RESULTS OF TV GAME COMPETITION - SEE INSIDE

Hobby Electronics

March '81
ISSN 0142-6192
60p

For A Down-To-Earth Approach To Electronics

BEGINNINGS OF REAL TV

We trace the origins of modern television

ALSO
INSIDE FOR YOU TO BUILD

PORTABLE PUBLIC ADDRESS AMPLIFIER -

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Even the old boys circuit is getting electronicized. With our help

Hobby Electronics

MARCH 1981
Vol. 3 No. 5

Editor: Hugh Davies
Assistant Editor: Keith Brindley **Editorial Assistant:** Tina Boylan
Drawing Office Manager: Paul Edwards **Group Art Editor:** Paul Wilson-Patterson B.A.
Managing Editor: Ron Harris B. Sc.

This month's cover shows three notable receivers from the history of TV. Left is a cut-away Colorstar TV made by Ferguson in 1968 (on show in Science Museum). Centre is a Baird prototype made by the Plessey Company in 1928. It had a 30-line, vertically-scanned picture with a frame rate of 50 frames/second, and is on view at the ITA Gallery, Brompton Road, London. In the background is an elegant model 702 receiver made by Marconiphone in 1938 (also on show in Science Museum). *More details on these TVs is given under The Beginnings Of Real TV on page 18.*

PROJECTS

FEATURES

NEWS & INFO

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HY120

HY60

MOSFET

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Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

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CHOOSE AN I.L.P BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.29 + £1.09
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W Into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77

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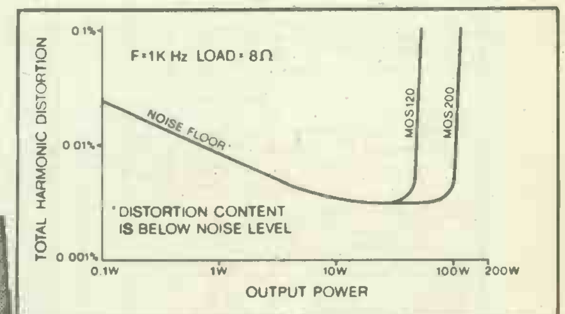
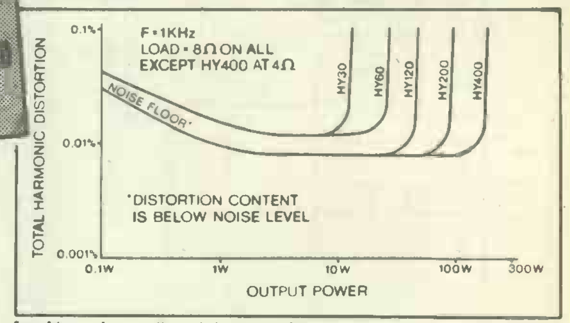
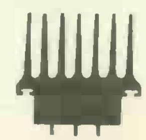


Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV
Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz - 3dB



Load impedance all models 4Ω - ∞ Input sensitivity all models 500mV
Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz - 3dB



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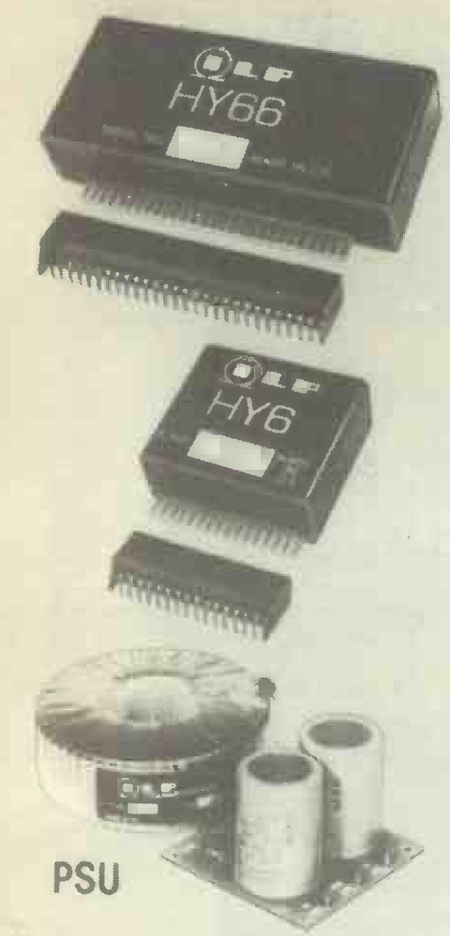
The introduction of standard heatsink extrusion for all I.L.P. power amplifiers achieves many advantages:— Research shows they pro[illegible] optimum thermal dissipation and stability. Slotted [illegible] easy mounting; standardisation enables us [illegible] keep our prices competitive. Surfaces are matt black, anodised for higher thermal conductivity. Extrusions vary in size according to module number.



PSU

NEW PRE-AMPS

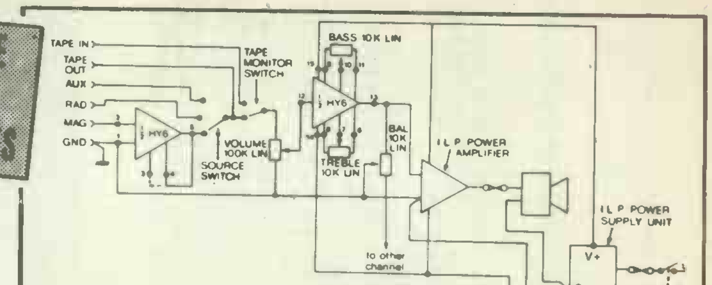
HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.

Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm.
Active Tone Control circuits provide ±12dB cut and boost.
Inputs Sensitivity – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £6.44 + 97p VAT Connectors included
HY66 stereo £12.19 + £1.83 VAT Connectors included

B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP, WITH STEREO CONNECTION SHOWN

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Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

PSU30 ±15V at 100mA to drive up to 12 x HY6 or 6 x HY66	£4.50 + 0.68p VAT
• *THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS*	
PSU36 for use with 1 or 2 HY30's	£8.10 + £1.22 VAT
• *ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS*	
PSU50 for use with 1 or 2 HY60's	£10.94 + £1.64 VAT
PSU60 for use with 1 HY120	£13.04 + £1.96 VAT
PSU65 for use with 1 MOS120	£13.32 + £2.00 VAT
PSU70 for use with 1 or 2 HY120's	£15.92 + £2.39 VAT
PSU75 for use with 1 or 2 **MOS120**	£16.20 + £2.43 VAT
PSU90 for use with 1 HY200	£16.20 + £2.43 VAT
PSU95 for use with 1 **MOS200**	£16.32 + £2.45 VAT
PSU180 for use with 1 HY400 or 2 HY200	£21.34 + £3.20 VAT
PSU185 for use with 1 or 2 **MOS200**	£21.46 + £3.22 VAT

1971-1980
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When, in 1971, Ian L. Potts founded his now world-famous company, he saw the need for a different and more rational approach to exploiting to the full, the potential that lay in modular construction. New thinking was badly needed. The result was a range of modules revolutionary in concept. The rightness of this new thinking is shown by the size of the company today, its new factory, its vast exports, its acceptance by constructors as *the* modules to build with. The range grows bigger and better. Exciting new lines (in no way conflicting with existing ones) are well past drawing board stage. This is why I.L.P are simply ahead and staying there.

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Monitor

50th Model Engineer Exhibition — Record Attendance

To the surprise of the organisers, attendance at this year's Model Engineer Exhibition, the 50th in its 73-year history, exceeded 81,000. (And we thought just over 17,000 was a large turn-out for Breadboard 80!)

It was also the largest exhibition since it started in 1907 and for this reason it was held at the Wembley Conference Centre, running from 1 to 3, 5 to 10 January.

HE visited the exhibition on Friday 9 January, and although most of the exhibits on display were mechanical or electro-mechanical in operation, we still thought it well worth the visit.

No sooner had we gained entry to the Centre we found ourselves surrounded by every conceivable type of model: from locomotives to sailing ships and from aeroplanes and cars to military models.

Of particular interest to electronics enthusiasts were the radio-controlled models, and plenty of space was allocated to these. Provision had been made in the lecture theatre for indoor 'round the pole' flying of model aircraft and for racing of model cars. (A safety net had been fitted between the stage and the auditorium.) On the roof outside the concourse a pool had been installed for model boats. Visitors were encouraged to enter competitions with their own models.

Stands in the exhibition catered for every need of the hobbyist, ranging from raw materials to the finished items. And if you didn't have a fully-equipped machine shop in the shed at the bottom of your garden then you could buy one of the many different varieties of model kits, some with pre-finished and pre-painted components.

For the die-hards who insist on making even the last nut and bolt, there were *tools*. If you wanted a lathe or a drilling machine, they were there. If you wanted a jeweller's vice or a set of miniature screwdrivers, they were there too. But most important of all, there was help. Many of the staff on the stands are hobbyists themselves and were keen to help and advise on visitors' problems.

Even the electronics enthusiast would benefit from a visit to the ME exhibition because of the wide selection of tools on show. In common with most exhibitions there were some interesting offers. And even the casual visitor must have been impressed by the care that had gone into those models. Some of the locomotives, for example, looked as if they were the result of shrinking powder applied to the full-scale models — such was the attention to fine detail.

Lord Gretton, president of The Society of Model and Experimental Engineers, was to have opened the exhibition but, unfortunately, was ill in hospital at the time. His son, John Gretton, who is a keen locomotive enthusiast himself, took his place.

Possibly because it followed a Bank holiday, Friday 2 January was *almost* the busiest day — but it was just beaten by the final Saturday.

Now we had some idea of how busy this exhibition was by the length of the queue on the Friday we made our visit. If you are interested, it would be better to get your tickets in advance and stroll past the queue in a leisurely manner. They are advertised during November and December in MAP model magazines, namely: Aeromodeller, Clocks, Military Modelling, Model Boats, Model Engineer, Model Railways, Radio Control Models, Radio Modeller, Popular Crafts, Scale Models, and Woodworker.

Tiger Moth on show at MEE. It was built by Ron Chivrall, who took Championship Cup for aircraft models. Detail extends to the tail trim system and cockpit instruments. Ron flew the real machine at Fair Oaks, Surrey

Stable Supply From Italy

This *could* be the kind of mains power supply offer you can't refuse ... imported from Italy. Model BRS27 is made by Bremi and gives a regulated fixed output of 13.8 VDC at 3 A maximum.

Stability is specified as being better than 0.1% with mains variations of 10% or load variations from 0 to 2.5 A. It includes an electronic current limiter, and ripple is specified as being 1 mV with 2.5 A load.

The supply comes in a robust black-finished steel box 173 mm wide by 90 mm high by 138 mm deep. Output sockets, mains switch and red indicator lamp are mounted on the front panel.

According to George Philips, managing director of the supplier, Open Channel Telecommunications, N. London, cost of the BRS27 is likely to be '£16.95 or under'.

