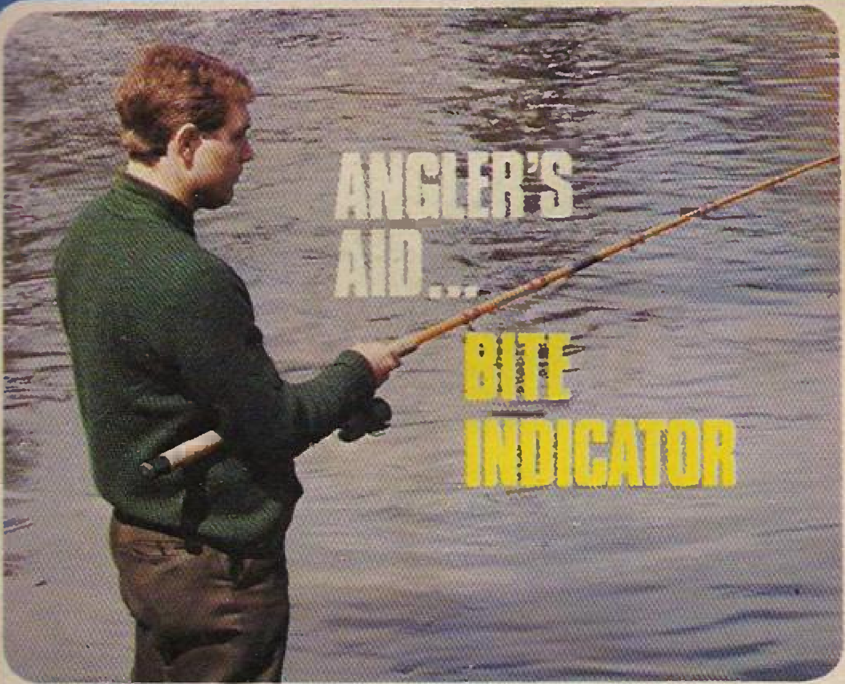
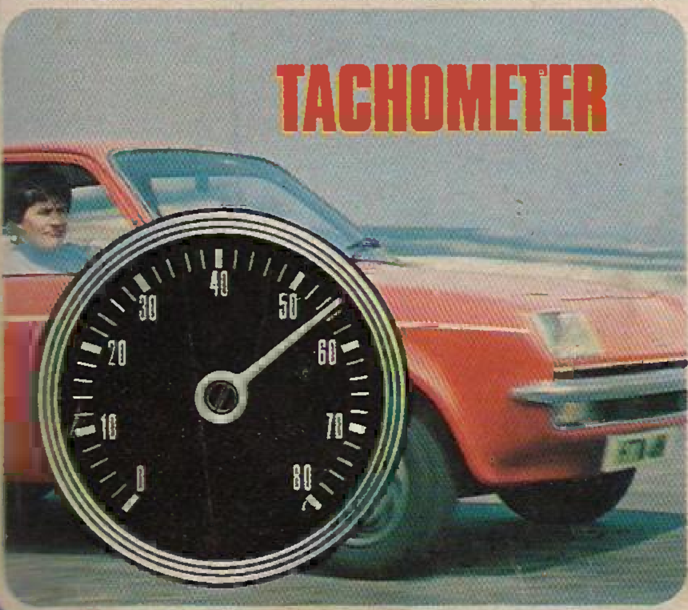
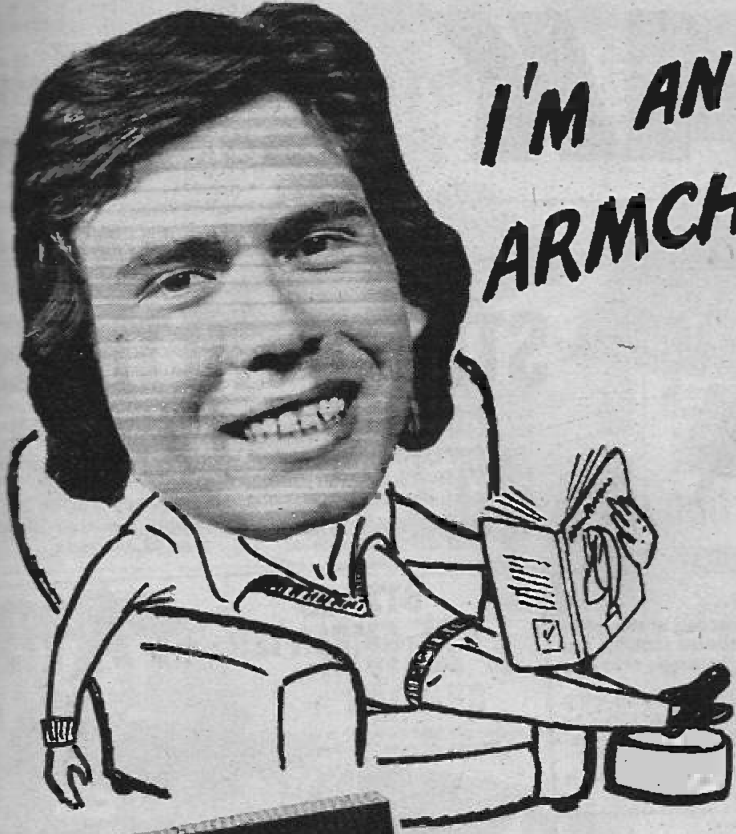
Construction and theory for everyone

everyday electronics

MAR. 76
30p







I'M AN ARMCHAIR SHOPPER!

On a cold dark winter's evening, with the rain lashing down and the wind howling around, there's nothing I like better than to curl up in front of a fire, with tea and toasted scones at my side . . . . and my catalogue on my lap. I then start choosing the bits and pieces for my next project. Home Radio Components had sent me one of their special order packs, so I had six order forms and six pre-paid addressed envelopes to simplify my job. I've now gone even one better. When I've written out my order, I pick up the phone and order direct. This was another thoughtful idea of Home Radio. They've made it easy for anyone to open a Credit Account without the delay and formality of references and all that fiddle faddle. Once you have an account, you can order anything, any time during the 24 hours! Just think what a boon that is, if you run out of wire or solder late at night.

HOW ABOUT YOU?

I expect by now you're itching to know how to get in on this. It's really quite easy; but for a start you need the fabulous Home Radio Components Catalogue. It costs 85 pence, plus 45p post and packing; but with the catalogue you get 14 vouchers, each worth 5 pence when used as directed, so you can recover 70 pence of your investment. Why hesitate any longer? *Post off the coupon below today, with your cheque or PO for £1·30, and join the merry band of Armchair Shoppers!*

Today's finest Components Catalogue **85p** plus 45p POST & PACKING

POST THIS COUPON
with cheque or PO for £1·30

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Please write your Name and Address in block capitals

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(Regn. No London 912966)

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

BI-PAK

High quality mono and othe

NEW

STEREO FM TUNER

Fitted with Phase Lock-loop

- ★ 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 **MK60** Kit etc. Alternatively the **PS12** 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 is easily installed using the simple instructions supplied.

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.

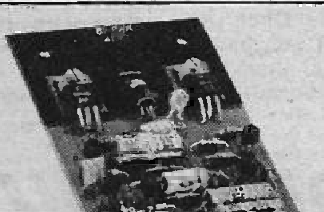
Frequency Response + 1dB 20Hz–20KHz.
Sensitivity of inputs:
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to RIAA curve within 1dB from 20Hz to 20KHz. Supply 20-35V at 20mA. Dimensions—299mm × 89mm × 35mm.

OUR PRICE £13.50

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 3¼", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £9·20** *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

Stabilized Power Supply Type SPM80

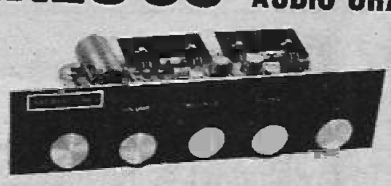
SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1·5A at 35V. Size: 63mm, 105mm, 30mm. Incorporating short circuit protection.

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

£3.00

TRANSFORMER BMT80 £2·60 + 62p. postage

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.*

Now...the most exciting Sinclair kit ever

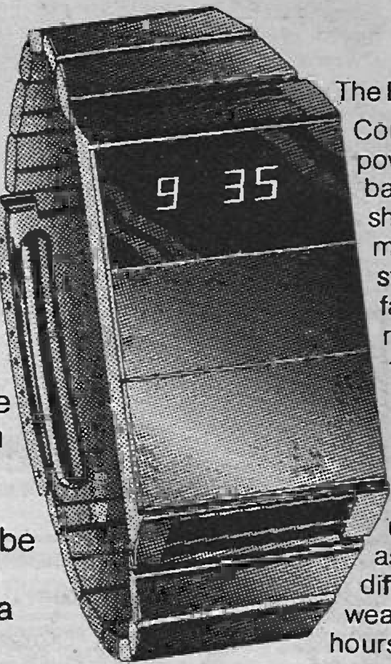
The Black Watch kit

At £14.95, it's

★**practical**–easily built by anyone in an evening's straightforward assembly.

★**complete** –right down to strap and batteries.

★**guaranteed.** A correctly-assembled watch is guaranteed for a year. It works as soon as you put the batteries in. On a built watch we guarantee an accuracy within a second a day–but building it yourself you may be able to adjust the trimmer to achieve an accuracy within a second a week.



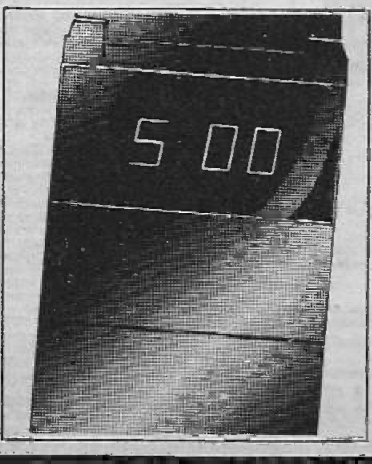
The Black Watch by Sinclair is unique. Controlled by a quartz crystal... powered by two hearing aid batteries...using bright red LEDs to show hours and minutes and minutes and seconds...it's also styled in the cool prestige Sinclair fashion: no knobs, no buttons, no flash.

The Black Watch kit is unique, too. It's rational–Sinclair have reduced the separate components to just four.

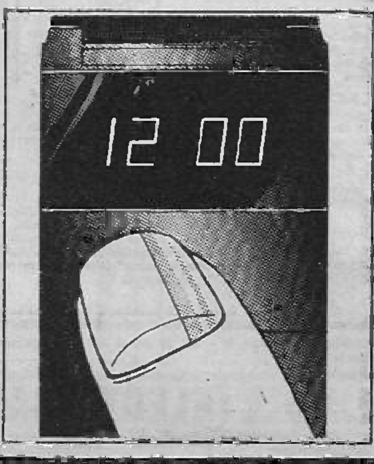
It's simple–anybody who can use a soldering iron can assemble a Black Watch without difficulty. From opening the kit to wearing the watch is a couple of hours' work.

The special features of The Black Watch

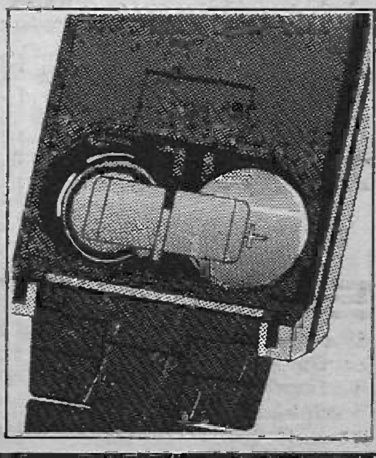
Smooth, chunky, matt-black case, with black strap. (Black stainless-steel bracelet available as extra–see order form.)



Large, bright, red display–easily read at night.
Touch-and-see case–no unprofessional buttons.



Runs on two hearing-aid batteries (supplied). Change your batteries yourself–no expensive jeweller's service.



The Black Watch–using the unique Sinclair-designed state-of-the-art IC.

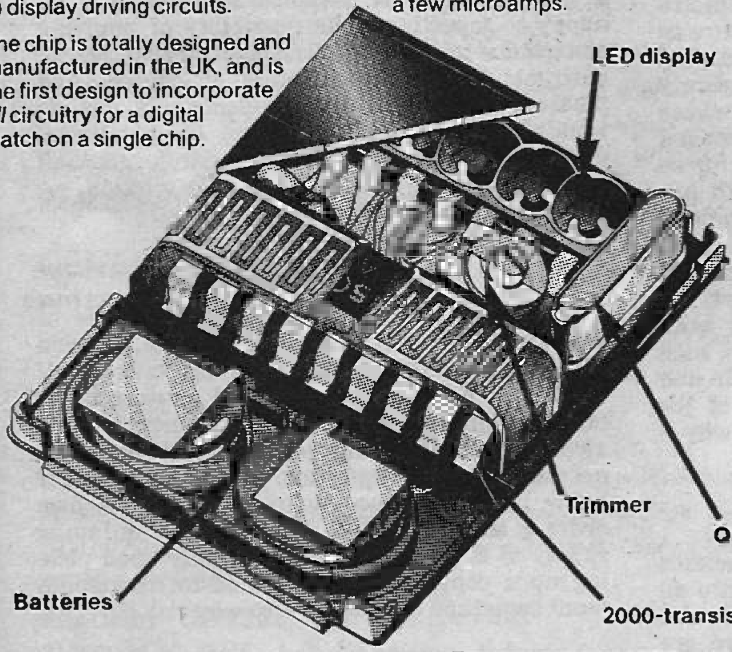
The chip...
The heart of the Black Watch is a unique IC designed by Sinclair and custom-built for them using state-of-the-art technology–integrated injection logic.

This chip of silicon measures only 3 mm x 3 mm and contains over 2000 transistors. The circuit includes

a) reference oscillator
b) divider chain
c) decoder circuits
d) display inhibit circuits
e) display driving circuits.

The chip is totally designed and manufactured in the UK, and is the first design to incorporate *all* circuitry for a digital watch on a single chip.

...and how it works
A crystal-controlled reference is used to drive a chain of 15 binary dividers which reduce the frequency from 32,768 Hz to 1 Hz. This accurate signal is then counted into units of seconds, minutes, and hours, and on request the stored information is processed by the decoders and display drivers to feed the four 7-segment LED displays. When the display is not in operation, special power-saving circuits on the chip reduce current consumption to only a few microamps.



Complete kit £14.95!

The kit contains

1. printed circuit board
2. unique Sinclair-designed IC
3. encapsulated quartz crystal
4. trimmer
5. capacitor
6. LED display
7. 2-part case with window in position
8. batteries
9. battery-clip
10. black strap (black stainless-steel bracelet optional extra–see order form)
11. full instructions for building and use.

All the tools you need are a fine soldering iron and a pair of cutters. If you've any queries or problems in building, ring or write to Sinclair service department for help.

Take advantage of this no-risks, money-back offer today!
The Sinclair Black Watch is fully guaranteed. Return your kit in original condition within 10 days and we'll refund your money without question. All parts are tested and checked before despatch–and correctly-assembled watches are guaranteed for one year. Simply fill in the FREEPOST order form and post it–today!

Price in kit form: £14.95 (inc. black strap, VAT, p&p).

sinclair

**Sinclair Radionics Ltd,
London Road, St Ives,
Huntingdon, Cambs., PE17 4HJ.
Tel: St Ives (0480) 64646.**
Reg. no: 699483 England. VAT Reg. no: 213 8170 88.

To: Sinclair Radionics Ltd, FREEPOST, St Ives, Huntingdon, Cambs., PE17 4BR.

Please send me — Total £

.... (qty) Sinclair Black Watch kit(s) at £14.95 (inc. black strap, VAT, p&p). ....

.... (qty) black stainless-steel bracelet(s) at £2.00 (inc. VAT, p&p). ....

* I enclose cheque for £.............................. made out to Sinclair Radionics Ltd and crossed.

* Please debit my *Barclaycard/Access/American Express account number

....

Name ____________________

Address ____________________

____

____________________ EE/3

Please print. FREEPOST–no stamp required. *Delete as required

everyday electronics

PROJECTS THEORY...

A NEW LINE

At the service of all. That is a good motto for electronics. We in our own modest way endeavour to see that this is really true. But one serious omission on our part was recently brought to our attention by a reader whose interests include fishing. Just how we managed to overlook two or three million anglers for so long is just unexplainable. But this default has at last been rectified and this month's Angler's Aid should make amends.

Concerning the ethics of employing technical aids such as this bite indicator in a sport, we leave this for others more conversant with angling to argue about. At least we know such devices have been around for quite a while and they are widely used amongst members of the angling fraternity. Our's is not to reason why—but simply to make available.

SPECIAL REQUESTS

As regular followers of EVERYDAY ELECTRONICS will know, we strive to bring electronics into all walks of life through the medium of simple and inexpensive projects. Angling apart, there are bound to be other hobbies and special interests that have not so far received due attention in the pages of this magazine.

The fault is not entirely ours! We must rely upon those who have special (and maybe obscure) interests to make their case.

We are always open to suggestions and where a genuine need is demonstrated we will be happy to investigate the possibility of applying electronics to meet it. We cannot guarantee the outcome of any investigation of course. And please remember, although electronics can do wonders, we have to limit the complexity of designs to keep within the general scope of this magazine. If there is a suitable solution, we will be glad to publish it.

DON'T CHANCE IT!

Difficulties in obtaining particular issues of EVERYDAY ELECTRONICS are reported to us from time to time. This causes us much concern. If we know the name of the local newsagent or other supplier, our circulation department will always investigate. But we must emphasise the necessity for the customer to let his supplier know, well in advance, his requirements. A firm order is the only way that prompt and unfailing supply of EE can be assured. To rely upon picking up a copy casually will lead to disappointment sometime or another—so why risk it?

Fred Bennett.

Our April issue will be published on Friday, March 19

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. 6 NO. 3 MARCH 1976

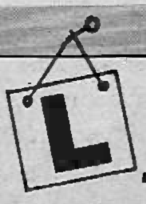
CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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 6 (state which) and indexes for volume 1 and 2 available for £1·85 and 30p respectively, including postage, from Binding Department, Carlton House, Great Queen Street, London, WC2E 9PR.



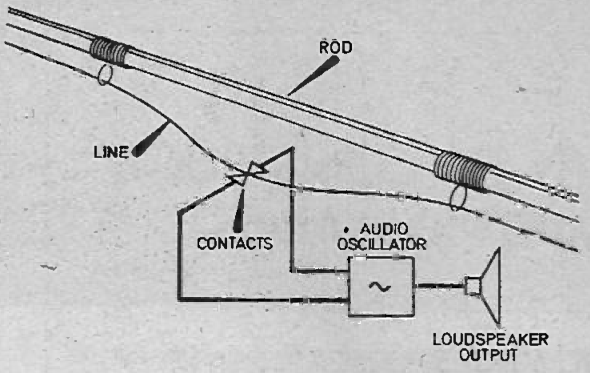
LEARNERS ...TAKE NOTE

Next month's issue carries a special supplement aimed at you.

See page 161 for details.

SIMPLY

The rod is rested after casting out and the line is inserted between two contacts. When the unit is turned on and the line is pulled out of the contacts the audio oscillator will operate causing a note to be heard from the loudspeaker.



THIS is a simple project that will be of special interest to the fisherman who ledgers, or uses two rods (one for float fishing and one for ledgering). The rod is placed on the bite indicator (after casting out); when the fish take the bait and pull the line a bleep will be heard and the rest is up to the skill of the fisherman to catch the fish.

CIRCUIT

Switch S2 (Fig. 1) is the normal on/off switch whilst S1 is a special spring-loaded switch which is held open by the line being passed through it. When the line is pulled by a fish it slips out of S1 allowing it to close and sounding the alarm.

The circuit is a simple multivibrator, oscillation is achieved by TR1 and TR2 switching on and off alternately, at a frequency determined by C1, C2, R2 and R3 these are chosen to provide oscillation in the audible frequency range. As TR2 switches on and off, it causes an audible tone to be heard in the loudspeaker LS1. Resistor R4 limits the current flowing in TR2 but allows enough to provide a reasonable output.

