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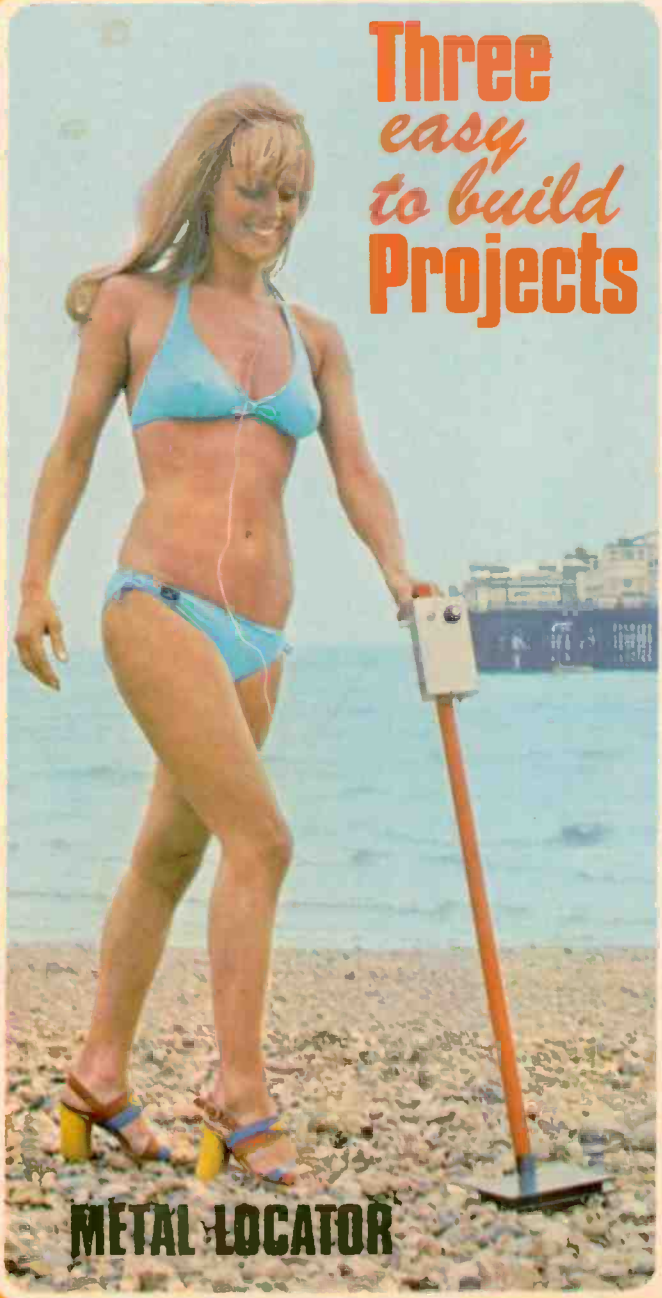
everyday electronics

SEPT. 74
20p

Three *easy to build* Projects



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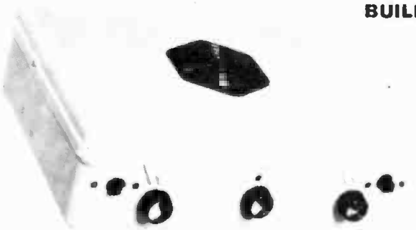


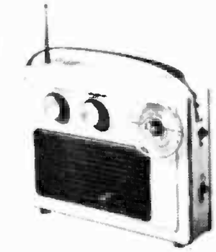
★ 4 Transistor Earpiece Radio ★ Signal Tracer ★ Signal Injector ★ Transistor Tester NPN-PNP ★ 4 Transistor Push Pull Amplifier ★ 5 Transistor Push Pull Amplifier ★ 7 Transistor Loudspeaker Radio MW/LW ★ 5 Transistor Short Wave Radio ★ Electronic Metronome ★ Electronic Noise Generator ★ Batteryless Crystal Radio ★ One Transistor Radio ★ 2 Transistor Regenerative Radio ★ 3 Transistor Regenerative Radio ★ Audible Continuity Tester ★ Sensitive Pre-Amplifier.

★ 24 Resistors ★ 21 Capacitors ★ 10 Transistors ★ 3½ loudspeaker ★ Earpiece ★ Mica Baseboard ★ 3 12-way connectors ★ 2 Volume controls ★ 2 Slider Switches ★ 1 Tuning Condenser ★ 3 Knobs ★ Ready Wound MW/LW/SW Coils ★ Ferrite Rod ★ 6½ yards of wire ★ 1 yard of sleeving, etc. ★Parts price list and plans 50p (FREE with parts).

Total Building Costs £7·23 P P & Ins. 44p. (Overseas P & P £1·85p.)
(+ 8% VAT 57p)

NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors, 9 Tunable wavebands as Roamer Ten, built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mw transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange control. Attractive all white case with red grille and carrying strap. Size 9½" × 7" × 2½" approx. Parts Price list and Plans 30p (FREE with parts)

Total Building Costs £6·95 P P & Ins. 44p.
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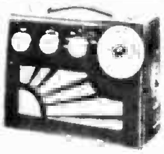
ROAMER TEN



with VHF including aircraft. 10 Transistors. Latest 4" 2 watt Ferrite Magnet Loudspeakers, 9 Tunable Wavebands. MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band. Built in Ferrite Rod Aerial for MW/LW. Chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600 mw Transistors. Car Aerial and Tape Recording Sockets. 10 Transistors plus 3 Diodes. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" × 7" × 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

Total building costs £8·50 P. P. & Ins. 52p
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NEW EVERYDAY SERIES

Build this exciting New series of designs

E.V. 5 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3" loudspeaker. Attractive case with red speaker grille. Size 9" × 5½" × 2½" approx.
Parts price list and Plans 15p. Free with parts.

Total Building Costs £2·95 P P & Ins. 30p
(Overseas P & P £1·25p)
(+ 8% VAT 23p)

E.V. 6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, 3" loudspeaker, etc., MW/LW coverage. Push Pull output. Parts price list and Plans 15p. Free with parts.

Total Building Costs £3·60 P & P Ins. 30p
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E.V. 7 Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" loudspeaker. Parts price list and easy build plans 20p. Free with parts.

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Build Radios· Amplifiers, etc. from easy stage diagrams. Five units including master unit to construct

Components include: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine 3" Tone Moving Coil Speaker: Terminal Strip: Ferrite Rod Aerial: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ¼" Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction.
Parts price list and plans 25p (FREE with parts).

Total Building Costs £5·50 P P & Ins. 38p
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(+ 8% VAT 44p)

POCKET FIVE

Now with 3" loudspeakers

3 Tunable wavebands. M.W./L.W. and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive Black and Gold Case. Size 5½" × 1¼" × 3½" approx. Plans and parts price list 15p. (Free with parts).

Total Building Costs £2·50 P P & Ins. 26p
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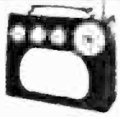
ROAMER EIGHT Mk 1

NOW WITH VARIABLE TONE CONTROL



7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Chrome plated Telescopic aerial can be angled and rotated for peak short wave listening. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet Loudspeakers. Air spaced ganged tuning condenser Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

Total Building Costs £6·98 P P & Ins. 47p
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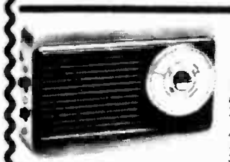
TRANSONA FIVE



Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial.
Plans and parts price list 15p (Free with parts).

Total Building Costs £2·75 P P & Ins. 26p
(Overseas P & P £1·25p)
(+ 8% VAT 21p)

ROAMER SIX

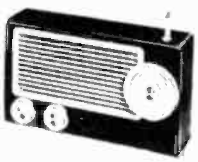
Case and looks as Trans-Eight

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3, Trawler band plus an Extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Plans and parts price list 25p (FREE with parts).

Total Building Costs £3·98 P P & Ins. 31p
(Overseas P. & P. £1·85)
+ 8% VAT 31p)

TRANS EIGHT

8 TRANSISTORS and 3 DIODES



6 Tunable Wavebands; MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

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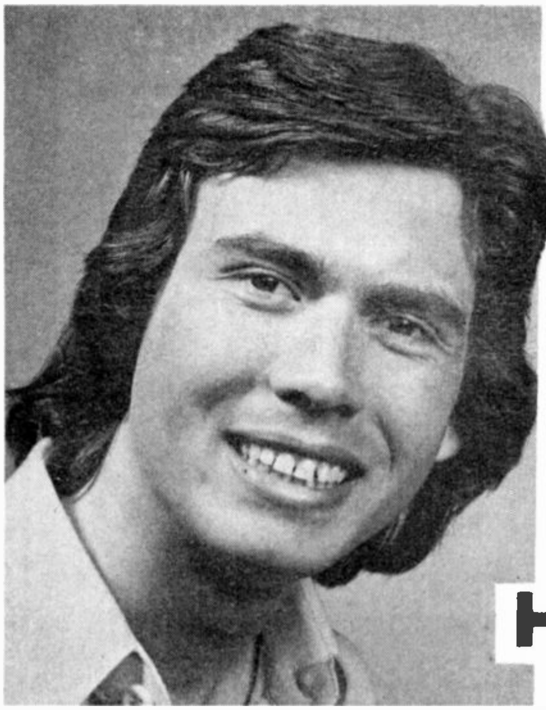

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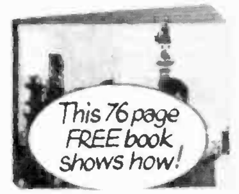

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10µF	25V	6½p	220µF	10V	6½p
10µF	63V	6½p	220µF	16V	8p
15µF	16V	6½p	220µF	63V	21p
15µF	63V	6½p	330µF	16V	12p
16µF	40V	6½p	330µF	63V	25p
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22µF	63V	6½p	470µF	40V	20p
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33µF	16V	6½p	680µF	40V	25p
33µF	40V	6½p	1000µF	16V	20p
32µF	63V	6½p	1000µF	25V	25p
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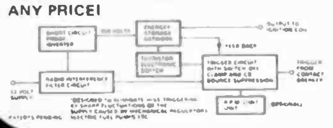

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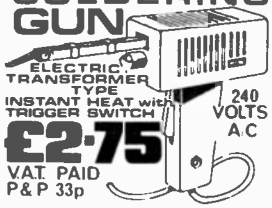

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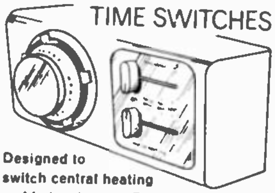

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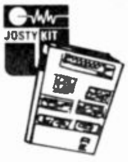

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everyday electronics

PROJECTS... THEORY......

THE SEEKERS

It is hardly an exaggeration to call electronics the universal provider. For electronics has made so much possible, in many quite different and totally unrelated spheres. Among its achievements, this technology based upon the free electron has fostered a number of spare time hobbies that would never have become universally popular without its aid.

Take for example the widely followed pastime of seeking out buried curios and relics which may have some intrinsic or historical value. The band of amateur "treasure hunters" has increased greatly since the introduction of the first transistorised lightweight metal detector. A sizeable industry has come into being just to cater for this growing outdoor leisure activity, and a wide range of commercial metal detectors or locators, is now available.

This type of instrument also happens to be an ideal project for the electronics constructor. Many designs have already been published, but we make no apology for adding yet another. In this issue we give full details for a home-built metal locator which should satisfy some of the continuous demands from would-be treasure hunters and curio collectors.

LATE APPEARANCE

Regular readers will have been puzzled and maybe annoyed because of the late appearance of EVERYDAY ELECTRONICS these last few months. We apologise for this unhappy state of affairs which is due to production difficulties—matters that are entirely beyond our control.

We also apologise to our advertisers who must have suffered inconvenience because of erratic publication dates. We hope things will be "back to normal" within the course of the next couple of issues.

VAT CHANGES

Changes in the rate of Value Added Tax were announced just before this issue went to press, and it has not been possible to amend prices quoted in advertisements.

Where prices are shown inclusive of VAT at 10 per cent, the REDUCTION may be calculated by dividing the inclusive price by 11 and then by 5.

If in doubt readers are advised to refer to the advertiser for a revised quotation.

Fred Bennett.

Because of prevailing production problems, no firm publishing date can be announced for the October issue. Readers are advised to check regularly with their local supplier from mid-September onwards.

EDITOR F. E. Bennett • ASSISTANT EDITOR M. Kenward • B. W. Terrell B.Sc.
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.EASY TO CONSTRUCT
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VOL. 3 NO. 9 SEPTEMBER 1974

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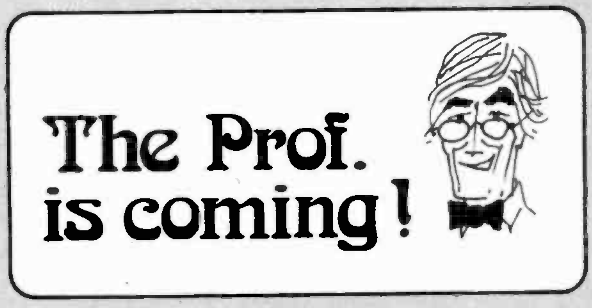

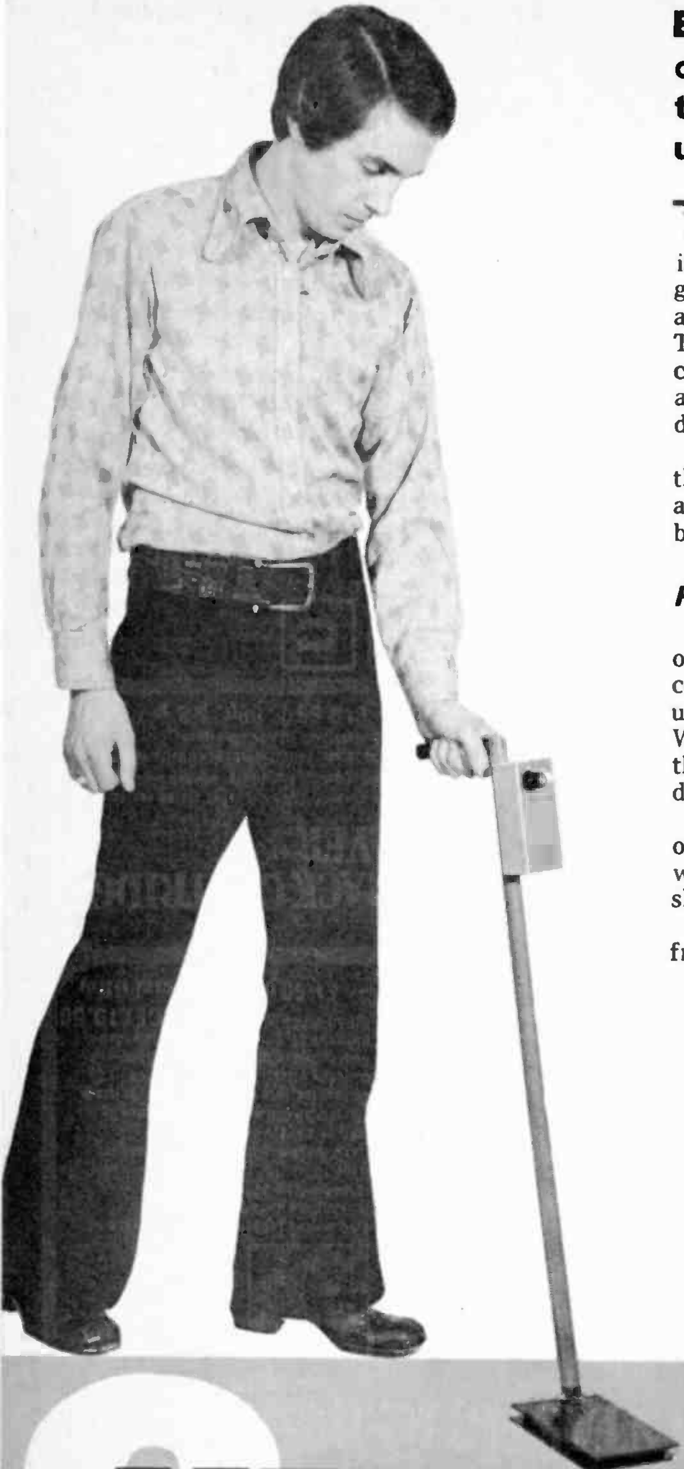

Enjoy the hobby and fun of "treasure hunting" with this simple and inexpensive unit.

THIS metal detector is easy to construct, both mechanically and electrically, and is also inexpensive. It is completely self contained, giving many hours of use from a PP3 battery, as the current consumption is only about 2mA. The circuit uses three silicon transistors and is capable of detecting a 10p piece at a depth of about 50mm and larger objects to a maximum depth of about 200mm.

This type of detector is quite sensitive despite the simplicity of the circuit, although a certain amount of skill is required if the best use is to be made of the unit.

PRINCIPLE OF DETECTION

A block diagram showing the various stages of the detector is shown in Fig. 1. The search coil consists of a large air-cored coil which is used to scan the ground which is being searched. When something made of metal comes near to the coil, it causes a minute change in its inductance.

The search coil is used as the inductor in an oscillator circuit, and any change in its value will therefore alter the frequency of oscillation slightly.

The output of this oscillator is fed to a beat frequency oscillator (b.f.o.). This has the same

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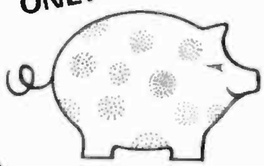

ESTIMATED COST* OF COMPONENTS
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METAL LOCATOR

BY R.A. PENFOLD

WHO KNOWS <u>WHAT</u> YOU MAY FIND !! .....

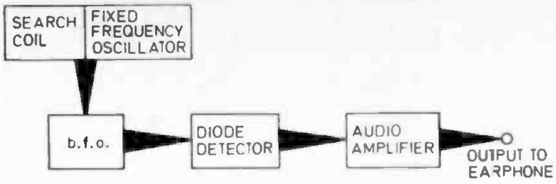


Fig. 1. Block diagram of the Metal Locator

nominal frequency as the first oscillator, but its frequency can be adjusted over a small range of frequencies either side of the nominal frequency. The combined output of these is fed to a diode demodulator, an a.f. (audio frequency) amplifier, and finally to a crystal. earpiece.

In use the b.f.o. is tuned a few hertz above or below the frequency of the search oscillator (approximately 100kHz). The two oscillator signals will hetrodyne, and will produce an audio output at the output of the detector. The hetrodyning principle is quite simple, and consists of the oscillator signals combining to produce the sum and difference signals. The difference signal is equal to the difference in the frequencies of the two oscillators, which as already stated is only a few hertz.

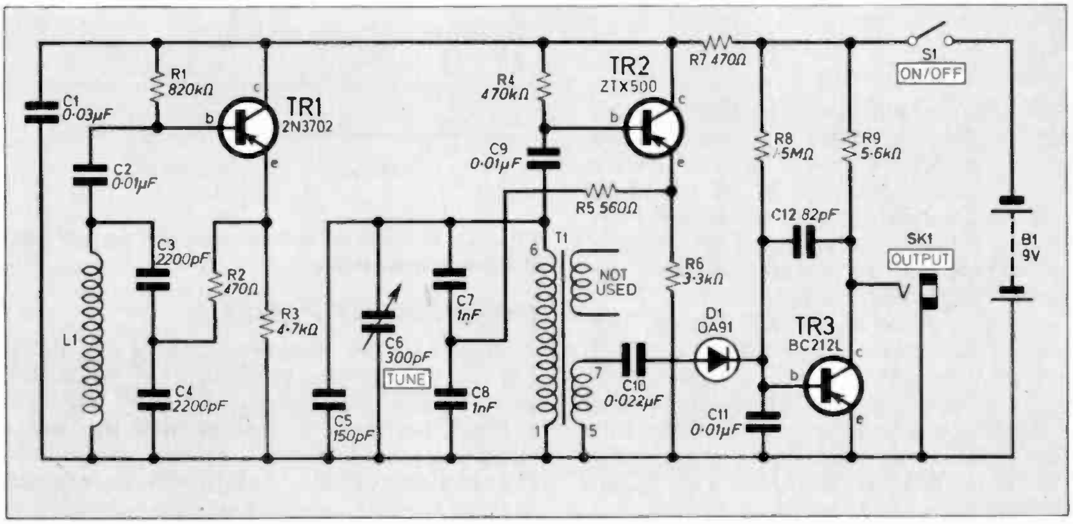
This low frequency audio signal is amplified by the a.f. amplifier, and is heard through the earpiece. The frequency of the audio signal does of course depend upon the frequencies of the two oscillators, and if the frequency of one of these should change, then the frequency of the audio signal will change also.

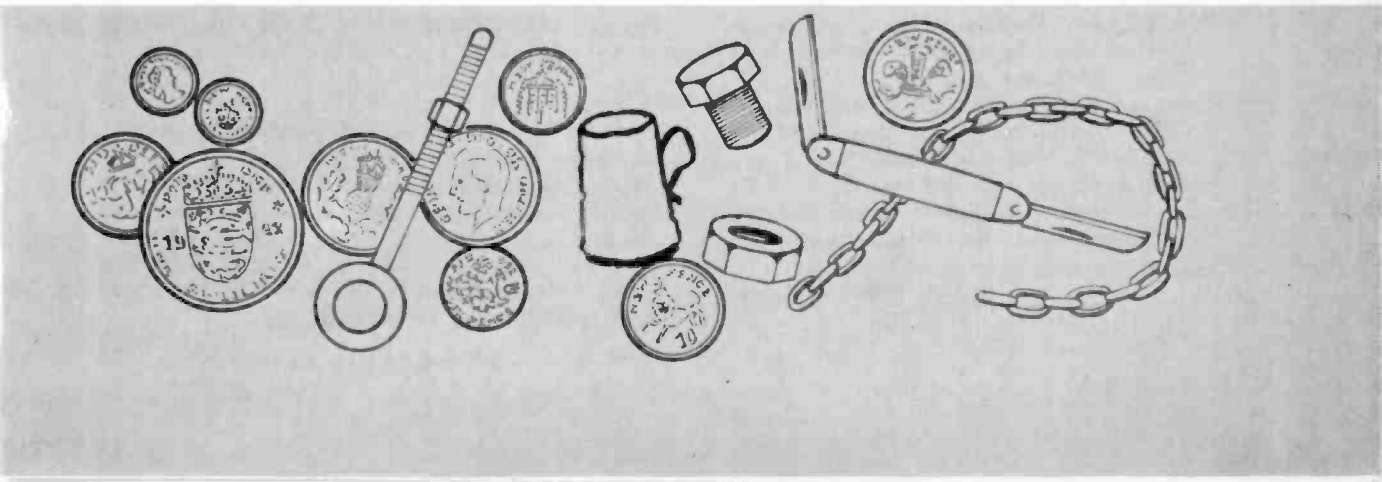
As the search coil is scanned across the ground, a change in the audio note in the earpiece indicates that the frequency of the search oscillator has changed, and thus indicates the presence of a metal object below the search coil.

CIRCUIT

A circuit diagram of the detector is shown in Fig. 2. The search coil (L1) is incorporated in an oscillator circuit employing TR1. This transistor is operated in the emitter follower mode, is biased by R1, and has R3 as its emitter load. Positive feedback is provided between TR1 emitter and base by R2. As the voltage gain of TR1 is slightly less than unity, the feedback is taken to a tap on L1 (formed capacitively by C3 and C4) to provide the necessary voltage step up to permit oscillation.

Fig. 2. The complete circuit diagram of the Metal Locator.





It is important that the oscillators are stable, so that the b.f.o. tuning control (C6) does not require constant readjustment. It is also important that the output waveform is reasonably pure, so that spurious audio signals are not produced. This circuit is very good in both these respects.

The b.f.o. uses TR2 in a circuit which is basically identical to that associated with TR1. This has the addition of extra tuning capacitors, C5 and C6, and two extra windings on the coil, (forming a transformer T1) one of which is used to couple the output of the oscillator to the detector diode, D1, via C10.

Transistor TR3 is used as a common emitter audio amplifier. Capacitors C11 and C12 filter out the r.f. component in the signal from the oscillators, leaving only the required audio signal. R7 and C1 are r.f. supply decoupling components, and S1 is the on/off switch. Note that only a crystal earpiece or crystal headphone can be fed from the output of TR3.

When looking at the circuit diagram it appears that the output of TR1 is not coupled to the rest of the circuit. There is in fact no coupling provided in the circuit as this is not necessary, as it is provided by stray capacitances, and by the signal which is radiated by the circuitry around TR1 being picked up by T1.

CONSTRUCTION

Details of the wooden frame of the detector are shown in Fig. 3. Start by making the wooden coil former for the search coil. The six parts which comprise this are glued together. Then mount the handle on the main pole. The corners of the handle are rounded off using a file, and then sanded to a smooth finish, to make it more comfortable to hold.

Next the pole is glued to the coil former. The bottom end of the pole is cut off at a slight angle, so that it is not quite at a right angle to the coil former, as can be seen in the diagram. Use a good quality adhesive for this join, such as an epoxy resin. Mounting details of the aluminium box are shown in Fig. 3, but this is not mounted until it has been drilled.

The search coil consists of 80 turns of 38 s.w.g. enamelled copper wire scramble-wound around the former. The leadouts are brought out through two small holes in the former, and are cut to about 50-75mm long.