He mentioned that another power supply, having the same electrical specification as the BRS27 but with lighter gauge steel for the box will be available shortly and will cost only £6.75.

What would you use 13.8 VDC at around 2.5 A for? One obvious application which comes to mind is equipment intended for mobile use, such as Citizens' Band rigs *when* these become legal.

Contact Open Channel Telecommunications, 407 Lordship Lane, London N17. Tel. 01-808 5656.

Tiny Tape Recorders

Two miniature hand-held recorders, models D6700 and D6710, are due for release by Philips Audio in March 1981.

Unlike Philips' Pocket Memo Range, which uses minicassettes giving 15 minutes playing time on each side, these two use *microcassettes*, which double this playing time.

Full details of these machines, and of the likely impact of microcassettes on the market are given in this month's special news feature of page 10.

Further details on the D6700 and D6710 are available from: Philips Audio, PO Box 298, City House, 420 to 430 London Road, Croydon, Surrey CR9 3QR.

Can You Design For The Disabled?

We're giving you, as a reader of HE the opportunity to design a project for a disabled person — and a chance to win a prize for your entry.

Did you know that at least 10% of the population of any country suffers from some form of physical or mental disability?

Now, 1981 has been proclaimed by the United Nations General Assembly as the International Year of Disabled Persons (IYDP).

So, in the April issue we are running a Design Competition to enable readers to do their bit and try to help the UN in its aims. We reckon that with all the brain potential out there, some of you will have ideas and designs which must help somebody.

The idea is that your design should aid a disabled or handicapped person — any aid — any handicap.

You stand to win large cash prizes, so you can't afford to miss it, can you? Remember to order your April copy of HE early, to make sure of your entry form and details.

Wire Up Your Boards With A Pencil

Looking a little like a red plastic carrot with an obliquely set metal probe at its tip, the Vector Wiring Pencil model p-173 can be used for point-to-point wiring of circuit boards. It is supplied with two 20 mm diameter metal bobbins of fine-gauge coated copper wire, each with a different-coloured coating for identification.

One of the bobbins is loaded into the cap of the tool and the wire is threaded out through the probe tip. The wire feed can be controlled by hand pressure on the bobbin, the rim of which protrudes slightly from the cap.

Wire is routed around the circuit board (plain board, that is, the type having no laminated copper strips) from component-to-component or pin-to-pin. At each connection point, the wire is wrapped around the wire-end or pin and soldered in place (the coating melts when a soldering iron is applied to it).

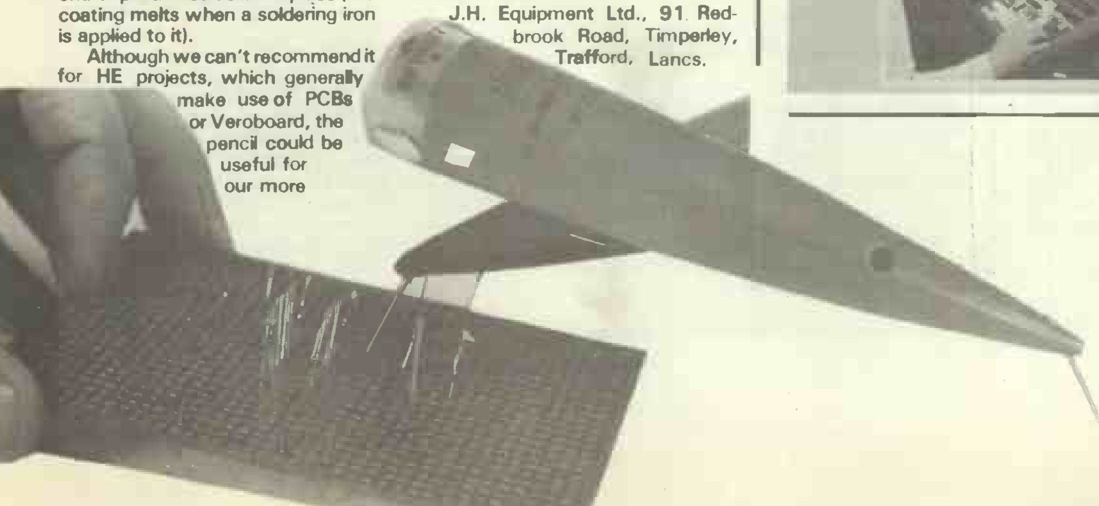
Although we can't recommend it for HE projects, which generally make use of PCBs or Veroboard, the pencil could be useful for our more ambitious readers who may like to experiment with breadboards. Certainly, the wire gauge is much too fine and delicate for permanent hook-ups. (See this month's Building Site for guidance on the right choice of wire for the job.)

Main feature of the wiring pencil is its light weight: our sample was only 25g (0.88 oz) including the bobbin. Cost, including two bobbins of wire and instructions, is £5.

Another wiring tool available from the supplier, J.H. Equipment, Lancs., strips the coating from the wire before it is wrapped. Thus there is no need for soldering. John Hancock, managing director, described this as more of an industrial tool, costing £16.

Both tools are imported from Vector Electronic Co. Inc., California, USA. Hancock said that he hoped to offer a kit soon comprising the p-173 Wiring Pencil and some circuit boards.

J.H. Equipment Ltd., 91 Redbrook Road, Timperley, Trafford, Lancs.



New Catalogue From Heath

Heath Electronics (UK) has produced its winter 1980-81 catalogue which is filled, as usual, with a mouth-watering selection of electronic kits.

One new kit is the Heathkit Ultrasonic Minuteman II security alarm system. This enables property to be protected inside and outside. Up to three ultrasonic detectors can be used, together with indoor/outdoor loudspeakers, key operators, magnetic door controls and window foil or other closed-circuit detector devices. Master ultrasonic control/detector GD-1800E protects an area up to 300 sq. ft. and the kit costs £141. Accessories include 'slave' ultrasonic kits at £52 each, key operators (for doors, closed-circuit loops etc) at £24.50 each and an all-weather alarm ('sounds loud wail') at £23 each.

Another new kit is the GC-1720 digital wall clock, 5¼" high by 7⅛" wide by 1½" deep (133 by 181 by 38 mm). Accuracy is claimed to be +1 minute a year, and the clock is claimed to run for two years on one 1.5 V alkaline cell. Time is displayed on four 1" liquid-crystal displays in 12 or 24 hour format. The GC-1720 costs £43.70.

Four new electronic weather forecasting aids include the ID-1890, a microprocessor-based digital wind computer and clock/calendar. Wind direction is displayed on a 16-point compass dial, and speed can be converted and displayed in MPH, KPH or knots. It will even store 'gust information', in terms of wind speed, direction and the time at which the gust occurred. Definitely for the serious sailor, the ID-1890 kit costs £158 (£253 assembled).

Heath is also offering some more teach-yourself courses, and these include weather forecasting (£55), optoelectronics (£46.50) and programming in COBOL (£90).

Hobbyprint Erratum

It has come to our notice, this month, that Hobbyprint Y (December 1980) has the Minisynth Keyboard printed on it at 60% full size. If you remember, we had to reduce it in size to get it on the foil pattern page, but somebody forgot to enlarge it again for the Hobbyprint. Do not despair, the error is being rectified!

Hobby Electronics

Look for the April issue. You can't afford to miss it!

Anatomy Of The Space-Shuttle

A special HE report on the forthcoming NASA Space-Shuttle launch. We investigate what the technical problems have been, why it's overdue, and give you a timetable running up to the launch and beyond

Tremolo

Just the effect you want for your guitar to complement the Fuzzbox in the March issue,although it will work with any electronic musical instrument. Simple-to-build, even simpler-to-use yet it won't burn a hole in your pocket

Russian Roulette

A novelty game designed to eliminate the players — without any mess whatsoever

---- STOP PRESS ---- STOP PRESS---- STOP PRESS ---- STOP PRESS ----

- COMPETITION - STOP - NEXT MONTH'S ISSUE OF HOBBY ELECTRONICS - STOP - PROMOTING THE UNITED NATION'S INTERNATIONAL YEAR OF THE HANDICAPPED PERSON - STOP - QUERY - DO YOU THINK YOU CAN DESIGN AN ELECTRONIC AID TO HELP A HANDICAPPED PERSON - STOP - ANY ELECTRONIC AID - SOLID-STATE, COMPUTER PROGRAM, EVEN VALVE - ANY ELECTRONIC AID - STOP - ANY HANDICAP - STOP - PRIZES TO WIN - STOP

---- STOP PRESS ---- STOP PRESS---- STOP PRESS ---- STOP PRESS ----

High Fidelity Comes To HE

Announcing a special audio project for HE: a hi-fi, high-power amplifier system which you can tailor according to your budget by making use of our special-offer kits. We start with the pre-amplifier in the April issue. This pre-amp requires *no wiring* except for the leads to the power supply! You can use it with your own amplifier too

Windscreen Washer Alarm

For the motorist who's fed up with cleaning his windscreen by hand because his washer bottle has run dry. As soon as the fluid drops below a predetermined level a 're-fill me' alarm is displayed

Plus:

News, views and info on CB, circuits, recent developments in electronics — everything for the electronics enthusiast and hobbyist — things you can't afford to miss. Get It!

Items mentioned here are those planned, but unforeseen circumstances may affect the actual contents.

Move Towards Microcassettes

You may have heard of microcassettes being used in dictating machines. Hugh Davies looks at how they could come to compete with compact cassettes in hi-fi recording

During the last year, a revolution in miniature has been taking place in the recording tape industry over the smallest audio cassette of all — the microcassette. From the results of development work in Japan on metal-powder tapes, microcassettes are to become available for high-quality (if not high-fidelity) recording.

To put this in perspective, a microcassette is only half the size of the popular compact cassette (the compact cassette is 100 by 64 by 12 mm compared with only 50 by 30 by 8 mm for the microcassette).

Microcassettes are not new: Matsushita and Olympus, working closely together, produced the first one in 1974. That's over six years ago, so why the revolution? The reason is that it is only in the last few months that the tapes have had any claim to high-quality reproduction. Standard ferro (iron-oxide) microcassettes are only suitable for speech or medium-quality audio reproduction, and for this reason their use has been restricted to hand-held recorders suitable for use as miniature dictating machines.

During 1980, some of the leading Japanese tape recorder manufacturers, principally Matsushita and Sony, showed that microcassettes, using special metal-coated tape, were capable of producing high-quality sound, approaching the performance of 'metal' compact cassettes. (Metal-coated tapes have a very high signal-to-noise ratio, and allow true hi-fi recording in cassette form.) Matsushita, for instance, has been working on its Angrom metal tape for microcassettes. The metal coating is evaporated onto a plastic base using what Peter Hamblin, Marketing Manager of Panasonic (part of Matsushita), described as 'a highly complex production process'. Playing time for this tape, he claimed, is 90 minutes/side at 2.4 cm/s (half the speed of a compact cassette), or 3 hours at 1.2 cm/s. (Most microcassette recorders offer both of these speeds.)