Angler's aid... BITE

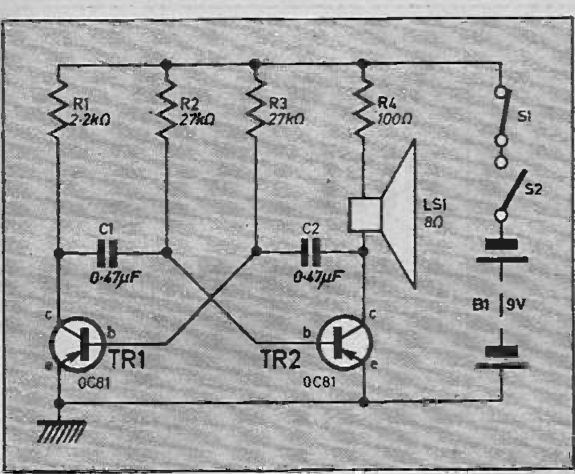


Fig. 1 The complete circuit diagram of the Bite Indicator

Components....

Resistors
R1 2·2kΩ
R2 27kΩ
R3 27kΩ
R4 100Ω
All ¼W ±10% carbon

SEE SHOP TALK

Capacitors
C1 0·47µF
C2 0·47µF

Semiconductors
TR1,2 OC81 or similar *pnp*

Miscellaneous
LS1 8Ω miniature loudspeaker
S1 formed from brass—see text
S2 s.p.s.t. switch
B1 9V PP3 battery
Plain 0·15inch matrix board, 15 by 10 holes connecting wire, 4BA fixings, materials for case.

CONSTRUCTION

The prototype box was made with plywood 10mm thick for the sides, top and bottom and 3mm thick for the front and back. The size of the box in the prototype was 200×100×50mm. Front panel drilling layout is given in Fig. 2. A tank cutter was used for cutting the hole for LS1. When all the holes are drilled the box can be painted, when the paint has dried, glue a 75mm square of speaker gauze over the hole then glue the speaker LS1 into place. Insert a $1\frac{1}{2}\times\frac{3}{8}$ inch BSF bolt in the bottom of the box, for the bank stick, this must be as tight as possible. The rodrest for the top of the indicator was made from an old wire coat hanger, bent into shape (Fig. 2) and bolted to the top of the box.

Switch S1 was made from two brass saddle clips straightened out, cut to size, bent into shape (Fig. 3) and bolted to the box with two 4BA screws. The contacts are set so that the clips are touching each other making the switch closed.

To commence construction of the circuit board first cut the board to size and file up the rough edges. Next drill the hole for mounting the board and then insert the components and connecting leads.

The indicator is wired up as shown in Fig. 2. Assemble resistors and capacitors first, then TR1 and TR2 using a heat shunt as they are being soldered, wire up the speaker, switches S1 and S2 and battery clip. A terry clip was glued into the box to hold the battery in place. Finally screw the circuit board into place and test the unit by simply switching on.

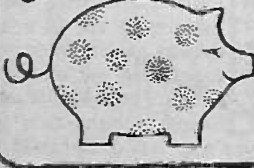
In use a rod is rested on the unit and the line threaded through S1 holding it open, when the line is pulled by a fish it slips out of S1 and the alarm is set off. ▣

INDICATOR

By PETER J. HOMER

FOR GUIDANCE ONLY

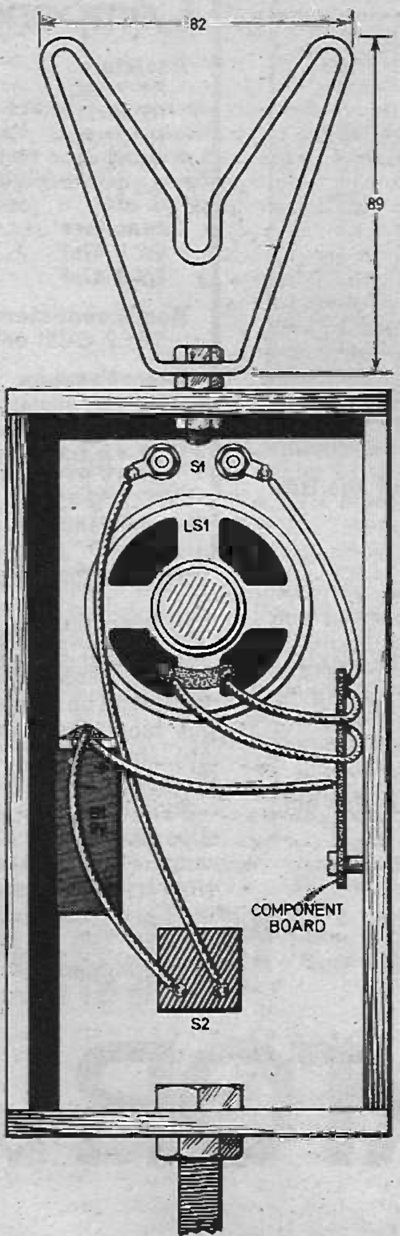
ESTIMATED COST* OF COMPONENTS
excluding V.A.T.



£1.80
excluding case

*Based on prices prevailing at time of going to press

Angler's Aid . . .
BITE INDICATOR



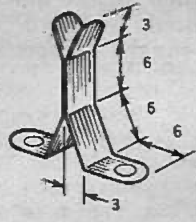


Fig 3. Construction of switch S1. The two contacts are held open by the line

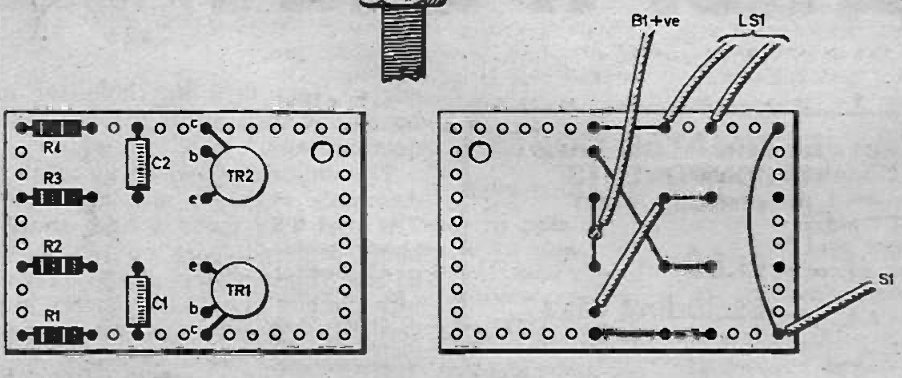


Fig. 2. The circuitboard layout and wiring and the complete construction of the Bite Indicator

New products and component buying for constructional projects

SHOP TALK

By Mike Kenward

FROM time to time we get readers' letters pointing out what appear to be large discrepancies between our published approximate cost and what the reader has had to pay for his parts. Sometimes the reader is very upset about this, quite understandably, as the project which he thought he was going to get for £5 actually costs him £8 to finish. We always take care to look into these letters to see what has gone wrong. We have found that we made a mistake in costing the *Stabilized Power Supply Unit* (Jan. 76) the approximate cost should have been £10·50.

However in most cases we have found that our prices are about right and that the readers' cost is increased for various reasons. One of these reasons is often that he purchased all the parts from a single supplier and that supplier charges slightly more for each item that others do. Thus on a unit containing some 20 or so components the cost has risen by about 80p. Most people would not complain about this order of difference on a project costing about £5 but this is where the second point comes into play.

One must remember that the total price the reader pays always includes V.A.T. and, on some projects about 40 per cent of the V.A.T. would be at the 25 per cent rate. Thus on a project which we costed at £5 (and for which the parts cost £5·80) you must add 58p for V.A.T. at the higher rate plus another 28p for V.A.T. at the lower rate. We now have a total increase, including the 80p mentioned above, of over £1·60. Therefore the total cost would now be about £6·60 instead of £5.

This is obviously a hyperthetical case but it does illustrate how it is easy to pay considerably more for some projects than our quoted approximate cost. Remember we do not include V.A.T. in our cost due to the two rates, and sometimes we do not include the cost of specialist items such as cases which could be made by constructors or for which large price differences may occur.

Whilst on the subject of V.A.T. it is worth noting that some very small mail order firms are not registered for V.A.T. and do not charge it on components sold.

A reader's letter published in this issue concerning the cost of the *Stabilised Power Supply Unit* in our January issue illustrates the points mentioned above. We should point out that we do not go out of our way to find the lowest price for each item, we price the units from various catalogues but we do use those catalogues that we know to be competitive, and feel this gives a fair indication of price to the reader.

Telephone Bell Repeater

Most of the parts for the *Telephone Bell Repeater* should be readily available from component suppliers. The Friedland bell transformer is available from most electrical shops and stores selling electric door bells. The other components which may not be readily available are the MC35 crystal mic insert and the Verocase, however both these should be available by mail from the larger suppliers that advertise in our pages.

This is the type of project that could be supplied by a single component supplier but take note of what goes before and check prices first.

Snap Indicator

Very few parts are used in the *Snap Indicator* and none of them should be difficult to obtain. This project will be very cheap to make provided the wooden case is used as shown. In this type of project the cost of a case is often more than all the other components.

Tachometer

The most expensive item for the *Tachometer* will be the meter, particularly if a 240 or 270 degree movement is used as shown in the photographs. The prototype used a meter from Henry's Radio but they tell us they are unable to get any more at the size and the larger one—72mm square—costs £7·50 including V.A.T. Obviously this makes it a very costly project and most people would opt for a normal meter or for an edgewise type, either of which should cost about £3 to £4. It is possible that some other suppliers have stocks of the smaller 240 degree meters at better prices but we cannot find any in our catalogues—incidentally Henrys do not list the above type (which is a T75 meter) in their new catalogue, because they were unable to obtain stocks until recently.

Bite Indicator

Once again no problems with buying components for the *Fish Bite Indicator* and, as suggested for the *Snap Indicator*, the use of a home made case will ensure that this project is cheap to construct. The connecting clips of a type 1289 4·5V battery could be used for the contacts as an alternative to the parts suggested.

See Shop Talk!

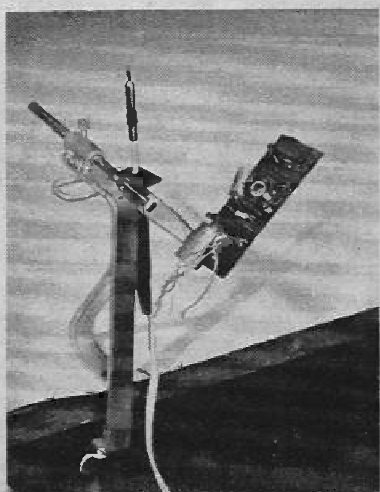
We recently published a note about our *See Shop Talk* notices being upside down. This seems to have done the trick as we now get fewer queries about component supplies that have already been dealt with in this page.

Having said that, we note that there are two in the post today!

Circuit Board Vice

A new circuit board vice has recently come our way from a firm called Cass of 73 Shirley Road, Southampton. The vice, shown in use below, costs £4·25 plus V.A.T. at 8 per cent plus 65p postage; we make that about £5·24.

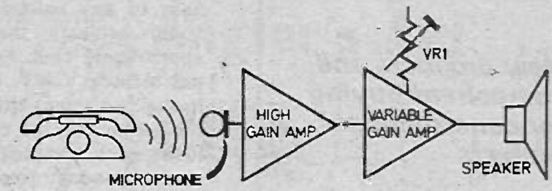
Since receiving the vice they have informed us that a later version will have jaws that revolve in two planes with wing-nut tightening.



HOW IT WORKS

Sound from the telephone bell is picked up by a microphone and passed to a high gain, two transistor amplifier (TR1, TR2). The amplified sound is then passed on to a second two stage amplifier (TR3, TR4) which can be adjusted (using VR1) to amplify only the sound of the bell.

A buzz in time with the ringing of the bell is heard from the speaker.



There are occasions in the home when the door or telephone bell may not be heard—as when watching TV or otherwise occupied in another room, or when upstairs. In these circumstances, the unit described here can be used to "relay" the warning to any other room required.

As the unit is sound-operated, no connection has to be made to any other circuit. It is in fact illegal to make unauthorised connections to a telephone.

The unit is designed so as *not* to relay speech, but to produce a "buzz" in the remote, warning speaker. It can be operated from the internal power supply from 240V a.c. mains, or can be run from a 9V battery. As the stand-by or resting current is under 1mA, battery operation is quite feasible when the unit will merely be switched on while watching TV in another room, or in similar circumstances.

REPEATER CIRCUIT

Fig. 1 is the complete circuit for mains operation. A small crystal mike insert (MIC 1) in the case picks up sounds from the bell. These are amplified by TR1, which is biased into its amplifying region by R1. The amplified signal appears across the collector load R2, and is coupled by C1 to the second amplifier TR2.

These two stages provide high gain, but require very little current from the power supply.

The collector load of TR2 is a preset potentiometer VR1. This allows sensitivity to be reduced, in those circumstances where sounds other than the telephone bell would operate the alarm.

FOR GUIDANCE ONLY

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

£4.00
excluding case

*Based on prices prevailing at time of going to press

Phone Bell REPEATER

By F. G. RAYER

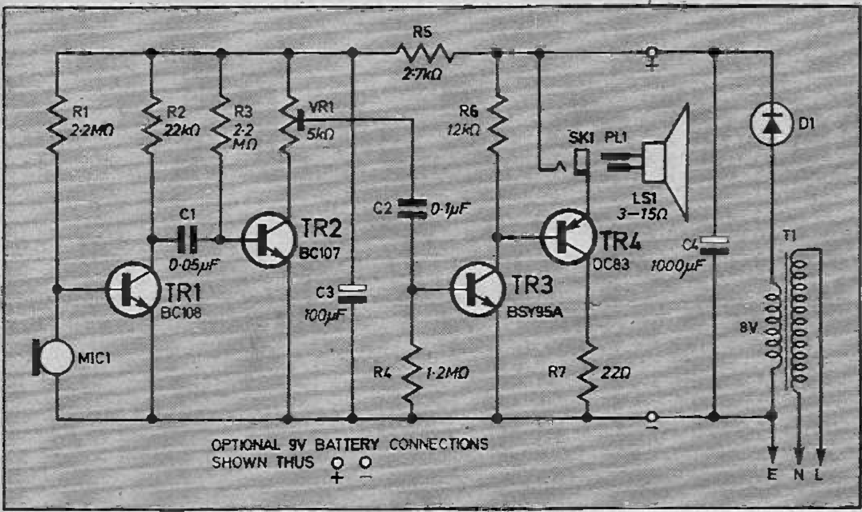


Fig. 1 The complete circuit, diagram of the Phone Bell Repeater.

Normally, TR3 is not conducting since its base is grounded by R4, so there is no voltage drop across R6, and TR4 is also cut off. When amplified audio signals reach TR3 via C2, TR3 conducts, thus moving TR4 base negative so that it also conducts.

Operating conditions are arranged so that low level sounds do not receive amplification by TR3 and TR4 in the way usual in an audio amplifier. The high level sound (bell) causes TR4 to conduct heavily, to produce the "buzz" in the speaker. Resistor R7 is to limit peak current through the speaker.

MAINS OR BATTERY OPERATION

The bell transformer T1, has a secondary with three tapping points. The 8V tap is used. The voltage is rectified by the silicon rectifier D1, and about 12V will be produced across the reservoir capacitor C4.

No on/off switch is fitted, because the unit is permanently plugged in, T1 being intended for continuous running, as with a bell circuit. Current drawn is extremely small.

When battery operation is preferred, C4, D1 and T1 are omitted. A 9V battery must then be provided, and is connected in the polarity shown. An on/off switch is included in one battery lead, and is fitted to the end of the case. Very many hours use can be had from a battery, and the change to 9V (from the 12V mentioned) makes little or no apparent difference to working.

COMPONENT BOARD

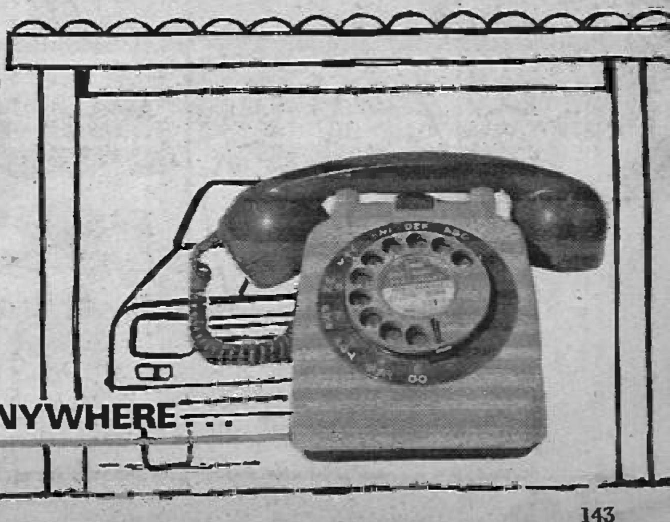
Components are positioned on the perforated board as in Fig. 2. First drill holes for the two 6BA bolts used to secure the board in the case. Pass the wire ends of resistors and capacitors through the holes, bend them over, cut to length, and solder connections as shown on the underside. Electrolytic capacitors C3 and C4 are placed with the positive and negative leads as indicated.

The preset potentiometer VR1 may be the flat or upright rotary type, or the long slider type shown. With the latter, a thin flexible lead must be soldered to the slider, and this is connected to C2.

Provide thin flexible leads 5 to 8cm long for the microphone. The lead from the negative line runs to the microphone case tag, and the remaining lead to the insulated tag.

Leads are also soldered on to run to the speaker jack socket (SK1). Also fit a red lead from C4 positive, and black lead from negative, for the connections to rectifier positive and T1 secondary. If a battery is to be used instead, these leads will run to it (with an on/off switch inserted in one connection). In this case, solder on positive and negative clips. Polarity must be correct.

Fit the transistors so that their leads come as



...REPEATS ANYWHERE...

Phone Bell
REPEATER

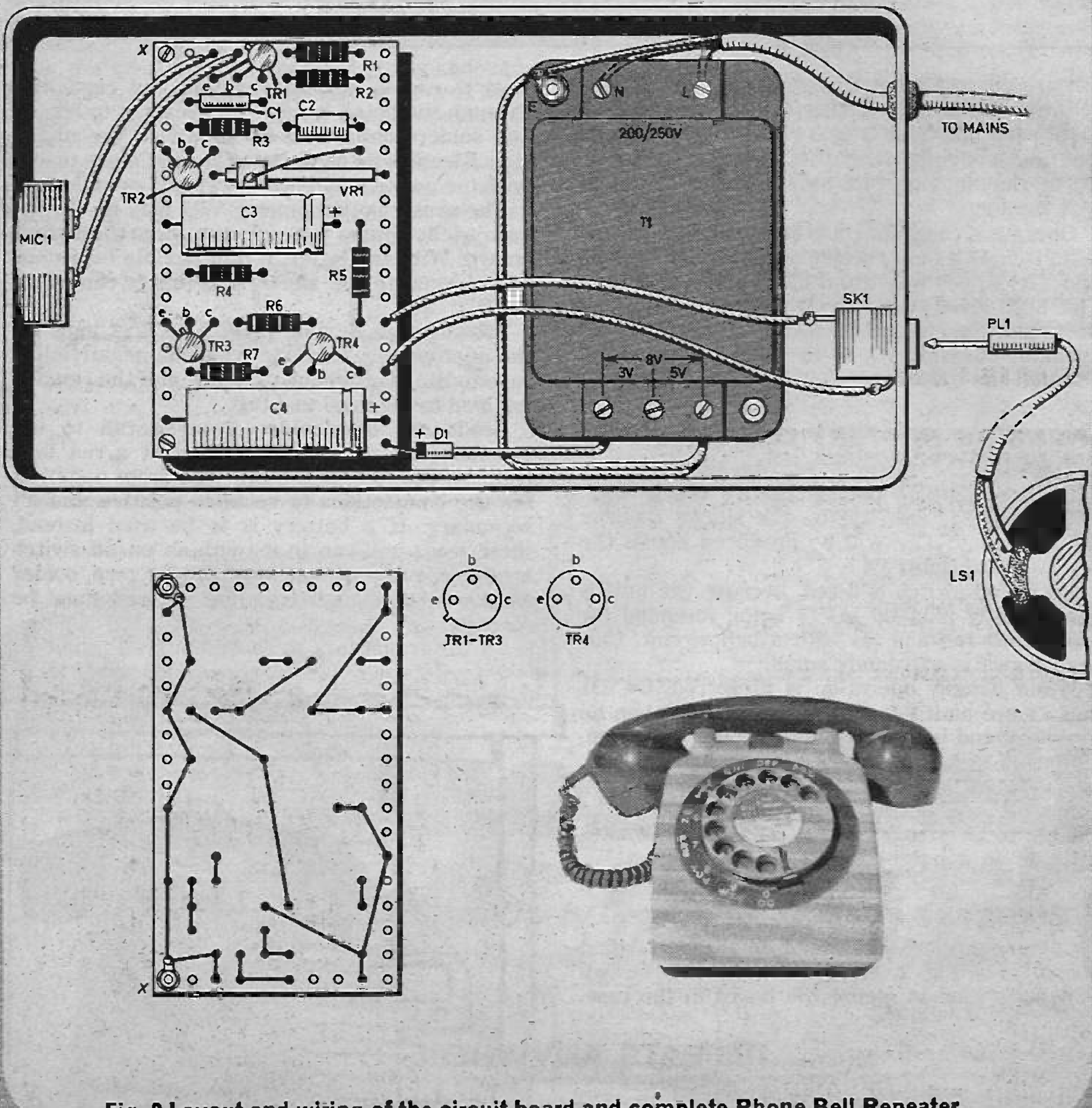


Fig. 2 Layout and wiring of the circuit board and complete Phone Bell Repeater.

in the underside diagram. Lengthy and unnecessary heating of these joints must be avoided, when soldering them.