The layout of the components in the case is shown in Fig. 4. The holes for the mounting bolts for the component panel and for C1 are drilled for 6BA clearance. Socket SK1 and T1 require 6mm diameter mounting holes. Do not tighten the mounting nut on T1 any more than finger tight, as its thread is easily stripped. The component panel is used as a template to locate the position for its mounting holes.

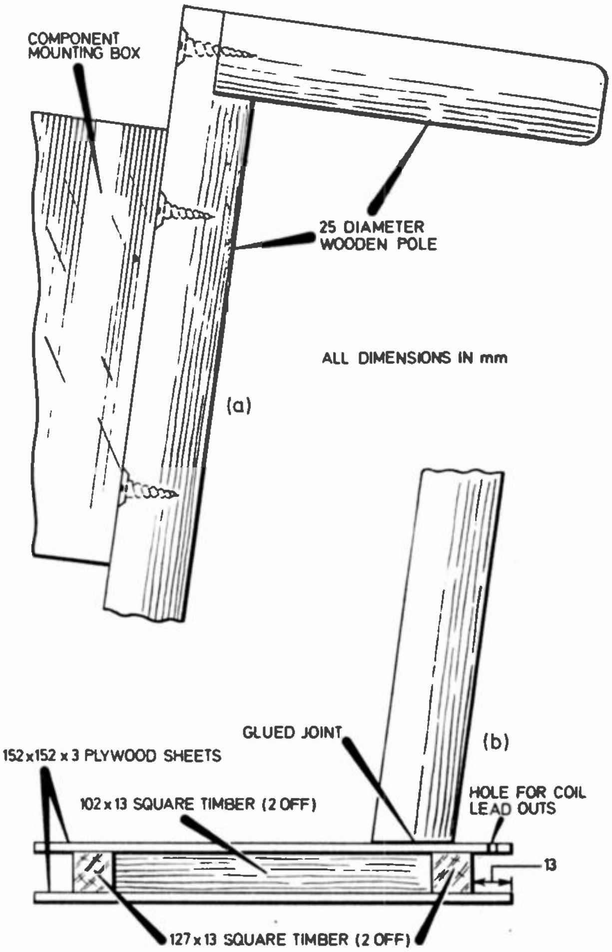


Fig. 3. Details of the woodworking as used in the prototype unit.

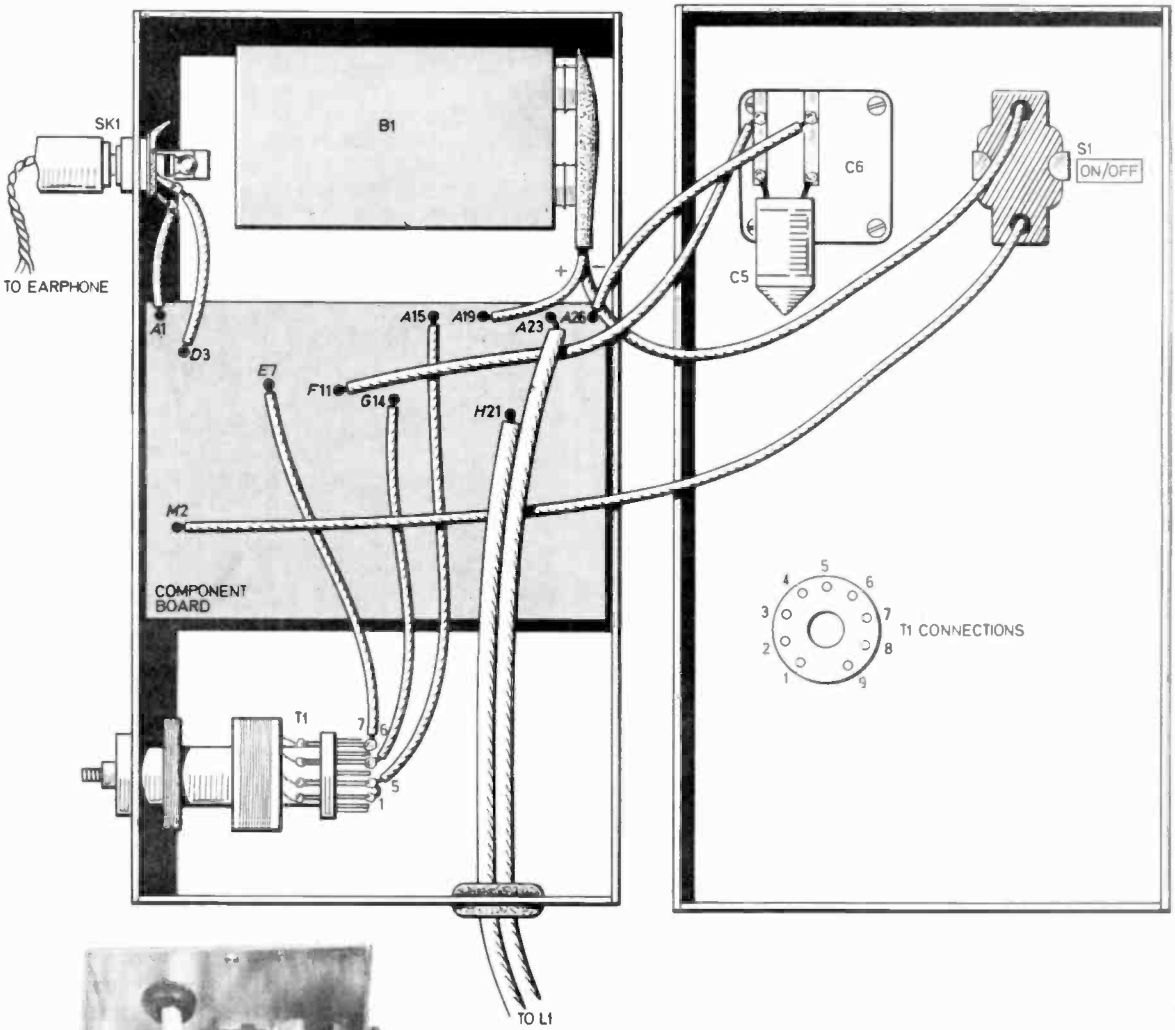
COMPONENT PANEL

Details of the component panel are shown in Fig. 5. Commence building this by cutting a panel of the required size (26 x 18 holes) using a small hacksaw, and then drill the two 6BA mounting holes. Note that the board has the copper strips running lengthwise. Before mounting the various components and soldering them into position, make the three cuts in the copper conducting strip.

In the nine places where leads connect the panel to C6, SK1, etc., connect insulated leads about 75-100mm long to the panel. Also connect the length of two way cable (a length of flat 2 core mains cable) which connects L1 to the rest of the circuit.

Now the panel is mounted inside the box using two 6BA 15mm long bolts. A couple of nuts are tightened over each of these between the panel and the case, to ensure that the copper backing strips of the panel do not short circuit through the metal case.

METAL LOCATOR



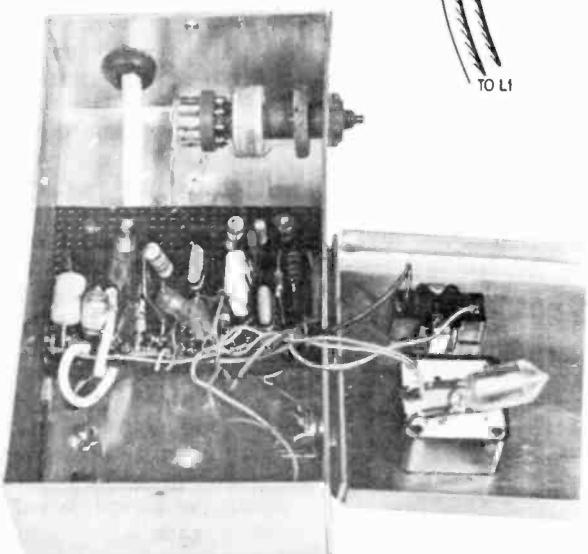


Fig. 4. Layout and wiring of the completed component mounting box. Pin numbering for T1 is shown separately.

Photograph of the completed component mounting box.

Components....

SEE
SHOP
TALK

Resistors

R1	820kΩ	R6	3·3kΩ
R2	470Ω	R7	470Ω
R3	4·7kΩ	R8	1·5MΩ
R4	470kΩ	R9	5·6kΩ
R5	560Ω		

All ½ watt ± 10% carbon

Capacitors

C1 0·03μF plastic foil
C2 0·01μF plastic foil
C3 2200pF polystyrene
C4 2200pF polystyrene
C5 150pF polystyrene
C6 300pf miniature solid dielectric variable (Jackson Dilemin or similar)
C7 1000pF polystyrene
C8 1000pF polystyrene
C9 0·01μF polyester
C10 0·022μF polyester
C11 0·01μF polyester
C12 82pf ceramic or polystyrene

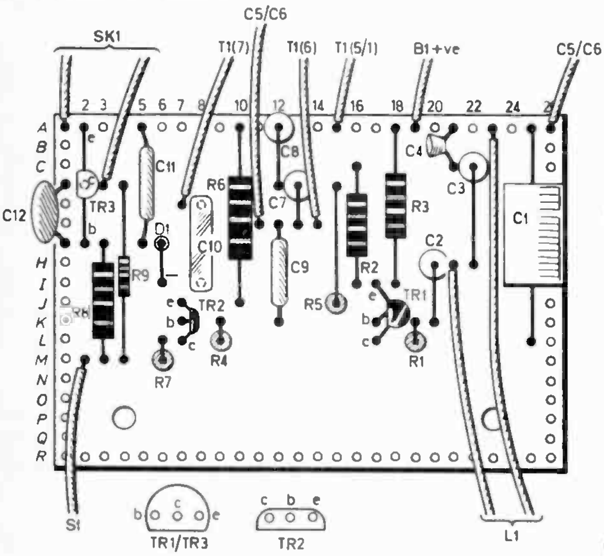
Semiconductors

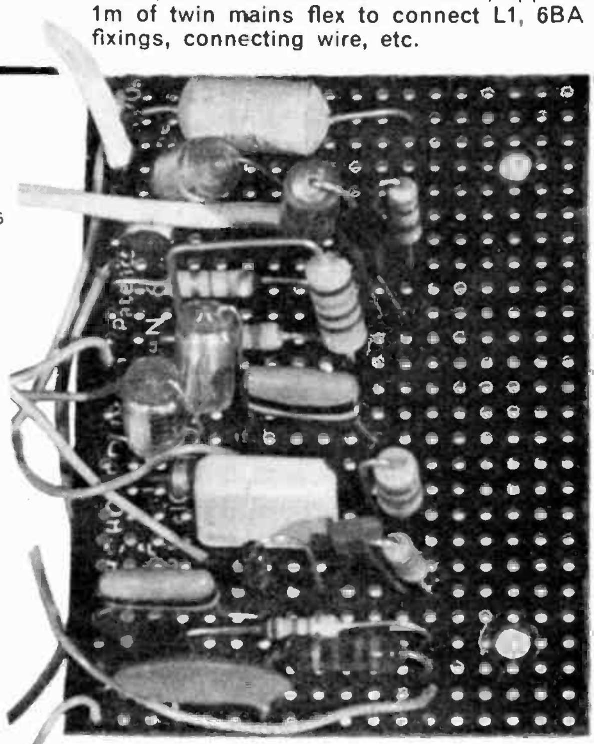
TR1 2N3702 silicon *pnp*
TR2 ZTX500 silicon *pnp*
TR3 BC212L silicon *pnp*
D1 OA91 diode

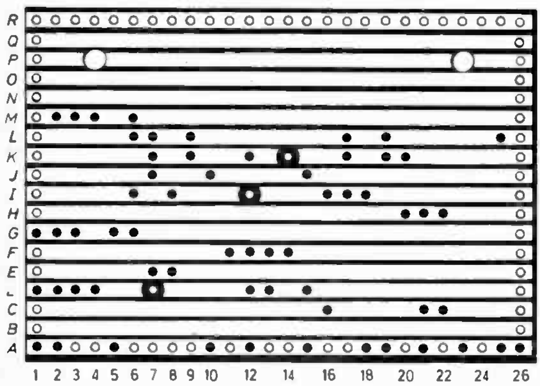
Miscellaneous

S1 On/off switch (s.p.s.t. toggle slide or push button).
T1 Denco transistor useage coil, colour code green, range IT.
SK1 3·5mm jack socket for crystal earpiece.
B1 PP3 battery and clip to suit.
38 s.w.g. enamelled copper wire for L1, crystal earpiece with plug, 0·1 inch matrix Veroboard, 26 holes by 18 strips, control knob for C6, aluminium case approx. 135mm x 75mm x 40mm, wood and screws for frame, approx. 1m of twin mains flex to connect L1, 6BA fixings, connecting wire, etc.

Fig. 5. The layout of the components on the component panel. Shown right is a photograph of prototype panel.







LICENCE

A licence is necessary to operate this Metal Locator in the British Isles. The circuit as shown is designed to operate within the frequency band specified by the Ministry of Post and Telecommunications (16 to 150kHz) and no alterations should be made to the published design that might alter the operating frequency.

The necessary licence costs 75p for five years. An application form for a licence is available from the Ministry of Posts and Telecommunications, Waterloo Bridge House, Waterloo Rd., London, SE1.

Next connect the free ends of the leads from the component panel to the appropriate components, and mount C5 across the terminals of C6. Connect the negative battery clip lead to S1, and then connect the battery itself. The battery is positioned in the case next to SK1, and is held in place by the lid of the case when this is screwed on.

Only two connections remain unwired, and these are those that connect the lower end of the two way cable to the lead outputs of L1. Once these have been completed, tape the lead to the pole using a couple of turns of insulation tape over these connections. Then use a few drawing pins, or more tape, to secure the cable to the back of the pole. Do not leave any spare cable curled up inside the case as this might cause instability.

Finally, paint or varnish the wooden parts of the detector.

NOTES ON USE

Before turning on, check all wiring thoroughly for mistakes, and screw in the core of T1 so that virtually none of the metal thread is protruding. Then plug a crystal earpiece into SK1, and turn on. A whistle should be heard from the earphone, and using C6 it should be possible to alter the pitch of this. It should be possible to find a point at which the tone disappears, and tuning C6 either side of this produces the tone. The further C6 is tuned away from this point, the higher the pitch of the tone.

Adjust C6 slighty in an anticlockwise direction from this point, and obtain as low a note as possible. To check that the unit is working properly, place the search coil over a 10p coin, or other metal object of about this size. This should cause the audio note to drop in pitch, and the tone will cease altogether if the coil is placed close enough to the coin.

Note that most metals cause the note to drop in pitch, but brass for instance, will have the opposite effect.

A little practice may be required while one gets used to using the unit, but then it should be found that even quite small objects can be detected. C6 should be set with the search coil on or near the ground, as placing the coil near the ground, or any very large object, will cause a slight change in the pitch of the note. ▣

...Counter Intelligence

BY PAUL YOUNG

A retailer discusses component supply matters.

THE LEFT HAND

If I tend to harp on shortages and price rises, it is with good reason I do assure you. I know it will not have escaped your notice, that one famous firm has withdrawn its catalogue (albeit temporarily) because they cannot keep up with the rapid price changes!

Only recently we went to order a six-way tag board and were told that the price would be 10p. We have been selling this particular article for years at 5p.

SUPPLY CHAIN

This problem, I am sure contributes in no small measure, to the ever lengthening delivery time. If you consider that this will be happening along the whole chain of supply. The wholesaler who supplies us finds the price to him has jumped and the manufacturer finds the price of the raw material has increased.

The wholesaler has in stock item X which we require, but he is forced to hang on to it, until his replacement stock has arrived, because only when he has been invoiced for his replacement stock will he know what to charge us!

You will see that this is going to stretch out the delivery period still further. To add to our discomfort, I have to waste much valuable time, replying to disgruntled customers, who cannot understand, why our prices have gone up, or why we are out of stock of many items.

"Sheer inefficiency" states one customer! I only wish it was, then it could soon be remedied—I could sack myself—but only time will cure the present malaise.

BUYING GROUP

We have always tried hard to keep prices down, and one positive action we took, was to form a buying group, with the object of bulk buying. I admit it was not entirely altruistic, but even so, you the customer benefited. In addition we were able to prevent certain items from completely disappearing.

Although we have had many successes in this direction, I have to admit to one recent failure. I refer to the ordinary "china eggs" used as aerial insulators. We were finally reduced to one supplier, and one of our Northern members did the buying.

He admitted to me, that he had to buy larger and larger quantities, running into thousands. I told him not to worry, as we would take a thousand, and all the other members were screaming for them! Finally he said, "They are finished, they will not make any more, no matter how large the order'.

NO DEMAND

Imagine my excitement when at the I.E.A. Exhibition earlier this year I saw a firm displaying this very article. "Can you supply them?" I asked. "Yes" replied the salesman. "How many would you order?" "Oh! At least 5,000" I replied. "All right", said the salesman, "I will telephone you after the Exhibition is over".

Eventually, he came through to me on the 'phone, "I am awfully sorry, we no longer manufacture them, it appears nobody wants them". (!)

Now do you see what I mean about the left hand? Pathetic, isn't it, to think that in our advanced technological age, one additional problem that is hamstringing us, is, of all things, *lack of communication!!*

LESSON 12 The Thyristor

THE thyristor or controlled silicon rectifier (CSR) is the last semiconductor device to be covered in the Teach-In '74 series. Other solid-state devices are available and as time goes by more new devices will appear. These will be covered by separate articles, as required, since in most cases they will be fairly complex integrated-circuits, designed to perform some specific task.

SOLID STATE SWITCH

The thyristor is really a solid-state switch and, depending on the type, can operate at potentials up to several hundred volts and can handle currents up to tens or even hundreds of amps. The type specified for our experiments (BTX30-25) is a "baby" of this large family and is only suitable for currents up to 500mA and voltages up to 25 volts.

The device involves a four-layer construction (*p-n-p-n*) and is illustrated together with the circuit symbol in Fig. 12.1. If we imagine the four layers cut along the dotted line we have two parts which resemble *pnp* and *npn* transistors and Fig. 12.1c shows an approximate "equivalent circuit" based on this idea.

The thyristor will block current flow between anode and cathode if the gate is left unconnected, at least up to the limit imposed by the voltage ratings of the device. This blocking applies to current attempting to pass *either* way between the anode and cathode. However, when current is trying to flow from anode to cathode (conventional current assumed) a short duration current pulse into the gate will cause the device to turn on.

What is perhaps more important, the thyristor will stay on even after the gate current pulse has stopped as long as there is sufficient current between anode and cathode. If this current is switched off momentarily at some other point, or falls to a sufficiently low level, the conduction path within the thyristor will block and we are then back to the starting point again.

Notice that once the gate current pulse has activated the conduction path the gate loses control and this makes the thyristor gate quite different to the usual base control in a transistor.

DEMONSTRATION CIRCUIT

A simple circuit that can be constructed on the Tutor-Board to demonstrate the features

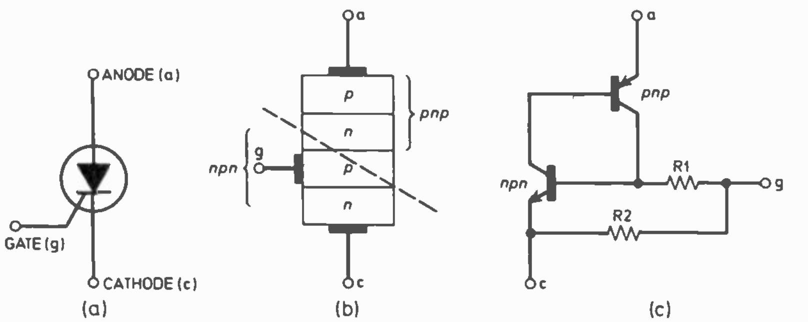


Fig. 12.1. The thyristor:
(a) circuit symbol
(b) four-layer schematic representation
(c) an approximate equivalent circuit.

* North Staffordshire Polytechnic (*Any communications arising from the Teach-In '74 series must be addressed to Everyday Electronics, Fleetway House, Farringdon Street, London E.C.4*).

mentioned above is shown in Fig. 12.2. The main current path from the battery is via the thyristor and lamp LP1. By closing S1 the gate will receive current via the 100 ohm limiting resistor and the lamp will light.

If S1 is now opened the gate current will stop but the lamp will remain on. By unscrewing LP1 the main circuit can be broken and when the lamp is reconnected the off state will have returned.

This test can be repeated with the lamp replaced by a 100 kilohm resistor and the 100μA meter in series. Switch S1 will turn the thyristor on, as previously, but when S1 is restored to the open position the meter will show that the thyristor conduction also stops.

This is due to the very low meter current, which is below the minimum holding current that is required to keep the thyristor in the conducting state. At low current levels the current gain of the *pnp* and *npn* transistors in the equivalent circuit of Fig. 12.1c is reduced and this is responsible for the thyristor failing to hold itself in conduction.

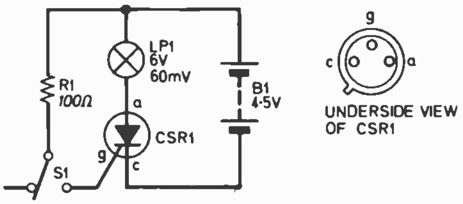


Fig. 12.2. Circuit for demonstrating the action of a thyristor. The thyristor used was a BTX30-25.

Thyristors are very useful in power applications such as motor control, lamp dimming and similar areas. They can be used on alternating voltage supplies and with suitable additional circuitry can be used to control the average power delivered to a load. Fig. 12.3 illustrates the use of a thyristor for controlling a burglar alarm.

The switches S1, S2, etc., are arranged to close if say a door or window is opened or some item such as a drawer is disturbed. Once the thyristor is triggered on, the alarm will continue to sound until the power is removed. The diode D1 protects the thyristor from the inductive surges that can occur as the bell or buzzer contact opens, and the resistor R3 ensures that the thyristor always receives a current in excess of the minimum holding current.

THYRISTOR RATINGS

Power dissipation must be limited in any semiconductor device and this means that there will be a maximum forward current allowed. When the thyristor is on there is a small voltage drop between anode and cathode and the product of this voltage and the forward current gives the power dissipation. The voltage drop is sometimes called the forward voltage and a typical value is approximately 1·2 volts for a small thyristor.

The voltage drop can be measured using the standard voltmeter arrangement and the circuit of Fig. 12.2. Note that the anode is positive with respect to the cathode. The voltage drop is effectively the sum of the voltages across two *pn* junctions in series and this accounts for the value of 1·2 volts.

When a thyristor is off there will be a small leakage current flow which will typically be less than 1μA irrespective of the direction of blocking. The thyristor normally blocks current flow when the cathode is positive with respect to the anode. This is the *reverse* blocking direction and will have a voltage limit specified.

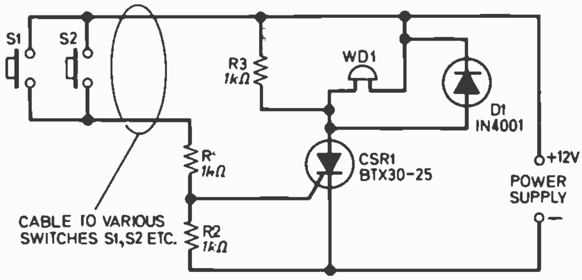


Fig. 12.3. Using a thyristor in a burglar alarm system.

With the anode made more positive than the cathode we have the *forward* blocking condition and this will also have a maximum allowed voltage rating. The triggering requirements at the gate are usually specified by quoting the current and voltage requirements. For the BTX30-25 thyristor the values are:

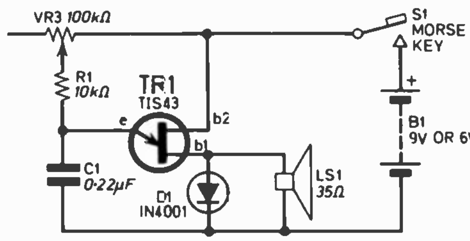
$V_{gt} = 3{\cdot}0$ volts $\qquad I_{gt} = 10$mA

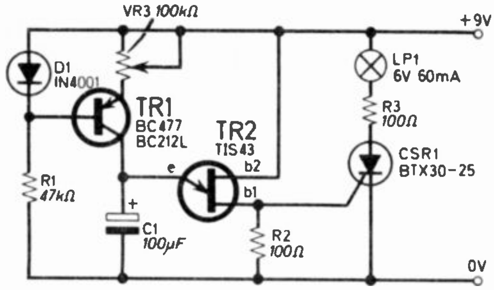
These are the minimum requirements to ensure triggering with any sample.

EXPERIMENTAL CIRCUITS

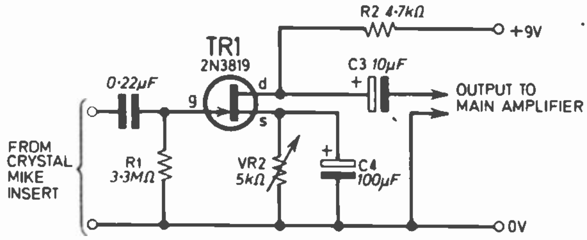
Several experimental circuits are included in this final lesson of Teach-In '74. The circuits are reasonably simple and can be adapted to suit readers' requirements. Regular study of articles

Morse Practice Oscillator: the oscillator pitch is adjustable at VR3. The Morse key can be improvised using old relay springs.