He said that a high-frequency (treble) response approaching 14 kHz was possible, although the problem of getting adequate low-frequency (bass) response had yet to be resolved.

The tapes look exciting, but what is there to play them on? The answer is very little — in the UK. It appears that because all the development work has taken place in Japan, all the really interesting machines are being held there for the time being. But that is not to say that the rest of the world has been left in suspense. It is understood that Sanyo demonstrated a mains-operated microcassette deck at the Hi-fi show in Dusseldorf, Germany as long ago as August 1980. Matsushita claims to have demonstrated a similar machine in the recent Tokyo exhibition. And Sony, which claims to hold 50% of the market for microcassette dictating machines, has also been active.

Microcassettes In the UK

Somehow, in the UK, we always seem to have to wait longer than everyone else for new ideas. It looks like being several months before high-quality or even hi-fi microcassettes and their recorders reach Britain. But meanwhile some of the currently-available minicassette 'hardware' using the standard tape is interesting in itself. Unlike compact cassettes, ferro and metal microcassettes can be played on the same machine *without any need for re-adjustment of recording bias*.

Microcassette recorders currently available in the UK are battery-powered and hand-held, and the playback quality of standard microcassettes is acceptable in such applications. Up till now, the machine market has obviously been dominated by Japanese manufacturers such as National Panasonic, Olympus, Sanyo, Sony and Sharp. But now the Dutch giant Philips has entered the market with two new recorders, with microcassettes compatible with the Japanese microcassettes to match. These products are due for release in March 1981. What is significant about this move is that it was Philips which produced the compact cassette back in the 60's, and it has ignored short-lived wonders such as 8-track and EL cassettes until microcassettes came along.

A Philips' spokesman told HE that: 'Phillips are not known to back losers' adding that the microcassette could take off as did its big brother the compact cassette.

Microcassette Construction

A microcassette is a truly scaled-down version of the compact cassette because, like the compact cassette, the tape is moved by a pinch wheel (a similar mechanism is used on open-reel recorders). Thus the tape moves at a constant speed as it is transferred from one reel to the other.

Another type of cassette, slightly larger than the microcassette, is the *minicassette*. This has been used mainly in dictating machines such as those in Philips' Pocket Memo range, but because the tape drive is indirect (the tape is moved by rotation of one of the cassette sprockets), tape speed is not constant over its length. This method of drive is known as 'rim drive'.

Comparison of microcassette and compact cassette

Microcassette (left) and minicassette

Philips' D6700 and D6710

The D6710 is a hand-held microcassette recorder 130 by 65 by 24.8 mm with a built-in electret microphone. We tested a sample D6710 at HE and found the microphone to be extremely sensitive. You didn't have to clutch the machine to your mouth (as was necessary with a sample 0085 Pocket Memo we tried) but could, under quiet conditions, leave it on the table to record a conversation. Sound output, specified as being 0.22 W maximum, was quite adequate too, considering that the recorder runs from only 3 VDC, supplied by two HP7-or AA-sized cells. It is claimed by Philips that the energy requirements, compared with an equivalent compact cassette machine, are cut by more than 50% — starting, presumably, with the need for only two cells. (Compact cassette recorders, providing loudspeaker output, usually need four or six cells.) Sockets are provided for external 3 VDC supply, earphone/line output and microphone/line input.

Two standard playing speeds (1.2 and 2.4 cm/s) can be selected, and other features include a 'silent' tape stop, a three-digit counter and an automatic recording level control.

Price for the D6710 is estimated by Philips to be £64.95. A similar model, the D6700, is due for release around the same time and is likely to be about £10 cheaper. It will have no automatic tape stop, no counter and will have a cheaper finish. These two machines will enable Philips to 'test the market' for microcassettes.

Sanyo M5850

One combined microcassette recorder and FM/AM radio released a few months ago is the M5850FG from Sanyo. Although the radio section is restricted to VHF (88 to 108 MHz) and MW (525 to 1605 kHz) and it may lack the sensitivity and sound output of a similar-sized radio receiver, the microcassette section has the same functions as Philips' D6710. It runs from 4.5 VDC, supplied by three HP7- or AA-sized cells. A 'beat 1 and 2' switch is included to allow the erase oscillator frequency to be shifted should it produce a heterodyne note with an incoming radio signal. Apart from having a press-button dial light, indicators are provided for battery/power and recording.

If the D6710 costs you about £65 then the M5850FG will cost you around £25 more for the radio facility.

Approximate weight (with batteries) of the M5850FG is 450 g (1 lb) compared with 280 g (10.25 oz) for the D6710.

What Is To Come

The above machines are examples of what is available for microcassettes at present, but what about the future? Japanese companies are working to perfect metal tape to meet hi-fi standards, and present progress looks encouraging. What we are likely to see from equipment manufacturers are more miniature radio receiver/microcassette combinations, with the strong possibility of stereo versions appearing later this year. It is also likely that microcassette equipment will become available for use in the car.

When Sony was asked about its plans for microcassette hardware, it said that it had nothing comparable with Sanyo's microcassette radio/recorder at present. Sony would prefer to include long-waves with the MW and VHF wavebands on any microcassette radio recorder it introduced to the UK market. It is likely to concentrate only on recorders for the next 12 months. A new range of 'budget to top-end' recorders is planned for the Spring and Summer.

Meanwhile, at HE, we'll keep an eye on the progress of microcassettes and we aim to produce a feature article in a few months time on the cassettes and the equipment available for playing them.

Philips D6710 microcassette recorder, Sanyo M 5850FG microcassette recorder/radio and Philips 0085 pocket memo. Microcassette and minicassette tapes are shown side-by-side in the foreground

HE

B

TTLs by TEXAS

		74290	150p	4020	100p
7400	11p	74293	150p	4021	110p
74S00	60p	74298	200p	4022	100p
7401	12p	74365	100p	4023	27p
7402	12p	74366	100p	4024	50p
7403	14p	74367	100p	4025	20p
7404	14p	74368	100p	4026	130p
7405	18p	74390	200p	4027	50p
7406	36p	74393	200p	4028	84p
7407	36p	74490	225p	4029	100p
7408	17p	**74LS SERIES**		4030	55p
7409	19p	74LS00	14p	4031	200p
7410	15p	74LS02	16p	4034	200p
7411	24p	74LS03	18p	4035	110p
7412	20p	74LS04	16p	4036	295p
7413	30p	74LS05	25p	4039	295p
7414	40p	74LS08	22p	4040	100p
74C14	90p	74LS09	21p	4041	80p
7416	27p	74LS10	20p	4042	80p
7417	27p	74LS11	40p	4043	90p
7420	17p	74LS13	40p	4044	90p
7421	40p	74LS14	50p	4046	110p
7422	22p	74LS20	20p	4047	100p
7423	34p	74LS21	40p	4048	55p
7425	30p	74LS27	38p	4049	45p
7426	40p	74LS30	20p	4050	45p
7427	34p	74LS32	27p	4051	80p
7428	36p	74LS37	30p	4052	80p
7430	17p	74LS38	38p	4053	80p
7432	30p	74LS42	70p	4054	150p
7433	40p	74LS47	75p	4055	125p
7437	35p	74LS51	24p	4056	135p
7438	35p	74LS55	30p	4059	600p
7440	17p	74LS73	30p	4060	115p
7441	70p	74LS74	27p	4063	120p
7442A	60p	74LS75	36p	4066	50p
7443	112p	74LS76	45p	4067	450p
7444	112p	74LS83	70p	4068	27p
7445	100p	74LS85	80p	4069	20p
7446A	93p	74LS86	40p	4070	30p
7447A	75p	74LS90	40p	4071	25p
7448	80p	74LS92	70p	4072	25p
7450	17p	74LS93	60p	4073	25p
7451	17p	74LS96	110p	4075	25p
7453	17p	74LS107	45p	4076	107p
7454	17p	74LS109	80p	4081	27p
7460	17p	74LS112	40p	4082	27p
7470	36p	74LS113	90p	4086	72p
7472	30p	74LS114	45p	4089	150p
7473	34p	74LS122	80p	4093	70p
7474	30p	74LS123	60p	4094	250p
7475	38p	74LS124	180p	4095	95p
7476	32p	74LS125	50p	4096	95p
7480	50p	74LS126	50p	4097	340p
7481	100p	74LS132	60p	4098	120p
7482	84p	74LS133	30p	4099	200p
7483a	90p	74LS136	55p	40100	220p
7484	100p	74LS138	65p	40101	132p
7485	110p	74LS139	75p	40102	180p
7486	34p	74LS145	120p	40103	180p
7489	210p	74LS147	220p	40104	99p
7490A	30p	74LS148	175p	40105	120p
7491	80p	74LS151	80p	40106	90p
7492A	46p	74LS153	50p	40107	60p
7493A	36p	74LS154	200p	40108	470p
7494	84p	74LS155	80p	40109	100p
7495A	70p	74LS156	80p	40110	300p
7496	65p	74LS157	60p	40114	250p
7497	180p	74LS158	60p	4502	120p
74100	130p	74LS160	90p	4503	70p
74107	34p	74LS161	75p	4507	55p
74109	55p	74LS162	140p	4508	290p
74116	200p	74LS163	100p	4510	99p
74118	130p	74LS164	90p	4511	120p
74119	210p	74LS165	140p	4512	80p
74120	110p	74LS166	180p	4514	250p
74121	34p	74LS173	110p	4515	300p
74122	48p	74LS174	100p	4516	110p
74123	60p	74LS175	100p	4518	100p
74125	75p	74LS181	320p	4520	100p
74126	60p	74LS190	100p	4521	250p
74128	75p	74LS191	100p	4526	108p
74132	75p	74LS192	100p	4527	150p
74136	75p	74LS193	100p	4528	100p
74137	50p	74LS195	140p	4532	140p
74141	50p	74LS196	120p	4534	550p
74142	200p	74LS197	90p	4536	375p
74145	90p	74LS221	120p	4538	120p
74147	190p	74LS240	175p	4543	180p
74148	150p	74LS241	175p	4553	320p
74150	130p	74LS242	170p	4556	72p
74151A	70p	74LS243	170p	4560	200p
74153	70p	74LS244	150p	4569	250p
74154	120p	74LS245	250p	4572	40p
74155	90p	74LS247	140p	4583	110p
74156	90p	74LS251	140p	4584	90p
74157	70p	74LS253	90p	4585	150p
74159	190p	74LS257	90p	4724	250p
74160	100p	74LS258	160p	40097	90p
74161	100p	74LS259	160p	14411	1100p
74162	100p	74LS266	100p	14412	1100p
74163	100p	74LS273	170p	14433	1100p
74164	120p	74LS279	90p	14500	700p
74165	130p	74LS283	90p	14599	290p
74166	120p	74LS298	160p	**INTERFACE ICs**	
74167	200p	74LS323	400p	AD536A	£13
74170	240p	74LS324	200p	AD561J	1400p
74172	450p	74LS348	200p	AD7524	600p
74173	120p	74LS365	48p	DM8123	175p
74174	90p	74LS367	70p	DM8131	375p
74175	85p	74LS368	100p	DP8304	450p
74176	90p	74LS373	150p	DS8835	250p
74177	90p	74LS374	150p	DS8836	150p
74178	160p	74LS375	120p	DS8838	225p
74180	93p	74LS377	160p	MC1488	75p
74181	160p	74LS378	140p	MC1489	75p
74182	90p	74LS390	120p	MC3446	300p
74184A	150p	74LS393	120p	25S10	350p
74185	150p	74LS399	250p	75107	160p
74186	500p	74LS445	140p	75110	325p
74188	325p	74LS670	400p	75150	175p
74190	120p	**4000 SERIES**		75154	175p
74191	120p	4000	15p	75182	230p
74192	100p	4001	22p	75322	300p
74193	100p	4002	20p	75324	375p
74194	120p	4006	95p	75361	300p
74195	95p	4007	27p	75363	400p
74196	95p	4008	80p	75365	200p
74197	80p	4009	40p	75451/2	72p
74198	150p	4010	50p	75491/2	70p
74199	150p	4011	20p	8T26	160p
74221	160p	4012	25p	8T28	250p
74251	140p	4013	50p	8T95	180p
74259	250p	4014	84p	8T97	160p
74278	290p	4015	84p	81LS95	120p
74279	110p	4016	45p	81LS96	120p
74283	140p	4017	70p	81LS97	120p
74284	360p	4018	89p	81LS98	140p
74285	360p	4019	45p	9602	220p

