Construction and theory for everyone

everyday electronics

JULY 76
30p

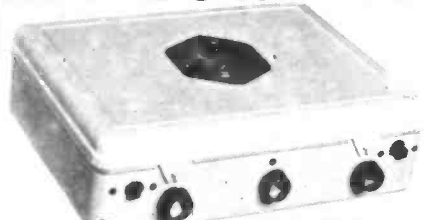
ALL INEXPENSIVE AND EASY TO BUILD

RADIO EXCHANGE LTD.

ALL PRICES INCLUDE VAT

NEW EDU-KIT MAJOR

Completely Solderless Electronic Construction Kit. Build these projects without soldering iron or solder



- ★ 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

Components include: 24 Resistors ★ 21 Capacitors ★ 10 Transistors ★ 3½in 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. Complete kit of parts including construction plans.

Total Building Costs £9·00 INC. VAT
P & P+Ins. 65p. (Overseas Seamail P & P £3·50)

VHF AIR CONVERTER KIT

Build this Converter Kit and receive the Aircraft Band by placing it by the side of a radio tuned to Medium Wave or the Long Wave Band and operating as shown in the instructions supplied free with all parts. Uses a retractable chrome plated telescopic aerial, Gain Control, V.H.F. Tuning Capacitor, Transistor, etc.
All Parts including Case and Plans.
£3·95 P & P and Ins. 40p.
INC. VAT

NEW Everyday Series

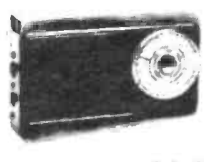
Build this exciting new series of designs.

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. All parts including Case and Plans.
Total Building costs **£4·30** INC. VAT P & P + Ins. 50p

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.
All parts including case and plans.
Total Building costs **£4·95** INC. VAT P & P + Ins. 55p

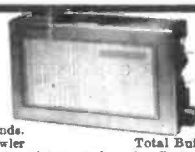
E.V. 7. Case and looks as above, 7 Transistors and 3 diodes. Six wavebands, MW/LW, Trawler Band SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" Loudspeaker.
All parts including Case and Plans
Total Building costs **£8·35** INC. VAT P & P + Ins. 55p

TRANSONA FIVE



NOW WITH 3" LOUDSPEAKER
Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and Parts Price List free with parts.
Total Building costs **£4·05** P & P + Ins. 50p

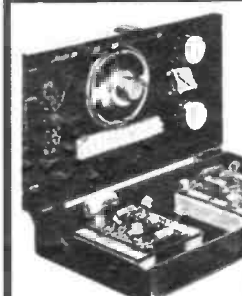
POCKET FIVE



NOW WITH 3" LOUDSPEAKER
3 Tuneable 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" × 1½" × 3½" approx.
All Parts including Case and Plans.
Total Building Costs **£3·60** INC. VAT P&P+Ins. 50p.

EDU-KIT

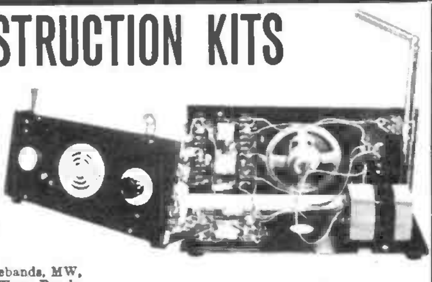
Build Radios, Amplifiers, etc. from easy stage diagrams.



Five units including master unit to construct.

Components include: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine tone 3" moving coil Speaker: Terminal Strip: Ferrite Rod Aerial: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ¾" 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.
All Parts including Case and Plans **£6·30** INC. VAT P & P+Ins. 55p

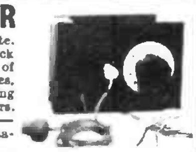
ELECTRONIC CONSTRUCTION KITS



ECK2 Self Contained Multi-Band V.H.F. Receiver Kit. 8 Transistors and 3 Diodes. Push/Pull output. 3" Loudspeaker, Gain Control. Superb 9 section swivel ratchet and retractable chrome plated telescopic aerial, V.H.F. Tuning Capacitor, Resistors, Capacitors, Transistors, etc. Will receive T.V. Sound, Public Service Band, Aircraft, V.H.F. Local Stations, etc. Operates from a 9 Volt PP7 Battery (not supplied with kit).
Complete kit of parts including construction plans
£7·15 INC. VAT P & P and Ins. 55p.

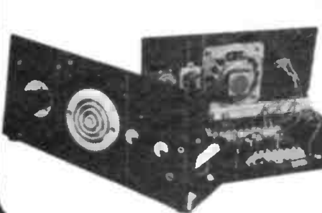
ECK 4 7 Transistors, 6 tuneable wavebands, MW, LW, TrawlerBand, 3 Short Wave Bands. Receiver Kit. With 5" × 3" Loudspeaker. Push/Pull output stage, Gain Control, and Rotary Switch. 7 Transistors and 4 Diodes. 6 section chrome-plated telescopic aerial. 8" Sensitive Ready Wound Ferrite Rod Aerial. Tuning Capacitor. Resistors, Capacitors, etc. Operates from a 9 Volt PP7 Battery (not supplied with kit). Complete kit of parts including construction plans. **£6·55** INC. VAT P & P and Ins. 55p.

JIFFY TESTER



Easy to build and operate. Fits in the pocket. A quick checker for continuity of resistors, chokes, diodes, transistors, circuit wiring (not mains) and loudspeakers. SPECIAL APPLICATION — can also be used as a versatile signal injector.
Complete with earpiece, jack plug and socket resistors, capacitors, components, etc. Complete kit of parts including construction plans. **£2·85** INC. VAT P & P+ Ins. 30p

EDU-KIT JUNIOR



Completely Solderless Electronic Construction Kit. Build these projects without Soldering Iron or Solder.

- ★ Crystal Radio Medium Wave Coverage — No Battery necessary.
- ★ One Transistor Radio.
- ★ 2 Transistor Regenerative Radio.
- ★ 3 Transistor Earpiece Radio Medium Wave Coverage.
- ★ 4 Transistor Medium Wave Loudspeaker Radio.
- ★ Electronic Noise Generator
- ★ Electronic Metronome.
- ★ 4 Transistor Push/Pull Amplifier.

All parts including Loudspeaker, Earpiece, MW Ferrite Rod Aerial, Capacitors, Resistors, Transistors, etc. Complete kit of parts including construction plans.
£6·55 INC. VAT P & P+ Ins. 55p

TO RADIO EXCHANGE LTD.,
61A HIGH STREET, BEDFORD MK40 ISA
Tel: 0234 52367.

ALL PRICES INCLUDE VAT Reg. No. 788372

★ Callers side entrance "Lavells" Shop.
★ Open 10–1, 2.30–4.30. Mon–Fri. 9–12 Sat.

I enclose £ ....

for ....

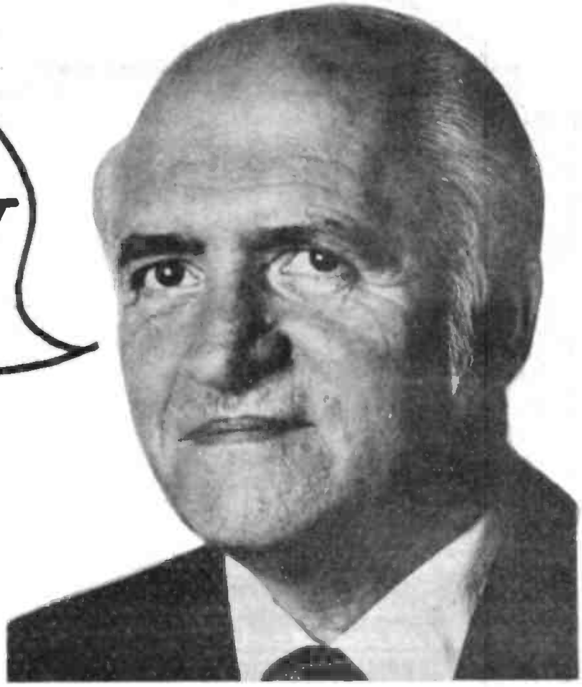
Name ....

Address ....

....

EE/7/76

Why not DIAL-A-COMPONENT?



These days you can Dial-a-Van, Dial-a-Recipe, Dial-a-Pop Tune, even Dial-a-Wine. But Home Radio Components Ltd. have been offering such a service for years! Those of you who already own one of the renowned Home Radio Components catalogues already know all about it. For the benefit of those who are still struggling along without one, here is how you set about it.

1. Purchase a Home Radio Components Catalogue. *(See details further on).*
2. Join the HRC Deposit Account scheme, by simply signing the simple form enclosed in the catalogue.
3. Send it to HRC with your deposit. The deposit is half of whatever credit you require; ie. if you want £10·00 you send £5·00.
4. You will receive back: a copy of your Agreement, special Order Forms, pre-paid envelopes for sending them, a Record Card on which to note your spending, and simple instructions to enable you to use the service to best advantage.

Now you are all set to dial your component orders any hour of the day, any day of the year—including Sundays, holidays, even Christmas day. You have your own exclusive telephone number, which after business hours is connected direct to an answerphone. *Like the idea?* Then send for your Home Radio Catalogue straight away. It costs only 65p plus 34p postage and packing, and it contains 6 vouchers each worth 5p when used as directed, so you can soon get back 30p of your investment. Moreover, if you join the Deposit Account scheme you will receive a new catalogue *free* whenever it is reprinted. It's hardly surprising that over a thousand customers are already using this simple method of buying their components. *Try it now—you'll never regret it.* Send 99 pence by cheque, Postal Order or Giro with the coupon below, and soon you'll be twirling your telephone dial whenever you urgently want some parts!

Today's finest Components Catalogue
65p plus 34p POST & PACKING

The price of 99p applies only to customers in the U.K. and to BFPO Addresses

Please write your Name and Address in block capitals

NAME..

ADDRESS ....

....

....

HOME RADIO (Components) LTD., Dept. EE,
234-240 London Road, Mitcham, Surrey CR4 3HD

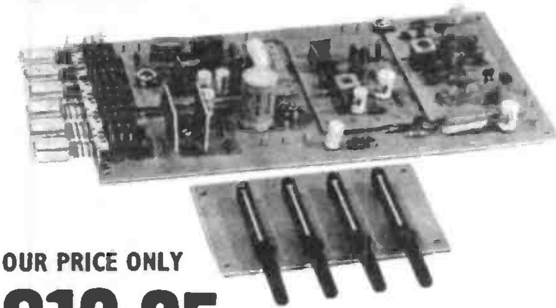
(Regn. No London 912966)

POST THIS COUPON with cheque or p.o. for **99p**

HOME RADIO (Components) LTD. Dept EE, 234-240 London Road, Mitcham, CR4 3HD. Phone 01-648 8422

BI-PAK

High quality audio



NEW

STEREO FM TUNER

Fitted with Phase Lock-loop Decoder

- ★ FET Input Stage
- ★ VARI-CAP diode tuning
- ★ Switched AFC
- ★ Multi turn pre-sets
- ★ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20–30v at 90 Ma max.

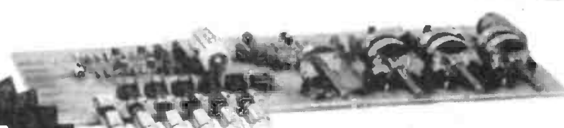
OUR PRICE ONLY

£19.95

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO** 30 or the **MK**60 Kit etc. Alternatively the **PS**12 can be used if no suitable supply is available, together with the Transformer **T461**.
The S450 is supplied fully built, tested and aligned.
The unit iseasily in stalled using the simple instructions supplied.

VAT ADD 12½%

STEREO PRE-AMPLIFIER PA 100



A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency Response + 1dB 20Hz–20KHz.
Sensitivity of Inputs:
1. **Tape Input 100mV into 100K ohms**
2. **Radio Tuner 100mV into 100K ohms**
3. **Magnetic P.U. 3mV into 50K ohms**

P.U. Input equalises to R1AA curve within 1dB from 20Hz to 20KHz. Supply 20-35V at 20mA. Dimensions—200mm × 80mm × 35mm.

£13.50 *p & p 45p*

MK60 AUDIO KIT:
Comprising: 2 x AL60's 1 x SPM80, 1 x BTM80, 1 x PA100, 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE** *£27·55 plus 62p postage.*
TEAK 60 AUDIO KIT:
Comprising: Teak veneered cabinet size 16¾" x 11½" x 3½", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE** *£8·20 plus 62p postage.*

AL 60

25 Watts (RMS)

● Max Heat Sink temp. 90C. ● Frequency response 20Hz. ● Distortion better than 0·1 at 1kHz. ● Supply voltage 15-50v. ● Thermal Feedback. ● Latest Design Improvements. ● Load—3,4,5, or 16ohms. ● Signal to noise ratio 80db. ● Overall size 63mm. 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.

ONLY £3.95

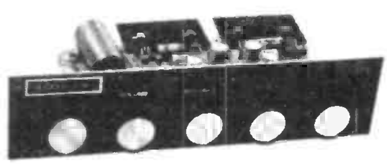
Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1·5A at 35V. Size: 63mm, 105mm, 30mm. Incorporating short circuit protection.

INPUT VOLTAGE	33-40V. A.C.
OUTPUT VOLTAGE	33V. D.C. Nominal
OUTPUT CURRENT	10mA-1·5 amps
OVERLEAD CURRENT	1·7 amps approx.
DIMENSIONS	105mm × 63mm × 30mm
TRANSFORMER BMT80	£2·60 + 62p. postage

£3.00

STEREO 30 COMPLETE AUDIO CHASSIS



7 + 7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins.).

TRANSFORMER £2·45 plus 62p p & p

TEAK CASE £3·65 plus 62p p & p.

£15.75 *P & P 45p.*

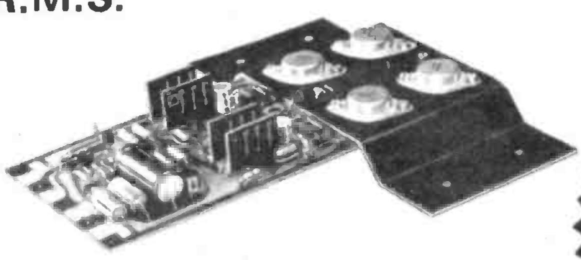
equipment mono and other modules for Stereo

IT'S NEW!

IT'S POWERFUL

IT'S THE AL250

125 watts
R.M.S.



POWER AMPLIFIER

**Specially designed for use in—
Disco Units, P.A. Systems, high power Hi-Fi, Sound reinforcement systems**

The module has a sensitivity of 450mV and a frequency response extending from 25Hz to 20KHz whilst distortion levels are typically below ·1%. The use of 4, 115w transistors in the output stage makes the unit extremely rugged while damage resulting from incorrect or short-circuit loads is prevented by a four transistor protection circuit.
The unit is intended for use in many applications such as disco units, sound reinforcement systems, background music players, etc.

SPECIFICATION:

Output Power: 125 watt RMS Continuous
Operating voltage: 50–80
Loads: 4–16 ohms
Frequency response: 25Hz–20kHz *Measured at 100 watts*
Sensitivity for 100 watts output at 1kHz: 450mV
Input impedance: 33Kohms
Total harmonic distortion
50 watts into 4 ohms: 0·1%
50 watts into 8 ohms: 0·06%
S/N ratio: better than 80dBs
Damping factor, 8 ohms: 65
Semiconductor complement: 13 transistors 5 diodes
Overall size: Heatsink width 190mm, length 205mm Height 40mm

ONLY £15.95 +8% VAT

MPA 30

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new Bi-Pak M.P.A. 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only. Used in conjunction are 4 low noise, high gain silicon transistors. It is provided with a standard DIN input socket for ease of connection. Supplied with full, easy-to-follow instructions.

£2.65

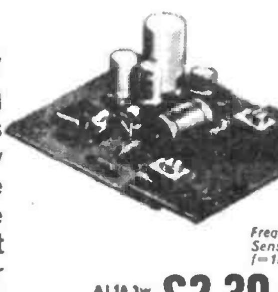
VAT ADD 12½%

POSTAGE & PACKING

Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1·00

AL10-20-30

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 home. Harmonic Distortion Po = 3 watts f = 0·25% Load Impedance 8-16ohm

Frequency response ± 3dB Po = 2 watts 50Hz-25KHz Sensitivity for Rated O/P—Vs = 25v. RL = 80ohm f=1KHz 75mV. RMS. Size: 75mm x 63mm x 25mm.

AL10 3w R.M.S. **£2.30** AL2: 5w R.M.S. **£2.65** AL30 10w R.M.S. **£2.95**

NEW

PA12 £6.50

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with **AL10 20 30** Amplifier Modules. Features include on/off volume. Balance, Bass and Treble controls. Complete with tape output.
Frequency Response 20Hz-20KHz (−3dB)
Bass and Treble range ±12dB
Input Impedance 1 meg ohm
Input Sensitivity 300mV
Supply requirements 24V. 5mA
Size 152mm x 84mm x 33mm

PS12

Power supply for AL10/20/30, PA12, S450 etc. Input voltagr 15-20v A.C. Output voltage 22-30v D.C. Output Current 800 mA Max. Size 60mm x 43mm x 26mm. **£1.20**

Transformer T538 £2.30

BI-PAK

P.O. BOX 6, WARE, HERTS

everyday electronics

PROJECTS. THEORY....

WORK OR PLAY?

A way of escape? Or an entry into a bright future? In fact, as a hobby, electronics may be either of these contradictory things. A means for total change and relaxation from one's normal day-to-day work or business, or the starting point for a professional career within that very field of electronics. It is a matter largely determined by age. The younger the individual the more likely the second description will apply, of course.

These are difficult times for school leavers. Competition for the better and more interesting jobs is keen and the standards imposed by employers are naturally high. They can afford to be very selective. The candidate who can demonstrate enterprise and initiative through, for example, involvement in some serious extra-mural pursuit must have the edge on the person who relies entirely on his or her scholastic attainments by way of recommendation.

And very naturally any young person attracted to a career in the field of electronics—and it is indeed a very large field, with diverse opportunities—starts off with a particular advantage if electronics has been followed as a hobby.

The nature and extent of job opportunities within the electronics industry makes a vast subject on its own. But each month another piece of the jigsaw is placed in position by our regular contributor on Careers matters. So a picture is being built up of the whole industry and its peripheral organisations. A picture which portrays the kind of trained and skilled personnel who are employed throughout all branches and at all levels of this technology, and explains the relevant educational and qualification requirements.

These articles are aimed specifically at those of our younger readers who very shortly will have to think of their future career. But also, they are valuable sources of reference for parents, teachers and others who may sometime find themselves in the position of careers advisers. And, finally, to the general reader who enjoys his hobby as an escape from other daily toil, the careers articles cannot be without appeal. For they throw some light on life within professional electronics and so help stimulate further every reader's interest in this most exciting and ever changing world of technology.

Fred Bennett.

Our August issue will be published on Friday, July 16
See page 375 for details.

EDITOR F. E. Bennett • ASSISTANT EDITOR M. Kenward • TECHNICAL EDITOR B. W. Terrell B.Sc.
ART EDITOR J. D. Pountney • P. A. Loates • K. A. Woodruff
ADVERTISEMENT MANAGER D. W. B. Tilleard • P. Mew

Editorial Department: Everyday Electronics, Fleetway House, Farringdon Street, London EC4 4AD. Phone 01-634 4452.
Advertisement Department: Everyday Electronics Advertisements, King's Reach Tower, Stamford Street, London SE1 9LS. Phone 01-261 5148.

...EASY TO CONSTRUCT
...SIMPLY EXPLAINED

VOL. 5 NO. 7 JULY 1976

CONSTRUCTIONAL PROJECTS

AQUAGUARD *A moisture, rain and water level detector* by Stephen Price **362**

ACCENTED METRONOME *A simple inexpensive design* by R. A. Penfold **366**

AUTO-COOL *Thermostatic control for a car fan* by C. E. Loney **384**

RF/AF SIGNAL GENERATOR *For checking radio equipment* by F. G. Rayer **386**

GENERAL FEATURES

EDITORIAL **360**

TEACH-IN 76 *Part 10, Electromagnetism* by A. P. Stephenson **370**

FOR YOUR ENTERTAINMENT *Resistance and Electricity Meters* by Adrian Hope **374**

YOUR CAREER IN ELECTRONICS *Electronic Data Processing* by Peter Verwig **376**

READERS' LETTERS *Your news and views* **379**

JACK PLUG AND FAMILY *Cartoon* **379**

I.C.s EXPLAINED *Part 3* by Brian Dance **380**

SHOP TALK *Component buying and new products* by Mike Kenward **383**

PHYSICS IS FUN *The electric bell* by Derrick Daines **390**

PROFESSOR ERNEST EVERSURE *The Extraordinary Experiments of.* By Anthony J. Bassett **393**

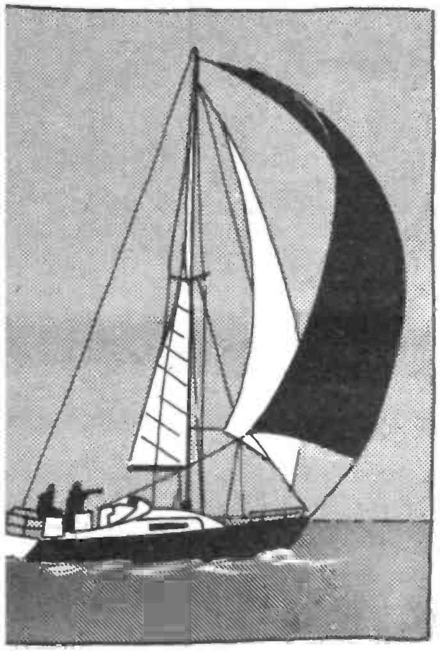
COUNTER INTELLIGENCE *A retailer's comments* by Paul Young **395**

DOWN TO EARTH *Mains hum again* by George Hylton **396**

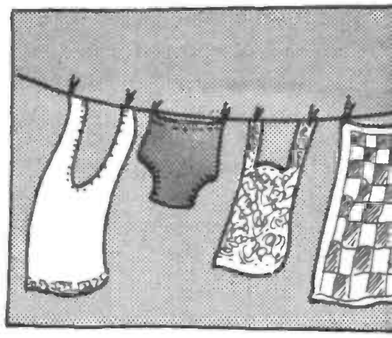
BACK NUMBERS, LETTERS AND BINDERS

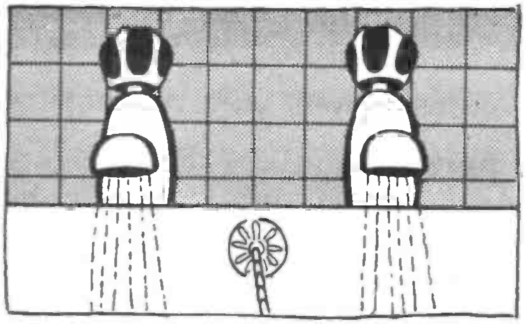
We are unable to supply back copies of Everyday Electronics or reprints of articles and cannot undertake to answer readers' letters requesting designs, modifications or information on commercial equipment or subjects not published by us. An s.a.e. should be enclosed for a personal reply. Letters concerning published articles should be addressed to: The Editor, those concerning advertisements to: The Advertisement Manager, at the addresses shown opposite.