FITTING IN CASE

The arrangement of components in the case is shown in Fig. 2. A ring of holes is drilled to match those in the microphone insert casing. Also drill holes for the mains cord, speaker outlet, and 6BA bolts to secure the transformer and circuit board. These bolts may be countersunk, to avoid damage to polished furniture.

With the circuit board, bolts can be passed up through the case, and through the board, with extra nuts to give clearance and lock the board. Alternatively terminal heads can be run on the bolts passed through the board, to receive short countersunk headed bolts passed up through the case.

Connections are made as in Fig. 2. The microphone is secured with adhesive, used sparingly so that it does not enter the holes.

A reasonably long mains cord is required, and should be 3A or similar type. Use brown for L, blue for N, and yellow-green for E. The other end of the cord goes to a 13A type plug with 2A or 3A fuse. If a voltmeter is used to check the d.c. voltage across C4, this is around 12V because C4 charges up to the peak potential of T1 secondary.

REPEATER USE

A suitable lead of 3A or similar twin flex is fitted with a plug for the jack socket. This lead runs to a speaker, which is best fitted in a cabinet, for a neat appearance. Any speaker with an impedance of three to 15 ohms is suitable, and it can be a 9cm (3in), 12·7cm (5in) or even larger unit, as preferred.

Set VR1 near maximum. Snapping the fingers near the microphone should produce a loud click or bang in the speaker. The unit is placed as convenient near the telephone, or other bell to be relayed. A test should show that the speaker produces a "buzz-buzz" or similar sound matching the ringing of the bell. ▣

Components....

SEE SHOP TALK

Resistors
R1 2·2MΩ
R2 22kΩ
R3 2·2MΩ
R4 1·2MΩ
R5 2·7kΩ
R6 12kΩ
R7 22Ω
All ±5% ¼W carbon

Capacitors
C1 0·05μF polyester
C2 0·1μF polyester
C3 100μF elect. 10V.
C4 1000μF elect. 16V.

Transistors
TR1 BC108 silicon *npn*
TR2 BC107 silicon *npn*
TR3 BSY95A silicon *npn*
TR4 OC83 germanium *pnp*

Miscellaneous
T1 200/250V primary, 8V secondary Friedland bell transformer
VR1 5kΩ preset potentiometer, linear or rotary
MIC1 Crystal microphone insert type M35
PL1, SK1 Miniature jack plug and socket
LS1 3 to 15 speaker (see text)
Plain perforated circuit board 0·15in matrix, 17 x 10 holes; Vero standard box type 90-30-087; Mains cable; 4BA fixings.

TEACH-IN 76

By A. P. STEPHENSON

Part Six

6.1 THE TRANSISTOR

The components described so far have all been "passive" a general term used to indicate their inability to amplify current or voltages. Such components are very useful as a support team but are unable, by themselves, to produce interesting or sophisticated circuitry.

The first practical amplifying device ("active" component) was the valve, or more specifically, the thermonic valve. These devices were invented just before World War 1 and remained unchallenged until 1948. In that year the **transistor** was born, and as far as the valve was concerned it was the beginning of the end. We shall consider only transistors in this series as valves, except in certain specialised areas, are becoming obsolete.

Transistors are made of crystaline materials known as semiconductors. There are several basic divisions of the transistor family: the **field effect transistor** (f.e.t.), the **metal oxide silicon transistor** (m.o.s.), and the most common species of all, the **bipolar transistor.** The term transistor used from now on in this series should be taken to mean the bipolar transistor.

If your interest in electronics grows, you may eventually want to know the theory behind the operation of the transistor but, at this stage, such knowledge could be confusing and off putting. We shall therefore take its operation for granted and concentrate only on behaviour and uses for the device.

Transistors can be either *pnp* type or *npn* type but we shall concentrate on the most common of the two, the *npn* type. Both types were specified at the beginning of the series.

6.2 CONSTRUCTION AND SYMBOLS

The transistor is simply a "sandwich" made from two kinds of semiconductor material known as (a) *n*-type which contains free negative charges (electrons) (b) *p*-type which contains free positive charges (known as **holes** because they represent places where electrons should be but are not.)

Three wires are brought out from the sandwich named the **collector, base** and **emitter**, see Fig. 6.2a.

The circuit symbol should be carefully studied because experiments will fail (and transistors possibly destroyed) if you get the wires mixed up. Note that the arrow head is always the emitter but points in a different direction for *npn* and *pnp* types. The base wire which comes from the middle of the sandwich is particularly sensitive and vulnerable. The BC107 used almost exclusively in your experiments is an *npn* type and Fig. 6 2b shows the lead out connections viewed from the underside. Be careful of the outer metal casing because it is internally connected to the collector.

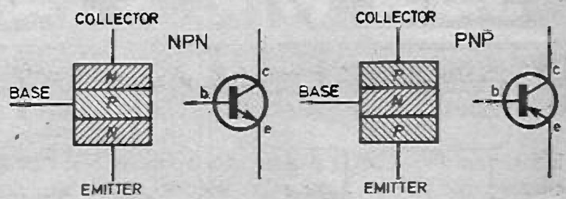


Fig. 6.2a. Schematic of the construction and circuit symbols for npn *and* pnp *transistors.*

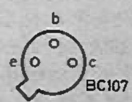


Fig. 6.2b. The lead out connections of the BC107 as viewed from the underside.

6.3 OPERATING CONDITIONS FOR THE NPN TRANSISTOR

The outstanding property of a transistor can be stated very simply:

> **A very small change of current between base and emitter causes a large change of current between collector and emitter.**

However, the transistor will only co-operate if it is supplied with correct voltages and what is more important, of the correct polarity.

Although we have agreed not to worry too much about the theory of operation, it will be helpful to know that a transitor may be considered as two diodes connected back to back, see Fig. 6.3a. A fragment of *n*-material joined to a fragment of *p*-material is all that is necessary to produce a junction diode; the *n*-type is the cathode and the *p*-type is the anode. An *npn* sandwich is therefore two diodes back to back sharing a common anode in the middle. The correct operating conditions, mentioned above are as follows.

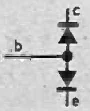


Fig. 6.3a. To explain some properties of a transistor it can be considered as two diodes connected back-to-back.

(a) The base emitter diode must be forwarded biased, i.e., the base must be positive relative to the emitter.

(b) The base collector diode must be reversed biased, i.e. the collector must be positive relative to the base.

Fortunately, it is unnecessary to use two separate batteries to supply these different voltages—we can easily use resistive voltage drops from one common battery.

6.4 ELECTRON FLOW IN THE NPN TRANSISTOR

Current behaviour of a transistor is shown in Fig. 6.4a and operates as follows.

(a) With switch S1 in the base lead off, there can be no currents anywhere because (i) the "bottom" diode has no forward bias (ii) the two diodes can pass no current from emitter to collector because they are back to back.

(b) When S1 in the base lead is closed it will cause the bottom diode to be forward biased causing a stream of electrons to flow from the negative terminal of the battery through the emitter towards the base. But (and this is a big but), when the electrons reach the base only a few of them "turn left" to form base current I_b. Most of them carry on to the collector because it is at a higher positive potential than the base.

So we have the following currents in motion, **emitter current** (I_e) flowing from battery negative, **base current** (I_b) flowing towards the battery positive via the emitter base junction, **collector current** (I_c) flowing out of the collector towards the battery positive terminal.

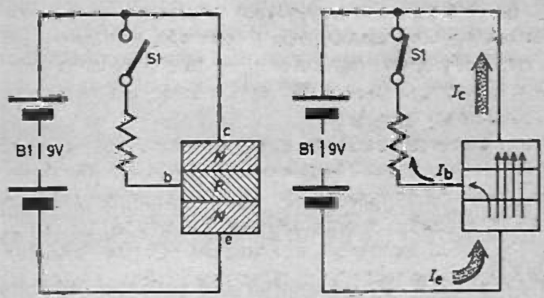


Fig. 6.4a. Current only flows when switch S1 is closed. Note that direction refers to electron flow.

6.5 CONVENTIONAL CURRENT FLOW AND VOLTAGE DROPS

Shown in Fig. 6.5a is the previous circuit redrawn including the circuit symbol of the transistor and a few "extras". Note that direction of current arrows have been reversed to conform to conventional current flow.

The 0·6 volts shown across base and emitter should be expected from last month's article on the diode. A diode when conducting drops about 0·6 volts. The 8·4 volts across R_b is due to Khirchoffs law of voltages ($0{\cdot}6 + 8{\cdot}4 = 9$). It is important to realise that these two voltages are predictable without knowing the value in ohms of R_b (providing it is not too

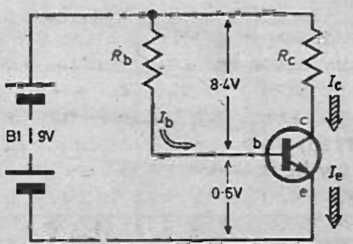


Fig. 6.5a. Conventional current flow in a forward biased transistor.

low).

We can also deduce from Khirchoff's law of currents that the sum of I_b and I_c must equal I_e, or as a general equation.

$$I_b + I_c = I_e$$

It is pertinent at this stage to ask whether this circuit has any practical uses. The answer is none whatsoever. It does however indicate in a striking manner how the basic laws and theory we have learned can be applied to a new, unfamiliar device.

The actual base current depends on R_b and must never be low enough to allow the base emitter voltage to rise appreciably above say 0·8 volts or the transistor may be destroyed (minimum R_b of 1 kilohm for a BC107).

Resistor R_c limits the collector current to any desirable value.

6.6 CURRENT GAIN

The base current is very much smaller than the collector current, how much smaller depending on a figure supplied by the manufacturers called the **static current gain** and has the strange symbol h_{FE}.

$$h_{FE} = \frac{\text{collector current}}{\text{base current}} \text{ or } h_{FE} = \frac{I_c}{I_b}$$

For the BC107, h_{FE} is given as a "typical value" of 200, which means that a base current of say, 10μA (10 microamps) can "turn on" a collector current two-hundred times greater (2000μA or 2mA).

The phrase "turn-on" is correct when we remember that without base current there is no collector current.

Although the "typical value" for h_{FE} is 200 (for the BC107), there are wide variations in individual specimens due to manufacturing tolerances. In fact, h_{FE} of the BC107's you have could be anywhere in the range 110 to 450!

The h_{FE} value also depends to some extent on the actual collector current (above figures assumed I_c of 2mA). Because the base current is small, the emitter and collector currents are almost equal. There are an enormous variety of transistors with different type numbers; the differences between many of them are trivial. The only reason for our choice of the BC107 are low cost and availability—there are probably fifty other types we could have used.

6.7 MANUFACTURERS RATINGS

Ratings mean values of voltage etc which *must not be exceeded.* For the BC107 some of the ratings are as follows:

Maximum volts across emitter and collector: 45 volts
Maximum collector current: 100mA
Total power dissipation maximum: 300mW
Maximum reverse voltage across base/emitter: 6 volts
Temperature inside transistor must not exceed 175 degrees Centigrade.

6.8 THE OUTPUT CHARACTERISTIC

Although base current has an enormous effect on collector current the collector voltage has very little. In fact providing we don't use too high collector currents, we could say that collector current is almost immune to collector voltages above half a volt.

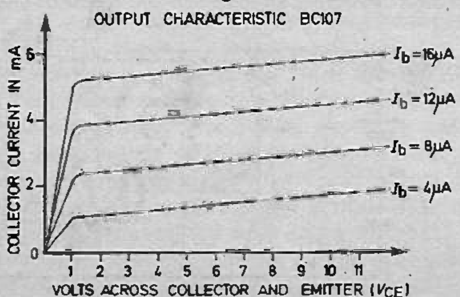


Fig. 6.8a. The output characteristic for a typical BC107 transistor.

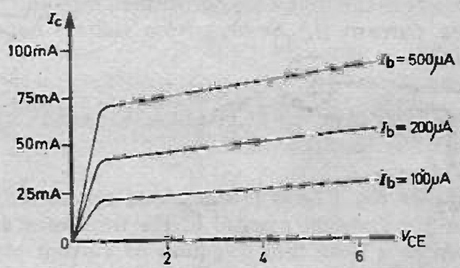


Fig. 6.8b. The output characteristic showing effect of collector voltage when base current is large.

The graph of Fig 6.8a shows some curves of I_c plotted against V_c for fixed values of I_b; these are called the **output characteristic.**

Taking the bottom curve (I_b fixed at 4μA), we notice that collector current is almost the same value, whatever the collector voltage (except at voltages less than 0·5V). This "constant I_c" effect is shown by all the separate curves, although you may have noticed a tendency towards a slight departure from the horizontal for the higher current curves.

With very large base and collector currents the collector voltage does have an increasing effect on current, see Fig. 6.8b.

TEACH-IN '76 EXPERIMENTS

EXPERIMENT 6A

To test an *npn* transistor with an ohmmeter

PROCEDURE

1. Assemble the components on the Circuit Deck as shown in Fig 6A. 1, and place your "resistance" calibration card (from experiment 3C.1) over the meter. (See *Teach-In Matters Arising*, page 150).
2. Touch together the two probes and "zero" the meter pointer by means of the 25 kilohm potentiometer (i.e. set control so that meter reads full scale which corresponds to zero ohms.
3. Hold the black probe (negative) on the base terminal of TR1, and the red probe (positive) on the emitter terminal. The meter should show a high resistance, greater than 100 kilohms. This is because we are applying reverse bias to the base/emitter "diode" of the transistor. The bias voltage is coming from the battery in the ohmmeter circuit.

Reverse the probes (black on emitter, red on base). The diode is now forward biased and should read low resistance, about 1 to 2 kilohms.

4. The base/collector "diode" should now be tested as follows: hold the black probe on the base and the red one on the collector. This is reverse bias and the meter should indicate high resistance, greater than 100 kilohms.

Reverse the bias (interchange black and red probes) to give forward bias, which should produce a low reading, 1 or 2 kilohms.

5. Finally, test between emitter and collector. The resistance should be high with the probes either way round, although one way the resistance will be very high.

If your transistor has passed these tests, then it is serviceable. In fact if later on you suspect it of being faulty, the above method is the normal technicians rough check.

The actual resistances measured are not too important because of manufacturing tolerances, all that matters really is the large difference between forward and reverse readings.

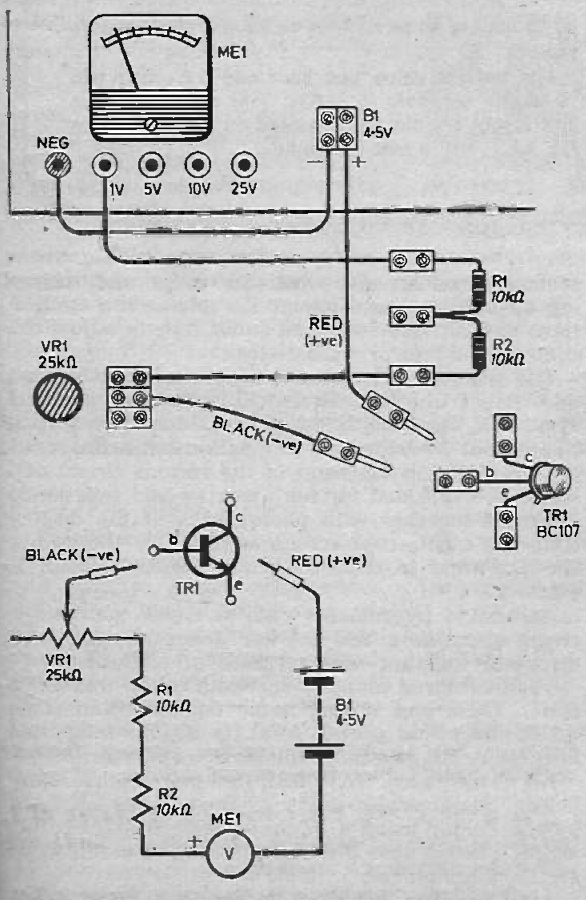


Fig. 6A.1. The circuit diagram and layout on the Circuit Deck for experiment 6A.

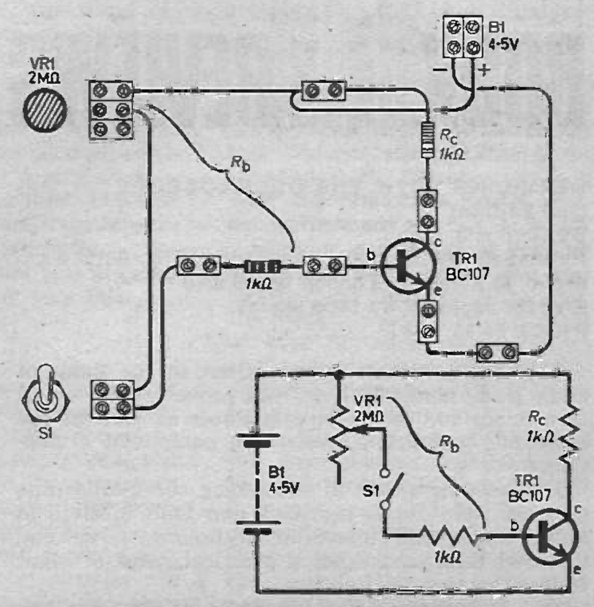


Fig. 6B.1. Wiring up connections on the Circuit Deck and theoretical circuit diagram from experiment 6B.

EXPERIMENT 6B

To show the effect of base current. on collector current.

PROCEDURE

1. Connect up the components on the Circuit Deck as shown in Fig. 6B.1. Leave the switch turned off, and turn the potentiometer fully anticlockwise (maximum resistance.)
2. Measure the collector current (by measuring the voltage across R_c and using Ohm's law). Because the base current is switched off, there should be zero volts across R_c.
3. Switch S1 on and check volts across R_c again—there should now be a small voltage indicating some collector current is flowing. Calculate how much.
4. Slowly rotate VR1 and observe volts across R_c rise (more collector current). This is because we are decreasing R_b thereby increasing base current.
5. At some position on VR1, the volts across R_c reach nearly 4·5 volts and will not rise higher (the transistor is now "saturated" and can pass no more current). Calculate how much.
6. Switch off and replace the wire link (between emitter and battery negative) with a 1 kilohm resistor and call this R_e.
7. Switch on. Adjust VR1 until there is 1 volt across R_c. There should now be 1 volt across R_e as well. How many volts will there be across base and emitter? Measure it to see if you are right.
8. Measure the voltage across base and emitter for various settings of VR1. It should never rise above about 0·8 volts even with maximum base current (VR1 fully clockwise). What would be the maximum base current? Answer about 4 milliamps.

TEACH-IN 76 *Matters Arising*

RESISTANCE CARD

The resistance card referred to in experiment 6A (paragraph 1) is that made during experiment 3C which concerned the making of an ohmmeter (see *Teach-In* December 1975, page 646). However, in the latter experiment a wrong value was given for R1; it should be 20 kilohms and not a 56 kilohm as shown.

The correct value can be made up using two 10 kilohm resistors in series. The circuit diagram and layout should be amended to that shown in Fig. 6A.1, and a new card made.

BOOK REVIEWS

SERVICING WITH THE OSCILLOSCOPE
(2nd Edition)
By Gordon J. King
Published by Newnes-Butterworths, The Butterworth Group, 88 Kingsway, London WC2B 6AB
Size 208 pages, 22·5 x 14cm approx.
PRICE £4·50

This book, written by an expert in the fields of audio, radio and television, will prove to be a sound investment for the service engineer as well as the electronic technician involved in equipment evaluation.