93 SERIES / 74S SERIES

93 SERIES		74S SERIES			
9301	160p	74S00	60p	74S114	120p
9302	175p	74S02	60p	74S124	300p
9308	316p	74S05	75p	74S132	160p
9310	275p	74S08	75p	74S133	75p
9311	275p	74S10	60p	74S138	225p
9312	160p	74S20	60p	74S139	225p
9314	165p	74S30	60p	74S157	250p
9316	225p	74S32	90p	74S174	250p
9321	225p	74S37	90p	74S175	320p
9322	150p	74S64	60p	74S194	350p
9334	360p	74S74	90p	74S241	450p
9368	250p	74S85	300p	74S260	70p
9370	300p	74S86	180p	74S373	500p
9374	200p	74S112	120p	74S374	500p

LINEAR ICs

AY1-0212	600p	LM13600	125p
AY1-1313	668p	MB3712	150p
AY1-1320	320p	MC1310P	150p
AY1-5050	140p	MC1458	48p
AY3-1270	840p	MC1495L	350p
AY3-8912	650p	MC1496	70p
AY5-1224A	240p	MC3340P	120p
AY5-1315	600p	MK50398	750p
AY5-1317A	775p	ML920	775p
AY5-4007D	520p	MM57160	620p
CA3019	80p	NE531	150p
CA3046	70p	NE555	20p
CA3048	225p	NE556	70p
CA3080E	72p	NE562B	425p
CA3086	48p	NE564	420p
CA3089E	225p	NE565	130p
CA3090AO	375p	NE566	155p
CA3130E	90p	NE567	140p
CA3140E	50p	NE571	425p
CA3160E	100p	NE5534A	250p
CA3161E	140p	RC4136	80p
CA3162E	450p	S566B	270p
CA3189E	300p	SAD1024A	1250p
CA3280	160p	SFF96364	1100p
DAC1408-8	200p	SL490	400p
FX209	750p	SN76477	180p
HA1388	260p	SP8515	750p
ICL7106	850p	TA7205	140p
ICL8038	300p	TAA621	275p
ICM7555	80p	TBA641B11	300p
LF13331	310p	TBA651	200p
LF351	48p	TBA800	90p
LF356P	95p	TBA810	100p
LM10C	425p	TBA820	90p
LM301A	27p	TBA950	300p
LM311	70p	TCA220	350p
LM318	200p	TCA940	175p
LM319	225p	TDA1004	300p
LM324	45p	TDA1008	320p
LM339	75p	TDA1010	225p
LM348	95p	TDA1022	570p
LM358P	50p	TDA1024	120p
LM377	175p	TDA1034B	250p
LM380	75p	TDA1170	300p
LM381AN	180p	TDA2002V	325p
LM386	95p	TDA2020	320p
LM393	100p	TL071/81	45p
LM709	36p	TL072/82	75p
LM710	50p	TL074	130p
LM725	350p	TL084	110p
LM733	100p	TL170	50p
LM741	18p	UAA170	175p
LM747	70p	UDN6118	320p
LM748	35p	UDN6184	320p
LM2917	250p	ULN2003	100p
LM3302	140p	XR2206	300p
LM3900	70p	ZN414	90p
LM3909	70p	ZN419C	225p
LM3911	130p	ZN424E	135p
LM3914	225p	ZN425E	400p
LM3915	225p	ZN427E	750p
		ZN1034	200p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p	78HGKC	600p
LM317T	200p	78HO5KC	550p
LM323K	500p	78MGT2C	135p
LM723	37p	79HGKC	600p
		TL497	300p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	90p	ORP61	120p
ORP12	120p	TIL78	55p
OPTO-ISOLATORS			
ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL116	90p
LEDS			
0.125		0.2"	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	25p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p		
		NSB5881	570p
		TIL311	600p
DISPLAYS		TIL312/3	110p
3015F	200p	TIL321/2	130p
DL704	140p	TIL330	140p
DL707 Red	140p	7750/60	200p
FND357	120p	**DRIVERS**	
FND500	110p	9368	250p
FND507	110p	9370	300p
MAN3640	175p	UDN6118	320p
MAN4640	200p	UDN6184	320p

TRANSISTORS

AC126	25p	BFR40	25p	TIP30A	48p	2N3055	48p
AC127/8	20p	BFR41	25p	TIP30C	60p	2N3442	140p
AC176	25p	BFR79	25p	TIP31A	58p	2N3553	240p
AC187/8	25p	BFR80	25p	TIP31C	62p	2N3565	30p
AF116	50p	BFR81	25p	TIP32A	68p	2N3584	250p
AD149	70p	BFX29	40p	TIP32C	82p	2N3643/4	48p
AD161/2	45p	BFX30	34p	TIP33A	90p	2N3702/3	12p
AU107	200p	BFX84/5	40p	TIP33C	114p	2N3704/5	12p
BC107/8	11p	BFX86/7	30p	TIP34A	115p	2N3706/7	12p
BC109	11p	BFX88	30p	TIP34C	160p	2N3708/9	12p
BC117	20p	BFW10	90p	TIP35A	225p	2N3773	300p
BC147/8	9p	BFY50	30p	TIP35C	290p	2N3819	25p
BC149	10p	BFY51/2	30p	TIP36A	270p	2N3820	50p
BC157/8	10p	BFY56	33p	TIP36C	340p	2N3823	70p
BC159	11p	BFY90	90p	TIP41A	65p	2N3866	90p
BC169C	12p	BRY39	45p	TIP41C	78p	2N3902	700p
BC172	12p	BSX19/20	20p	TIP42A	70p	2N3903/4	18p
BC177/8	17p	BU104	225p	TIP42C	82p	2N3905/6	20p
BC179	18p	BU105	190p	TIP54	160p	2N4037	65p
BC182/3	10p	BU108	250p	TIP120	120p	2N4058/9	12p
BC184	11p	BU109	225p	TIP122	130p	2N4060	12p
BC187	30p	BU126	150p	TIP142	130p	2N4061/2	18p
BC212/3	11p	BU180A	120p	TIP147	130p	2N4123/4	27p
BC214	12p	BU205	200p	TIP2955	78p	2N4125/6	27p
BC237	15p	BU208	200p	TIP4055	70p	2N4401/3	27p
BC327	16p	BU406	145p	TIS43	45p	2N4427	90p
BC337	16p	E300	50p	TIS93	30p	2N4871	60p
BC338	16p	E308	50p	ZTX108	12p	2N5087	27p
BC461	36p	E310	50p	ZTX300	13p	2N5089	27p
BC477/8	30p	MJ2501	225p	ZTX500	15p	2N5172	27p
BC516/7	40p	MJ2955	90p	ZTX502	18p	2N5179	90p
BC547B	16p	MJ3001	225p	ZTX504	30p	2N5191	90p
BC548C	9p	MJE340	50p	2N457A	250p	2N5194	90p
BC549C	18p	MJE2955	100p	2N696	35p	2N5245	40p
BC557B	16p	MJE3055	70p	2N697	25p	2N5296	55p
BC559C	18p	MPF102	45p	2N698	45p	2N5401	50p
BCY70	18p	MPF103/4	40p	2N706A	30p	2N5457/8	40p
BCY71/2	22p	MPF105/6	40p	2N708	30p	2N5459	40p
BD131/2	50p	MPS6531	50p	2N918	45p	2N5460	60p
BD135/6	54p	MPS6534	50p	2N930	18p	2N5485	44p
BD139	56p	MPSA06	30p	2N1131/2	36p	2N5875	250p
BD140	60p	MPSA12	50p	2N1613	25p	2N6027	48p
BD189	60p	MPSA13	50p	2N1711	25p	2N6041	160p
BD232	95p	MPSA20	50p	2N2102	70p	2N6044	160p
BD233	75p	MPSA42	50p	2N2160	350p	2N6052	300p
BD235	85p	MPSA43	50p	2N2219A	30p	2N6059	325p
BD241	70p	MPSA56	32p	2N2222A	30p	2N6107	65p
BD242	70p	MPSA70	50p	2N2369A	25p	2N6247	190p
BDY56	200p	MPSU06	63p	2N2484	30p	2N6254	130p
BF200	32p	MPSU07	60p	2N2646	45p	2N6290	65p
BF244B	35p	MPSU45	90p	2N2904/5	30p	2N6292	65p
BF256B	70p	MPSU65	78p	2N2906A	30p	2SC1172	150p
BF257/8	32p	OC28	130p	2N2907A	30p	3N128	120p
BF259	36p	OC35	130p	2N2926	9p	3N140	120p
BFR39	25p	TIP29A	40p	2N3053	30p	3N141	110p
		TIP29C	55p	2N3054	65p	3N201	110p

3N204	120p
40290	250p
40360	40p
40361/2	75p
40364	120p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40841	90p
40871/2	100p

DIODES

BY127	12p
BYX36-300	20p
OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

HEAT SINKS

For TO220 Voltage Regs and Transistors	22p
For TO5	12p

BRIDGE RECTIFIERS

1A	50V	19p
1A	100V	20p
1A	400V	25p
1A	600V	30p
2A	50V	30p
2A	100V	35p
2A	400V	45p
3A	200V	60p
3A	600V	72p
4A	100V	95p
4A	400V	100p
6A	50V	80p
6A	100V	100p
6A	400V	120p
10A	400V	200p
25A	400V	400p