Binders for volumes 1 to 5 (state which) are available for £2·10, including postage, from Binding Department, Carlton House, Great Queen Street, London, WC2E 9PR.



AQUA GUARD





By STEPHEN PRICE

THE Aquaguard described here is a multipurpose device for which many applications will be found in the home, school laboratory and on marine craft. It provides a loud, audible warning signal whenever a special probe is immersed in or bridged by water.

DESIGN

Moisture detectors make use of the fact that ordinary tap water possesses a comparatively low electrical resistivity. This is due to the presence of dissolved impurities, such as mineral salts, which ease the passage of current through what would otherwise be a very high resistance.

The circuit of a fairly typical detector is shown in Fig. 1. The probes consist merely of conducting metal rods which are spaced by a small distance. The resistance between these probes in free air is almost infinite, or perhaps we should say, it can be considered infinite (apologies to mathematicians)!

In this situation the base of TR1 is open circuit, and assuming this transistor is of the silicon variety, only a very small leakage current will flow through the device and this will prove insufficient to provide bass bias for TR2, which in consequence, remains turned off. But if the probes are immersed in water, a resistance in the order of tens of kilohms appears between base of TR1 and the positive supply line.

As TR1 is an *npn* transistor it becomes forward biased and current flows readily between its collector/emitter junction (equal to base current × h_{fe}). This will have the effect of placing a low resistance between the positive supply and TR2's base with the result that this transistor also turns on, and due to its own current gain, passes a high collector current. The relay coil energises and generates a magnetic field which closes the contacts of RLA1 and rings the bell.

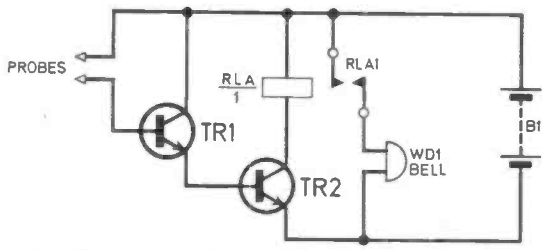


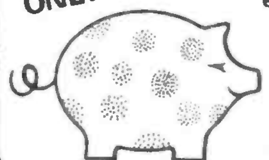
Fig. 1. Basic detector circuit.

Although the circuit of Fig. 1. is both simple and reliable, it has the disadvantage of requiring a relay and also a sounding device (in this case an electric bell). A far better design would employ an electronic sound generator driving a small loudspeaker. The electromagnetic relay should also be eliminated.

To this end the circuit of Fig. 2. was developed, the heart of the device is a multi-

FOR GUIDANCE ONLY

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



£2.20
excluding case

*Based on prices prevailing at time of going to press

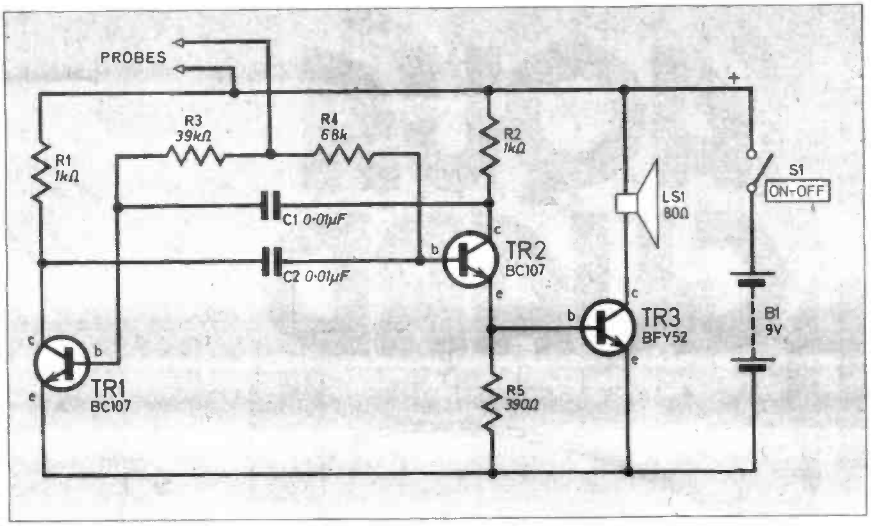


Fig. 2. The complete circuit diagram of the Aquaguard.

vibrator oscillator comprising TR1 and TR2 with associated components. Many readers will be familiar with this particular circuit which consists simply of two common emitter amplifiers, the output of each stage being coupled to the input of the other via a capacitor (C1 and C2). Continuous feedback is thus established and the circuit oscillates at a frequency of period *C.R.* 0·7 seconds where *C* is the value of the coupling capacitors in Farads and *R* the value of the base resistors (R3 and R4) in ohms. The circuit produces a square, or rectangular, wave output as TR1 and TR2 turn on and off alternately.

Providing that low leakage transistors are employed, the multivibrator cannot oscillate unless the base bias resistors (R3 and R4) are connected to the positive supply line but examination of Fig. 2. reveals that these resistors are in series with the probes and so oscillation will only take place when a resistance exists between the probes themselves namely, the resistance of the water.

CAPACITORS

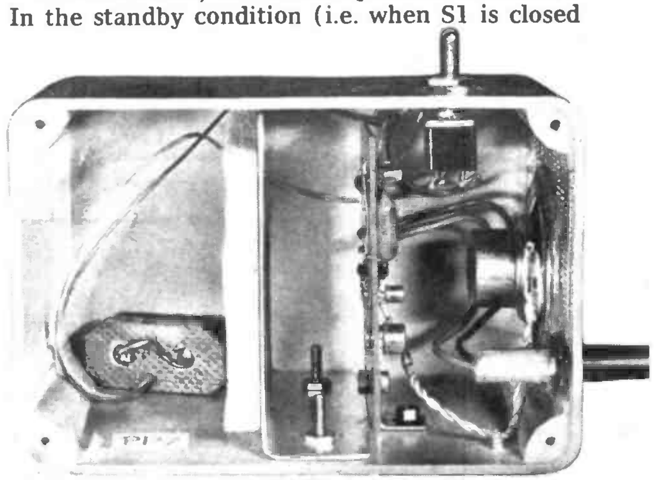
Those who have studied previous circuits which make use of the multivibrator as an audio oscillator may be surprised to find capacitors with values as low as 0·01µF being used in a circuit designed to produce an output of approximately 1kHz. The method in this particular brand of madness is to give R3 and R4 comparatively high values so that any changes in resistance between the probes (i.e. due to variation in the waters resistivity, corrosion of probes etc) has a minimal effect on the oscillator's frequency; or to put it another way, the ratio between the resistance of the water and the values of R3 and R4 is fairly high.

Transistor TR3 is a simple common emitter amplifier operating in class D (switching mode). Whenever TR2 turns on a small voltage appears across R5 which results in the base of TR3 being held at a positive potential above ground thus turning this transistor hard on at saturation. The resulting collector current energises the loudspeaker voice coil. If TR1/TR2 are not oscillating (i.e. there is no water between the probes) a voltage cannot possibly be developed across R5 because TR2 will be off consequently there is no bias or the amplifier and TR2 passes only a few microamps of leakage current.

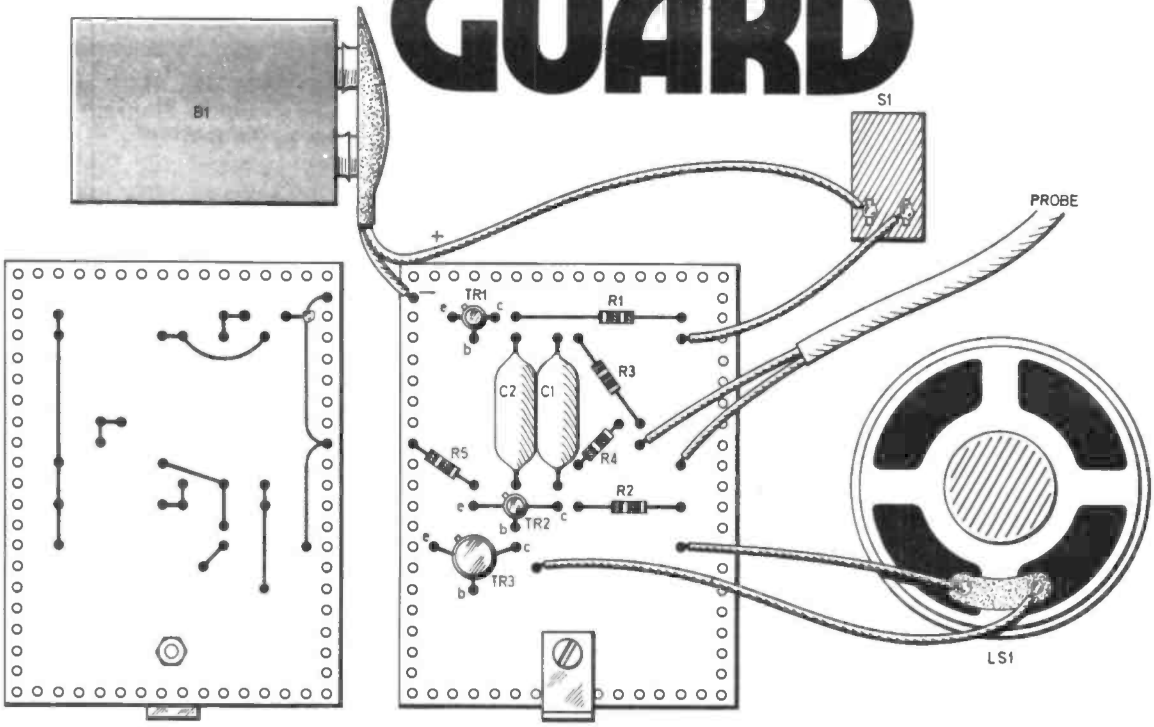
MARK TO SPACE

The resistors R3 and R4 have been given unequal values (39 kilohms and 68 kilohms respectively) in order to produce a mark to space ratio of just under 1:2. Briefly this results in TR3 being switched off for a longer period than it is switched on during each cycle. This reduces power consumption without unduly effecting the volume of sound produced.

To summarise, the circuit operates as follows: In the standby condition (i.e. when S1 is closed



AQUA GUARD



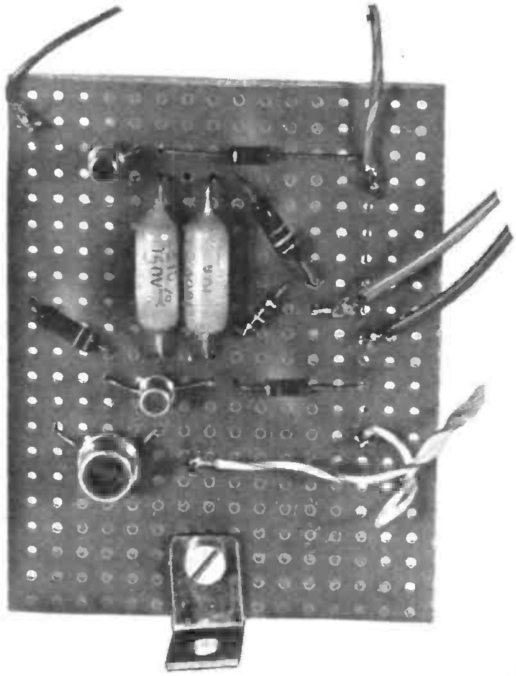
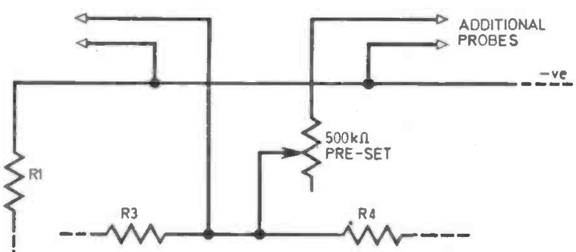


Fig. 3. Layout and wiring of the Aquaguard.

Fig. 4. Circuitry for using two probes.



but no water exists between the probes) the device does not operate and only leakage current flows in the three transistors. This current is extremely small and therefore does not drain the battery in any way, when the probes are immersed in water the multivibrator starts oscillating immediately and an amplified warning tone is emitted from the loudspeaker. This sound will continue until S1 is opened or the water level drops.

CONSTRUCTION

The first task will be to mount the necessary components (excluding S1, LS1 and B1) and wire the circuit of Fig. 2. onto a piece of plain matrix board. For those who have not come across this type of circuit board before, it consists, simply of a thin paxolin sheet which has a matrix of small holes, drilled over its whole area, through which component leads may pass. The component layout is shown in Fig. 3. The mounting of components should prove a very straightforward operation as there are only ten separate items.

The only precaution in soldering the underside connections is to ensure that shorts do not occur where leads cross each other (e.g. R3 must not touch C2) and it is therefore advisable to use sleeving on certain leads. Be careful not to overheat any of the components, especially the transistors.

Finally, flying leads are attached to provide connections to one side of S1, the negative battery terminal, loudspeaker and probe.

The whole unit (excepting probes) can be housed in a box of approximate dimensions 100×100×120mm. This will give adequate room for a medium sized 9 volt battery (e.g. PP7).

HOUSING

The case may be fabricated from sheets of 3 ply or alternatively a ready made plastic case can be employed. A pattern of small holes can be drilled to give a passage for the sound from the loudspeaker, the battery is mounted behind an aluminium bracket which not only holds the battery in place, but also confines any leakage which could otherwise corrode components. A foam rubber pad is stuck to the back of the case and cushions the battery in order to prevent it rattling. The on/off switch, S1 is best positioned on the top of the unit just behind the loudspeaker. The circuit board is mounted on a small metal bracket. A small hole in a bottom corner at the front of the case provides an outlet for the probe lead (note the grommet fitted here).

The simplest probe will consist merely of two bared wires, which should be tinned to reduce corrosion. These can be simply dangled over the edge of a cold water tank, for instance, and when a dangerous level is reached the leads will become immersed and the alarm sounded.

A more substantial probe, can be constructed from brass strips mounted on a piece of Perspex. The strips may be bent to shape in a small vice. The whole probe is held together by insulating Perspex plates.

REFINEMENTS

A plug and socket arrangement might be employed for the probe lead on the front of the unit thus enabling a variety of probes to be employed.

It is also possible to connect two probes simultaneously, but it will be necessary to provide some form of indication as to which probe the alarm is being sounded for at any given time. The arrangement shown in Fig. 4, achieves this by producing two distinct tones; a high pitch for one probe and low pitch for the other. The 500 kilohm pre-set pot controls the frequency of the low pitched tone. There should be adequate room on the circuit board for this component.

The many applications for this simple unit are too numerous to mention. Although we hate to be reminded of the fact in Britain; the detector will make an excellent rain alarm, provided that a probe consisting of finely spaced wires or a piece of copper clad Veroboard with alternate strips connected together is constructed to catch the first drops. ▣

Acknowledgement. We would like to thank **Yachting Monthly** for supplying the cover photograph used to illustrate this article.

Components....

Resistors

R1 1kΩ — R4 68kΩ
R2 1kΩ — R5 390Ω
R3 39kΩ
All ¼ or ½W carbon ±10%

Capacitors

C1 0·01μF polyester ±20%
C2 0·01μF polyester ±10%

SEE SHOP TALK

Semiconductors

TR1 BC107 silicon *npn*
TR2 BC107 silicon *npn*
TR3 BFY52 silicon *npn*

Loudspeaker

LSI 40 to 80Ω moving coil approx. 60mm

Miscellaneous

S1 Single pole on/off switch.
B1 9V Battery PP7/PP9, etc.
Small plastic or wooden case, speaker grille, Paxolin matrix board 50 x 75mm, 0·15 inch matrix, solder tags, battery connector, connecting wire, nuts and bolts (6BA), grommet, twin flex for connecting probes.

Accented Metronome

By R.A. PENFOLD

An inexpensive and useful musical accessory.

MANY electronic metronome designs have appeared in the technical press in the past, but this one is different from the majority of these in that it has the unusual feature of being able to emphasise every second, third, or fourth beat. The beat is emphasised by being made a little louder and deeper in pitch than the standard beat.

The unit can thus be made to produce a definite rhythm of two, three, or four beats to the bar. It can also be used as an ordinary metronome without emphasis for more complicated rhythms such as 5/4.

The device is completely self contained, and has an internal speaker and 9 volt battery (PP3) supply. The frequency range covered is from less than 60 to above 270 beats per minute, and this is continuously variable in one range.

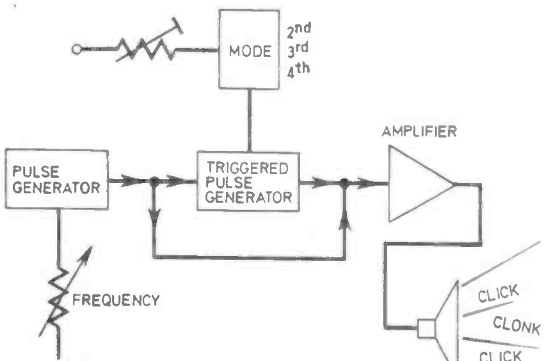
CIRCUIT OPERATION

Two unijunction transistors form the basis of the circuit, and these are TR1 and TR3 in the circuit diagram of the metronome, which is shown in Fig. 1. These are both used as relaxation oscillators, TR1 providing the basic beat signal, and TR3 together with TR2 operating as a frequency divider which provides the emphasis signal.

Construction of a unijunction transistor is shown in Fig. 2.

With reference to Fig. 1, when the supply is connected, C1 will begin to charge via VR1, R1,

HOW IT WORKS



Basically the *Accented Metronome* consists of two pulse generators, one being triggered by the other as shown in the block diagram left. The first generator is a free-running unijunction relaxation oscillator and the output is fed directly to the amplifier and heard in the loudspeaker. The frequency of this generator is controlled by a potentiometer fixed to the front panel.

An output from the first generator is fed to the second generator where it causes the timing capacitor here to charge up. It may take several input pulses to produce an output pulse. The number of input pulses required to produce an output coincident with every 2nd, 3rd, or 4th first generator pulse can be set by presets in the circuit thereby "accenting" the 2nd, 3rd or 4th beat.

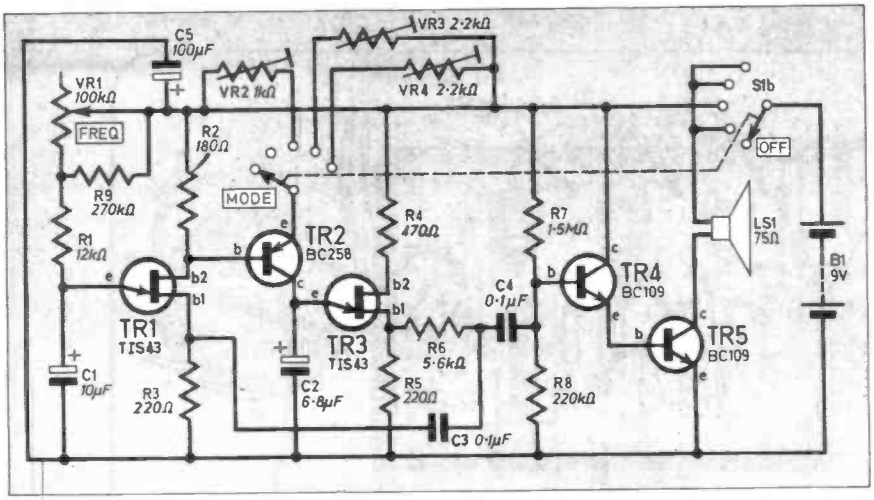


Fig. 1. The circuit diagram of the Accented Metronome.

and R9. No significant current can flow into the emitter of TR1 until about 0·6 volts more than the voltage on the silicon at the position of the junction appears at the emitter. This is because the diode that is formed by the junction is reversed biased. As the junction is about half way up the silicon bar, about half the supply voltage will appear at the junction.

When the charge voltage across C1 reaches this level plus about 0·6 volts dropped across the junction, the diode will be forward biased, and a current will flow into the emitter. This current flow causes a regenerative action to take place in the unijunction, and it is beyond the scope of this article to describe this action in detail. However, this results in the input impedance to the emitter falling to a few ohms until C1 is almost fully discharged, whereupon it once again has an extremely high input impedance. Capacitor C1 does of course discharge very rapidly into the emitter of TR1.

