0.3 volts reaches the base through R5 cutting the transistor off. When a key contact is closed, +28V is applied to R3 making C1

charge more positively. Thus the base becomes more positive and is biased on, so that the signal passes out from the collector.

When the key is released, one of two conditions is established; either the base is biased again for cut-off, discharging C1, or, if the diode is connected, +12V or +20V is switched to this. C1 will then discharge quickly through R3 and the diode but only until either the 12 or 20 volt level is reached; after this, the diode appears as an open circuit and further discharge of C1 is through R3, R6 and R7 at a much slower rate.

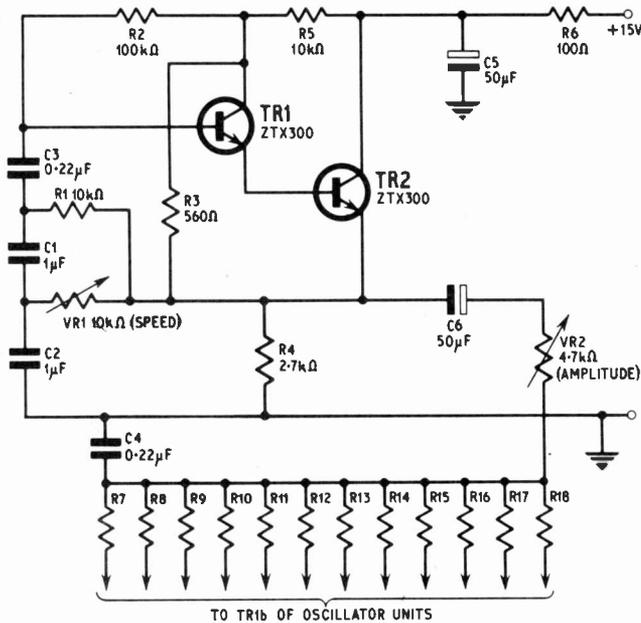
By varying the voltage on the diode, different rates of sustain are possible, equal in fact to what one would obtain from a reverberation device but much more controllable and with no frequency discrimination or possibility of overload. These two latter limitations must in fact apply to some extent to any system common to a large number of notes of varying intensity and pitch simultaneously applied.

PERCUSSION

It would be possible to use percussion circuits with this kind of organ but these must of necessity follow the generators and again must be a common unit.

A good many circuits have been published in various books, but quite frankly the author does not think that this effect can enhance the capabilities of this particular organ and it is only effective on flutes or similar voices of small harmonic content. In any case, percussive sounds do not belong to any family of organ tones.

VARIABLE VIBRATO



VIBRATO UNIT (ONE REQUIRED)

Resistors

- R1 10kΩ
- R2 100kΩ
- R3 560Ω
- R4 2.7kΩ
- R5 10kΩ
- R6 100Ω
- R7-R18 470kΩ (12 off)
- All 10%, ½ watt carbon

Capacitors

- C1-C2 1μF polyester (2 off)
- C3 0.22μF polyester
- C4 0.22μF polyester
- C 50μF elect. 25V
- C6 50μF elect. 25V

Transistors

- TR1-TR2 ZTX 300 (Ferranti) (2 off)

Potentiometers

- VR1 10k linear carbon
- VR2 4.7k horizontal preset

Fig. 11.2. Circuit of phase shift oscillator which will provide vibrato if connected to the twelve tone generators

VARIABLE VIBRATO

As we know, the tremulant or vibrato is produced acoustically by the revolving rotor above the manual loudspeaker. Sometimes added effects are possible with an electronic vibrato applied to the oscillators. This has certainly one advantage, that the rate of vibrato can easily be altered by a simple potentiometer.

A suitable circuit is given in Fig. 11.2 where it must be noted that all the 470 kilohm resistors have to be connected before the organ is tuned.

This oscillator gives a very good waveform and it will be realised that this is very important. If the modulation were not sinusoidal, or were lop-sided as it were, or if it contained harmonics, then there would be distortion of the signal which would change as the vibrato voltage swung from positive to negative. In an extreme case clipping could occur giving rise to spurious and discordant signals from the dividers.

One must decouple the vibrato oscillator very thoroughly from the power supply, this being achieved by the L filter C5/R6.

HEADPHONES

One of the advantages of the electronic organ is that we can bring the volume down to a whisper, an impossibility with any physical system. This raises the question of using headphones for practice.

Unfortunately in this organ we split the output into two channels, so that we must feed the signal from one amplifier into one of the earpieces, and the signal from the other into the second earpiece. If we assume these to be moving coil (otherwise we shall not hear much of the pedal section), then the impedance will be similar to that of the loudspeakers; we therefore only require a simple network to reduce the power to the 'phones and properly load the amplifiers at the same time. This is shown in Fig. 11.3.

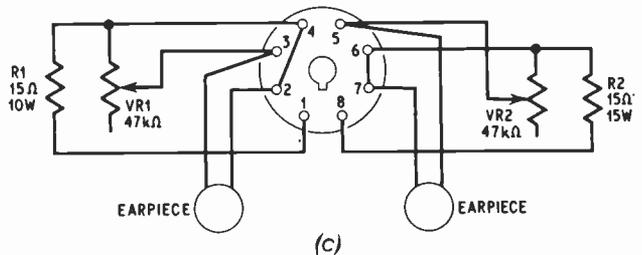
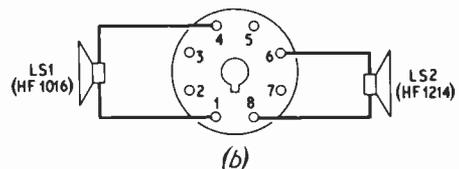
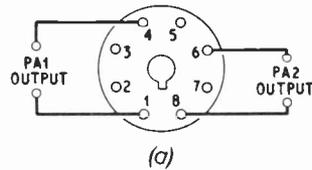


Fig. 11.3. Octal socket (a) and octal plug (b) connections for linking loudspeakers and amplifiers. For private practice with headphone an octal plug should be wired as in (c)

Perhaps the best way to mount the parts is on an octal base, when the loudspeaker connections can be on an octal plug to substitute when required. In the setting of VR1 and VR2 to a satisfactory listening level it must be emphasised that the wiper adjustment proceeds from the high resistance end.

PLAYING THE ORGAN

Now that we have an organ capable of producing many different sounds, what are we going to do with them? Readers who know about organs can answer this at once, but what about those unaccustomed to such instruments? Why are there all these pitches, and do all notes have the same effect, or are there some restrictions? Well of course every instrument has its limitations, and horrible sounds can be produced on any piano, organ, or indeed practically every physical instrument.

It will be recalled that this organ is based on what we call the solo and accompaniment system, which is just what it says. Everyone starts to play (unless being taught by a qualified teacher) by finding tunes on single notes. This is what the top keyboard is for, because even an accomplished player will frequently do the same thing. Therefore, for single notes only, any stop and any part of the top keyboard can be used; 2ft and 4ft stops are high pitched; 8ft and 16ft are low pitched.

A tremendous variety of melodic sounds can be found for simple tunes—there is no limit, since nearly 8 octaves is available by means of the different stops—equal to a keyboard longer than a grand piano!

ACCOMPANIMENT

The lower keyboard could be used in the same way, but its primary purpose is to provide simple or complex chords or figures for accompaniment. If you cannot play, this function will call for practice; but in any case, the loudness of the primary accompaniment stops—8 and 4ft flutes, 8 and 4ft strings—is less than that of the solo manual. This causes the melody to stand out, the exact relative loudness being regulated by the two swell pedals.

PEDAL BASS

The pedalboard is most likely to cause difficulty; yet, because only one note at a time is played on it, one can become quite proficient after reasonable practice. The sole purpose of this clavier is to provide the bass; and here there are a loud and a soft 16ft tone—an octave below the normal pitch; and an 8ft tone to reinforce the 16ft, which can become monotonous in time.

The pleasure derived from an organ depends on ringing the changes tonally.

CONSONANT CHORDS

We cannot give any guide as to any particular way to learn to play, but we can suggest how to avoid discordant sounds due to other causes. It is well known that because of the method of tuning for any instrument having 12 intervals to the octave, some chords are more agreeable than others; this is because some are relatively pure, whilst others produce beats.

When these beats are fast, they have little effect; for instance, 2ft, 4ft and 8ft stops down to about tenor C, 130Hz. Below this, the beat frequency approaches the tone frequency, and the tone becomes more coarse when chords are played.

For this reason, it is not satisfactory to use chords of 16ft pitch much below mid C, 261Hz. Indeed, when

one goes far enough down the keyboard, it is only octaves which can be tolerated—and this applies to all keyboard instruments of full compass.

So, as regards the top manual, caution is called for in using chords below mid C, but of course, single notes can be played right down to the bottom of the keyboard; indeed, this forms a useful bass for those who cannot use a pedalboard.

VOICE PAIRING AND VIBRATO

The melody is generally required to stand out from the accompaniment, not only by virtue of increased volume, but by contrast in tonal texture. For example, to accompany the solo violes by the violes on the lower keyboard would reduce contrast, but by using the accompaniment flutes, the solo would stand out well. Equally, the horns should be accompanied by the flutes, but the tibias can have either flutes or strings as accompaniment since they are usually used in combinations such as: 4ft and 8ft; 16ft and 4ft; 2ft, 4ft, 8ft and 16ft together.

The tibia is rather lifeless without vibrato, but takes on a curious appeal when so modulated. Vibrato should therefore always be used with this kind of voice in chorus, except in the event of a church organ effect, when of course it would not be required.

Most organ voices change their character with vibrato, and this applies especially to the strings.

EXTENDED SOLO

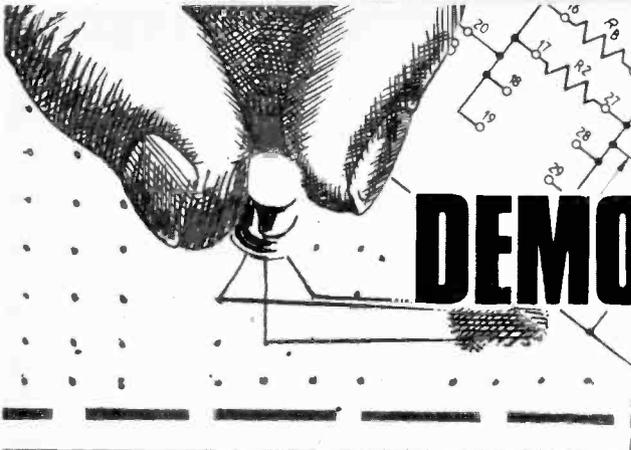
It will soon be found that the playing procedure is reversible, as it were; for example, the 4ft and 8ft tibias can be kept down by the solo swell pedal, and the clarinet or trumpet on the lower manual used as solo voices.

In this way, further sound patterns are possible, so by exploration, the constructor will find that there are more possibilities than appear at first sight.

To obtain melodious effects, the organ must be in tune. Once tuned, it will not drift out, since if polystyrene capacitors are used, the silicon planar transistors will be found to be perfectly stable against all changes of temperature likely to be found in a house.

In conclusion, and depending to some extent on reactions from readers, we hope to publish further possible modifications and extensions to the Practical Electronics organ, from time to time. ★





DEMO SWITCHING CIRCUITS

4

ASTABLE MULTI By B. Pounder

WE saw last month that, when the monostable has been triggered, the coupling capacitor C1 charges on a well-defined time constant and causes the base voltage of TR2 to rise continually from an initial negative value. Eventually, when TR2 base voltage passed through zero to a small positive value, TR2 began to conduct and the circuit switched back to its initial state.

ASTABLE SWITCHING

In the astable multivibrator, a capacitor is included in both coupling networks. Thus, as soon as the circuit switches, the appropriate capacitor begins to charge and eventually causes the switch back to the initial state.

However, the other capacitor will commence to charge following this second switching and, as soon as it drives the base of the off transistor positive, that transistor will turn on, so the circuit switches again. The process obviously continues, the transistors switching on and off alternately.

The circuit (shown in Fig. 4.1) acts as an oscillator, a relaxation oscillator. Typical output waveforms are shown in Fig. 4.2 which also illustrates how by the use of two different time constants, a variable "mark/space" ratio can be obtained, that is, the on times of either of the transistors can be made different from the off times.

DESIGN PROCEDURE

The calculation of component values is straightforward, the procedure for calculating these being given in the "design steps" panel.

DESIGN STEPS

- Step 1. Decide upon the required output swing V_o .
- Step 2. $V_{CC} = V_o$.
- Step 3. Choose a suitable collector current I_c , bearing in mind the load requirements and calculate $R_c = R_1 = R_4 = V_{CC}/I_c$.
- Step 4. Calculate $R_b = R_2 = R_3 = (V_{CC} - V_{be}) h_{FE}/I_c \approx h_{FE}R_c$ if $V_{CC} \gg V_{be}$.
- Step 5. Calculate C_1 and C_2 from $C_1 = \tau_1/0.7R_b$, $C_2 = \tau_2/0.7R_b$.

LIGHT FLASHER

Let us apply these results to design a demonstration circuit which will cause a pair of 6V, 100mA bulbs to turn on and off alternately at a frequency of about one cycle per second.

- Step 1. $V_o = 6V$.
- Step 2. $V_{CC} = 6V$.

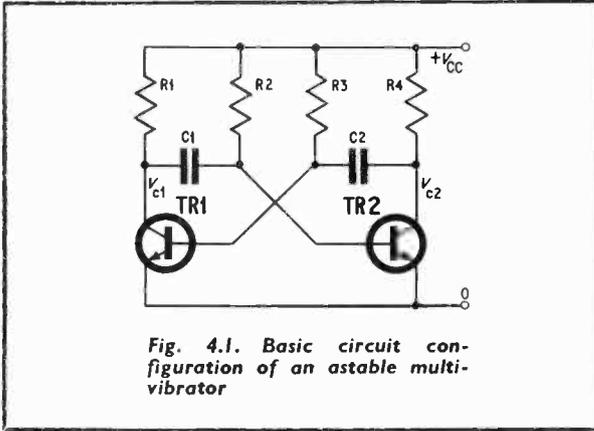


Fig. 4.1. Basic circuit configuration of an astable multivibrator

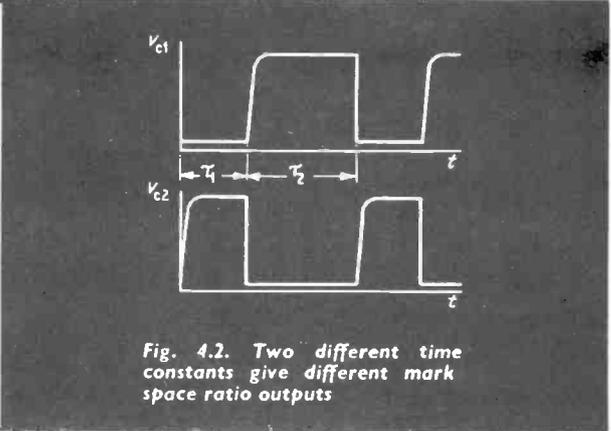


Fig. 4.2. Two different time constants give different mark space ratio outputs

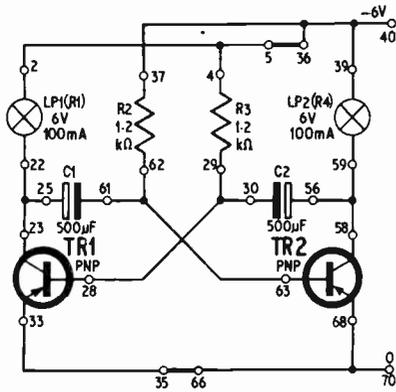
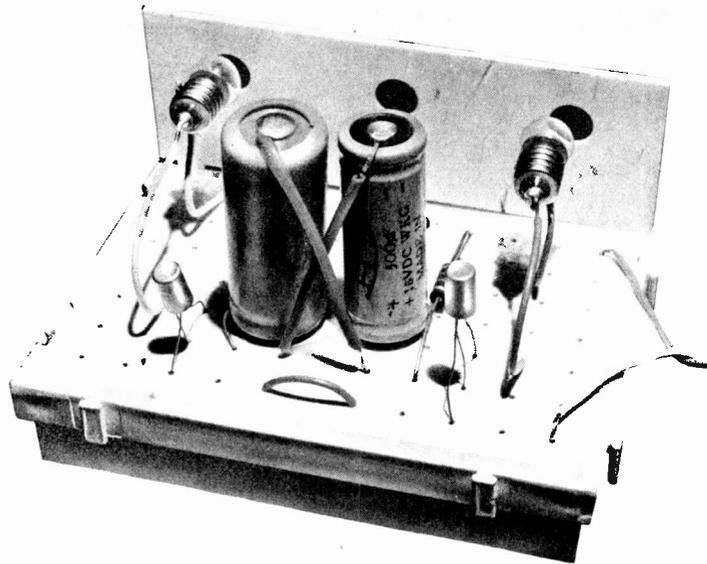


Fig. 4.3. Practical circuit for an astable multivibrator light flasher with S-DeC connections



Step 3. $I_c = 100\text{mA}$, so $R_c = 6/0.1 = 60$ ohms.

Step 4. Assume a minimum value of 20 for h_{FE} . Thus $R_b = 20 \times 60$ ohms = $1.2\text{k}\Omega$.

Step 5. $\tau_1 = \tau_2 = 0.5\text{s}$, so $C_1 = 0.5/(0.7 \times 1,200) = 420\mu\text{F}$.

Since both halves of the circuit are symmetrical $C_1 = C_2$ and can be $500\mu\text{F}$.

The circuit and suggested S-Dec connections are shown in Fig. 4.3. The transistors must be capable of operating at 100mA collector current; *pn*p devices are shown, types such as the OC72 or OC83 being suitable.

If *np*n transistors are preferred, the polarities of the electrolytic capacitors and battery supply must be reversed.

AUDIO RELAXATION OSCILLATOR

The circuit shown in Fig. 4.4 consists of an astable multivibrator working at a frequency of about 1kHz into a simple loudspeaker amplifier. Note that *np*n transistors are used for the multi, and *pn*p for the amplifier.

There is a danger of damaging the silicon types due to reverse bias base-emitter breakdown; this was mentioned in connection with the monostable multivibrator last month. To eliminate this possibility,

protection diodes are included in the base leads. Any diode will be suitable for this application, for example, OA71, OA81.

The component values for the multivibrator are calculated in the same way as before, but after the loudspeaker amplifier has been designed as follows.

First assume that a small 80Ω speaker is to be used. When TR4 is on, its collector current will be approximately $6/80 = 75\text{mA}$. The base current of TR4 will be about one twentieth, i.e. about 4mA, assuming a minimum h_{FE} of 20 at 75mA collector current. This base current is the emitter current of TR3, so the base current of TR3 will be not more than 0.2mA assuming the same value for $h_{FE(\text{min})}$.

If TR3 and TR4 are germanium transistors, e.g. OC72, there will be about 0.6V drop between the top rail and the base of TR3 when the transistors are on ($2 \times 0.3\text{V}$).

Now TR3 and TR4 will be on when TR2 is off, the collector voltage of TR2 being at near zero, so there will be a path for the base current of TR3 via R5. Thus $R_5 = (6 - 0.6)/0.2 = 27\text{k}\Omega$.

Note that when TR3 is off, its collector voltage will be approximately 6V, so R5 will be effectively returned to the positive rail. There will be no path for the base current of TR3 under this condition.