ZENERS

2.7V-33V

400mW	9p
1W	15p

TRIACS PLASTIC

3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

1A 50V	70p
1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
BT106	110p
C106D	45p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	140p
2N5060	34p
2N5064	40p

LOUDSPEAKERS

Size		
2¼"	64R	80p
2¾"	8R	80p
2"	8R	90p
1½"	8R	100p

MODULATORS

6MHz UHF	375p
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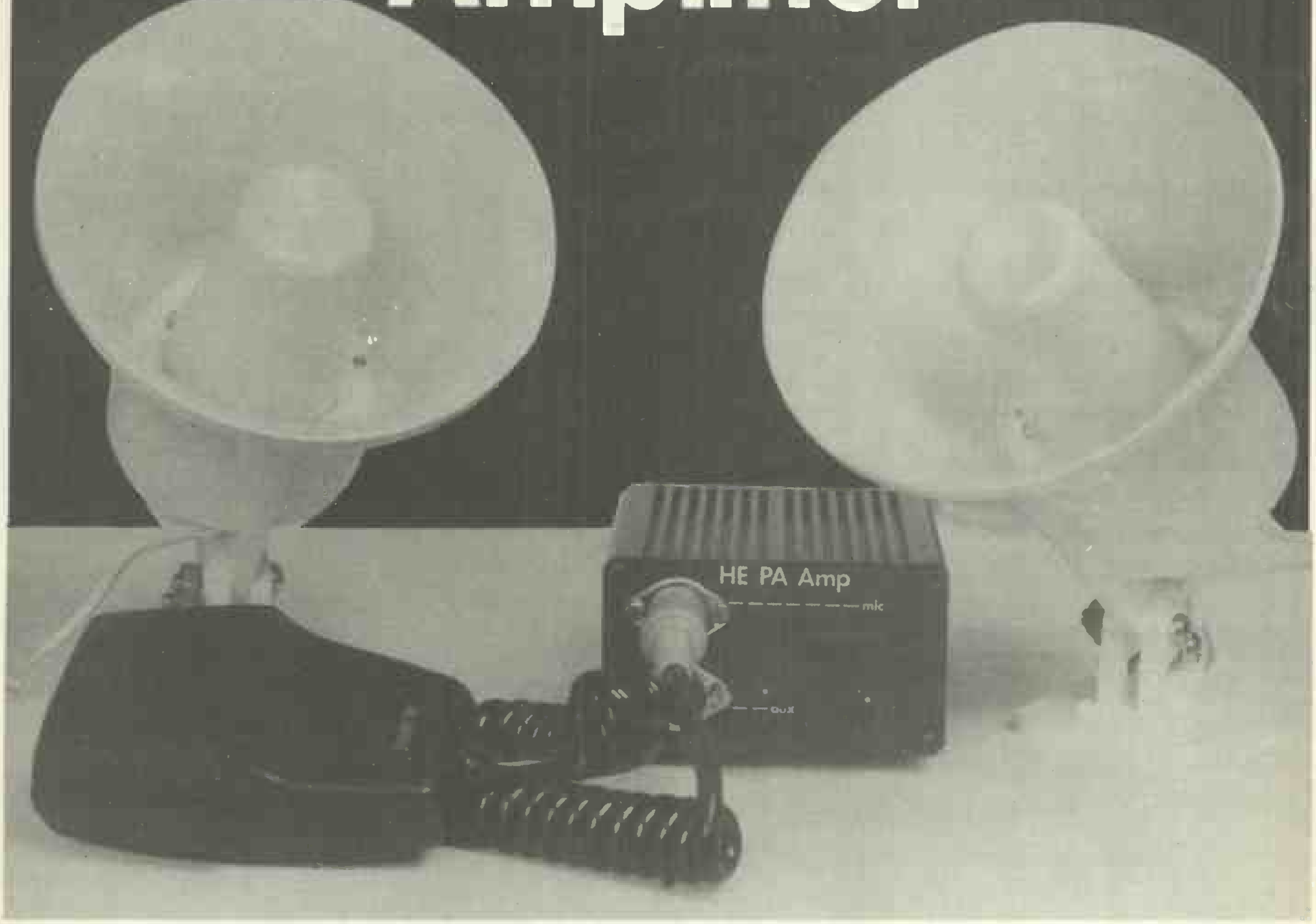
Public Address Amplifier



Make yourself heard above the crowd with this high-power, battery-operated, low-cost amplifier — ideal for any public gathering. A kit is available at a special-offer price

SPRING IS THE TIME of year when fêtes, fairs, garden parties and other outside gatherings start to be organised, so we reckoned that now was the time to launch this project to help defeat the problem of trying to address *every* member of a large crowd. You won't have to shout your voice hoarse anymore once you've built the HE Public Address Amplifier because with suitable horn speakers and a microphone (see Buylines for a suggested source) your voice will be lifted above the merry throng to an almost ear-piercing level.

A simple circuit provides 18 watts RMS into 4R-impedance speakers, the supply being a standard 12 V car battery. Power also can be taken directly from a nearby car's electrical circuit, say by plugging into the lighter socket. Alternatively a 240 V operated 12 V power supply can be used if you have access to mains.

There are two inputs — for a microphone and an auxiliary line — each with an individual volume control to allow mixing of voice with, say, background music or a guitar or other instrument.

Based around an IC, the HA1388, the whole circuit is constructed neatly on Veroboard which can then be built into a 100 mm Sink Box. Way back in July 1980 you may remember that we used both the HA1388 and the Sink Box in our popular Car Booster amplifier. The IC provides a high-power audio output, with a low-voltage power supply and the box provides a rugged housing — both are ideal for car or mobile use.

Construction

Take extreme care when building up your project. We show details for Veroboard but there is nothing to stop you designing your own PCB if you want a smaller board: just remember that parts of the circuit require large amounts of current so keep the tracks wide. If you use Veroboard make all track breaks first in the usual way and then solder in the links.

Insert and solder all components, resistors first, followed by capacitors and finally semiconductors, leaving IC1 till last. **Figure 1** shows the insertion details of IC1. Unusually, it is

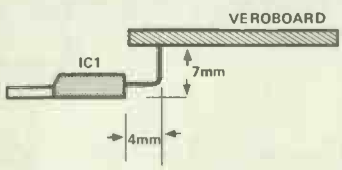


Figure 1. Correct mounting procedure for IC1, below the board.

mounted *underneath* the board and needs to be the correct distance from it, as shown. This positions the IC in the correct place for bolting it onto the underneath of the case so that the metal surface of the Sink Box can act as a heatsink and dissipate the large amount of heat which the IC generates at full output. You must take care when mounting the chip on board to ensure you don't damage it. That finishes construction of the Veroboard itself, although if you wish you can use connecting pins to help when making the off-board connections.

Next comes the job of fixing the board into the case. The box is all metal of course, and so the underneath of the Veroboard needs to be insulated from it, by glueing two small strips of paxolin or plastic to the case bottom. Also, two similar pieces can be glued to the sides thus providing a guide rail for the board to slide into. Two bolt holes should be drilled to enable the IC to be fastened down. No insulation measures need to be taken here as the metal plate on the back of the IC is internally connected to 0 V, thus the whole box will be at this potential. (This is a point you should bear in mind if your vehicle is of the positive-earth type. If so, insulate the box from the car chassis rather than the IC from the box).

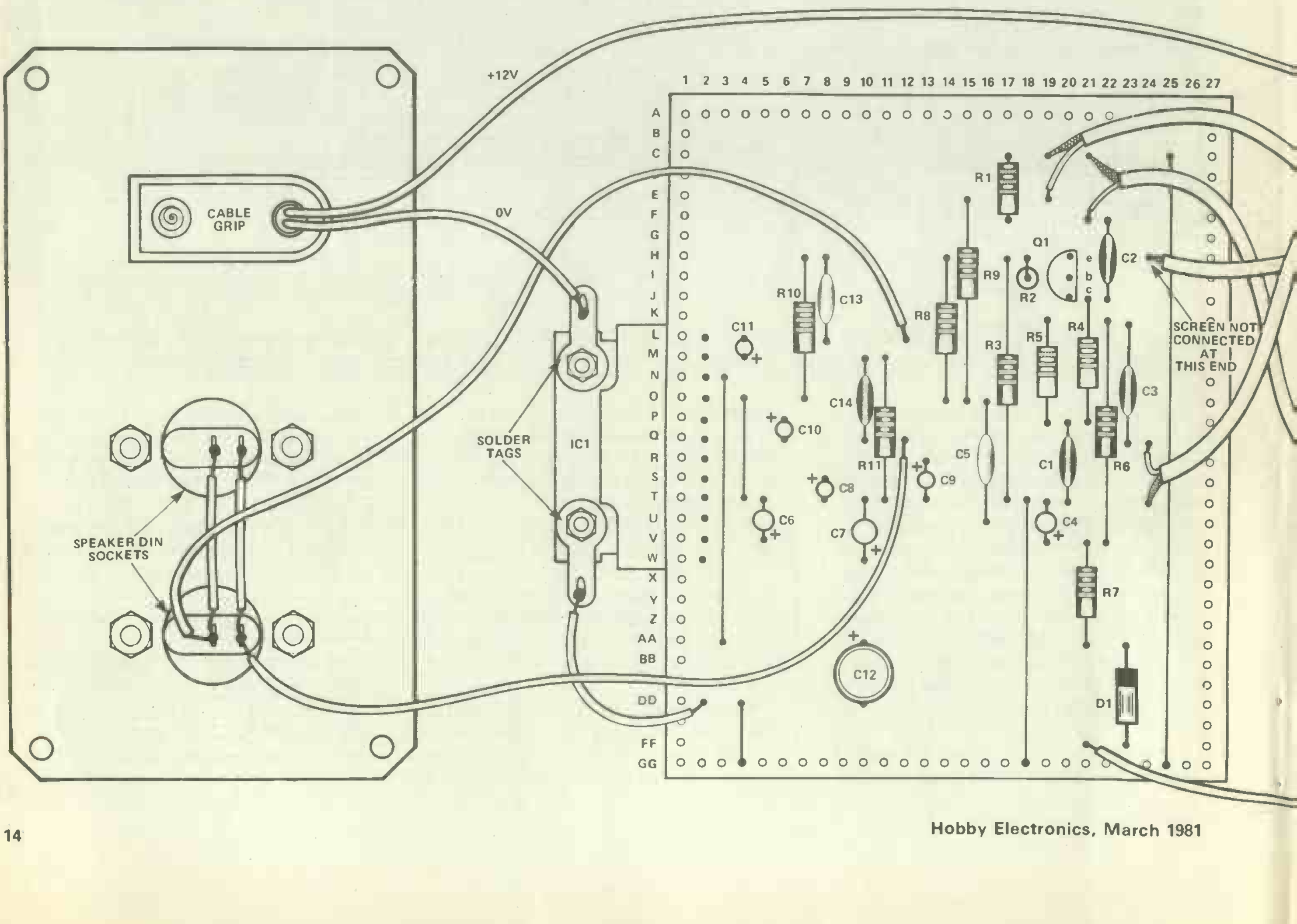
Mark and drill the two end panels for input and output sockets, potentiometers and power cable and then fit all controls and sockets ready for final wiring-up. Carefully follow the details in **Fig.2** and solder all connections. Note that screened cable should be used at the input.