For the duration that C1 is discharging, the resistance in the silicon bar falls to about half its previous level. This produces a brief positive pulse across R3, and a negative one across R2.

FREQUENCY DIVIDER

The static voltage across R2 is insufficient to turn on TR2, but the pulses produced across R2 will momentarily turn TR2 on. This is of course provided that S1 is in position 2, 3, or 4, with one of the preset resistors switched into circuit. These resistors control the level of current that is pulsed through TR2.

Transistor TR2 collector feeds a second unijunction relaxation oscillator. Preset VR2 is adjusted so that after one pulse of current, the voltage across C2 is just below the triggering point of TR3. The next pulse therefore causes TR3 to trigger and a pulse is simultaneously produced across R3 and R5. After a further two pulses TR3 will again be triggered, and so TR2 and TR3 operate as a divide-by-two circuit.

Components VR3 and VR4 are adjusted for slightly lower currents through TR2, so that three and four pulses respectively are required before TR3 triggers. Thus divisions of three and four are also provided.

OUTPUT AMPLIFIER

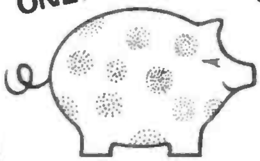
The pulses produced across R3 and R5 are fed to the base of TR4, which is an emitter follower. This drives TR5, common emitter output stage, and directly drives a high impedance speaker. Resistors R7 and R8 bias TR4 and TR5 so that they are only just turned on. The positive pulses from TR1 and TR3 are amplified by this arrangement, and produce a click from the speaker. The output stage operates in class B and gives good battery life.

The pulses from TR1 are purposely fed to the amplifier via a capacitor which has rather a low value for the impedance into which it operates. This tends to attenuate the bass frequencies, and a fairly high pitched metronome-like click is emitted from the speaker. The coupling capacitor, C3, is loaded by R5 and R6 which forms a simple high pass filter. There is little attenuation of the bass frequency content of the pulses from TR3, as these are fed to the input of the amplifier via resistor R6. Capacitor C4 is a d.c. blocking capacitor, and it provides little in the way of bass roll-off as it is looking into the high input impedance of TR4.

Every second, third, or fourth pulse from the speaker can therefore be clearly accentuated by a deepening in pitch, and there is also an in-

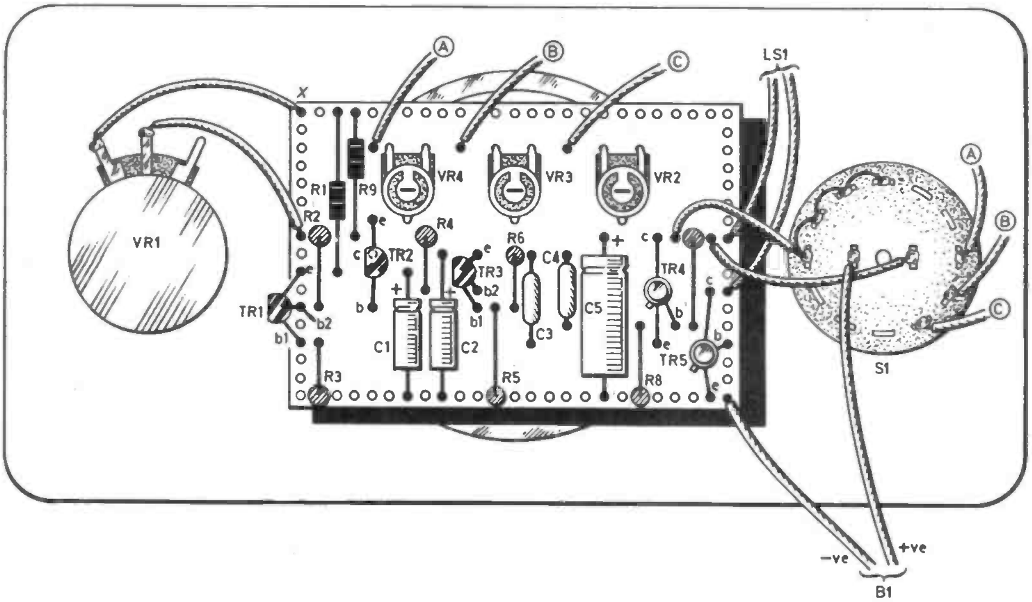
FOR GUIDANCE ONLY

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



£3.40
excluding case

*Based on prices prevailing at time of going to press



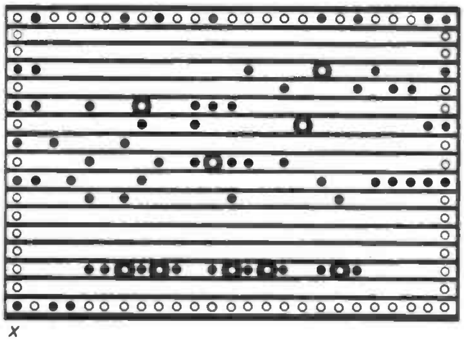
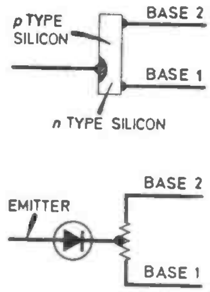


Fig. 3. Wiring up details and layout of the components on the unit lid.

Fig. 2. Basic details of unijunction structure.



Components....

SEE SHOP TALK

Resistors

R1	12kΩ
R2	180Ω
R3	220Ω
R4	470Ω
R5	220Ω
R6	5·6kΩ
R7	1·5MΩ
R8	220kΩ
R9	270kΩ

All ¼W carbon ±10%

Potentiometers

VR1	100kΩ log. carbon
VR2	1kΩ horizontal preset
VR3	2·2kΩ horizontal preset
VR4	2·2kΩ horizontal preset

Capacitors

C1	10μF 10V elect.
C2	6·8μF 10V elect.
C3	0·1μF type C280
C4	0·1μF type C280
C5	100μF 10V elect.

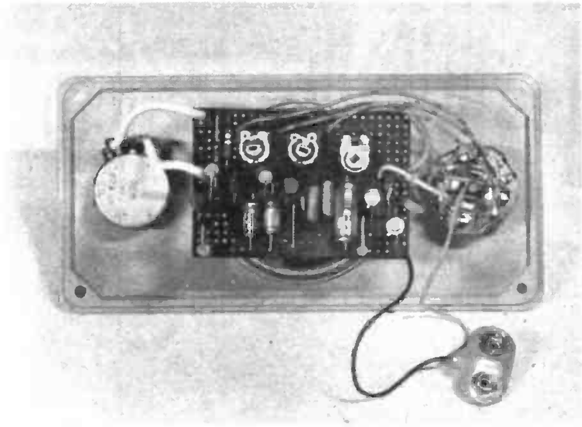
Semiconductors

TR1	TIS43 *n*-type unijunction
TR2	BC258 silicon *pnp*
TR3	TIS43 *n*-type unijunction
TR4	BC109 silicon *npn*
TR5	BC109 silicon *npn*

Miscellaneous

S1	2-pole 6-way wafer switch
LS1	75 ohm miniature loudspeaker approx. 50mm diameter
B1	9V type PP3

Veroboard: 0·1 inch matrix 17 strips x 25 holes; case size 150 x 75 x 47mm (type 1006 or similar); two knobs; PP3 battery connector.



Photograph showing the prototype component board fitted to the underside of the lid.

crease in volume on the emphasised beat.

With S1 in position 1, the frequency divider is disabled, and the unit operates as an ordinary metronome. With S1 rotated fully anticlockwise, the unit is turned off.

The potentiometer, VR1, controls the speed at which C1 charges, and so it also controls the frequency of the beat; R9 shunts VR1 to the required maximum value of about 70 kilohms. The supply is decoupled by C5.

COMPONENT PANEL

All the small components are mounted on a piece of 0·1inch pitch Veroboard having 25 holes by 17 copper strips. This is carefully cut from a larger piece of board using a small hacksaw. The nine breaks in the copper strips are then made at the points indicated in Fig. 3, which shows both sides of the panel. If a proper spot face cutting tool is not available, a small twist drill (about size No. 24) can be used instead.

Next mount and connect all the components, leaving the transistors until last and remember to use a heatshunt on the leads of the transistors when soldering.

In the positions where leads from the panel are eventually to connect to the speaker, S1, VR1 and battery, connect insulated leads about 90mm long to the panel. Those to VR1 and the speaker must be of a heavy gauge of single strand wire, say, about 14 s.w.g., as it is the stiffness of these wires that provides the mounting for the component panel. Any thin insulated wire is suitable for the other leads. Also connect the negative battery clip lead at this stage.

CASE

A commercially made plastic case is used as the housing for the prototype metronome. This has dimensions of 150mm×74mm×47mm, and consists of a moulded outer casing and a removable front panel. The unit is constructed on the front panel.

The case does not have to be made from plastic, and there are several cases of similar size and construction available, but made from aluminium, which are quite suitable.

A 50mm diameter cut-out for the speaker is made in the centre of the front panel. This is most easily made using a fretsaw or a coping saw. A miniature round file can be used, but this is a slower method.

A piece of speaker cloth or fret is glued over the front of the speaker cut-out, and the speaker is glued in place behind the cut-out. A good quality adhesive (Araldite or Bostik) must be used here.

Potentiometer VR1 is mounted to the right of the speaker, and S1 is mounted to the left of the speaker such that they are equally spaced either side of the speaker.

WIRING

The component panel is situated at the rear of the speaker. A layer or two of insulation tape is spread over the rear of speaker to prevent the copper strips from being short circuited through the metal speaker casing. If a metal case is used, it would be advisable to use a layer of tape at strategic places on the inside of the case as well.

Next connect the leads from the component panel and lastly the positive battery lead to S1b.

ADJUSTMENT

Give the wiring a thorough check over before turning the unit on. Upon switching on, a clicking should be emitted from the device. Switch S1 to position 2 and adjust VR1 for maximum frequency (fully anticlockwise).

Adjust VR2 so that every second beat is accentuated. It should be adjusted as far as possible in a clockwise direction, without the 2 to 1 frequency division ratio being lost. Then when VR1 is adjusted for slower speeds, and the battery voltage drops with age, the correct 2 to 1 division ratio will still be obtained.

The other presets VR3 and VR4 are similarly adjusted to accentuate every third and fourth beat respectively.

CALIBRATION

A scale showing the number of beats per minute can be marked around the control knob of VR1. The number of beats produced per minute is easily determined at the slower speeds simply by counting the number of pulses produced during a one minute period. At faster speeds it is easier to reduce the period to 15 seconds, and then multiply the number of beats counted by four. ▣

TEACH-IN 76

By A.P. STEPHENSON

Part Ten

10.1 THE SOLENOID

If a battery is connected across a coil of wire, the current will produce a magnetic field around the coil. This is called an **electromagnet** because the magnetism vanishes again if the current is switched off. Any coil used for this purpose is called a **solenoid**, your reed coil is an example.

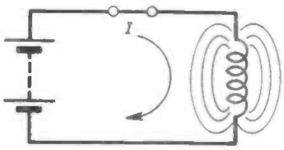


Fig. 10.1a. Current flowing through a solenoid causes a magnetic field to be set up.

If the coil is wound on a soft-iron "former" the effect is magnified, i.e. more magnetism for the same current. A very useful yardstick to measure the magnetic effect is the **magneto-motive-force** or simply **m.m.f.** which is proportional to the **ampere-turns**. Thus the value of the m.m.f. is current *times* the number of turns. In equation form, m.m.f. $= N \times I$ where N = number of turns.

Thus a few turns with large current is the same as a large number of turns with a small current. The unit of m.m.f. is the ampere-turn.

10.2 ELECTROMAGNETIC INDUCTION

Michael Faraday made some startling discoveries in connection with changing magnetic fields, see Fig. 10.2a.

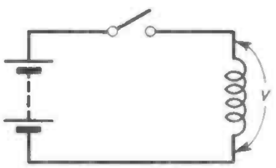


Fig. 10.2a. The field collapses and a high voltage spike appears across the coil at instant switch is opened

Whenever you switch off the current from a coil, a relatively high e.m.f. is induced across. it. The equation of this behaviour in modern symbolism is as follows:

> **Induced volts = L x rate of change of current.**

Where L is in henries and rate of change is in amps per second.

The symbol L in this equation stands for the **inductance** of the coil and depends on such things as the diameter, length, number of turns and the presence of iron or its compounds in the core former. Note carefully that a change is sufficient, it is not necessary to switch off the current completely.

The unit of inductance is the **henry**.

> **A 1 henry coil will have 1 volt induced across it if the current is changed at the rate of 1 amp per second.**

10.3 THE TIME CONSTANT

Although coils are wound with copper wire, the resistance can be quite high if several thousand turns are involved. Because of this internal resistance, r, a practical coil can be represented by a "perfect" inductor in series with a resistance as shown in Fig. 10.3a.

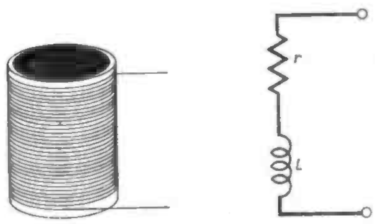


Fig. 10.3a. A practical coil shown left and its theoretical equivalent.

Another strange property of coils is their reluctance to allow currents to change as if they possessed some kind of current inertia.

If we close a switch which starts current flowing in a coil, the time taken for the current to grow to the final value of V/r amps depends on the ratio L/r which is called the **time constant**. Thus,

Time constant = L/r seconds

and is defined as the time taken for the current to grow to about two thirds of its final value.

Example

A 2 henry coil having an internal resistance of 100 ohms is suddenly connected across a 9 volt battery. The final current would be $V/r = 9/100$ amps $= 90$ milliamps and the time constant is $L/r = 2/100 =$ 20 milliseconds. Thus it would take 20 milliseconds for the current to reach a value of 6 milliamps.

The rest of the story is best explained by the graph shown in Fig. 10.3b which may be recognised by mathematical types as an exponential curve and by the observant types as a curve which strikingly represents the growth of voltage in a capacitor-resistor circuit. In fact capacitors and coils are like electronic fish and chips—different and yet dependent on one another and often found together. Inductance dislikes current changes and capacitance dislikes voltage changes.

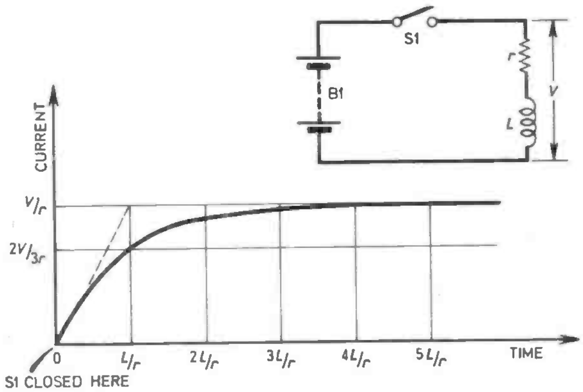


Fig. 10.3b. Graph of current growth in a coil.

10.4 THE TRANSFORMER

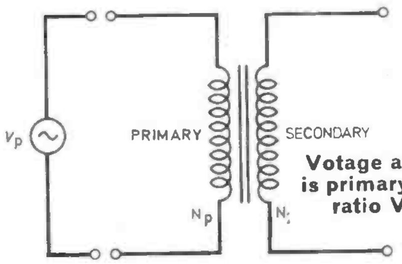
Another brain child of Faraday was the peculiar behaviour of two coils when they are close together or wound on top of one another.

He noticed that an induced e.m.f. appeared in one coil whenever the current was changed in the other. Also he noticed that the magnitude of the induced e.m.f. was proportional to the ratio of the turns on each coil. The arrangement has great practical use in a device called a **transformer**, see Fig. 10.4a.

Providing the input voltage to the primary coil is a sinusoidal variation (this term will be explained later) we can either step up or step down any voltage by suitable adjustment of the turns ratio.

Example

Suppose we have 230 volts but want 23 volts. A transformer with say, 10,000 turns on the primary and 1000 turns on the secondary will step down the primary voltage by 10 to 1, i.e. convert the 230 volts to 23 volts. The actual number of turns on each is not too important because it is the ratio that matters although too few turns would reduce the efficiency—at least four turns per volt is a rule of thumb but this depends on the iron core material.



Votage across secondary is primary voltage x turns ratio $V_s = V_p\left(\frac{N_2}{N_1}\right)$

Fig. 10.4a. Theoretical circuit representation of a transformer.

The term "iron" which has been mentioned several times, must be considered a blanket term to cover a wide range of materials which include iron and described under the heading of the **ferromagnetics**. They all have the property of enormously increasing the magnetic effect of current carrying coils. A measure of this multiplylng ratio is called the **relative permeability**, (symbol μ_r) which is defined by

$$\mu_r = \frac{\textbf{magnetic flux with specific material as core}}{\textbf{magnetic flux with an air core}}$$

Some examples being, soft iron $\mu_r = 200$, "Ferrites" (which are compounds of iron oxide) $\mu_r = 500$ to several thousand.

There is one obstacle with using iron cores—e.m.f.s are induced not only in the wires but also in the core. This causes unwanted currents (called **eddy currents**) which heat up the core and waste power. In practice, these currents are reduced by constructing the core of thin laminated sheets which collectively increases the overall resistance of the iron. The ideal core would have high μ, but infinite ohms resistance.

The bell transformer specified for use in this series has one winding with a large number of turns and marked "240 volts", and another winding with fewer turns on but with a tap brought out from near the middle. This enables three outputs to be obtained and are marked 3 volts, 5 volts and across the two outers, 8 volts.

From what has been said already, it will also be clear that it is possible to use the transformer the other way round, i.e. to step up 3, 5 or 8 volts to 240 volts. **Do not use this on the mains yet**—wait until the experiments are described later.

One final thing about transformers—we don't get anything for nothing! Voltage can be stepped up but only at the expense of current. Suppose we load the secondary coil by feeding its output terminals to a resistance. The law is, **no power gain**! If primary volts *times* amps is say 1 watt, then it is impossible for secondary volts *times* amps to exceed 1 watt. In fact, because of some losses which are inevitable, the secondary power would be a little less than 1 watt.

10.5 THE ELECTROMAGNETIC RELAY

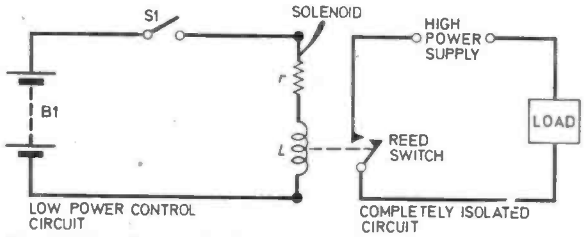
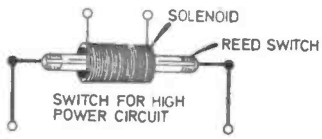


Fig. 10.5a. Theoretical circuit of an electromagnetic relay system.

Relays are electromechanical devices in which a solenoid is used to close (or in some cases open) a pair of switch contacts. They are excellent gadgets wherever it is required to switch a relatively high power circuit on or off by means of an entirely separate low power control circuit, see figure 10.5a.

The reed switch is a modern example of such a relay, and consists of a solenoid which slips over a glass tube containing two springy arms with soft iron "pole pieces" almost touching. Current through the solenoid produces a magnetic field which pulls the pole pieces together and closes the switch, see Fig. 10. 5b.

Fig.10.5b. Reed switch and solenoid connections



TEACH-IN '76 EXPERIMENTS AND EXERCISES

EXPERIMENT 10A

To investigate electromagnetic induction.

PROCEDURE

1. Wire up the components as indicated in Fig. 10A.1. The bell transformer can be laid on the table or screwed down on the side or front panel of the Circuit Deck.
2. Operate the switch S1 from off to on and note the voltmeter will momentarily kick one way and fall back to zero.
3. Now switch off and note the voltmeter will kick the other way and then fall back to zero.

Although it is advisable to set the voltmeter to highest range first, you will probably find that the 1 volt range is eventually needed to obtain a visible deflection.

CONCLUSIONS

Only when the input current to the primary is changing is an induced voltage present across the secondary.

Thus when we switch on, the current has changed from nothing to something! On switching off the current changes from something to nothing! In both cases the twitch of voltage is momentary.

This experiment you have just carried out was the classical experiment of Michael Faraday—only he, poor fellow, had to wind his own transformer with

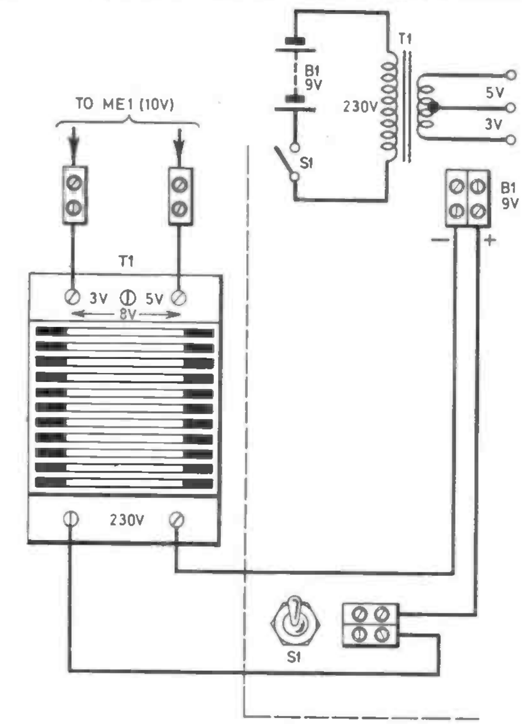


Fig. 10A.1. Wiring up details and theoretical circuit diagram for Experiment 10A.

crude wire, insulated by wrapping calico round the outside.