The book is aimed at presenting the oscilloscope as a valuable aid to servicing and fault location in audio, radio and television, including stereo and coloured television, from a practical point of view. It does this very well.

The first chapter introduces the oscilloscope and explains the functions of the controls found on the instrument and points regarding their use; this section also deals with what to look for when choosing an oscilloscope. Chapter 2 explains the applications to basic television and audio, how to adjust the controls and interpret the display.

The next five chapters are devoted to television and covers interlace filter, sync networks, flywheel sync, field timebase, line timebase, line drive, testing line output transformers to mention but a few.

Typical circuit diagrams of the various circuit networks are included for fault tracing and test points indicated together with photographs of the display from the oscilloscope screen as taken by the author showing what to expect when a particular fault is evident.

Associated instruments such as signal generators, sweep generators and marker generators are also discussed together with methods of alignment.

The final three chapters deal with colour television, stereo radio and testing audio equipment in some detail and would prove useful for anyone interested in these fields, especially the service engineer.

All chapters are well illustrated and contain many helpful photographs, many of them being obtained by the author using a Polaroid camera fitted to his 'scope. Photographs are also included of oscilloscope ancillary equipment.

An expensive book at £4·50 (stiff cover), but should more than pay for itself for those in, or about to enter, the "service" or "maintenance" field. B.W.T.

Your Career in ELECTRONICS

By Peter Verwig

PASSIVE COMPONENTS MANUFACTURE

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 components means big business. It is also important business. Components are the building blocks of electronics and lousy components can only result in lousy equipment which doesn't work well in the first place and is bound to give endless trouble during its service life.

Britain, as one of the pioneering countries in radio broadcasting and professional radio communications and, later, in the broad field of electronics, was one of the first countries in the world, if not the absolute first, to build up a powerful components manufacturing capability to serve the home industry and to export overseas. The component manufacturers were the first to establish a trade association in the 1920s and today the Radio and Electronic Components Manufacturers' Federation has a membership of some 150 British firms, any one of which can offer good career prospects.

ACTIVE AND PASSIVE

Components fall naturally into two broad product groups, active and passive. Active components are valves and semiconductors of all types. Passive components are resistors and capacitors, wound magnetic components, plugs and sockets, printed circuits, switches, in fact all types of components except valves and semiconductors. In each major group there is generally a further division into consumer products and professional products, each tailored to their respective markets.

Consumer products are those which go into equipment bought by the general public such as radios, TV, audio, tape recorders. Professional products find their way into broadcasting equipment, industrial automation, computers, defence equipment, in fact almost any application where performance and reliability are more important than price.

At one time it would have been true to say that the general rule was for consumer products to be cheap and cheerful while professional products were expensive and exotic. This general rule no longer applies except in the very cheapest consumer products because many items of consumer equipment, for example hi-fi equipment and colour TV, use professional quality components in critical circuit applications if not throughout.

In domestic TV, the trend towards using high quality components has accelerated in the UK because of the high proportion of sets which are rented with free service as part of the rental agreement. The rental companies soon found that skimping on component costs was bad business because, quite apart from aspects of customer dissatisfaction, the cost of service calls was growing and is still growing very fast.

WELWYN

This month we are looking at careers in passive components manufacture and have chosen as our practical example Welwyn Electric Ltd. We have chosen Welwyn for a number of reasons, one of them being its location in the North East, just to prove that all good jobs in electronics are not in the over-popular and over-populated South East. Other reasons are that it is big enough to have a good intake of young people each year, is well in the forefront of modern component technology and has the quality of management that leads to stability of employment. On the other hand, Welwyn is not too big to retain a family feeling about it so that one is conscious of belonging to a team with all its members pulling in the same direction.

As in other articles in this series where a particular company has been selected for mention, much of what is described applies generally to other companies in similar businesses although the details will, of course, vary.

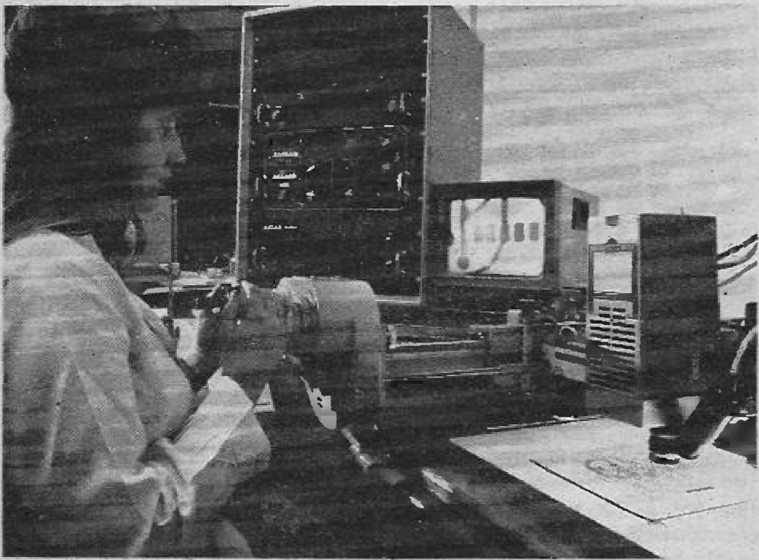
WELWYN HISTORY

Welwyn Electric started life in 1937 at Welwyn Garden City (hence Welwyn in the name) as specialist manufacturers of resistors and potentiometers. The company is now a wholly-owned subsidiary of Royal Worcester Ltd., famous for decorative porcelain and fine chinaware. During its first ten years, which included the war period, Welwyn prospered but remained comparatively small with some 200 people employed. The big expansion came following the move to Bedlington, Northumberland, in 1947. The total workforce on the site has been as high as 2,000 but is currently some 1,600 people.

At the end of 1973 Welwyn acquired Colvern Ltd of Romford, Essex, a long-established manufacturer of resistors and potentiometers. Other subsidiaries include three specialist companies engaged in strain measurement and Welwyn Electric GmbH in Wiesbaden, W. Germany, to look after the important export market in Germany.

Director of research at Bedlington is Dr. Peter Kirby who was awarded the OBE last November. He leads a research department of over 60 scientists, engineers and technicians in research laboratories housed in their own building at Bedlington.

The first 25 years of Welwyn's life was devoted exclusively to the manufacture of resistors. But in recent years Welwyn has also diversified into related products. It was natural, for example, that the company should become involved in thick and thin film resistor networks when these technologies became available,



Training on an optical inspection machine. The operator is checking the positional accuracy of holes in printed circuit master artwork.

(Below) At the controls in the Apprentice Training Machine Shop.

and today Welwyn is heavily involved in the design and manufacture of thick film circuits including complete hybrid modules, some of great complexity. More recently, a large investment was made in plant for the production of printed circuits including both flexible and rigid types.

MARKET

Welwyn's general policy is to operate "up-market", that is at the professional end of the marketing spectrum. Some hybrid modules, for example, destined for aerospace applications cost more than £100 each, a far cry from comparatively simple resistors costing a few pence each.

By deliberately going for quality rather than price Welwyn has avoided the violent swings in trade that are associated with the consumer component market although that market is not neglected. But by keeping consumer products to some 20 per cent or lower of total turnover there is much greater overall stability in business. And while British industry as a whole is criticised for not investing as much as it should in new plant and machinery, Welwyn is currently investing heavily in new plant for greatly increased production, mainly in the thick film business where future growth in demand is a certainty.

APPRENTICESHIPS

In addition to craft apprenticeships in both mechanical and electrical trades, there are four different training schemes for young entrants. They are Engineering Apprenticeship, Commercial Apprenticeship, Science Training Scheme, and Student Training Scheme. With the exception of the Student Training Scheme the normal entry age is 16-17½ years and candidates need appropriate "O" level passes in four subjects. which involves a degree course of four years or an HND course of three years, has a normal entry age of 18-19½ years and candidates need two "A" levels and three "O" levels for the degree course or one "A" level and four "O" levels for the HND course.

Students normally study academically at Newcastle on Tyne Polytechnic but are allowed to attend alternative universities or polytechnics of their own choice if they have a particular preference or for special courses.

There is a certain amount of flexibility. Clearly, ambition demands that you should read for a degree if possible but it may be that you have not the entrance qualifications for the Student Training Scheme. In this case, any of the other three schemes can still be an attractive route to good professional qualifications.

Whether on day release or on

a sandwich course Welwyn either pays wages during study as appropriate for your age, or supplements the local education authority grant covering fees and maintenance during in-college periods. The quality of Welwyn's training and the quality of the apprentices themselves is illustrated by the 1975 pass figures which showed that 89 per cent of all examination entrants passed their exams. A very good score indeed.

Career advancement training is also available later. When an apprenticeship or student training has been completed this is merely a good start in life. Courses of further study are encouraged to equip young people to assume greater job responsibility and help their climb up the promotion ladder.

An essential ingredient in the Welwyn training schemes is the personal factor — relationships between the company, the young people concerned, their parents and the local schools. A member of the company's senior staff is appointed as personal tutor for each new entrant to any of the training schemes, and the relationship is maintained and developed throughout the training period. Similarly, a Welwyn man is charged with the job of maintaining liaison with each of the schools in the area from which trainees and apprentices may emerge. The development of these personal relationships has been welcomed by the school authorities.

Welwyn staff are also involved in the educational scene in the North-East, instanced by Peter Kirby's involvement with both Newcastle and Edinburgh Universities as a visiting professor, and as an external examiner at Newcastle Polytechnic.

RANGE OF SKILLS

It is interesting to note that Welwyn, and other companies engaged in similar activities, have need of a very wide range of skills and these don't just embrace electrical and electronic engineering. There is room also for physicists and chemists and mechanical engineers. After fundamental research in the laboratories a new component needs to go through an engineering development stage which generally needs careful consideration of how it can best be manufactured and tested to specification.

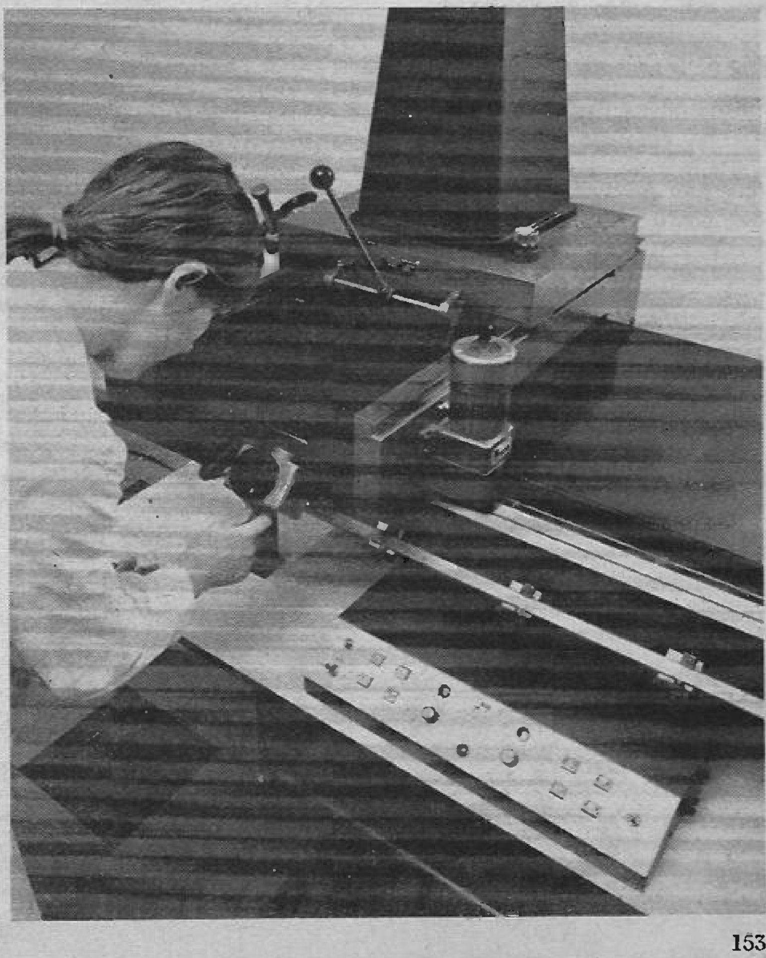
Much, if not all, of the machinery and tools for line production is designed and built on the spot. Even where machinery is commercially available there is frequent need for modifications for special tasks and there is a continuous process of production development because, as experience is gained on a new product or process, there are always better or cheaper methods of doing the job provided, of course, that the quality of the product doesn't suffer.

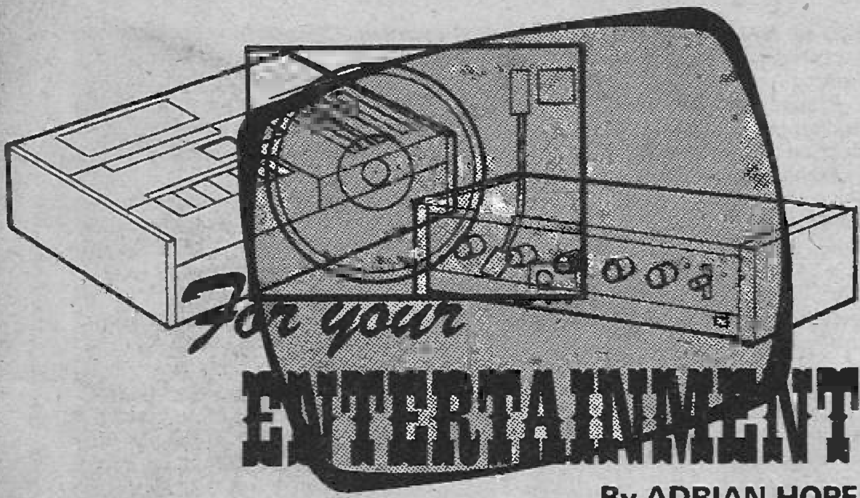
SUGGESTIONS AWARD

Many of the suggestions for improving efficiency are contributed by workers on the production lines who receive cash awards related to the level of improvement. A recent modification to measuring head jigs brought the "inventor" a cash award of £252. The suggestion of a foot-operated valve instead of a hand-operated one was worth £115 to its originator. Ladies do quite well, a recent list of awards showing that one received £250 and another £43.

The "suggestion award" scheme is a sign of the down-to-earth attitude that Welwyn has throughout its whole operation. Management and staff are part of a complete team. Everyone knows that the next few months are going to be tough and there will have to be some belt-tightening. John Herrin, managing director, in his Christmas message to all the staff was cautious in forecasting no great upward surge in demand at home before the end of 1976 although exports would pick-up a little earlier. On the other hand, the £500,000 investment programme for the Integrated Circuit and Modules Division is now reaching completion showing a great measure of confidence in the future.

Learning to use a precision step-and-repeat camera for producing master artwork for thick film circuits.





For your ENTERTAINMENT

By ADRIAN HOPE

AT first it was only in discotheques that one saw flashing strobe lights, and coloured shapes pulsating in time with the music or slowly changing in amœboid fashion. But now these gadgets are being sold domestically, and there is no doubt that they can have a very relaxing effect. At the Château d'Hérouville studio in France, where the likes of David Bowie and Elton John record, the engineers project colour oil wheel effects on the wall between the monitor speakers while mixing down master tapes through the night.

Simple Effects

Anyone wondering about kinetic lighting effects of this type for domestic use might like to hear of a couple of interesting tips that I have picked up over recent years. First, if you want to make a really simple sound to light converter, of the type whereby an audio signal produces a light that flashes in time with the music, there is always one very easy way to do it. Almost everyone interested in electronics and audio now has an old mono amplifier kicking around unused and unwanted. Even if it has a fault on it, such as hum or distortion, you can use it as a simple sound/light converter.

Simply feed an audio signal into the power amp, turn the gain up full, and connect the loudspeaker output terminals to a few low-voltage bulbs in series or parallel. The output of most amplifiers is quite sufficient to drive a few low-voltage bulbs, and if you colour them and put them in reflectors and behind a rotating colour filter wheel to project shapes, you can get some worthwhile effects.

If the light flickers too closely in time with the music, you simply rectify the output and smooth it slightly. Of course you won't do the amplifier any good, but then again, leaving it sitting around in a cupboard won't do it any good either. Sooner or later the electrolytics will break down, so you might as well let it die working as part of a kinetic sculpture.

Polarised Light

Most colour wheels are built up from sandwiched layers of coloured oils which never mix, but intermingle optically. Light from an ordinary slide projector shone through such a rotating wheel produces a never-ending and ever-changing globular colour pattern. But a particularly interesting effect can be obtained by using polarised lights.

Take an ordinary slide projector and buy a sheet of polarising material (Proops, in Tottenham Court Road, usually have some). Cut one square and use it as a filter *behind* the slide carrier, so that all the light passing through to the slide carrier is polarised. Then cut a disc of the polarising material, mount it on a low-speed motor (preferably only a few revs per minute) and fix the motor so that the disc rotates in the light beam leaving the projector lens.

With nothing in the slide carrier, the light projected will gradually change from zero to maximum, as the disc revolves and its axis of polarisation moves into and out of alignment with the polarised light coming from the fixed filter. Now play around with a few odd materials in the slide carrier.

Liquid crystals and even clear, transparent objects in the slide carrier will produce changing colours on the screen as the various polarisation effects combine. Crumpled cellophane gives probably the most surprising effects and if you want to go one stage further, try crushing cellophane between a couple of plastic discs and then rotating the cellophane-disc sandwich in the region of the slide carrier using another low speed motor.

Once you have adopted the basic approach of using one fixed polarising sheet behind the slide carrier and another in front of the lens, you can develop your own individual ideas, producing all manner of original effects. Although I have tried everything mentioned so far, I have never yet tried what I am told produces the best effects of all. A strip of Perspex with a few cracks in it is mounted in place of the slide carrier and an electromagnetic or simple cam-and-motor system used to put it under fluctuating stress. The changing colour patterns round the cracks are reputed to be out of this world.

For Betting People

A while ago, I suggested ways to win an innocent bet by having a pocket calculator always read out the same answer. Here's another way to astonish your friends, this time with a gramophone record. A year or so ago, the Monty Python team released an LP under the title "Matching Tie & Handkerchief" (Charisma CAS1080).

There is something odd about this record, which will one day make it a collectors' item but still very few people in this country appear to know the story. To cut it short, the LP has three sides. One of its two faces is cut with a double scroll, so that there are two completely different recordings on the same side, and it is a matter of pure chance which one the record stylus will track when it is lowered at random onto the beginning of the recording. Provided that your friends are unaware of the double recording, it makes a good party trick to bet that you can get two, quite different recordings out of the same side of one record.

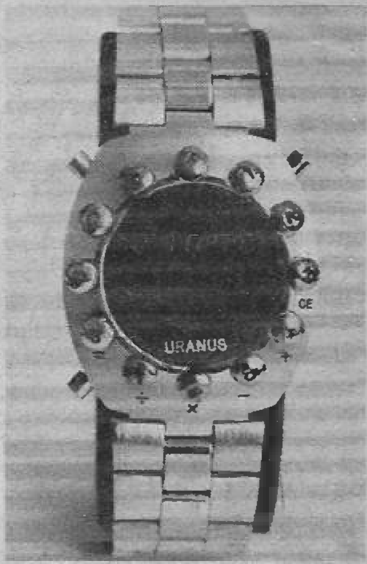
Incidentally, the Monty Python idea came from an old recording of a horse race, with a different winner for each of several grooves on the same side. But it now emerges that the idea for that horse race record probably came from an Emile Berliner recording made in 1901.

Solar Energy Watch/ Calculator

In *Calculators Galore* (Jan. issue) I mentioned watches with built in calculators, we now hear of what is believed to be the world's first digital watch, incorporating a wrist-band calculator and powered by solar energy. The "watch" is available from Laskys; it is called the Uranus Time Computer and represents "the state of the art" in digital integrated circuit technology.

The watch function displays, on command, hours, minutes, day of the month and seconds. The calculator is a four-function, +, ×, ÷, −, machine with an 8-digit display, full floating decimal and automatic constant.

The Time Computer contains a solar cell which draws its power from sunlight, daylight or artificial light. The batteries, therefore, never need replacing. The "watch" is on special display at 481 Oxford Street, Laskys' major store. It is available to special order for £295 including VAT.