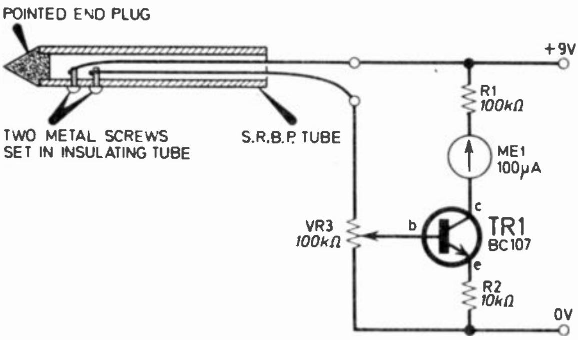




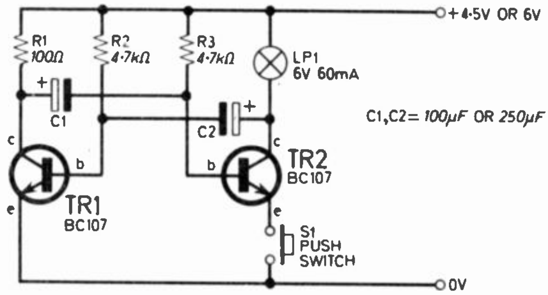
Time Delay Unit: delay time is proportional to value of VR3 and C1. Thyristor turns on when C1 discharges by action of TIS43.



Crystal Microphone Amplifier: set VR2 to give 4V across R2. If main amplifier has low input impedance, C3 can be increased to 100μF.



Moisture Detector: to calibrate, insert probe in moist soil, grain etc. and adjust VR3 to give suitable reading, e.g. half f.s.d.



Lamp Flasher: lamp flashes when S1 is pressed and continues until S1 is released. LP1 always lights at instant switch is pressed.

in EVERYDAY ELECTRONICS should provide readers with further projects and it is hoped that, by applying the basic principles that have been covered in this series, a better understanding will result.

For those who would like to review their progress a Teach-In Test is also included—the answers will be given next month. Also next month a constructional project that uses the components specified for this series, see page 503 for more details.

Best of luck and success in your new hobby. ▣

TEACH-IN '74 END OF TERM TEST

1. Which relationships are *not* correct in the following?

   Power = I^2R Current = $\frac{V^2}{R^2}$

   Voltage = $\frac{\text{Power}}{\text{Resistance}}$
2. How are voltage and current in an ideal inductor related? What is the equivalent relationship for an ideal capacitor?
3. How can a dry battery be checked to see if it is exhausted?
4. Can a thyristor be turned off by a gate trigger pulse?
5. Are transistors affected by temperature?
6. What is the total power rating for two 1kΩ 1 watt resistors when connected (a) in series (b) in parallel?
7. What is the emitter-base reverse voltage rating for the BC107 transistor?
8. What is meant by resonance?
9. What is the average value of a half-wave rectified supply if the input is 10 volts r.m.s?
10. Four 10kΩ resistors are connected end to end to form a "square". What is the resistance between (a) Opposite corners? (b) The ends of any *one* resistor (i.e. adjacent corners)?
11. Will a moving coil meter indicate a.c. current?
12. What resistor value is needed to make the 100μA meter into a 0-5V voltmeter? Assume the moving coil has a resistance of 1kΩ.
13. Sketch the voltage-current curve for a normal diode.
14. What are the main features of a monostable?
15. Why is a diode sometimes used in series with a transistor base or emitter lead?
16. How can we test two *npn* transistors to see which has the higher current gain?
17. What is meant by the time constant of a resistor-capacitor circuit?

Answers next month.

New products and component buying for constructional projects

SHOP TALK

By Mike Kenward

BACK in our June issue we made mention of a rumour concerning a retail outlet for R.S. Components—it was not unfounded. On July 10, R.S. announced the formation of Doram Electronics Ltd (derived from door to door amateur electronics); the new company are going to sell virtually all the R.S. products, probably at much less than they are at present available (obviously!) and also many other items of interest to the amateur such as more semiconductors, a range of cases, etc.

R.S. have approached the problem in their usual thorough manner and will be selling a catalogue from early September onwards for 25p including postage. The catalogue will, in addition to listing all the components, detail various kits available.

The reputation R.S. Components have for fast efficient service should stand Doram in good stead, and Doram intend to continue this service—goods or money back within seven days. The overseas constructors have not been forgotten and, although a minimum order of £5 and special postage will be applicable, they will be able to order in the normal manner for Doram.

If readers order their catalogue early—the 25p is refundable if you place an order of over £5 within a year—their names will go into a draw for a £10 voucher or one of 49 £5 vouchers that will be selected at random by Brian Rix (a radio amateur) at the Amateur Radio Traders Exhibition at Granby Hall, Leicester, to be held from October 31 to November 2.

Doram will be a mail order only company, and almost exclusively cash with order; their address is P.O. Box TR8, Wellington Road Industrial Estate, Leeds, LS12 2UF. (Tel. Leeds 34222). We wish them well and look forward to a reliable supply service for all our readers.

In-House Communicator

There really should be no supply problems with parts for the *2 Way In-House Communicator*. Some intercom designs cause minor problems because they employ 80 ohm speakers, but this is not the case with this design, and all parts should be readily available.

The cases used in the prototype are available from H. L. Smiths 287/9 Edgware Road, London, W2 1BE, if your normal supplier cannot provide anything suitable. This firm (H. L. Smiths) specialise in cases and chassis and can also supply aluminium in sheet form.

Crystal Set

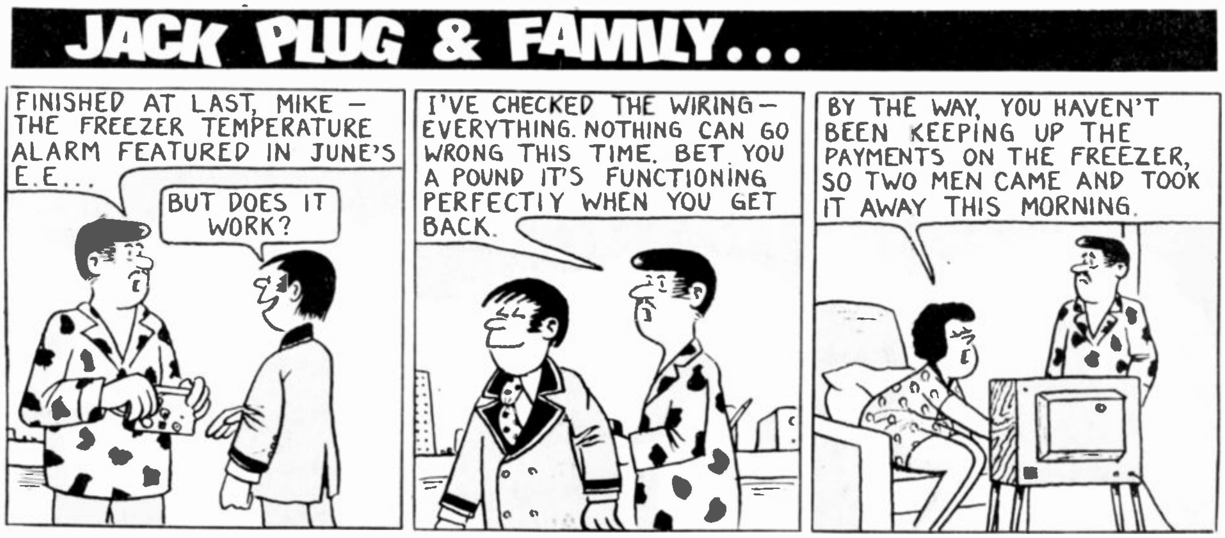
Once again you should have no problems when buying components for the *Simple Crystal Set*. Not only is the design very simple, few parts are used, and all should be readily available.

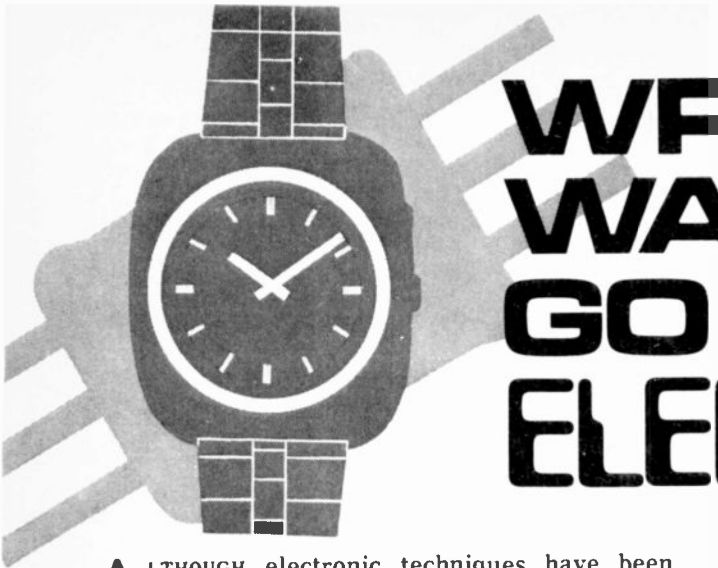
Perspex for the case should be obtained from a hardware shop or one of the small sign-making firms that appear in most larger towns. Alternatively, any type of plastic box of a similar size will do.

Metal Locator

One component for the *Metal Locator* needs a few words, the Denco coil. This is available from a few retailers or direct from Denco—make sure you give all the information when ordering. The coil costs 48p plus 6p post and packing, plus V.A.T. on the total (60p should cover it).

Most other components should be readily available—the case you use should be similar in size to that specified and aluminium, also you should not alter the layout or circuitry in any way. This may upset the performance and may make the locator illegal—see licencing details in the article.





WRIST WATCHES GO ELECTRONIC!

BY J.B. DANCE

Although electronic techniques have been used for the very accurate measurement of time for a number of decades, it is only in the last few years that they have made an appreciable impact in the wrist-watch field. Methods of measuring time using mechanical oscillators were developed by Christiaan Huygens of Holland in the 17th Century, but most watches and clocks being manufactured at the present time still employ this same basic form of oscillator.

CONVENTIONAL WATCHES

Wrist-watches which employ a purely mechanical oscillator (normally a balance wheel and hair spring) as the time keeping mechanism and a main spring as a source of power have a number of disadvantages:

(i) Although conventional watches can be made reasonably accurate, their accuracy falls far short of that obtainable by electronic techniques. A good balance wheel watch will have an accuracy of the order of one minute per week, but most watches fall below this standard.

(ii) One might expect that the frequency of the balance wheel would be independent of the amplitude of oscillation (isochronism). In practice, however, the frequency is somewhat dependent on the amplitude and hence on the state of the mainspring.

(iii) Balance wheel watches are affected by magnetic fields, temperature changes, shock, acceleration, changes of position and even changes of atmospheric pressure.

(iv) Most watches require winding about once per day, but even self-winding watches stop if they are not regularly worn (e.g. during a period of illness).

(v) It is not easy to obtain enough power from a conventional watch spring to operate an alarm which can be heard in conditions of high ambient noise.

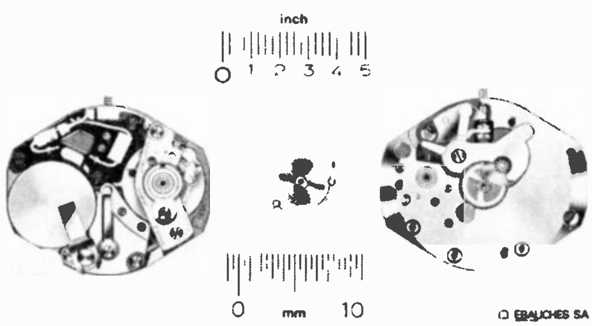
(vi) Conventional watches cannot provide digital readout—although many people would not want this anyway.

ELECTRONIC WATCHES

Although electronic watches have some of the above disadvantages, the major disadvantage at the present time is the price. Tuning fork watches are available from about £40 and have an accuracy of about one minute per month. Although prices have fallen considerably, there are still few quartz controlled watches available for less than £100; they provide an accuracy of the order of one minute per year.

Many watches are expensive because they have a gold case, but some watches with a magnetically driven balance wheel are cheaper than the prices mentioned. The prices quoted in this article are believed to be the recommended retail prices at the time of writing, but they can change considerably in a short period.

A minor disadvantage of electronic watches is the necessity of replacing the power cell once per year, but this is largely outweighed by the fact that no regular cleaning or other maintenance is required. Some types of electronic watches require no oil, but in the others the forces in the gear train are small, so the oil does not need renewing periodically.



A miniature 4Hz balance wheel movement controlled by an integrated circuit.

FIRST ELECTRIC WATCH

The first wrist-watch driven by a battery was released by the LIP Company of France in March 1952; it is still in production today as LIP types R.148 and R.184. This watch employs a balance wheel, but is more accurate than many conventional watches, since the amplitude of swing of the wheel remains almost constant throughout the life of the power cell. In addition, no winding is necessary.

The LIP watch contains no electronic components other than a diode to suppress transient voltages which would damage the contacts. As the balance wheel swings, a jewelled cam on its pivot pushes a fine wire against a contact and this allows a current to flow through an electromagnet. The latter attracts a magnet fitted to the rim of the balance wheel at such a time that the pulse increases the amplitude of swing.

The current flowing in the inductive electromagnet builds up to about 1mA in 3ms, but quickly returns to zero. At other times the balance wheel swings freely, so the mechanical losses are very small. The mean current taken from the 1·55V cell is about 5μA.

TRANSISTOR DRIVEN BALANCE WHEELS

The use of delicate mechanical contacts in electrically driven watches is clearly undesirable, since they may need replacing at intervals. Watches were therefore developed in which the switching is carried out by a transistor. In these watches the energy required by the balance wheel is introduced magnetically.

The balance wheel may have two magnets fixed to it, as shown in Fig. 1; these magnets move across the face of a coil assembly. The latter contains two coils, a feedback coil and a power coil. As the magnets pass the coil faces, a pulse induced in the feedback coil causes a transistor to pass a current through the power coil. The magnetic field of the latter drives the balance wheel.

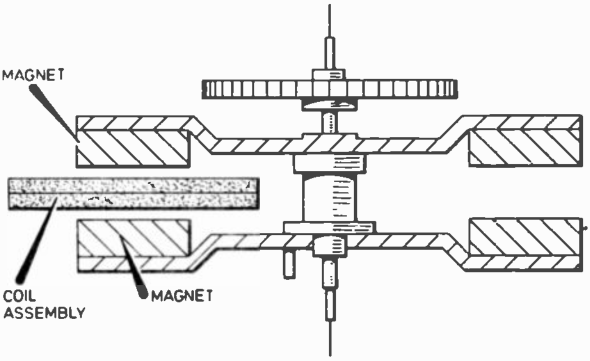


Fig. 1. The balance wheel and coil assembly used in some types of transistor driven watches.

A movement of this type developed by Ebauches S.A. (a group of Swiss watch manufacturers) is known as the Dynotron. The inside of a watch of this type is shown in Fig. 2. Barium ferrite magnets are fitted to the balance wheel which oscillates at about 3Hz. The Q value of this oscillator is around 300—higher than that of a conventional balance wheel, since frictional losses are reduced to about 1·5μW.

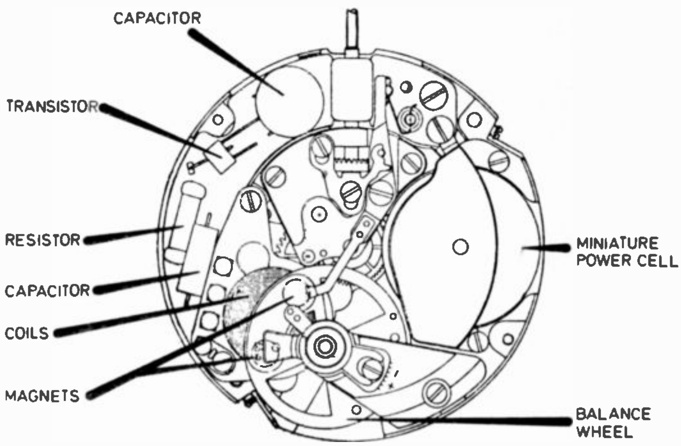


Fig. 2. The interior of the Dynotron movement.

CIRCUIT

The circuit used in the Dynotron movement is shown in Fig. 3. The resistor R1 is included so that some current will pass when the balance wheel is stationary; this ensures that the watch will start automatically when a new power cell is fitted. Alternating voltages induced in the feedback coil by the moving magnets on the balance wheel are applied (via the power cell) to the base-emitter junction where rectification takes place.

The tantalum capacitor C1 therefore becomes charged with a polarity which opposes that of the power cell. It discharges slowly through R1 and a small pulse of current passes when the voltage across the feedback coil is near its maximum value

The voltage induced in the power coils opposes that of the power cell at the time the

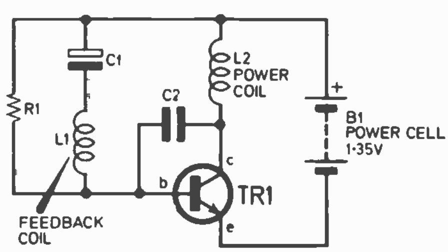


Fig. 3. The circuit of the Dynotron.

transistor conducts. The difference between these voltages determines the current through the power coils. A small decrease in the amplitude of oscillation of the balance wheel will therefore produce a large increase in the current in the power coil. Thus the amplitude of oscillation is stabilised by this process.

The capacitor C2 prevents spurious oscillations from occurring due to coupling between the two coils. The transistor is biased to cut off except during the short pulses (duration about 10ms). This enables the Dynotron to be driven for a year by a Mallory W12 cell of 85mA-hour capacity. This cell is 11·5mm in diameter and 3·4mm in height and stores 1200J/cm^3.

The feedback coil has 1,350 turns of 18μm diameter copper wire (20-21μm with the insulation), whilst the power coil has 3,350 turns of the same wire. A suitable transistor is the Philips BC112 in a plastic encapsulation of dimensions 1·8 x 1·8 x 2mm. It must have low leakage current, low saturation voltage and a h_{FE} of 100 or more at an I_c of about 200μA.

Watches of this type tend to have a constant amplitude of oscillation and this tends to improve their accuracy. An error of a few seconds per day is typical. Similar watches are available from Junghans of Germany, LIP of France, Timex, etc.

Bulova Accutron watches which employ a tuning fork movement.

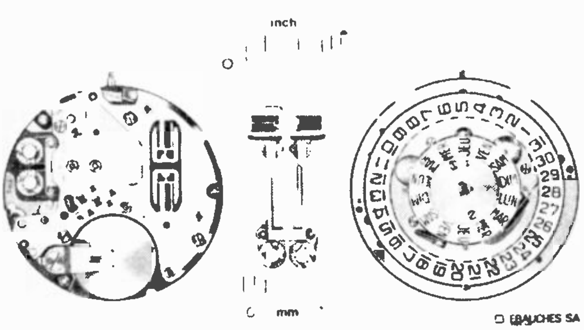
TUNING FORK MOVEMENTS

Wrist watches employing electronically maintained tuning forks have been available since Bulova announced their first Accutron model in October 1960. The name is derived from a combination of the words accuracy and electronics. This was the first watch which departed from the use of the traditional balance wheel and the first watch to be provided with a written guarantee of accuracy (±1 minute per month). It represented one of the most important developments in watch manufacturing techniques.

A typical 360Hz tuning fork used in a Bulova Accutron is shown in Fig. 4. A conical magnet with a cup of a magnetic material is fitted to each tine of the tuning fork. A coil of about 8,000 turns of 15μm diameter copper wire is placed over one magnet and two coaxial coils on the other magnet, the smaller one being used for feedback purposes. A smaller tuning fork mechanism of a different shape is used in Accutron models for ladies; it resonates at 480Hz.

The circuit of a Bulova 214 series Accutron is shown in Fig. 5; it is essentially the same as that of the Dynotron circuit of Fig. 3. The amplitude of vibration is stabilised in a similar way to that in the Dynotron balance wheel movement. Other Accutron models employ a slightly different circuit, but the current consumption has a mean value of 8 to 10μA in all types.

A watch in the Swissonic 100 range which employs the Mosaba balanced tuning fork movement.



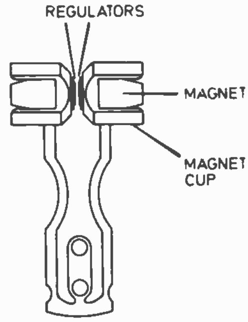


Fig. 4. The tuning fork used in some types of the Bulova Accutron watches. The coils fit over the magnets (but inside the magnetic cups) without touching either the moving magnets or the cups.

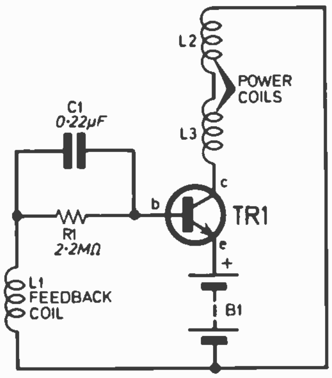


Fig. 5. The circuit of the Bulova Accutron 214 series of watches.

The movement of the tuning fork (exaggerated in Fig. 6) is used to drive a miniature toothed index wheel by means of a ratchet and pawl mechanism. The index wheel has 300 teeth spaced at 0·025mm intervals on the circumference of the 2·4mm diameter wheel.

Both the index lever (which is attached to a tine of the fork) and the pawl have a tiny jewel at the point where they contact the teeth of the wheel. If the index lever moves the wheel rather more than one tooth position per vibration, the pawl will return it during the other half of the cycle so that the net movement is one tooth.

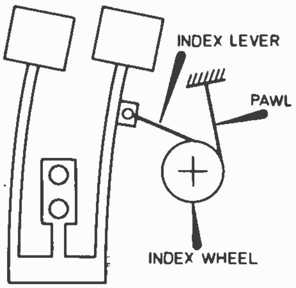


Fig. 6. The mechanism used to convert the motion of the tuning fork into rotary motion.

The frequency of some types of Bulova Accutron watches is dependent on their position. When the tines of the fork point downwards, the watch runs a few seconds per day faster than when they are horizontal. The connoisseur can use this phenomenon to achieve extremely high accuracy by leaving his Accutron in certain positions for a certain number of nights per month. Normal regulation of the watch is effected by moving small regulator plates attached to the inner ends of the tuning fork.

Bulova Accutron watches are available in a large number of models at recommended U.K. prices from about £40 (stainless steel case) to £500 (gold case with matching bracelet). Accutron models for ladies are available from about £50 in stainless steel (£60 with date indication).

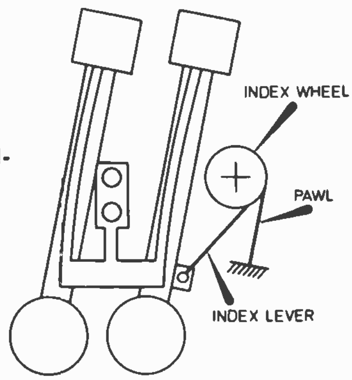
THE MOSABA

Ebauches S.A. has developed a tuning fork watch under a licence agreement made with Bulova in 1968. The movement is known as Mosaba (Mouvement sans Balancier). It operates at 300Hz and employs a balanced movement, the resonant frequency of which is independent of its position. This balanced movement is illustrated in Fig. 7; both ends of the fork move, but the movement is far smaller than that shown.

The Mosaba movement is used in the Longines Ultronic range, in the Tronosonic watches made by Baume and Mercier and in the Omega f300 range. The U.K. prices of the Longines Ultronic models range from about £90 to £220. The Omega f300 series (introduced in August 1970) range from about £80 in stainless steel to £470 in gold with a matching bracelet.

These watches all have an accuracy of the order of one minute per month. The damping is very low, typical Q factors being about 300.

Fig. 7. The balanced Mosaba movement.



MEGASONIC 720

The Omega Company have recently announced that they are producing a new type of watch known as the Megasonic 720. It has an accuracy of ±10 seconds per month in normal wear—considerably better than any other type of watch using a mechanical resonator. The frequency of oscillation is 720Hz, the resonator being driven by an integrated circuit.

This watch is said to be less sensitive to shock than those employing the normal tuning fork movement; this is partly due to the higher frequency of the resonator and partly due to the use of a new micro-motor of 7mm^3 volume. The price has not yet been fixed, but it is expected that it will not be very much higher than that of other types of tuning fork watches.

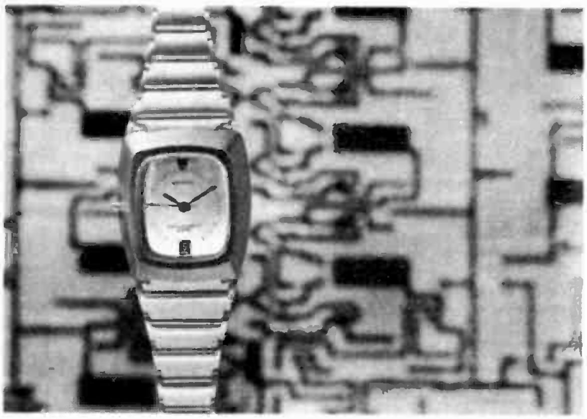
QUARTZ WATCHES

The stability of quartz oscillators is too well known to electronic engineers to require much explanation. Q factors of the order of 10^6 can be obtained. Quartz oscillators were first used with thermionic valves in large clocks, but the availability of transistors enabled them to be used in small clocks and then in a pocket watch. Although the first quartz controlled wrist-watch did not become available until April 1971, many watch manufacturers have now entered the field.