EXPERIMENT 10B

The properties of a reed relay.

PROCEDURE

1. Assemble the components on the Circuit Deck as shown in Fig. 10B.1. The relay will require four wires which can be twisted connections or preferably soldered. Set VR1 fully on (clockwise), switch on and note that the reed switch clicks and the lamp lights. So much for the crude operation, now proceed with the following careful measurements, starting with VR1 fully off and the voltmeter connected across the solenoid (points *X*, *Y*)
2. Slowly advance VR1 until lamp just lights and note the voltage reading, call this V_{min}; I_{min}, the current flowing, can now be calculated because the SS/12 solenoid has a resistance of about 900 ohms. Allowing for tolerances you will probably find V_{min} is about 4 volts, so I_{min} = 4 volts/900 ohms = 4·5 milliamps.
3. Slowly reduce VR1 until lamp just goes out, note the voltage and call this V_{hold}; this will probably be about 3 volts. By calculation we find that I_{hold} = 3 volts/900 ohms = 3·3 milliamps.
4. The two very sensitive states (just on or just off) can be employed in a further set of experiments with permanent magnets. If you have a horse-shoe or bar magnet use this, but if not, as a last resort, use your loudspeaker which contains a very powerful magnet. Hold the magnet in various positions near the solenoid, using its "field" to assist or oppose the electromagnetic field due to the current. The solenoid current can be considered as bias and the magnet as the trigger to take it over or under the top.

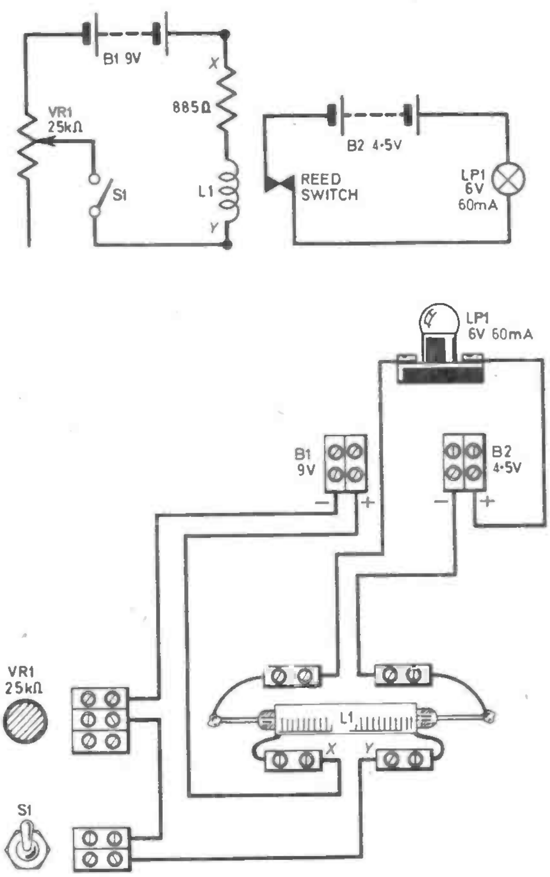


Fig. 10B.1. Circuit Deck layout for Experiment 10B.

CONCLUSIONS

(a) Although the solenoid is rated "12 volts, 900 ohms", which implies a current of 12 volts/900 ohms = 13mA, the reed operates well below these figures.

(b) It takes less current to hold-in a relay than it takes to pull it in.

(c) External magnets can replace, or be used in conjunction with the solenoid current.

The reed switch in this experiment is of course being underemployed—it can in fact operate 15 watt loads.

Question

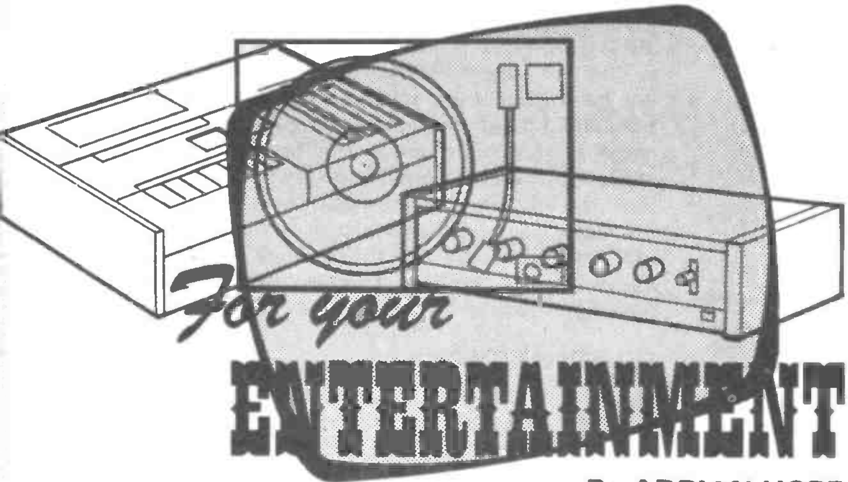
The above solenoid is rated at "135 ampere turns". How many turns on it? *Answer* About 10,000.

EXERCISES

10.1 If 2mA are passing through a 10,000 turn coil, what magneto-motive force is produced?
10.2 How much current must pass through a 1,000 turn coil to produce 5 ampere turns?
10.3 A coil of 2,000 turns has a resistance of 500 ohms. How much m.m.f. is produced if it is energised by a 9 volt battery?
10.4 A coil of 2 henries inductance has its current changed by 10 amps in 0·1 seconds. How much voltage is produced?
10.5 What are the time constants of the following coils (a) 5 henries of 100 ohms resistance (b) 5 henries of 10 ohms resistance.
10.6 The primary of a transformer has 4,000 turns and is fed by 230 volt a.c. mains, (a) how many secondary turns are required to deliver 3 volts, and (b) if the secondary is delivering 2 amps, how much primary current will flow?
10.7 A relay is switching a 230 volt 100 watt lamp by means of a small switch in the solenoid circuit. The solenoid has a resistance of 100 ohms and is designed to operate from a 6 volt supply.
(a) What is the current through the lamp?
(b) What is the current through the solenoid?
(c) What is the power in the solenoid circuit?
(d) What is the power in the lamp circuit?
(e) What is the power gain of the system?

Answers

10.1 20 ampere turns. 10.2 5 milliamps. 10.3 36 ampere turns. 10.4 200 volts. 10.5 (a) 50 milliseconds, (b) 500 milliseconds. 10.6 (a) 52 turns, (b) 26 milliamps. 10.7 (a) 0·43 amps, (b) 60 milliamps, (c) 0·36 watts, (d) 100 watts of course! (e) Approx. 278:1.



For your ENTERTAINMENT

By ADRIAN HOPE

HERE'S another of those chances to astound your friends or win a small bet. Try dropping casually into the conversation mention of a material having a resistance of so many ohms per square, for instance 100 ohms/sq. Unless the people with whom you are talking have previously encountered this odd form of measurement, they will almost inevitably chorus, "Ohms per square what?" Your answer is then, "It doesn't matter what," and this is where the innocent bets are laid.

To win, explain as follows. Consider a flat, square sheet of any conductive material, looking rather like a linotile, with a terminal on each of two opposite parallel sides. The conduction path between the two terminals will have a finite resistance. Now increase the area of the square by any amount, be it an inch, foot or mile, and the resistance of the conduction path will remain the same, provided the object remains a square and its thickness remains the same. It isn't magic; it's obvious when you think about it.

As the square increases in size, so two things happen. First, the width of the conduction path (the length of the sides carrying the terminals) increases; and secondly, the length of the conduction path (the distance between the terminals) increases by a corresponding amount.

The decrease in resistance caused by the increasing breadth of path exactly cancels out the increase in resistance caused by increasing path length. So the total resistance stays the same. A particularly easy way to think of the square is as a bank of separate resistors in parallel. Increasing the square size adds enough in parallel ($\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$) to cancel out the extra in series ($R = R_1 + R_2$) and the net result is always the same.

Electricity Meters

More on resistance, and proof that if you are dealing with electricity it helps to know Ohm's law. Like almost everyone else, I suspect, I was horrified by my last winter's electricity bill. I paid it but asked for the meter to be checked. I was equally horrified by what happened next.

The LEB official who arrived to reassure me that my meter was in fact correct offered to run an on-the-spot check, to prove it was reading accurately. "We'll take that 1 kilowatt fire," he said, pointing at an electric fire that I had had for ten years, "and check the meter with it. Because the meter wheel revolves two hundred and twenty-five times for one kilowatt hour, we need only switch on the fire, time four minutes with a watch and check the wheel turns fifteen times."

I tried, unsuccessfully, to point out to the official the fallacies in this approach, an approach, incidentally, that is widely recommended as a convenient D-I-Y meter check. I can see at least three fallacies, but readers may well be able to think of some more.

First, it is quite impossible to say whether any wheel has made *exactly* fifteen revolutions in *exactly* four minutes. But even the slightest error at this level will be puffed up into a massive error when converted to a period of three months. Conversely, even a medium-sized error that appears over three months will not show up in four minutes.

Even more important, it is quite absurd to assume that every electric fire which is nominally rated at 1 kilowatt does in fact have the exact resistance (57·6 ohms) needed to produce 1,000 watts on a 240 volt supply. As home constructors well know, all electrical components have a tolerance, and even a brand-new element could well be ten per cent out, or change ten per cent in value over the years of use. This would produce a similar change in the wattage rating of the fire which is hardly insignificant even if it doesn't show on the clumsy revolution test that the official had in mind.

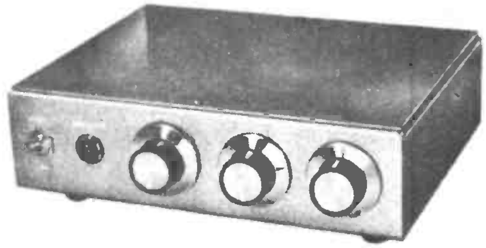
Perhaps most relevant, the Electricity Board is legally entitled to let the supply voltage vary by 6 per cent, and a 6 per cent drop on 240 volts produces (because of the square law) an 11 per cent change in wattage.

All manner of combinations are possible, one error compensating for another and so on, making a mockery of the test run. For instance, a meter error of 11 per cent (meaning eleven extra pounds on a £100 quarterly bill) would vanish if the voltage happened to be six per cent out at the time of the check!

The LEB Press Office subsequently gave a reassurance that the official who visited me was well out of line and should never have suggested such an absurd check. The standard procedure for checking a meter is to strap a rotating standard meter alongside the consumer meter and compare results.

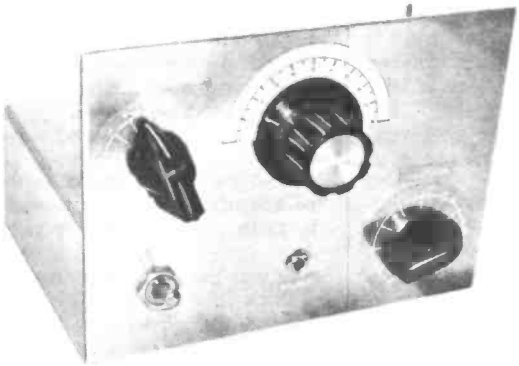
If the consumer is still unhappy, he can even demand an independent check. But do please think twice before putting your electricity board to the expense of running such a check. Most electricity bills are now higher than ever simply because the price of electricity has gone up, not because the meter has clocked up more units. Every full test that is run costs the Electricity Board money, which in the end puts more money on the price of electricity.

Next Month



2 W Amplifier

A general purpose amplifier which is suited to both workshop and entertainment applications.



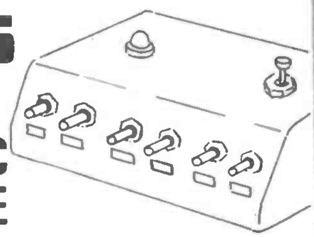
Beginners Short Wave Receiver

An inexpensive and easy to construct unit with a frequency coverage of approximately 1·67 to 31·5 MHz (150 to 9·5 metres).

Touch Sensitive Door Alarm

An unusual door alarm system originally designed for use on internal doors.

Couples ...AN ELECTRONIC GAME



A simple game with an unusual slant. Challenge your friends to find the correct combination.

everyday electronics

August issue on sale Friday July 16

IMPORTANT make sure of your copy, place an order now

Your Career *in* ELECTRONICS

By Peter Verwig

THE ELECTRONIC DATA PROCESSING

A career in electronics is an exciting prospect! Month by month our contributor Peter Verwig explains what working in electronics is all about, how to prepare yourself for a rewarding career, and the job opportunities available in the world's fastest growing industry.

Electronic data processing has been, and still is, a huge growth industry. It is also a young industry. You only need to be thirty years old to claim that every major development in EDP has been made in your own lifetime. And you only need to be five years old to be able to say that you have lived through three generations of computer technology.

In 1971 there were still a number of computers in service which were first-generation machines using thermionic valves, although most had by then been displaced by second-generation machines using transistors and discrete components and third-generation machines using miniaturised circuit modules. Today's fourth-generation machines make extensive use of integrated circuits.

VALVES

Looking at today's equipment it is hard to believe that the ENIAC computer built in the United States only thirty years ago needed a very large building and 100 kilowatts of power for its 18,000 thermionic valves. Three years later, in 1949, the British machine, EDSAC 1, used only 3,000 valves but operated at six times the speed of ENIAC. These early pioneering machines were used in scientific work as powerful "number-crunchers". They speeded up and took the tedium out of immense mathematical calculations.

It was inevitable that the new electronic tool would soon find other applications but it was not until 1953 that the first computer for commercial use was built. It was a derivative of EDSAC and was called LEO (Lyons Electronic Office) and was built by J. Lyons and Co., to improve efficiency in running the company's teashops. It performed what, by today's standards, were rather limited business tasks but it was wholly successful and triggered off, slowly at first and later gathering pace and force, an avalanche of ideas which has transformed business methods and administration.

All the early business computers suffered from the problem that they had to be integrated into an already established system of working which was not designed for automation. There was a long and protracted "learning curve" which caused a great deal of agony to computer users. Business systems are now planned round the computer and the early tarnished image which resulted in enormous popularity of the computer as a subject for comedy, and an inexhaustible supply of jokes, has long since passed.

By the end of 1960 there were about 300 computers in use in the United Kingdom. At the end of last year there were nearly 45,000 systems which, together, were worth not far short of £2,000 million. The grand total includes all types from the huge multi-million pound complex down to small business computers and visible record computers.

PERFORMANCE

Computer technology has been putting more speed and computing power into ever-smaller packages. The company which today commands a business minicomputer has the same sort of computer power and at lower cost than was possible with yesterday's maxi. In the past ten years the speed of performing raw arithmetic calculations has increased by a factor of 200 while the cost of an arithmetic operation is only one thirtieth.

The mammoth computer of the early 1960s, as exemplified by IBM's STRETCH in the USA and ICT's ATLAS in Britain, were displaced by modular units which formed the basis of "families" of computers all using the same instruction codes, data presentation and operating methods, so that a user could graduate to a larger machine of the same family when the workload increased without having to replace everything.

In fact STRETCH, the wonder of the day, had a disappointing performance and ATLAS, the first prototype of which was completed in 1961, was still experiencing operational difficulties in 1965 although these problems were mainly confined to software, i.e. the programming. The modular concept with a high level of standardisation between systems in the same family not only gave greater flexibility in application but also easier maintenance.

With the advent of microprocessors, quite powerful computers could be built on a single printed circuit board and these tiny units can be distributed round a system to perform a number of local tasks thus relieving the pressure on the central large processor.

Such microprocessors have fallen in cost to a level where they can be economically used in dozens of applications and are the "brains" in "smart" or "intelligent" terminals. But remember that although such phrases are in common useage, the computer is still the dumb creature it always was and can only do what it is told to do through programs which are devised by humans.

TIME-SHARING

One of the great growth areas has been time-sharing in which a large central processor is used simultaneously by several users, most frequently using remote terminals coupled by data transmission lines. Pioneers of this technique were the airlines with seat reservation systems. It is now common practice for computers to "talk" to each other over data links and the visual display unit (VDU) looking like a TV set with a keyboard is in widespread use as a remote terminal.

As in most fast-moving technologies demanding huge resources in research and development, the computer industry has had its business casualties. In the early days of digital computers two sectors of industry became involved. One was the established office equipment manufacturers, the other was electronics companies. In the first group were companies like Burroughs, Power Samas, British Tabulating Machine, National Cash Register, IBM, Remington Rand, and De La Rue Bull Machines. In the second were names famous in electronics like Ferranti, Standard Telephones & Cables, EMI, Elliotts, English Electric and AEI. The odd-one-out was LEO Computers, a subsidiary of the catering company J. Lyons.

The electronics companies were clever at designing and building bigger and better machines but had little or no knowledge of the business machine market. The office equipment manufacturers knew the market well enough but were inexperienced in electronics. It was inevitable that firms should either get together or get out of the business.

MERGERS

The first of the big British mergers was between British Tabulating Machine and Power Samas who came together under the name of International Computers and Tabulators Ltd, familiarly known as ICT. In 1965 the huge British merger took place when the fragmented efforts of AEI, ATE (part of Plessey), Elliott, English Electric, Ferranti, GEC, and ICT emerged as one big company, International Computers Ltd. ICL's early years were difficult because they inherited different ranges of computers of non-compatible types from the various manufacturers.

Of the electronics companies, many just surrendered their business machine interests and retained a strong computer presence in other fields. Ferranti, for example, is a major supplier of military computers for the defence industry.

The success of the big merger in the UK business machine field is now showing through in ICL as a profitable operating company. Its 1975 turnover was £240 million and number of employees 28,000. The once completely dominant IBM is now barely ahead of ICL in the UK in market share, and ICL is now expanding again having recently purchased the international division of Singer Business Machines. Third in the UK in market share is Burroughs, fourth is Honeywell. Of the mini-computer manufacturers Digital Equipment Corporation is still the market leader world-wide.

A sign of the times is that Computer Automation is able to supply packaged minicomputers for as little as £400 in 100-off quantities and quite frequently minicomputer companies sell to other computer manufacturers, a recent example being the supply by Computer Automation of 140 minis to Burroughs for inclusion in air traffic control systems in the United States ordered by the Federal Aviation Administration.

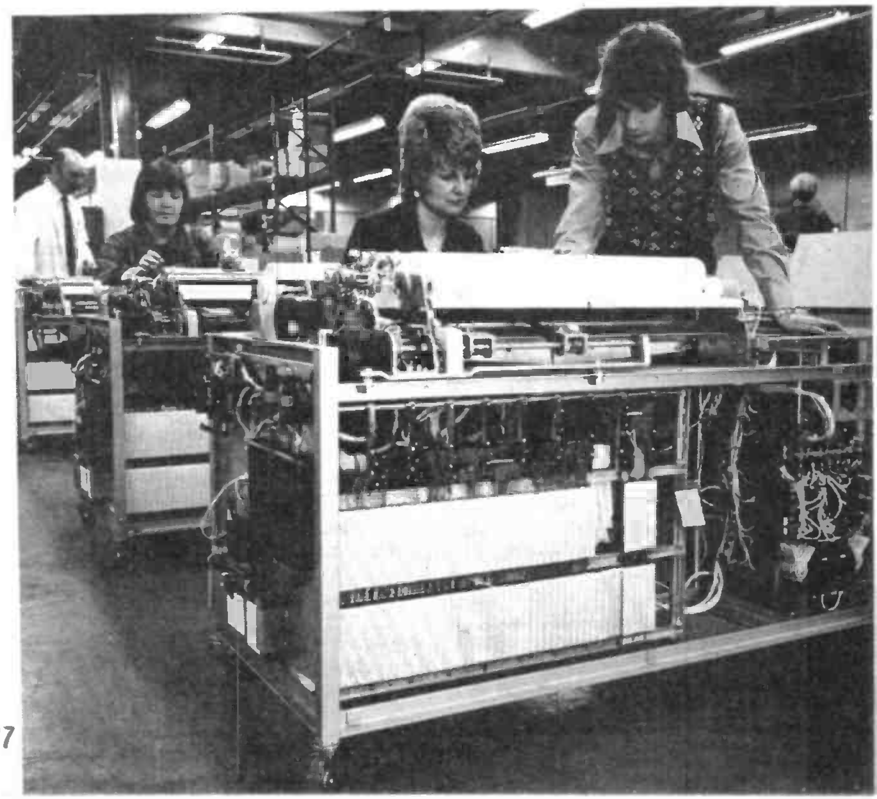
There is often quite close collaboration between companies. Plessey Traffic and Instrumentation joined forces with Ferranti to win a contract in Australia for the supply of hazard warnings for motorists on a new motorway in New South Wales. Ferranti supplied two Argus 700 computers for the control centre. This installation is an example of overlap in the application of computers.