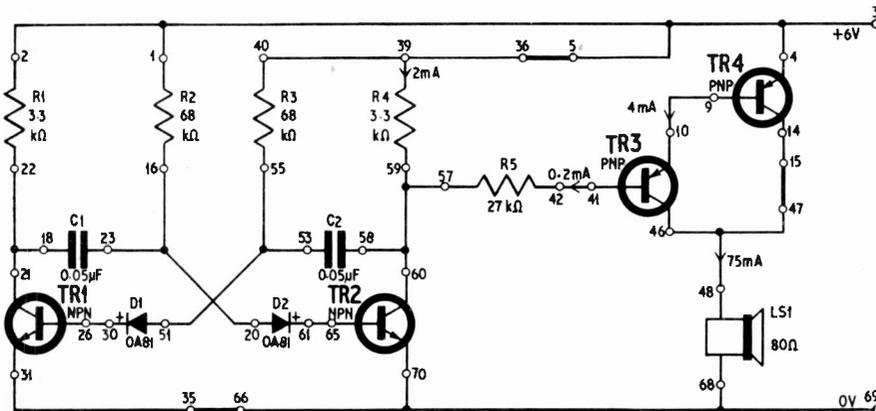
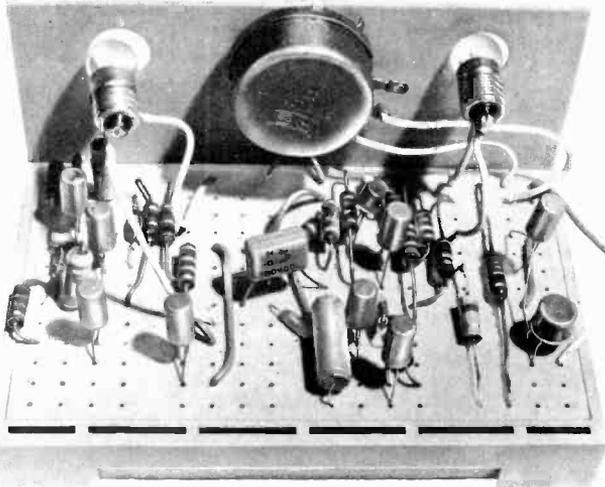


Fig. 4.4. Astable multivibrator with a simple loudspeaker amplifier. Note the use of *np*n and *pn*p transistors (see text)



A frequency divider unit built on T-DeC from the circuit shown in Fig. 4.5. The divider is made up from circuit blocks consisting of an astable multivibrator, Schmitt trigger and a monostable multivibrator, all of which have been explained in this series

Fig. 4.5 (right). Progressive building up of circuit blocks to form a frequency divider. Connections are for T-DeC

The multivibrator can be designed assuming an on collector current of 2mA. Thus when TR2 is on, it will be only little affected by the extra current which it must pass from the base of TR3. This excess is 0.2mA at the most. Transistors TR1 and TR2 are *npn* types, almost any low current device being suitable.

FREQUENCY DIVIDER CIRCUIT

A frequency divider circuit is given as an example of how to interconnect some of the basic circuits considered in this series up to now. A suggested layout for the frequency divider, suitable for a T-Dec, is given in Fig. 4.5. It is a simple matter to make the necessary alterations for a μ -Dec if preferred.

The circuit consists of an astable multivibrator (TR1, 2) operating with a period of approximately 0.5 second. The output is coupled to a Schmitt trigger (TR5, 6) so that the corners of the waveform can be sharpened, and thence via a CR differentiating network (C3, R12) which provides sharp voltage spikes to a monostable multivibrator (TR7, 8).

The period of the monostable can be varied by means of potentiometer VR1 to achieve frequency division by 2 or 3. Simple lamp bulb driver circuits (TR3, 4; TR9, 10) are included to provide a visual indication of the operation of the circuit.

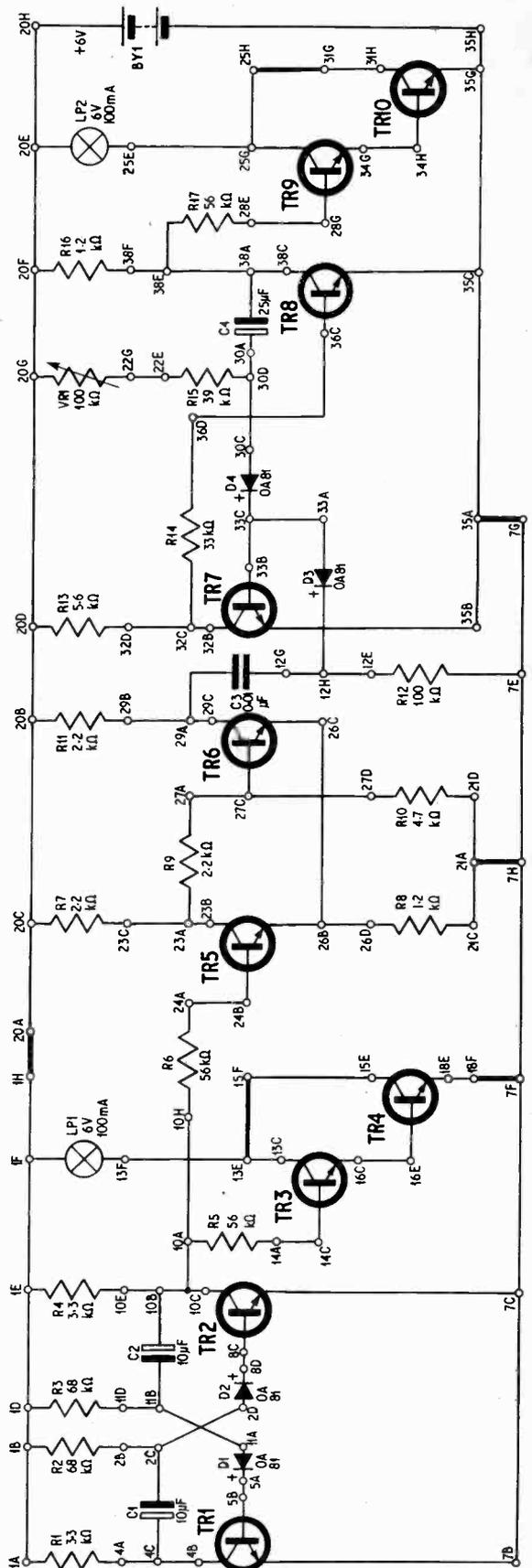
If necessary, the timing capacitors can be reduced to increase the operation frequency; the waveforms can be observed on an oscilloscope by connecting the 'scope across the lamp LP2.

To be continued

CORRECTION

December 1969, page 923, 14 lines from bottom of page should read:

"The resistance in each base lead of the series transistors must therefore be $(6-0.9)/0.252 \approx 2,000$ ohms.



A VOLTAGE TO FREQUENCY CONVERTER

By K. J. MATTHEWS B.Sc. Grad.Inst.P.

FINDING its main use in electronic music, this device provides a variety of sounds and effects that could otherwise only be obtained with fairly expensive apparatus. The device provides square wave output, the frequency of which is determined by the input voltage and, when used in conjunction with a sine/square wave signal generator, provides some interesting sounds.

OPERATION

The circuit diagram of the unit is shown in Fig. 1. TR1 and TR2 form an astable multivibrator, the frequency determining components being C1 and C2. In place of the usual resistors to the zero voltage rail, two OC200's are used; the current through these is controlled by the input voltage. The time constant of TR2 and TR3, and C1 and C2 can be varied, thus controlling the frequency of operation.

Capacitors C1 and C2 have been made $0.01\mu\text{F}$ to produce a basic frequency, when no input signal is applied, of approximately 4kHz. The input voltage swing allowable is $\pm 6\text{V}$ providing an equivalent frequency range of 1.5kHz to 6kHz.

Components are not critical although silicon transistors are used to provide a good degree of stability.

As the circuit is designed to operate from two 9V batteries in series, giving a 9-0-9V supply, there may be some difficulty if a mains power supply is to be used. In this case, the network shown in Fig. 2 may be used.

APPLICATIONS

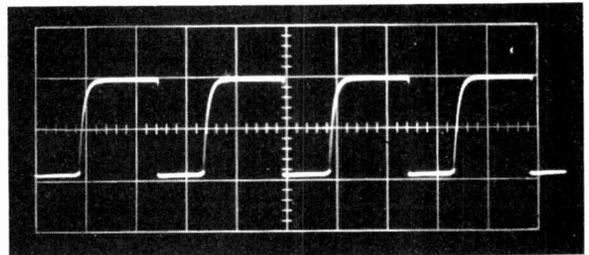
The circuit may be tested by connecting the output to an amplifier and applying a variable voltage to the input. It should be possible to hear the note vary from 1.5kHz to 6kHz as the voltage input is steadily increased. Various applications now become apparent; by applying a sawtooth or ramp function to the input, the note can be swept over the frequency range equivalent to the peak-to-peak voltage of the input signal.

For a sine wave input up to 20Hz the change in pitch can be heard distinctly; up to 100Hz the resulting sound is not unlike birdsong. A 500Hz input produces

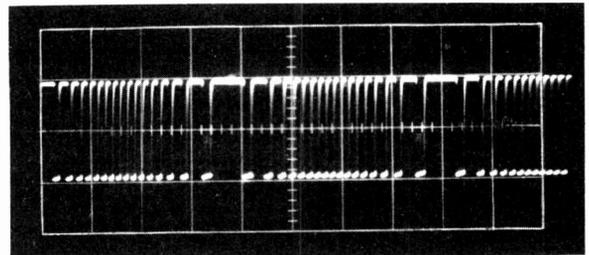
a "rich dirty note", and peculiar effects are obtained when the input frequency approaches the basic multivibrator frequency (4kHz).

A square wave input, from a slow running multivibrator (up to 100Hz) will give particularly interesting results if the circuit of Fig. 3 is used. The output switches alternately from one note to the other in phase with the square wave input. The frequency distance between the notes is controlled by the amplitude of the input pulses and the two notes can be shifted up and down the audio frequency band by the d.c. offset voltage provided by potentiometer VR1.

Interesting room for experiment in the music concrete field can be foreseen, if the low frequency notes from ordinary audio signals are amplified to $\approx 5\text{V}$ peak to peak and fed into the circuit.



The basic multivibrator output. The amplitude of the pulses is 4 volts peak to peak and their duration is 0.015 milliseconds



Frequency modulated output obtained by using a 200Hz sine wave input to the converter

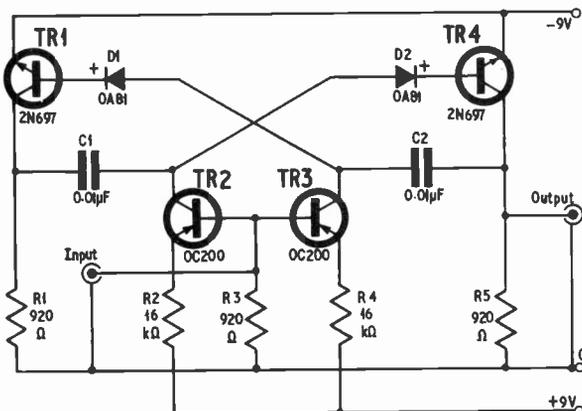


Fig. 1. Circuit diagram of the voltage to frequency converter

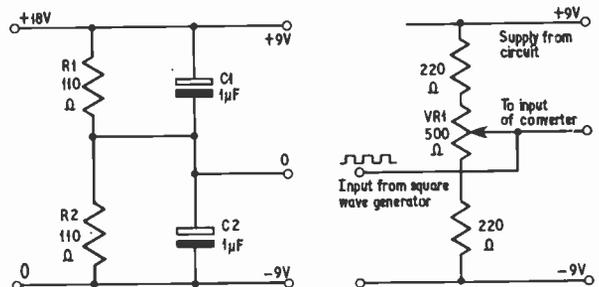
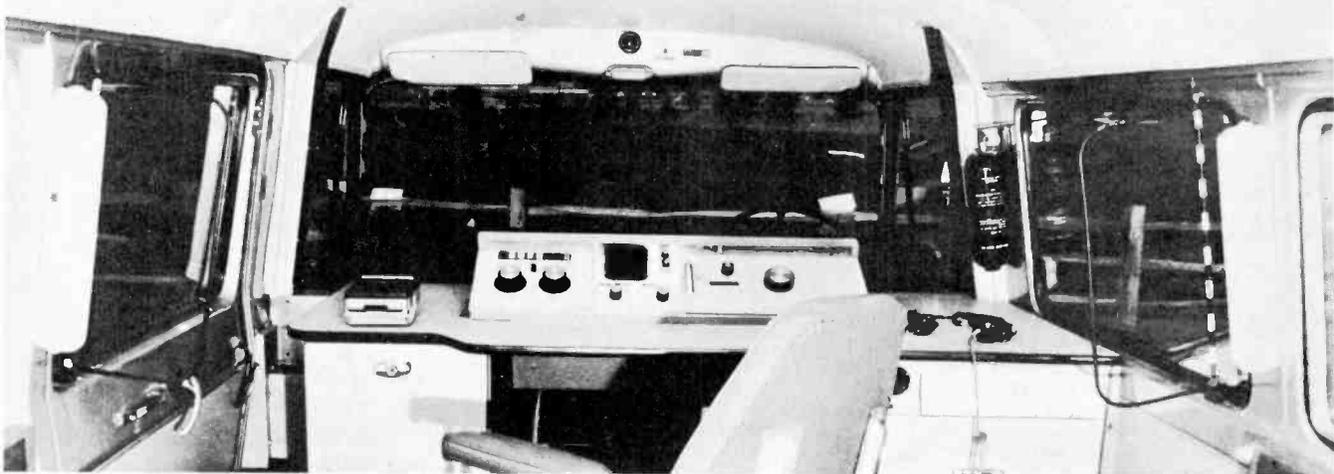


Fig. 2. Circuit used when the converter is to be supplied from an 18V d.c. power supply

Fig. 3. Circuit for alternately switching the output from one note to the other



ELECTRONORAMA

More Detector Vans

THE VAN pictured right could recover an estimated £7½m loss of television licence fees. Vosper Electric, who convert the Commer vans into television detectors, have recently received an order for 18 detector vans from the Government; they have already completed a previous order for ten detector systems.

The sophisticated electronic detection equipment is housed in a console fitted behind the front seats as shown above, and consists of a receiver covering the frequency range 470 to 860MHz which is fed from a pair of wideband aerials, the spacing between which is automatically adjusted as the receiver is tuned. This aerial system has a known directional characteristic and can be used to receive signals from either side of the vehicle, thus facilitating the scanning of buildings on both sides of the road.

The receiver output is displayed on a cathode ray oscilloscope. As the vehicle moves slowly past a chosen house, the oscilloscope display, on a repeater screen, is photographed by an instant-developing Polaroid camera on the left of the console. Special sight-line indicators at the windows of the van enable the operator to pinpoint the boundaries of the property, and by pressing a button he can indicate these on the photograph. In this way the operator is able to determine the approximate position in the house of the television receiver, and the channel in use can be identified from the frequency to which the detector receiver is tuned.



The detector vans already in use have proved very successful. The appearance of a van in any area usually results in a considerable number of television licences being obtained by people who had previously neglected to do so, and the publicity which follows the prosecution of those who persist in using a television set without a licence has the same effect.

Advance in IC Technology

A UNIQUE method of producing integrated circuits, which constitutes a significant advance in microelectronic technology, called Planox, has been developed at the SGS International R & D Laboratories at Agrate, Milan. The process enables the oxide layers on the surface of the wafer to be effectively flat so that device reliability is greatly enhanced and manufacturing yields are improved.

In an MOS device, the oxide layer grown on the gate regions has to be extremely thin in order to achieve low threshold voltage sensitivity; and the oxide layer in the field region has to be thick to avoid spurious MOS effects.

When produced by conventional methods, the thick layer on the field region gives rise to high "steps" of oxide on the chip surface over which the metallisation pattern has to be formed. The resultant sharp bends in the metallisation can lead to weak spots or "microcracks" with consequent less reliable interconnections or even open circuits. Thus yields are lower and device costs are higher.

The Planox process eliminates this problem by the removal of sufficient underlying silicon to accommodate the oxide thickness so that the resultant surface is essentially flat.

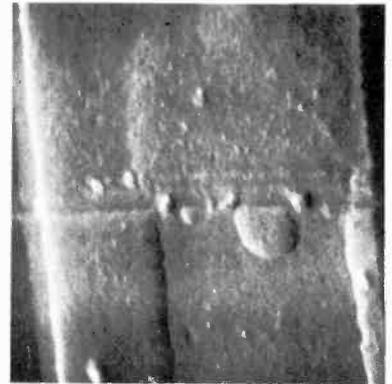
The SGS Planox process will be introduced into the production of SGS MOS devices during the second quarter of 1970.

Electronic Map Reading

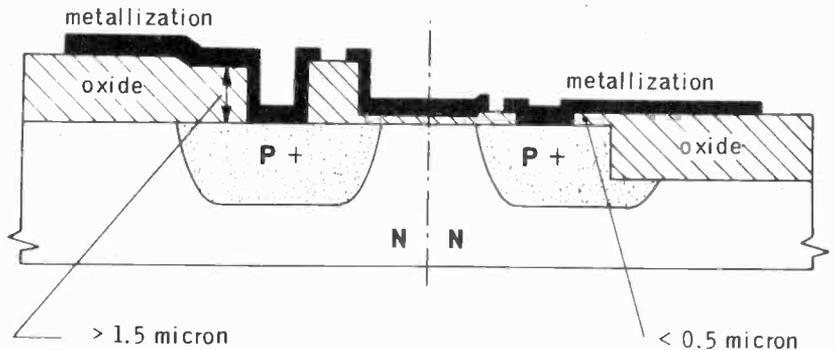
TWO WELL established data processing equipments, both of them British, have been integrated to provide a novel system of information processing known as Microtrace. It comprises a digitiser, computer and software, the digitiser being the Pencil Follower manufactured by d-mac, while the computer is the Micro-16 developed with NRDC backing by Digico.

The new equipment enables data to be immediately processed, while lines and shapes on drawings, strip charts or films are followed with the "free pencil".

Microtrace will be available in a variety of configurations, with software to suit specific applications. The first of these, MapScan, which is shown in use on the right, allows area and distance measurements to be made in normalised units to meet the needs of civil engineers, surveyors, planners and cartographers, and can assist them in their decision making. A medical version of the system is already available for the processing of auto-analyser charts; and plans are in hand to extend the usage to land registration, metrication, and pipe-work design.



Comparison microphotographs of part of the gate region of an MOS transistor. Magnification is approximately 3,000 times



A conventional device. A metal stripe, the gate electrode, crosses the boundary between the field (thick oxide) and the gate region (thin oxide). The high step in the oxide is evident

A Planox device. The boundaries between the field, gate and source regions do not have any apparent oxide steps between them. The reduced width of the gate stripe is due to the elimination of the need for design tolerances to align the gate oxide with the source and drain diffusions



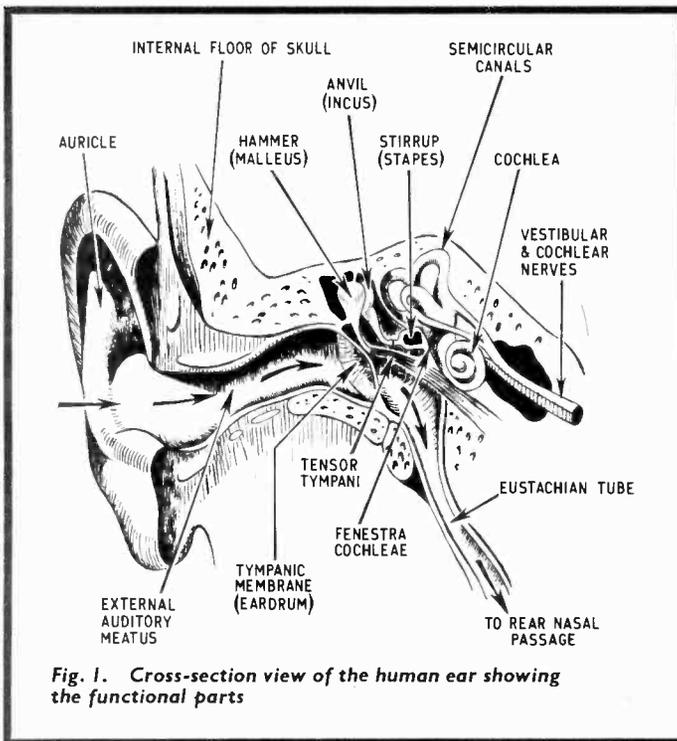
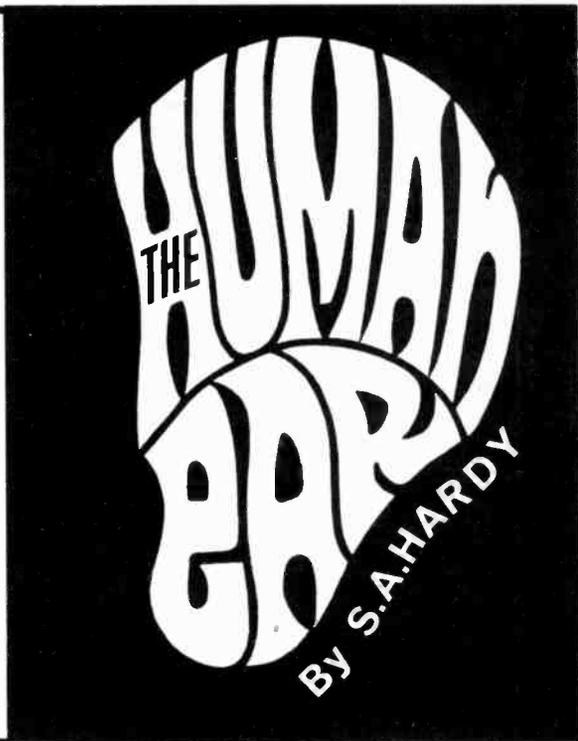


Fig. 1. Cross-section view of the human ear showing the functional parts



ONE of the most popular uses of electronics lies in the reproduction of sound in some form or other. Whether it be an audio amplifier or a sound effects device, the human ear is probably the most essential component in the chain of audio intelligence. It is appropriate, therefore, that the working characteristics of the ear should be understood in order to get the best possible mental interpretation of sound.