Counter Intelligence

By PAUL YOUNG

During the winter months with many novices joining our ranks, I thought it might be a good idea to discuss what you should buy in the way of equipment. Few of us today have much money to spare, and for many, it will mean buying the very minimum to commence with and then to build it up as you go along. First of all what basic tools will you require initially. I suggest a grub screw driver, and a medium-sized electricians' screw driver. These two will suffice in that department for some time. Later on you will want to supplement them with Phillips and Pozidrive screw drivers, because both these types are becoming increasingly popular. Next, a pair of pliers with pointed ends, and a rather more substantial pair with square ends. Add to this a small pair of side cutters and you are ready to go quite a long way.

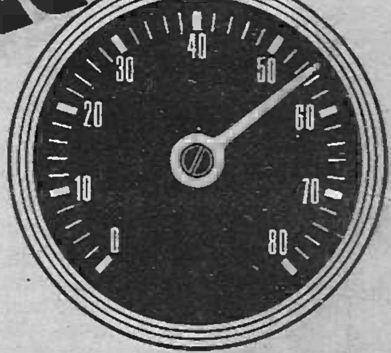
Just a word about cutters and pliers. You may wonder why the prices can vary from £1·00 to £6 or over, and naturally enough ask yourself which you should buy. The price depends on the maker, the material, and whether it has a box joint, or an overlap joint. As to what you should buy, let me make these observations. I have in my pocket a small pair of pliers and cutters, which were given to me when I joined the old Marconiphone Company in 1932. The cutters have the tiniest little nick on one blade where I once cut through a live mains cable, otherwise they are both as good as new. They are both manufactured by Lindstrom and made of best Swedish Steel. Today they would cost you over £5 a pair.

If you can afford it, buy the best, they are frequently cheaper in the long run. However, if you are prone to lose things, it might be as well to buy the cheaper ones. As you become more ambitious there is plenty of hardware you can add to your collection. A set of box spanners to cover 0BA, 2BA, 4BA and 6BA nuts and also a set of open-ended spanners covering the same sizes. Eventually you will need metric sizes. A set of small Allen Keys is becoming a "must" these days, especially as some manufacturers fit grub screws in their knobs that can only be tightened in this way. You would, of course, find a miniature vice extremely useful.

One essential piece of equipment is the soldering iron. If it is temperature controlled like the Oryx or Weller, the wattage is not important, otherwise buy a miniature iron, in the range of 15 to 25 watts of which there are many good examples available. All that remains for you to purchase now, is a multimeter. Here you have a wonderful selection to choose from. In addition to those made in the U.K., there are meters from Japan, Italy, and even Soviet Russia. My advice on these would be, do not buy something costly to begin with.

You are much more likely to damage your meter in the early stages, due to inexperience. Provided it gives you some voltage and current ranges, plus continuity, you will find it will be suitable for your requirements ninety-nine times out of a hundred. Then, when you are affluent, by something really good, and I would council in these transistorised days with a sensitivity of not less than 20,000 ohms per volt.

TACHOMETER



By B. W. TERRELL B.Sc.

Keep an eye on your car engine speed with this simple to construct project.

A TACHOMETER, or rev. counter as it is more commonly called is considered by some to be a luxury item for the car. Hence its absence from the dashboard of most cars (except some of the more expensive cars and sports models).

Engine temperature and lubrication information is available on all cars, so why not engine speed? This is a very important parameter that the driver should be aware of, since over-revving an engine can have disastrous (and expensive) effects. With reference to the workshop manual you can ensure that maximum engine revolutions are never exceeded. Details are usually given in the manual for gear changes as a function of engine speed to obtain maximum acceleration which is only possible when a rev. counter is fitted.

Also, if one is making adjustments to the car's ignition or fuel system, the workshop manual may say "with the engine speed set to 1,200 r.p.m. adjust . . .". Without a rev. counter this would be difficult to judge except for the experienced ear. With a rev. counter this is a simple matter.

The unit described here was found particularly useful on the author's car when teaching his wife to drive when the unit was used as a reference for when to change the gears.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Tachometer is shown in Fig. 1. Components TR1, TR2, R3 to R6, VR1 and C2 form an adjustable monostable multivibrator. This circuit has, as its name implies, one stable state (TR2 turned on fully, with TR1 completely turned off); it also has a transient state where TR2 is off with TR1 on.

When the battery is connected, the circuit takes up and remains in its stable state. The monostable may be "triggered" into the transient state by applying a brief negative pulse to the base of TR2 thus turning it off. As this happens TR1 is turned on and stays on for a period determined by the values of C2 and (R4 + VR1). From the onset of the transient state, C2 is discharging through (R4 + VR1) and after a time given by

$$t = 0{\cdot}7 \times C2 \times (R4 + VR1)\text{seconds}$$

is discharged sufficiently to allow TR2 to turn on again causing TR1 to turn off, i.e., it has reverted to its stable state. The circuit remains in this state until triggered again.

Diode D2 is included in the circuit to protect transistor TR2 since excessive reverse voltage can be applied to the base/emitter junction when the monostable operates.

In the stable state, the voltage at the collector of TR2 is at nearly zero volts with respect to the 0V rail. For the time the circuit is in the transient state, the output is at the positive rail voltage, which in this case is 10 volts.

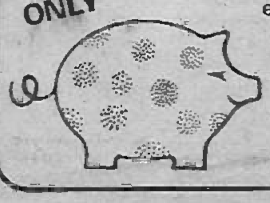
INPUT/OUTPUT

Thus a train of short duration negative pulses applied to the base of TR2 causes a train of constant amplitude (10V) constant width (t) pulses to be produced at the collector of TR2, see Fig. 2.

Resistor R7 and preset VR2 in series with

FOR GUIDANCE ONLY

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



£1.40 excluding meter—see Shop Talk

*Based on prices prevailing at time of going to press

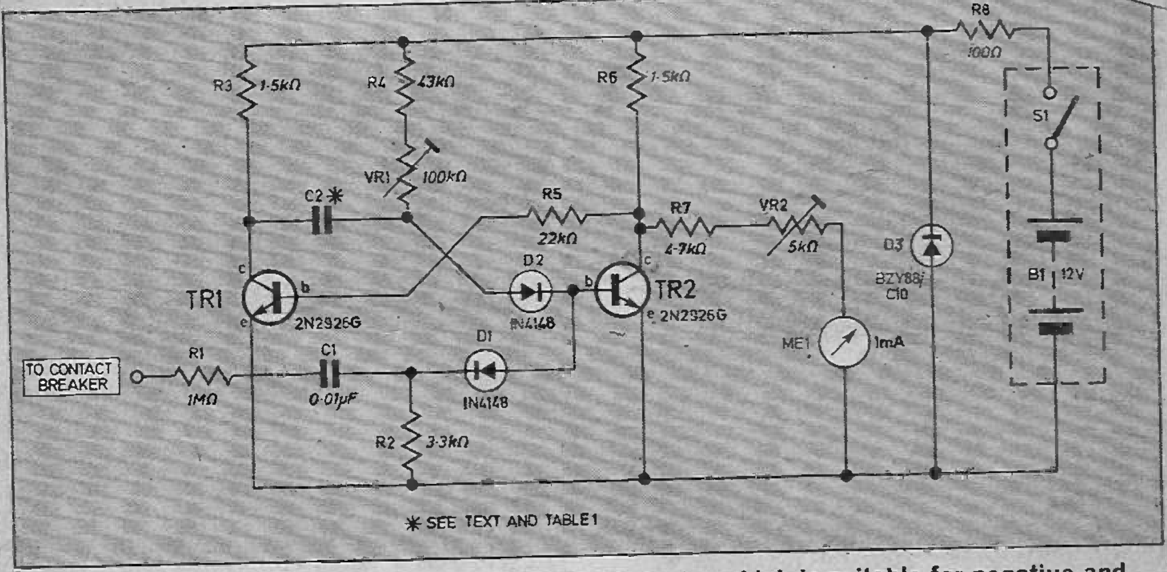


Fig. 1. The complete circuit diagram of the Tachometer which is suitable for negative and positive earth systems.

1mA d.c. meter ME1, converts the latter to a voltmeter. The level indicated on the voltmeter when the monostable is being triggered by a train of input pulses can be seen to be directly proportional to the off time of TR2 between consecutive pulses, see Fig. 2b.

Thus the mean output voltage between successive pulses is given by:

$$V_m = \frac{10t}{T} \text{ volts}$$

where $t = 0{\cdot}7 \times C2 \times (R4 + VR1)$ and T is the time between consecutive pulses (inverse of the input frequency) of the input pulses.

It can be seen from these equations that the level indicated on ME1 is directly proportional to the frequency of the input pulses.

Now the input pulses are derived from the moveable part of the contact breaker (points) located in the distributor and are fed via attenuator R1 to differentiator C1 and R2 whose time constant has been made small to encourage overshoot, see Fig. 3. These are then rectified by D1 allowing only negative pulses to be presented to the base of TR2.

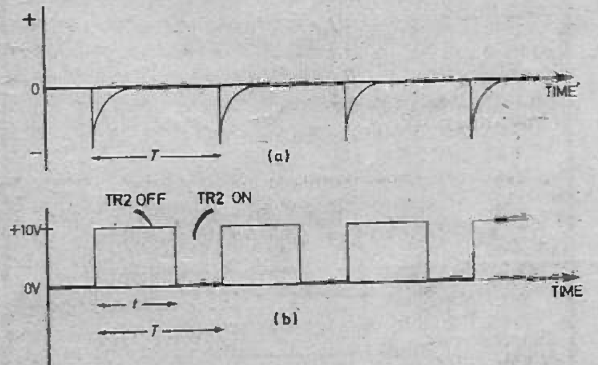


Fig. 2(a). A train of negative pulses on the base of TR2, causes an output on TR2 collector as shown in (b).

TIMING COMPONENTS

The Tachometer was primarily designed for use with the author's four-cylinder four-stroke engine car, and as this is the most common type of engine found in the U.K. the following calculations are directed for this type of engine. Component changes for other engine types are given in Table 1.

It was decided to set the maximum reading of the unit at 8,000 r.p.m. This should suit most needs.

With a four-cylinder four-stroke engine there are two sparks per engine revolution; in other

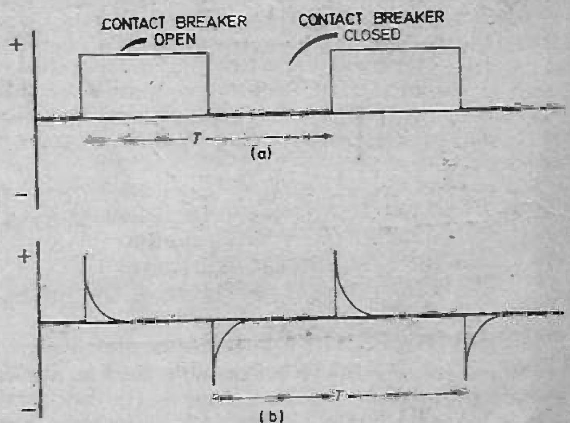
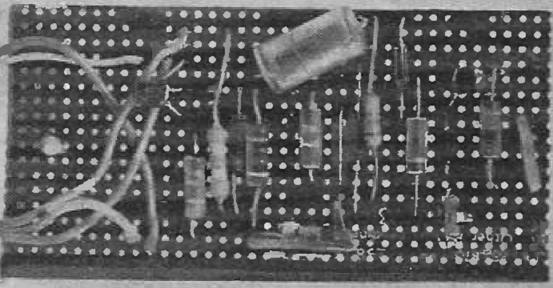


Fig. 3(a). Shows the voltage appearing on one side of the contact breaker with the engine running and (b) the effect of differentiator circuit, C1, R2.

Table 1: Timing capacitors for different engine types and pulses per second for maximum reading.

Engine type Cylinders	Stroke	Pulses per second for 8000 r.p.m.	C2 (μF)
3	2	400	0·033
4	2	$533^1/_3$	0·022
4	4	$266^2/_3$	0·047
6	4	400	0·033
8	4	$533^1/_3$	0·022



Photograph of the completed prototype component board.

words the contact breaker closes twice for each revolution. Thus for a maximum reading of 8,000 r.p.m., the input pulses are arriving at a rate of 16,000 p.p.m. or $266^2{}_3$ p.p.s. This sets the maximum off time of TR2 at approximately 3 milliseconds (for 4-cylinder 4-stroke only).

If we arbitrarily set a mean level of 1 volt equal to 1,000 r.p.m., then for maximum revs. the mean voltage level at the collector of TR2 will be 8 volts. Choosing a convenient value of 100 kilohms for the series combination (R4+VR1) yields the capacitor values given in Table 1. These values have been rounded off to the nearest preferred values. To allow for rounding off and capacitor tolerances R4 is made equal to 43 kilohms and VR1 equal to 100 kilohms so that the precise value can be obtained.

METER

The meter used in the prototype was a 1mA type and series combination (R7+VR2) was arranged so that 1mA flows (f.s.d.) when there is 8 volts across the meter and the total series resistance. It is not essential that a 1mA movement is used, but this value should not be exceeded otherwise the monostable output may be overloaded. Other suitable movements are 500μA, 100μA and 50μA.

The value of the series resistance depends on the movement used and the internal resistance of the meter, and can be calculated from:

$$R_x = \left[\frac{8}{I_f} - R_m\right] \text{ ohms}$$

where R_x is the total resistance in series with the meter (R7+VR2) in ohms
I_f is the f.s.d. current in amperes
R_m is the internal resistance of the meter in ohms.

In the prototype, R7=4·7 kilohms and VR2=5 kilohms was found to be suitable for the 1mA movement.

CONSTRUCTION

In the prototype the circuit was built on a piece of 0·1inch matrix Veroboard size 17 strips by 36 holes and mounted inside a commercially available plastic case of approximate dimensions 120×75×35mm. The case had a screw down lid. The flying leads from the component board are taken to a 5-way connection block fixed to the outside of the case.

Begin construction by cutting the board to size and making the cut-outs along the copper strips and the fixing hole as detailed in Fig. 4; also shown in Fig. 4 is the layout of the components on the topside of the Veroboard. All components with the exception of ME1 are mounted on the board.

Components....

SEE SHOP TALK

Resistors
- R1 1MΩ
- R2 3·3kΩ
- R3 1·5kΩ
- R4 43kΩ
- R5 22kΩ
- R6 1·5kΩ
- R7 4·7kΩ
- R8 100Ω ½W

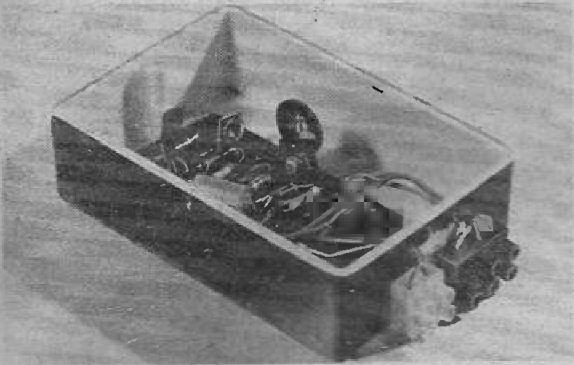
All ¼W carbon ± 10% except where stated

Capacitors
- C1 0·01μF plastic or ceramic
- C2 see Table 1

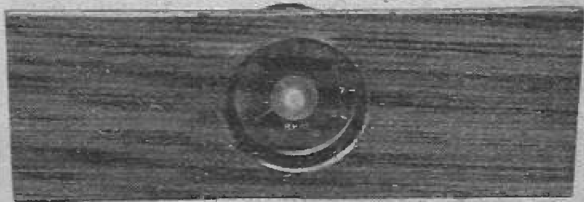
Semiconductors
- TR1 2N2926G silicon *npn*
- TR2 2N2926G silicon *npn*
- D1 1N4148 or similar silicon diode
- D2 1N4148 or similar silicon diode
- D3 BZY88C10 10 volt Zener 400mW

Miscellaneous
- ME1 see text
- VR1 100 kilohm skeleton preset
- VR2 5 kilohm skeleton preset
- Veroboard: 0·1in. matrix, 17 strips by 36 holes; 5-way terminal block; plastic case; connecting leads.

TACHOMETER

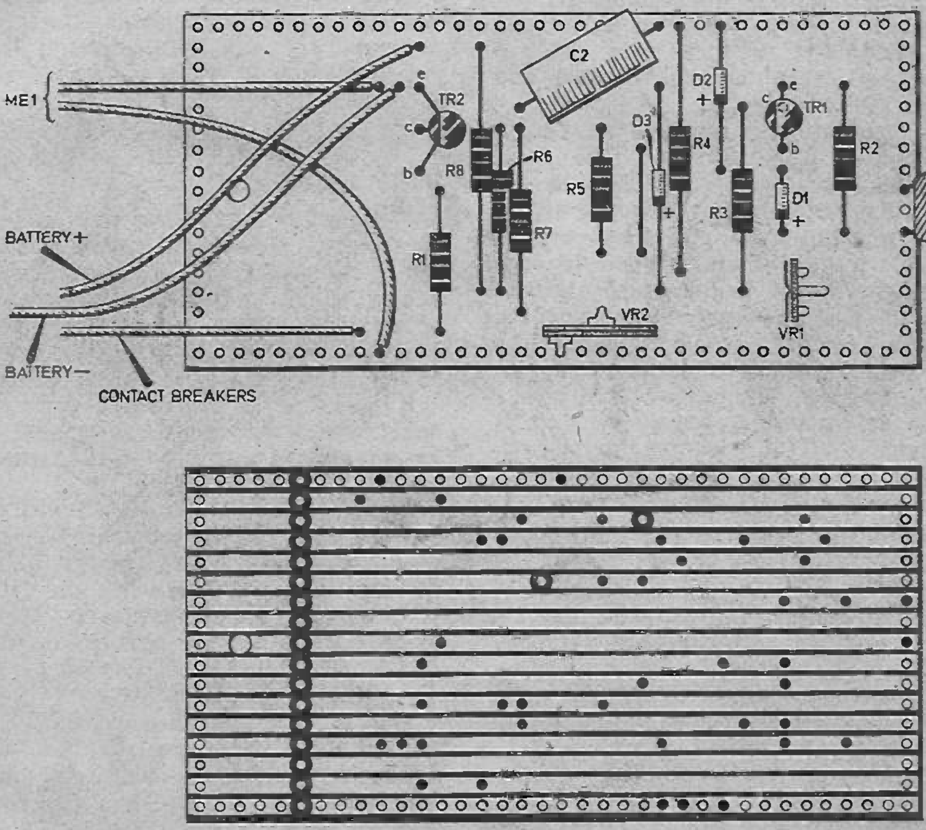


Photograph of the completed unit with lid and meter removed.



Photograph showing the meter fixed to a wooden front panel. This was mounted with the case in a parcel compartment in the author's car.

Fig. 4. The layout of the components on the Veroboard and wiring up details. The board must be mounted inside a plastic box.



Position and solder first the resistors, capacitors and potentiometers as shown, followed by the semiconductors. Use a heatshunt when soldering the latter as heat from the soldering iron can easily damage these devices.

Now solder the flying leads to the board, using different coloured wires if available, and then secure the board to the base of the case by means of a 4BA nut, bolt and shakeproof washer. Pass the flying leads out through the two holes drilled at one end of the case and connect these to the terminal block as detailed in Fig. 4.

Before the meter is wired in, an ohmmeter should be connected across R7 in series with VR2 and the latter adjusted to give a reading equal to the calculated R_s. A dab of paint or sealing wax on VR2 will secure this set value.

METER FACIA

It is most unlikely that the meter obtained is graduated from 0 to 8 f.s.d. This is done by removing the glass cover from the meter and then carefully taking off the meter facia; there are usually two very small screws to be extracted.

If the facia colour is to remain unchanged, remove with a stiff eraser all the numbers, and all the graduations except those at 0 and full scale. Next divide the angle between the two extreme markers into eight equal sectors and number 0 to 8 using Indian ink or Letraset.

If a black meter facia is required as seen in the photograph of the prototype, the facia should be removed as before and the extreme graduations (0 and full scale) covered with a thin strip of masking tape and then sprayed with a matt black aerosol paint. When dry, the tape should be removed and the arc between the extremes divided as before into eight equal sectors. White Letraset or paint should be applied to each mark and each numbered as shown in photograph. The meter needle may then need to be coloured for easy viewing. It is recommended that the car's maximum revs. be indicated on the facia by means of a coloured line or spot.

CALIBRATION

Calibration is best carried out with the aid of an audio signal generator having a square wave output. It is necessary for calibration purposes to short out resistor R1. Make up a lead with crocodile clips at both ends and clip this across R1.