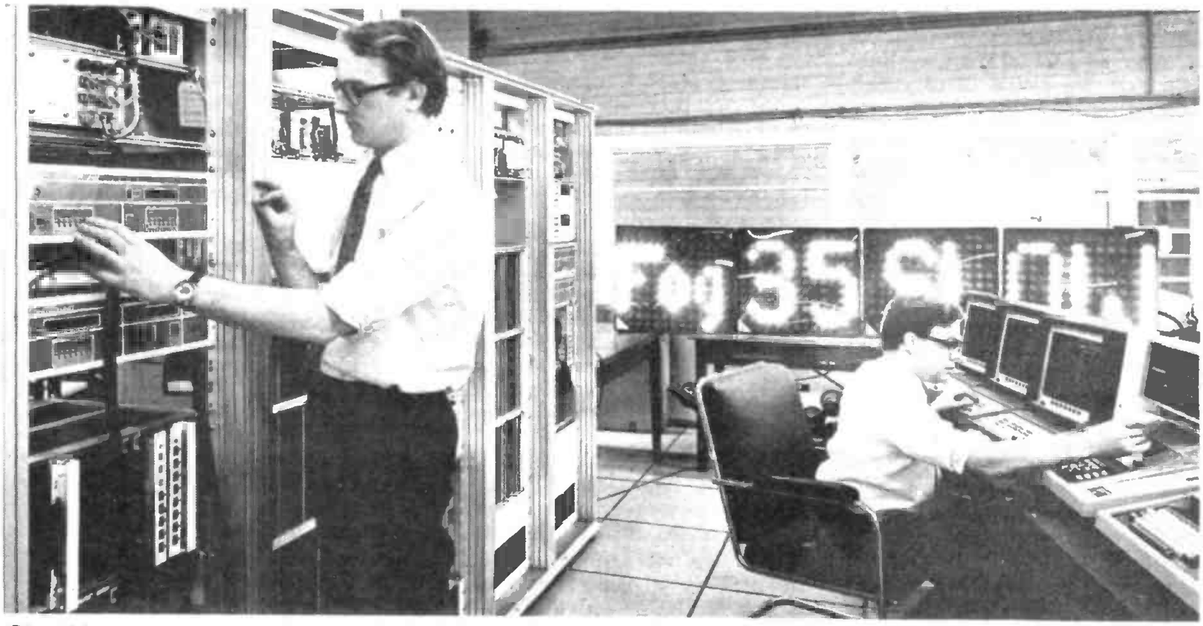
Although the Argus is nominally an "industrial" computer, in the motorway task it is also a "business" computer because as well as controlling the hazard signs it also does the bookeeping for the motorway toll system and also spins off statistical data.

In the main, though, we are this month discussing purely business installations and the career opportunities in the business sector. Where are all the installations? The short answer is everywhere. In central government, in local government, in banks, insurance offices, supermarket chains, in the Post Office. The latter is one of Britain's biggest users and its data processing service turned over £27 million in 1974/75, the revenue coming largely from other Post Office departments.

Whitbread, the brewers, are currently implementing a nationwide high-speed computerised ordering system. Littlewood's, the Liverpool-based mail order company is expanding its order-processing network. The Royal

Testing of the latest L9000 minicomputer manufactured by Burroughs at Cumbernauld, Scotland.





Checking out a computer-controlled hazard system for motorways at Ferranti, Manchester, before delivery to Australia. The computer does the toll-booth accounting and provides statistical data as well as controlling the hazard signs which can be seen in the background.

Navy has its main computer centre at Bath, linked to all Royal Navy general stores. The present low-speed data links are being up-dated to high-speed links. There is constant movement in the whole electronic data-processing industry creating constant employment for those in the EDP business.

SOCIETY

EDP is now, in its maturity, a well organised industry in its own right. The professional body is The British Computer Society with various grades of membership and its own examining body. An HND in Computer Studies gives exemption from Part 1 and a degree in Computer Science would normally exempt the holder from Part 2 as well. The BCS covers the whole career structure of computing which includes jobs like systems analyst and computer operators and programmers.

If, however, you are an electronics engineer, or aspiring to be one, the normal professional body would be the IEE for graduates or one of the technician societies for non-graduates. The electronic engineer working on computers and with appropriate experience might also think it worthwhile joining the BCS but a non-electronic person in the BCS (e.g. a programmer) would not be eligible for membership of electronic engineering professional bodies. The EDP industry is also notable for internal clubs and societies in which members have an interest in common. An example is the Honeywell Computer Users Association which has about 450 members throughout the United Kingdom.

There are well-established courses for computer operators and system analysts where the bias is on business studies rather than engineering although, of course, these grades of workers need to understand broadly how computers work and have a sound appreciation of their capabilities and limitations.

Most readers of EE will, however, be more interested in building a career in computer technology, in design, construction and testing, installation and maintenance. Here, the academic ladder is much the same as for other sectors of electronic engineering. There is no substitute for the basic training leading up to possession of ONC, HNC or a degree, with more specialisation in the direction of computer sciences as you progress beyond the fundamentals.

ELECTROMECHANICAL EQUIPMENT

One aspect in which EDP engineering differs from general electronic engineering is that there is far more electromechanical equipment involved. This occurs mainly in the peripherals of a system and includes items like magnetic tape and disc drives, keyboard entry systems and line printers. So to be a good service engineer you will need mechanical aptitude as well as a first-class knowledge of electronics

Another difference is in the way business is conducted in EDP. A great number of computer users prefer to lease equipment from the manufacturers rather than buy it. In effect the customer buys the service of a computer for a fixed rental which includes maintenance and therefore the large body of computer service engineers are employed by manufacturers rather than users. Even those who own their computers often have a maintenance contract with the manufacturer. So an approach to a major manufacturer is an obvious first line of attack.

There are also ways of entry. The Exchange Telegraph Company Ltd (EXTEL) has an Engineering Division which as well as maintaining equipment in Extel's own information services runs a contract maintenance service whose customers include other news agencies, airports, universities, the BBC, the Post Office and computer bureaux.

Extel's field maintenance force operates from 19 service centres in the UK.

Extel's service is mainly on peripheral equipment, especially terminals, and whereas a manufacturer's service engineer will be a specialist on a particular range of equipment supplied by his employer, an Extel engineer has to deal with many different types of equipment from several manufacturers.

It can be worthwhile, too, to look round the general electronics industry where many companies have a strong interest in the supply of peripheral equipment. Racal Electronics Group, for example, has two companies with strong links in EDP. One is Racal-Milgo specialising in high speed data transmission, the other is Racal-Thermionic with magnetic recorders. Another company in the Group supplies high quality magnetic tape to the computer industry. Redifon also has data processing business interests. There are dozens of companies such as these where some computer experience is a useful attribute.

The best method of entry is, however, through one of the great EDP manufacturers, all of whom are willing to train promising entrants who have got what it takes to get on in the world. The leading companies have training divisions and you can enquire of personnel departments of companies like IBM, ICL, National Cash Register, Honeywell, Burroughs and Univac what qualifications are necessary for entry into various grades of work and for career possibilities.

If you are near a major public library it is more than probable that the reference section will have a copy of "Working with Computers", a guide to jobs and careers in the EDP industry, published by the British Computer Society in association with the National Computing Centre.

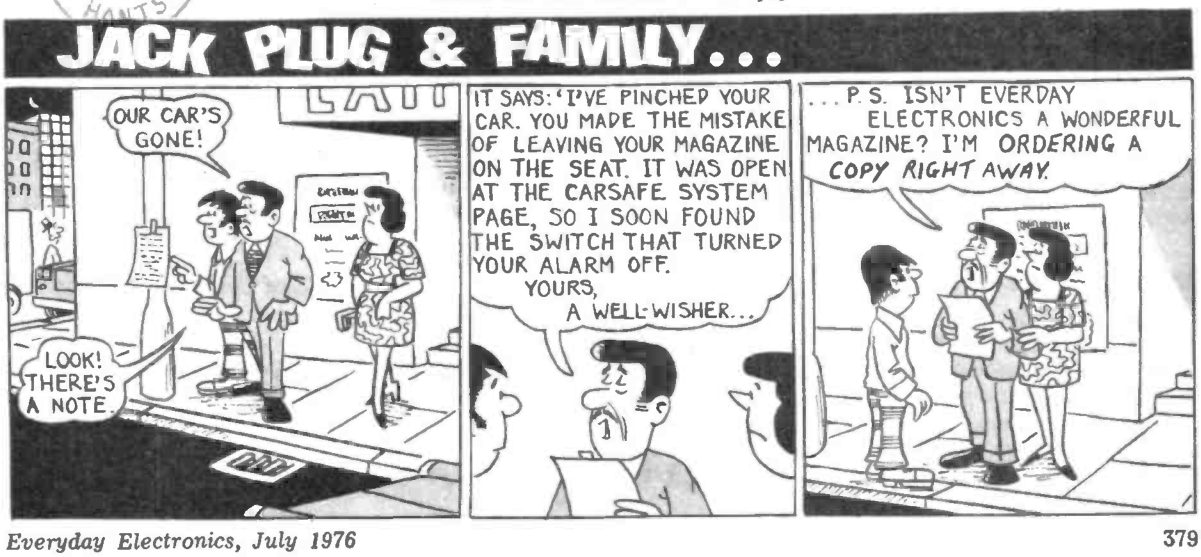
Transdata 810 video display unit data terminal, an example of modern terminal design by Siemens, West Germany.

READERS LETTERS

I would be very grateful if you could supply me with a circuit diagram to build a walkie-talkie set, as I am undertaking to build one as a project in an electronics club at school.

Peter Murray,
Coventry.

This is a frequent request with which we are unable to comply. It is illegal to operate such equipment in this country unless it is used on recognised amateur bands by a licensed radio amateur. If you are interested in becoming a radio amateur we suggest you write to the Radio Society of Great Britain, 35 Doughty Street, London WC1N 2AE.



I.C's EXPLAINED PART THREE

By BRIAN DANCE

COMPLEX digital integrated circuits are used in a very wide variety of applications, such as in electronic clocks and watches, in large computers and pocket calculators, for industrial control logic, for the control of washing machines, in pulse code modulation telephony systems, in television intercontinental-standards conversion equipment, etc.

It is obviously out of the question to explain the operation of such a wide variety of complex circuits in an article of reasonable length, but we will cover the operation of some of the modern devices.

DIGITAL CIRCUITRY

In digital logic circuitry the voltages and currents at any point have only a limited number of values (in contrast to linear circuits where they may have any values between certain limits). The most commonly used type of equipment employs binary logic in which the voltage or current at any point in the circuit has one of two possible values at any instant.

The two values are usually known as "high" and "low" voltages, any intermediate value of the voltage existing only for a very short time whilst the circuit is switching from one stage to the other. One of the best known examples of a binary digital code is the Morse code in which information is conveyed by a signal which is either on or off.

The advantage of using the binary system is that very economical standard switching circuits can be used in non-critical circuits to switch between the two levels with very high reliability. As in the case of a Morse signal, it is only necessary for the equipment to distinguish between the presence or the absence of a signal or voltage.

LOGIC

The two states of a binary circuit are usually represented by the digits "0" and "1". The "1" may represent a voltage which is either positive or negative with respect to the "0"; in most cases it represents a positive voltage and one is then using "positive logic".

A binary digit (either a 0 or a 1) is known as a "bit". In many systems information passes at a rate of some millions of bits per second (Mb/s), but a television signal requires over 100Mb/s.

There are a number of relatively simple circuits employing diodes and/or transistors for digital switching in which the output depends on the state of one or more input voltages. These circuits are normally constructed using standard integrated circuits which are available as the families of logic devices to be discussed shortly.

The simplest s.s.i. (small scale integration) devices include gates, inverters and flip-flops. They are used in very large numbers in some types of equipment. More complex m.s.i. (medium scale integration) devices such as counters each contain quite a number of the simple building blocks, whilst still more complex devices employ l.s.i. (large scale integration).

Current trends are for more and more complex devices to be used to minimise the number of individual integrated circuits required in any piece of equipment.

LOGIC ELEMENTS

The symbols for some of the basic logic units are shown in Fig. 301. An AND gate has the property that its output will be a 0 unless both input *A* and input *B* of the circuit are simultaneously in the 1 state, in which case the output will be 1. An AND gate may have more than two inputs, in which case a 1 will be obtained at the output only if all of the inputs are in the 1 state.

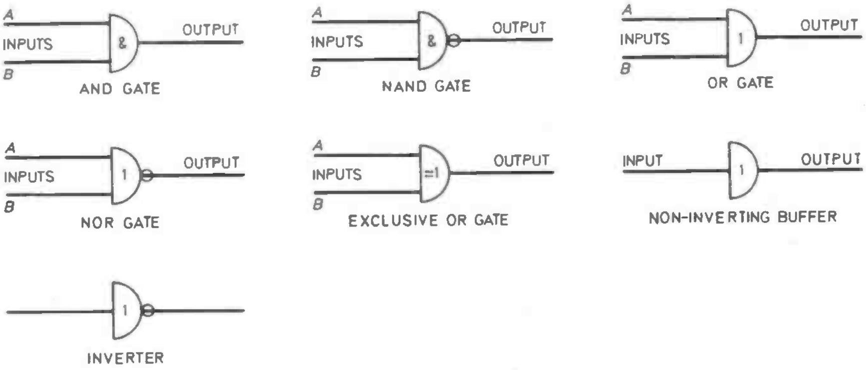


Fig. 3.1. Symbols for some of the basic logic units.

An inverter provides an output which is always in the opposite state to the input. A NAND gate has an output which is always in the opposite state to an AND gate with the same inputs and is therefore equivalent to an AND gate followed by an inverter.

An OR gate will produce a 1 output when either input *A* or input *B* is in the 1 state. A NOR gate produces an output which is always opposite to that of an OR gate with similar inputs; it is therefore equivalent to an OR gate followed by an inverter.

In the case of an OR gate, the output is a 1 if both inputs are in the 1 state, but with an exclusive OR gate, a 1 output will be obtained only if one (but not both) inputs are in the 1 state.

Complex digital systems can be made from either NAND or NOR gates together with flip-flops. Even the simplest integrated circuits normally contain several of the simple gates in a single device, but it is usually far more convenient to employ some of the more complex devices.

Circuit designers solve logic design problems by the use of a special type of mathematics known as Boolean Algebra, but this need not concern us here.

LOGIC FAMILIES

A family of logic devices consists of a large number of different devices designed to be used together. For example, all the devices of any one family are normally operated from the same power supply voltage and the output from any device is suitable for feeding to the input of any other device in the same family.

In general, the idea is that the circuit designer who is reasonably familiar with a given family shall not have to look at the data sheet of each device in too much detail before using it, but can just connect the outputs from each device to the inputs of other appropriate devices to construct the particular logic system he needs.

The earliest logic families employed resistor-transistor logic (RTL) and resistor-capacitor-transistor logic (RCTL). Diode-transistor logic (DTL) followed, but as these families are no longer normally used for new equipment designs, they will not be considered here.

One can obtain very high operating speeds by the use of emitter coupled logic (ECL), but this will not be discussed either, since it is not very easy to use (especially at high speeds) and is seldom encountered by the amateur experimenter. Examples are the Motorola MECL devices and the Signetics 1000/10,000 series.

The most commonly used logic family in recent years has been transistor-transistor logic (TTL) which was introduced in 1964. It can operate at fairly high speeds and is available as a very wide range of integrated circuits from various manufacturers.

The more recently introduced COS/MOS or CMOS family is, however, now becoming extremely popular as the device prices in this range fall very rapidly. It is likely to displace TTL in most applications.

These two logic systems will be discussed in more detail.

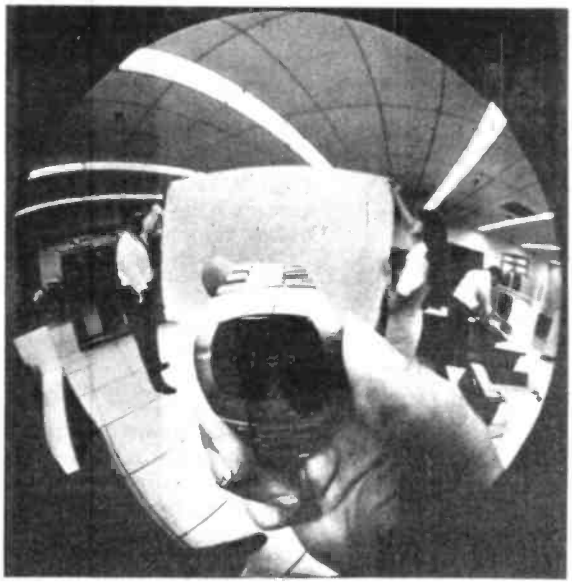
TTL

Any standard TTL device should be operated from a power supply of nominal value 5V. The tolerance for the industrial devices is only in the narrow range of 4·75 to 5·25V, although the more expensive military range has twice the supply voltage tolerance. TTL devices may undergo electrical breakdown if the applied supply exceeds 7V.

The simplest TTL devices are priced at about 20p, but more complex devices are available costing a few pounds.

In TTL logic circuits there is a compromise between maximum operating speed and the power required by each device. One can reduce the time constants by using devices which have lower values of internal resistors, but this causes the power requirement to increase.

A low power series of devices is available which requires about one third of that required by similar standard devices, but which can



A digital watch employing i.c.s manufactured by RCA.

operate at about one third of the speed. Similarly the high speed devices can operate at nearly twice the speed of the standard devices, but consume about twice the power. Schottky devices contain Schottky clamping diodes; the latter raise the maximum operating speed without increasing the power required.

NAND GATE

The circuit of a standard TTL NAND gate is shown in Fig. 3.2. Four of these circuits are used in the quad 2 input NAND gate type 7400. Perhaps the most noticeable thing about this circuit is the use of a multi-emitter transistor, TR1, to which the inputs are connected. Both inputs have to be high to cut this transistor off. Multi-emitter transistors are found in all TTL input circuits; the device used in the 7430 has 8 emitters and that in the 74133 has 13 emitters.

The output shown in Fig. 3.2 is the "totem pole" type in which either TR3 or TR4 is conducting, but never both simultaneously (except momentarily during switching). If TR4 conducts, the output is low, whilst if TR3 conducts, it is high. Two outputs of this type must never be connected together, since if TR3 of one output and TR4 of the other conduct simultaneously, a high current would flow.

The other type of output found in TTL devices is the "open collector" which is like the Fig. 3.2 circuit, but TR3 and the associated components are omitted. Several open collector outputs can be connected together and joined by a resistor of about 1 kilohm to the positive 5V line to make a "wired OR" circuit without the use of further devices.

TYPES

Many of the standard TTL devices are available from a number of manufacturers. For example, Texas Instruments make the well-known quad 2-input NAND gate type SN7400N, commonly known as the 7400. It contains four gates in a 14 pin dual-in-line package.

Signetics offer the same device under the type number N7400A, the corresponding Motorola device is the MC7400P and the T7400 is a similar device from SGS-ATES. Fortunately these "74" series of devices all have similar numbers for corresponding devices, but at one time the Mullard/Philips company produced the 7400 under the type number FJH131; they now refer to it as the GFB7400D.

A similar "54" series with corresponding individual device type numbers is available to military type specifications.

The SN74H00N is a high speed version of the 7400, whilst the SN74L00N is a low power version and the SN74S00N is a Schottky clamped type. Most of the 74 series have 14 or 16 pins, but a few have 24.

The last few paragraphs have specifically covered the 7400 type of device, but as there are well over one hundred individual type numbers, it is quite impossible to cover all of them. They are not all available in high speed, low power or Schottky clamped versions.

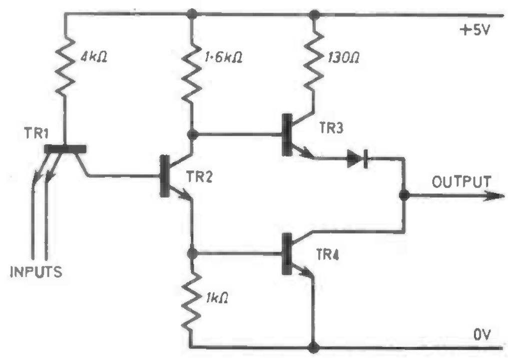
For those who would like a few more type numbers, one may mention the 7404 hex inverter (6 inverters in one package), the 7410 triple 3 input NAND gate, the 7430 8 input NAND gate, the 7473 dual J-K flip-flop and the 74121 monostable—just a few examples of a vast range of products.

There is also a 75 series of interface devices designed for use with the 74 series. They contain line drivers and receivers and other devices designed for feeding signals into and out of the 74 type devices.

Apart from the 74 series of devices, other TTL devices are available. One may mention the Signetics 8000 series of moderately complex devices.

Continued next month

Fig. 3.2. The circuit of a standard TTL NAND gate.



New products and component buying for constructional projects

SHOP TALK

By Mike Kenward

NOW that holiday time is here, many constructors tend to lay down their irons and take to outdoor activities, however it's best not to forget electronics completely, after all, it could be useful in conjunction with other hobbies—see the *Aquaguard* this month if you do any sailing! Even on holiday, electronics need not be totally forgotten and for anyone going to Wales this year, there is the added attraction of an exhibition by the British Amateur Electronics Club. It is being held from July 17 to 24 and will be open every night from 7 p.m. and also on the afternoons of July 17, 18 and 24. The exhibition is held at The Shelter at the centre of the Esplanade, Penarth, South Galmorgan and there is usually a wide range of amateur constructed exhibits many of which are working.

We visited the IEA/Electrex exhibition at the new National Exhibition Centre in Birmingham recently—the centre is obviously an advance on Olympia or Earls Court but no doubt still has its problems—we were told it is very noisy when it rains, and it looks little better than a collection of aircraft hangers. It is also very easy to lose direction among the exhibits since there is no way of telling north from south, east or west when inside any "hall". To get to the point one of the new items on display was the Avo Model 73 which is a new high quality multimeter costing £33 plus 8 per cent V.A.T. from the famous Avo stable. The new meter should be everything most amateurs will ever need and includes a new fail-safe fuse protection system to prevent it being burnt out.

The Avo 73 covers 0·15 to 750V d.c., 7·5 to 750V a.c., 3 to 3,000mA a.c. and 0·075 to 3000mA d.c., and can measure 1 ohm to 1 megohm, accuracy on d.c. is 2·5 per cent and 3·0 per cent on a.c. Sensitivity is 20kΩ/V d.c. and 1kΩ/V a.c.