This article is aimed at providing a fairly straightforward account of the relationship between sound waves and neuro-intelligence through the medium of a human transducer. The ear is divided into three main sections, which will be described in the following sequence: external ear, middle ear, and inner ear. See Figs. 1 and 2.

EXTERNAL EAR

Sound waves are produced by the vibrations in air of solid objects, such as a tuning fork, a violin string, the diaphragm of a loudspeaker or telephone earpiece. The vibration of solid objects sets the surrounding molecules of air into motion to form pressure waves, which move away from the sound source, much in the same way as throwing a pebble into still water to form ever increasing numbers and sizes of ripple rings about the impact point.

These air pressure wave changes are picked up by the external visible part of the ear, properly called the auricle, and channelled into a tube approximately 2½cm long called the external auditory meatus. This is lined with minute stiff hairs and wax producing glands to stop the ingress of dust and dirt into the delicate internal tissues.

The innermost end of the external auditory meatus is completely closed by the tympanic membrane (eardrum), which vibrates in sympathy with the air pressure changes transmitted to it through the external ear.

MIDDLE EAR

The movements of the tympanic membrane are transmitted through the area called the middle ear by the three smallest bones in the human body (the ossicles). These, in order from the tympanic membrane to the fenestra vestibuli (oval window), are the malleus (hammer), incus (anvil) and stapes (stirrup) (see Fig. 2.)

The footplate of the stirrup rests in the oval window, which is the entry to the inner ear—the hearing centre proper. Also attached to the tympanic membrane is a small muscle called the tensor tympani which, by controlling the tautness of the tympanic membrane, enables the human ear to adjust to large differences of sound level (a kind of automatic volume control) (see Fig. 1).

The other end of the tensor tympani is anchored to the upper surface of the eustachian tube which leads out of the middle ear into the nasopharynx (the cavity forming the rearmost portion of the nasal passages).

The eustachian tube also acts as an air pressure relief pathway, so that the ambient air pressure on either side of the tympanic membrane can be equalised. (This is the reason why passengers travelling in aircraft are advised to swallow and yawn during the ascent and descent to assist the pressure equalisation process.) This is also the reason why a large yawn under normal atmospheric conditions produces a "popping" sensation in the ears.

The apexes of the hammer and anvil are supported at their junction by small suspensory ligaments attached to the upper surface of the middle ear chamber. A small muscle, called the stapedius is attached to the stirrup to restrict the movement exerted by the tensor tympani. These ligaments and muscles are all part of the ear's a.v.c. system, in fact during extremely loud percussive sounds the malleus and incus actually part company.

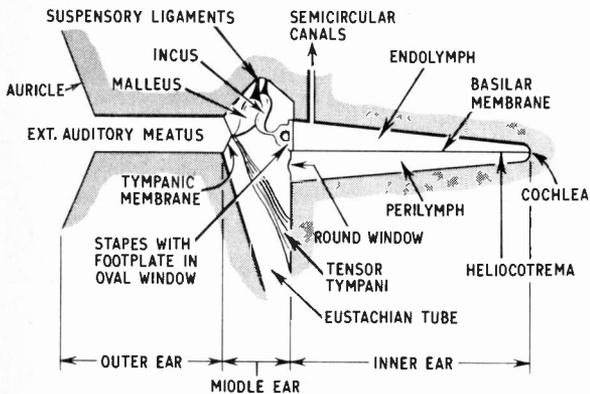


Fig. 2. Simplified diagram of the auditory canal showing the cochlea fully extended

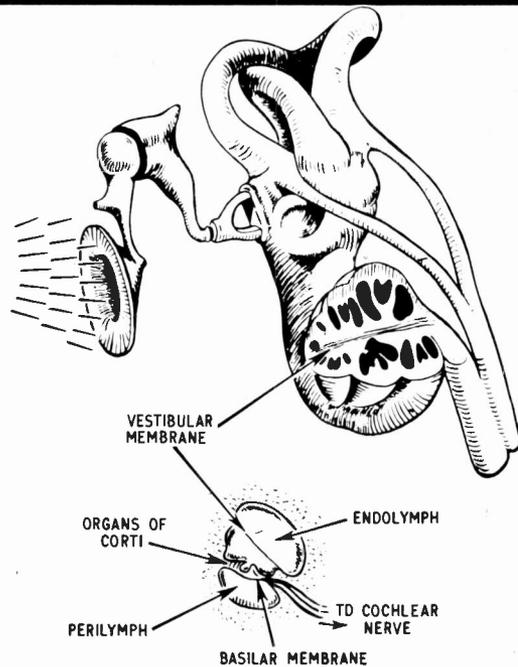


Fig. 3. Cross-section through the cochlea with other middle ear components

INNER EAR

The inner ear, or bony labyrinth, consists of the vestibule, into which the footplate of the stirrup is driven via the oval window, and extends into a snail shaped part called the cochlea containing the hearing sensory cells. Also three semicircular canals of unequal length emerge from the vestibule, two in a horizontal plane, the other in the vertical plane, and at an approximate ninety degree angular displacement from each other, forming the balance centres.

The bony labyrinth, except for part of the cochlea, is filled with a fluid called endolymph. Movement of

this fluid induced by very low frequency sound waves, or motion of the head, causes nerve cells (cupula) in the semicircular canals to move. By virtue of the unequal lengths of the canals, the brain discriminates between the different neural signals generated by the nerve cells (cupula).

If it was possible to unwind the cochlea from its spiral form into a straight line, it would resemble a converging tube closed at its narrowest end, and divided by a curtain called the basilar membrane (Fig 3). The base of the latter contains rod like nerve cells called the organs of corti which, when stimulated by sound

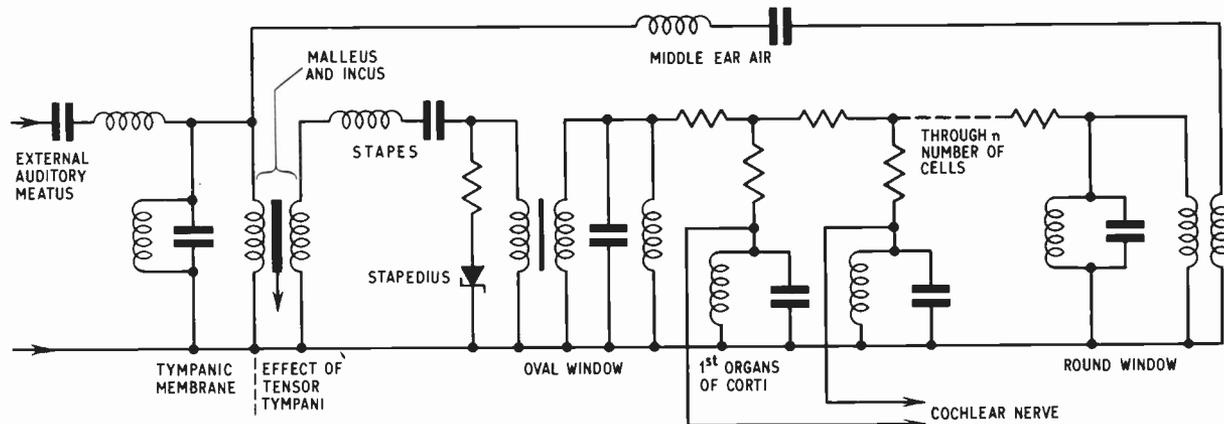


Fig. 4. The functions of the ear components may be likened to an electrical circuit with inductors, capacitors and resistors

transmitted via the stirrup footplate causing wave motion in the endolymphatic fluid, produces the neural signals the brain translates as audible sound.

A poor analogy to the organs of corti is the crystal microphone, where sound waves mechanically stress a material to produce electrical impulses. At the narrowest end of the cochlea is a minute hole (heliocotema) in the basilar membrane, which acts as a large differential fluid pressure relief valve between the endolymph and perilymph, (Fig. 2).

The latter acts as a pressure equalisation device so that, as the stirrup moves inwards, the increase in endolymphatic pressure is transmitted through the basilar membrane and the perilymph to the round window which moves outwards.

The whole of the bony labyrinth is embedded in bone, which forms the lower internal floor of the brain

MEASUREMENTS OF HEARING

In this description, reference will be made to normal or average hearing and ears, but it should be remembered that no two ears are identical—even when having a common owner. In fact each ear is as individual as a fingerprint.

A good human ear can usually hear pure sine wave tones in the frequency range 30Hz to 12kHz providing there is sufficient amplitude of the waveform at the extremes of this frequency spectrum. However, it is not unusual to find subjects who can hear above 16kHz, and below 30Hz.

It is against this amplitude and frequency response characteristic that audiometric tests are made to enable a physician to determine the efficiency and diagnose any possible malfunction of the ear. Fig. 5 shows typical graphs.

A simplified form of audiometric test set comprises a

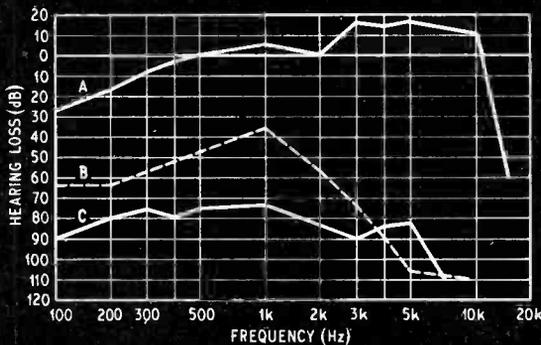


Fig. 5. Frequency response characteristics of a single ear (a) with normal hearing, (b) with a defect in the middle ear, (c) with a neural defect

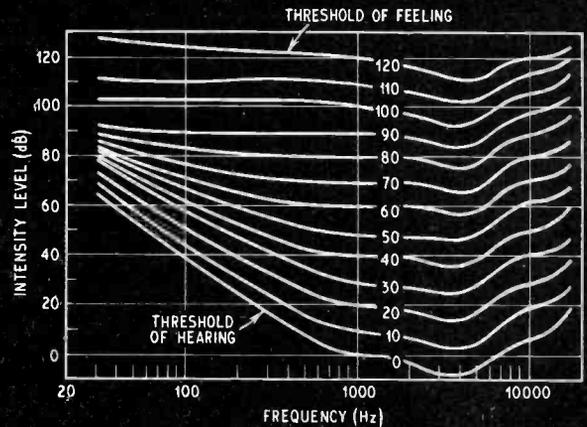


Fig. 6. Fletcher Munson equal loudness contours

cavity, except the oval window and the round window which open directly into the middle ear cavity. Thus audible sound may be transmitted directly through the skull to the cochlea as in the case of the dento-phonics. This is the well-known bone conduction principle often used with certain types of hearing aid.

PROCESS OF HEARING

Neural signals generated by the balance centres and the organs of corti are transmitted through the vestibular and cochlea nerve trunk by a system of pulse rate modulation to the brain. It is the brain which determines the intensity, pitch and harmonic content of a sound. The ability to select certain sounds (for example, listening to a conversation with a high background noise level) are also mental processes.

In fact the ear may be crudely described in three parts: an acoustic to mechanical transducer (the outer ear), a mechanical to hydraulic transducer (the middle ear) and hydraulic to electro mechanical stress transducer (the inner ear). The neural signals from the latter are fed to the brain for decoding.

pure sine wave tone generator having a frequency range 125Hz to 12kHz, an attenuator calibrated in decibels to determine hearing loss, a linear response amplifier, and headphones of known characteristics to which the calibration of the attenuator is related.

The output of the amplifier is switched to the headset earpiece on the ear under investigation. In more sophisticated equipment a second tone or masking noise is injected at a predetermined level to enable the operator to measure the discerning capabilities of the subject's hearing.

SENSITIVITY

The Fletcher-Munson curves of equal loudness demonstrate the average response of the human ear to sound levels at all frequencies within the above spectrum, taking into account the non-linear function of the middle ear mechanism. These curves were first produced in the Bell Telephone Laboratories by measuring the ear characteristics of a large number of subjects in relation to the preset level of a 1kHz continuous reference tone (see Fig. 6).

These curves are often used in the design of audio amplifying equipment for obtaining compensatory responses of the equipment at different loudness levels. However, these loudness controls are mainly found on American equipment, while British audio experts generally believe that the need for such devices is based on an ill-conceived notion, which is not related to hearing sensitivities to live sound.

The ear is normally quite sensitive to pitch change as distinct from frequency change. Pitch in this sense is a function of the intensity or loudness and frequency of a pure tone and is a subjective quantity; at least 50 milliseconds are usually required for the change to be aurally assessed by the brain (see Fig. 7).

However, the ear is not sensitive to changes of phase in pure tones, but if the sound has a high harmonic content, which is subjected to relatively large time delays and loudness levels, the ear can detect these

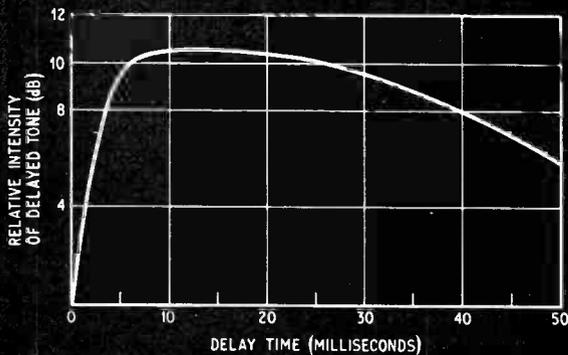


Fig. 7. Effect of intensity and pure tone frequency on pitch

deposits under medical supervision. If care is not exercised in syringing, damage can be caused to the ear drum.

If the ear drum is perforated as a result of some physical injury, it can be repaired by plastic surgery, otherwise called a tympanoplasty. However, due possibly to old age, layers of spongy bone deposits are laid down in the middle ear restricting the movement of the ossicle bones. This may result in at least partial deafness, but surgical intervention is possible and one or more of the damaged ossicles may be replaced by a prosthesis, a plastic or stainless steel part.

In the case of a congenital deformity of the ear it is sometimes possible to perform gross plastic surgery, such as in the case of a child born without an external auditory meatus. Certain diseases can cause malfunctions of the nervous system appertaining to the ear and, even if the disease is arrested, there is little

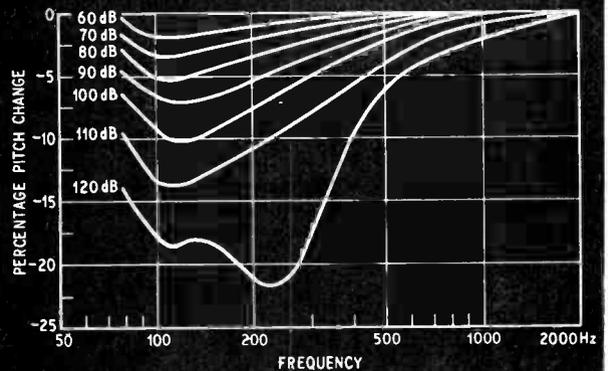


Fig. 8. The Haas effect. Increase of delayed tone level to give equal loudness

differences if the phase delay is greater than 90 degrees.

Subjects with normal hearing in both ears can locate the source of sound, this being a mental process, even though the auricles assist in the assessment made by the brain. Again a phenomenon, called the Haas effect, takes place when subjects are asked to locate the source of pure tone sounds. For instance, if the time delay between two identical pure tones is in the order of 5-30 milliseconds, then the first tone to arrive at the ear will indicate the apparent source of both sounds, even if 8dB weaker than the second tone (see Fig. 8).

MALFUNCTIONS OF THE EAR

Malfunctions of the ear, usually referred to as deafness, are many and varied and thus only a few specific examples and their related treatments are mentioned. Examples of temporary deafness are eustachian tube blockage caused by a head cold, and excessive cerumen deposits in the external auditory meatus. The first can be treated by medically prescribed drugs, the second by extracting excessive

that can be done to correct the hearing, except the possible use of a prescribed hearing aid.

An important factor, in this day and age, is the damage that can be done to the ear by continued over-exposure to extremely high noise levels, but persons subjected to this influence can use ear plugs and ear defenders to protect their hearing. Continued exposure to sound levels in excess of 80dB may be considered a health hazard.

CONCLUSION

This article has been an attempt to give an understanding of the human ear and the delicate nature of its construction. In the light of such knowledge, the various technical requirements for interpretation of different sounds using electronic equipment, can be readily understood. Readers are recommended to consult reference books for more detailed information.



electronic LOCK

By P. L. WOODS

THE electronic lock described in this article is designed to put the burglar in his place. To break in, an electronic signal generator would have to be used, and a lengthy search, at various frequencies, made over the whole area of the door. The lock leaves no indication on the outer surface of the door as to its presence.

THE lock works on the magnetic induction of a signal in a hidden pick up coil which electronically operates a solenoid used as a door bolt. Impregnability is derived from the fact that a tuned circuit, comprising of an inductor and a capacitor, will only respond to one main frequency, and hardly at all to frequencies on either side of the main frequency—except harmonics.

CIRCUIT OPERATION

The signal to operate the lock is obtained from a one transistor oscillator (TR1) in the "key", see Fig. 1. By means of L1 a varying magnetic field is set up around the oscillator unit, which may be picked up by any other coil in the vicinity. In this case it is L3 which is tuned by C3 (Fig. 2) to the same frequency as the oscillator. The signal that the coil picks up is rectified by D1 and fed to a smoothing capacitor, C4. Thus the signal is converted to a fairly steady d.c. which is fed to the base of TR2. Transistor TR2 amplifies the signal which is then fed to the Schmitt trigger (TR3 and TR4) via the sensitivity control VR2.

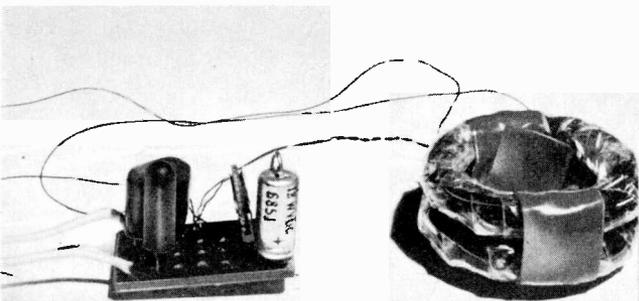
The Schmitt trigger detects the signal at VR2 wiper, causing TR4 to conduct, operating the relay and closing the contacts which operate the solenoid (used as a door bolt) thus allowing the door to be opened.