Parts List

RESISTORS (All ¼W, 5%)

R1,5	100k	
R2,6,8,9	47k	
R3,7	4k7	
R4	220k	
R10,11	2R2	
POTENTIOMETERS		
RV1	100k logarithmic with single-pole, single-throw switch	
RV2	100k logarithmic potentiometer	
CAPACITORS		
C1,2,13,14	100n polyester	
C3,5	220n polyester	
C4	10u, 16 V	
C6,9	100u, 6 V	All printed
C7	100u, 16 V	circuit
C10,11	100u, 10 V	mounting
C8	47u, 6 V	electrolytics
C12	2200u, 16 V	
SEMICONDUCTORS		
IC1	HA1388, power amplifier	
Q1	BC184 NPN transistor	
D1	1N5401, 3 A diode	

MISCELLANEOUS
Case to suit (see Buylines)
Knobs
2 x 5-pin, 180° DIN sockets
2 x speaker DIN sockets
Cable grip, in-line fuse holder + 3 A fuse
27 hole x 33 strip 0.1" Veroboard
Microphone and speakers to suit (see Buylines)



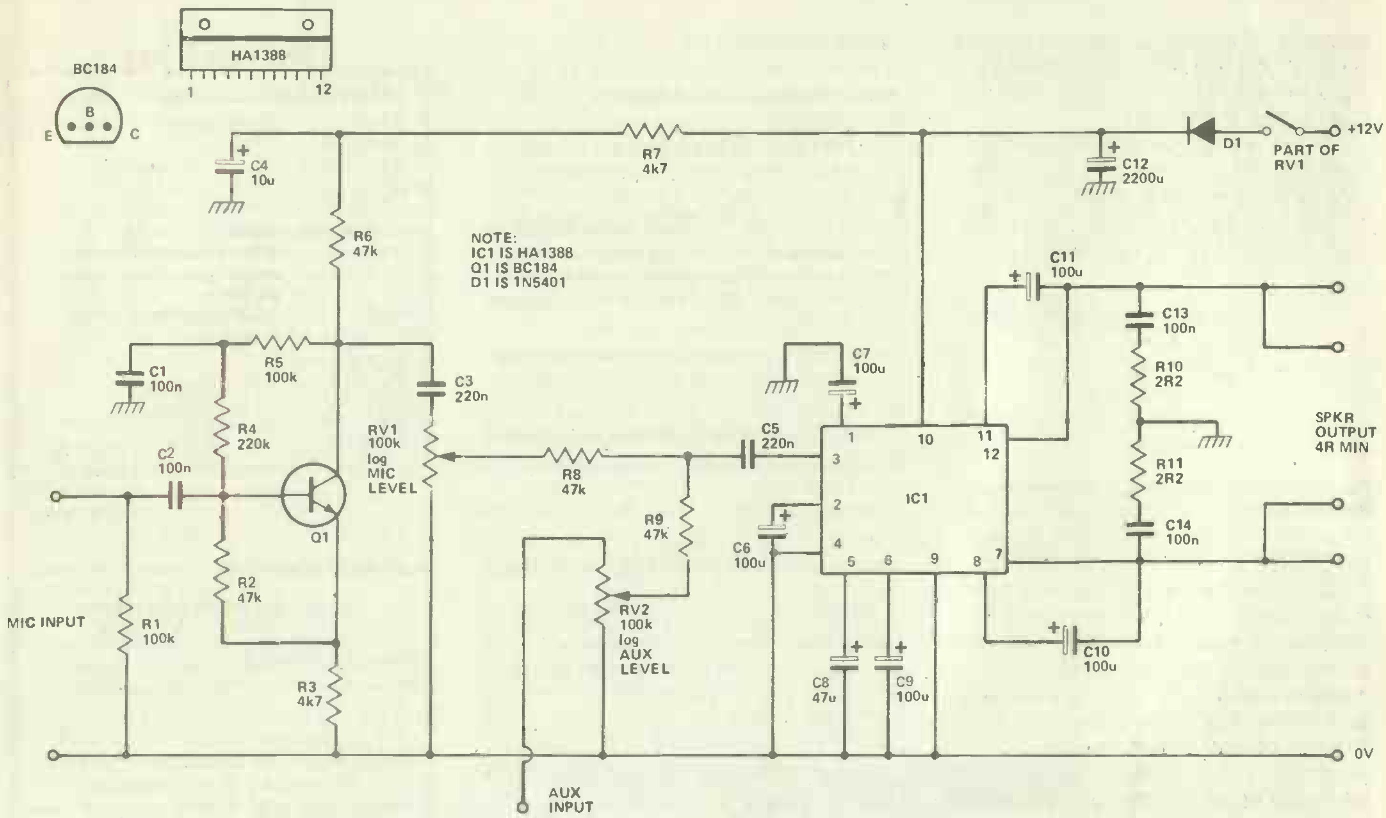
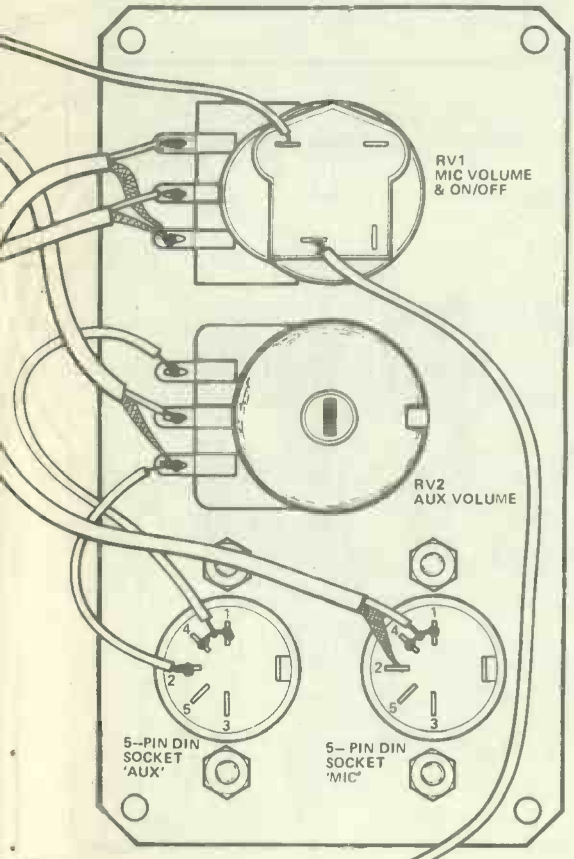
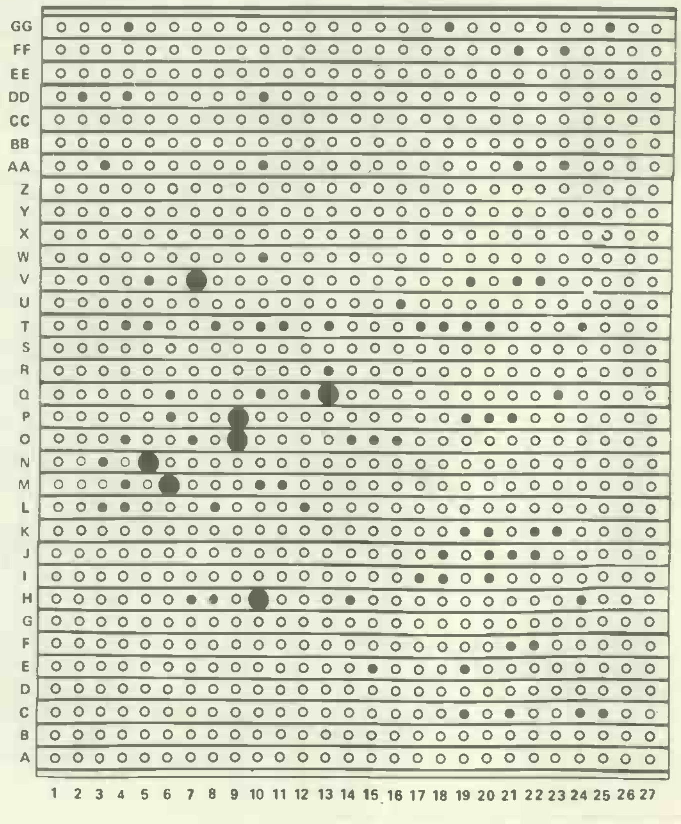


Figure 3. Circuit diagram of the HE PA Amplifier

Figure 2 (below). Veroboard layout, connection details and underside board view showing track breaks and component locations. Note the two solder tags which bolt to IC1's body





Note also that fairly heavy-gauge cable is necessary for the power and output connection because a lot of current will be flowing through them at times. Use of fine-gauge wire will result in loss of power and possible audible instability. Use sleeving, if you have any, to cover all soldered connections thus helping to prevent short circuits.

Finally make sure you connect an in-line fuseholder with a 3 A slow-blow fuse in the power lead, then if things *do* go wrong with all this current flowing around, damage to the circuit can be avoided.

How It Works

Integrated circuit IC1, the HA1388 is a high-gain, high-output power amplifier which requires a low-voltage power supply of 8 to 18 VDC maximum to operate. Maximum output power is 18 watts RMS at 13.2 VDC, this being the approximate voltage present in a car electrical system. The IC will drive a speaker/speaker system of 4R minimum impedance with full power output.

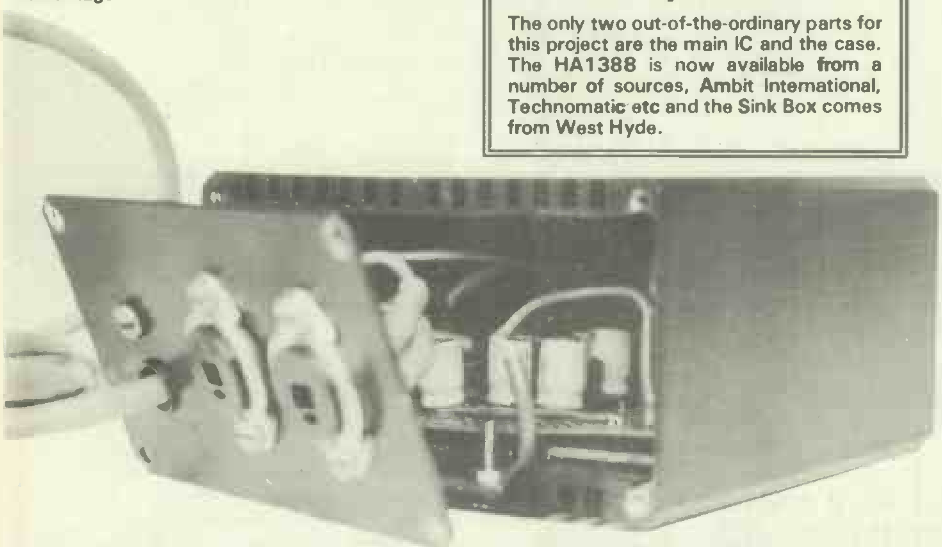
Sensitivity of the amplifier is exceptionally good, only a few mV at its input terminal (pin 3) being required to drive the output to full power. It also has a reasonably high input impedance which enables it to be driven directly from most signal sources.