Having decided this new meter would be just right for the serious constructor and while considering getting one myself, a press release from Hawker Siddeley landed on my desk describing the new Crompton Parkinson Type 3 meter. This one costs £19 and covers 0·1 to 2,000V d.c., 2·5 to 1000V a.c., 0·05 to 5,000mA d.c., 0·25 to 2500mA a.c. and can measure 1 ohm to 1 megohm. Sensitivity is 20kΩ/V d.c. and 4kΩ/V a.c., accuracy on a.c. and d.c. is 2·5 per cent. The measurement circuits are protected against overload and short-circuit and the meter can be used to measure capacitance by employing a mains input. So you pay's your money and you take's your choice—if you can afford it!

Avo's can be obtained from many retailers—more details direct from Avo Ltd., Archcliffe Road, Dover, Kent, CT17 9EN. The Crompton Type 3 meter is only available from E.I.S.A.S. 7 Heron Trading Estate, Wickford, Essex, at a cost of £21, including V.A.T., post and packing.

RF/AF Signal Generator

As Paul Young mentioned last month, those valve coils are coming back into fashion again with the increasing use of f.e.t.s. and this point is well illustrated by the *RF/AF Generator*—it uses four of them. The Wearite coils concerned together with the Jackson variable can be obtained from Home Radio should a local supply not be available, this also applies to the Universal Chassis parts. All other components be readily available.

Accented Metronome

As far as we can see there should be no buying problems for parts used in the *Accented Metronome*. This is the first metronome of this type we have published and one of the simplest circuits for an accented type we have come across.

Any small case can be used to house this unit and there are many small plastic types available.

Auto Cool

The parts for the *Auto Cool* that can be obtained from component retailers should not provide any problems. Things like the indicator lamp, in-line fuse holder, switch and connecting wire are probably best obtained from a car spares department and the fan motor, fan (see text) and potentiometer can probably best be purchased from a car breaker or second-hand spares dealer.

One unusual component, the thermostat, should be available from most domestic central heating suppliers.

Aquaguard

Parts for the *Aquaguard* should all be readily available. Any small case can be used to house this project and, as we have said before there are a large number of small plastic ones now available. If the unit is to be used in a damp atmosphere, e.g. in a bathroom or at sea, it would be a good idea to find a case with a close fitting lid or one with a flange around it.

Left: The Avo 73
Right: Crompton Type 3

AUTO COOL

By C. E. LONEY

THE design that follows was constructed in an effort to save heavy use of the choke on cold mornings and consequently to reduce fuel consumption.

A thermostatic fan allows the engine to warm up more quickly because no air is forced through the radiator until the water is up to normal running temperature. The fan also ensures that engine temperature is kept high on cold days and saves power because it is electrically driven, not driven off the engine.

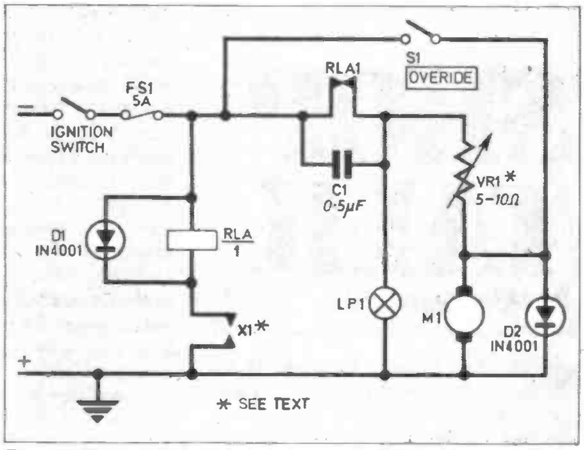
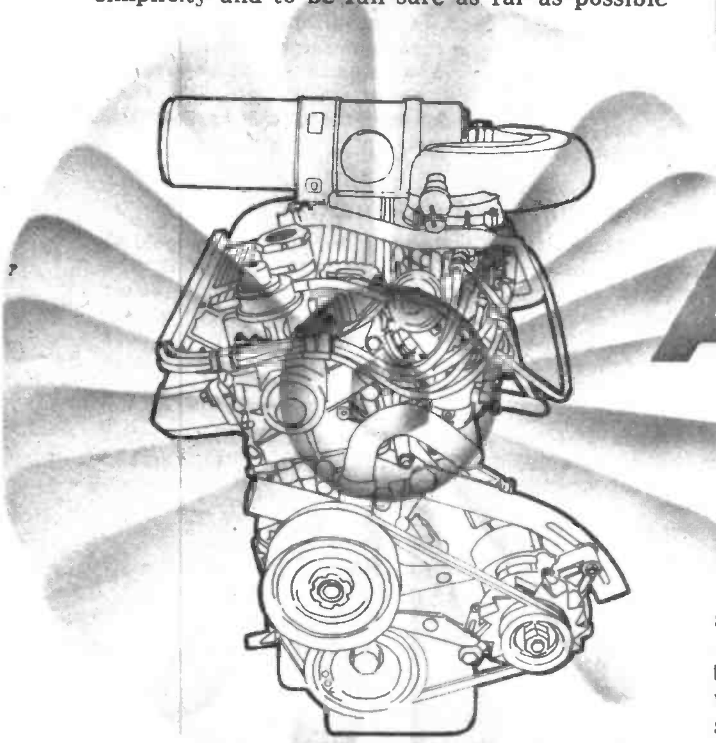


Fig. 1 Circuit diagram of the Auto Cool.

CIRCUIT

The circuit shown in Fig. 1. was designed for simplicity and to be fail safe as far as possible



in operation. The thermostat (X1) is of the type used for central heating systems and is clamped to the outside of the top of the radiator. In this thermostat the contacts are closed when cold.

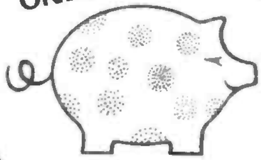
When the engine is cold and ignition on, the contacts of X1 are closed and RLA is operated, thus holding open contacts RLA1 which are normally closed. As the temperature rises the thermostat opens, degenergising RLA and allowing RLA1 to close, thus operating the fan motor.

Components D2 and C1 have been included to eliminate sparking across RLA1 when the contacts open and D1 performs a similar function for X1.

It was found useful to be able to reduce the speed of the fan on very cold days to prevent continual switching on and off, indicated by the "motor on" lamp LP1. To this end a high wattage variable resistor VR1 was employed in series with the motor. An overide switch is added just in case the system fails.

FOR GUIDANCE ONLY

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



£3.30
excluding motor

*Based on prices prevailing at time of going to press

FAIL-SAFE ACTION

With the circuit as shown the motor will be continually on should the thermostat fail to open or relay RLA1 fail to operate for any reason. This means that the engine will be "over cooled" in much the same way as it would be with a conventional fan and one can continue to use the vehicle until the fault can be rectified.

CONSTRUCTION

Construction of the unit is mainly a matter of siting the individual items, making sure no moisture can get into them, and then wiring up (see Fig. 2). Obviously the positioning of each item will depend on the car on which it is used.

If the circuit is employed on a negative earth all that needs to be altered is the polarity of the diodes—simply wire them up the other way around. If the car has 6V electrics the unit will still work correctly but of course a 6V motor must be employed.

COMPONENTS

The motor used to drive the fan was taken from an old car heater, more about its use later; the potentiometer which forms VR1 comes from the wiring to the original heater fan. This component must be modified slightly so that it has no off position; this can easily be done by adding a new rotation stop to the body.

All components used in the supply to the motor should be capable of taking the motor current. Thus RLA1 and S1 should be rated at about 3 amps. The wiring to these components should be carried out with heavy duty wire as normally used for car wiring.

FAN CONSTRUCTION

To drive the fan a heater motor unit of the snail type construction (6V or 12V to suit car) is required, this can be obtained quite cheaply from a scrap car dealer. The motor and "squirrel cage" type fan are removed from the unit and the fan cut down to leave a flat disc which is designed to lock onto the motor spindle.

Next a plastic fan, already fitted to many cars these days, is removed from the engine pulley or also obtained from the scrap dealer and, taking care to ensure it lies centrally on the disc to avoid running vibration, holes are drilled using the existing fan holes as a guide. The fan is bolted to the disc using shake proof nuts and the fan assembly then locked onto the motor spindle.

Finally using the mounting holes on the motor case, the completed fan can be mounted behind the radiator grill and in front of the radiator or behind the radiator but in front of the engine, depending on the space available. Two metal strips across the car body form a suitable mounting but the motor could just as easily be mounted on a triangular frame, or another suitable method of fixing found.

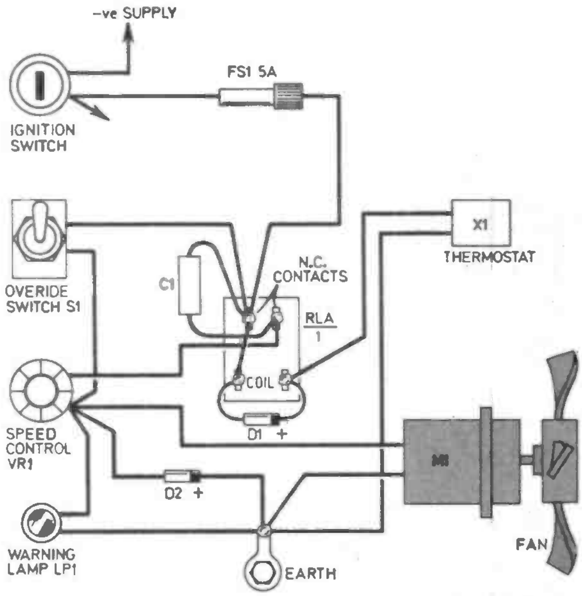


Fig. 2. Wiring diagram for the parts of the Auto Cool. For negative earth reverse D1 and D2.

FAN MOUNTINGS

Obviously, the fan will have to be on the motor spindle the right way around to force air through the radiator. Alternatively the connections to the motor brushes can be reversed to achieve the required direction of air flow. ▣

Components....

SEE SHOP TALK

Capacitor
C1 0·5μF 400V working

Potentiometer
VR1 5 to 10Ω high wattage—see text

Semiconductors
D1, D2 IN4001 diodes (2 off)

Miscellaneous
S1 S.p.s.t. toggle switch 3A rating
LP1 6V or 12V indicator lamp
RLA 50 to 1000Ω 6 to 15V operating relay with one set of normally closed contacts rated 3A or more d.c.
X1 Hot water system (domestic) type limpet thermostat, operating at between 150 and 190 degrees F.
M1 6V or 12V fan motor—see text
FS1 5A fuse in line holder
Connecting wire rated at 5A, earth tag.

RF/AF SIGNAL GENERATOR

By F. G. RAYER

This Radio Frequency/Audio Frequency Signal Generator is an instrument which can provide a tone-modulated radio frequency signal or a single audio frequency tone. The r.f. signal is used for quick checks in locating the source of a fault in intermediate frequency and radio frequency stages, and as an aid in alignment or trimming. The a.f. signal alows rapid stage-by-stage checks of audio frequency amplifiers, or the a.f. section of a receiver.

With home-built equipment, there can be some difficulty in calibrating the r.f. bands over which a generator can be tuned. In the generator described here, this is overcome by using air-cored, fixed-inductance coils which are manufactured to a high degree of accuracy, in conjunction with a particular variable capacitor. It is then possible to fit a ready calibrated scale, to read off frequencies. More details about the uses of an RF/AF Signal Generator are given later, and it can be seen to be a very useful piece of test equipment.

R.F. CIRCUIT

The r.f. oscillator is built around field effect transistor TR1 as shown in Fig. 1. Pole S1a of the 3-pole 4-way switch selects L1, L2, L3 or L4, for the four r.f. ranges. On ranges 2 and 4, tuning is by the section C1b of the 2-gang capacitor. To obtain suitable frequency coverage, the other part of this gang, C1a, is also in use on ranges 1 and 3, being brought into circuit by section S1b of the switch. The four ranges are calibrated as follows:

Range 1: 300 to 900kHz
Range 2: 0·7 to 2·5MHz
Range 3: 2·7 to 10MHz
Range 4: 11 to 30MHz

Switch S1c switches the drain of TR1 to the feedback windings of the coils, to obtain the oscillation necessary to generate the r.f. signal; S2 is a separate 2-way slide switch. When at "r.f." the signal is obtained via C3 and R3, going to the attenuator VR1, which allows the strength of the output signal to be adjusted; C9 is an isolating capacitor for external circuit leads.

A.F. CIRCUIT

Transistors TR2 and TR3 have feedback via C6 and C7, and form an audio oscillator (simple astable multivibrator). For audio circuit tests S2 is at "a.f." so that the a.f. signal is obtained from C9, going to VR1 and the output socket as before.

When the r.f. oscillator TR1 is in use, its drain supply from R4 from the junction of R5 and R6 in the collector circuit of TR2 results in the "r.f." output being modulated by the audio tone, so that it becomes audible when tuned in by a receiver.

INSULATED BOARD

Most small components are assembled and wired on a piece of 0·15inch matrix s.r.b.p., as in Fig. 2. The long bracket allows the board to be mounted by the screws holding the slide

FOR GUIDANCE ONLY

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

£6.40
excluding case

*Based on prices prevailing at time of going to press

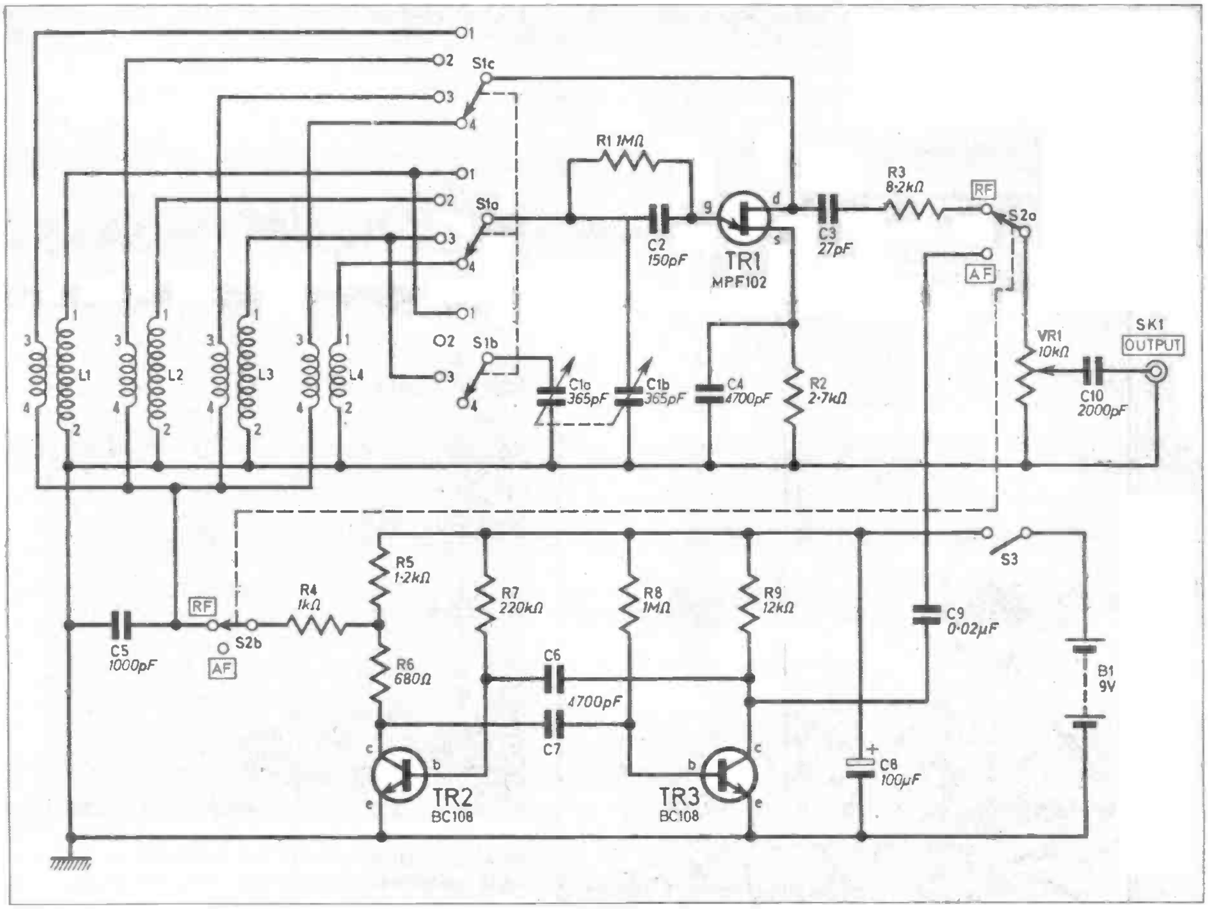


Fig. 1. The complete circuit diagram of the RF/AF Signal Generator.

Components....

SEE SHOP TALK

Resistors

- R1 1MΩ
- R2 2·7kΩ
- R3 8·2kΩ
- R4 1kΩ
- R5 1·2kΩ
- R6 680Ω
- R7 220kΩ
- R8 1MΩ
- R9 12kΩ

All ¼W carbon ±10%

Capacitors

- C1 2 x 365pF Jackson type 02
- C2 150pF ceramic
- C3 27pF ceramic
- C4 4700pF ceramic
- C5 1000pF ceramic
- C6 4700pF ceramic
- C7 4700pF ceramic
- C8 100μF 10V elect.
- C9 0·02μF ceramic
- C10 2000pF 300V mixed dielectric

Potentiometer

- VR1 10kΩ carbon lin.

Semiconductors

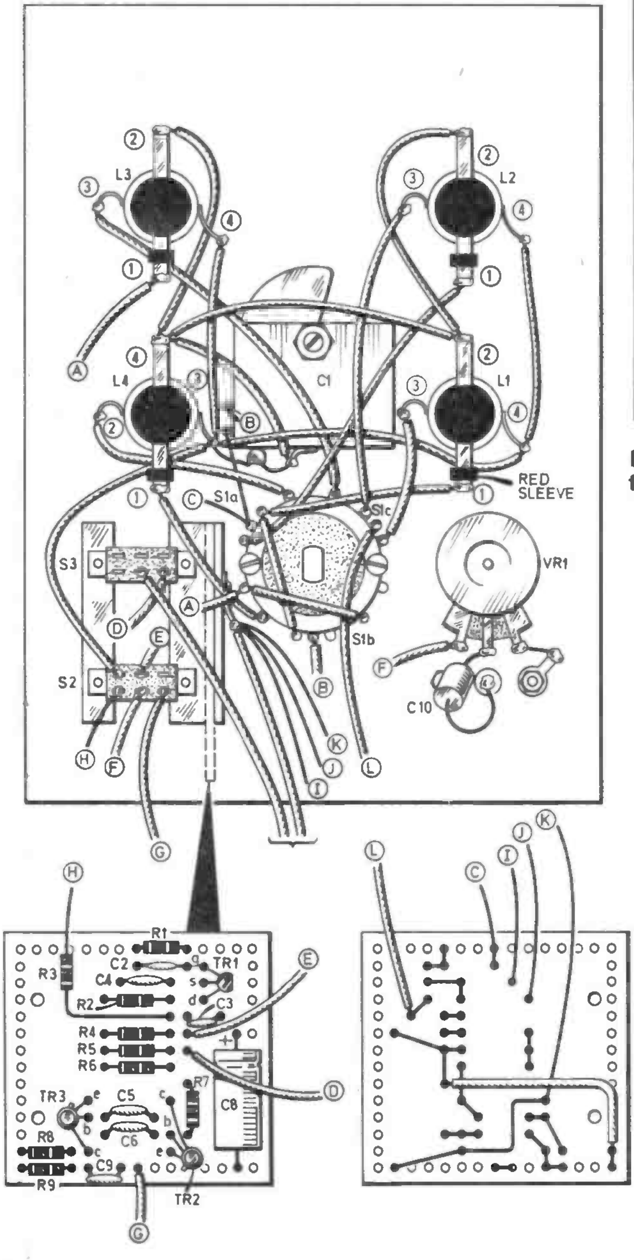
- TR1 MPF102 *n*-channel field effect transistor
- TR2 BC108 silicon *npn*
- TR3 BC108 silicon *npn*

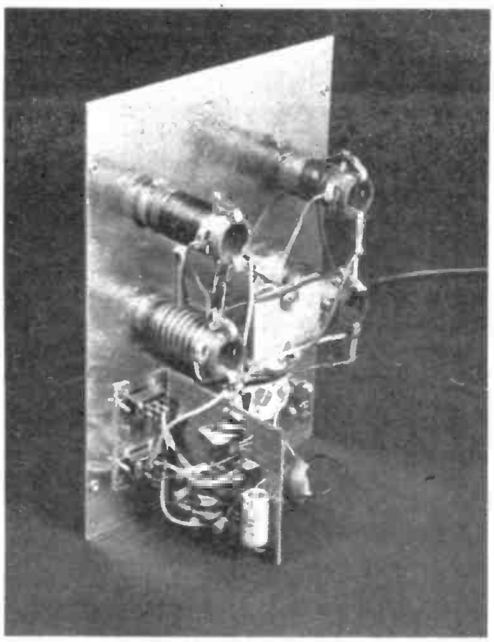
Miscellaneous

- L1 Wearite PO1
- L2 Wearite PO7
- L3 Wearite PO5
- L4 Wearite PO4
- B1 9V PP6
- S1 3-pole 4-way rotary wafer switch
- S2 2-pole 2-way miniature slide switch
- S3 On/off miniature slide switch
- SK1 Co-axial socket and plug to suit

Plain matrix board 0·15 inch pitch, 60 x 55 mm; Universal chassis size 125 x 180 x 75mm approx. with extra 125 x 180 mm panel for case; battery clip for B1; knobs (3 off); co-axial cable; crocodile clip.