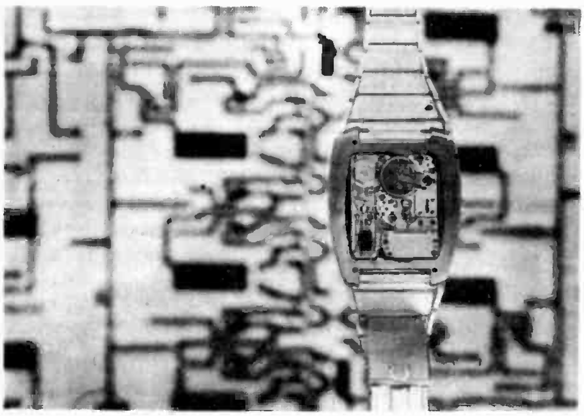
The very rapid development of quartz controlled watches in the last few years is closely related to improvements in CMOS (complementary metal oxide silicon) digital techniques. In this type of logic circuit each element consists of an n channel f.e.t. and a p channel f.e.t. connected internally in a complementary configuration. It is particularly suitable for microminiature circuits, since each pair of CMOS f.e.t.s require a very small area on the silicon chip.

In addition, they can operate from low supply voltages over a wide temperature range at very low currents. Most of the power is dissipated when the transistors switch from one state to the other. The mean current is determined mainly by the frequency of operation and by the output capacitance of the complementary pairs.

A CMOS integrated circuit can be made with about a thousand transistors on a minute silicon chip. Such a circuit can operate the quartz oscillator and divide its frequency by a large factor to produce output pulses which can operate a mechanical system.



Above and below, the Omega Electroquartz showing the Mallory WH3 power cell.



THE BETA 21

The first types of quartz crystal controlled wrist-watches employed the Beta 21 movement which was designed by the Centre Electronique Horloger S.A. of Neuchâtel, Switzerland. This basic movement has been marketed under more than twenty brand names, but some manufacturers who used it initially have now evolved their own designs.

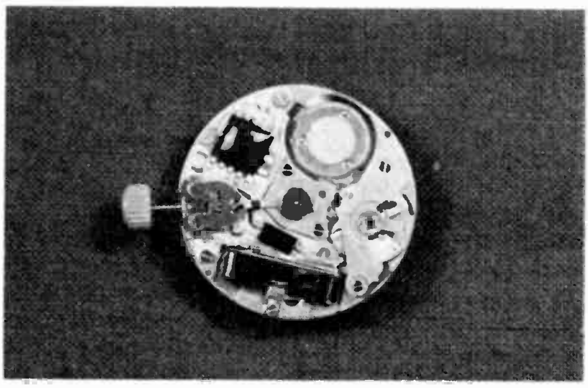
The Beta 21 employs a 8,192Hz quartz oscillator. The frequency is divided by a factor of 32 to produce a 256Hz signal. The latter drives a motor which operates a pawl mechanism to produce a rotary motion. The hands are operated by a conventional gear train. As in almost all quartz watches, the accuracy is of the order of one minute per year. The regulation of quartz watches is carried out by adjusting a small trimmer capacitor in the oscillator circuit.

The Omega Electroquartz (introduced in November 1970) employs the Beta 21 movement. The price ranges from £295 in stainless steel to £825 in gold with a gold bracelet. The Rolex quartz watch has been made in limited numbers in gold only with a gold bracelet.

QUARTZ-BALANCE WHEEL WATCHES

A watch developed by the Golay Company of Switzerland (the μ-Quartz) employs an electronically driven balance wheel similar to the Dynotron, but the frequency is controlled by a quartz oscillator. In this watch the hair spring is deliberately designed so that the frequency of oscillation is dependent on the amplitude.

The 32,768Hz (2^{15}Hz) pulses from the quartz oscillator are divided in frequency by an integrated circuit. The amplitude of the pulses which drive the balance wheel is dependent on whether it is running fast or slow relative to the quartz



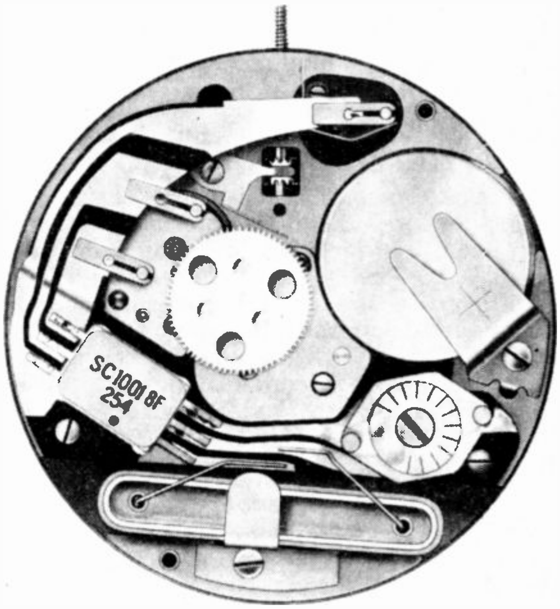
The Golay quartz controlled watch showing quartz crystal enclosure, balance wheel, power cell integrated circuit and trimmer capacitors.

oscillator; this provides the necessary correction to the frequency of the wheel. The current consumption of this 30mm diameter movement does not exceed 13μA from a silver oxide cell. The U.K. agents are Toolex Ltd., Sherborne, Dorset.

A balance wheel is also used in the Timex quartz watch, but at the time of writing this watch is not on sale in the U.K. The frequency of the 49,152Hz quartz oscillator is divided by an integrated circuit to produce 6Hz pulses which control the balance wheel frequency. The balance wheel operates a mechanical contact. The accuracy is quoted as 15 seconds per month.

QUARTZ WATCH WITH STEPPING MOTOR

The Girard-Perregaux Company introduced its GP quartz wrist-watch series 350 in the U.S.A. in January 1972 after over six years of developmental work in the Company's laboratories. It became available in other countries a few months later; in England the prices vary from about £100 for a stainless steel model to over £800 for a model in white gold with a matching bracelet. The accuracy is about one minute per year.



The Girard-Perregaux quartz controlled watch.

The GP quartz watch employs a 32,768Hz quartz controlled oscillator. The quartz rod is about 13mm in length and is enclosed in a vacuum chamber 17·5mm long. The pulses from the oscillator are divided in frequency by a factor of 65,536 (2^{16}) by means of a Motorola CMOS integrated circuit; the latter contains the equivalent of 312 transistors in a 6 x 4mm encapsulation. The resulting 0·5Hz pulses are amplified and shaped.

The output from the integrated circuit consists of a short pulse of one polarity followed one second later by a pulse of the opposite polarity. These pulses drive a miniature stepping motor which causes the centre second hand of the watch to jump forward once per second.

The stepping motor has a volume of less than 0·13cm^3 and its spindle rotates half a revolution in about a fiftieth of a second each time a pulse is fed to it. The minute and hour hands and the date indicator are driven from the second hand wheel by means of a conventional gear train.

The GP watch is powered by a 1·35V mercury cell which is 11·6mm in diameter by 5·2mm in thickness. The power cell has a life in excess of one year, but it is recommended that it be changed annually. The whole movement is 30mm in diameter by 7·2mm in thickness. No oiling or cleaning is required. Very strong magnetic fields may cause the movement to stop momentarily, but will leave no residual effect.

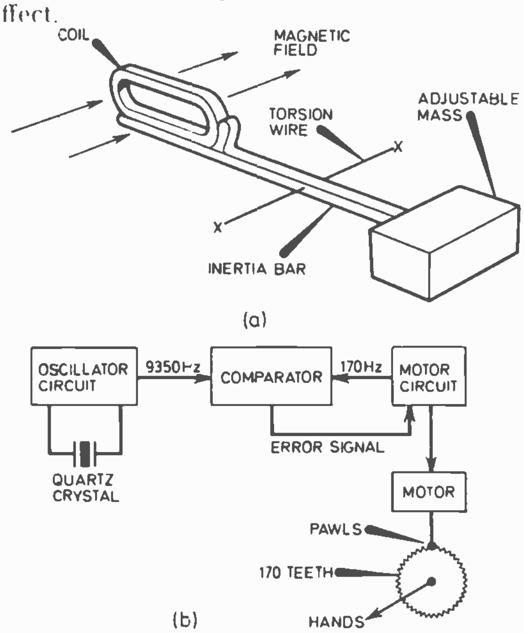


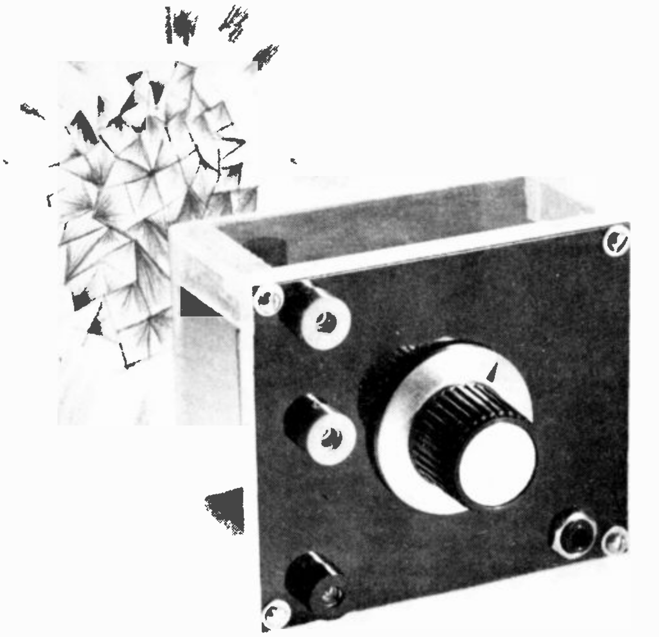
Fig. 8 (a) The vibrator used in the Longines Ultra quartz watch, (b) a block diagram of this system.

ULTRA-QUARTZ

The Longines Ultra-quartz watches are available from about £150 (stainless steel) to £550 (gold with bracelet). They are probably the only quartz controlled watches which do not employ an integrated circuit.

The quartz crystal resonates at 9,350Hz and the signals from it are used to correct the frequency of a mechanical vibrator oscillating at 170Hz (see Fig. 8). The vibratory motion is transformed into a rotary motion by a pawl system. The circuit employs only 14 transistors, 7 capacitors and 19 resistors. The comparison or servo circuit employed in this watch has led to it being called a "cynbernetic" watch.

To be continued



Simple CRYSTAL SET

By F.G.RAYER

A very simple unit, ideal for the personal listener.

This unit will provide personal reception with a pair of headphones, or single earpiece, or will give an output which may be taken to a tape recorder, or to an amplifier for radio reception through the amplifier and its loudspeaker. It thus has quite a wide field of practical utility.

The receiver is very easily made, but is nevertheless capable of excellent results for local reception, when an aerial, and possibly an earth connection, can be provided. It is, in fact, a modern type of crystal receiver, with a semiconductor diode, and with steps taken to avoid the very flat tuning which can otherwise be a nuisance with this type of circuit.

CIRCUIT

In Fig. 1, L1 is the tuning coil, wound on a length of ferrite rod to secure an improved Q or increased efficiency, which results in greater selectivity of tuning and better sensitivity. For maximum possible efficiency, C1 is an air-dielectric capacitor. The diode D1 is tapped down L1 further to reduce damping on this circuit.

Alternative aerial sockets SK1 and SK2 are provided, SK1 is usually better with a fairly short aerial, while SK2 is used for a long aerial. Socket SK3 is for an earth connection. This is not always required, but improves volume.

Resistor R1 is the diode load resistor, with bypass capacitor C2, and coupling to the external circuit is by C3. This allows phones to plugged in, or a screened lead to an amplifier or other equipment. Tuning coverage is for the usual medium wave band.

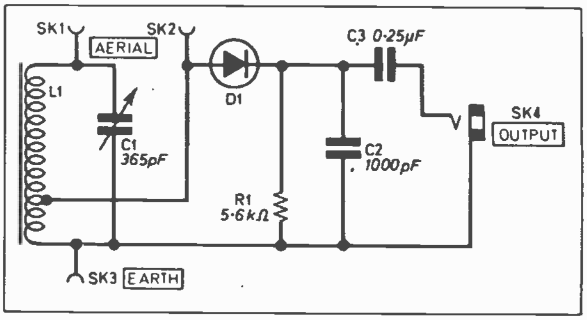


Fig. 1. The complete circuit diagram of the Simple Crystal Set.

INDUCTOR L1

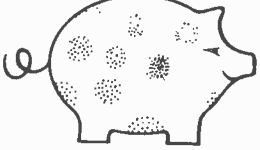
The inductor L1 has 60 turns of 26 s.w.g. enamelled wire, wound side by side on a ferrite rod 10mm (3/8 inch) in diameter and about 50mm long. The tapping for socket SK2 is a small loop, 15 turns from the earthed end. The ferrite rod need not be of exactly this size. The rod is a tight fit in a hole in a piece of wood or paxolin about 30mm x 20mm and is also cemented in place. A small bracket then supports it as shown in Fig. 2. Touches of cement will also secure the wire ends.

CONSTRUCTION

The front panel is 1·5mm thick perspex, 75 x 90mm, Fig. 2. Drill a central hole for C1 spindle. These capacitors are often fixed by three 4BA bolts. One way to find correct drilling positions for these is to press a piece of paper on to the

FOR GUIDANCE ONLY

ESTIMATED COST* OF COMPONENTS including V.A.T.

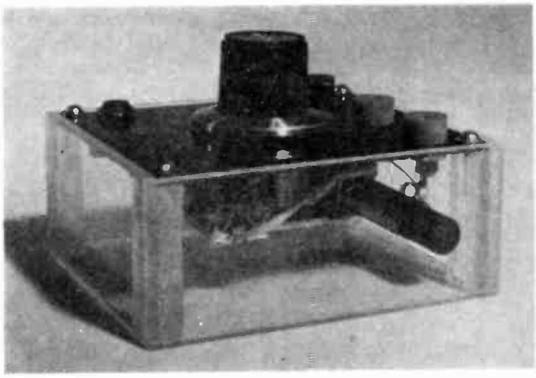


£1.50 excluding case

*Based on prices prevailing at time of going to press

Simple CRYSTAL SET

By F.G. RAYER



Photograph of completed unit indicating method of construction of the perspex case.

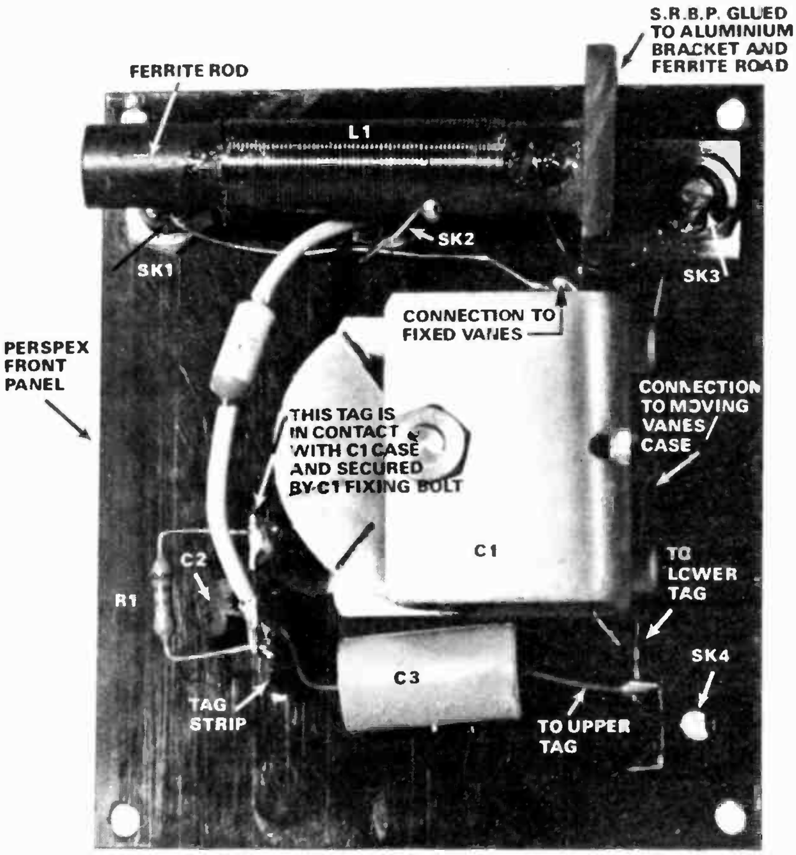


Fig. 2. The complete layout and wiring details of all the components which are mounted on the rear of the front panel.

Components....

Resistor
R1 5·6kΩ ¼W ±10% carbon

Capacitors
C1 365pF Jackson 00 single gang variable
C2 1000pF
C3 0·25μF

SEE SHOP TALK

Diode
OA81 or similar

Miscellaneous
LI 60 turns of 25 s.w.g. enamelled copper wire on 10mm (⅜inch) by 50mm ferrite rod
SKI-3 single banana or wander sockets 2 red 1 black and plugs to suit
SK4 3·5mm jack socket and plug to suit
Tag strip (2 way with mounting tag), control knob for C1, materials for case, 6BA fixings, connecting wire

front face of the capacitor, letting the spindle pass through a hole. Then place the paper on the panel, and mark for drilling with a sharply pointed tool.

An insulated tag strip, to support R1, C2, C3 and the diode is fixed between capacitor and panel by one of the bolts, and washers ˛˜ equal thickness are put on the other bolts, between capacitor and panel. It is essential that the bolts are short, or that sufficient washers or other spacers are put on them so that they only run into the tapped holes in C1 to the depth of the front metal plate. If not, C1 will be short circuited and or damaged.

Connections are all shown in Fig. 2. The moving plates or frame tag of C1, go to earth at socket SK3. Resistor R1 and C1 are earthed by the tag strip, fixed as described. The *lower* tag of the output socket (SK4) also goes to earth, so that when a screened lead is plugged in, the outer conductor is earthed.

HEADPHONE ONLY

If a personal headphone receiver only is required and the output will not be fed to other equipment, then R1 and C3 may be omitted. The output socket rear contact is then wired directly to D1(+).

RECEIVER CASE

The case for the prototype was made from 3mm thick Perspex. The case is a simple construction with four pillars in the corners for strength. These pillars are cut from 6mm thick material, and are 10mm x 30mm. Each is tapped at one end for a 6BA screw. (A satisfactory alternative is to drill holes which will accept self-tapping screws.) One piece is cemented in each corner. This strengthens the box, and the tops of the strips are inset 1·5mm so that the 1·5mm thick panel is flush. It is secured with four 6BA bolts.

It is also possible to build the receiver in one of the small plastic boxes which can be purchased in various sizes, using the lid as the front panel.

USING THE RECEIVER

For direct listening, any headset of about 500 ohms to 4,000 ohms will be satisfactory, or a medium or high impedance single earpiece. Low impedance phones are not suitable.

It will be remembered that an aerial is necessary with this receiver. This may be an indoor or outdoor wire. A long, high aerial outside will give maximum volume, but is by no means essential, except in some areas where reception is poor.

Taking the aerial lead to socket SK2 allows greater selectivity or sharpness of tuning, but socket SK1 gives better volume, so is more appropriate for a poor or short aerial.

In some cases it will be found that volume is sufficient with no earth, but until this has been found it should be assumed that an earth connection will have to be provided. This lead should run to an earth spike or other metal object in the ground.

Indoor aerials can be made with single plastic covered bell wire, inconspicuously fitted along one or two walls of the room near the ceiling. Outdoor aerials can be of 7/26 or other aerial wire, available in coils of 20m and longer; this is also suitable for the earth connection. ▣

PLEASE TAKE NOTE

Bright Ideas—July issue
Will the following contributors to this feature kindly contact the editor. J. Beever, M. Renshaw and P. Stokes.

Telephone Call Charge Calculator (July 74)
It has been brought to our attention that there is an error in the circuit diagram, Fig. 4. The link from pin 5 on S2 should go to R4 and not R5 as shown. The wiring diagram, Fig. 7, is correct.

Automatic Light Level Controller (July 74)
Capacitor C3 should be 0·1μF as shown on the circuit diagram not 0·01μF as in the components list.

WINGING ITS WAY TO YOU

NEXT MONTH!

THE EE DELTA Electric Guitar

The EE Delta is a solid electric guitar, simple to build and costing a fraction of price of a commercial guitar. Full constructional details are given together with free full size blueprint detailing the guitar and fitments.

HOME SECURITY SYSTEM

Even if you do not possess any items of particular value a home burglar alarm can be very useful in preventing ransacking and theft of sentimental items from your home.
It it opens lock it, and switch on the Home Security System. If you are at home or away it will provide added protection.

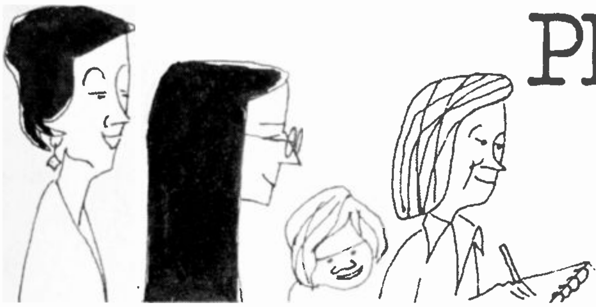
Reaction Timer

A construction exercise for those readers that have completed the Teach In 74 course. Although many other readers will no doubt build this relatively simple instrument.

All in next month's issue of

everyday electronics

OCTOBER ISSUE
ON SALE
LATE SEPTEMBER



Physics is FUN!

By Derrick DAINES

MAGNETIC INDUCTION

Obtain a piece of wood about 25mm thick and drive a steel nail through it, so that the nail protrudes on either side of the wood, Fig. 1. Stand it up and bring one pole of the magnet close to it but *not actually touching*. The other end of the nail will be found to be magnetic and pins will cling to it. Removing the magnet will cause the bulk of the pins to drop off, but not all. This odd behaviour goes under the resounding title of **magnetic induction.**

Magnetism can be induced in a piece of iron.

Notice that not all of the pins or filings drop off the iron nail immediately; some remain for quite a while. Obviously, the nail is still slightly magnetic and while we're dealing with classy names, you may as well know that we call this **residual magnetism** or, more often, **remanence.**

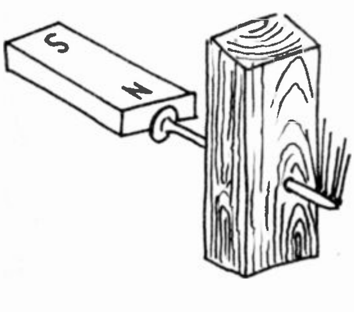


Fig. 1. Bringing a magnet near to a nail causes the pins to be attracted to the nail.

The experiment will of course work when the magnet actually touches the nail, but we particularly wanted you to experience for yourself the fact that magnetism can be induced at a distance.

Now remanence and induction have far-reaching effects in electronic circuitry. Tape recorders and computers cannot function without them, for example, whilst in other cases they are a darned nuisance. So what can we do about them in cases where they are not wanted? Last month's experiment with the tin provides the clue.

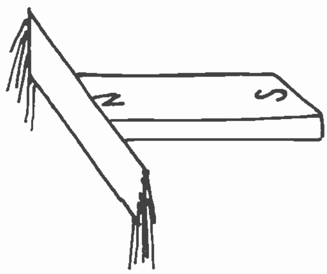


Fig. 2. Only the extremes of the tinplate attract the pins.

Cut a strip of tinplate about 25mm wide and place it across one pole of your magnet. The two ends of the tin will now pick up pins, whilst the pole will not, Fig. 2. We have, as it were, transferred the effective pole to the ends of the tin. Now the question arises, what would happen if we bend the tin round into a ring? Clearly, something odd will happen in the middle.

Try it. Cut two identical strips of tin and bend them into rings. Lay two magnets on the table, with one of the rings between them. Place a sheet of paper across the top and the second ring exactly over the first. Sprinkle iron-filings over all, as in the first experiment. Tap gently.

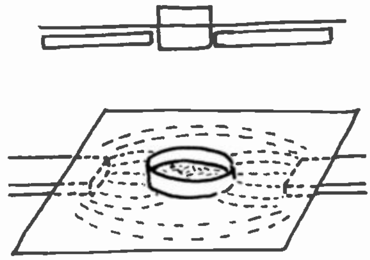


Fig. 3. The area within the ring is unaffected by the magnets indicated by random orientation of filings.

As we would expect, outside the circle the filings take up their North/South orientation, but inside they remain randomly scattered. (Note: if you have a very strong magnet, the filings inside will also be orientated; remember that the field is three-dimensional. The magnetic flux is sweeping through space over the top of the rings!)

That magnetism is induced in the ring will be obvious from the way that the lines of force bend in the vicinity (Fig. 3) but the magnetism is induced to go round and round. Remember that the centre of a magnet does not attract filings!

A ring of iron or aluminium forms a shield against magnetism.

In electronics it is modern practice to put a shield round all components (such as coils) that are likely to produce magnetic fields.

DEMO CIRCUITS

14

By MIKE HUGHES

The Parallel Resonant Filter

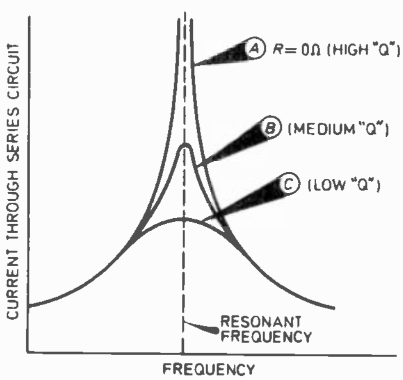
THE author has been in dread of covering this aspect of electronics in simple terms. Unlike most areas it is not possible to draw straightforward analogies or use obvious reasoning when describing what happens in accurate detail. The only recourse is to plod through some fairly difficult mathematics which, we assume, you would rather by-pass. Having said that let's hope we haven't frightened you off because the practical side of this circuit is simplicity itself and provided you will accept (take, for granted) one or two simple statements then there will be no problems.