COMPONENT DETAILS

The coils L1, L2 and L3 are similar, being wound on a 1in diameter former from 30 s.w.g. wire, 300 turns going into each coil. Coils L1 and L2 are taped together and can be placed around the "key" circuit board to save space.

As 12 volts are required to operate most relays and solenoids, three 4.5 volt type 1289 batteries were used, connected in series, to give 13.5 volts; this will ensure a long and useful battery life. Total power consumption from these batteries in the prototype was 100mA, with the relay operating. Drain on the battery, with no signal applied, was approximately 5mA. The current taken by the oscillator was 40mA from a PP6 battery.

While OC71 and 72 transistors are specified, almost any a.f. transistors can be used with equal success. Transistors TR1 and TR4 must be of an output type,



Key for the electronic lock before installation in its case

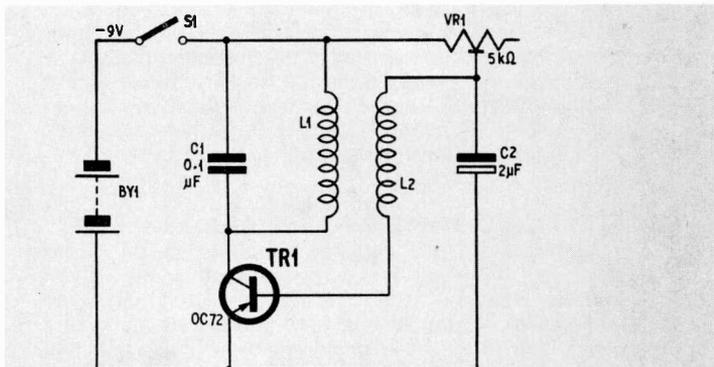
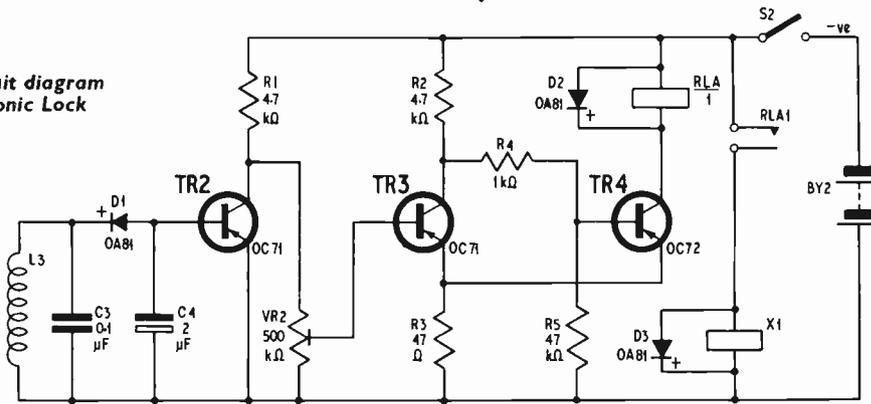


Fig. 1. Circuit diagram of the "key" for the Electronic Lock

Fig. 2. Circuit diagram of the Electronic Lock



as each has to pass a higher current than TR2 and TR3 which act only as small signal amplifiers.

Diode D1 should be a small general purpose type, such as OA81 or OA91. D2 and D3 should not be smaller than OA81's, as they have to pass the back e.m.f. developed when the relay and solenoid are switched off. Almost any relay with a low current 12V coil can be used provided it has one pair of normally open contacts.

The solenoid is a 12V type modified for use as a lock. Fig. 3 shows how it may be arranged to act as a door bolt. The spring holds the bolt in the door frame but must not be too strong or the bolt will not retract when current is passed through the coil. It should be possible to construct the complete solenoid using a coil of about 3,000 turns of 30 s.w.g. enamel covered copper wire—some experimentation with coil, spring and bolt sizes will probably be necessary.

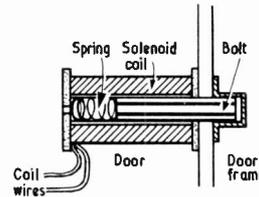


Fig. 3. Showing a solenoid used as a door bolt

CONSTRUCTION

Both the "key" and the lock were constructed on small pieces of Veroboard (Figs. 4 and 5), the "key" coils being large enough for the associated circuit board to be placed inside them. The complete "key" can be conveniently mounted inside an old torch case or a special tubular case can be manufactured. It should be noted that there should be no metal section between coils L1, L2 and L3, since this will prevent operation of the lock.

It is convenient to mount the lock circuitry inside a small box, which includes the solenoid, and affix this to the back of the door. The batteries or mains power supply can be either included in the box or mounted externally. It is advisable not to mount T1 too near to L3 as this could affect operation of the circuit.

POWER SUPPLY

Much thought has been given to the question of how to power the lock when fixed to a front door. Dry batteries are liable to fail when the lock is in use, while the mains is subject to sudden power cuts.

One answer is to tap the power needed from a bell transformer (Fig. 6), rectify and smooth it to feed a DEAC cell battery via a dropping resistor (R6). Thus the battery is on constant trickle charge, and the power for the lock can be taken from it. Components T1 and R6 must be chosen to suit the size of battery used. Fuse FS1 is included to safe-guard the circuit.

The unit will always work, even during power cuts, and no switch is needed as the unit may be left on all the time without fear of battery failure. In the circuit shown in Fig. 2 switch S2 was included as the lock can then be turned on before use and off once the door has been closed, thus increasing battery life.

COMPONENTS . . .

KEY

Capacitors

- C1 0.1 μF
- C2 2 μF elect. 12V

Potentiometer

- VR1 5k Ω skeleton preset

Transistor

- TR1 OC72

Miscellaneous

- S1 SPST toggle switch
- BY1 miniature 9V battery
- 30 s.w.g. enamel covered copper wire
- Veroboard 1 1/8 in × 3/8 in, 0.15 in matrix

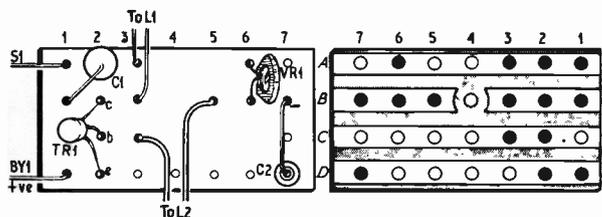
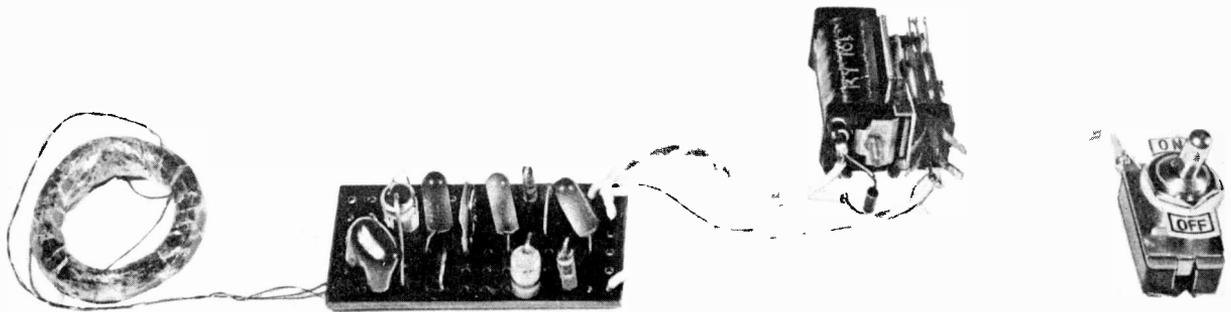


Fig. 4. Veroboard layout and wiring of the "key"



The complete lock wired up ready to be installed on a door

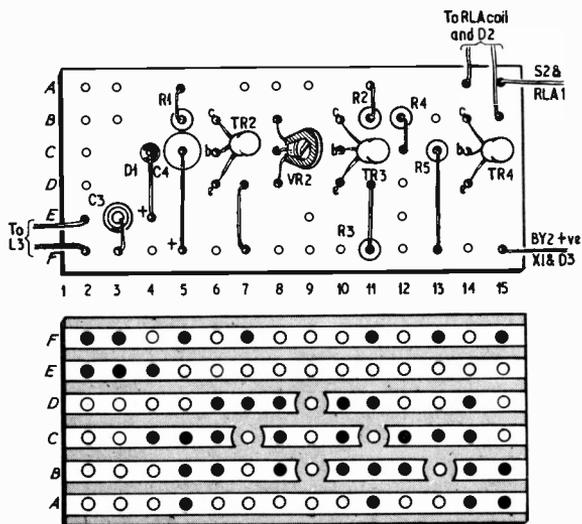
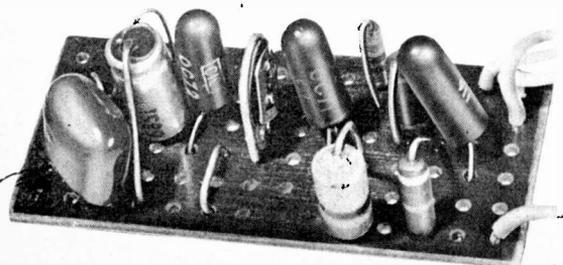


Fig. 5. Veroboard layout and wiring of the lock circuit

It has been brought to our attention that under the Wireless Telegraphy Act 1949, a licence is required to operate the Electronic Lock described in this article.

Under section 1a (radio frequencies for low power non-speech devices) the band 16 to 150kHz can be used for induction communication systems operating over a short range.

A licence for 5 years costs 15s and can be applied for on a special form obtainable from the Ministry of Post and Telecommunications, Waterloo Bridge House, Waterloo Road, London S.E.1.



COMPONENTS . . .

LOCK

Resistors
 R1 4.7k Ω R3 47 Ω R5 47k Ω
 R2 4.7k Ω R4 1k Ω
 All $\frac{1}{4}$ W, 10% carbon

Potentiometers
 VR2 500k Ω skeleton preset

Capacitors
 C3 0.1 μ F
 C4 2 μ F elect. 12V

Semiconductors
 TR2, 3 OC71 (2 off)
 TR4 OC72
 D1, 2, 3 OA81 (3 off)

Miscellaneous
 RLA 12V (see text)
 S2 SPST toggle switch
 BY2 12V battery (see text)
 X1 solenoid, 12V (see text)
 Materials for cases (see text)
 Veroboard $2\frac{1}{2}$ in \times 1in, 0.15in matrix
 30 s.w.g. enamel covered copper wire

SETTING-UP AND ADJUSTMENTS

When the oscillator has been made, but before it is placed in its case, it should be adjusted as follows: A crystal ear-piece should be connected across L1, and the battery connected up. As VR1 is rotated, a note should be heard (providing the frequency of oscillation is within the audio frequency). If this is not the case, the connections to L1 should be reversed.

If the oscillator still does not function, the transistor and wiring should be checked.

When a note is heard, the coils of the oscillator should be placed on top of L3 and a high impedance voltmeter, having a 5V a.c. range, should be connected across L3, the oscillator started, and VR1 adjusted for maximum reading on the meter. The oscillator should then be switched off, and the meter removed, so that the lock may be adjusted.

With the lock switched on, VR2 is turned until the relay operates; VR2 is then turned back until the relay just switches off. Bringing the oscillator coils near to L3 should then cause the relay to operate. The lock may now be mounted in its final position, L3 being cited at the chosen spot on the back of the door, and the

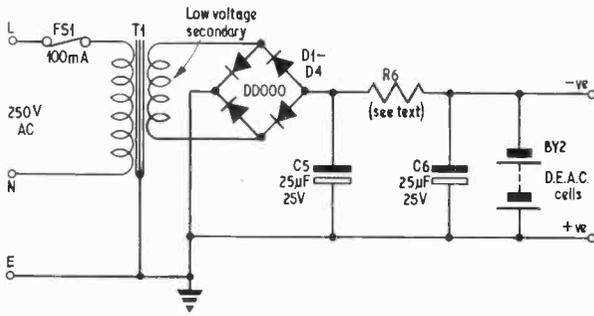


Fig. 6. Suggested circuit for a mains power supply

wiper of VR2 moved slowly towards the TR2 collector end, until the lock just operates when the key is brought near to it. The solenoid is mounted so that in the off position it engages in the door frame.

MODIFICATIONS

The lock, as described here, works on only one frequency. If the key were comprised of two oscillators, working on different frequencies, it would become almost impossible to find the two correct frequencies.

The lock would then need two receiver coils, and two Schmitt trigger units, feeding an AND gate, the output being used to operate the relay and solenoid. Alternatively, two relays could be used each operating a set of contacts in series with the solenoid.

The frequency of operation is governed by C1 and C3. Both of these capacitors should be of the same value, or the unit will not work properly. The 0.1µF capacitors used in the original gave a frequency of about 16kHz. Increasing the value of these capacitors will lower the frequency, and vice versa.

The maximum frequency that may be used is governed by transistor TR1. The OC72 used in the prototype will oscillate up to about 25kHz; if it is desired to use a frequency above this value, a BC187 transistor should be used; this will oscillate up to 300MHz. There is no need to change the value of TR2, TR3, or TR4. The frequency of operation should not be above 150kHz in order to comply with Ministry of Post and Telecommunications requirements.

The Electronic Lock can be used for a variety of applications and is suited to mounting inside a small box or case containing valuables. When the lock is mounted on a door it may be necessary to include a pushbutton or toggle switch to short out contacts RLA1 in order that the door may be opened from inside without the use of a "key". The lock will not work when there is a metal barrier between the "key" and pick up coil. ★



NEWS BRIEFS

Exhibition of Public Address Equipment

THE Association of Public Address Engineers is sponsoring what is claimed to be Europe's first exhibition devoted exclusively to public address and allied equipment. The exhibition called Sound 70 International, will be held at Camden Town Hall (opposite St Pancras Station) London, from March 10 to 12, 10 a.m. to 9.30 p.m.

Admission is by ticket only, obtainable on application to: Hon. Secretary, A.P.A.E., 394 Northolt Road, South Harrow, Middlesex.

The PRACTICAL ELECTRONICS 50 plus 50 Power Amplifier will be on display on this magazine's stand at Sound 70 International.

President of the R.S.G.B.

ON January 16, at the Bonnington Hotel, London, Dr J. A. Saxton, D.Sc., Ph.D., C.Eng., F.I.E.E. F.Inst.P. was installed as the thirty-sixth President of the Radio Society of Great Britain.

In 1960 Dr Saxton was appointed Deputy Director of the Radio Research Station. Between 1964 and 1966 he held the post of Director of the U.K. Scientific Mission and scientific counsellor at the British Embassy, Washington D.C., U.S.A.

On his return to the U.K. he was appointed Director of the Radio and Space Research Station, a position he still holds.

Dr Saxton is currently the Chairman of the Electronics Division of the Institution of Electrical Engineers.

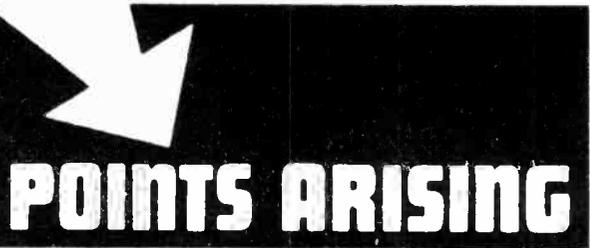
Eastern Trade

SINCE the GEC-Elliott Automation group was formed just over 18 months ago, they have more than trebled their business with Eastern Europe.

Orders for industrial plant systems, on-line computers, process instrumentation and scientific instruments totalling more than seven million pounds have been placed by the Soviet Union, Bulgaria, Czechoslovakia, Hungary, Poland, Rumania and Yugoslavia.

Companies within the group are at present negotiating for contracts ranging from steel mill plant and control systems, to marine automation controls, process instruments and scientific apparatus.

It would seem that opportunities for exporting to Eastern European markets has never been better.



THYRISTORS AND THE EXPERIMENTER

(January 1970)

Correction to Fig. 10. The value of R1 should be 47 kilohm not 4.7 kilohm.

Correction to Fig. 11. The collector of TR2 should be connected to TR1 base (see Fig. 10), and not as shown.

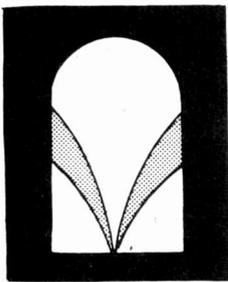
SOUND OPERATED SWITCH (February 1970)

In Fig. 14c a 10 kilohm resistor should be placed across the output terminals for correct switching of TR10.

PE APRIL FEATURES

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An extremely compact unit that can power any low current a.c./d.c. equipment. Designed primarily for electric shavers, the circuit uses two inexpensive transistors in a feed back oscillator circuit. This project is cheap, easy to build, and extremely useful for car, caravan, or boat owners.



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An electron beam tube driven by a double triode amplifier provides visual indication of audio input signal level. Among the many possible uses for this mains powered unit is that of a bridge balance indicator for measurement purposes. Some suitable bridge circuits are included.

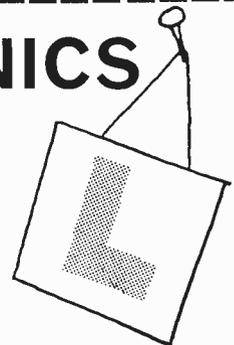


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26	32	275	1/6			60	500	4	3d		
28	75/75/75/75	150	2/6			61	150	30	1/6		
30	12.5	40	9d			62	64/32/8	275	2/6		
32	3,000	35	7/6			64	40	6.4	3d		
33	3,000	15	3/-			67	30	6	3d		
34	3,000	30	7/-			68	100/100/50	275	5/-		
35	250	70	2/-			69	50/50/50	350	4/-		
36	2,500	9	2/-			70	40/40/20	275	2/-		
38	750	12	1/9			71	400	6.4	3d		
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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								

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4pF	8pF	18pF	30pF	62pF	100pF	158pF	200pF	620pF	1,500pF	3,000pF
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R.F. ATTENUATOR AND POWER SUPPLY

WE completed construction of the various modules last month. Before describing the assembly of the modules the R.F. Attenuator and Power Supply have to be detailed.

R.F. ATTENUATOR

The R.F. Attenuator is situated between the aerial input socket and the input to the R.F. Unit. The object of the attenuator is to allow the operator of the equipment to reduce the sensitivity of the receiver in the presence of large unwanted signals, thus reducing the effect of intermodulation distortion.

CIRCUIT DESCRIPTION

The attenuator is operated from the front panel, without bringing the a.c. signal to the controlling potentiometer, in the following manner. The aerial signal is transformed up by T4 (Fig. 6.1), the secondary of which is shunted by a reasonably symmetrical transistor TR32. When the d.c. voltage on the base of TR32 is increased negatively by rotating VR1, TR32 effectively becomes more of a short circuit to the a.c. signals thus reducing the level of the aerial signal applied to the R.F. Unit.

Resistor R101 has been included to partially isolate the transistor from the following circuitry thereby increasing the effective range of the attenuator. Table 6.1 gives some indication of the attenuation that may be achieved with a given d.c. voltage at the slider of VR1. Capacitor C101 ensures that there will be no high frequency feedback from the negative 12 volt line; this is quite essential as the sensitivity of the receiver at this point is considerable and will be capable of amplifying signals in the order of a microvolt or so.

Table 6.1. ATTENUATION

Voltage at wiper of VR1	Attenuation of input signal in dBs
0V	0
0.1V	0.6
0.2V	2.4
0.4V	4.2
0.8V	7.2
1.0V	8.6
2.0V	13.5
4.0V	18.8
8.0V	24.6
10.0V	26.6
12.0V	29.7

CONSTRUCTION

Transformer T4 is wound to the information given in Fig. 6.2 and the unit is wired up on perforated board as shown in Fig. 6.3. This board will later be mounted in the equipment case that houses the modules.

The transformer can be glued to the mounting board and the wires passed through holes to the wiring on the underside.

SETTING UP INSTRUCTIONS

Equipment Required:

- Power supply capable of delivering 12 volts at 2mA.
- Signal generator capable of delivering 1 millivolt into 50 ohms at 5MHz.
- Valve voltmeter capable of measuring 1 to 5 millivolts at 5MHz.