RF/AF SIGNAL GENERATOR





Photograph showing the completed prototype generator removed from its case.

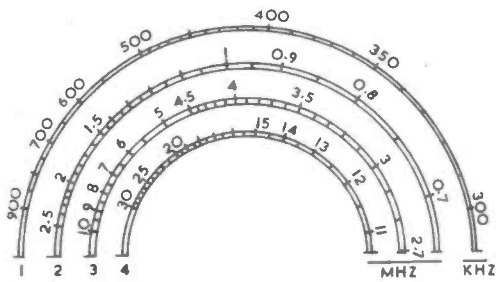


Fig. 3. Details of the scale used for the prototype unit shown $^2/_3$ full size of that used.

Fig. 2 (left). The layout of the components on the Veroboard and complete wiring up details.

switches, the tag MC forming a return to the metal case, through the bracket.

Resistors and capacitors can be inserted first. The board is turned over, and wires are soldered as shown, excess length being cut off. Insulated sleeving need only be used on the lead from R8 to R7. Gate, source and drain leads of TR1, and emitter, base and collector leads of TR2 and TR3 are then arranged to emerge as shown, and are soldered; a heat shunt is recommended when doing this.

In some places external leads are needed, but these can be left until later, as both sides of the board can be reached.

CASE AND PANEL

A metal box is required, and is economically obtained by using a universal chassis size approximately 125×180×75mm, with an extra 125×180mm flat plate for the back. When assembling this, top and bottom fit inside the side members, and the panel is inside the four front flanges. It is necessary to cut about 3mm from the bottom edge of the panel.

Drill for C1 (75mm) from the panel top, see Fig. 2, with the rotary switch 45mm lower. Volume control, VR1, output socket, and slide switches are 25mm from the panel edge. Other component positions can be seen from Fig. 2. The variable capacitor C1 requires a 12mm clearance hole, and three holes for 4BA bolts. These run into tapped holes in the capacitor, and must be short enough to avoid touching the capacitor moving plates, when tightened.

Slots for the slide switches are made by drilling a few holes and finishing off with a small file. The bracket holding the board goes under the switches, as seen in Fig. 2, so they are packed up by a strip of the same material, or washers.

The case is not finally assembled until construction is finished. The panel is then held with 6BA bolts or self-tapping screws. A self-tapping screw holds a strip of metal to the bottom, and it is shaped to secure the PP6 battery. The back is fixed with self-tapping screws.

INDUCTORS

Each inductor has four tags, number 1 tag being marked by a red sleeve. All are fitted to the front panel by 6BA bolts, which run into a thread provided for this purpose. Countersunk headed bolts are best as the frequency scale on the front panel can then lie flat.

Referring to Fig. 2, all tag 2's should be joined to the tag MC on C1 by a lead from tag 2 of L4. Capacitor C5 is directly connected from tag 4 of L4 to MC. Each tag 1, of L1, L2, L3 and L4 is wired to switch positions 1, 2, 3 or 4 of section S1a. Feedback winding tags 3 are similarly wired to S1c.

The operations performed by the switch, and tags to use, will be clear when the switch is examined. If there is any doubt at all about which tags to use, either connect one coil only (say L1) at first and check that the generator works on this range, or test each pole with a meter (or even a battery and bulb) to find out what circuits are made for each position of the switch knob.

Fit leads for battery negative to MC and positive to S3. Connections from the board to switches can be made as shown.

In the prototype the scale (see Fig. 4) was held in position by the case flanges, and can be covered with transparent material for protection. Fit the rotary switch knob to indicate the band correctly.

A cursor, made from Perspex or similar material with a hair line, is most suitable for tuning indications, and can be cemented to the knob. It should be set to read the lowest frequency on the scales with the capacitor fully closed.

A convenient output lead is about half to one metre of co-axial or screened cable, fitted with a plug to match the output socket. Take the outer brading of the free end or a separate flexible lead to a clip, and the inner lead to an insulated prod which can be made from a discarded ball-point pen case fitted with a stout wire point, or something similar.

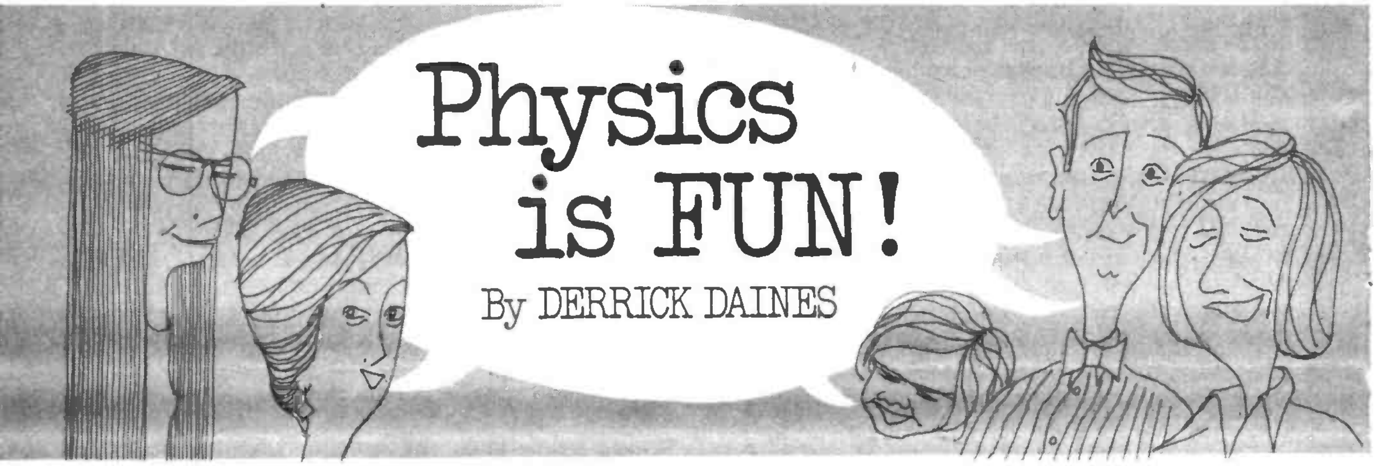
TESTS

There is normally no danger to be expected in making checks on battery operated equipment. With mains equipment, high voltages are present, and can be dangerous. With a.c./d.c. type equipment, or receivers or amplifiers deriving operating voltages directly from the mains, the chassis or other parts may be at mains potential, and such equipment should only be dealt with by a person familiar with this.

ALIGNMENT AID

The generator provides a stable signal at any wanted frequency within the bands provided, to align i.f. or other sections of a radio. The frequencies to use, or other details, will usually be found in the adjusting details of the receiver. Sufficient coupling from the generator is often obtained by placing the output lead or prod near the r.f. circuit concerned, without any actual connection to it.

With r.f. circuits, it should be remembered that harmonics or multiples can be heard. For example, if the generator is tuned to 600kHz, its signal will be tuned in at 600kHz with the receiver; and also at 1200kHz (2nd harmonic), 1800kHz (3rd harmonic) and so on. The harmonics grow progressively weaker. If necessary, they can always be identified immediately, because they are higher in frequency than the generator frequency. ▣



Physics is FUN!

By DERRICK DAINES

THE ELECTRIC BELL

You will have found that the vibrator motor of last month emits quite a hefty buzz when working and this is one way of making a good working buzzer. However, trying to make a bell in this way is wholly unsatisfactory. Among other things, the mass of a clapper cannot be made to accelerate sufficiently to enable it to give a bell a hefty whack—at least, in the fiftieth of a second available in the vibrator principle. A much better way is to use direct current and to use the movement of the clapper arm itself to switch the current to the coil on and off.

Mount the coil on its side as detailed last month, Fig. 1. The core is the usual 10mm iron bolt with as many turns of enamelled copper wire round it as can be accommodated between the card cheeks. A strap of tinplate secures the coil to the wooden base, but make sure that the coil is well insulated from the tinplate. Leave the lead-out wires quite long.

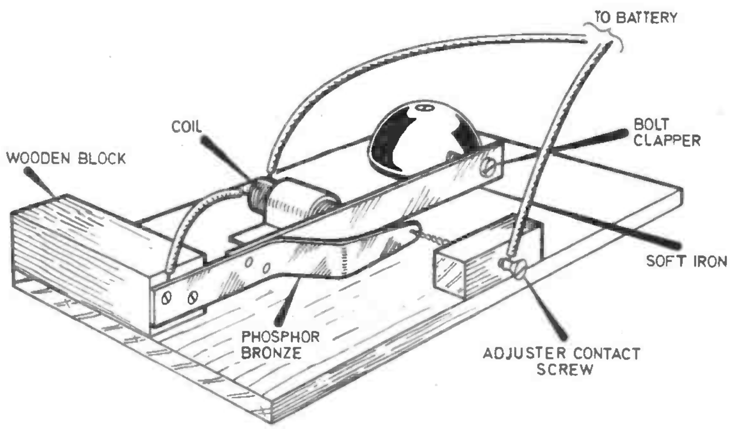
The armature deserves more care than that of the vibrator motor. A piece of clockspring or phosphor bronze will withstand the whipping back and forth; this is rivetted to the soft iron of the armature proper and an extention is bent to the shape shown, see Fig. 1. Stripping an old Post Office relay will produce many suitable pieces of metal for mounting and contacts. A suitable thin piece of iron may be obtained from a piece of old hacksaw blade suitably softened by heating it to cherry red and allowing to cool slowly. A small bolt at the end serves as a bell clapper.

MOUNTING ON A BOARD

The completed armature is mounted on the wooden block so that the gap between the coil core and the iron of the armature is about 2 to 3mm. Opposite the make-break contact another block is fastened so that a thin wood screw passing through a hole touches the contact. A bell can be fashioned from almost any metallic object that will ring—an old sugar bowl, a knob, a piece of Meccano—anything. Mount it with a 3mm gap between it and the bolt forming the clapper. The actual method of mounting will depend upon the object, utilising a piece of narrow paxolin tube as a stand-off with a long thin woodscrew through the centre of the bell is a good method. Do not tighten fixing screws too much, or the sound of the bell will be damped.

Wire up to the battery as in Fig. 1. When a low voltage d.c. is applied (say between 3V and 12V), the armature is attracted towards the electromagnet, at the same time striking the bell. However, the movement of the armature also breaks the contact between the woodscrew and the phosphor-bronze strip, cutting off the supply of current to the coil. The armature springs back, remaking the contact and the process repeats itself.

Fig. 1. Construction and wiring details for the home-made electric bell.



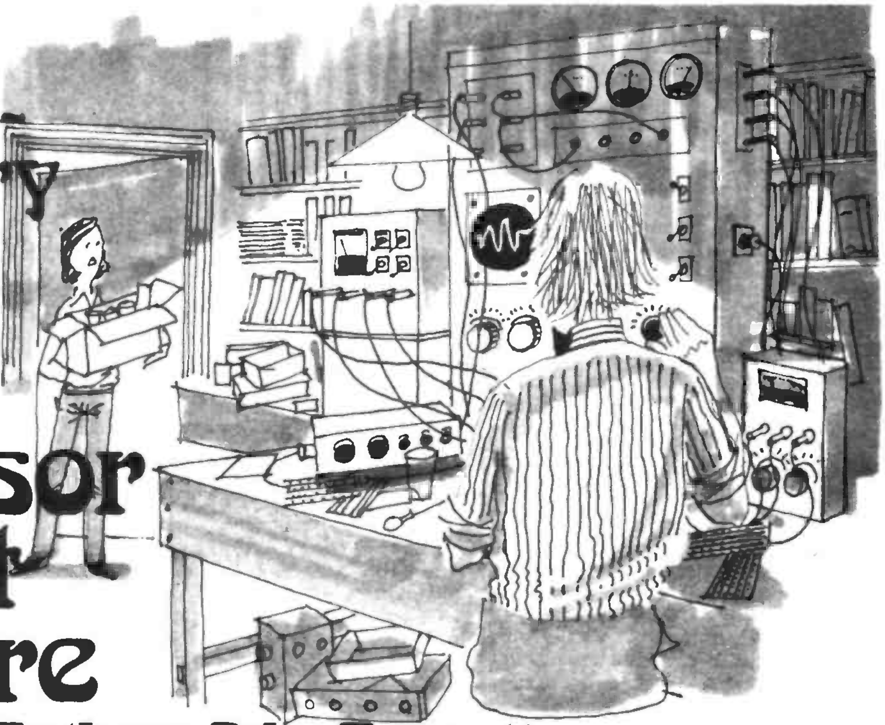
VARIATION ON A BEAN TIN

As a variation, the clapper can be contrived to strike the edge of a cymbal, which produces a noise that has to be heard to be believed, while a super klaxon can be made from an old baked bean tin. Arrange for the clapper to strike the tin squarely in the centre of the bottom and for a finishing touch add a cone of stiff card glued into the open end.

Earplugs! Lovely earplugs! Buy your earplugs 'ere!

Published approximately the third Friday of each month by IPC Magazines Ltd., Fleetway House, Farringdon St., London EC4 4AD. Printed in England by Index Printers Ltd., Dunstable, Beds. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/Sia) Ltd. South Africa—Central News Agency Ltd. Everyday Electronics is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on cover, excluding Eire where the selling price is subject to V.A.T., and that it shall not be lent, resold, or hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

The Extraordinary Experiments of Professor Ernest Eversure



by Anthony John Bassett

PRESSING a few buttons on the panel the Prof. removed the six stationary dots so as to leave only the single movable spot on the screen. The glowing trails of Bob's figures and squiggles had by now nearly faded from the screen. Now it was the Prof's turn to work the pedals and joystick and Bob watched in amazement as the Prof. used the moving spot with its glowing yellow tail to trace out a simple circuit diagram on the viewscreen, Fig. 1.

"Look no hands and no feet," the Prof. remarked as Bob was astonished to see that although the Prof. had lifted his hands and feet clear of the controls, the controls were still moving and the spot was tracing its way over the circuit diagram again and again so that before the yellow line could fade out the spot had traced over them again. This way everything the Prof. had drawn on the viewscreen was being preserved in view.

Soon Bob saw the explanation for this strange occurrence. Seated in another robot tester nearby was the Prof's latest experimental robot. In front of it was another viewscreen to which the Prof. had relayed a copy of his circuit diagram. The robot was working the pedals and joystick tracing the diagram over and over.

"Here you can see, Bob, how the circuit very much resembles the circuitry for vertical or horizontal shift controls but the extra capacitor is able to give a delayed action effect. There are quite a number of variations which can be made around the basic circuit."

"This could make a good exhibition project for our schools' science fair," exclaimed Bob. "I'm sure we could rig up a set of pedals and a joystick controlling potentiometers connected through a circuit such as this, to a d.c. oscilloscope. Then visitors could have a go on these controls. It's quite fun, very interesting and I'm sure they would be impressed."

Fig. 1. Modification of the circuit shown last month providing a delayed effect.

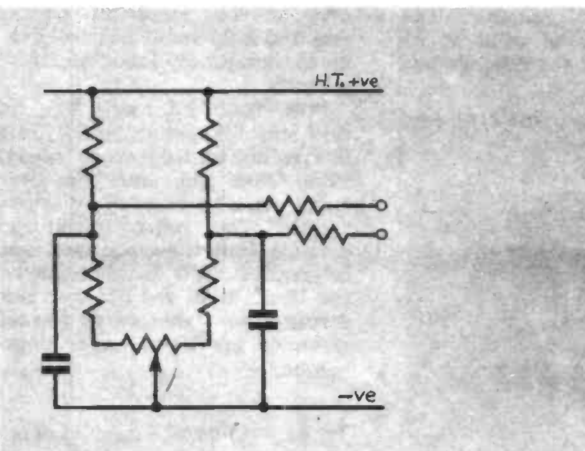
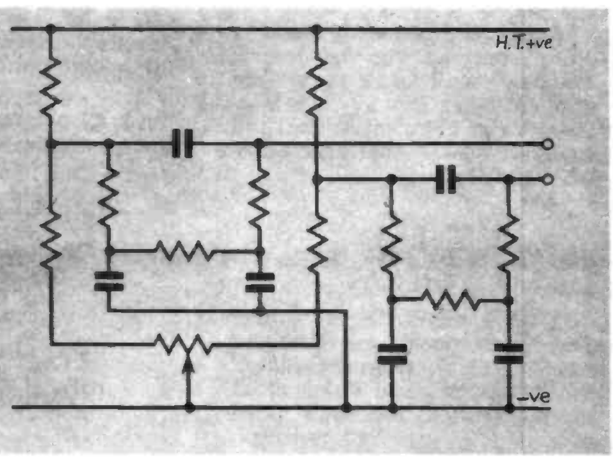


Fig. 2. A circuit to provide a rather more tricky effect than that of Fig. 1.



VARIATION

The Prof. agreed. "One of the variations which could be used is this," he informed Bob, taking over the controls once more the Prof. overrode the robot and by working the pedals and joystick deftly altered the diagram to give the circuit of Fig. 2. The robot continued to trace this new circuit.

"This one is a bit more complicated but it would make the equipment more interesting to use. You could build say this circuit on the vertical and the previous one on the horizontal deflection potentiometers."

Now the Prof. stopped the robot from his duty of tracing and retracing the circuit diagram and as the robot went back to his other duty with the mysterious biscuit tins and the voltage breakdown tester, the Prof. allowed the diagram to fade and brought the spot to the centre of the screen.

Now he asked Bob to take over the controls and keep the spot in the centre of the screen. The Prof. pressed some buttons and a number of circles appeared on the viewscreen like a bullseye target with the movable spot in the centre.

"Now is the time to show you how the low frequency random noise can be used to test coordination of movement," the Prof. told Bob, pressing another button to feed a random deflection signal to the spot on the viewscreen. The spot began to move away from the centre of the screen, first one way then the other, up, down and from side to side. Bob found it was almost impossible for him to keep it inside the inner circle and despite his most ardent efforts it quite often went outside the second one, too.

To add to the distractions another visitor entered the laboratory. The new visitor was a young lady of about Bob's age. She was Suzy the sister of Bob's friend Paul and in one hand she held an electrolytic capacitor.

ELECTROLYTIC CAPACITORS

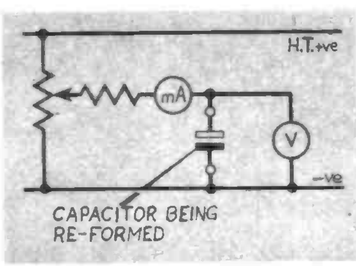
"I think this is faulty, Prof.," Suzy began appealingly, "I wonder whether you can find out for me?" Meanwhile Bob had switched off the robot tester, and as he came over to join Suzy and the Prof. he heard the Prof saying: "Yes, certainly, Suzy. The robot is testing and re-forming a batch of electrolytic capacitors for me at the moment and I can put this one of yours in with the others."

The three of them went over to where the robot was working and the Prof. handed the electrolytic capacitor, which Suzy had brought, over to the robot. As the Prof. gave instructions to the robot it opened one of the biscuit tins. Inside Bob could see another electrolytic capacitor was clamped to an insulating panel. The robot quickly disconnected and removed this capacitor, which had by now been tested thoroughly, and clamped Suzy's capacitor in the box. He connected two wires, one red and one black to the capacitor and firmly closed the box. Now he connected the wires which came through a grommet in the side of the box to the voltage breakdown tester and began to increase the voltage.

Bob saw that as with other capacitors the voltage rose jerkily rather as if superimposed on the steadily rising voltage which he would have expected, there was a random low frequency signal which caused the voltmeter and milliammeter needles to flicker unsteadily over their dials.

"The reason for this unsteady voltage rise," the Prof. informed Bob, "is that the capacitor is not merely being charged it is also having its dielectric re-formed. If an electrolytic capacitor becomes damaged, which can be easily done if a reverse charge or an a.c. voltage is fed into it causing it to become reverse polarised, the layer of the aluminium oxide dielectric on the anode becomes uneven in thickness and its insulating properties are insufficient to withstand the full working voltage of the capacitor. The capacitor cannot be used at its full voltage until the damage has been repaired and the robot is using the breakdown voltage tester to test and reform some electrolytic capacitors now.

Fig. 3. Circuit for reforming and testing electrolytics.



REFORMING

The Prof. drew another circuit diagram (Fig. 3). "Here is a low current variable h.t. supply similar to the one in the breakdown voltage tester. The output is connected to the voltmeter and to an electrolytic capacitor which should be enclosed in a large earthed metal box whilst it is being reformed and tested."

"Why does your robot use such large metal boxes, Prof?" asked Suzy.

"There are several reasons for using these boxes, one is that sometimes electrolytic capacitors burst when being re-formed. Usually this only happens if you try to do it too quickly and use too high a current. Then the capacitor heats up to beyond boiling point and the steam pressure bursts the seal. The size of the box is large in order to contain the fumes and the contents of the capacitor.

"Although my experimental robot will increase the voltage very slowly indeed and use a small current of only about one milliamp, so that the chances of overheating the capacitor are very small I still insist on using these large boxes as a safety precaution. Also the boxes are all earthed which helps to avoid having too much h.t. exposed during the process of re-forming which may take quite a while, especially since it is best to form each capacitor gradually, giving it a few minutes rest periodically.

This explains why the robot is forming several capacitors in rotation. Whilst the robot takes care of your capacitor perhaps you and Bob would like to have a go at some of my latest electronic games?"

"Oh, Prof! I'd really like to," said Suzy. "Especially if they're as interesting as that space capsule thing that Bob and you were using when I arrived."

"Ah! The robot tester, you mean, I think these are even more interesting than that," remarked the Prof., as he led Bob and Suzy across the laboratory towards some of his latest experimental games.