The parallel tuned LC circuit is one of the most important in radio work because it is this that enables a receiver to sort out one station from another when you adjust the tuning dial; it is also used in a superhet's "local oscillator" in the "i.f. amplification" stages and often crops up in audio applications as well. We have, unwittingly, come across it already in this series when we were talking about the Hartley oscillator. Without saying more it is essential that you are able to recognise it for what it is and understand something of how it works.

RESONANCE

We must first recap a little on the last part. We saw that at a certain frequency, when the reactances of an inductor and a capacitor (wired in series) are the same, theoretically the net reactance of the two together is zero. This is due to the fact that the direction of current flow in the inductor, at an instance in time, is theoretically exactly opposite to that in the capacitor. The current flowing through an LCR series circuit at resonance is limited only by the circuit resistance. This means that if we deliberately left out the resistor we would (in an ideal world) get zero impedance across the LC combination at the resonant frequency and, assuming zero source and load resistance, infinite current could flow. This is shown diagramatically in Fig. 14.1 as the current curve, *A*, that shoots off towards infinity as we approach resonance.

Fig. 14.1. Increasing the value of R in the circuit reduces the resonant current and gives a broader frequency response.



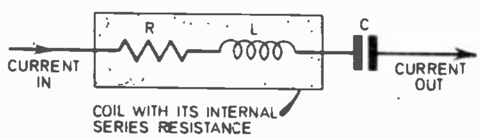
In practice we can never get zero d.c. resistance in any circuit, because even copper wire has some resistivity. So we can say that any coil of wire must have some internal resistance. In the case of a coil of a few hundred turns of 36 s.w.g. wire this will be small but there all the same. We can consider this "internal coil resistance" as being in series with the coil's inductance, hence, for the purposes of our argument we show a practical inductor as being in series with its own internal resistance (Fig. 14.2).

Remember, though, that this resistor is not an extra circuit component, it is shown purely to represent d.c. resistance of the coil; the reactance of the coil still comes from its inductance.

QUALITY

Imagine we had wound our coil out of wire having fairly high resistance; when we hit resonant frequency we obviously cannot get

Fig. 14.2. At resonance the current is limited only by R. In practise the inductor always has some d.c. resistance thus infinite current cannot be achieved.



infinite current; in fact the resonant current might be very low as shown in the lower curve of Fig 14.1. The curve is "flatter" or "not so sharp". Having very low (preferably zero) circuit resistance gives us very sharp tuning but as soon as we introduce even a fraction of an ohm of pure resistance the tuning qualities of the circuit are degraded.

This *Quality* of a tuned circuit is very important because it controls the criticality of our tuning and we give it a term. Its name is simply Q. Q is defined as the reactance of the inductor divided by the circuit resistance

$$Q = \frac{X_L}{R} = \frac{2\pi f L}{R}$$

It has no units and is simply a number; for example we might say a circuit has a Q of 100 and this immediately gives us an indication of its tuning qualities. You can see from the equations that if *R* is zero, Q becomes infinite. Alternatively you could say the higher the inductance and the lower the resistance then the higher will be the Q value. Usually the resistance of a coil will increase as you increase its inductance (proportional to the number of turns) so it is not usually possible to increase Q solely by increasing inductance—unless you use lower resistance wire!

Usually one aims to have as high a Q as possible for a tuned circuit (although there are some exceptions) so it is always preferable to use low resistance wire which is as thick as possible to wind high Q coils.

R.F. CURRENTS

At radio frequencies current tends to flow down a wire near its outer surface (the skin effect) hence very high quality v.h.f. coils might be either silver or gold plated to reduce their skin resistance. Alternatively a wire might be made up of many finer insulated wires (like mini flex) twisted together giving maximum skin area. This is called Litz wire. Normally we are not concerned with such sophisticated problems but as you progress you might come across specifications requiring Litz wire.

PARALLEL CIRCUIT

If we try to pass alternating current through a parallel arrangement of a capacitor and an inductor (Fig. 14.3) it should be fairly obvious that at low frequencies the inductor has low reactance while the capacitor has high reactance; hence the current passes preferentially through the inductor—the circuit shows fairly low overall impedance. As we increase the frequency the inductive reactance increases and the capacitive reactance decreases. The net effect of this is that the current that can flow through the circuit falls (the impedance is increasing). This continues until we hit the critical frequency when the two reactances are the same; at this point the current that flows becomes a minimum (it appears we get a maximum impedance)—we will say more about this in a moment.

As we increase the frequency still further the current finds a low reactance path through the capacitor and the impedance falls off again. The frequency at which we get minimum current (i.e. maximum impedance) is when the two reactances are the same

$$X_L = X_C$$

$$\text{or } 2\pi f L = \frac{1}{2\pi f C}$$

i.e. when the frequency equals $\dfrac{1}{2\pi\sqrt{LC}}$

Notice that this formula, which describes the **resonant frequency** of our parallel circuit, is the same as that for the series circuit described last time! The only difference is that with this circuit we get maximum impedance at resonance whereas with the series circuit we got minimum impedance. These two facts are the most important to remember!

INFINITE IMPEDANCE

Staying with the parallel circuit; if there was no internal series resistance to the coil the impedance would, theoretically, become infinite (this is the hard bit to justify without mathematics); this is because the current through the

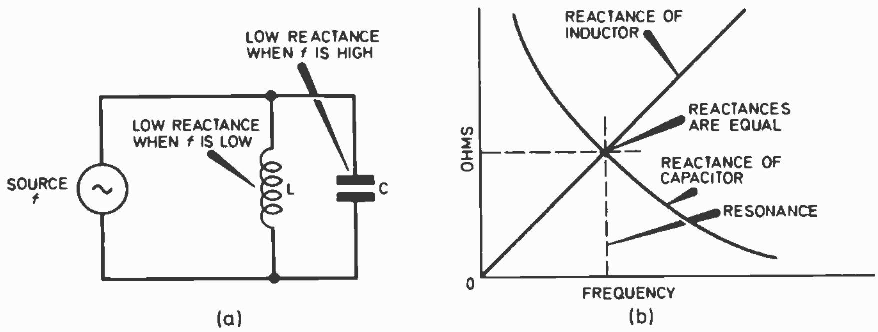
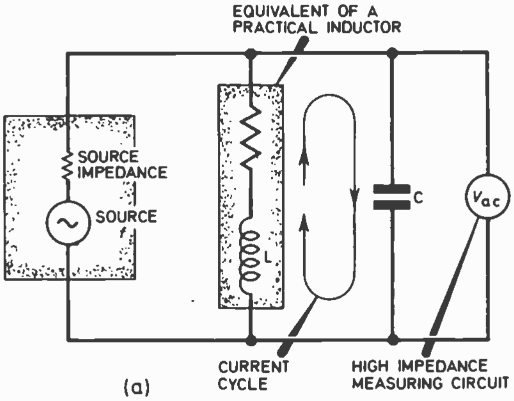


Fig. 14.3. The graph shows how the reactances of an inductor and capacitor vary with frequency—if they were both measured independently.



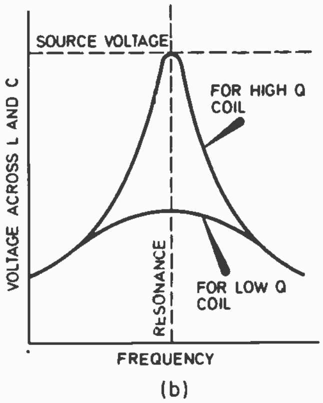


Fig. 14.4. At resonance current cycles around the LC circuit without any extra being drawn from the source (ideally). However power is lost in the internal resistance of the cell.

coil and capacitor are equal and running in opposite directions. The net current flow is simply cycling round and round the inductor and capacitor without leaving the circuit or entering it. Once this state of affairs has started, theoretically it would go on for ever without any extra help from outside. We say the circuit is **ringing** and this is very similar to the decaying oscillations you hear from a bell after it has been struck.

In practise the current cannot, of course, go on for ever otherwise we would have hit on perpetual motion! Because there is bound to be some internal resistance within the coil a certain amount of electrical energy gets dissipated as heat and the current would die away—this would usually occur within a few cycles of the current going round the LC loop. The current is then replaced by more which is drawn from the external source. As no external current would be needed to keep a theoretically perfect LC circuit resonating and more important that it would draw no current its impedance must be infinite!

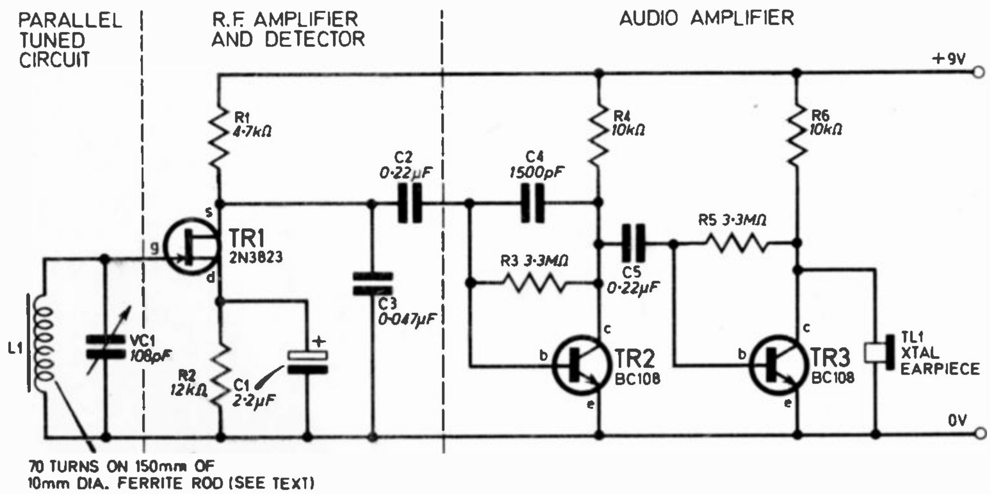
In practise any internal resistance prevents this impedance reaching infinity hence the sharpness of tuning is, again, defined by the Q of the coil and we can calculate the maximum resonant impedance of a parallel tuned circuit as being

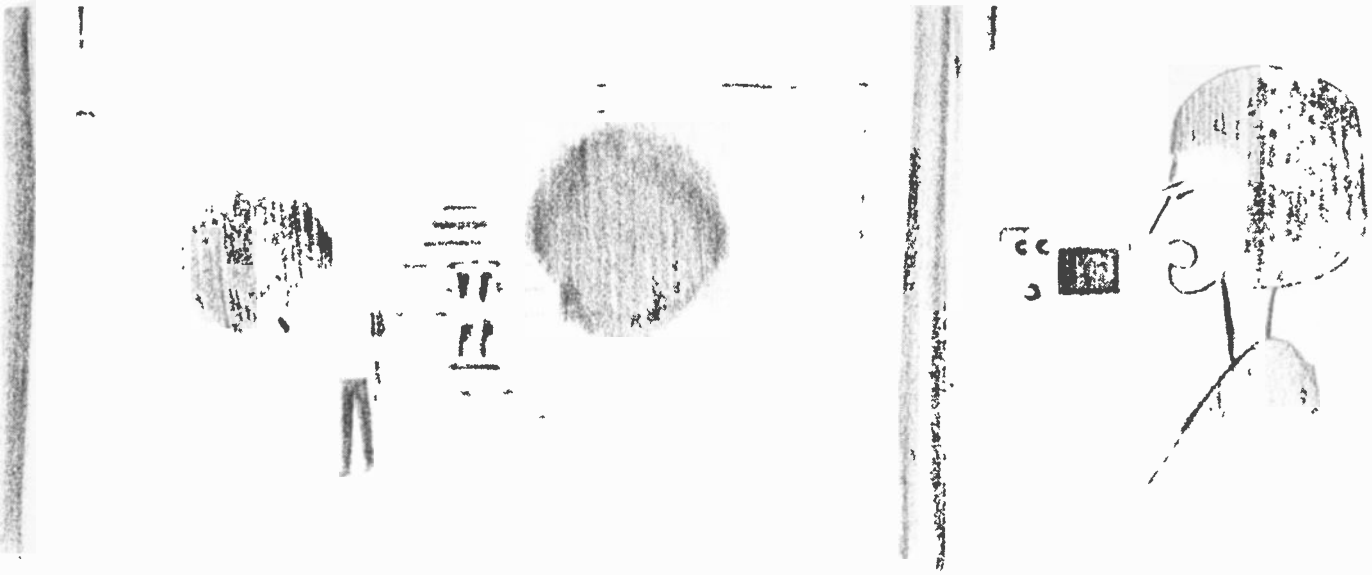
Z (for resonance) $= Q \times X_L$ (measured in ohms)

If we were to monitor the voltage developed across an LC parallel circuit at different frequencies (Fig. 14.4) we would get maximum *voltage* output at resonance (when L and C give maximum impedance) and the magnitude of this voltage would be greatest for the highest Q coil we used. Unfortunately as soon as we try to measure this voltage we invariably lower the Q of the circuit by introducing resistances from our measuring equipment and hence affect the sharpness of tuning. To keep this effect to a minimum the measuring circuit (which is in shunt across the LC arrangement) should be of as high a resistance as possible (preferably several megohms).

Continued on page 520

Fig. 14.5. Simple radio receiver using a parallel tuned circuit. A compression trimmer is suitable for VC1.





2 WAY IN-HOUSE COMMUNICATOR

By C.F.TERRELL

A simple communication system for use in the home

THE ability to communicate with persons in other parts of the house without straining one's voice or having to leave the room is extremely useful. More so for the housewife who may be busy in the kitchen, for example, where it may not be convenient or safe for her to leave the kitchen but she needs to contact her husband working in the garage or greenhouse or other such places.

The In-House Communicator described here allows a two-way conversation to be held from any two locations. Each location has a call facility.

CIRCUIT DESCRIPTION

The complete diagram of the In-House Communicator is shown in Fig. 1.

It was decided to use 8 ohm loudspeakers in the unit since these are more readily available and generally cheaper than the higher impedance types normally used. The loudspeakers are used both as 'speakers and microphones. The output from such a "microphone" is in the order of one millivolt.

Using low impedance speakers as microphones calls for an amplifier with low input impedance and high gain. This is accomplished by the use of TR1 connected in the common base mode. The output impedance of a common base amplifier is quite high.

With the switches in the positions shown, the output from LS1 is fed to the emitter of TR1 whose base is held at "signal ground" by capacitor C2. The base of TR1 is d.c. biased by the potential divide action of resistors R2 and R3.

Output from TR1 is directly coupled to the base of TR2 arranged as an emitter follower (high input impedance—low output impedance). The gain of this stage is unity and serves to match the high output impedance of TR1 stage to that required by TR3.

Transistor TR3 is connected in the common emitter mode and acts as the driver for the output transistors TR4,5 connected as a class B push-pull amplifier. The output is from the emitter junctions and is capacitively coupled to the 'speaker LS2 by C5.

The biasing and split collector load of TR3 has been arranged so that both output transistors are on the verge of conduction. Therefore all signals greater than −4·5 volts are amplified by transistor TR5 and all signals less than −4·5 volts are amplified by TR4.

With the switches in the positions as shown in Fig. 1 the master unit, containing all the

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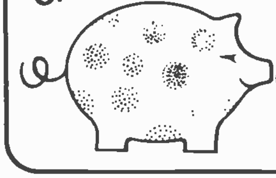

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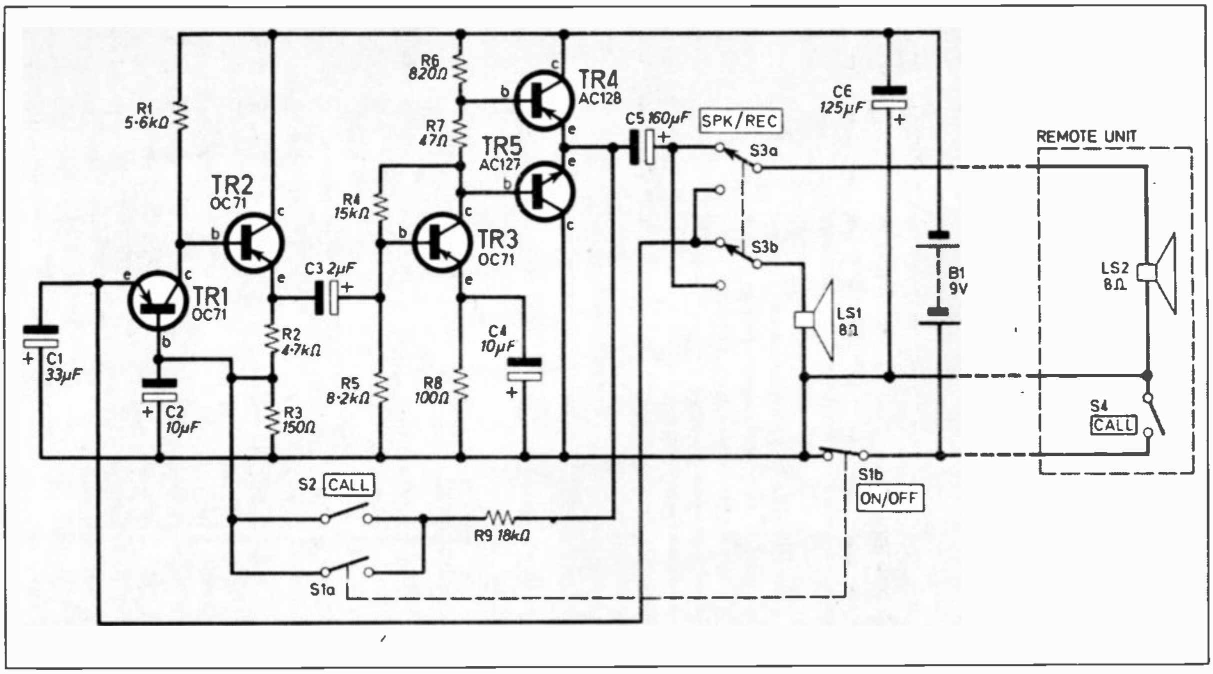


Fig. 1. The complete circuit diagram of the 2-way In-House Communicator. The remote unit is shown in dotted box.

circuitry, is able to speak to the remote unit. When S3 is reversed, LS1 and LS2 are transposed and the remote unit is able to talk to the master.

Operating either of the call switches S2 or S4 results in an audible tone being heard in the appropriate unit. This is achieved by introducing positive feedback around the output stage, from the output via R9 to the driver input causing oscillations to build up.

CONSTRUCTION

The prototype units were constructed on a piece of 0·15in. matrix Veroboard size 12 strips by 25 holes and housed in two commercially available plastic cases size 155 x 105 x 60mm and 115 x 70 x 35mm.

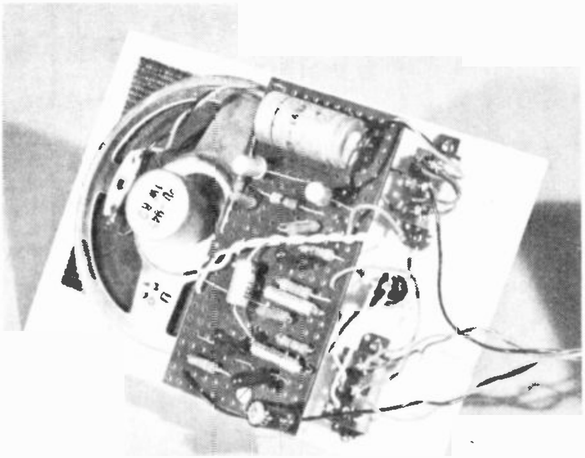
The layout of the components on the topside of the board and the breaks along the copper strips on the underside are shown in Fig. 2.

Begin assembly by drilling the two fixing holes and making the breaks along the copper strips as indicated. Next mount and solder in position the resistors, capacitors and wire links. The transistors should now be soldered in position. It is important that a heatshunt be used when soldering the transistors as these are easily damaged by the heat from the soldering iron.

Cut-outs for the speakers and switches should now be made on the front panels of the cases, as indicated in Fig. 2. In the prototype all the panel mounted components were glued to the panels to give a neat appearance and avoid the showing of fixing screws.

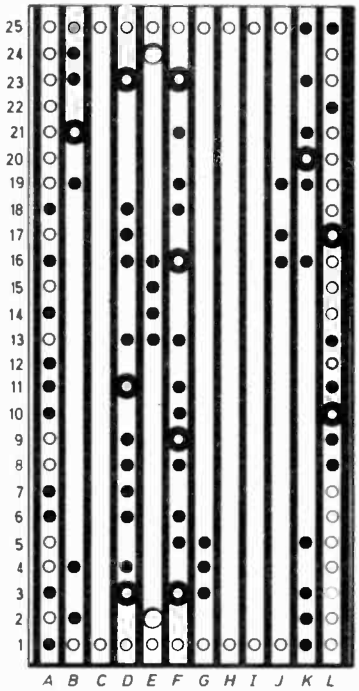
With the speaker cut-outs made, pieces of speaker fret should be glued in position and then the speaker glued over and around this. With the other components mounted in position on the front panel they should be wired up and to the component board as detailed in Fig. 2.

In the prototype, 25mm long tapped spacers (2 off) were secured to the board by means of two 4BA bolts and the other ends glued to the rear of the front panel with Araldite, once again eliminating screw fixings showing on the front panel.



Photograph of completed prototype master unit showing assembly details.

2 WAY IN-HOUSE COMMUNICATOR



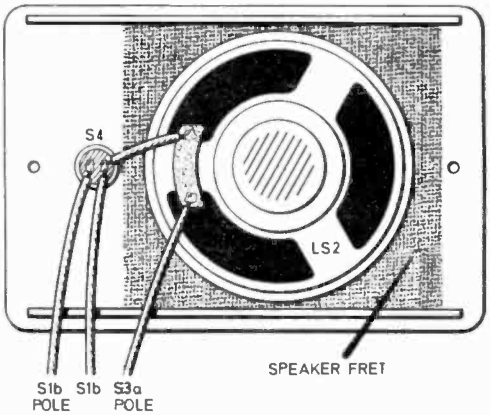
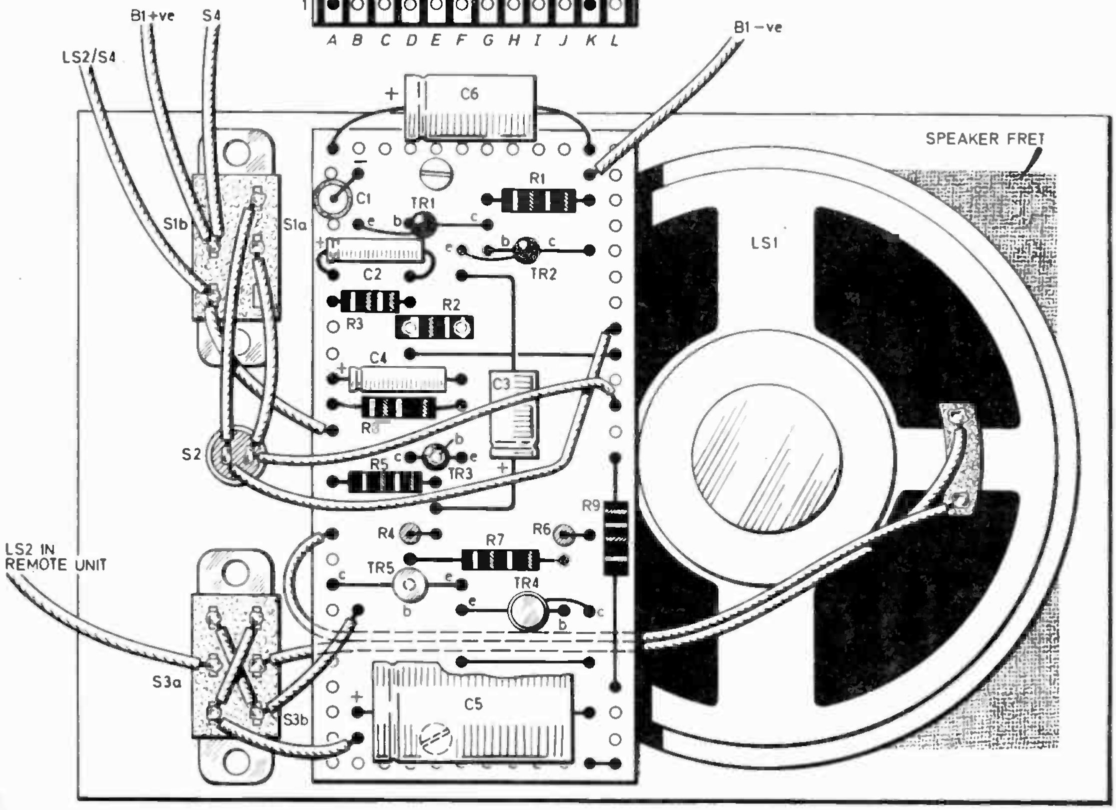


Fig. 2. Complete assembly and wiring details of the remote unit (above) and the master unit (below). Also shown is the layout of the components on the topside of the Veroboard, and the breaks on the underside.