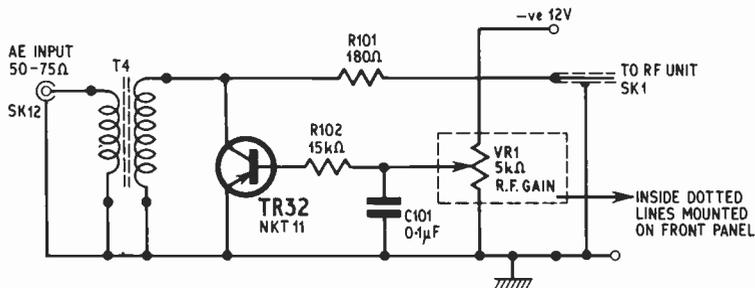


Fig. 6.1. Circuit diagram of the R.F. Attenuator

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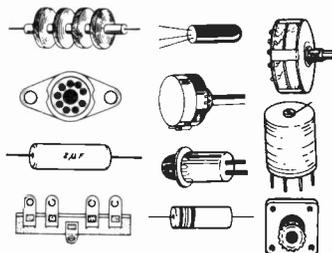
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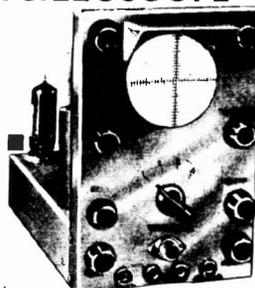
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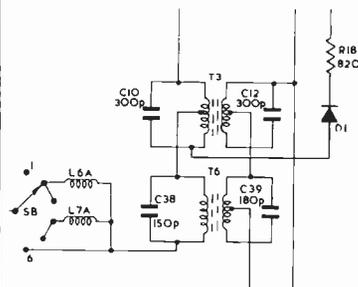


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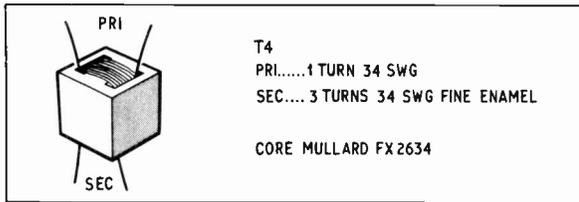


Fig. 6.2. Transformer winding details of T4

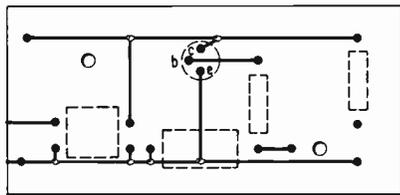
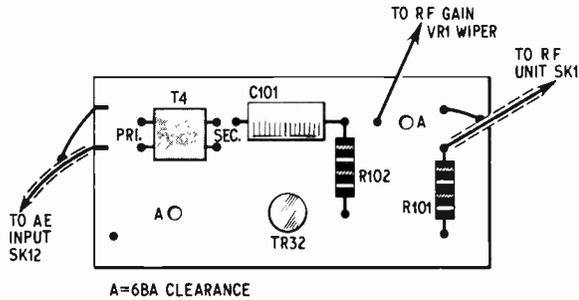


Fig. 6.3. Layout and wiring diagram of the R.F. Attenuator

POWER SUPPLY

The power supply for the receiver is derived fundamentally from a proprietary unit which is capable of delivering 21 volts d.c. at approximately 320 milliamps. However, as the equipment requires a positive and negative 12 volt supply, a separate power supply board has been introduced to provide the two 12 volt supplies.

CIRCUIT MODIFICATIONS

Considering the Newmarket PC102 which is the fundamental supply, it will be noticed that the unit is supplied wired up to deliver a negative supply, therefore as the receiver and ancillary equipment requires this supply to be positive, a minor modification must be made to the PC102. In the circuit diagram (Fig. 6.4) four points have been marked as A, B, C, and D. In the original supply A and B were linked together and the resistor R111 was wired between points C and D. For our purpose, however, the link A and B has been replaced by R111 and a link has been placed between C and D (see Fig. 6.5). This now produces a positive supply where the negative line can be directly earthed.

If the PC102 was used as supplied but with the links rearranged as indicated above, the output voltage would vary depending upon the current taken from the power supply. To avoid excessively high voltages appearing upon the output supply during testing or subsequent arrangement of modules, the output voltage has been simply stabilised by the addition of a Zener diode D115.

COMPONENTS . . .

R.F. ATTENUATOR

Resistors

R101 180Ω } 1/8W, 5% carbon film
R102 15kΩ }

Capacitor

C101 0.1μF polyester 20%

Inductor

T4 See Fig. 6.2

Transistor

TR32 NKT11

Miscellaneous

VR1 5kΩ carbon potentiometer 1in
Veroboard, plain perforated 3in × 1½in, 0.1in grid

PROCEDURE

Apply the power supply in the correct polarity and advance VR1 ensuring that the d.c. voltage at the slider of the potentiometer goes from 0 to 12 volts. Inject an input signal of 1mV, at a frequency of 5MHz into the aerial input socket. Check on the valve voltmeter, connected across the point going out to SK1 with a 50 ohm load at this point, that for the indicated voltages at the slider of VR1 the attenuation follows a similar pattern to that shown in Table 6.1.

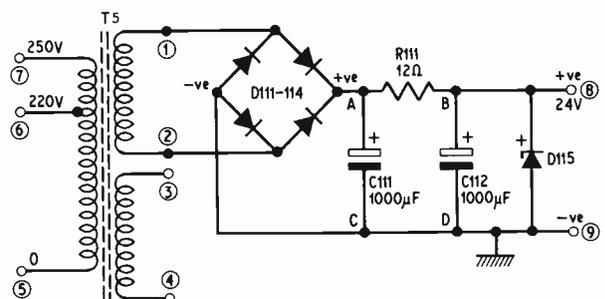


Fig. 6.4. Circuit diagram of the modified PC102 Power Supply module

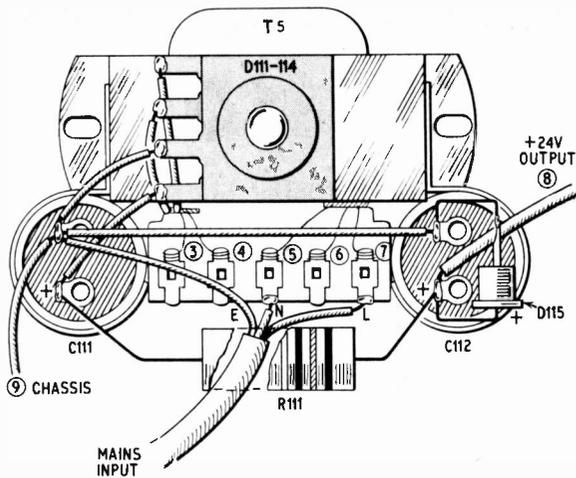


Fig. 6.5. Layout and wiring of the modified PC102 module

The resultant voltage is divided by the potential divider formed by R115, R116 and R117. The reason for including this potential divider is to take some of the dissipation away from the following Zener diode as the receiver and associated equipment does not require a considerable amount of current from the negative 12 volt supply.

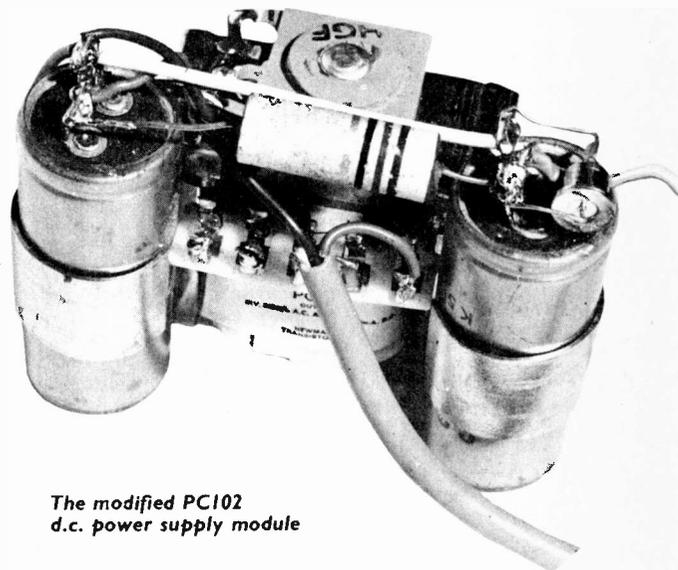
CONSTRUCTION

The power supply board is a piece of plain perforated veroboard measuring 4in by 3in. On this board are mounted all the supply components except the PC102 module and C114, both of which are mounted on the chassis of the receiver. All components are wired up on the underside of the board after being positioned as shown in Fig. 6.7. Four 4B.A. fixings are used to mount the board to the chassis and one of these also earths the power supply board to the chassis. The PC102 module has its own earth lead as shown in Fig. 6.5.

POWER SUPPLY BOARD

The power supply board (Fig. 6.6) develops the positive and negative 12 volt supply for the equipment in the following manner. In the first instance the positive 24 volt supply from the PC102 is fed through R112 and R113 to the Zener diode, D116. This Zener diode ensures that the positive 12 volt supply does not exceed 12 volts thus avoiding damaging the transistors within the equipment should some of the load be removed inadvertently. If the positive 12 volt supply is shorted in error R112 and R113 will act as a protection circuit in as much as the full voltage will be dropped across these two resistors which will dissipate approximately 3 watts each.

The negative 12 volt supply uses the extra winding on T5 which is capable of delivering 21 volts at half an amp. This extra winding is fed into a bridge rectifier (D117-120) and partially smoothed by the reservoir capacitor C114. Resistor R114 and C115 form another filtering circuit to reduce the ripple further.



The modified PC102 d.c. power supply module

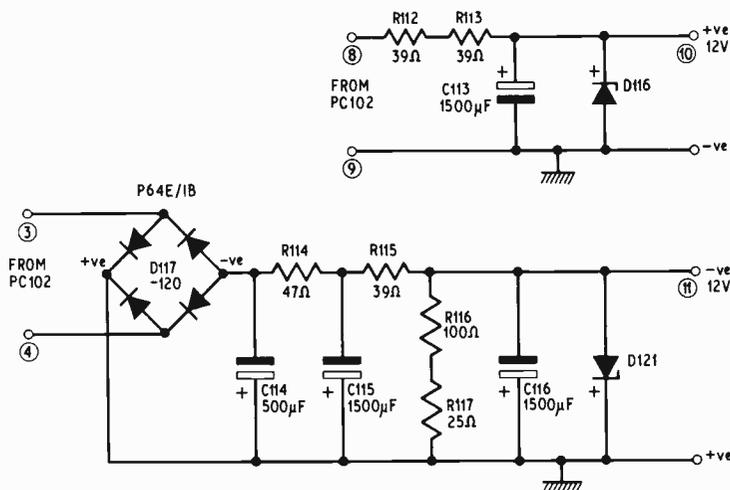
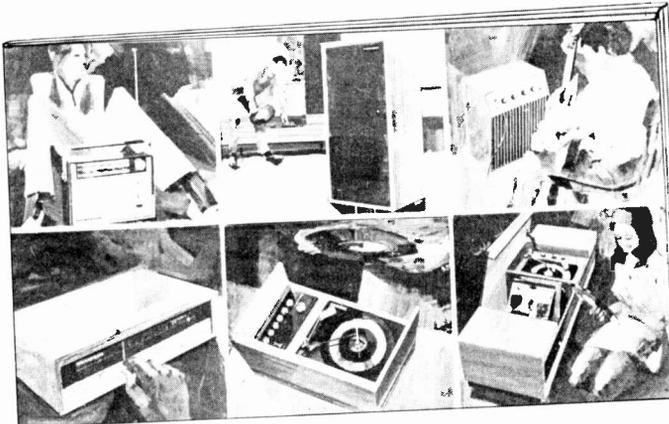


Fig. 6.6. Circuit of the power supply board

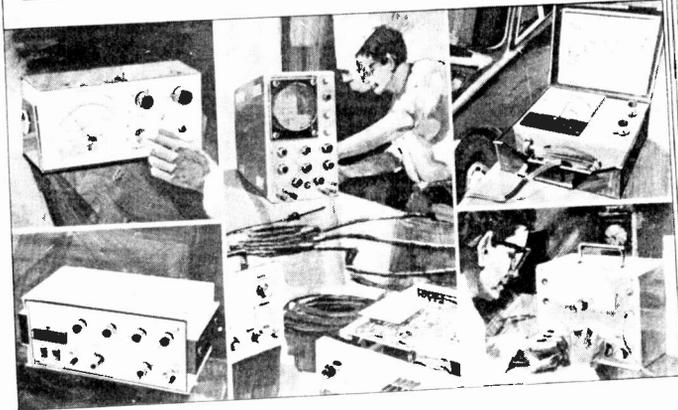
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2G311	6/-	2N3390	7/6	3N83	3/6	BC148	3/6	BFW60	5/6		
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2N404	4/6	2N3392	5/-	3N141	21/6	BC158	3/6	BPY10	35/-	NKT10519	6/6
2N696	4/6	2N3393	5/-	3N142	16/6	BC159	4/6	BSX19	3/6		
2N697	5/-	2N3394	5/-	3N143	19/6	BC160	12/6	BSX20	3/6	NKT20329	6/6
2N698	6/-	2N3402	5/6	3N152	24/-	BC167	3/6	BSX21	7/6		9/6
2N702	2/6	2N3403	5/6	R.C.A.		BC168	3/6	BSX26	10/6	NKT20339	
2N706A	4/6	2N3404	7/6	40250	12/6	BC169	3/6	BSX27	10/6		18/6
2N708	4/6	2N3405	9/6	40251	17/6	BC170	3/6	BSX28	6/6	NKT80119	
2N709	12/6	2N3414	5/6	40253	8/6	BC171	3/6	BSX60	19/6		15/6
2N718	6/-	2N3415	6/6	40254	10/6	BC172	3/6	BSX61	12/6	NKT80112	
2N726	5/-	2N3416	7/6	40259	9/6	BC182	4/6	BSX76	4/6		19/6
2N727	5/-	2N3417	9/6	40310	13/-	BC183	4/6	BSX77	6/6	NKT80113	
2N743	4/6	2N3570	12/6	40311	10/6	BC184	4/6	BSX78	6/6		22/6
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2N753	5/6	2N3605	5/6	40314	10/6	BCY10	5/6	BSY11	5/6		18/6
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2N918	6/-	2N3662	7/6	40317	11/-	BCY31	5/6	BSY26	4/-	NKT80213	
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2N1632	8/6	2N3859A	6/-	AC173	5/6	BF128	6/6	BSW41	8/6	OC46	3/-
2N1637	8/6	2N3860	6/-	ACY18	5/-	BF17	11/6	BSW70	6/6	OC70	3/6
2N1638	7/6	2N3877	8/-	ACY19	5/-	BF178	10/6	D16P1	7/6	OC71	2/6
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2N1711	6/6	2N3900	7/6	ACY21	5/-	BF180	7/6	D16P3	7/6	OC74	4/6
2N1889	6/6	2N3900A	8/6	ACY22	4/6	BF181	6/6	D16P4	8/6	OC75	4/6
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2N2712	6/6	2N5232	5/6	ASV29	5/6	BFY18	4/6	MPF105	8/6	TIS45	3/6
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2N2906	6/6	2N5307	7/6	ASV72	5/6	BFY30	10/6	NKT137	6/6	TIS53	6/6
2N2906A	8/6	2N5308	7/6	ASV83	5/6	BFY36	4/6	NKT210	6/6	TIS60	6/6
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2N2925	3/6	2N5355	5/6	AUY10	30/6	BFY50	4/6	NKT214	4/6	ZTX109	3/6
2N2926	3/6	2N5356	6/6	BC107	3/6	BFY51	4/6	NKT215	4/6	ZTX300	4/6
.. Green	3/6	2N5365	6/6	BC108	3/6	BFY52	4/6	NKT216	7/6	ZTX301	4/6
.. Yellow	2/9	2N5366	10/6	BC109	3/6	BFY53	5/6	NKT217	8/6	ZTX302	5/6
.. Orange	2/6	2N5367	12/6	BC113	3/6	BFY54	6/6	NKT219	6/6	ZTX303	5/6
2N3011	12/6	2N5369	8/6	BC115	6/6	BFY75	6/6	NKT223	5/6	ZTX304	5/6
2N3014	6/6	2S005	15/-	BC116	12/6	BFY76	8/6	NKT224	5/6	ZTX500	5/6
2N3053	6/6	2S020	37/6	BC118	6/6	BFY77	11/6	NKT225	4/6	ZTX501	5/6

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SETTING UP INSTRUCTIONS

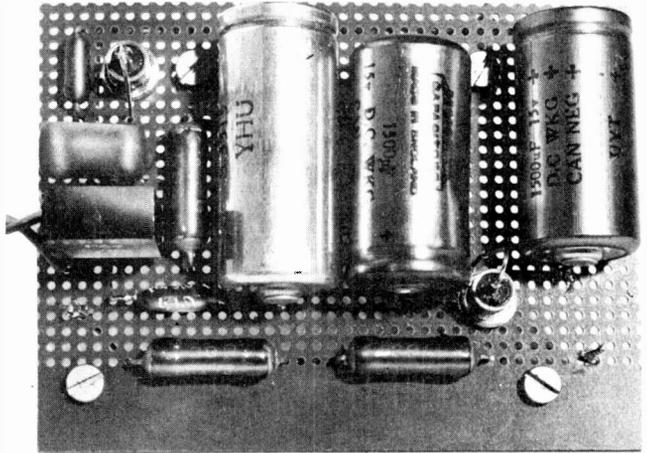
Equipment required:

- (a) **Multimeter** capable of measuring up to 30V d.c.
- (b) **Resistors**, 10W 150Ω and two 2W 250Ω

PROCEDURE

The Newmarket PC102 can be tested as a separate unit once the modifications have been made as indicated previously. Before switching on the mains supply connect a 10 watt 150 ohm resistor across points 8 and 9 and also connect a multimeter across the same points, in the correct polarity, and check whether the voltage at this point is 24 volts plus or minus 1.5 volts. Check that the voltage at point A is not more than 28 volts.

Once the above test has been carried out the power supply board can be connected to the appropriate points on the power supply unit. The 150 ohm test resistor previously connected across points 8 and 9



The power supply board

COMPONENTS . . .

POWER SUPPLY

Resistors

- R111 12Ω (included in PC102)
- R112 39Ω
- R113 39Ω
- R114 47Ω
- R115 39Ω
- R116 100Ω
- R117 25Ω

All 3W wirewound except R111

Capacitors

- C111 1,000µF elect. 35V
- C112 1,000µF elect. 35V
- C113 1,500µF elect. 15V
- C114 500µF elect. 50V
- C115 1,500µF elect. 18V
- C116 1,500µF elect. 15V

} included in PC102

Semiconductors

- D111-114 bridge rectifier included in PC102
- D115 24V 5W Zener diode
- D116 12V 5W Zener diode
- D117-120 P64E/1B bridge rectifier (S.T.C.)
- D121 12V 5W Zener diode

Miscellaneous

- PC102 d.c. power supply module (Newmarket)
- Veroboard, plain perforated 4½in × 3½in, 0.1in grid
- 4B.A. fixings
- Mains lead

should be removed. A 250 ohm, 2 watt resistor should be connected between points 10 and earth and another 250 ohm, 2 watt resistor connected between point 11 and earth. The voltage between point 10 and earth should be 12 volts plus or minus 1 volt with positive to earth and 12 volts plus or minus 1 volt between point 11 and earth, with negative to earth.

The tests are now complete and both 250 ohm resistors should be removed. If R112, R113, R114 and R115 become excessively hot it is reasonable to suppose that there is a short circuit between point 10 and earth or 11 and earth. When the power supply board has been connected to the equipment the voltage should be measured across all these points once again.

The power supply board should not be run without the loading resistors or with the modules disconnected.