With the signal generator set to the frequency appropriate to the engine type, see Table 2, wire between the contact breaker leadout on the unit and the earthing terminal. With VR1 turned down (minimum resistance) slowly turn up VR1 until ME1 indicates 3,000 r.p.m. When this setting has been accurately made, a dab of paint or sealing wax on VR1 will prevent this set value changing due to vibration, for instance, that will be experienced in the car. Remember to remove the shorting link across R1 when calibration is completed.

If a signal generator is not available there are other methods of calibrating the unit when it is fitted to the vehicle, such as comparison with a calibrated tachometer already fitted in, say, a friend's car, or by use of a stroboscope aimed at the timing mark on the crankshaft pulley. These two methods do not require R1 shorted.

Table 2: Calibration details

Engine type Cylinders	Engine type Strokes	Input frequency (Hz)	Meter reading r.p.m.
3	2	150	3000
4	2	200	3000
4	4	100	3000
6	4	150	3000
8	4	200	3000

If none of the above equipment is available, a good approximate method for most cars is to run the engine for a short while until it has "warmed up" and then adjust VR1 to give a meter reading of 800 r.p.m. This is the idling speed of most cars.

INSTALLATION

The positioning of the unit and meter will be a matter of personal choice and is therefore left to the constructor. For the sake of accuracy and reliability, it should be mounted away from areas where large temperature changes may occur, such as near the heater, or if mounted under the bonnet, near the exhaust manifold.

If mounted in the engine compartment the case should be made watertight, Hermatite gasket glue is ideal for sealing the holes and lid lip.

It is essential that one supply wire makes good contact with the car chassis. The supply lead should be made at the ignition switch so that the unit is switched on when the car is started, make sure the polarity is correct. The connection to the contact breaker lead can be made on one side of the ignition coil, consult your workshop manual for details.

The unit has been successfully tested on several different makes of car and with two different capacitive discharge ignition systems, namely the PE Scorpio Mk 2 and the Sparkrite GT3.

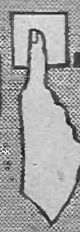
For cars with 6 volt systems, the unit must be powered by an independent supply. Two PP4 type batteries in series will be suitable. ▣

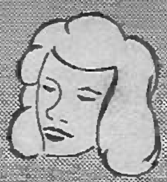
There's something for everyone

Next Month!

SPECIAL 8 PAGE SUPPLEMENT...

BEGINNERS GUIDE
Electronics made easy





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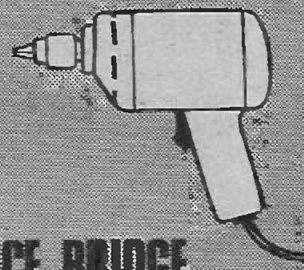

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April issue on sale Friday March 19.

EE Kit Report

sinclair BLACK WATCH

THE Black Watch kit arrives neatly packaged with the instructions and a few components under the inner plastic packing. The first thing to do is to identify the components and read the **instructions** and addendum **carefully**.

A list of tools required is given at the beginning of the instructions, we made the kit using an Antex CCN iron which is not of the earthed type recommended but is a special low leakage iron and, with a small (1·5mm) bit, is suitable. In addition to the list of tools we feel a Swiss type file is very useful (this is mentioned later in the assembly instructions) as is a small paint brush in order to varnish the circuit board.

SOLDERING STAGES

Seven stages of construction are listed before the first testing; we found the instructions clear and easy to follow although some comments can be made on the actual assembly. We will take the stages in order:

1. Varnishing the printed circuit board (p.c.b.) which is a double-sided board with plated-through holes. This stage provided no problems, we left the board to dry overnight before continuing.

2. Preparing the trimmer consists of removing four small lugs from the trimmer leads. We found the cutters we had—a small high quality pair—were unable to cut the lugs off the larger lead. Having overcome this problem with bigger cutters we found it necessary to file off the burrs in order to get the capacitor flat down on the board. It was also necessary to use the heavier cutters on the thicker lead to trim off after soldering.

3. Soldering in the capacitor; no problems with this operation—but make sure it is in the right way round.

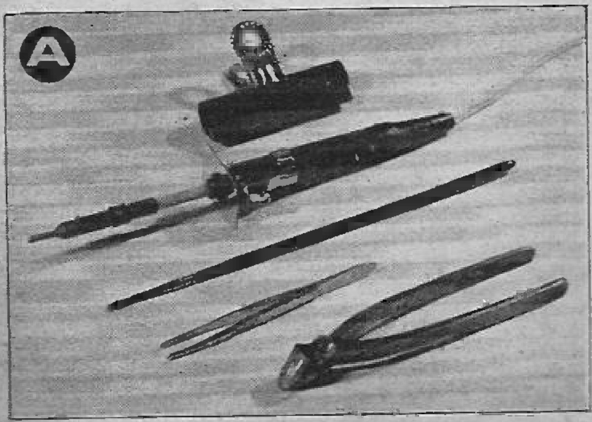
4. Connecting the quartz crystal; once again no problems with the operation. A warning is given about overheating but this will not worry those who can solder well.

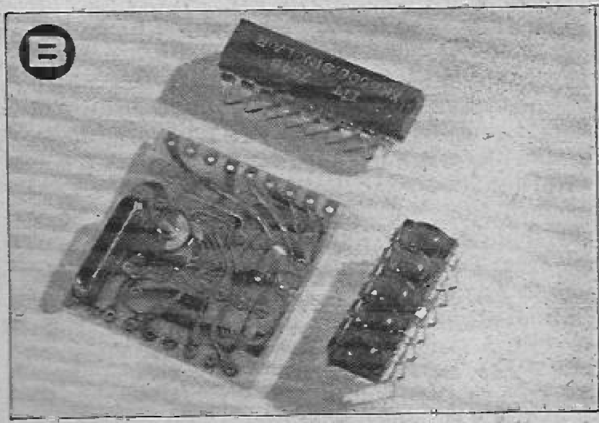
5. The display is shown clearly in the instructions with its polarity indicated. The most difficult part of inserting this component is to get all the leads through the holes. The leads may need to be carefully bent inwards to get the display in. Make sure it is right down against the board before soldering.

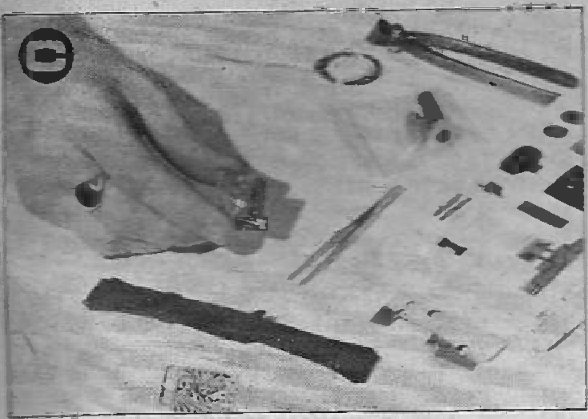
6. Inserting the i.c. provided the same problem as operation 5 and we found it essential to make sure the i.c. is down on the board as far as it will go—it will not actually go down flush due to the shape of the leads.

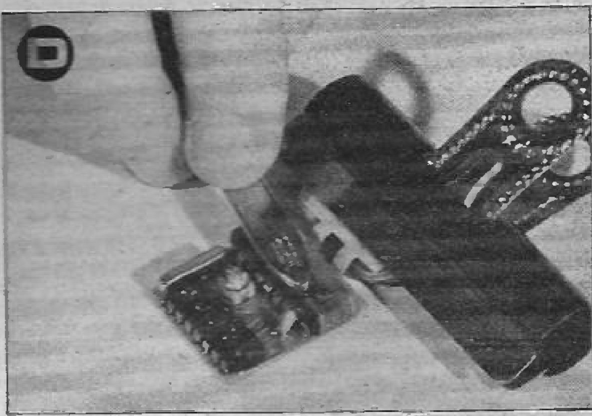
There are no special handling precautions with this i.c. since it is made by the I^2L process and it is not prone to damage caused by static electricity. This is a great advantage to the kit constructor.

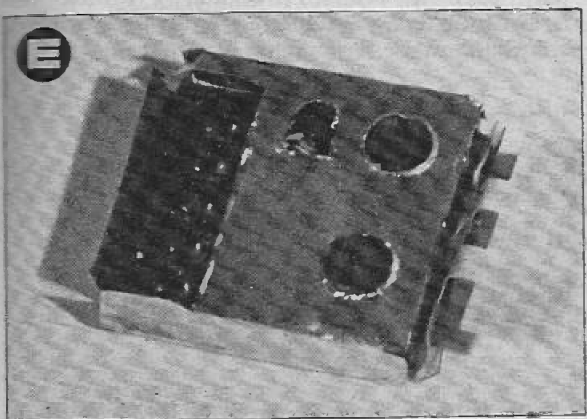
7. Insertion and soldering of the flexible p.c.b. section did not cause any problems although warnings are given about overheating whilst soldering.

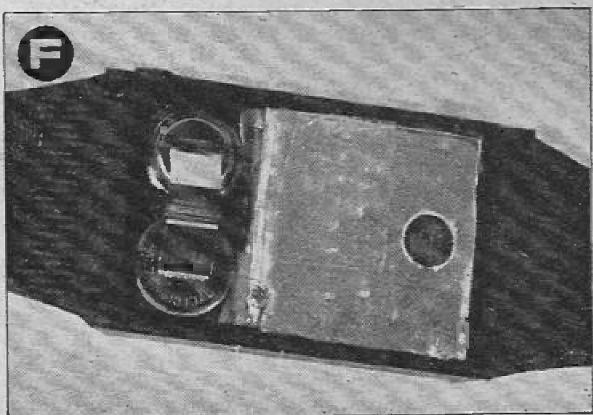


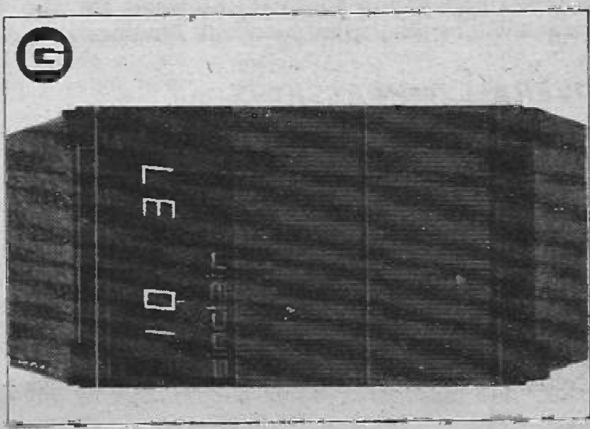












A. Tools required to complete the watch, a Swiss file is also very useful.

B. Part way through the construction, the display and i.c. still to be soldered in.

C. General view of construction to give an idea of size.

D. Initial testing stage using a clip to hold the batteries.

E. Circuit board fitted with screen. Note enlargement of small trimmer hole.

F. The inside of the completed watch.

G. The completed watch showing time display.

This completed the assembly of the p.c.b., and testing instructions are given. These are again easy to follow and we found that the watch worked first time. Next comes another varnishing process and after this we left the unit to dry for two hours in a warm place.

Having completed all the soldering we assumed that the most difficult part was over and that the watch had been easy to build, however, we reckoned without the "after thought" in the form of the copper screen, and the final fitting in the case.

COPPER SCREEN

The addendum covers the folding and fitting of the copper screen. We folded it as instructed and found that when in place it completely covered the trimmer screw, this was soon put right with a sharp knife as can be seen from the photographs. Having made the alteration we soldered the screen to the required point and, in order to take final photographs, fitted the unit in the case. This final operation was not easy as the screen tended to get in the way and cause the back of the case to spring off. However, this was eventually overcome.

The unit should normally be adjusted to run at the correct speed before insertion in the case but this takes at least two days to accomplish and we wanted to take photographs of the finished watch.

When the watch had been completely assembled in its case it was found that although it ran correctly, when one of the button areas was pressed to display the time, the final digit lit up very brightly as an "8" and the others were very dim. This was found to be caused by the screen being pressed hard onto the p.c.b. by the back of the watch case and was overcome by inserting some insulation between the screen and the p.c.b.

Due to the difficulties we had with the screen we feel that constructors may well finish up discarding this and using the watch without it. This could give rise to alteration of the timing due to interference. However we have since learnt from Sinclair that in future (probably by the time you read this) the need for the screen will be eliminated by circuit modifications.

OVERALL IMPRESSIONS

To sum up we found the actual soldering processes and construction of the watch up to testing to be relatively easy. Provided the correct iron is used and the operator is fairly competent at soldering most people should be able to follow the first seven stages; a steady hand and a reasonable eye are necessary due to the size of the unit.

However the final assembly stages, particularly with respect to the screen, can be rather tricky and may defeat some people. Due to this we recommend that readers buy the later kits that do not require the screen.

As far as adjusting the watch goes this is simple but may take a few days depending on the accuracy required and how lucky one is with the initial setting. The first two sets of cells in the prototype went flat in 4 and 3 days respectively. We believe this was due to wearing the watch in bed where the display "buttons" could be depressed accidentally for some time. New cells were fitted at a cost of 30p.

The finished watch is neat, if rather large for some wrists, but we found that the pressure needed on the press button areas was high and that the corners on the watchcase were rather sharp. For anyone with any doubts about construction there is a repair service for the kit with a fixed charge of £3·50 and the completed watch is guaranteed for one year.

However those people who still have doubts might do better to buy the finished watch paying the extra £7 instead, perhaps of the £3·50 repair fee (complete watches are at present available at about £2 off from Laskys). We do not advise anyone who is not proficient at soldering to attempt the construction.

In use the main criticisms were of the plastic case itself—as mentioned above—the push areas do not inspire confidence and most people found the pressure required to be greater than they would have liked, although this has improved with use. With respect to this criticism we have heard that it is very likely that Sinclair will be supplying other case styles in the future.

BRIEF SPECIFICATION

★**DISPLAY**—Hours and minutes or minutes and seconds, initiated by two press-to-see areas on case. Twelve hour cycle.

★**ACCURACY**—Better than one second per day (set by the constructor).

★**BATTERIES**—Two RM41H 1·4V Duracells costing about 30p (per pair) should last up to one year in normal use. Easy to change in a few seconds.

★**CASE**—Black plastic with mauve Perspex viewing area, rubber strap (stainless strap available).

★**SETTING**—Push area on back of case to increment and hold hours and minutes.

READERS' LETTERS

Faster Flashing

I have successfully made the *Christmas Lights Flasher* described in the December issue of EVERYDAY ELECTRONICS. I have observed that when light falls on the unit the flashing rate is about twice as great as it is when the unit is covered. Please could you explain this to me.

I. Daisley,
Cambridge.

This is due to the breakdown point of the neons being affected by the light. The breakdown voltage will rise when the neon is in darkness thus slowing the flash rate.

Ferric Chloride

Having read Mike Hughes' excellent article *Guide to Circuit Boards and Construction Methods* (Feb. '76) I would like to refer to his instructions on etching. There is nothing wrong with the points he makes if your readers are using the type of Ferric Chloride he describes. This kind varies in colour from biscuit to orange, is supplied in lumps and is very hard. It also contains a good deal of water. Now the type of Ferric Chloride that many are buying today is American army surplus, is made to a Mil.Spec., it looks like coal dust and contains almost no water.

We supply this with our own kits and as a result of experiments carried out over many months, in addition to all the unpleasant traits that Mr. Hughes warns readers against, we also noted the following: When added to water, very considerable heat is generated. The first time I mixed it, I did it in a plastic dish, and the heat melted the bottom out of the dish.

I therefore advise, that it is carefully mixed in an old jam jar, adding the crystals to the water (and not the other way round), in very small quantities at a time. I would add here, you will probably find, that after you have added about two level dessert spoonfuls to the water, the jam jar will be too hot to pick up!

We also found that if we made the solution too strong using this black Ferric Chloride, no etching will take place at all. Lastly we found when we had hit on the right proportions, the etching takes place quite nicely without having to wipe the board occasionally. All we did was rock the dish every ten minutes or so, the total etching time taking about 20-30 minutes.

I hope these remarks prove useful to those who are using this type of material.

A. Sproxton,
Home Radio Components

Cost Box

I find that sometimes your "estimated cost box" is really quite unreasonable, giving estimates some way below the probable price of the projects. The particular one I have in mind is the *Stabilised Power Supply Unit* from your January 1976 issue. In *Shop Talk*, you say that about £3·00 is a reasonable price for the meters, quite rightly. This leaves £2·00 out of the stated £8·00, with which one is presumably expected to buy the whole of the remainder of the components for the unit.

About 21p should cover R1-7 and VR1; C1-2 could be bought for about 30p each. The bridge rectifier cost me 18p, the Zener 9p, the 2N3704 also 9p, the OC204 32½p, and the AD142 61½p. This group comes to more than £2 and we have not yet covered the cost of the transformer and hardware.

As a matter of fact, the entire unit cost me more than £13, although this did include certain components which I could have got for less.

Before entirely losing favour with you, I ought to point out that I do think that the cost box is an excellent idea; indeed it is one of the aspects of *EE* which I particularly like. My only criticism of the layout of the magazine is in fact, that you put the contents page after all the advertisements instead of at the beginning. This makes it very awkward when one wants to look up the page number of an article, or see what projects a particular issue contains.

Hoping that these comments may be of interest to you.

M. Hughes-Chamberlain,
Hindhead

We have made a mistake on the cost for the Power Supply—it should be £10·50. We apologise for this and thank you for pointing out the difference.

Regarding the £13 you paid, you must remember that this includes VAT. The meters would be about £5·60 without VAT. The list of parts you quote comes to £2·11 or £1·95 without VAT thus leaving about £3·00 from our revised total for the remaider. See Shop Talk *for further comment on costs.*

R.M.S. and all that

I have read with great interest your article in the December '75 edition of EVERYDAY ELECTRONICS about building the *I.C. Stereo Amplifier*. There are some questions which I would like to ask. They are:

1. What does r.m.s. stand for? You state that the TBA800 i.c.s. are capable of a max continuous output of 5 watts r.m.s.
2. What would happen if I used a 240V-12V transformer instead of a 240V-6V? Is there any need to do this if I want the amplifier for my guitar?

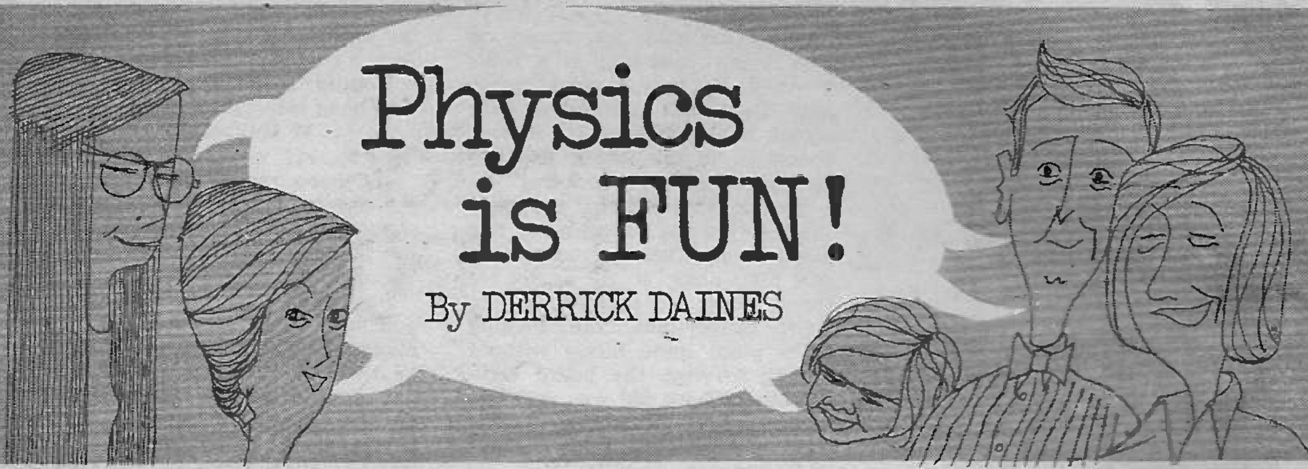
I understand most of what you are saying due to my knowledge of physics plus the fact that I have got the Dictionary of Elecronics, but these questions always perplex me.

Hasan Abdulla,
Reading.

The term r.m.s. stands for root mean square and this is the value of an alternating voltage or current that will produce the same energy as an equal d.c. The mains voltage, in common with other a.c. voltages is quoted as an r.m.s. voltage (240V a.c. in most areas).