Components....

Resistors
- R1 5·6kΩ
- R2 4·7kΩ
- R3 150Ω
- R4 15kΩ
- R5 8·2kΩ
- R6 820Ω
- R7 47Ω
- R8 100Ω
- R9 18kΩ
- All ¼ watt carbon ± 10%

SEE SHOP TALK

Capacitors
- C1 33μF elect. 9V
- C2 10μF elect. 9V
- C3 2μF elect. 9V
- C4 10μF elect. 9V
- C5 160μF elect. 9V
- C6 125μF elect. 9V

Transistors
- TR1,2,3 OC71 germanium *pnp* (3 off)
- TR4 AC128 germanium *pnp*
- TR5 AC127 germanium *npn*

Miscellaneous
- S1 double-pole double-throw slide
- S2 push-to-make
- S3 double-pole double-throw slide
- S4 push-to-make
- LS1, 2 miniature 8 ohm impedance loudspeaker (2 off)
- B1 PP6 9 volt battery
- Veroboard 0·15in. matrix, 12 strips by 25 holes; stand-off tapped pillars 25mm (2 off); speaker fret; battery clips; cases (2 off); length of three-core cable.

The required length of three-cored cable (mains cable is suitable) should now be soldered to the master unit switches (Fig. 2) and fed out through a small hole at the side of the master case.

In the prototype, the battery was held in position with double-sided Sellotape; alternatively a small bracket can be made to suit. With the battery secured in place, a layer of foam rubber secured around it and over the base of the case, the front panel should be fixed in place.

The external cable should now be passed through a hole in the side of the remote unit and wired up as indicated in Fig. 2.

All that remains is to label the front panels as shown in the photograph. In the prototype, Letraset, sprayed with a clear varnish was found to give a neat and durable finish.

INSTALLATION

The rooms in which the units are to be installed and the positions within the rooms will be an individual choice, but a couple of points should be noted.

It is best to have the units wall mounted in an easily accessible place in the room. If they are fixed or laid on, for example, a worktop in the kitchen, they can readily be damaged due to falling objects in the kitchen or knocked off the worktop.

The height of the units above the ground should be carefully considered. ideally at mouth level of the user. If mounted in the kitchen the master should not be positioned in a hot spot. near the cooker or central heating boiler for example, or near a fire in any other room, otherwise the performance may be impaired. The cable joining the two units must be safely positioned so as not to be a hazard; if one of the units is positioned outside the house. weatherproof cable is advised.

IN USE

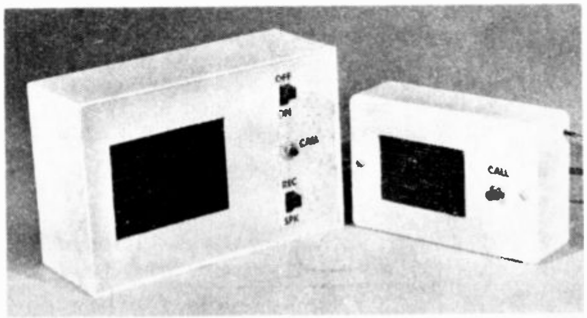
The In-House Communicator can find other uses than that for which it was designed. such as a baby alarm or doorbell for invalids and aged people, especially useful for the latter in determining the identity of the caller. In this case the remote unit would be positioned outside the front door and S4 marked "push".

With no conversation taking place, S3 should be at the receive position (REC) and S1 in the OFF position. With this set of conditions the remote unit can call the master by depressing S4 whereupon the master user will set S3 to speak (SPK) and S1 to ON, and can then speak to the remote user. For the master to then receive messages from the remote unit, S3 must be switched to REC.

For the master to call the remote unit, S2 must be depressed when S1 is at ON and S3 at SPK. When the conversation is over, S1 must be set to OFF, and S3 to REC. With a little practice the correct operation will soon be found easy.

One final point when using the unit, always give an indication that you have finished speaking for the moment by giving a code word such as "over" or "Roger", and the last person to speak should sign off with something like "over and out". ▣

Photograph of the completed units ready for installation.



SEMICONDUCTOR PRIMER

By A.P. STEPHENSON

20 ■ SIMPLE DESIGNING

Design of a simple class A common emitter stage amplifier using potential divide biasing is detailed below and in Fig. 20.1.

Requirements

The output is to have a voltage swing of 8 volts peak-to-peak and the emitter resistor is to waste 20 per cent of the rail voltage.

The transistor has a gain (h_{FE}) of 100 and is to operate with a 1mA collector current.

Design Procedure

Base current is given by:

$$\frac{\text{collector current}}{h_{FE}} = \frac{1\text{mA}}{100} = 10\mu\text{A}$$

Step 1 First, all VOLTAGE DROPS should be calculated as shown in Fig. 20.1. Remember that about 0·6 volts must be allowed for across the base/emitter junction of TR1 (shown *npn*).

Step 2 Now calculate the currents in base bias chain *R1*, *R2*. This current is not critical but should normally be much larger (say ten times larger) than the base current. Since base current is 10 microamps, the bias chain may be set at 100 microamps (0·1mA).

Step 3 Apply Ohm's law to produce resistor values. It is at this stage that intelligent approximations can be made to "round off" in accordance with preferred values.

This yields $R1 = 68$ kilohm, $R2 = 2{\cdot}7$ kilohm, $R_L = 3{\cdot}9$ kilohm $R_E = 2$ kilohm.

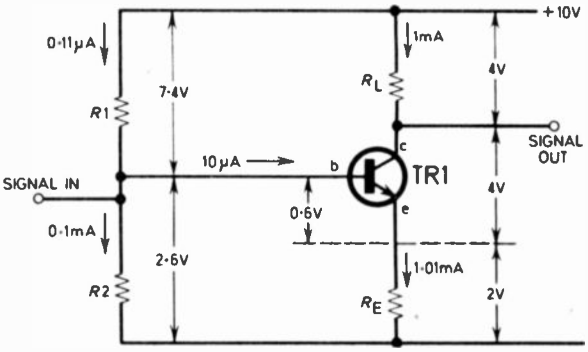


Fig. 20.1. Calculated current flow and voltage drops in the design of a simple single-stage amplifier.

21 ■ D.C. COMPONENT AT THE OUTPUT

The "output signal" of an amplifier is really a steady d.c. level with superimposed variation.

Consider the circuit diagram of Fig. 21.1, a simple amplifying stage in which the resistor bias values are such that the voltages shown are those with NO input signal—called the quiescent conditions.

Without any signal, the output is delivering a steady d.c. voltage of 8 volts which is not a signal, Fig. 21.2a.

If a small a.c. voltage signal of say 0·1 volts peak is applied to the input, the output terminal will swing up and down by one volt, since the voltage gain is 10. The actual output will thus vary between (8+1)V and (8−1)V as the signal deflects it, i.e. between 9 and 7 volts see Fig. 21.2b.

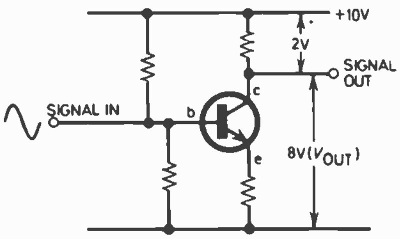


Fig. 21.1. Quiescent voltage conditions at the output of a simple amplifier having a gain of 10.

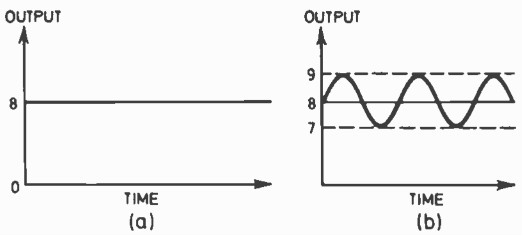


Fig. 21.2. Output voltage at the collector of TR1 with (a) no input signal (b) 100mV peak a.c. signal.

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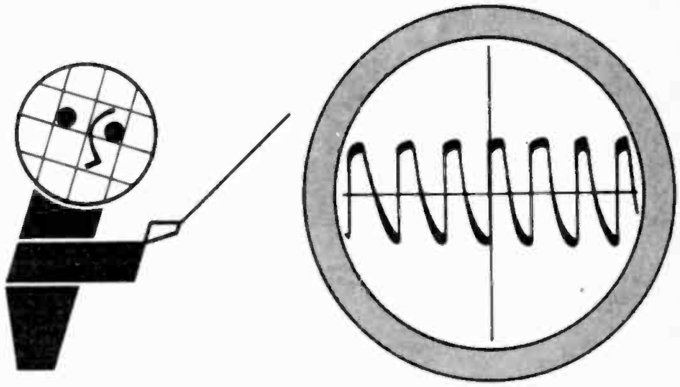

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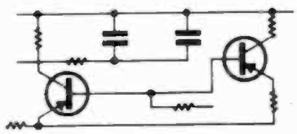

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KNOW YOUR COMPONENTS...

Hints & Tips for the Novice Constuctor

By Ron Adams

The Diode

Extra care must be taken in fitting the diode because, like an electrolytic capacitor, it is polarised and could be damaged by reverse connections. The body markings must be carefully noted.

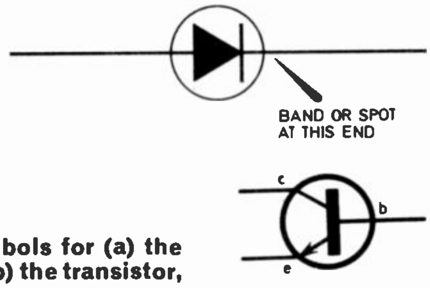
Most diodes have a band on their bodies which normally indicates cathode connection. Some diodes are marked with the diode circuit symbol, which is fine as long as you relate the symbol to the physical component.

A diode can be damaged by excessive heat, so don't leave your soldering iron on the solder joint too long. A good tip is either to use a heat shunt, this is a device to conduct the heat away from the diode; i.e. a pair of long-nosed pliers, or a good substitute is a flat aluminium spring hair clip, or to keep the diode leads as long as possible by putting one complete turn or loop in each wire before mounting on the component board.

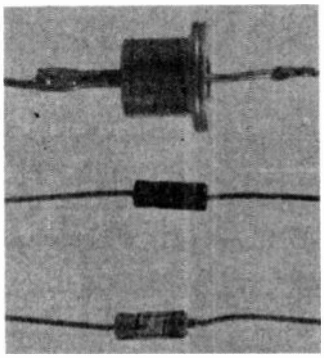
The Transistor

Great care must also be used in mounting the transistor. The temperature problems are the same as for the diode.

The lead connections are obviously very important and must be checked with the appropriate data sheets, etc. On most metal-can transistors the collector is connected to case, therefore transistors should not touch each other.

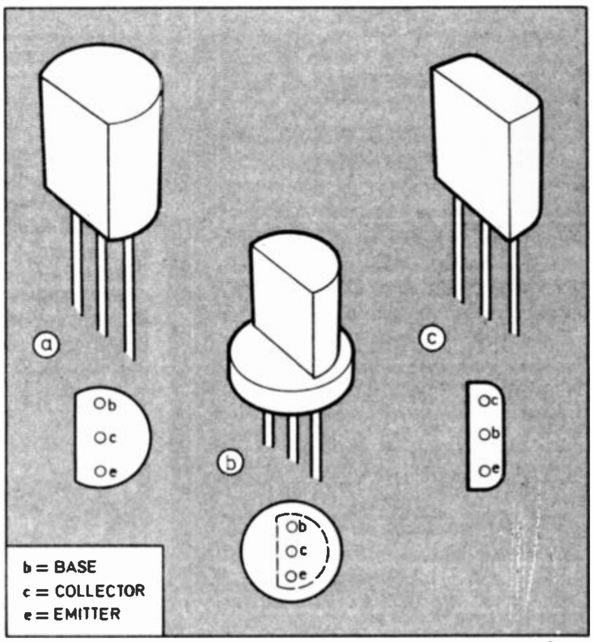


Circuit symbols for (a) the diode and (b) the transistor, *npn*.



Three common types of diode (a) power or rectifier type—1N92 (b) small signal silicon—1N914 (c) small signal germanium—OA91.

Photograph showing a few of the many different types of transistor encapsulations. (a) AD149 (b) BC107 (c) OC72 (d) AC128 (e) AD161 (f) BD201 (g) BC147—Lockfit. *(Mullard)*



Three common types of encapsulations showing lead connections. (a) case type TO-92 for 2N3704, (b) TO-98 for 2N2926, (c) Ferranti encapsulation for such as ZTX301.

DOWN TO EARTH

By GEORGE HYLTON

"Please explain the expression 'virtual earth' which I have sometimes seen used in describing amplifiers."

A virtual earth is a point in a circuit which is at the same voltage as "earth" even though it is not actually connected to earth. It can be seen what a virtual earth is by making up a rather unusual bridge circuit (Fig. 1a). Here B1 drives a current through R1 and it flows in the direction shown by the upper arrow. Similarly B2 and R2.

OPPOSING FLOWS

These currents flow in opposite directions through the meter. If they happen to be equal they cancel and the meter reads zero.

To the uninitiated this may seem impossible. The batteries are still there. The resistances are still there. So what's happened to the current? The answer is that it is still flowing quite happily—but not through the meter. It all flows from the positive side of B1 through R1 and R2 in series and into the negative side of B2. So B1 and B2 are just two batteries in series driving a current through two resistances in series.

Remember that this is only true in the special case where each battery supplies the same amount of current. Change either voltage or resistance and the balance is upset and the meter reads.

Now, if a voltmeter reads zero there is no volts across it. This means that there is no difference in voltage between point *A* and point *C*. Points *A* and *C* are at the same voltage. In the circuit there is an earth connection to point *A*. But point *C*, although not earthed, is still at the same voltage as the earthed point. Point *C* is a virtual earth.

UNDECIDED

In Fig. 1b, B1 and B2 are "series-aiding"; i.e. they push the current in the same direction. Voltage drops appear across R1 and R2 as shown, leaving point *C* in a state of acute indecision, not knowing whether to be positive or negative.

For special values of B1, B2, R1, and R2 it is neither positive nor negative, *with respect to earth*, but neutral. A meter connected from *C* to *A* will then read zero. Point *C* is a virtual earth.

If you have begun to suspect that Fig. 1b is the same as 1a only drawn differently and with the meter omitted you are right! The point is that in practical circuits you often see something much more like 1b than 1a. Before we look at one, let me make the point that B1 and B2 could just as well be two a.c. voltages in antiphase. In practical circuits they are a.c. signal voltages, as in the audio amplifier, Fig. 2.

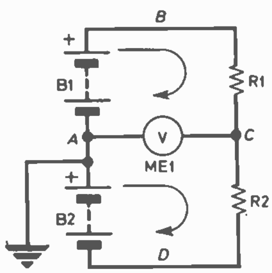
PRACTICAL CIRCUIT

The input is v_1, TR1 provides voltage gain and also inverts the phase of v_1; TR2 is an emitter-follower which passes on the voltage at TR1 collector to the output as v_2, without further change of phase. At a particular instant the polarities of v_1 and v_2 could be as shown. These voltages aid one another to drive a current through R1 and R2 in series.

Now comes the tricky bit. Output voltage v_2 is *created* by applying the input v_1. It's created because the amplifier responds to v_1. Well, no, that's not quite true. The amplifier responds to the signal voltage between point *C* and earth, which is the true input to TR1. This is *not* the same as v_1, because some of v_1 is lost in R1. The greater the current in R1, the more of v_1 is lost.

But the current in R1 depends on v_2 as well as v_1, since these two voltages are series-aiding. Since v_2 depends on the gain, then as the gain increases so the current in R1 increases and so more of v_1 is lost before reaching TR1.

In practical circuits, nearly all of v_1 is lost in R1. The tiny bit that remains at *C* is still enough when amplified by TR1, to produce v_2. The higher the amplification, the less of v_1 is needed at *C*. As the gain approaches infinity, the voltage at *C* sinks towards zero. But zero in this case means earth voltage. So if the voltage gain is high, point *C* is nearly at earth voltage, it is a virtual earth.



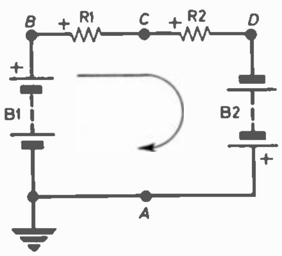


Fig. 1. Two simple bridge circuits to illustrate virtual earth.

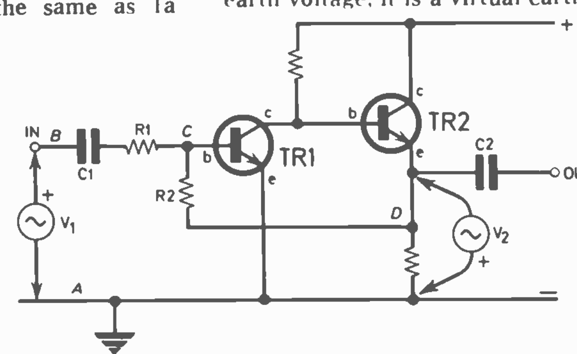


Fig. 2. A simple two-stage audio amplifier.

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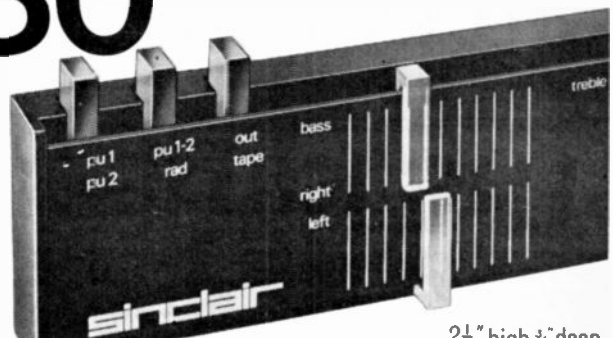

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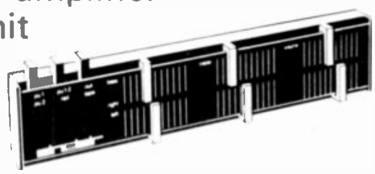

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R R P £11.95 +£1 19 V A T

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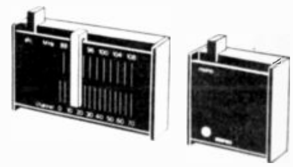

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Decoder R R P £7.45 +0 45p V A T

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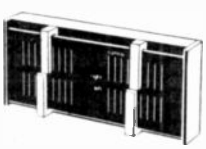

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Voltage gain – minus 0 2dB
Frequency response – 36Hz to 22KHz, controls minimum
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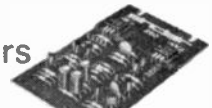

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Signal to noise ratio – 64dB
Distortion – less than 0·1% at 10W into 8 Ω
Power requirements – 12 – 35 volts

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Size – 55 × 98 × 20mm
Input sensitivity – 100-250mV
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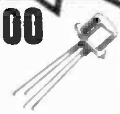

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for your Entertainment...

By Adrian Hope

MESSING around with calculators can be almost as much fun as messing around with boats—more so in the winter and on wet Sunday afternoons. Even those (like myself) with a mental block when it comes to mathematics can enjoy using or playing arithmetical games with an electronic calculator.

The first electronic calculator, which was made at the end of the last war, used 18,000 electronic valves and so was hardly a practical proposition. But even that was more practical than the mechanical toothed-wheel calculators that had been under development since the 17th century.

The advent of the transistor made life easy for the designers of calculators, if only because 18.000 large, hot valves could be replaced by 18,000 small, cool transistors. But even transistors take up space and it was the wherewithal to cram most of those transistors onto a single chip (ie integrate them into one circuit) that made the pocket calculator a reality.

CHEAPER CALCULATORS

The reason why calculators keep getting cheaper is that chips cost a fortune to design and put into production but relatively little to produce once the production run is under way.

Thus those people who bought calculators when they first appeared paid much, much more for them then than they would be paying now. And the trade-in value on a calculator is virtually nil. They are still being improved and new chips developed which means that no one wants to buy an old second-hand model when they can just as easily and just as cheaply buy a better new one.

The sad truth is that what cost £100 a few years ago may not be half as good as what costs £30 brand new today. But with raw material prices going up all the time it is unlikely that calculators will continue to get much cheaper and my guess is that the price of a reasonable model will in the end, settle at around £15.

CHOOSING

There is no point in buying a machine which will work out square roots, tangents and cosines, and all manner of other mathematical mumbo jumbo if it is only to be used for routine arithmetic.

Likewise, although the constant facility (which enables a whole string of similar multiplications to be carried out) may be invaluable to some people, it will be utterly redundant for others.

Although a memory may be useful to enable one calculation to be held in limbo while another side calculation is tackled, a full functional memory is pretty expensive. But a simple memory, which will enable the user to retrace his steps through one stage of a calculation to correct a mistake and so avoid starting the whole calculation over again, may be quite cheap and so well worth looking for.

Percentage keys are only really useful if they are so-called "live" or "net and gross" keys which enable the operator easily to add on and subtract a few per cent extra for this and a few per cent extra for that (for example) on a special offer.

Simple percentage keys often do little more than shift the decimal point a couple of places to the left, (divide by 100) and provide no facility for adding or subtracting the result from the original price in question.

FREE-FLOW LOGIC

My own personal hobby-horse is that a machine should have *full flow arithmetic* (sometimes called *free flow logic* or *free flow arithmetic* or *chain flow logic* or some other similar term). In simple language this means that the operator can enter all his calculations into the machine keyboard just as he would write them.

On most of the early machines, and many of the cheaper modern machines, it is necessary to follow the machine's own logic when entering up calculations rather than act normally.

Experienced salesmen will know what you mean when you ask for a machine which has chain or free flow logic. But others will just look blank. The best way of checking in the shop whether a machine has what you want is to try entering a simple calculation as you would write it and see what happens.

Take for example the sum $11-2+4\times2$. Keying in the first number, 11, pressing the minus sign and then keying in 2 may well give you the result minus 9 instead of plus 9. From then on the calculation is doomed. Keying in plus 4 gives you the answer minus 5 instead of plus 13, and multiplying this by 2 gives you the answer minus 10 instead of the answer plus 26.

Of course using the machine's particular logic (which usually involves pressing the minus sign after the 2 has been keyed in rather than before) will give you the correct result and if you are happy to work that way you can save yourself a fair amount of money.

This is because the new generations of machines all tend to work with human logic rather than machine logic and the warehouses are full of old-logic machines that become more obsolete every day. So keep a very wary eye open on very cheap offers. Quite often these will be batches of old odd-logic machines which are technically sound but have become a drug on the market.

Counteract

I have just read Mr. Paul Young's contribution to EVERYDAY ELECTRONICS April 1974, concerning supplying overseas customers.

I would suggest that Mr. Young has not tried every way to get around the problem he describes. I would propose that he institutes a flat postage and packing charge of say £2 for all overseas orders. I would think that this would cover the extra time involved, small items could be airmailed and larger ones sent surface post.

As prices of electronic components in New Zealand are more than double U.K. prices it is economical in many cases to order from the U.K. even with the higher post and packing. I am hoping Mr. Young will see fit to reconsider his policy so that he can update his wall map with many more blue-headed pins.

I am one of those who does not have a pen friend in the U.K. to purchase goods on my behalf.

Ronald Mathews,
Nelson, New Zealand

Thank you for your interesting and constructive letter.

We should love to fill our map up with blue pins, but we should go bankrupt in the process.

There was not enough room (printing space) in my article to go into the subject more deeply, and most people assume that we have just trifled around with the problem before giving it up. The facts are that for ten years we tried to make overseas mail pay. We did everything to encourage it, and had it grown to large enough proportions, there would have been no problem, because it would have been worthwhile having an export department. However, since the gross turnover never rose above £1,500, it was with much reluctance that we had to abandon it.

The position at the moment is that we accept only BFPO orders, as the postage is the same as for the U.K. Other than this we will accept an order if it is over £50 in value, and if several people could pool their requirements, it may be possible to reach this amount.

One thing we find puzzling is that other overseas would-be customers have praised other U.K. suppliers so highly, that we cannot understand why they are dissatisfied that we cannot match their performance.

Paul Young

N. E. Radio Course

I write once again, firstly to thank you for the publicity you have given my course for the R.A.E. (Radio Amateurs Examination) in the past, and secondly to ask that brief details again be included in EVERYDAY ELECTRONICS.

The course commences in the middle of September at the Gosforth Secondary School, North Road, Gosforth, Northumberland —from 7 pm to 9 pm on Tuesdays/Wednesdays. A prospectus and further details may be had from the principal on written or telephone request.

D. R. Loveday,
G3FPE,
Newcastle upon Tyne

Continued from page 507

PRACTICAL CIRCUIT

We can demonstrate the effect of parallel resonance by making a simple tuned radio frequency (T.R.F.) radio. See Fig. 14.5. The coil is wound on a ferrite rod having dimensions 150mm length by 10mm diameter. Use 70 turns of 22 s.w.g. wire and close wind the turns. The rod picks up radiated electromagnetic fields from any radio stations in the area and induces voltage across the ends of the coil. The parallel circuit of L1 with VC1 shows low impedance to all but the resonant frequency, hence that frequency alone will give a maximum voltage across the end sof the coil. This frequency can be varied by adjusting the value of VC1.