Note: a kit of Neosid coil parts is now available from Neosid Ltd., Stonehills House, Howardsgate, Welwyn Garden City, Herts. The kit, to be called "Wideband Kit" contains the following parts:

Former 722/1 Bakelite	7 off
Base plate 5027/6PLD	7 off
Aluminium screening can 7100	7 off
Screw core 4 × 0.5 × 10/900	6 off
Screw core 4 × 0.5 × 10/500	1 off
Cup core 1070/900	1 off

The "Wideband Kit" is available from Neosid at the above address on receipt of a 30s. postal order - no cheques.

Next month: Main chassis assembly

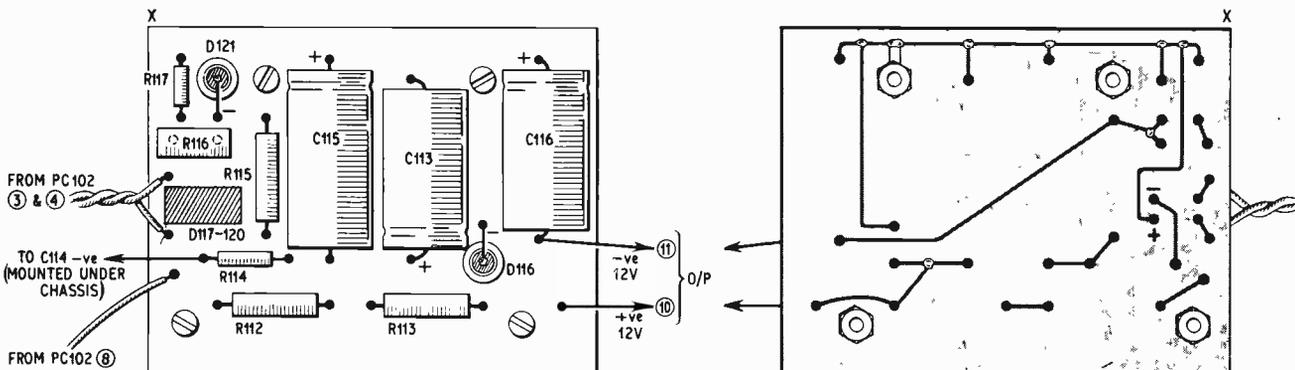
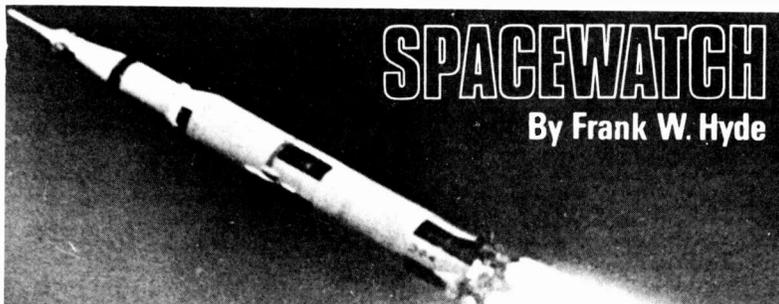


Fig. 6.7. Layout and wiring diagram for the power supply board



GALACTIC X-RAYS

Recent rocket flights have registered a diffuse background of X-rays and it would appear that there is a component that arises from our own galaxy. The X-ray astronomy group of Leicester University have been responsible for many of the experiments in this field using rockets which are launched from the Woomera base in Australia.

On flight *SL273* the X-ray detector which scanned across the plane of the galaxy showed a peak against the background X-radiation. The instrumentation was sufficiently sensitive to ensure that they were not confusing this peak with the radiation from discrete sources such as the Crab Nebula and other supernova remnants.

It is hoped that further flights will enable the rather embarrassing number of theories to be clarified. It is significant that none of the theories put forward before the discovery suggested the existence of such a peak.

GERMAN-FRENCH SATELLITE

The plans for the launch of the satellite *DIAL* (Diamant-Allemand) are well under way and, due to be launched later this year, it will be put into an orbit nearly equatorial with a perigee of 350km and an apogee of 1,800km. The launch vehicle will be a *Diamant-B* and the location of the lift-off is Kourou in French Guiana.

The payload consists of two independent units which will separate from each other in orbit. The task of the first part called *Minikapsel* will be to send back detailed information about the performance of the carrier rocket's performance.

The second part, the scientific capsule *WKA* (Wissenschaftliche Kapsel) will measure, among other projects, the spatial and time distribution of the Lyman-Hydrogen-Alpha radiation using an ionisation chamber photometer. The measurement of the concentration of the atomic hydrogen simultaneously with the measurement of the electron density will help towards knowledge of the recombination processes. Spectrometer measurements of the proton and alpha particles will also be made.

An experiment will be made on the equatorial electrojet. This is the ring current, which according to a theory by Prof. Untiedt of Gottingen,

is produced by the interaction of the ionising radiation and the earth's magnetic field. The sensitive magnetometer which will be carried on the satellite should be able to demonstrate the existence of the ring current.

SPACE STATIONS AND SPACE SHUTTLES

The current missions of the *Apollo* series end in 1972 and by this time the United States expect to have the next stage of space exploration well under way. The recommended plan by the Space Task Group is for *Apollo 20* to be followed by a series of extended *Apollo* missions when astronauts would spend up to three days on the moon's surface.

If the space environment is to be efficient for conserving the earth's resources, scientific exploration, and for experimenting with manufacturing processes and materials by the end of the 1970's, then large space stations will be a necessity. Such stations would accommodate a number of scientists and technicians and the lifetime of the stations would be in excess of ten years.

A new space transport system is needed for the shuttle service to and from such space stations. As at present envisaged the shuttles would be rocket powered with vertical take-off from a launching pad. The space shuttle would consist of an orbiter vehicle and a booster element. The orbiter vehicle would contain the crew, passenger and cargo accommodation as well as the fuel for the orbital and landing phases of the mission. The booster would carry the fuel needed to achieve the required orbit. It will be necessary for this to be manned and also to have a power system that will enable it to return to base and make a horizontal landing on a conventional airstrip.

The principal reason for the space station or space base in orbit is to provide facilities for scientific research and other technical activities that cannot be conducted on earth. As with laboratories on earth, the space stations would be equipped with advanced instrumentation and staffed with scientific and engineering personnel.

One special laboratory is to be used to carry out fundamental research in physics. As an example, by using cosmic ray particles that are

thousands of times more energetic than any that can be produced on earth in the largest accelerators, fundamental experiments could be carried out on the constitution of elementary nuclear particles.

The laboratory would be able to make studies of processes which on the ground depend on gravity gradients for particle diffusion. Thus the growth and purification of crystals and the materials for solid state electronic devices could be undertaken.

Perhaps one of the most fruitful areas of research is that of biomedicine. It offers the opportunity to study, experiment and observe men, animals, and other biological organisms under space conditions which are fundamentally different from those on earth.

Astronomy and its associated activities are offered unlimited benefits not least of which is to be out of the earth's atmosphere.

MOONQUAKE

When the lunar vehicle *Intrepid* was crashed onto the moon a new surprise was sprung upon the scientific world. The information that resulted was as unexpected as it was valuable.

Any information that it might yield was regarded as worthwhile when the decision was taken to make the experiment. The normal result should have been for the vibrations to die away rapidly and not to go on reverberating like a bell. Such a scientific bonus has led to the conclusion that this is a major discovery about the moon.

Three possibilities are suggested as explanations for the prolonged vibrations. They are that the moon traps and propagates a seismic wave over and over again. That the moon is an unstable structure and the crash started a cascade of avalanches and collapses over a wide area of the moon's surface. Finally, that the vibrations were caused by the fallback of debris and dust thrown up to great heights by the impact.

ATMOSPHERIC RESEARCH

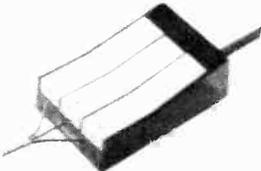
So many recent advances have been made in this field that an intensified international effort is now needed. Large amounts of data are needed to assess the air-surface interaction and atmospheric radiation. It has already been suggested that a full global study should take place in the late 70's.

A basic system of seven satellites and about a thousand balloons in orbit would enable wind and temperature observations to be made, and provide a monitoring system for cloud conditions and special formations. There is no doubt that satellites offer the main hope not only for the detailed study and evaluation of the lower atmospheric structure but also for accurate forecasting.

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39/6 P. & P.

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MODEL MAKER'S MOTOR

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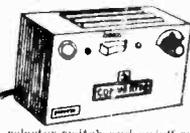
DE-LUXE STEREO HEADPHONES

With soft rubber earpieces, Impedance 8-16 ohms. Frequency response 23-13,000cps. With lead and stereo plug. Only 59/6. P. & P. 3/6.



Battery Eliminator

Enables transistor equipment to be operated from AC mains. 6/9 12V output selector switch and on/off switch. 100mA. Case size 4 2/4 2 1/2 in. Complete with mains lead, connecting leads and instructions. 59/6. P. & P. 3/6.



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10 watt Amplifier. Size only 1 0.4 0.2in. A true hi-fi amplifier complete with manual giving details of a wide range of applications and instructions. Guaranteed 5 years. ONLY 59/6. P. & P. 1/6.

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J1002	3"	Triple Play Poly	600ft 10/6 P. & P. 1/2
J1003	5"	Long Play PVC	900ft 10/6 P. & P. 1/8
J1004	5"	Double Play Poly	1200ft 15/6 P. & P. 1/8
J1005	5 1/2"	Long Play PVC	1200ft 12/6 P. & P. 2/6
J1006	5 1/2"	Double Play Poly	1800ft 22/6 P. & P. 2/6
J1007	7"	Standard Play PVC	1200ft 12/6 P. & P. 2/6
J1008	7"	Long Play PVC	1800ft 17/6 P. & P. 2/6
J1009	7"	Double Play Poly	2400ft 25/6 P. & P. 2/6
J1010	7"	Triple Play Poly	3600ft 50/6 P. & P. 2/6



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AUTO WOUND TRANSFORMERS

All winding voltage ratings and tappings 0-115-200-220-240V, except MT113 0-115-210-240V

		Size	Weight	Price
MT113	20W	2 1/4 1 1/2in	11oz	12/6 (P. & P. 2/6)
MT14	75W	2 1/2 2 1/2in	11b 14oz	21/6 (P. & P. 4/6)
MT4	150W	3 1/2 3in	3lb	33/6 (P. & P. 6/6)
MT65	200W	3 1/2 4 1/2in	4lb	38/6 (P. & P. 6/6)
MT66	300W	4 1/2 4 1/2in	7oz	59/4 (P. & P. 9/6)
MT110	400W	4 1/2 4 1/2in	11lb	85/6 (P. & P. 10/6)
MT67	500W	5 1/2 4 1/2in	12lb 8oz	89/6 (P. & P. 10/6)
MT83	750W	4 1/2 5 1/2in	13lb 4oz	95/7 (P. & P. 10/6)
MT84	1000W	4 1/2 5 1/2in	16lb	142/2 (Carr. extra)
MT93	1500W	5 1/2 5 1/2in	28lb 6oz	170/6 (Carr. extra)
MT94	1750W	5 1/2 6 1/2in	31lb	185/6 (Carr. extra)
MT95	2000W	7 1/2 6 1/2in	40lb	211/2 (Carr. extra)
MT73	3000W	6 1/2 7 1/2in	45lb 8oz	300/6 (Carr. extra)

LOW VOLTAGE 12V RANGE

Primary 200-250V; secondary 12V				
MT111	0.5A	3 1/2 2 1/2in	12oz	15/3 (P. & P. 2/6)
MT11	2A	3 1/2 2 1/2in	11b	19/6 (P. & P. 3/9)
MT69	4A	3 1/2 3 1/2in	21b 4oz	28/6 (P. & P. 6/6)
MT70	6A	4 1/2 3 1/2in	31b 12oz	39/6 (P. & P. 6/6)
MT72	10A	3 1/2 4 1/2in	61b 3oz	51/6 (P. & P. 9/6)
MT115	20A	4 1/2 4 1/2in	111b 13oz	95/6 (P. & P. 9/6)
MT187	30A	5 1/2 4 1/2in	161b 12oz	180/6 (P. & P. 13/6)

LOW VOLTAGE 24V RANGE

Primary 200/250V; secondary 24V				
MT58	1A	2 1/2 2 1/2in	11b 7oz	23/9 (P. & P. 4/6)
MT114	3A	2 1/2 3in	31b 6oz	38/6 (P. & P. 6/6)
MT72	5A	4 1/2 3 1/2in	51b 12oz	53/10 (P. & P. 6/6)
MT17	8A	4 1/2 3 1/2in	71b 8oz	72/7 (P. & P. 9/6)
MT115	10A	4 1/2 4 1/2in	111b 13oz	95/6 (P. & P. 11/6)

LOW VOLTAGE 30V RANGE

Primary 200/250V; secondary tapped 12-15-20-24-30V				
MT112	0.5A	3 1/2 2 1/2in	11b 4oz	17/4 (P. & P. 3/9)
MT79	1A	2 1/2 2 1/2in	21b	23/6 (P. & P. 6/6)
MT20	3A	4 1/2 3 1/2in	41b 6oz	46/2 (P. & P. 6/6)
MT51	5A	4 1/2 3 1/2in	61b 8oz	60/8 (P. & P. 9/6)
MT88	8A	5 1/2 4 1/2in	91b 6oz	92/4 (P. & P. 11/6)
MT89	10A	5 1/2 4 1/2in	121b 2oz	103/6 (P. & P. 11/6)

LOW VOLTAGE 50V RANGE

Primary 200-250V; secondary tapped 19-25-33-40-50V				
MT102	0.5A	2 1/2 2 1/2in	11b 11oz	21/3 (P. & P. 6/6)
MT104	2A	4 1/2 3 1/2in	51b	45/8 (P. & P. 6/6)
MT106	4A	4 1/2 4 1/2in	91b 4oz	77/6 (P. & P. 9/6)
MT118	8A	5 1/2 5 1/2in	181b 9oz	132/6 (P. & P. 13/6)
MT119	10A	6 1/2 4 1/2in	191b 12oz	165/6 (P. & P. 15/6)

LOW VOLTAGE 60V RANGE

Primary 200/250V; secondary tapped 24-30-40-48-60V				
MT124	0.5A	3 1/2 2 1/2in	21b 4oz	24/6 (P. & P. 6/6)
MT127	2A	4 1/2 3 1/2in	51b 6oz	52/10 (P. & P. 6/6)
MT123	4A	4 1/2 3 1/2in	101b 6oz	99/6 (P. & P. 11/6)
MT122	10A	6 1/2 6 1/2in	231b 2oz	152/6 (Carr. extra)

MAINS H.T. RANGE

			Size	Price P & P
MT1A7	250-0-250V	80MA	6.3V 3.5A 5/6.3V 1A 3 1/2 3in 33/6	6/6
MT6A7	250-0-250V	100MA	6.3V 3.5A 5/6.3V 1A 4 3 1/2 3in 38/6	6/6
MT110	250-0-250V	120MA	6.3V 3.5A 5/6.3V 1A 4 4 3 1/2 4in 44/6	6/6
MT11A7	300-0-300V	100MA	6.3V 3.5A 5/6.3V 1A 4 3 1/2 3in 37/6	6/6
MT12A7	300-0-300V	120MA	6.3V 3.5A 5/6.3V 1A 4 3 1/2 3in 42/6	9/6
MT33A7	300-0-300V	150	6.3V 3.5A 5/6.3V 1A 4 4 3 1/2 3in 54/6	9/6
MT2A7	350-0-350V	80	6.3V 3.5A 5/6.3V 1A 4 3 1/2 3in 38/6	6/6
MT7	350-0-350V	100	6.3V 3.5A 5/6.3V 1A 4 3 1/2 3in 42/6	6/6
MT8	350-0-350V	120	6.3V 3.5A 5/6.3V 1A 4 3 1/2 3in 50/6	6/6

BATTERY CHARGER TYPES

Primary voltage 200-250V; secondary 6-12V (Rectifier not included)				
MT45	1-5A	2 1/2 2 1/2in	11b 9oz	21/9 (P. & P. 4/6)
MT46	2A	3 1/2 2 1/2in	21b 4oz	25/4 (P. & P. 6/6)
MT47	3A	4 1/2 2 1/2in	31b 8oz	28/4 (P. & P. 6/6)
MT5	4A	4 1/2 3 1/2in	31b 11oz	33/6 (P. & P. 6/6)
MT78	5A	4 1/2 3 1/2in	51b 4oz	42/6 (P. & P. 6/6)
MT86	6A	4 1/2 3 1/2in	51b 12oz	48/6 (P. & P. 6/6)
MT48	7A	4 1/2 3 1/2in	61b	50/7 (P. & P. 9/6)
MT146	8A	5 1/2 4 1/2in	61b 4oz	75/6 (P. & P. 9/6)
MT49	9A	4 1/2 3 1/2in	71b 8oz	99/6 (P. & P. 9/6)
MT147	10A	4 1/2 3 1/2in	91b 4oz	102/6 (P. & P. 9/6)
MT50	12.5A	5 1/2 4 1/2in	111b 14oz	125/6 (P. & P. 11/6)

Amperages are d.c. when used with nominal selenium bridge rectifiers

MAINS ISOLATING RANGE also available

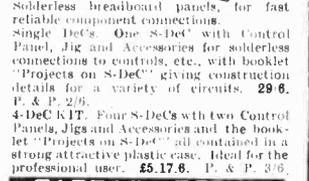
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Overload protection. 20,000 opv. AC volts 10, 50, 250, 1,000V. DC volts 5-25, 125, 500, 5,500V. D.C. Current 0-500, 0-2500mA. Resistance 0-60K, 0-5 Megohm. Decibels -20 to +22dB. Size of meter 4 1/4 3 1/4 in. 85/6. P. & P. 3/6.



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10V voltage: 5-25-50-250-500-2.5K (20,000 ohms per volt). AC Voltage: 10-50-100-300-1000 volts (10,000 ohms per volt). DC Current: 0-50mA, 0-2.5mA, 0-250mA. Resistance: 0-6K, 0-5 Megohm. Decibels -20 to +22dB. Size 4 1/4 3 1/4 in. Complete with case 77/6. P. & P. 3/6.



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P. & P. Decks 12/6. Bases 4/6. P. & P. Deck & Base 15/6.	

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British made and designed for use with transistor circuitry but ideal for many other uses. A.C. 240V, 18W. Length 7 1/4 in. Lin slide-on bit. Price 32/6. P. & P. 2/6.



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An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Heraft) bakelite flush mounting shuttered 5A switch sockets for only 10/- plus 3/6 post and insurance. (20 boxes post free.)

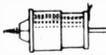


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0-30pfd an old design but one which has never been bettered. 1—each, 10/- doz. £4.0.0 per 100.



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



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2in stroke. Size 2 1/2in 2in 1 1/2in. 14/6, postage 2/3.



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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.



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5 amp, changeover contacts. 1/9 each 18/- doz. 15 amp model 2/2 each or 21/- doz.



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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.



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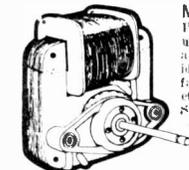
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250V a.c. working condensers for power factor correction, motor starting etc. 3.5 mfd. 6/6 each, 6.5 mfd. 8/6 each, 8 mfd. 9/6 each. 3 amp battery charger kit comprises copper backed circuit board, 3 amp mains transformer, regulator resistors and smoothing condenser 29/6 inc. wiring diagram, post & ins. 4/6.

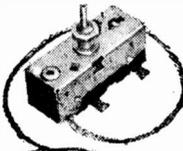
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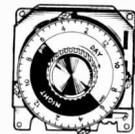
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This has a sensor attached to a 15A switch by a 14in length of flexible capillary tubing—control range is 20 F to 150 F so it is suitable to control soil heating and liquid heating especially when in buckets or portable vessels as the sensor can be raised out and lowered into the vessel. This thermostat could also be used to sound a bell or other alarm when critical temp. is reached in stack or heap subject to spontaneous combustion or if liquid is being heated by gas or other means not controlled by the switch. Made by the famous Tellington Co. we offer these at 12/6 each. Postage and insurance 2/3.