By quoting a continuous r.m.s. figure for output we are saying that the amplifier will reproduce a continuous sine wave tone at a level of 4 watts r.m.s. If we had quoted a peak output it could possibly have been as high as 10 watts.

The mains transformer used in this design is 240V/20-0-20V at 750mA and this specification should be kept to.



CIRCUIT BREAKER

A WIDESPREAD use of the electro-magnet in industry is in the circuit-breaker and the project to be described not only illustrates the principle very well, but can also be put to good use—for example, in a model railway set. Like a fuse, the circuit-breaker is designed to trip or break the circuit when the current becomes excessive, thus preventing damage to either the appliance or the supply.

Compared to the fuse a circuit-breaker is slow and is expensive to install, but it becomes economic where frequent replacement is involved or where currents are heavy. Our model may be made for a few pence and is capable of carrying sufficient current to drive a train set. It is also possible to adjust the trip current to within fairly close limits. **Note that this unit must not be used at voltages above about 20 volts.**

I prefer to start my projects with the hardest part first, while my enthusiasm is high. The hardest part of this project is the armature, Fig. 1. Cut a piece of thick brass to the dimensions shown and fasten a piece of mild steel plate to it, using countersunk rivets or screws and nuts. Another rivet, this time with a square-section head, is added as a catch. The brass is now soldered to a 75mm brass rod. Finally, a piece of phosphor-bronze strip 50mm long is soldered to the rod also. Readers who have access to welding equipment may with advantage make the whole armature out of mild steel, using an old clock spring in place of phosphor-bronze.

The base is cut out of ply, 150mm long by 100mm wide. At one end a balsa block is glued and screwed into place, while the larger block at the other end is better made out of hardwood, which is less likely to split. Dimensions are given in Fig. 2.

Now the coil should be wound. For this the first requirement is a good big steel bolt about 10mm diameter or more. Make two thick cardboard washers 25mm outside diameter, a tight fit over the bolt and push one onto the bolt tight up against the head. Now wind on the bolt two turns of brown parcel tape and glue on the other washer. The washers should be 25mm apart. Winding may now commence, with the excess bolt held in the chuck of a drill. The exact size of wire is not important, but a fairly thick enamelled wire is best. Wind on as much as the bobbin will hold and bring out the two ends (Fig. 3). To hold the turns in place another couple of layers of parcel tape are used.

Finally, cut off the excess bolt by holding it in the vice and supporting the coil with the fingers while sawing. The coil is held in place on top of the hardwood block by a strap of tinplate.

Position two angles of tinplate with holes for the armature pivot so that the armature just touches the head of the bolt when in the vertical position. When released, the armature should fall back under its own weight. Glue a piece of scrap wood behind it so that this movement is not more than a few degrees.

TESTING AND ADJUSTMENT

A second spring is now pinned to the balsa block in the position shown. In the at rest position, this spring is higher than the catch on the armature and a preliminary test may be made to ensure correct functioning. Wire up as in Fig. 4, then bend the horizontal spring down so that it is held under the catch on the armature. Pass a current through the coil, and increase this current until the armature moves over, thus releasing the spring.

For adjustment, a hole is drilled through the hardwood block of such a size as to accept a long thin woodscrew, finger-tight. This hole must be exactly opposite the armature spring and the screw is turned through until it contacts the spring. Now it will be observed that the solenoid is pulling the armature against the pressure of the spring and turning the screw in or out will adjust the trip current fairly closely within limits set by the construction of the coil (Fig. 5).

Of course, since the current is flowing through the catch to the horizontal spring, once the contact is broken the coil will no longer be energised and the armature will fall back. But it is too late; the spring has flown upwards out of the way.

This upward movement of the spring can be utilised to light a lamp that will indicate when the circuit-breaker has tripped; Fig. 6 shows the idea. We also need a convenient way of resetting the gadget. A plunger—preferably insulated—can be positioned above the spring, but it is tolerably obvious that such a plunger cannot actually rest on the spring at all times, since it would hinder free upward movement. The plunger therefore needs its own retraction spring; Fig. 6 shows this.

NOTE: A magnet must not be used near a colour T.V. screen —ref. this page last month.

Physics is FUN!

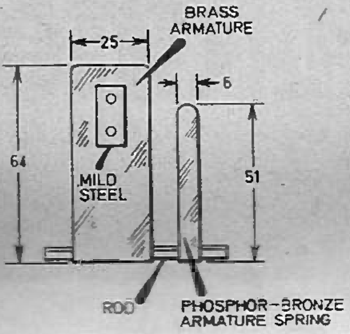


Fig. 1. Construction of the armature, its pivot rod and spring.

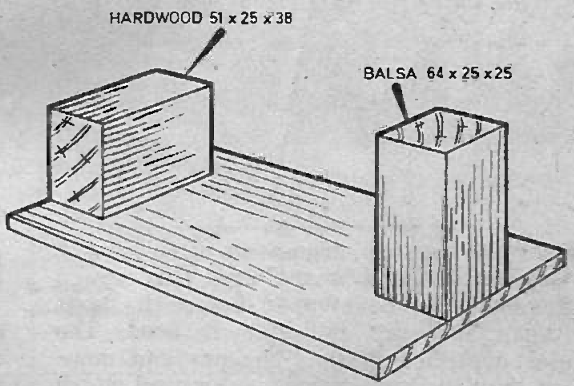


Fig. 2. Basic mounting board and blocks.

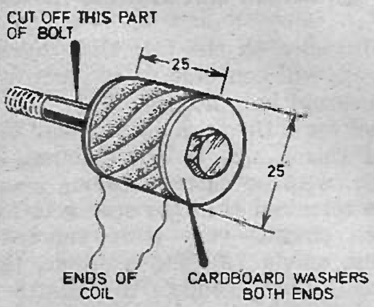


Fig. 3. Construction of the coil.

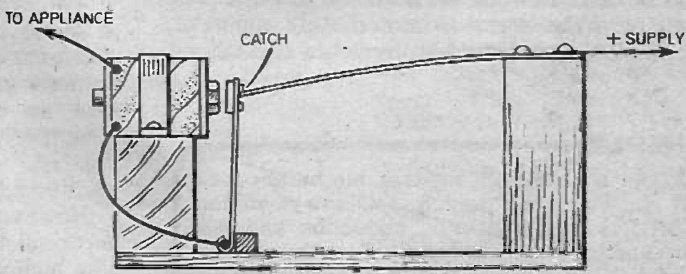


Fig. 4. Wiring and catch arrangement.

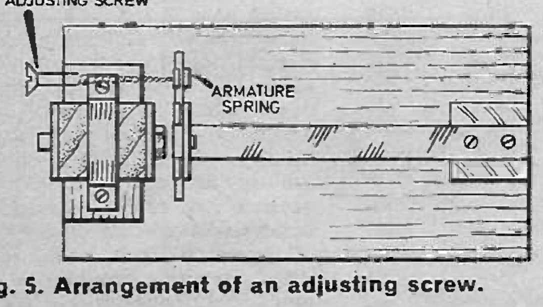


Fig. 5. Arrangement of an adjusting screw.

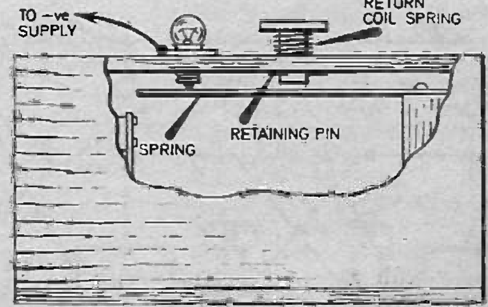


Fig. 6. Return plunger and indicator lamp mounted on a simple case fixed to the base panel.

SNAP INDICATOR

By L. GREEN

When playing snap, arguments often arise as to who screamed "snap!" first. This type of disagreement can be stopped before it starts if a snap sequence indicator is used. The indicator described here is cheaper and more efficient than its predecessors and is well worth building to keep the peace.

CIRCUIT DESCRIPTION

The full circuit diagram is shown in Fig.1. The simplicity of the circuit is immediately apparent, but unlike transistorised equivalents this circuit uses thyristors which enable the lamps to be lit brightly when they are on.

The use of thyristors also means that a memory is incorporated into the design in that, even if the player to respond first releases his button, the circuit will still indicate the correct sequence.

The circuit relies on the fact that thyristors, once triggered, will continue to conduct even if the trigger current is removed.

The symbol for a thyristor is very like that of a diode and this is not by coincidence. In its "off" state i.e. with no current having been fed into its gate terminal the thyristor acts almost like an open circuit—very little current will flow between anode (a) and cathode (k) no matter which way round the battery is connected.

However, if we pass current into the gate (g) terminal the thyristor will conduct and act just like a diode. If the current flowing from anode to cathode is of sufficient magnitude (this will depend on the particular device used) the

SIMPLY

When a contestant presses his button (say S1) an electronic switch called a thyristor (CSR1) is triggered into conduction and the corresponding lamp lights. Because the voltage across CSR1 is now very small there will not be enough current to trigger CSR2 should the other contestant press his button.

The circuit will remain in this state until reset by opening S3.

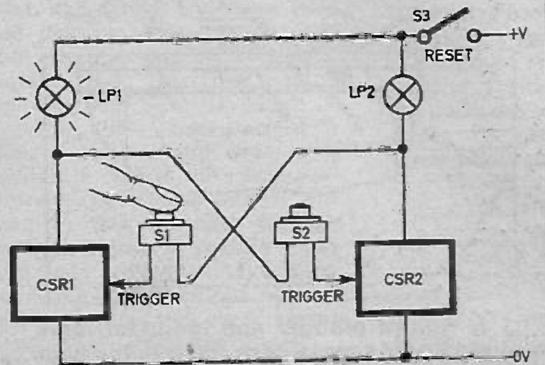
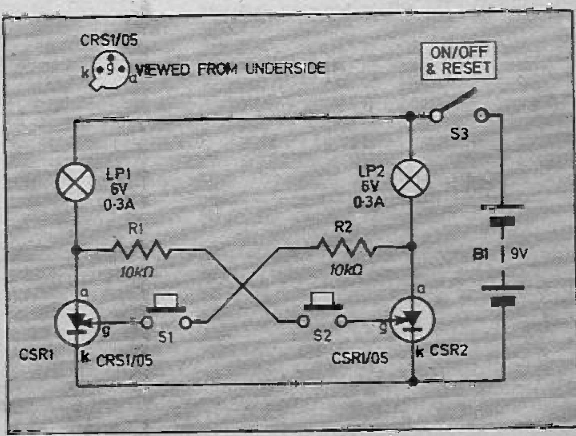


Fig. 1 The circuit diagram of the Snap Indicator.



SNAP INDICATOR

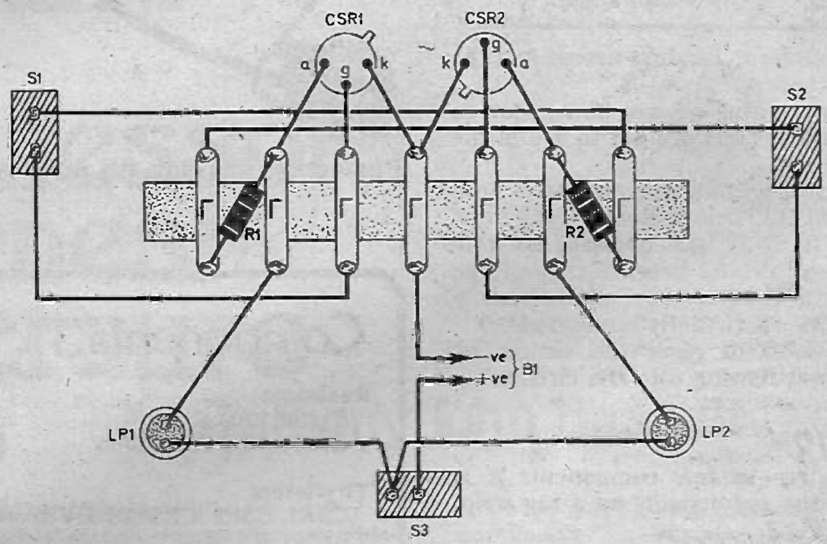


Fig. 2 Construction and wiring of the Snap Indicator—layout in the case is not shown for simplicity.

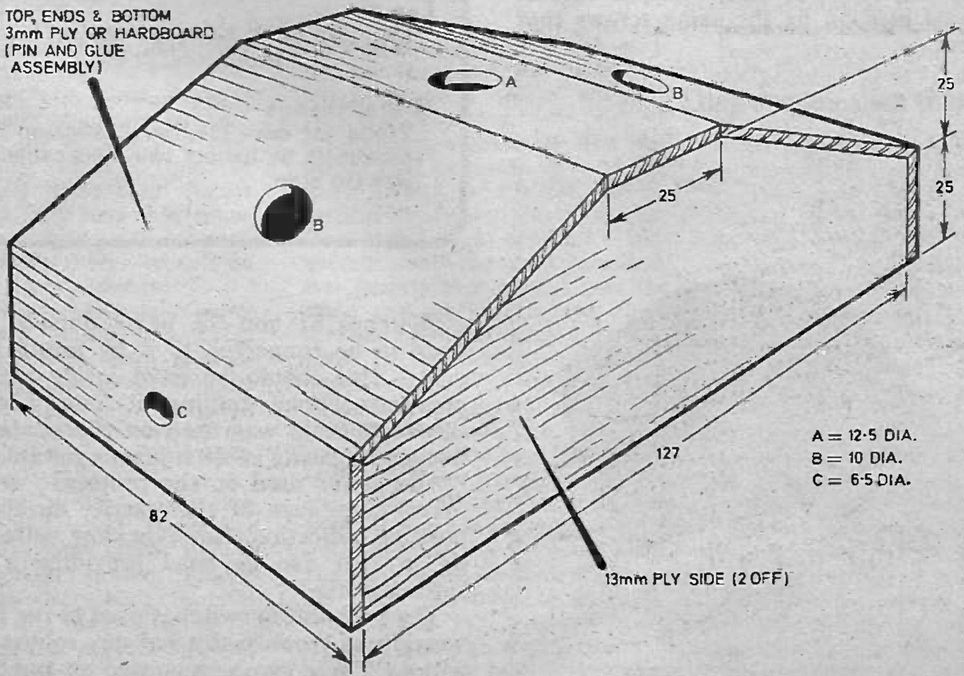
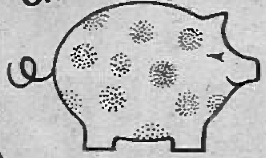


Fig. 3. The construction of the prototype case. This can be finished as detailed in the text.

FOR GUIDANCE ONLY

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



£2.00
excluding case

*Based on prices prevailing at time of going to press

thyristor will continue to conduct even when the gate current is stopped.

Having understood this we can now go on to look at the way these facts are put to use in the circuit.

When S1 is closed, gate current flows into CSR1 via LP2 and R2. This switches CSR1 "on" and LP1 lights. If S2 is now pressed, no gate current can flow into CSR2 because the voltage at the anode of CSR1 is very low (it is heavily conducting) so R1 is virtually grounded.

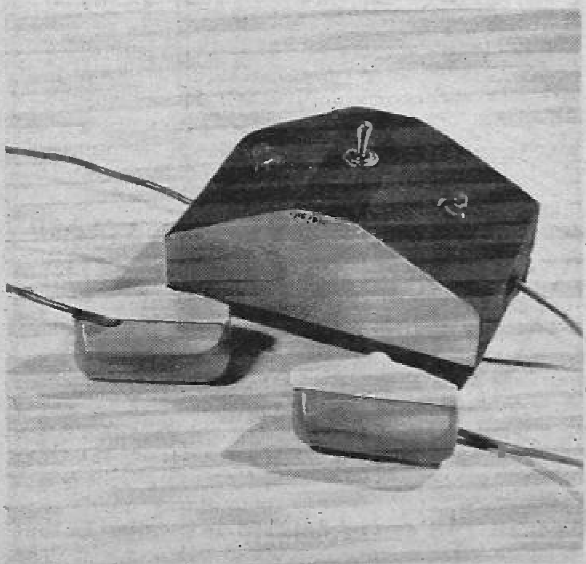
Switch S3 is used to reset the circuit by stopping all current flowing into the circuit.

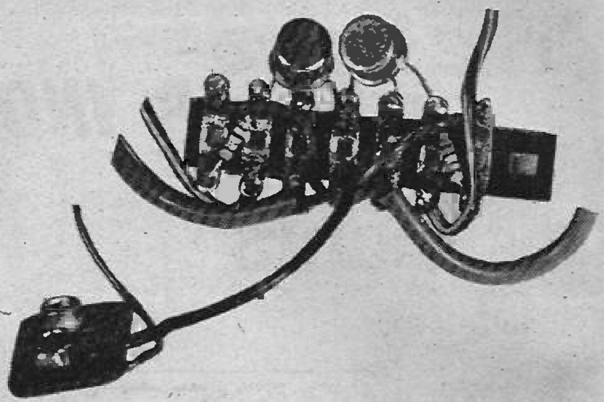
CONSTRUCTION

Because there are so few components it is simple to mount the components on a tag strip. This is shown in Fig.2.

The case was made from wood as shown in Fig.3. After the case has been assembled and the irregularities removed with wood filler, the case can be painted with hardboard sealer. The sides are painted with enamel paint and the top, bottom and ends covered with stick-on Velour. The base was held on by the same screws that hold the feet.

Photograph of the complete unit.





Photograph showing the internal construction.

Components....

SEE SHOP TALK

Resistors
R1, R2 10kΩ (2 off)
Both ±10% ¼W carbon

Thyristors
CSR1, CSR2 CRS1/05 50V 1A thyristors (2 off)

Switches
S1, S2 s.p.s.t. push-to-make release-to-break pushbutton (2 off)
S3 s.p.s.t. on/off toggle switch

Lamps
LP1, LP2 6V 0·3A l.e.s. lilliput lamp with lampholder (2 off)

Miscellaneous
Wood for case (see text), stick-on Velour, grommets, 9V battery, twin-core cable, seven-way tag strip.

Switches S1 and S2, being outside the case need to be connected to it by round twin-core cable. This should be fixed inside the case to prevent anyone pulling it out. Lightweight screened cable was used on the prototype but five-amp lighting cable is just as suitable.

The lamps used on the prototype are recommended because of their style, durability and positive indication. However, low voltage lamps up to 40W can be used providing a suitable battery is used.

The pushbutton switches used in the prototype were from Woolworth's but any robust switches will do. These can be mounted on small wooden blocks so that they are easily held by each contestant. ■

The Extra-ordinary Experi-ments of Professor Ernest Eversure

by Anthony John Bassett

A SURPRISE VISITOR

A distinguished person makes a surprise visit . . . and young Bob soon realises that "the best laid schemes o' mice an' men gang aft a-gley". His hoped-for session with the breakdown voltage tester to carry out some experiments with diodes has to be cancelled, since more important and quite startling matters require the Professor's immediate attention. Bob is not disappointed with his latest visit to the Prof., as you will learn.

As Bob entered the laboratory he found that the Prof. was about to leave it. "Just about to receive a very important person", Bob. "It is Sir Rockwell Orbiter, who has just returned from the International Electronic Games Symposium, and says that something very puzzling and interesting cropped up there—so he's on his way to ask my opinion!"

"International Electronic Games Symposium", mused Bob, "Hey Prof., that sounds really fascinating. I wish I could come with you and hear what Sir Rockwell Orbiter has to say. Please let me come Prof., I promise not to be any trouble at all!"

"We——ell", the Prof. considered. "You must remember that Sir Rockwell is not only a very important person, but is probably also very busy. Rumour has it he was once attached to M15 or M16 or something. Still might be—but his visit is to do with electronic games, and I know that you're very interested in these—I suppose it might even be an advantage to have you along—provided you're on your very best behaviour."

Bob knew, regrettably, that this meant that he would have to use great efforts to restrain his insatiable curiosity, and refrain from butting into the Prof's. conversation with too many questions. But despite this snag it was the same curiosity which had given him the powerful urge to beg the Prof. to let him attend. So he could hardly wait to meet the enigmatic Sir Rockwell Orbiter.

"Right then you can join us in my lounge a little later, Bob," said the Prof. "I am sorry I can't carry out those further experiments with the breakdown voltage tester, as I promised on your last visit. Our investigations into diodes of all kinds will have to wait, I'm afraid. But for the next few minutes you can amuse yourself with one of my high power electronic pocket calculators. Go ahead and try out this one." The Prof. indicated one from a variety of calculators which were on a workbench. "You can join us later in the lounge." Bob picked up the calculator and began to use it. Immediately he became aware of an harmonious chiming sound, as if about a million different chimes were sounding quietly and harmoniously together. This was the Profs. experimental electronic multichime sonic indicator announcing the arrival of his visitor.