We measure this "tuned voltage" by connecting L1 to an amplifier circuit (TR1). We are using an f.e.t. because it gives us a very high input impedance (so that we do not affect our Q too much). Transistor TR1 also rectifies any tuned radio frequency signals which, of course, would be modulated with audio. This operation is called detection. Capacitor C1 removes the radio frequency component after rectification and leaves the audio signals which are further amplified by the two simple audio stages that follow. The overall amplification is sufficient to give very good reception of medium wave signals (the frequencies of which fall into the range of about 1·3MHz down to 500kHz).

Those who are mathematically inclined might like to try and work out the inductance of the coil if you assume it takes a capacitance of 40pF to tune in a frequency of 1MHz. If you then assume a Q of 1,000 work out the resonant impedance of the tuning circuit—you may be surprised how high it is!

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2N916	0·24
2N918	0·47
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2N1302	0·19
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2N1305	0·24
2N1306	0·31
2N1307	0·22
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2N1309	0·36
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2N1671B	1·72
2N1671C	4·32
2N1711	0·45
2N1907	5·50
2N2102	0·50
2N2147	0·70
2N2148	0·94
2N2160	0·60
2N2192	0·40
2N2192A	0·40
2N2913	0·40
2N2193A	0·61
2N2194	0·73
2N2194A	0·30
2N2218A	0·60
2N2219	0·45
2N2219A	0·60
2N2220	0·45
2N2221	0·41
2N2221A	0·40
2N2222	0·40
2N2222A	0·50
2N2368	0·31
2N2369	0·37
2N2369	0·41
2N2646	0·77
2N2647	1·12
2N2904	0·55
2N2904A	0·70
2N2905	0·45
2N2905A	0·50
2N2906	0·31
2N2906A	0·37
2N2907	0·40
2N2907A	0·45
2N2924	0·15
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2N3054	0·60
2N3055	0·75
2N3390	0·26
2N3391	0·23
2N3391A	0·29
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2N3442	1·69
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2N3638A	0·15
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2N3705	0·12
2N3706	0·09
2N3707	0·13
2N3708	0·70
2N3709	0·11
2N3710	0·12

2N3711	0·11
2N3712	0·96
2N3713	1·20
2N3714	1·33
2N3715	1·50
2N3716	1·80
2N3771	2·20
2N3772	1·80
2N3773	2·65
2N3779	3·15
2N3790	2·40
2N3791	2·35
2N3792	2·69
2N3794	0·10
2N3819	0·37
2N3820	0·38
2N3823	1·42
2N3900	0·21
2N3901	0·32
2N3903	0·24
2N3904	0·27
2N3905	0·24
2N3906	0·27
2N4036	0·63
2N4037	0·42
2N4058	0·16
2N4059	0·09
2N4060	0·11
2N4061	0·11
2N4062	0·11
2N4126	0·20
2N4289	0·13
2N4919	0·84
2N4920	0·99
2N4921	0·73
2N4922	0·84
2N4923	0·83
2N5172	0·12
2N5174	0·22
2N5175	0·26
2N5176	0·32
2N5190	0·92
2N5191	0·95
2N5192	1·24
2N5195	1·46
2N5245	0·43
2N5457	0·49
2N5458	0·45
2N5459	0·49
40361	0·48
40362	0·50
40363	0·61
40389	0·46
40394	0·56
40395	0·65
40406	0·44
40407	0·33
40408	0·50
40409	0·52
40410	0·52
40411	2·25
40414	3·55
40430	0·85
40583	0·23
40601	0·67
40602	0·46
40603	0·53
40604	0·56
40636	1·10
40669	1·00
40673	0·70
AC107	0·25
AC113	0·16
AC117	0·20
AC126	0·25
AC127	0·25
AC128	0·25
AC151V	0·14
AC152V	0·17
AC153	0·25
AC153K	0·25
AC154	0·20
AC176	0·18
AC176K	0·25
AC187K	0·23
AC188K	0·34
ACY18	0·24
ACY19	0·27
ACY20	0·22
ACY21	0·26
ACY28	0·20
ACY30	0·42
AD142	0·50
AD143	0·45
AD149V	0·66
AD150	0·63
AD161	0·45
AD162	0·45
AD161	pr
AD162	1·05
AF109R	0·40
AF115	0·24

AF116	0·25
AF117	0·20
AF118	0·50
AF124	0·24
AF125	0·20
AF126	0·19
AF127	0·20
AF139	0·39
AF170	0·25
AF172	0·25
AF178	0·55
AF179	0·65
AF180	0·50
AF186	0·40
AF200	0·35
AF239	0·51
AF240	0·72
AF279	0·54
AF280	0·54
AL102	0·75
AL103	0·70
BC107	0·16
BC108	0·15
BC109	0·19
BC113	0·13
BC115	0·15
BC116	0·15
BC116A	0·18
BC117	0·21
BC118	0·11
BC119	0·29
BC121	0·23
BC125	0·15
BC126	0·20
BC132	0·11
BC134	0·11
BC135	0·11
BC136	0·15
BC137	0·15
BC138	0·24
BC140	0·34
BC141	0·29
BC142	0·23
BC143	0·21
BC145	0·21
BC147	0·11
BC148	0·13
BC149	0·12
BC153	0·18
BC154	0·18
BC157	0·14
BC158	0·13
BC159	0·14
BC160	0·37
BC167B	0·13
BC168B	0·13
BC168C	0·11
BC169B	0·13
BC169C	0·13
BC170	0·11
BC171	0·13
BC172	0·11
BC182	0·12
BC182L	0·12
BC183	0·09
BC183L	0·09
BC184	0·11
BC184L	0·11
BC186	0·25
BC187	0·27
BC207	0·12
BC208	0·11
BC212K	0·10
BC212L	0·10
BC214L	0·21
BC237	0·09
BC238	0·09
BC239	0·09
BC251	0·20
BC252	0·18
BC253	0·23
BC257	0·09
BC258	0·09
BC259	0·10
BC261	0·10
BC262	0·18
BC263	0·23
BC300	2·12
BC301	0·34
BC302	0·29
BC303	0·54
BC307	0·10
BC307A	0·10
BC308	0·09
BC308A	0·10
BC308B	0·09
BC309	0·10
BC309A	0·10
BC309B	0·10
BC237	0·21
BC238	0·19
BC337	0·19

BC338	0·19
BCY30	0·43
BCY31	0·52
BCY32	1·15
BCY33	0·34
BCY34	0·37
BCY38	0·53
BCY39	1·05
BCY40	0·87
BCY42	0·15
BCY58	0·21
BCY59	0·22
BCY70	0·17
BCY71	0·22
BCY72	0·13
BCY87	3·54
BCY88	2·42
BCY89	0·97
BD115	0·75
BD116	0·75
BD121	0·75
BD123	0·32
BD124	0·67
BD131	0·40
BD132	0·50
BD135	0·43
BD136	0·49
BD137	0·55
BD138	0·63
BD139	0·71
BD140	0·87
BDY20	1·05
BF115	0·25
BF116	0·23
BF117	0·43
BF119	0·58
BF121	0·25
BF123	0·27
BF125	0·25
BF152	0·20
BF153	0·21
BF154	0·16
BF158	0·23
BF159	0·27
BF160	0·23
BF161	0·42
BF163	0·32
BF166	0·32
BF167	0·21
BF173	0·24
BF177	0·29
BF178	0·35
BF179	0·43
BF180	0·35
BF181	0·34
BF182	0·40
BF183	0·40
BF184	0·30
BF185	0·17
BF194	0·16
BF195	0·17
BF196	0·15
BF197	0·15
BF198	0·18
BF199	0·18
BF200	0·40
BF225J	0·19
BF237	0·22
BF238	0·22
BF244	0·16
BF245	0·33
BF246	0·43
BF247	0·23
BF254	0·16
BF255	0·17
BF257	0·46
BF258	0·59
BF259	0·55
BFS21A	2·30
BFS28	0·92
BFS61	0·27
BFS98	0·20
BFX29	0·30
BFX30	0·25
BFX44	0·33
BFX63	2·48
BFX68	0·30
BFX84	0·24
BFX85	0·30
BFX87	0·28
BFX88	0·25
BFX89	0·45
BFY18	0·35
BFY19	0·35
BFY20	0·50
BFY29	0·40
BFY50	0·23
BFY51	0·19
BFY52	0·21
BFY53	0·16
BFY90	0·60
BRY39	0·44

BU104	1·42
BU105	2·25
C106A	0·46
C106B	0·55
C106D	0·65
C106E	0·43
CA3020A	1·80
CA3046	0·70
CA3048	2·11
CA3089E	1·96
CA3090Q	4·23
LM301A	0·48
LM304A	2·03
LM309K	1·88
LM702C	0·75
LM709T099	0·48
8DIL	0·38
14DIL	0·33
LM723C	0·75
LM741T099	0·40
8DIL	0·46
14DIL	0·38
LM747	1·00
LM7488DIL	0·60
14DIL	0·73
MC1303p	1·26
MC1310	2·92
MC1458CP1	0·79
MJ480	0·90
MJ481	1·14
MJ490	0·98
MJ491	1·38
MJE340	0·42
MJE2955	1·12
MJE3055	0·68
MP8111	0·32
MP8112	0·40
MP8113	0·47
MPF102	0·39
MPSA05	0·25
MPSA06	0·26
MPSA55	0·26
MPSA56	0·27
NE555V	0·90
NE560	4·48
NE561	4·48
NE565A	4·48
OC23	0·56
OC28	0·76
OC35	0·60
OC42	0·35
OC45	0·32
OC71	0·12
OC72	0·13
OC81	0·20
OC83	0·20
ORP12	0·50
SC35D	1·68
SC36D	1·46
SC40D	1·89
SC41D	1·32
SC45D	1·89
SC46D	1·96
SC50D	2·60
SC51D	2·39
SL414A	1·80
SL623	4·59
TAA263	0·70
TAA350	2·10
TAA621	2·03
TAA661B	1·32
TAD100	1·50
Filter	0·70
TBA271	0·64
TBA641B	2·25
TBA800	1·50
TBA810	1·50
TIL209	0·35
TIP29A	0·49
TIP30A	0·58
TIP31A	0·62
TIP32A	0·74
TIP33A	1·01
TIP34A	1·51
TIP35A	2·90
TIP36A	3·70
TIP41A	0·79
TIP42A	0·90
TIP2955	0·93
TIP3055	0·60
ZTX300	0·12
ZTX302	0·20
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ZTX502	0·17
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Resistors			Tantalum Bead Caps	
Power W	Tol	Price	Value	Price
⅛	5%	1p	1/35v	14p
¼	5%	1·5p	22/35v	14p
½	5%	2p	47/35v	14p
1	10%	2·5p	1µ/35v	14p
2	10%	6p	2·2/35v	14p
2½	5%	7p	4·7/35v	18p
5	5%	9p	2·2/16v	14p
10	5%	10p		

Hmm note: alignment of values in the printed box differs; see below.

Veroboard Largest stockist

	Copper		Plain	
	·15	·1	·1	·15
2·5 x 3¾	20	28	–	14
2·5 x 5	30	30	–	14
3¾ x 3¾	30	30	–	–
3¾ x 5	35	34	–	24
2½ x 17	67	89	–	49
3¾ x 17	95	1·21	76	69

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Thermistors
Mullard E299DD Series 12½p
E298ED Series 10p
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Veropins	·1	·15
36pcs	24	24
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Full range of Carbon and Wirewound resistors available.

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Type	Price £	Type	Price £	Type	Price £	Type	Price £
SN7400	16p	SN7432	45p	SN7483	1·20	SN74154	1·66
SN7401	16p	SN7437	35p	SN7484	95p	SN74155	1·55
SN7401AN	38p	SN7438	35p	SN7485	1·58	SN74157	1·09
		SN7440	16p	SN7486	45p	SN74160	1·58
SN7402	16p	SN7441	85p	SN7490	65p	SN74161	1·58
SN7403	16p	SN7442	85p	SN7491	1·10	SN74162	1·58
SN7404	24p	SN7445	1·59	SN7492	75p	SN74164	2·01
SN7405	24p	SN7446	2·00	SN7493	65p	SN74165	2·01
SN7406	45p	SN7447	1·30	SN7493	65p	SN74167	4·10
SN7407	45p	SN7448	1·50	SN7494	85p	SN74174	1·80
SN7408	25p	SN7450	16p	SN7495	80p	SN74175	1·29
SN7409	33p	SN7451	16p	SN7496	1·00	SN74176	1·74
SN7410	16p	SN7453	16p	SN74100	2·16	SN74180	1·44
SN7411	25p	SN7454	16p	SN74107	43p	SN74181	5·18
SN7412	28p	SN7460	16p	SN74118	1·00	SN74190	1·95
SN7413	50p	SN7470	30p	SN74119	1·92	SN74191	1·95
SN7416	45p	SN7472	38p	SN74121	57p	SN74192	2·05
SN7417	30p	SN7473	44p	SN74122	80p	SN74193	2·30
SN7420	16p	SN7474	48p	SN74123	72p	SN74196	1·58
SN7423	37p	SN7475	59p	SN74141	1·00	SN74197	1·58
SN7425	37p	SN7476	45p	SN74145	1·44	SN74198	3·16
SN7427	45p	SN7480	75p	SN74150	1·44	SN74199	2·88
SN7430	16p	SN7481	1·25	SN74151	1·10		
		SN7482	87p	SN74153	1·09		

Diodes & Rectifiers

PIV	50	100	200	400	600	800	1000
1·5	0·08	0·09	0·10	0·11	0·12	0·15	0·20
3	0·15	0·17	0·20	0·22	0·25	0·27	0·20
10	—	0·35	0·40	0·47	0·56	—	—
35	0·84	0·92	1·18	2·15	2·52	3·65	4·20

CATHODE STUD ONLY

IN3766 (35 A 800pv) £3·65 IN3768 (35 A 1000pv) £4·20.

IN34A	0·10	BA141	0·17	BY237	0·12½	OA79	0·07
IN914	0·07	BA142	0·17	BYZ10	0·35	OA81	0·08
IN916	0·07	BA144	0·12	BYZ11	0·32	OA85	0·10
AA119	0·07	BA145	0·17	BYZ12	0·30	OA90	0·07
AA129	0·15	BA154	0·12	OA9	0·10	OA91	0·07
BA100	0·15	BY100	0·15	OA10	0·20	OA95	0·07
BA102	0·25	BY126	0·15	OA47	0·07½	OA200	0·07
BA110	0·25	BY127	0·17½	OA70	0·07½	OA202	0·10
BA115	0·07	BY140	1·00	OA73	0·10	OA210	0·27½

Bridge Rectifiers

	Plastic				Metal— Professional quality			
	1A	2A	4A	6A	5A	15A	25A	50A
50	0·24	0·32	0·60	0·62	2·22	2·64	3·36	12·30
100	0·36	0·37	0·70	0·75	2·24	3·00	3·60	12·36
200	0·30	0·41	0·75	0·80	2·82	3·78	4·32	14·40
400	0·36	0·45	0·85	1·10	3·72	4·20	5·40	16·38
600	0·40	0·52	0·95	1·25				

AB Potentiometers—carbon

Rotary type 45
Singles (Log and linear) **15 pence**
Single switched (Log and linear) **21 pence**
Doubles (Log and linear) **38 pence**
Slider type 58
Singles (Log and linear) **30 pence**
Doubles (Log and linear) **50 pence**
Presets (Please specify vertical or horizontal)
0·1 watt 6 pence   0·2 watt 6 pence   0·3 watt 7½ pence

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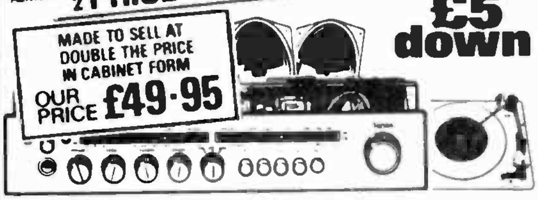

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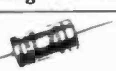

6·3 VOLT

68μF	6½p
150μF	6½p
470μF	11p
680μF	13p
1500μF	18p
2200μF	18p
3300μF	26p

10 VOLT

47μF	6½p
100μF	6½p
220μF	8p
330μF	10p
470μF	10p
1000μF	11p
1500μF	20p
2200μF	24p

16 VOLT

15μF	6½p
33μF	6½p
150μF	6½p
150μF	8p

16 VOLT

220μF	9p
680μF	17p
1000μF	17p
1500μF	25p
2000μF	43p

25 VOLT

10μF	6½p
22μF	6½p
47μF	6½p
100μF	8p
150μF	8p
220μF	10p
470μF	16p
680μF	20p
1000μF	22p
2200μF	39p
5000μF	68p

40 VOLT

6·8μF	6½p
15μF	6½p
33μF	6½p

40 VOLT

47μF	6½p
100μF	9p
68μF	10p
220μF	11p
470μF	19p
680μF	25p
1000μF	25p
2200μF	44p

63 VOLT

1μF	6½p
2·2μF	6½p
4·7μF	6½p
6·8μF	6½p
10μF	6½p
22μF	6½p
68μF	10p
100μF	11p
150μF	13p
220μF	19p
330μF	22p
470μF	26p
1000μF	44p

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Carbon track 500Ω to 2·2 meg Ω Log or Linear.
Single 13p. Dual gang (stereo) 44p.
Single type with D.P. switch 26p.

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matrix	0·15 matrix	0·1 matrix
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3¾ x 3¾	22p	24p
3¾ x 5	28p	28p
2½ x 17	60p	79p
3¾ x 17	81p	£1·05
Pin insertion tool	—	82p
Spot face cutter	52p	52p
Pack of 36 pins	42p	42p
	20p	20p

Resistors
¼ watt 5% carbon 1p
½ watt 5% carbon 1p
1 watt 10% carbon 3½p

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250V P.C. mounting: 0·01μF, 0·015μF, 0·22μF, 3½p. 0·33μF, 0·047μF, 0·068μF, 4p. 0·1μF, 4½p. 0·15μF, 0·22μF, 5½p. 0·33μF, 7p. 0·47μF, 9½p. 0·68μF, 12p. 1·0μF, 14p. 1·5μF, 22p. 2·2μF, 27p.

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Our 112 page catalogue No. 7 (green and yellow covers) is packed with components, accessories, materials, tools plus much technical information and many diagrams. It costs 25p. post free and includes a refund voucher for 25p. allowable on orders list value £5 or more. Our computer-controlled stocks and despatch ensure much better chances of your getting what you want quicker however large or small your order.

EVERYTHING BRAND-NEW & GUARANTEED ● GENUINE DISCOUNTS ● FREE POSTAGE IN U.K.

RESISTORS

Code	Watts	Ohms	1 to 9	10 to 99	100 up (see note below)	
C	1/3	4·7–470K	1·3	1·1	0·9	nett
C	1/2	4·7–10M	1·3	1·1	0·9	nett
C	3/4	4·7–10M	1·5	1·2	0·97	nett
C	1	4·7–10M	3·2	2·5	1·92	nett
MO	1/2	10–1M	4	3·3	2·3	nett
WW	1	0·22–3·9	11	10	8	nett
WW	3	1–10K	9	8	7	nett
WW	7	1–10K	11	10	8	nett

Codes:
C = carbon film, high stability, low noise.
MO = metal oxide, Electrosil TR5, ultra low noise.
WW = wire wound, Plessey.

Values: All E12 except C⅓W, C¾W, and MO½W
E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

Tolerances:
5% except WW 10% ± 0·05Ω under 10Ω and MO ½W 2%.

Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions of one penny on total value of resistor order.) Prices for 100 up in units of 100 only.

ELECTROLYTICS

Axial Lead

μF	3V	6·3V	10V	16V	25V	40V	63V	100V
0·47	—	—	—	—	—	—	11p	8p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	8p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	8p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

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P.20 SINGLE log. 4·7 Kohms to 2·2megohms ea. 14p
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JP.20 DUAL GANG log. 4·7Kohms to 2·2megohms, ea. 48p
JP.20 DUAL GANG Log/antilog 10K, 22K, 47K, 1 megohm only ea. 48p
JP.20 DUAL GANG antilog 10K only 48p
2A DP mains switch for any of above 14p extra. Decades of 10, 22 and 47 only available in ranges above.

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Linear or log. 4·7K to 1 meg. in all popular values ea. 30p

SLIDER, STEREO
Type PG 58 ST
4·7K—1 meg. lin. or log. per tr.
Matched tracks. 60p
Escutcheon plates, ea. 10p
Control knobs, ea. 7p

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CH3. 7·5mH 25p CH4. 10mH 25p
CH5. 1·5mH 25p
COILS
DRX1 Crystal set 31p DRR2 Dual range 45p

COIL FORMERS & CORES
NORMAN ¼" Cores & Formers 7p
⅜" Cores & Formers 8p

SWITCHES
DP/DT Toggle 25p SP/ST Toggle 18p

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1¼" and 20mm. 100mA, 200mA, 250mA, 500mA, 1A, 1·5A, 2A
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(Angled) £3·85 per pair.

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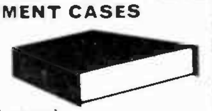

(Black Vinyl covered)

No.	Length		Width		Height	Price
BV1	8"	×	5½"	×	2"	90p
BV2	11"	×	6"	×	3"	£1·20

ALUMINIUM BOXES

BA1	5½"	×	2½"	×	1½"	42p
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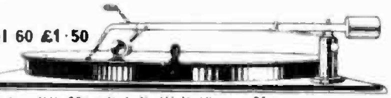
BA3	4"	×	2½"	×	1½"	41p
BA4	5½"	×	4"	×	1½"	47p
BA5	4"	×	2½"	×	2"	41p
BA6	3"	×	2"	×	1"	34p
BA7	7"	×	5"	×	2½"	66p
BA8	8"	×	6"	×	3"	84p
BA9	6"	×	4"	×	2"	54p

BIB HI-FI ACCESSORIES
De Luxe Groov-Kleen
Model 42 £1·84
Chrome Finish Model 60 £1·50



Ref. 36A. Record/Stylus Cleaning Kit 28p
Ref. 43. Record Care Kit £2·35
Ref. 31. Cassette Head Cleaner 54p
Ref. 32. Tape editing Kit £1·54
Model 9. Wire Stripper/Cutter 83p
Ref. P. Hi-Fi Cleaner 31p
Ref. 32A. Stylus Balance £1·36
Ref. J. Tape Head Cleaning Kit 51p
Ref. 34. Cassette Case £1·27
Ref. 56. Hi-Fi Stereo Hints & Tips 32p

ANTEX SOLDERING IRONS
X25. 25 watt £1·93
CCN 240. 15 watt £2·15
Model G. 18 watt £2·15
SK2. Soldering Kit £2·86
STANDS: ST1 £1·21. ST2 77p
SOLDER: 18SWG Multicore 7oz 82p
22SWG 7oz 82p. 18SWG 22ft 28p
22SWG Tube 22p

ANTEX BITS and ELEMENTS
Bits No.