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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 Persepex cover, plus 3/6 postage and insurance, a real snip which should not be missed.



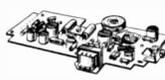
DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 x 13 amp sockets and on/off switch with neon warning light in metal box to take standard 13 amp fused plugs. Supplied complete with 7 ft of heavy cable and 13 amp plug. Our price 39/6, wired up ready to work, plus 4/6 P. & I.



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 5/-.



THIS MONTH'S SNIP

See in the dark INFRA RED MONOCULAR

This equipment is complete and portable. Basically it consists of an infra red image converter tube with optical lenses for focussing the image and a Zeambini pile to provide the necessary E.H.T. The monoscope is housed in a hide case heating 6in x 6in x 4in approx. Made originally for the army for night observations sniping, etc., this equipment has many scientific and practical applications a limited quantity only is available in original sealed carton price 29.19.6. NOTE although unused in fact still in original sealed cartons. The equipment is approx. 25 years old and consequently the Zeambini pile may need drying out (a better idea might be to replace it with a battery operated power unit—there is plenty of room).



STANDARD WAFER SWITCHES

Standard Size 1 1/2 wafer—silver plated 5 amp contact standard 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	6/6	6/6	6/6	6/6	6/6	6/6	10/6	10/6
3 poles	6/6	6/6	6/6	6/6	10/6	10/6	14/6	14/6
4 poles	6/6	6/6	6/6	10/6	10/6	10/6	18/6	18/6
5 poles	6/6	6/6	10/6	10/6	14/6	14/6	22/6	22/6
6 poles	6/6	10/6	10/6	10/6	14/6	14/6	26/6	26/6
7 poles	6/6	10/6	10/6	14/6	18/6	18/6	30/6	30/6
8 poles	10/6	10/6	10/6	14/6	18/6	18/6	34/6	34/6
9 poles	10/6	10/6	14/6	14/6	22/6	22/6	38/6	38/6
10 poles	10/6	10/6	14/6	18/6	22/6	22/6	42/6	42/6
11 poles	10/6	14/6	14/6	18/6	26/6	26/6	46/6	46/6
12 poles	10/6	14/6	14/6	18/6	26/6	26/6	50/6	50/6

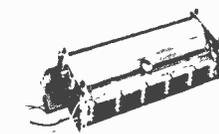
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MINIATURE

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.

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



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Type "B" 15 amp. This is a 17in. long rod type made by the famous Sanvic 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 furnace, oven, kiln, immersion heater or to make flame-stat or fire alarm. 8/6 plus 2/6 post and insurance.

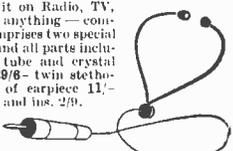
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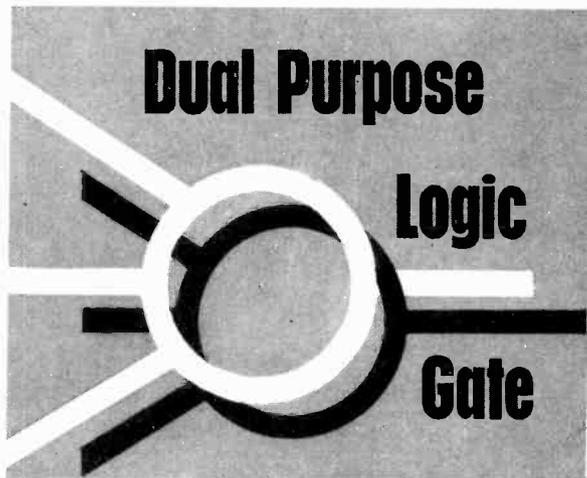


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GATE circuits may be regarded as the electronic analogy of switch or relay circuits. In conventional electrical practice, a number of switches may be wired in parallel, the whole being connected in series with a light bulb and power supply. If any of the switches are operated, the bulb will come on.

However, a number of electronic transducers may have their outputs fed to an electronic gate so that if any of the transducers are operated a common circuit will be brought into action. One example of the use of a circuit is in carrying out logic functions when certain conditions are satisfied.

MANUAL SWITCHING

A simple manually operated electrical switch can be considered as having only two states: either on or off. A number of switches can be arranged in a number of ways, to carry out a number of functions.

Fig. 1a shows three switches wired in parallel, and the combination is wired in series with a lamp and a battery. If any one of the switches is closed, the bulb will light, i.e. if S1 or S2 or S3 is on, the bulb will be on; it is reasonable, therefore, to call this arrangement an OR circuit.

Suppose it is required to have the lamp off only when all switches are open (Fig. 1b). This condition will

make this circuit into an AND gate, since the lamp will only be off when S1 and S2 and S3 are open.

Alternatively, a circuit may be wired up with the switches in series (Fig. 1b). In this case, the lamp will only light when S1 and S2 and S3 are closed. So this kind of circuit can be called an AND gate.

If the conditions are such that the lamp must go out when S1 or S2 or S3 are open (Fig. 1b), then this circuit acts as an OR gate.

The first circuit (Fig. 1a) is called a parallel gate circuit; an OR gate for switching on the load; an AND gate for switching off the load.

The second circuit (Fig. 1b) is called a series gate circuit; an AND gate for switching on the load; an OR gate for switching off the load.

The most commonly found type of gate in logic systems is the parallel gate and being perhaps the most useful, this article shows how a simple transistor gate circuit can be made.

ELECTRONIC SWITCHING

Each of the first three transistors are the switching elements in parallel with each other, and in the base circuit of an output transistor driving a relay. See Fig. 2.

Referring to Fig. 2, the three transistors TR1, 2, and 3 are connected as grounded emitter d.c. amplifiers and all share a common collector load R7. The collectors are direct coupled to the base of TR4 which drives the relay.

The input resistors limit the current fed to each input transistor. The three base resistors R2, 4 and 6 are taken to a switch selector to bias the bases negative for the AND function; bias for the OR function is provided by incoming negative going pulses, the base resistors then being grounded.

"AND" GATE

Taking first the AND function, the input bases are biased switching the first three transistors on. This presents a low resistance path and grounds the base of TR4, causing it to cut off. The relay is also off.

When considering the input signal to a gate, the input is either positive or negative with respect to the common line.

If a positive pulse is fed into TR1 the base bias is reduced and TR1 switches off. But the other two

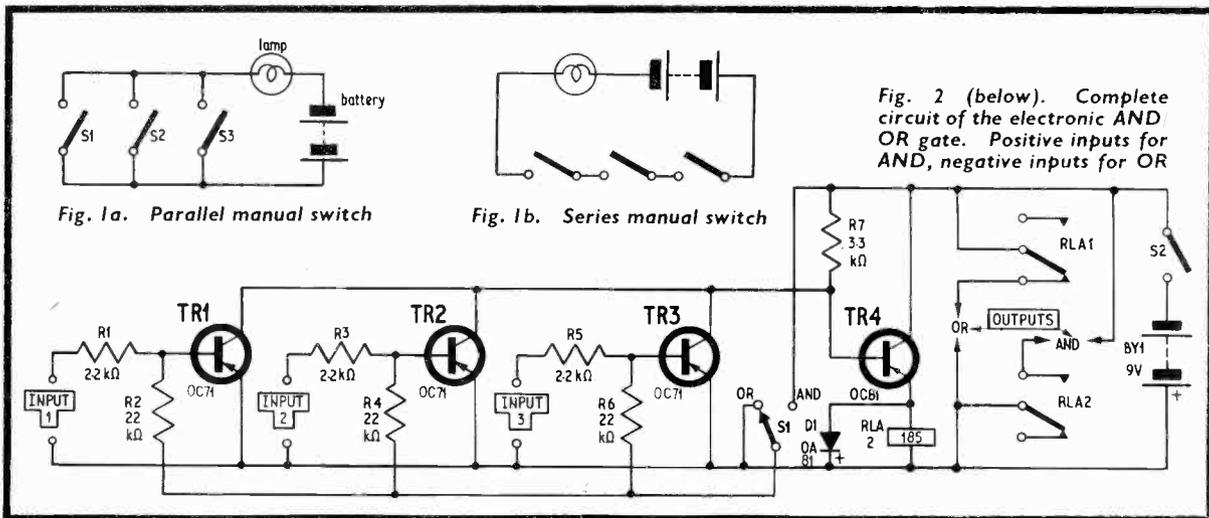


Fig. 2 (below). Complete circuit of the electronic AND OR gate. Positive inputs for AND, negative inputs for OR

COMPONENTS . . .

Resistors

R1	2.2k Ω	R5	2.2k Ω
R2	22k Ω	R6	22k Ω
R3	2.2k Ω	R7	3.3k Ω
R4	22k Ω		

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

Transistors and Diode

TR1, 2, 3	OC71 or similar
TR4	OC81 or similar
D1	OA81 or OA5

Relay

RLA 185 Ω to 250 Ω 6V rating with two sets of changeover contacts

Switch

S1 Single pole changeover slide or toggle switch

Miscellaneous

S.R.B.P. sheet
"Cir-kit" stick-on wiring
Battery 9V and connectors

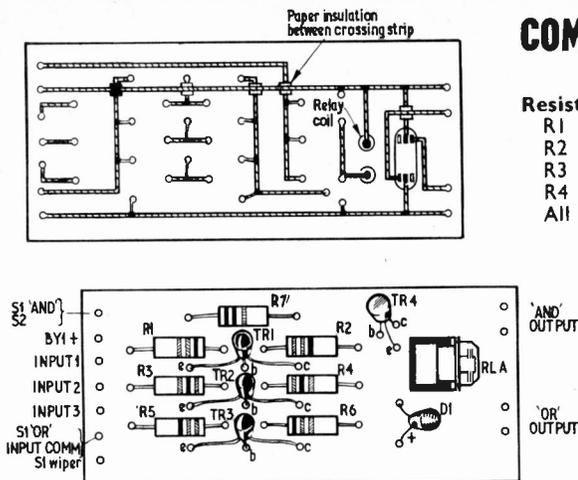


Fig. 3. Two-mode gate, AND and OR outputs

transistors are still on and holding TR4 and the relay off. It is necessary to provide positive pulses to each of the three inputs to enable TR4 base voltage to rise and switch on TR4 and the relay.

Therefore, an output from the relay will only appear if positive inputs of more than $\frac{1}{4}$ V are fed to each base. This can be simulated using a 1 $\frac{1}{2}$ V battery and the series resistors R1, R3, and R5, but in practical circuits a low voltage pulse is usually available. These resistors may have to be altered or removed.

"OR" GATE

The circuit can be operated as an OR gate simply by removing the negative bias with switch S1. The three transistors are now off and leave TR4 conducting with the relay energised. It only requires a negative pulse of about 0.2V to switch on the input transistors and cut off TR4 and the relay.

Only one negative input is needed to do this, so a pulse to either TR1 or TR2 or TR3 will produce a negative output from the relay contacts.

RELAY

The switch and relay wiring make one circuit easily adaptable for both functions, although two separate circuits are usually used in permanent installations. Transistors have been used here to achieve some measure of voltage gain to drive the relay, which makes the unit useful for several applications whatever the switched voltage may be. This voltage is then only limited by the ratings of the relay contacts.

The relay coil should operate from a 9V supply; the 6V 185 ohm types generally available are ideal. The prototype circuit used a relay with a 250 ohm coil resistance. Changeover contacts are preferable and

the relay should have at least two sets of these. If mains or high current control is required, heavy duty contacts must be fitted. The diode D1 is essential and is used to prevent damage to TR4 due to the back e.m.f. produced when the relay releases.

The circuit is not limited to only three inputs. Any number of inputs can be connected if each has one transistor with the necessary resistors connected to TR4 base, the common battery positive line and S1. If the constructor wishes to use *npn* transistors the battery supply must be reversed. Transistor TR4 should be adequately rated to handle the relay current without using a heat sink.

CONSTRUCTION

Several methods of construction can be adopted according to individual requirements. The prototype used "Cir-kit" stick-on wiring, the suggested layout being shown in Fig. 3.

Cir-kit is a self-adhesive copper strip with a paper backing. The required lengths are cut and laid on Perspex or plastics laminate sheet. Where two strips cross each other, paper insulation *must* be inserted between them.

Fig. 4 and the photograph show an extended version to include NAND and NOR functions. Switch S1 is a double-pole changeover type. ★

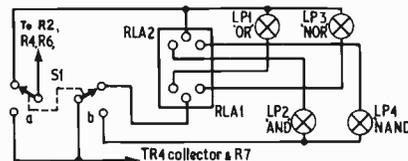
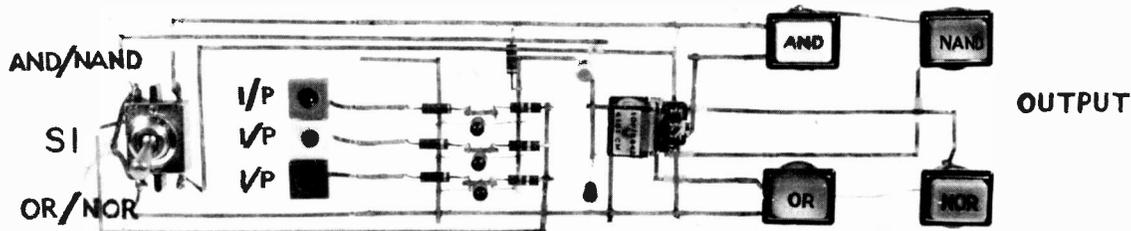


Fig. 4. Modification to wiring for four-mode gating



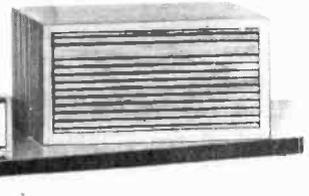
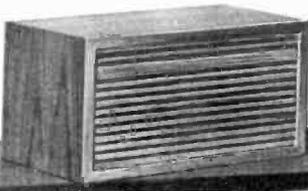
Four-mode gate layout. Switch and relay wiring is shown in Fig. 4

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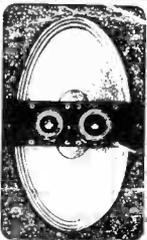
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A10 Sil. Alloy PNP 50-2	= 25321-325, OC200-205	£2	£7.10	£12.10	£100

A1 to A7 Guaranteed 80% Good usable Transistors ideal for low cost production work and experimental use. A8 to A10 are all perfect devices, factory tested, no open or short circuit Transistors in these lots.

BRAND NEW FULLY TESTED EPOXY CASE UNIJUNCTION TRANSISTORS. Type T1543 and BEN 3000 and replacement for 2N2646. Full data available. **LOWEST PRICE AVAILABLE ANYWHERE.** 100 off 4/- each = £20; 500 off 3/6 each = £87.10; 1,000 off 3/- each = £150. Sample devices 7/- each on request.

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BY100 SIL. RECT'S 800 PIV 550mA.
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TESTED TRANSISTORS

each	ONE PRICE ONLY PNP, NPN SILICON PLANAR 1/- EACH	each
BC108	2N696	2N1132 2N2220 25733
BC109	2N697	2N1613 2N3707 2N3391
BFY50	2N706	2N1711 2N3711 T1544
BFY51	2N708	2N2904 25102 2N2906
BFX84	2N929	2N2905 25103 2N2907
BFX86	2N930	2N2924 25104 2N2696
BFX88	2N1131	2N2926 25732 2N3702
		2N3703
		2N3707

From Manufacturers' Over-runs—Unmarked Plastic and Metal cases. Devices similar to above Nos.

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AC125	ACY22	ACY36	NKT677	OC81	2G381
AC126	ACY27	NKT141	NKT773	OC82	2G382
AC127	ACY28	NKT142	NKT773	2G301	2G399A
AC128	ACY29	NKT212	OC44	2G302	
AC130	ACY30	NKT213	OC45	2G303	
ACY19	ACY31	NKT214	OC71	2G308	
ACY20	ACY34	NKT215	OC72	2G371	
ACY21	ACY35	NKT271	OC75	2G374	

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Boat Show 70

ONCE again summer is brought to the heart of London in coldest January; the International Boat Show must surely instil some of that carefree summer feeling in all who visit Earls Court and perhaps this is one reason why the exhibition is ever increasing in popularity—the abundance of pretty girls may well be another!

It is at this time of the year when anyone with even the slightest of interest in water sports can see and discuss, at Earls Court, the boats and sailors made famous over the last year, the new trends and innovations in boats and equipment, the "sea" fashions and the various displays of underwater swimming, boat building, fishing, rescue and many other activities connected with the water.

The Baron range of instruments described on this page



Practical Electronics March 1970

ELECTRONICS

This year there was even an underwater television system to show recovery operations performed by the British Sub-Aqua Club, who carried out a typical diving expedition to a specially prepared wreck under the pool. This underwater display is the first "electronics" that visitors notice and probably take for granted—as they do their own television and the world-wide broadcast system of today.

Never before has there been such a wide range of electronic equipment available, designed especially to go afloat, from so many firms. It was only a few years ago that one or two firms had the boating scene, as far as electronics go, to themselves.

With increased competition, prices must come down or performance improved, and one cannot help noticing that some established firms have altered neither; perhaps they are relying on reputation and time will tell if that alone is enough. Electronics, like boat design, is moving fast.

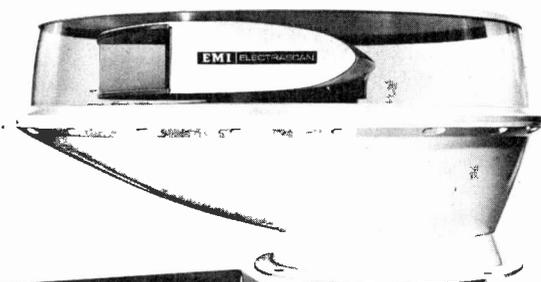
NEW PRODUCTS

It is good to see so many new products, many of which have some interesting ideas incorporated and most of which have been well proved at sea. One range of instruments for the small sailing yacht that is particularly outstanding in some respects is that now being marketed by Baron Instruments of Cowes.

This range has a neat and compact control panel with no external leads to foul the chart table, and is manufactured to DEF 5000 specifications (a government specification for armed forces apparatus). The Baron range includes an efficiency instrument, an innovation which should prove extremely useful to racing yachtsmen. This instrument is basically an amplified water speed indicator that filters out speed fluctuations caused by wind variations, thus it is far more useful for boat trimming than a simple amplified speed indicator.

EMI are probably the largest electronics company to manufacture a range of aids for the yachtsman and they have increased their excellent range of "Electra" instruments. All the small Electra instruments are housed in a single sealed case with controls and readout on the perspex front panel; another good feature is the absence of internal batteries, all units are designed to be fed from the boat's own supply and where this is not

Electra-Scan, the stylish new radar system from EMI



possible one battery box can be provided to power all the units. Two new instruments from EMI are Electradepth 2, a transistorised echo sounder with neon readout and Electra-Scan, a lightweight radar for small boats.