The signal from a microphone is amplified by Q1 and associated components R1 to 7, C1 to 4, by a factor of 10 so it is about the same amplitude as the line input signal (auxiliary) from say, a cassette player or even an electric guitar. Both input signals are then mixed by RV1 and RV2 and applied to the main amplifier IC.

Diode D1 is in circuit to ensure that no damage will occur if power is inadvertently connected in reverse and capacitor C12 helps to smooth out the many voltage fluctuations which often are inherent in mobile applications.

HE

From this photograph of the back of the Sink Box you can see how IC1 is bolted to the bottom of the case. This provides both excellent heatsinking and a good earth point for the solder tags



Buylines

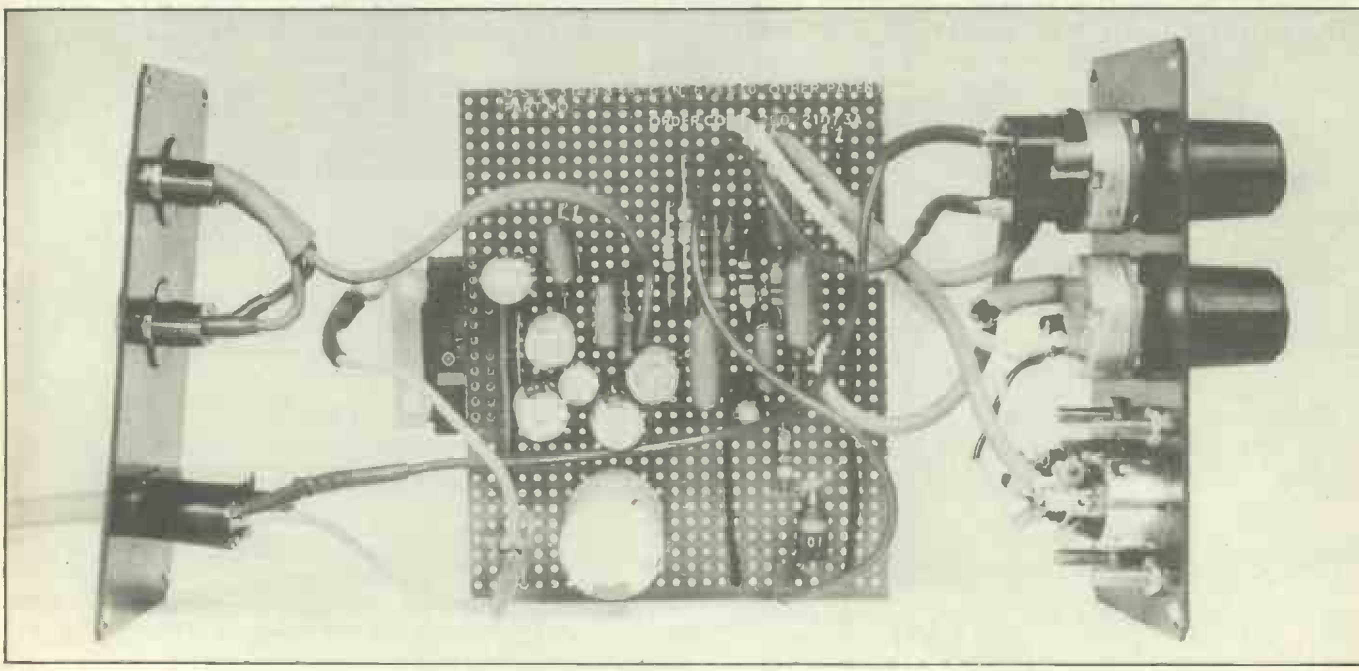
The only two out-of-the-ordinary parts for this project are the main IC and the case. The HA1388 is now available from a number of sources, Ambit International, Technomatic etc and the Sink Box comes from West Hyde.

Special Offer Kit

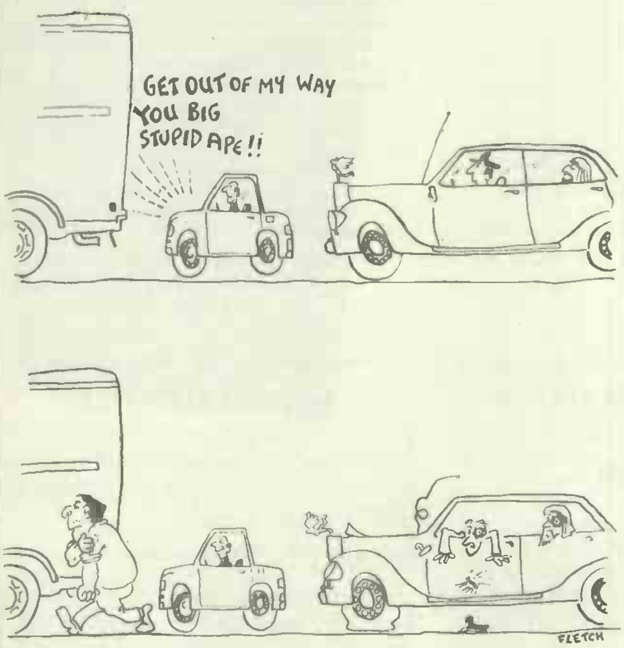
If you wish to buy all parts for the Public Address Amplifier together, Magenta Electronics will supply everything (case, Veroboard, pots, knobs, components etc.) down to the last nut and bolt, for the special offer price of £16.56 inc VAT. Please add p&p at a standard rate of 40p.

We also obtained our two rear-entrant horn speakers and the hand mike from Magenta. The speakers cost £6.83 each and the mike is priced at £4.40. Remember the 40p standard charge for p&p applies whatever the *total* cost of your order.

Below you can see the insides of the HE Public Address Amplifier. Keep the wiring as neat as you can and use sleeving at connection points



Example of HE Public Address Amplifier in use



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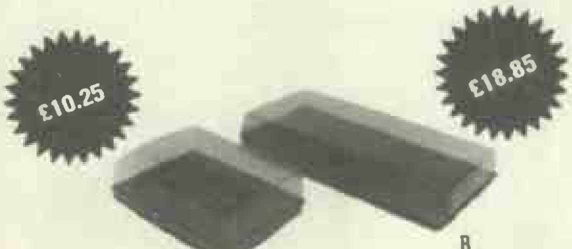

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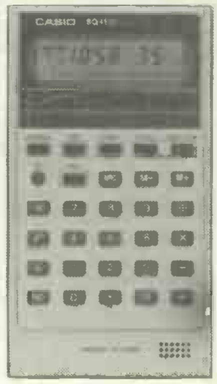

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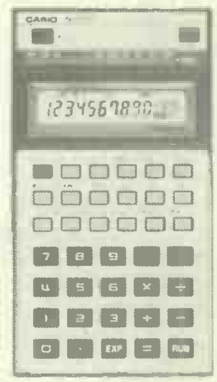

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The Beginnings of Real TV

Modem TV has origins dating back to the last century. Ian Sinclair traces some of the surprising milestones on the way

Try asking a number of people if they know who invented TV. If they come up with a name at all, it certainly won't be the name of any of the true pioneers of television as we know it today. Would you yourself recognise the names of Nipkow, Rosing or Campbell-Swinton? As we'll see, no one man invented TV but of all the contenders, Cambell-Swinton comes nearest to being the inventor of the system we know, even though the technology of the day was unable to permit him to demonstrate how correct his ideas were.

Let's look, then, at the long chain of events which shaped the TV system of today and the men whose efforts made it all possible. We could start with Berzelius in 1817, whose discovery of selenium introduced the first photoconductive element to us. Alternatively, we could choose Becquerel who investigated photovoltaic cells in 1839 and, incidentally, also discovered radioactivity. Probably the best start, though, is in 1873 with the first engineering advances, as distinct from purely scientific discoveries. In that year, the telegraph engineer, Willoughby Smith, published brief details of a remarkable discovery — that selenium was photoconductive. Selenium had been known since Berzelius' discovery of it in 1817, but it had not been put to any practical uses. Berzelius had noted that it conducted electricity, though very poorly: so that his discovery ranks as the first discovery of a semiconductor. Willoughby-Smith's interest was in using selenium to make high-resistance values for use in measuring instruments. His assistant had noticed that these instruments gave different readings as the light falling on them varied, and had gone on to discover that the resistance of selenium decreased when the material was exposed to light.

Selenium In Image Transmission

At this time, Graham Bell was working on the device which he was to announce in 1875 — the telephone. The two ideas prompted many inventors to put forward ideas for devices which would transmit images over telephone lines, facsimile transmission as we call it today. One scheme, devised by Carey in 1875 was for a large set of selenium cells linked to a corresponding set of electric lights by cables. It would probably have worked, but needed a large number of parallel lines, one for each cell. An alternative idea which he suggested used only a single wire for transmission, and included, for the first time, the principle of scanning the cells at the 'transmitter'. The scanning mechanism was clockwork, and though the transmitter could have worked, there was no way of synchronising the receiver so that it would correctly 'unscramble' the information coming over the wire.