To be continued

COUNTER INTELLIGENCE

By PAUL YOUNG

I WANT to talk about "inflation" and before you all start muttering, "That old tub thumper Paul Young is climbing on his soap box again", let me quickly add, that the reason for this apparent digression is to show you how the side effects, damage your component buying.

We all know how the easy buying of any commodity has steadily deteriorated in the last few years and components are no exception. Let me now explain how inflation has helped to bring this about. Assume I am running a small component retail business. I have £20,000's worth of stock and a £3,000 overdraft at the bank. Inflation is running at 25 per cent per annum. At the end of the year I need £25,000 to maintain the same amount of stock. Where will the extra £5,000 come from?

I first go to my genial bank manager, and ask "Can I increase my overdraft to £8,000". He says "Nah! Mate, sorry, its not on!" What now?

Well, something has to be done so we reduce our stock by £5,000. Translated into practical terms it means buying smaller quantities, which in turn means paying more for it, and being out of stock more often. Plus the additional cost of the work of processing more orders, and extra postage. Remember too, that this is continuous, not a 25 per cent increase and stop, but 25 per cent year after year!

What other alternatives are there for dealing with the situation? The most obvious one is to cut down our range, but naturally enough we are going to hive off the slow selling lines first, so it can only be regarded as a long term solution. Even so this is the course most of us will be forced to adopt.

I had a vivid example of this recently. We offer 180 different chassis sizes. The firm that makes them said we have got to increase the price 500 per cent (no its not a misprint, 500 per cent). We replied we might as well remove it from our catalogue altogether. In the end we worked out a compromise where we reduced our number of sizes to 36 and they produced them in quantity, and after all that, the price still had to go up by 100 per cent. See what I mean?

Now all of this simply reinforces what I have been preaching for many years, that to get all your requirements you will have to purchase from several sources. To which I will now add, that the number is likely to increase. In fact the general trend over the last few years has been for us to specialise.

I had a letter only the other day saying "Your catalogue is ten years out of date, you only list about a dozen i.c.s!" (big dent in Paul Young's ego). To which I had to reply "Yes I must agree, we are weak on i.c.s and semiconductors, but look at our resistors and capacitors. Where else in the UK would you be able to buy such a range."

Ultimately the Government must do something drastic to curb inflation if we are not to finish up like Germany around 1926. It reached a stage where, employees had to be paid daily and bring suitcases to carry their wages home in.

There is a wonderful story of a man going home with one of those old fashioned wicker work laundry baskets filled with notes. He put the whole lot down outside a shop while he went in to make a purchase, and when he came out, he found the money tipped out on the pavement and the basket gone! Well the Germans solved it, and so did General De Gaulle. All he did was to overstamp all the 1000 Franc notes with a rubber stamp which said 10 New Francs!! I hope we can solve it, because I cannot face the possibility of my staff coming to collect their wages in wheel barrows.

DOWN TO EARTH

By GEORGE HYLTON

MAINS HUM AGAIN

Two letters arrived recently on what, at first sight, seem to be quite different subjects but which turn out to have much in common. A reader in Malta (Francis Aquilina) is having trouble with mains hum. "Why," he asks, "does my power supply keep making a humming sound on my radio even though I smoothed it with 2000μF?"

The other reader (Tom Smales of Wrexham), has been using the *Warning Winker* (an l.e.d. flasher which reminds you that something is left switched on) in conjunction with the *Add-on Amplifier*. "When in use a click can be heard in the loudspeaker corresponding to each flash of the l.e.d."

How can these two forms of *interference* be prevented? Regular readers of this column will not be surprised if I kick off by saying that I don't know. The reason is that I haven't been given sufficient information to diagnose the trouble precisely. No reflection on our readers: it's unlikely that they had the means of providing the information required. If they had, they'd have found the cure themselves and E.E. would never have heard about the problem! So I'll have to make a general appraisal and throw out a few hints for likely courses of action.

Unwanted signals (hum, noise, clicks, etc.) can get from one circuit to another in various ways. If two circuits are connected together *in any way*, e.g. if they work from the same battery, then the connections form a possible route for transferring interference from one circuit to the other. Also, currents which change rapidly in one circuit produce changing magnetic fields which can induce voltages in conductors in the other circuit, without physical connection.

Also, one circuit may act as a miniature radio transmitter and radiate interference to the other. Sometimes there is enough capacitance between circuits to transfer interference in the form of a changing electric charge.

These are not the only ways of coupling one circuit to another but they are the main ones and account for most of the hum and other unwanted signals which are experienced. Let's look at them in more detail.

MAGNETIC FIELDS

Mains power units usually contain transformers. Mains frequency currents in the transformer windings create strong a.c. magnetic fields. Ideally these fields should be trapped in the iron core of the transformer. In practice there is an appreciable stray field around it, vibrating away merrily at the mains frequency (50Hz in Britain). A 50Hz voltage is induced in any conductor which gets in the way. If the conductor is a coil the voltages induced in all the turns add, giving a reinforced hum signal.

Radio receivers always have coils in them: an aerial coil, at least, and often i.f. transformers and audio transformers, too. Ferrite rod aerials, which are dedesigned to respond to the magnetic field of a radio transmission are particularly likely to pick up hum. If the mains unit is removed a foot or so from the radio and connected by long leads this sort of hum should stop. Also, turning the mains transformer into different positions alters the strength of the hum.

If you are very lucky you may find a position where there's no hum. Often, however, it's necessary to insert a high-pass filter (a small series capacitor and shunt resistor) at a strategic point in the r.f. or i.f. parts of the circuit—10nF and 10kΩ are a fairly good bet. (See *Down to Earth* Dec. '74 for a more detailed explanation of how 50Hz hum in r.f. circuitry produces an audio effect.)

It doesn't have to be a mains transformer which creates an interference field. Any wiring with rapidly changing currents in it can do so, especially if it's close to a ferrite rod aerial. This is why the *Warning Winker* can interfere with reception if badly installed in a set: fairly strong current pulses flow when the l.e.d. flashes. This is unlikely to have much bearing on the interference it produced in the *Add-on Amplifier*, though. Couplings via the common battery is more likely.

The amplifier (July '75) has 100μF across the battery, but this is on the low side and 1,000μF (12V or over) may make quite an improvement. Also, the negative lead of the Winker circuit should go straight to the negative terminal of the capacitor, and not share its connection with the negative wiring of the amplifier. (Use separate "earths" for common-side connections if interference is a risk.)

EARTHING

Where equipment is powered by a mains unit, it is always possible that the cause is similar: faulty wiring of the earthy or common side of the circuit. Large ripple currents flow through the reservoir capacitances in power units. A ripple current of 1 amp flowing through a bit of hook-up wire with a resistance of 0·01 ohm sets up 10mV. If this gets into an amplifier through shared "earth" wiring it is bound to cause hum.

The remedy: take all "earth" connections straight to the earthy terminal of the reservoir capacitor. No part of the earth line should be shared by both the earth connections from the power unit and those from the equipment being powered.

Finally, radiation and capacitive coupling. Both can be eliminated by enclosing the offending circuit in an earthed metal box. You can make one from an old tin can from the kitchen.

Where leads must come out it is often possible to use screening braid and magnetic and radiative effects can be reduced by twisting pairs of leads (e.g. the power or battery leads) tightly together.

Everyday Electronics Classified Advertisements

BOOKS and PUBLICATIONS

Start your own business printing pound notes

Printing pound notes? Well not quite—but "start your own business rewinding electric motors" could easily be your licence to make money in 1976.

Lavishly illustrated, this unique instruction manual shows step by step how to rewind motors working part or full time, without experience. Everything you need to know easily explained, including where to obtain materials, how to get all the work you need, etc, etc.
A goldmine of information and knowledge. Only £3·65 plus 25p P&P. From:—

Magnum Publications Dept. EE5, Brinksway Trading Estate, Brinksway, Stockport SK3 0BZ

EDUCATIONAL

TAPETALK
THE CLEVER WAY TO LEARN
TWO C60 Cassettes entitled
INTRODUCING ELECTRONICS
£5·44 plus 55p VAT/P. & P.
TAPETALK, P.O. Box 99 (EE)
Milton Keynes MK3 5BR
Tel.: Milton Keynes (0908) 77710

TRAIN FOR SUCCESS
An ICS home study course will give you the qualifications to improve your career prospects in electronics.

C & G Exams
Course for Certificates in Telecoms Technicians, Electrical Installations, Radio, T.V. and Electronics Technicians & Radio Amateurs.

Practical Radio
Courses include FREE construction kits.

Colour TV Servicing
Covers principles, practice and alignment with numerous illustrations and diagrams. Other courses for Radio & Audio Servicing.

Technical Training
Courses include Electronic Technicians, Computer Technicians, Radio and Television Technicians and many more.

Write for full details TODAY.
ICS School of Electronics,
Dept. 711V, Intertext House,
London SW8 4UJ.
Telephone 01-622 9911 (all hours).

FOR SALE

EVERYDAY ELECTRONICS No. 1 to date, also Demo-Deck. Complete with assorted electronic parts and multimeter. Offers to ABBOTT, 10 Blacknore Road, Streatham, London SW16 1NH. Write or call evenings.

AKG D190C MIKES. New and boxed £24. 'E' model £26 inc. VAT and postage. J. J. FRANCIS (WOOD GREEN) LTD., Manwood House, Matching Green, Harlow, Essex. Tel: Matching 476.

ELECTRONICS COURSE including all parts to build your own oscilloscope, unused £20. Value £80. Also a few beck numbers of Everyday Electronics. WRIGHT, Flat 'C', 2 Park Quadrant, Glasgow G3 6BS.

RECEIVERS and COMPONENTS

FOUR PANELS EX F.M. STEREO AMP 14 Transistors, 3 stereo pots, 7 way push button assembly coils and IFs etc. £1·75 (45p) 20 NEONS 80p (20p) COPPER CLAD P.C. BOARDS $5\frac{1}{2}$in x $5\frac{1}{2}$in 6·75p $12\frac{1}{2}$in x 9in 65p $8\frac{1}{2}$in x $9\frac{1}{2}$in 3-£1·25 all C.P. TALKING PAGE PANEL, 2 pots, 12 silicon transistors and S.C.R. plus 8 electrolytics etc. 80p (20p) 100 ASSORTED S/mica, polyester, polystyrene etc. capacitors 80p (20p) List 15p refund on purchase 7lbs assorted components £2·50 C.P. J. W. B. Radio, 2 Barnfield Crescent, Sale, Cheshire M33 1NL. Postage in Brackets. Mail Order Only.

VALVES
Radio-TV Industrial Transmitting
2,200 Types. 1930 to 1975, many obsolete. List 20p S.a.e. for quotation. Postal export service. We wish to purchase all types of new and boxed valves. Wholesaler's, Dealer's, etc. stocks purchased.
COX RADIO (SUSSEX) LTD.,
The Parade, East Wittering, Sussex.
Tel: West Wittering 2023.

SERVICE SHEETS

BELL'S TELEVISION SERVICES for service sheets, manuals & books on radio/TV etc. Service sheets 50p plus SAE. Service sheet catalogue 25p. Back issues of magazines from April '74 onwards cover price plus 12p post. Free booklists on request. SAE with enquiries please to:— B. T. S. 190, Kings Road, Harrogate, Yorkshire. Telephone Harrogate (Code 0423) 55885.

SERVICE SHEETS for Radio, TV, Tape Recorders, Stereo, etc., with free fault-finding guide, 50p and SAE. Hamilton Radio, 47 Bohemia Road, St. Leonards, Sussex.

MISCELLANEOUS

STYLI & CARTRIDGES. For the best at keenest prices send SAE for free illus. list to FELSTEAD ELECTRONICS (EE), Longley Lane, Gatley, Ches. SK8 4EE.

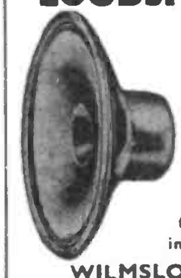
I.C.s. TTL. C/Mos. Linear. Capacitors. Resistors (E12). SIL/Rectifiers. Diodes. LED. Thyristors. Zeners. Voltage Reg. DIL Sockets. Bridge Rectifiers. Potentiometers. Presets. Triacs. Diac. Plugs. Sockets. Cable. Vero. Carefully selected range, excellent despatch service. Same day turn round. S.A.E. List ORCHARD ELECTRONICS, Flint House, High Street, Wallingofrd, Oxon. Tel: 0491-35529.

LOWEST COST IC SOCKETS. Use Soldercon IC socket pins for 8 to 40 pin DIL's. 50p for strip of 100 pins, £1·50 for 3 strips of 100, £4 for 1000. 10p p&p for orders under £2. Add 8% VAT. Instructions supplied—send sae for sample. SINTEL, 53e Aston Street, Oxford. Tel: 0865 43203.

HOME SCIENTISTS
Get the key to a FANTASTIC WORLD of previously UNHEARD-OF-PROJECTS. The NEW Boffin catalogue lists LOTS of HIGHLY UNUSUAL, LOW-COST BARGAINS, READY-BUILT MODULES. Here are just a few examples, there are stacks more!
Dazzling MINI-STROBE (pocket size) £3·50
PEOPLE DETECTOR £4·20
Big-Ear SOUND-CATCHER £4·20
Mini DREAM LABORATORY £4·20
Don't take our word for it though! GET A COPY & SEE!
SEND ONLY 20p, and we'll RUSH YOU A COPY (YOU'LL GET THE GOODIES' JUST AS QUICKLY TOO!)
BOFFIN PROJECTS
4 Cunliffe Road, Stoneleigh, Ewell, Surrey
(Mail Order U.K. Only)

SUPERB INSTRUMENT CASES by Bazelli, manufactured from heavy duty PVC faced steel. Hundreds of people and industrial users are choosing the cases they require from our vast range, competitive prices start at a low 75p. Over 400 Models to choose from, Prompt despatch, Free literature, (stamp would be appreciated). Bazelli, Department No. 24, St. Wilfreds, Foundry Lane, Halton, Lancaster LA2 6LT.

LOUDSPEAKERS



Speakers, kits and cabinets for D.I.Y., HiFi, P.A., Disco, etc. by EMI, Fane, Goodmans, Baker, Kef, Elac, Richard Allan, Wharfedale, etc. Send stamp for free booklet "Choosing a speaker"
WILMSLOW AUDIO
Dept. EE, Swan Works, Bank Square, Wilmslow, Cheshire SK9 1HF
Tel. Wilmslow 29599

RECHARGEABLE NICAD BATTERIES Pencell, AA—94p. Sub 'C'—£1·16. 'C'—£1·92. 'D'—£2·59. PP3—£4·48. Chargers £4·48, £4·48, £4·98, £4·98, £3·98, respectively. Others. All prices include VAT, add 10% post and package. S.a.e. for price list plus 25p for information booklet. SANDWELL PLANT LTD., 1 Denholm Road, Sutton Coldfield, West Midlands. 021-354 9764.

BUILD THE
TREASURE TRACER MK III Metal Locator

- Varicap tuning
- Britain's best selling metal locator kit; 4,000 sold
- Weighs only 22oz. Fitted with Faraday shield
- Speaker and earphone operation
- Knocks down to only 17in
- Prebuilt search coil assembly
- Thoroughly professional finish
- As seen on BBC1 and BBC2 TV
- You only need soldering iron, screwdriver, pliers and snips
- Five transistor circuit

Send stamped addressed envelope for leaflet

Complete Kit **£12·50** Built & tested **£17·50**
Post 85p-£1·00 VAT (8%) Post 85p-£1·90 VAT (8%)
MINIKITS ELECTRONICS
6b CLEVELAND ROAD,
LONDON, E18 2AN (Mail order only)

ENAMELLED COPPER WIRE

SWG	1lb	4oz	2oz
14–19	2·40	·60	·50
20–29	2·45	·82	·59
30–34	2·60	·89	·64
35–40	2·85	1·04	·75

Inclusive of P. & P. and VAT

S.A.E. brings Catalogue of copper and resistance wires in all coverings.

THE SCIENTIFIC WIRE COMPANY
P.O. Box 30 London E.4. 9BW.

---

555 Timer 38p. Slide Switches DPDT 10p
Stethoscope Earphone 8 ohm 3·5mm plug ... £1·12
Resistors:
¼ w 5% E12 1 ohm to 2·2 meg ... 1p
¼ w 10% E12 2·7 meg to 10 meg ... 1p
Miniature Transformers: LT44 ... 25p
LT700 ... 28p
Volex mains plugs ... 38p
LM3909 LED Flasher ... 68p
Speakers: 70 mm, 80 ohm ... 95p
70 mm, 56 mm, 50 mm, all 8 ohm ... 55p
Printed Circuit Kit ... £2·65
IN 4148 ... 3p
Denco D.P. Coils, ranges 1 to 5 Green 78p
Ranges 1 to 5 Blue, Yellow, Red, White 74p
Ranges 6 to 7 Blue, Yellow, Red ... 64p
Push on-release off switches... ... 14p
BC 107/8/9 ... 9p
LOG pots 5, 10, 25, 250, 500K, 1M ... 17p
LIN pots 500K ... 17p
Switched LOG and LIN ... 31p
5 pin DIN plugs 18p. 5 pin DIN sockets 10p
3 pin DIN plugs 13p. 3 pin DIN sockets 10p
2 pin DIN L/S plugs 9p. Solder tags 10 for 5p
Alligator clips ... 11p/pair
Multicore Solder ... 9p/metre
Co-ax 75 ohms ... 10p/metre
Co-ax50 ohms ... 15p/metre

20p post and packing. VAT included.
For catalogue and lists send 15p.

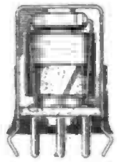
CLEVELAND SUPPLIES (E.E.)

P.O. BOX 20, REDCAR, CLEVELAND

DENCO (CLACTON) LIMITED

Dept. E.E.

357-8-9 OLD RD., CLACTON-ON-SEA ESSEX CO15 3RH



Our components are chosen by technical authors and constructors throughout the world for their performance and reliability, every coil being inspected twice plus a final test and near spot-on alignment.

General Catalogue showing full product range 32p. Overseas Customers 70p, Air-Mail Post Paid.

U.K. & OVERSEAS MANUFACTURERS/STOCKISTS ENQUIRIES WELCOME

Australian Readers Please Note—Our Complete Range of Coils are available from Hobipak, Box 224, South Carlton, 3053, Victoria, Australia.

ELECTRONI-KIT

BUILD, DISMANTLE AND REBUILD OVER 100 DIFFERENT PROJECTS AND DESIGN NEW CIRCUITS TOO

Radio Receivers and Transmitters, Telephone Amplifiers, Time Buzzers, Battery Checkers, Computer Circuits, Amplifiers, Directional Transmitters, Metal Detectors, Continuity Testers, Electronics Birds, Guns, Metronomes, Sirens, Roulette, Etc., Etc. **ALL IN ONE KIT**

"... educational kits of exceptional quality" (AUDIO mag.)

"... worthwhile ... good value for money" (EVERYDAY ELECTRONICS mag.)

Educational manuals included with each kit. No previous experience required. Suitable for beginners and experts too.

100 project kit £19·60
45 project kit £15·60
25 project kit £12·10
(Add-on kits available too)

Prices include Manuals, Batteries, VAT and p and p

Cheque/P.O. (or 11p for illustrated literature) to **DEPT. EE**

Satisfaction guaranteed

ELECTRONI-KIT LTD. 408 St. John's Street, London, EC1. (01-278 4579)

QUALITY STEREO SOUND

SOLENT AUDIO SYSTEM

ALMOST ½ PRICE OFFER!

£7·50 down

Solent Mark II Stereo Tuner Amplifier chassis with AM/FM radio covering long medium short and Stereo FM wavebands. Separate Base and Treble controls. 30 watts total power output (frequency response 25-20,000 Hz) AFC Switching Tape record and playback facilities. Dimensions 18½" x 9" x 3½" The very latest BSR automatic record deck with cue and pause control. Two matching elliptical speaker units.

Order early limited stocks available cash price £69·95. Credit Sale £7·50 deposit 9 monthly payments of £8·00 (Total Credit price £79·50). P. & P. £3·50. Send £11·00 today.

Chassis only available for cash at £45·00.

Full 12 months Guarantee.

CALLERS WELCOME.

Access and Barclaycard Orders Accepted by Telephone

FREE! Stereo headphones supplied with every complete order.

LEWIS radio EE/7/76 100 CHASE SIDE SOUTHGATE LONDON N14 5PL Telephone: 01-882-1644

TECHNICAL TRAINING IN ELECTRONICS AND TELECOMMUNICATIONS

ICS can provide the technical knowledge that is so essential to your success; knowledge that will enable you to take advantage of the many opportunities open to you. Study in your own home, in your own time and at your own pace and if you are studying for an examination ICS guarantee coaching until you are successful.

City & Guilds Certificates:
Telecommunications Technicians
Radio, TV, Electronics Technicians
Technical Communications
Radio Servicing Theory
Radio Amateurs
Electrical Installation Work
MPT Radio Communications Certificate

Diploma Courses:
Colour TV Servicing
Electronic Engineering and Maintenance
Computer Engineering and Programming
Radio, TV, Audio Engineering and Servicing
Electrical Engineering, Installation and Contracting

POST OR PHONE TODAY FOR FREE BOOKLET.

ICS To: International Correspondence Schools
Dept. 710V Intertext House, London SW8 4UJ or telephone 622 9911

Subject of Interest ....
Name ....
Address ....
.... Tel: ....

Published approximately the third Friday of each month by IPC Magazines Ltd., Fleetway House, Farringdon St., London EC4 4AD. Printed in England by Index Printers Ltd., Dunstable, Beds. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/Sia) Ltd. South Africa—Central News Agency Ltd. Everyday Electronics is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on cover, excluding Eire where the selling price is subject to V.A.T., and that it shall not be lent, resold, or hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.