102	For model CN240 3/32"	38p
104	For model CN240 3/16"	38p
1100	For model CCN240 3/32"	38p
1101	For model CCN240 3/8"	38p
1102	For model CCN240 ¼"	38p
1020	For model G240 3/32"	38p
1021	For model G240 1/8"	38p
1022	For model G240 3/16"	38p
50	For model X25 3/32"	38p
51	For model X25 1/8"	38p
52	For model X25 3/16"	38p

ELEMENTS
ECN 240 £1·16 ECCN 240 £1·32
EG 240 £1·16 EX 25 £1·16

ANTEX HEAT SINKS 10p

V.A.T. included in all prices. Please add 10p P. & P. (U.K. only). Overseas orders—please add extra for postage.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C1	250	Resistors mixed values approx. count by weight	0·55
C2	200	Capacitors mixed values approx. count by weight	0·55
C3	50	Precision Resistors 1%, 2% mixed values	0·55
C4	75	⅛th W Resistors mixed preferred values	0·55
C5	5	Pieces assorted Ferrite Rods	0·55
C6	2	Tuning Gangs, MW/LW VHF	0·55
C7	1	Pack Wire 50 metres assorted colours	0·55
C 8	10	Reed Switches	0·55
C 9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Type	0·55
C12	40	Paper Condensers preferred types mixed values	0·55
C13	20	Electrolytics Trans. types	0·55
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·55
C15	4	Mains Slide Switches	0·55
C16	20	Assorted Tag strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	3	Relays 6—24V Operating	0·55
C20	4	pack sheet of Copper Laminate 20 sq. ins	0·55

PLUGS AND SOCKETS
SOCKETS

PS 35 DIN	2 Pin (Speaker)	0·06
PS 36 DIN	3 Pin	0·10
PS 37 DIN	5 Pin 180°	0·10
PS 38 DIN	5 Pin 240°	0·10
PS 39	Jack 2·5mm Switched	0·09
PS 40	Jack 3·5mm Switched	0·10
PS 41	Jack ¼" Switched	0·17
PS 42	Jack Stereo Switched	0·26
PS 43	Phono Single	0·06
PS 44	Phono Double	0·10
PS 45	Car Aerial	0·09
PS 46	Co-Axial Surface	0·09
PS 47	Co-Axial Flush	0·14

INLINE SOCKETS

PS 21	D.I.N. 2 Pin (Speaker)	0·13
PS 22	D.I.N. 3 Pin	0·17
PS 23	D.I.N. 5 Pin 180°	0·17
PS 24	D.I.N. 5 Pin 240°	0·17
PS 25	Jack 2·5mm Plastic	0·10
PS 26	Jack 3·5mm Plastic	0·12
PS 27	Jack ¼" Plastic	0·24
PS 28	Jack ¼" Screened	0·28
PS 29	Jack Stereo Plastic	0·22
PS 30	Jack Stereo Screened	0·32
PS 31	Phono Screened	0·14
PS 32	Car Aerial	0·15
PS 33	Co-Axial	0·17

PLUGS

PS 1	D.I.N. 2 Pin (Speaker)	0·11
PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·14
PS 5	D.I.N. 5 Pin 240°	0·15
PS 6	D.I.N. 6 Pin	0·15
PS 7	S.I.N. 7 Pin	0·15
PS 8	Jack 2·5mm Screened	0·10
PS 9	Jack 3·5mm Plastic	0·09
PS 10	Jack 3·5mm Screened	0·12
PS 11	Jack ¼" Plastic	0·13
PS 12	Jack ¼" Screened	0·18
PS 13	Jack Stereo Screened	0·29
PS 14	Phono	0·06
PS 15	Car Aerial	0·15
PS 16	Co-Axial	0·10

CABLES

CP 1	Single Lapped Screen	0·06
CP 2	Twin Common Screen	0·08
CP 3	Stereo Screened	0·08
CP 4	Four Core Common Screen	0·23
CP 5	Four Core Individually Screened	0·30
CP 6	Microphone Fully Braided Cable	0·10
CP 7	Three Core Mains Cable	0·07
CP 8	Twin Oval Mains Cable	0·06
CP 9	Speaker Cable	0·04
CP 10	Low Loss Co-Axial	0·10

CARBON POTENTIOMETERS
Log and Lin
4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M

VC 1	Single less Switch	0·14
VC 2	Single D.P. Switch	0·26
VC 3	Tandem Less Switch	0·44
VC 4	1K Lin Less Switch	0·14
VC 5	100K Log anti-Log	0·44

HORIZONTAL CARBON PRESETS
0·1 watt 0·06 each
100, 220, 470, 1K, 2·2K, 4·7K, 10K, 22K, [illegible] K, 470K, 1M, 2M, 4·7M

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Type	Amps.	Price	P & P
MT50/½	½	£1·93	30p
MT50/1	1	£2·42	35p
MT50/2	2	£3·30	40p

CARTRIDGES
ACOS GP91-18C. 200mV at 1·2cms/sec £1·16
ACOS GP93-1. 280mV at 1cm/sec £1·65
ACOS GP96-1. 100mV at 1cm/sec £2·65
TTC J-2005. Crystal/Hi Output 95p
TTC J-20 10C Crystal/Hi Output Compatible £1·10
TTC J-200 CS Stereo/Hi Output £1·60
TTC J-2105 Ceramic/Med. Output £1·64

CARBON FILM RESISTORS
The E12 Range of Carbon Film Resistors, 1/8th watt available in PAKS of 50 pieces, assorted into the following groups:—

R1	50 Mixed 100 ohms–820 ohms	40p
R2	50 Mixed 1K ohms–8·2K ohms	40p
R3	50 Mixed 10K ohms–82K ohms	40p
R4	50 Mixed 100K ohms–1 Meg. ohms	40p

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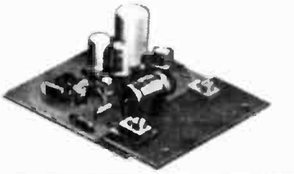
BI-PAK *QUALITY* COMES TO AUDIO!

AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0·25%
LOAD IMPEDANCE	—	8 - 16 Ω
INPUT IMPEDANCE	f = 1KHz	100 kΩ
FREQUENCY RESPONSE ± 3dB	Po = 2 WATTS	50 Hz - 25KHz
SENSITIVITY for RATED O/P	Vs = 25V. Rl = 8Ω f = 1KHz	75mV. RMS
DIMENSIONS	—	3" × 2½" × 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL = 8Ω f = 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts RMS £2·19
AL 20. 5 watts RMS £2·59
AL 30. 10 watts RMS £3·01

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4·35
PA 100. (Use with AL30 & AL60) £13·15

POWER SUPPLIES

PS 12. (Use with AL10, AL20, AL30) 88p
SPM 80. (Use with AL60) £3·25
FRONT PANELS SP 12 with Knobs £1·10

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20, AL30) £1·93 P & P 15p
BMT80 (Use with AL60) £2·15 P & P 25p

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response—
20Hz - 50KHz (-3dB)
Bass control—
± 12dB at 60Hz
Treble control—
± 14dB at 14KHz
*Input 1. Impedance
1 Meg. ohm
Sensitivity 300mV
†Input 2. Impedance
30 K ohms
Sensitivity 4mV

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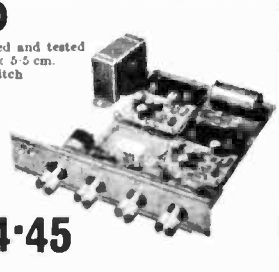
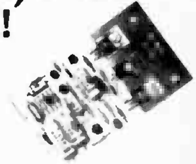
The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion Bass control ± 12dB at 60Hz typically 0·25% at 1 watt. Treble con. ± 14dB at 14kHz.

£14·45

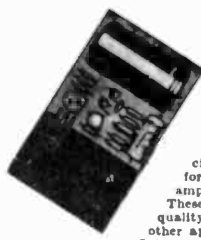
NOW WE GIVE YOU 50w PEAK (25w R.M.S.) *PLUS* THERMAL PROTECTION! The *NEW* AL60 Hi-Fi Audio Amplifier FOR ONLY £3.95



- Max Heat Sink temp. 90°c.
- Frequency Response 20Hz to 100KHz
- Distortion better than 1% at 0·1KHz
- Supply voltage 15-50 volts
- Thermal Feedback
- Latest Design Improvements
- Load—3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F enthusiast.

STABILISED POWER MODULE SPM80

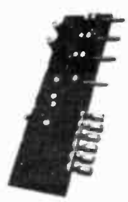


SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATION

Frequency Response	20Hz — 20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	1·25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1·5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Bass Control	± 15bB at 20Hz
Treble Control	± 15dB at 20 KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than −65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

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BACK NUMBERS, December 1971 onwards. For details phone 01-455 7932, evenings.

RECEIVERS and COMPONENTS

3 ASS. M.C. METERS 2-3" £1·15 (27p).
WIRE ENDED NEONS 10—50p (10p).
COPPER CLAD PAX. PANELS 5½" x 5½" 6—50p c.p. 7½" x 9" 6—£1·30 c.o.
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J. W. B. RADIO
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SERVICE SHEETS for over 6,000 models of Television, Radios, Transistors, Stereo, Tape Recorders, Record Players, etc., at only 30p plus S.A.E. with free Fault-Finding Guide. Over 50,000 sheets in stock for 10,000 models. S.A.E. enquiries. Catalogue 20p plus S.A.E. Hamilton Radio, 47 Bohemia Road, St. Leonards, Sussex. Telephone Hastings 429066.

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WANTED lessons and components for first E.E. Teach-In. Also E.E. back numbers Oct. '73-Mar. '74.—Box No. 4.

MISCELLANEOUS

RADIO & TELEVISION AERIAL BOOSTERS £2·95p, five television valves 45p. 50p bargain transistor packs, bargain £1 resistor and capacitor packs. UHF-VHF televisions £7·50, carr. £1·50p. S.A.E. for 3 leaflets. ELECTRONIC MAIL ORDER (BURY) LTD., Bridge Street, Ramsbottom, Bury, Lancs.

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LOGIC PROBE	£4·45
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NEW

12V 8W
FLUORESCENT LIGHT KIT

You can build this reverse polarity proof light for use in homes, garages, caravans, for camping, or emergency lighting. Everything; tube, all metalwork, all components, P.C.B., instructions, etc., is supplied.

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SUPERB INSTRUMENT cases by Bazelli, manufactured from heavy duty PVC faced steel, choice of 174 types, send for free list: Bazelli Instrument Cases, Dept 24, St. Wilfrid's, Foundry Lane, Halton LA2 6LT, near Lancaster.

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Anhydrous technical quality in sealed bags 1lb 55p (20p), 3lb £1·32 (30p), 10lb £3·85 (60p).

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3lbs asstd. panels £1·10 (30p), 7lb £2·20 (40p), 56lb £14 (£2). 12 high quality panels with trimpots, IC's, power transistors etc. £2·20 (30p), 100 panels £13 (£1). Pack of boards containing at least 500 components inc. at least 50 transistors 66p (20p).

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Contain 2xCV2271 dekatrons, 2 4-digit resettable counters, 2 sealed relays, R's, c's etc. Only £1·70 (30p).

3W TAPE AMPLIFIERS
2xECC83, EL84, EZ80 on 12 x 5 x 3" chassis with tone and volume controls. 3 watts output to 7 x 4" 3 Ω speaker (provided) £2·50 (50p). Or in case 14 x 13 x 9" with non-standard tape deck £3·50 (£1). Suitable cassette £1·10, tape 75p, head 30p.

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Contains 1·7V @ 1A transformer (can be modified to give up to 10V output) lamp, switch, jack plug etc. ONLY £1·65 (30p).

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Hundreds of new resistors, capacitors, pots, switches, + PC boards with transistors and diodes and loads of odds and ends. Still only £1·82 (40p). New 6 x 4" 4 Ω speakers £1·10 pr (20p). 500 asstd. resistors £1·10 (20p). 150 mica, ceramic, poly caps 66p (14p).
All prices include VAT. SAE list, enquiries.

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51 Shirley Park Rd, SOUTHAMPTON. TEL 0703 772501. Callers only at 38 Lower Addiscombe Road, Croydon.

CONSTRUCTION AIDS. Screws, nuts, spacers, etc., in small quantities. Aluminium panels punched to spec. or plain sheet supplied. Fascia panels etched aluminium to individual requirements. Printed circuit boards-masters, negatives and boards, one-off or small numbers. Send 6p for list. RAMAR CONSTRUCTOR SERVICES, 29 Shelbourne Road, Stratford-on-Avon, Warks.

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Speakers, kits and cabinets for D.I.Y., Hi Fi, P.A., Disco, etc. by EMI, Fane, Goodmans, Baker, Elac, Richard Allan, Wharfedale, etc. Send for free booklet "Choosing a speaker"

WILMSLOW AUDIO
Dept. H. Swan Works, Bank Square, Wilmslow, Cheshire SK9 1HF
Tel. Wilmslow 29599

BEGINNERS, we exist for you. Instruction, components, constructional kits. Send S.A.E. to Electrolern, Lyburn Lodge, Nomansland, Wiltshire.

TELESCOPIC AERIALS 23in 28p. 3 digit counters 30p. Reed switches, large/small 8p Magnets 6p. Add 10p p&p. Latest list No. 9 6p—Grimsby Electronics, 64 Tennyson Road Cleethorpes, Lincs.

PRESSURE SWITCH PADS, 6-12 volts, size 8in x 21in. Suitable for your alarm systems. Price 90p each, plus postage and packing. Phelmetrics, 233 Seymour Grove, Manchester M16 9QS.

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NO LICENCE EXAM. Transmitter/Receiver	£6·40
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Super SOUND-CATCHER	£2·20

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Send remittance to:

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4 Cunliffe Road, Stoneleigh, Ewell, Surrey
(Mail order U.K. only)
Or for more details, send 20p for lists, plus free design project sheet

RECORD PLAYBACK HEADS (TRUVOX)

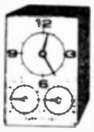
Individual prices of these are:
2 track record playback heads 50p each.
4 track record playback heads 75p each.
Erase heads are also available separately:
2 track 33p; 4 track 55p.
MV metal mounting shields 39p each.
2 track-heads already fixed on heavy mounting plate with shield £1·23.

DRILL CONTROLLER

NEW 1KW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £1·65 plus 13p post and insurance. Made up model also available. £2·50 plus 13p post & p.

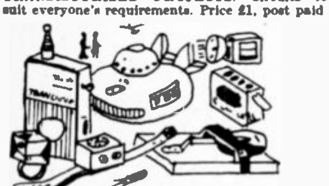
TIME SWITCH



Smith's mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars, keep pets warm, halve your heating bills, etc. £1·95.

EXPERIMENTER PRINTED CIRCUIT KIT BUILD 60 INTERESTING PROJECTS

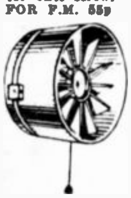
CONTENTS: (1) 2 Copper Laminate Boards 4½in. × 2½in. (2) 1 Board for Matchbox Radio. (3) 1 Board for Wristwatch Radio, etc. (4) Resist. (5) Resist Solvent. (6) Etchant. (7) Cleanser/Degreaser. (8) 16-page Booklet Printed Circuits for Amateurs. (9) 2 Miniature Radio Dials SW/MW/LW. Also free with each kit. (10) Essential Design Data Circuits, Chassis Plans, etc. for 60 TRANSISTORISED PROJECTS. Circuits to suit everyone's requirements. Price £1, post paid



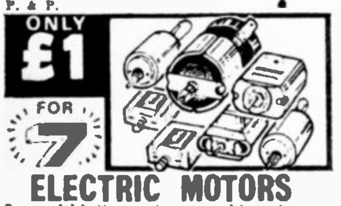
TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7¼ to 47in. Hole in bottom for 6BA screw. 43p. KNUCKLED MODEL FOR F.M. 55p

EXTRACTOR FAN



Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 5½" casing with 5½" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. £2·75 + 20p P. & P.



ELECTRIC MOTORS

7 powerful battery motors as used in racing cars and power models. Output and types vary to make them suitable for hundreds of different projects—tools, toys, models, etc. All brand new, reversible and for 1½ to 12v. Bats., wiring diagrams included. Post and VAT 30p.

FREE Details of how to make miniature power station.

HI-Q TUNER COMPONENTS

For experimenting with the ZN414.
KIT NO. 1. Plessey Miniature Tuning Condenser with built-in LW switch and 3in ferrite slab and litz wound MW coil, 72p.
KIT NO. 2. Air space. tuning condenser 6in. ferrite rod litz wound MW and LW coils. 94p.
KIT NO. 3. Air spaced TC with slow motion drive 8in. ferrite rod, with litz wound LW and MW coils, £1·10.
KIT NO. 4. Permeability tuner with fast and slow motion drive and LW loading coils, 50p.

INTEGRATED CIRCUIT BARGAIN

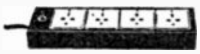
A parcel of integrated circuits made by the famous Plessey Company. A once-in-a-lifetime offer of Micro-electronic devices well below cost of manufacture. The parcel contains 5 ICs all new and perfect, first-grade device, definitely not sub standard or seconds. 4 of the ICs are single silicon chip GP amplifiers. The 5th is a monolithic NPN matched pair. Regular price of parcel well over £5. Full circuit details of the ICs are included and in addition you will receive a list of many different ICs available at bargain prices 25p upwards with circuits and technical data of each. Complete parcel only £1 post paid.
DON'T MISS THIS TERRIFIC BARGAIN.

THYRISTOR LIGHT DIMMER

For any lamp up to 1kw. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price £2·95, plus 20p post and insurance. Industrial model 5A £3·30. Not on plate.

MULLARD UNILEX STEREO SYSTEM

There is no doubt that it is a good system, we believe that for the money it is without comparison. We demonstrate gladly at our Tamworth Road depot. Prices of the individual items for this:—
1 Unilex Amplifier Ref. EP.9000 £1·60
1 Unilex Pre-Amp Ref. EP.9001 £1·80
1 Unilex Power Unit Ref. EP.9002 £2·80
1 Control panel kit with spun aluminium faced knobs £3·30 Or the complete outfit—£11·30 post paid. Pair of 15 ohm speakers made by E.M.I. are also available if required, £3·30 the pair. No extra postage if ordered with the above, otherwise add 25p



DISTRIBUTION PANELS

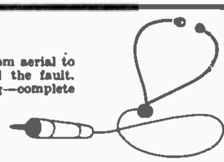
Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2·75 plus 25p P. & P.

THIS MONTH'S SNIP

TELEPHONES WITH INTERNAL BELL

Complete as illustrated. Ex-G.P.O., guaranteed in good condition and serviceable. With diagram and instructions showing how to connect in pairs or as multi-way office intercoms. Price £1·50 + 50p p. & p.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2·20 twin stetho-set instead of earpiece 83p extra post and ins. 20p

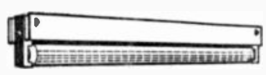
SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in × 18in £1·69. 13in × 10in £1·21.

SHORTWAVE CRYSTAL SET

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19.25.31.39 & 49 metre bands—Kit contains chassis front panel and all the parts. £1·25—crystal earphone 33p.

THE TWENTYLITE



Fluorescent lighting units with polyester choke and finished white enamel. 2ft. model, ideal kitchen, bedroom, hallway, porch, lift, etc., with tube. Assembled ready to install. Price £2·20 + 40p P. & P.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1·10, plus 20p postage.

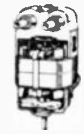
1 CHIP RADIO

Ferranti's latest device ZN414 gives result better than superhet. Supplied complete with technical notes and circuits. £1·38 each. 10 for £11·11.

LIGHT SWITCH KIT

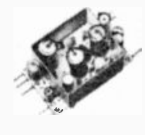
Light switch kit. Comprises photo resistive cell, solid state relay, resistors and condenser. This is mains operated and will switch up to 350W (1½ amps), price £1 with circuit. Much higher loads can be switched if used in conjunction with relay type JB7 which is also available price 90p with circuit.
Photo Resistive cell mounted on switch plate with filter and protective cover, £1 (as illustrated).
Light switch kit with this, £1·78.
Light Switch
The above kit made up ready to work and tested, £2·95.

MULTI-SPEED MOTOR



Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000, 12,000 & 15,500 r.p.m. Shaft is ¼ in. diameter and approximately 1 in. long. 230/240v. Its speed may be further controlled with the use of our Thyrister controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price 97p plus 23p postage and insurance.

MULLARD AUDIO AMPLIFIERS



All in module form, each ready built complete with heat sinks and connection tags, data supplied.
Model 1153 500mW power output 72p
Model 1172 750mW power output 94p
Model EP9000 4 watt power output £1·60
EP 9001 twin channel or stereo pre amp. £1·99

SPIT MOTOR

200-250V induction motor, driving a Carter gearbox with a 1½" output drive shaft running at 5 revs p.m. Intended for roasting chickens, also for driving models—windmills, coloured disc lighting effects, etc. £2·05 plus 20p post and ins.

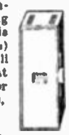
NUMICATOR TUBES

For digital instruments, counters, timers clocks, etc. Hi-vac XN.3. Price 99p each. 10 for £9.

SEALED RELAYS

STC sealed relays. Makers type ref. 6945. These are metal encased plug in with two pairs changeover contacts. Approx. size 1½" high × 1" × ¾". We understand these are vacuum sealed. Two types available 6v (45 ohms coil price £1·50; 24v (700 ohms coil) price £1·75.
STC sealed relay. Again, type 6945, sealed metal case plug in but for 12v operation (170 ohms coil) and with 2 pairs normal open contacts. £1·25.

WALL THERMOSTATS



Made by the famous Smiths Instrument Co. called Colourstat. Wall mounting and in a handsome plastic case. (Cream and beige). Adjustable by slider (lockable) and may be set to control temperatures from around freezing through to 50°C. The slide panel is engraved and indicates (frost) (warm) (very warm), etc. The thermostat will control heaters, etc., up to 15 amp at normal mains voltage and is ideal for living room, bedroom and greenhouses, etc. Price £1·65. Don't miss this.

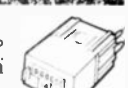
20 WATT CAMPING LIGHT

Also makes good car emergency light. This uses a standard 2 foot 20 watt tube and operates from a 12v. car battery drawing approx. 1A. This gives illumination per amp/hour of battery life far in excess to filament lamps and in fact to the miniature 8-13 watt camping lights often offered. Complete unit ready to operate, in strong white enamelled metal frame. These would normally sell at £6, are unused but slightly soiled and we offer these at £4·50 plus 40p post and packing.

WINDSCREEN WIPER CONTROL

Vary speed of your wiper to suit conditions. All parts and instructions to make. £2·48.

6 DIGIT COUNTER



Resettable. 440 ohm coil up to 25 impulses per second. Ex-equipment but guaranteed perfect, £2·20 each.

PRESSURE SWITCH

Containing a 15 amp. change over switch operated by a diaphragm which in turn is operated by air pressure through a small metal tube. The operating pressure is adjustable but is set to operate in approx. 10 in. of water. These are quite low pressure devices and can in fact be operated simply by blowing into the inlet tube. Original use was for washing machines to turn off water when tub has reached correct level but no doubt has many other applications £1·38, each.

12 VOLT 1½ AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d/ smoothing. Price £2·20 + p. & p. 20p.
Heavy Duty Mains Power Pack' Output voltage adjustable from 15–40V in steps—maximum load 250W—that is from 6 amp at 40V to 15 amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £6·33 plus 65p post.

TERMS:—
Add 10% V.A.T.
Send postage where quoted—other items, post free if order for these items is £6·00, otherwise add 30p.

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 102/3 TAMWORTH RD., CROYDON CRO 1XX.

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Henry's

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BUY NOW AT BARGAIN PRICES
Hi Fi and Transistors – Up to date Brochures on request

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Due to rapid price changes, shortages of paper and raw materials, all prices in the existing catalogues no longer apply. Call or phone for latest prices. A new catalogue will be available for Aug/Sept. 1974.

You pay less VAT with Henry's Low Prices

BUILD THE TEXAN

20 + 20 WATT IC STEREO AMPLIFIER
As featured by Practical Wireless 1972

Now built and used by thousands of satisfied customers. Features slim design overall size in cabinet 15½" x 2¾" x 6¼". 6-IC's, 10 transistors, stabilisers Gardners low field transformer. Fibre Glass PC Panel, complete chassis work. Now available built and tested as well as in kit form. HIGH QUALITY & STABILITY ARE PREDOMINATE FEATURES — DEVELOPED BY TEXAS ENGINEERS FOR PERFORMANCE, RELIABILITY AND EASE OF CONSTRUCTION. FACILITIES. On/off switch indicator, headphones socket, separate treble, bass, volume and balance controls, scratch and rumble filters, mono/stereo switch, input selector; Mag. P.U., Radio Tuner, Aux. Can be altered for Mic., Tape, Tape-head, etc. Constructional details Ref. No. 21 30p. Distributed by Henry's throughout UK. FREE—Teak cabinet with complete kit.

Kit price **£28·50** (+VAT +50p carr/packing) or built and tested **£35·00** (+ VAT + 50p carr/packing) as illustrated.

BUILD THE NEW HENELEC STEREO FM TUNER

A completely new high stability stereo FM tuner. Features variable capacity diode tuning, stabiliser power supply, IC Decoder, high gain low noise. IF stages. LED indicators. Tuning meter, AFC, easy to construct and use. Mains operated. Slim modern design with fibre glass PC, teak cabinet, etc. Available as a kit to build or ready built. Overall size 8" x 2¾" x 6¼". Produced to give high performance with a realistic price. (Parts list and constructional details Ref. No. 5 30p). Henry's are sole distributors UK and Europe.

KIT PRICE **£21·00** (+ VAT) or built and tested **£24·95** (+ VAT)

EARN YOURSELF EASY MONEY, WITH PORTABLE DISCO EQUIPMENT

DISCO MINI A complete portable disco, fitted mixer/preamp, 2 decks all facilities.	£98·50
As above but with Slider Controls	£118·50
100 watt amplifier for above	£49·50
SDLS 100 watt mixer/amplifier with slider controls	£69·00
R50 50 watt mixer/amplifier	£49·50
R100 100 watt mixer/amplifier	£57·50
DISCO AMP 100 watt mixer/amplifier	£73·00
Northcourt:	
400 40 watt mixer/amp	£37·50
800 80 watt mixer/amp	£45·00
DISCO MIXER/PREAMPLIFIERS (OP for up to 6-100 watt amplifiers)	
SDLI (rotary controls)	£49·50
SDLII (slider controls)	£58·50
DISCO VOX (slider controls) the complete disco preamp	£72·00
DJ100 100 watt power amplifier for above	£49·50
DJ30L Mk II 3 channel 3kw sound to light	£36·00
DJ30L Mk III slider controls	£45·50
DJ DISC LITE as 30L-2 plus variable speed flashes	£54·00
Carlsboro Reverberation Unit	£44·00
Disco anti-feedback microphone	£11·95
Colt 150 watt liquid wheel projector	£23·50
150 watt QI liquid wheel projector	£50·00
150 watt QI cassette wheel projector	£50·00
Spare Effects and liquid cassettes large range of patterns	£6·00
6 inch Liquid wheels	£5·00
Various cassettes	£6·00
Mini spot bank fitted 3 lamps	£12·95
Auto Trilite (mini with flashers)	£17·00
Bubblemaker with liquid	£22·50

MIXERS/MICS/SPEAKERS/LIGHTING
U.K.'s largest range of Disco Lighting. FREE STOCK LIST REF. No. 18 ON REQUEST.
AKG / RESLO / DJ / CARLSBORO / EAGLE MICS., STANDS, MIXERS, CABINETS. CHASSIS AND COMPLETE SPEAKER SYSTEMS, MEGAPHONES, TURNTABLES, PUBLIC ADDRESS COMPONENTS.

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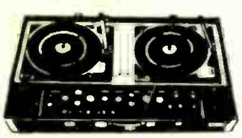

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