"When you've finished your calculations Bob, come directly across to the house and join us in the lounge, do not touch anything else in the laboratory." The Prof. turned and left the laboratory.

"O.K. Prof. thanks" called out Bob as he continued to manipulate the electronic calculator.

MASTER CONTROLLER

Now one of the answers given by the calculator was beginning to puzzle Bob, and as it was too complex a calculation to work out without electronic assistance, he decided that he would like to check the result on another calculator. Nearby on the workbench Bob spotted a different and quite exciting looking calculator. It had more controls and a bigger keyboard and display than the one Bob was using and it looked to be altogether a better job. Bob picked up and examined it with interest, and he soon noticed that it also appeared to have a built in microphone and loudspeaker—and some of the keys and controls were marked with symbols which he did not understand.

"I simply won't use these controls" thought Bob, "I'll just use the keys which I understand to check my own calculations.'

But this was easier said than done, and in a very short time, Bob found himself in a glorious tangle with the Prof's. strange calculator. The first thing he noticed was that where most pocket calculators have a numerical display this one had a larger area which lit up and displayed a picture.

As Bob pressed the buttons a variety of pictures appeared in succession. They were maps, recipes, formulæ, pages from library books, all kinds of information. The machine gave the time, date, weather forecast and all kinds of information for London, Rome, Hong Kong, Moscow, New York, Peking—any city one wished, both displayed on the screen and by announcements from the speaker, and a huge variety of information seemed to be available from the small slim, portable device.

When Bob pressed one particular combination a girl appeared on the screen and promptly announced to him "International Telephone Operator Service, which number do you require?"

"Sorry Miss—I'm not trying to call anyone." Bob replied, embarrassed. In confusion he quickly pressed a few more buttons so that the girl's face disappeared from the screen and her voice ceased to issue from the speaker.

"Crumbs" thought Bob, "this isn't an ordinary calculator at all! What on Earth is it doing now?" From the speaker came a loud bellow of indignation and discomfort and the voice of the Prof. as he calmed his distraught distinguished visitor. Bob could see them clearly on the small viewing screen, and whilst one moment they appeared to be cold and shivering, the next moment they appeared to be perspiring in an overheated room.

"I don't understand this at all," the Prof. was saying. "The system is fully automatic and fail safe, yet the heating and air conditioning regulators in my lounge seem to be oscillating violently so that one moment we're very cold—next we're very hot. Surely nobody could have tampered with the master controller. But Ah! That is the only explanation and I think I know who that somebody is!"

"Oh No!" thought Bob suddenly realising with dismay that he himself held the master controller in his hand—and that he had disobeyed the Prof's. instruction not to touch anything in the laboratory apart from the small calculator. "Sorry Prof.," he apologised handing the master controller to the Prof. who had just entered the laboratory to put things right. "I wanted to use this to check the results of the other calculator and I seem to have made a terrific mess of things."

Sir Rockwell Orbiter who had followed the Prof. into the laboratory now appeared as the Prof., pressing a few buttons and adjusting the controls, re-set the master controller to its correct adjustment. Now Sir Rockwell Orbiter spoke up once again, but this time, no longer against the trouble Bob had caused, but in his defence. Sir Rockwell had heard Bob's apology to the Prof. and now it was his turn to exert a diplomatic and calming influence. Almost immediately as he spoke his words and manner put Bob at ease again.

MOODSTONE CALCULATOR

"It's partly my fault," said Sir Rockwell, "If I had known that you were struggling with your homework calculations, I would not have caused such a fuss."

"Nobody's to blame," cut in the Prof. "You've hardly had time to settle down from an exciting and very eventful journey in foreign lands—I don't know where you find the stamina for such tremendous journeys.

"But let me introduce you to Bob! This is Sir Rockwell Orbiter!"

"Never mind the Sir my friends just call me Rocky," said Sir Rockwell modestly, "Here Bob—you might be able to use my new calculator to check your homework whilst I have a look at the Prof's. master controller. It looks really fascinating and I cannot possibly resist such interesting electronic gadgets!"

"Hop on!" invited the Prof.

Bob's eyes boggled once again at the sight of the strange calculator which Sir Rockwell now fished out of his pocket and presented to him. It was obviously a peculiar foreign make of a variety that was completely new to him. As Bob opened the case to gain access to the controls, he found to his complete astonishment that the calculator was even stranger than the Prof's. master controller. Very weird and unusual looking it opened up like a folding map to reveal a number of hinged control panels, and to his dismay he could not understand any of it, as all of the controls were labelled in strange foreign figures resembling some form of technological Hieroglyphics!

Whilst Bob's imagination

struggled to conjure up images of the buttons on the calculator being contacted by the nimble digits of an alien being from some far distant civilisation in outer space, a strange object came over his shoulder and pressed a few of the buttons on one of the panels. Before Bob's eyes the unknown foreign symbols faded out to be replaced a moment later by a complete set of mathematical symbols in the kind of figures Bob could understand. The entire machine also appeared to have been relabelled in English within a matter of seconds.

"It is based upon an electronic variation of the Moodstone Ring" said Sir Rockwell, who had reached over Bob's shoulder with a laboratory probe to press the buttons which had changed the symbols on the calculator. "Prof. I believe you know something about these Moodstone gadgets and I can see that Bob is interested, I wonder whether you could tell us a little about this?"

"Yes certainly" the Prof. answered. "The original Moodstone Passion Ring is not an electronic device in the conventional sense, although it does depend for its effect upon changes in the shape and energy disposition of electron shells in complex molecular structures. It is based upon a series of chemical substances which change colour according to the body temperature of the wearer of the Passion Ring.

"In Sir Rockwell's calculator similar chemicals have been adapted to change their optical properties in accordance with an electronically generated stimulus instead of a temperature variation. By this means the symbols can be changed to suit any language. Simultaneously the logic systems in the calculator are adapted to the mathematical conventions of the nationalities which use these symbols.

"Fascinating," remarked Sir Rockwell. "Now before we get down to the main business I've come to see you about, I'd be really glad if you could also explain your master controller to me so that if unusual effects begin to manifest once more in your lounge, I'll know what it is, and won't suspect strange substances in the coffee."

At the prospect of a demonstration of the master controller, Bob immediately tore himself away from his ill started homework, and joined the Prof. and Sir Rockwell Orbiter, as they made their way through the Prof's. garden and greenhouse towards the house. "The master controller is connected by means of multipath multi-frequency radio links to a number of powerful computers which add greatly to the functions of the specially produced circuitry of the controller itself. Some of the computers store and process up to the minute information on weather conditions and forecasts, date and time all over the world together with all the latest news and scientific discoveries and predictions.

"Others carry huge data banks of information, reference material from the past or complete libraries which can be passed on to the user of the master controller.

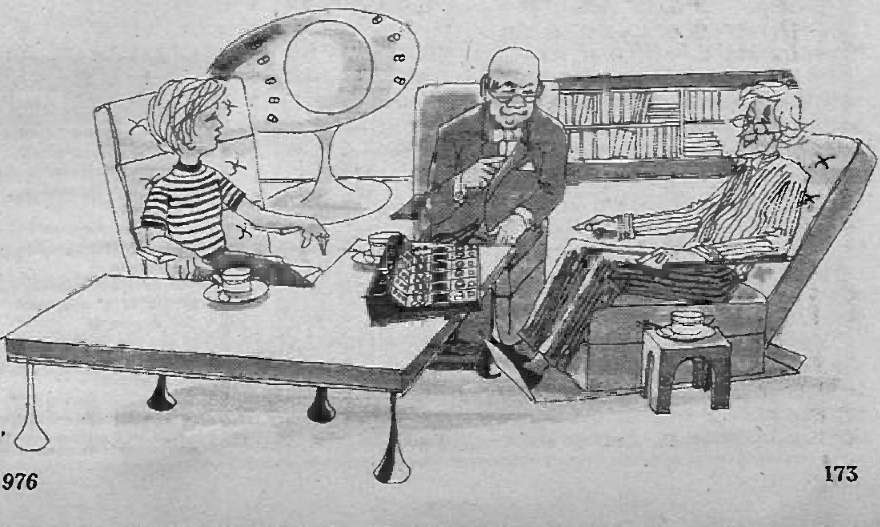
"Although the master controller is able to make a connection with all information and communication services there is still some spare capacity left over in its powerful computer circuitry, and I have used this to programme the environment in my lounge and that's what you upset Bob, when you tried to use it as a calculator! You accidentally reprogrammed it so that the air conditioning temperature and humidity began to oscillate. We suddenly found ourselves in a frosty sub zero lounge which rapidly warmed up to humid tropical temperatures then froze us again, baked us in dry desert-like environment and so on. Sir Orbiter said that the variation was greater than any of the climatic extremes he has met anywhere! It should be back to normal by now, though."

Bob found that he had been so interested in the Prof's. description that he had not even noticed that they had entered the house already and he had completely missed sight of all sorts of wonders on the way to the lounge. Now, however, the three stood at the entrance to a room which was obviously not back to normal by any of the usual civilised standards. Although the temperature and humidity could not be faulted the room was empty, the floor and walls completely blank.

"Oh, sorry, I forgot," the Prof. apologised. "After the upset I instructed the Robot to take everything out of the room, and check it but I forgot to instruct him to bring it all back again! And I don't think he'll have it all ready yet—still we might as well be comfortable whilst we wait—I'll rustle up some spare furniture from another room."

"Here, I'm sure that Bob and I could give you a hand with that!" offered Sir Rockwell, turning back into the entry hall.

"Not at all my dear fellow, you're both guests in my house," replied the Prof. "Besides it's no trouble, here come some comfortable armchairs now."



"How do these chairs work?"

The Prof. had pressed a few buttons on the master controller, and now a procession of radio controlled furniture began to approach them along the corridor.

Bob and Sir Rockwell were amazed as a radio controlled table sped past followed by a strange looking T.V. set, and other weird articles of furniture which the Prof. had designed. Now three comfortable looking armchairs approached, and stopped.

"Hop on!" invited the Prof. indicating the chairs and sitting in one himself. As Bob and Sir Rockwell each selected an armchair and sat in it the three armchairs began to move again and ushered them in a ceremonial procession into the lounge which, though containing only a few samples of the Prof's. amazing furniture was by now quite comfortable and perfectly adequate for the forthcoming discussion of the International Electronic Games Symposium.

"Prof., I'm enormously impressed and fascinated by this furniture!" remarked Sir Rockwell. "How do these chairs work?"

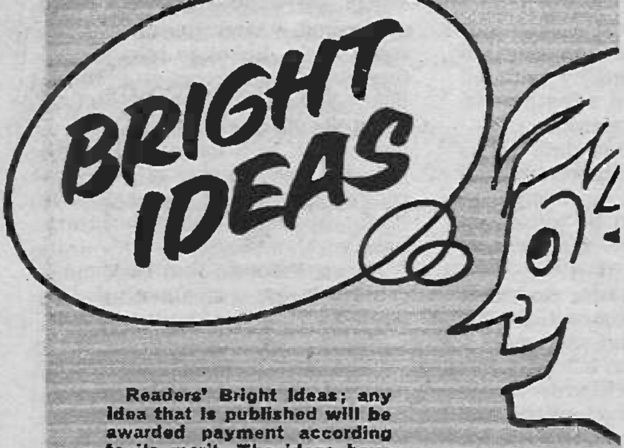
"Oh, it's quite easy to make a motorised radio controlled armchair!" replied the Prof. "Actually I only made one of them then I gave the Robot instructions to build the rest!"

"Wow!" exclaimed Bob. "And with the master controller they're really 'James Bondish'. I'll bet you could fit these with ejector seats to throw spies out through the roof or whichever window you choose."

While Sir Rockwell howled with gleeful laughter at this wild suggestion, smacking Bob heartily on the back with such vigour that he was nearly ejected in the prescribed manner, the Prof. suppressed a grin and explained patiently that the radio controlled furniture was part of a household experiment to build furniture for disabled persons who could not do very much with normal furniture. It could help in the future to improve the quality of life for the disabled. Under the Prof's. instructions to the master controller the furniture was now tastefully arranged around the lounge and the three of them were comfortably established around the Prof's. table.

"Now, Sir Rockwell, whilst we wait for some refreshment to arrive Bob and I are both very anxious to hear about your visit to the International Electronic Games Symposium, I gather that what you have found out there is really fascinating and that crazes for some amazing new electronic games are sweeping across entire communities!"

Continued next month



Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

Small circuit boards often get jostled around by the brush when applying the resist. This can easily result in mistakes and an untidy finished appearance.

To keep the board firm and secure yet without damaging it, simply use double sided sticky tape or single sided tape folded over, then stick one side of the tape to a large piece of paper or a table top, etc., and the other side to the non-copper side of the printed circuit board.

Kenneth Jatzuk,
Keighley.

PLEASE TAKE NOTE

Some points concerning the construction of the Digital Clock (Jan. '76) should be noted. Capacitor C2 should be 390pF instead of 1nF. This should be changed if the display flickers.

Should the clock start advancing the minutes every 20 seconds and hours every 20 minutes add a 10MΩ resistor between pads marked "—" and "R" on the p.c.b. and a 2·2nF capacitor between "R" and "+".

The earth pin (Fig. 7) should be wired to the pad marked "—" not to "R".

In *Physics is Fun* last month we suggested using a magnet on a T.V. screen. This must not be done to a colour T.V.

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DOWN TO EARTH

By GEORGE HYLTON

DECIBELS AND MULTIMETERS

In an earlier *Down to Earth* I explained the reason for inventing that curious unit, the decibel (dB). What I didn't do, for lack of space, was to talk about decibel measurements. Quite a lot of multimeters have decibel scales and some readers (including *Mr. M. Clarson* of Co. Cork) want to know how these dB ranges are used. This can be rather puzzling when, as is often the case, there is no position marked "decibels" on the meter's range-selector switch!

REFERENCE LEVELS

Decibel measurements are also known as *level* measurements. This is a good starting point for an explanation. You might talk about shelves being fixed at different levels on a wall, or houses being built at different levels on a hillside. Such statements contain the general idea that one level is being *compared* with another.

Contour lines on maps give heights above sea-level. Sea-level is a convenient reference point, a standard level for comparing other levels, above or below. However, we aren't always interested in the height above sea-level but merely in *relative* levels.

If we are laying drains between houses *A* and *B* the important thing may be just which is higher, *A* or *B*, since this is what determines which way the water runs. The heights above sea-level may not need to be known for the immediate purpose.

In expressing electrical signal levels in decibels we may be concerned with either type of measurement—absolute levels above some standard reference level, the equivalent of sea level; or relative measurements in which we merely want to know how much stronger is signal *A* than *B*. This is one source of confusion, but another, perhaps more widespread one, is that when *voltage* levels are compared in decibel form the dB figure comes out higher than when *power* levels are compared. Thus a *voltage* of 10V is 20dB up on 1V, but a *power* of 10W is only 10dB up on 1W. Why, when the ratio is 10 in both cases?

POWER AND VOLTAGE

Fortunately the explanation is easy, so let's dispose of this one right away. Decibels, strictly speaking, are about power. But to have power you must have voltage, current, and resistance. Power is dissipated when a voltage is applied to a resistance and current flows. Power (watts) equals volts times amps.

Since voltage is easier to measure than power, it's often more convenient to measure volts but pretend you are measuring power and express the measurement in dB just as if it were a proper power measurement.

If you multiply the voltage applied to a resistance ten times, the current also increases ten times. So power which is voltage times current, increases not ten times but a hundred times. This is why the dB figure for voltage ratios is bigger than the dB figure for power ratios. The "dB volts" figure is in fact just twice the "dB power" figure. You could think of a 20dB reading for a 10-fold voltage rise as 10dB for the voltage increase plus 10dB for the accompanying current increase.

If this is a bit too academic for you, don't worry. You can still make dB measurements quite happily using the dB scale on your multimeter, without bothering your head about it.

On the cheaper sort of meter, there's no dB range as such, but merely a *scale* marked in dB, often with "0dB" about a third of the way along. It's intended to use this for *relative* measurements.

To use it, you select an a.c. voltage scale which suits the voltage levels of the signals you are measuring but you read off on the dB scale.

FREQUENCY RESPONSE

A common use of the dB scale is in the measurement of the frequency response of an audio amplifier. The meter is connected across a suitable resistance such as the loudspeaker voice coil (or better a dummy load in the form of a real resistor connected in place of the speaker) and the signal voltage is read off the dB scale. You must have an artificial signal source in the form of a sinewave oscillator adjustable over a wide frequency range (such as 10Hz to 100kHz).

To begin with, apply a signal at a frequency well within the normal audio range, e.g. 1kHz, and adjust the level so that the meter reads 0dB. Then vary the frequency downwards until the response begins to droop. You may find, for example, that it is 3dB down (−3dB) at 40Hz and −6dB at 25Hz. Similarly the high-frequency response may be −3dB at 14kHz and −6dB to 20kHz.

PRECAUTIONS

Some precautions are advisable in making this sort of measurement. The first is to make sure that the amplifier can take the signals you are applying to it. Many power amplifiers are constructed on the assumption that the only signals which will be applied to them are speech and music.

If you apply continuous sinewaves, the amplifier may be driven to full power all the time and it may not be able to take it. For safety's sake, take your frequency response at a lower power level.

GENERAL RESPONSE

Another precaution concerns the frequency response of the oscillator and the meter. Before measuring the amplifier response, measure the oscillator output on the same meter (if possible on the same voltage range) over the full frequency range. Note any drops or rises and allow for them when you make measurements on the amplifier.

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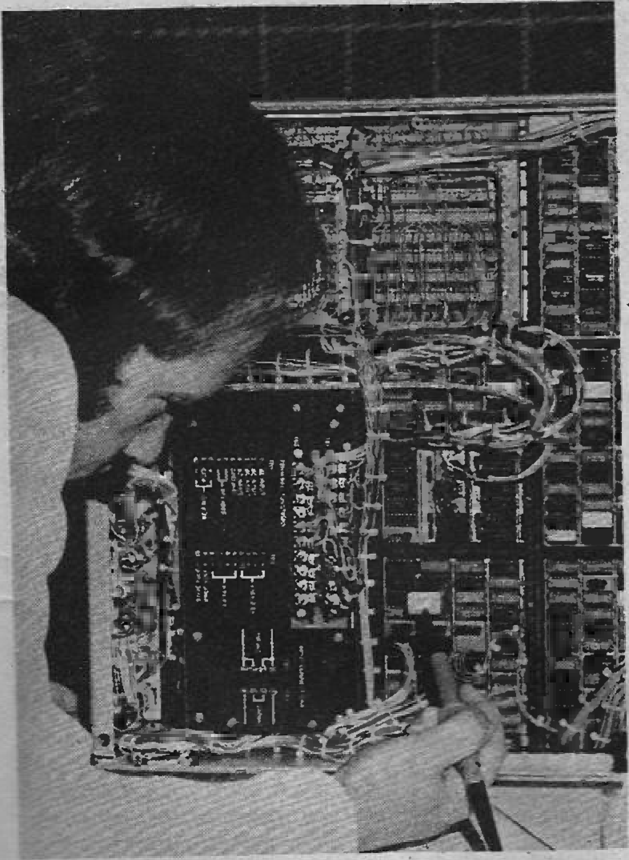

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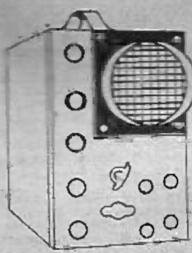

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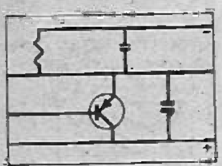

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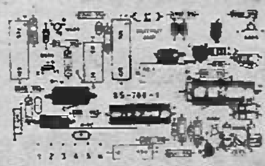

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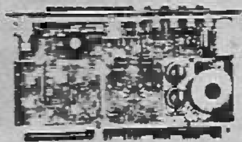

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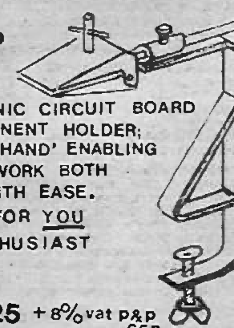

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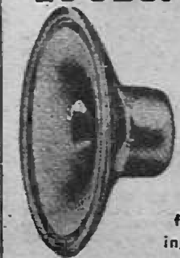

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