RADAR

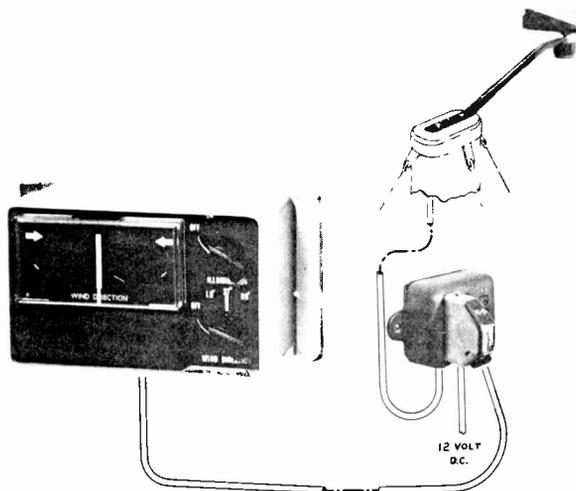
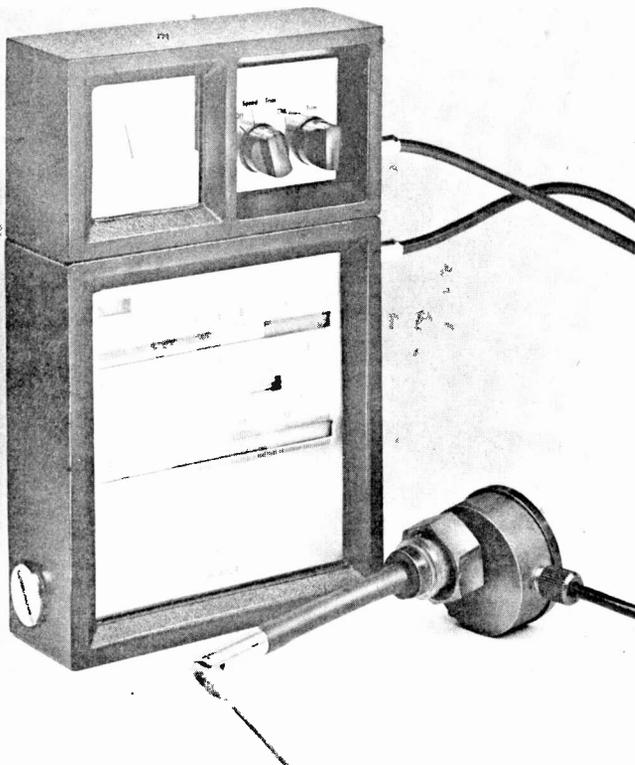
Electra-Scan is a low price radar that will obviously be compared with the Decca 101 and which should come out very well from the comparison. The radar is housed in two units (scanner and display) and is simple to install—four bolts and a cable is EMI's claim. With a range of 30 yards to 16 miles in six steps, and an "auto-alert" to sound a warning when an echo appears anywhere within the selected range, this unit is well worth serious consideration by all yachtsmen.

Decca have not been standing still during the year and, in addition to two new automatic pilots specially designed for users of small craft, Decca Pilots 250 M.C. (mechanical and hand hydraulic steering) and 350 S.O. (hydraulic steering), they have improved the performance of the 101 radar. The 101 now has ranges of 6 and 18 miles and uses a longer pulse to give more "solid" echoes. An anti-rain clutter control is now provided and the Super 101 has been re-styled.

DEVELOPMENTS

Brookes and Gatehouse, one of those firms who appear to be relying on reputation, are worthy of mention this year because of surprisingly little visible design and development activity, in fact as far as we could see they have only introduced a rim fitting indication light for some of their instruments—it will not fit all types—and a battery charger for a rechargeable cell they are now marketing. This firm are

The Adur speedometer and log; the log has a large clear face on which the navigator can make notes at various distance run points. Note the unusual probe with its "clean" underwater line



Bettatac by Pylon Developments is a helm's aid for beating and running. This instrument is unusual in its display as it indicates corrective action required on the tiller. The complete installation is shown; a windspeed indicator is available as an addition

worthy of better things and it would be good to see those internal cells done away with altogether, a battery charger that operates from the ship's supply is only half the solution to power supply problems. Perhaps we will see startling advances next year.

A truly professional direction finder and marine receiver has been lacking from the range available to small boat owners for some time; fortunately this gap has been filled by Derritron with their DF70 receiver. This equipment, which was displayed undergoing vibration and water resistance tests, can receive long, medium and trawler bands and is suitable for r/t, s.s.b. and c.w. transmission reception. A built-in null indicator is provided and the receiver can operate from internal batteries or an external supply.

OTHER EQUIPMENT

There were many other interesting equipments, some new and good, like the Adur course run indicator, on which can be made brief notes of course and comments for reference, and some older but improved like the Ajax electronics radio telephones with increased output power. There were instruments for the small yacht that will do all the thinking—the apparent wind direction indicator by Pylon Developments that indicates corrective action required on the tiller—and equipment to provide comfort aboard the larger vessel, such as the new Muirhead Murmaid stabilisation system.

In all, we can now safely say that the electronic industry is attuned to the needs of both the weekend and professional yachtsman, and perhaps the next year will see an even greater advancement in equipment development. It would be comforting to see more automatic safety devices displayed even if the Coastguard in conjunction with the armed forces and the RNLI do run an efficient "electronic assisted" service. They actually carried out 137 more rescue operations during the 12 months ending September 1969 than the previous year, and rescued some 2,747 persons. Electronics can not only help prevent accidents at sea but can assist the rescue operation when an accident does occur.



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RESISTORS

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

CODES: C = carbon film, high stability, low noise. MO = metal oxide, ElectroSil TR5, ultra low noise. WW = wire wound, Plessey.
VALUES: 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 one ohmic value and power rating. (Ignore fractions of one penny on total resistor order.)

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Any type with 1/2 amp double pole mains switch:	extra 2/3	Log/Anti-log:	10kΩ, 47kΩ, 1MΩ only 8/6
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2N2926Y	2/3	BC148	3/3
2N2926G	2/3	BC149	4/3
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2N3702	3/6	BC159	3/9
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1H6GT	7/3	19BG6G	17/6	DK96	7/3	EL33	8/9	6CL83	10/-	UBF89	6/9
1N6GT	7/9	20P2	13/6	DL35	5/-	EL34	9/6	6CL84	7/6	UC92	5/6
1R5	5/9	20P3	11/9	DL92	5/9	EL41	11/-	6CL85	9/-	UC94	7/-
1S5	4/3	20P4	18/6	DL93	6/6	EL44	4/6	6CL86	8/3	UC95	5/3
1T4	2/9	25L6GT	5/-	DL96	7/3	EL90	4/6	6KNA4	12/6	UCF80	7/8
3S4	5/9	25L4GT	11/6	DY86	5/9	EL500	12/6	6FL290	11/9	UCF42	12/-
3V4	6/6	30C1	6/6	DY87	5/9	EM80	7/6	6L36	9/9	UCF81	6/8
6Y3GT	5/9	30C15	13/-	EABCS	8/6	EM81	7/6	6L81	7/9	UCF82	7/-
5Z4G	7/6	30C17	16/-	EAF42	10/-	EM84	6/6	6L82	6/6	UCF83	11/6
630L2	12/-	30C18	14/-	EBB1	2/3	E387	7/6	6L83	6/6	UCF84	10/6
6AL5	2/3	30F5	16/-	EB33	8/-	E371	7/6	6L84	6/6	UCF85	6/9
6AM6	2/9	30FL1	13/9	EB44	9/6	EY86	6/6	6E40	8/-	UCF89	6/9
6AQ5	4/6	30FL12	14/8	EBF80	6/6	EZ40	8/-	6G24	8/9	UCF41	7/6
6AT6	4/-	30FL14	14/9	EBF89	6/3	EZ41	8/-	6L508	23/6	UCF44	10/9
6AU6	4/6	30L1	6/6	ECOS1	3/9	EZ80	4/6	6M84	7/8	UCF44	20/-
6BA6	4/6	30L15	14/-	ECOS2	4/9	EZ81	4/9	6X25	10/6	UCF84	7/6
6BE6	4/9	30L17	15/6	ECOS3	7/-	GZ92	8/9	6L500	13/-	UCF89	6/9
6B16	8/6	30P4	12/-	EBY8	8/-	GZ34	8/9	6L504	13/6	UCF41	7/6
6BW6	13/-	30P12	13/9	EC90	3/3	KT61	8/9	6Y33	10/-	UCF86	5/9
6F13	3/6	30P15	12/-	EC904	12/-	KT66	16/-	6Y81	5/3	UCF48	10/-
6F14	9/-	30P11	13/9	ECF80	6/6	N78	17/6	6Y82	5/3	UCF19	7/9
6F23	14/3	30P13	15/6	ECF82	5/9	PAB8	7/6	6Y83	5/9	Z77	2/9
6F25	13/-	30P14	16/6	ECF85	6/-	P86	10/3	6Y800	7/6	AC107	8/6
6J6	3/-	35L5GT	8/6	ECF42	13/6	P88	10/3	6Y2001	3/6	AC127	2/6
6K7C	2/6	35V4	4/6	EF81	5/9	PC90	8/9	6Y801	6/9	AD140	8/6
6K8G	2/9	35Z4GT	5/-	EF83	8/3	PC97	8/6	R19	9/6	AF115	3/-
6L18	6/-	60G3	12/6	EC184	7/6	PC900	7/6	R20	12/6	AF116	3/6
6SN7GT	4/3	ACV210	7/-	ECL80	7/-	PC84	6/6	C25	13/-	AF117	3/6
6V6G	3/3	AZ31	9/6	ECL82	6/9	PC85	6/-	C26	12/-	AF125	3/6
6V6GT	6/6	1729	12/6	ECL83	8/6	PC88	9/-	C47	13/6	AF127	3/6
6X4	4/3	CC33	13/6	ECL86	8/6	PC89	10/8	C49	13/6	OC81	2/3
6X5GT	5/9	CY33	18/6	EF37A	6/9	PC818	11/6	C78	13/6	OC82	2/3
6Z7	7/-	DA92	6/9	EF39	4/9	PCF80	6/6	U191	12/6	OC71	2/6
7C6	6/9	DA92	7/3	EF41	10/9	PCF82	6/6	U193	8/6	OC72	2/6
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10P13	15/6	DF33	7/9	EF86	6/3	PCF800	13/6	U801	19/6	OC82	2/3
12AT7	3/9	DF91	2/9	EF89	5/3	PCF801	8/9	U801	19/6	OC81	2/3
12AUG	4/9	DF96	7/3	EF91	2/9	PCF802	8/9	U802	8/6	OC82	2/3
12A7	4/9	DH77	4/9	EF94	4/6	PCF805	14/-	CAF42	10/3	UC82D	2/6
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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.

Denmark calling

Sir—First of all, I wish to congratulate you on your excellent magazines, and I also wish to join the American subscriber who, some time ago, wrote you that he found your magazine so much more "down to earth" than anything comparable over there. The same goes for this country, where we do not have similar monthlies that supply their construction suggestions in a form which make them easy to follow for us, who enjoy the electronics hobby as a hobby and who—unfortunately—do not possess very much background knowledge on the various subjects.

However, one little complaint: don't you ever think about your poorly positioned overseas readers? Very often I find that components, which you specify in your designs, are unavailable and even unconvertible over here. My latest project has been the cymbal simulator described in your May 1968 issue—or, rather, it has been the latest project of my poor wife, who finally became so fed up with my soldering activities that she started on her own. It being her first project, I naturally had to assist her and ran into considerable trouble.

Remember, PRACTICAL ELECTRONICS is the magazine *WE* resort to for projects—even on the continent.

C. Hagen,
Denmark.

Stop "foiling"!

Sir—The Tape Stop-Foil Device suggested by Mr Price of Pencoed on page 954 of your December issue suffers from a serious shortcoming.

Tape heads are very susceptible to permanent magnetisation, and manufacturers take the precaution of seeing that both erase and replay heads are firmly shorted out during warm-up and after switch-off.

Whether the recorder is valved or transistorised, the coupling capacitors charge up during the warm-up period, and discharge after switch-off, and it is vital to ensure that this current does not flow through the head windings. Neglect of this pre-

caution leads to increased noise, increased distortion and partial erasure of the high-frequency components of the recorded signal.

Turning the whole machine off at the mains is just not on, Mr Price, and if it should happen by accident, immediate demagnetisation of both heads is the least that should be done.

A. S. Henderson,
Enfield,
Middlesex.

On the right lines

Sir—May I commend you on the way and direction your magazine has developed over the past two years; also upon the two articles *Hi-fi Stereo Amplifier*, by Mr M. J. Gay which I shall construct, since it seems to me to approach hi-fi in a new way, and *Demo Switching Circuits*, by Mr B. Pounder.

This to me is a marvellous choice for a series, and having read the first two articles I trust Mr Pounder will continue for a long time to write such sound educational articles. May I suggest, however, that he departs a little from his written policy in the first article and expands a little to describing suitable power supplies or perhaps referring back to such circuits already published in P.E.

A further suggestion is not to completely exclude the medium priced test gear; the inclusion of such information at least widens the knowledge of your readers even if they are unable to use the gear itself.

Also, could he enlarge his explanations to include values of components which would give a greater output. This last suggestion, should you feel it to be worthwhile, could be applied to *Model Railway Logic Systems* by Mr P. Goodes, recently published, to give an output of, say, 3A with a power supply of 24 volts. This voltage is not uncommon in the model railway world, and would be interesting to at least some of your readers. This I happen to know, since your articles have been quoted to me by model railway people.

H. A. Nichol,
Upminster,
Essex.

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Coil	Working d.c.	Contacts	Price
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170	9-12	3 c/o + 1 H.D. c/o	12/6
230	6-12	2 c/o	12/6
280	6-12	2 c/o	14/6
700	12-24	2 c/o	12/6
700	16-24	4 c/o	15/6
700	16-24	4M 2B	12/6
2500	30-50	2 c/o H.D.	12/6
9000	40-70	2 c/o	10/-

H.D. = Heavy Duty. POST PAID I.B. = Including Base

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5	6, 12V at 20A	£6.8.9	6/6
6	17, 18, 20V at 20A	£7.5.9	6/6
7	6, 12, 20V at 20A	£6.17.6	7/6
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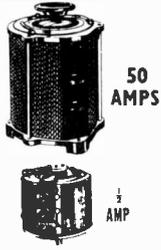
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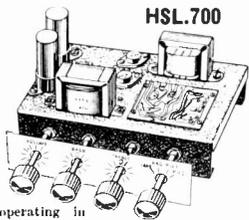
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MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9-0-9 at 500mA. 11/-, P. & P. 2/6. Pri. 200/240V. Sec. 12-0-12 at 1 amp. 14/6, P. & P. 2/6. Pri. 200/240V. Sec. 10-0-10 at 2 amp. 27/6, P. & P. 3/6. Tapped Primary 200-220-240V. Sec. 21-5V at 500mA. 12/6. P. & P. 2/6.

BRAND NEW! PARMEKO MAINS TRANSFORMERS. Primary 110V-250V. Secondary 330-0-330V, 100mA A and 6-3v, at 2 amps, 6-3v, 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 37/6. P. & P. 8/-.

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SPECIAL OFFER!!

Your opportunity to acquire a first class HI-FI LOUD-SPEAKER SYSTEM at an extremely moderate price! Beautifully made oak finish enclosure with most attractive tyran front. Size 18 1/2" high x 10 1/2" wide x 6" deep. Fitted with E.M.I. Ceramic Magnets 13" x 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 (p.e.) pull output per channel (16W mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohm. 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 ±3dB, 20-20,000c/s. Bass boost approx. to +12dB. Treble cut approx. to -16dB. Negative feedback 18dB over main amp. Power requirements 25V at 0.6 amp.

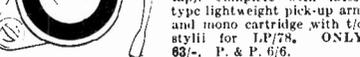
PRICES: AMPLIFIER KIT £10.10.0; POWER PACK KIT £3.0.0; CABINET £3.0.0. All Post Free.

Also available STEREO 10+10. As above but 10 watts per channel. **PRICES: AMPLIFIER KIT £12.** POWER PACK KIT £3.10.0.

(Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).

Official stockists of all PEAK SOUND HI-FI EQUIPMENT

including:
P. W. DOUBLE 15 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.)



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 speaker. Size 7in. w. x 3 1/2 in. h. Ready 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/P CABINET MK II Vcut motor board size 14 1/2 in. clearance 2in. below. 5 1/2 in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18-15-8in. 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. Ready built on plated heavy gauge metal chassis, size 7 1/2 in. w. 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 44.15.0. P. & P. 6/-.

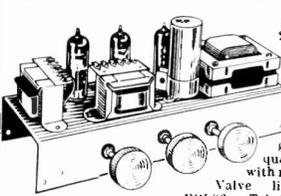
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. 79/6. P. & P. 6/-.

BRAND NEW TRANSISTOR BARGAINS. GET 15 (Matched Pair) 15/-; V15/10p, 10/-; OC71 5/-; OC76 6/-; AF117 3/6; 2G339 (NPN) 3/-. Set of Mullard 6 transistors OC44, 2-OC45, AC128D, matched pair AC128 25/-; ORP12 Cadmium Sulphide Cell 10/6. All post free.

YVNAIR AND BEXINE SPEAKERS AND CABINET FABRICS app. 5 1/2 in. wide. Usually 35/- yd., our price 15/- yd. length. P. & P. 2/6 (min. 1 yd.). S.A.E. for sample.

POWERFUL COMPACT MOTOR for 6-v. Battery operation approx. 25mA. Made originally for "Greenoot" record player decks. Built in constant speed device. Ideal for models, etc. Overall size approx. 1 1/2" x 1 1/4" x 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 mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up—2 ECL85 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 11in. w. x 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. Price 8 gns. P. & P. 8/-.

4-SPEED RECORD PLAYER BARGAINS

Mains models. All brand new in maker's packing.
B.S.R. UA25 with latest mono compatible cart. £6.19.6 All plus Carriage and Packing 6/6.
LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60 etc. Send S.A.E. for Latest Prices!
PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, AT60, SP25. With transparent plastic cover. OUR PRICE 5 gns. complete. P. & P. 8/6.

SONOTONE STAHC compatible Stereo Cartridge with diamond stylus 50/-, P. & P. 2/-.
LATEST ROMETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. 32/6, P. & P. 2/-.
LATEST ROMETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. 30/-, P. & P. 2/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT

Type TA1
● Peak output in excess of 1 1/2 watts.
● All standard British components.
● Built on printed circuit panel size 6 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 matching pair of AC128 o/p). ● 9 volt operation.
● Everything supplied, wire, battery clips, solder, etc.
● Comprehensive easy to follow instructions and circuit diagram 2/6 (Free with Kit). All parts sold separately. **SPECIAL PRICE 45/-, P. & P. 3/-.** Also ready built and tested, 52/6. P. & P. 3/-.

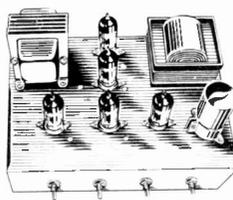
HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound Hi-Fi mains transformer, E280 rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3.5 watts. Volume and tone controls, chassis size only 7in. wide x 3in. deep 6in. high overall. A.C. mains 200/240V. Supplied absolutely Brand New completely wired and tested with valves and good quality output transformer. FEW ONLY.

OUR ROCK BOTTOM BARGAIN PRICE 55/- P. & P. 6/-

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monoaural amplifier with an output of 14 watts from 2 ECL85 in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and other instruments to follow each other. Fully shrouded section wound output transformer to match 3-15 ohm speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 ECL85, ECC83, EF86 and E280 rectifier. Simple instruction booklet 2/6 (Free with parts). All parts sold separately. **ONLY £7.9.6.** P. & P. 8/6. Also available ready built and tested complete with st. input sockets, 29.5.0. P. & P. 8/6.



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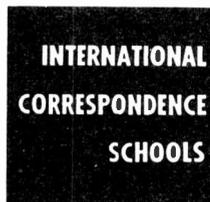
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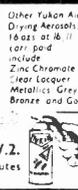
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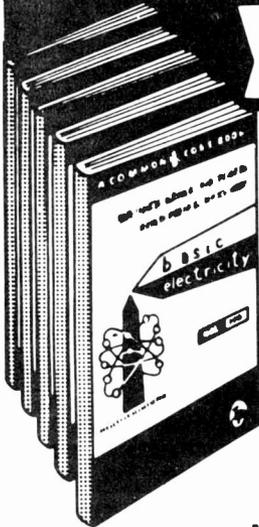
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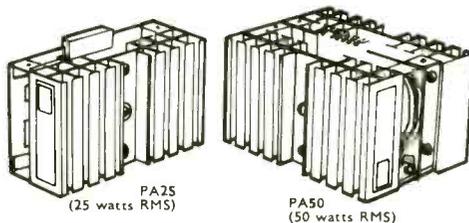
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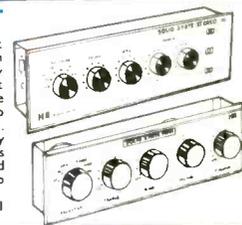
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