Need For Scanning

A working model of a facsimile machine was demonstrated in 1881, by Selford Bidwell, to the Royal Institution in London. The transmitter used a single selenium cell, and the image was formed by a pinhole in one end of the box containing the selenium cell. The position of the pinhole could be varied by a set of cams, so scanning different parts of the image in turn over the selenium cell. At the receiver, a picture was re-constituted by electrochemical action using paper moistened with chemicals which changed colour when a current passed through them. It worked — but the synchronisation was purely mechanical — the receiver was connected by a revolving shaft to the transmitter. The

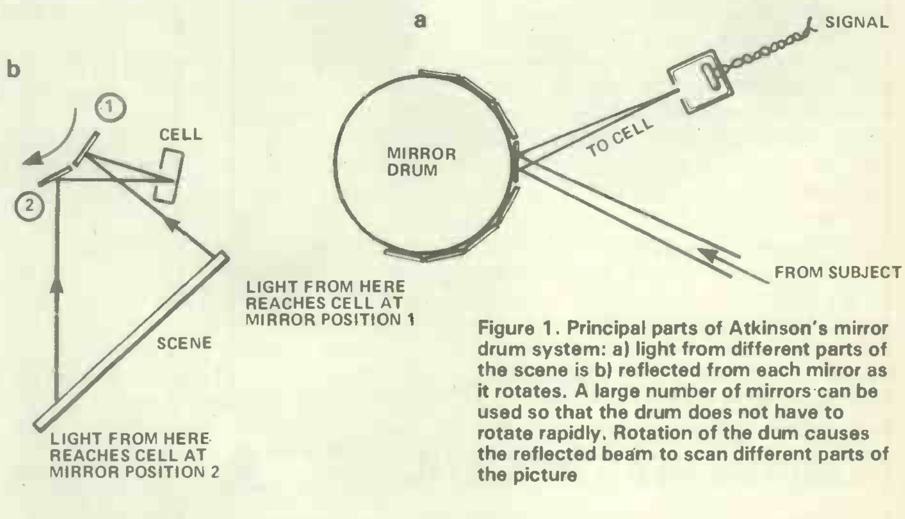


Figure 1. Principal parts of Atkinson's mirror drum system: a) light from different parts of the scene is b) reflected from each mirror as it rotates. A large number of mirrors can be used so that the drum does not have to rotate rapidly. Rotation of the dum causes the reflected beam to scan different parts of the picture

whole machine is in the Science Museum, which acquired it in 1908.

The need for scanning had been recognised, and by the mid-1880s, two important mechanical methods of scanning were well known. Atkinson's mirror drum (1882) used a set of flat mirrors mounted around the outside of a drum. As the drum was rotated, each mirror caused light from a reflected image to scan across a cell (Fig. 1). The Nipkow disc of 1884 used a wheel with holes drilled in it to provide both horizontal and vertical deflection at the same time (Fig.2), and his Patent of 1884 contained all the details of the apparatus which Baird would later use.

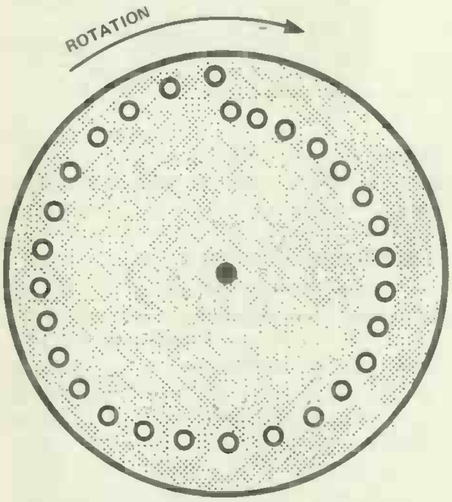


Figure 2. Nipkow disc, the scanning system used by most of the mechanical TV systems

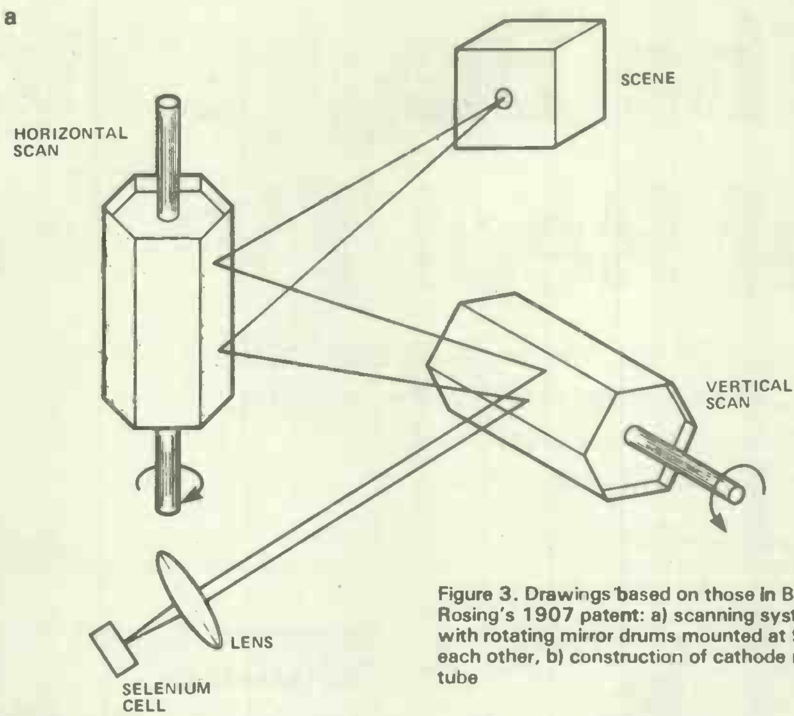
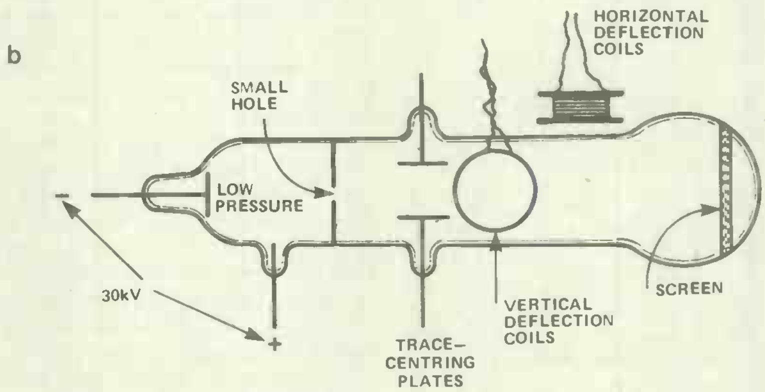


Figure 3. Drawings based on those in Boris Rosing's 1907 patent: a) scanning system with rotating mirror drums mounted at 90° to each other, b) construction of cathode ray tube



Beyond Selenium

The practical problem which prevented these pioneers from producing a 30-line TV picture in the 1880s was their use of selenium. Like so many photoconductive materials, selenium has a long time-constant, so that scan rates of more than a few bits (fragments of picture information) per second were impossible. For slow facsimile work, this was of little importance, but for the transmission of any sort of moving picture, the time-constants were impossibly long. For that reason alone, mechanical TV systems were developed no further at that time, and no new suggestions were put forward.

By 1897, the possibility of all-electronic TV came flickering onto the horizon. In that year, Karl Braun developed a workable cathode ray tube which contained most of the essentials of the tube of today. Although the electron beam was generated by passing current through a gas at low pressure rather than by thermionic emission, the deflection system and fluorescent screen were virtually the same as those we would recognise today. The possibilities which were opened up by this invention were immediately recognised by research physicists, who seized on the new device as a method of displaying alternating voltages. Engineers took a bit longer to see what might be achieved.

The first recorded suggestion that a cathode ray tube could be used for television seems to have come from Boris Rosing.

Rosing was a teacher with the St. Petersburg Technological Institute, and he wasted no time in applying for a British Patent for his invention. Rosings' TV system used mechanical scanning at the transmitter, by mirror drums mounted at 90° to each other (Fig.3a). One drum revolved fast to provide line scan, while the other revolved slowly to provide frame scan. The cathode ray tube (Fig.3b) was used at the receiver, with its deflection coils fed from generators. The scheme was unworkable because the signals from the transmitter were much too feeble to operate the receiver: no amplification was then possible.

Insight Into Modern TV

At about the same time, A. A. Campbell-Swinton, an engineering consultant, had become interested in television and had concluded that mechanical systems were too primitive. In a letter written to the journal Nature (which is still where you'll find the first reports of significant new

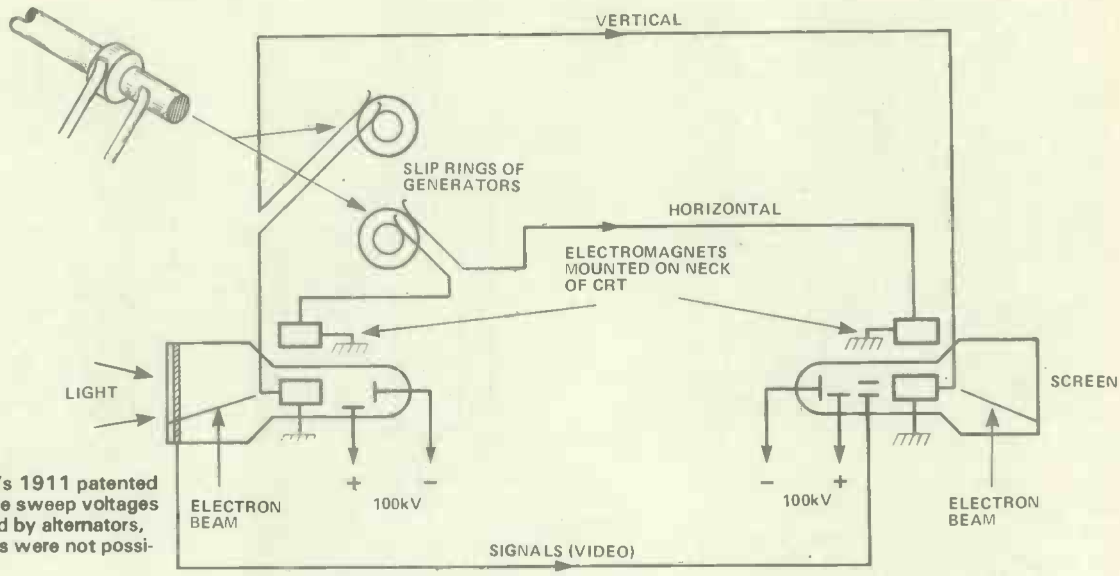


Figure 4. Campbell-Swinton's 1911 patented sketch in simplified form. The sweep voltages were to have been generated by alternators, because electronic oscillators were not possible at that time

discoveries) he described in outline all the details we would recognise as essential to all-electronic TV. An extract from the letter shows how far ahead his thinking was: '. . . employment of two beams of cathode rays (one at the transmitting and one at the receiving station) synchronously deflected by the varying fields of two electromagnets placed at right angles to one another and energised by two alternating electric currents of widely different frequencies, so that the moving extremities of the two beams are caused to sweep synchronously over the whole of the required surfaces within the one-tenth of a second necessary to take advantage of visual persistence. Indeed, so far as the receiving apparatus is concerned, the moving cathode beam has only to be arranged to impinge on a sufficiently sensitive fluorescent screen, and given suitable variations in its intensity to obtain the desired result. The real difficulties lie in devising an efficient transmitter . . .'.

It takes only slightly more modern wording to be used as an acceptable description of TV today, yet this was published in 1908. Campbell-Swinton recognised that there was much to do, but in 1911 he took out a patent, and also delivered a lecture to the Rontgen Society in which he gave more details about his proposal. Campbell-Swinton's patented sketch, in simplified form, is shown in Fig.4.

Need For Amplification

As it happened, one of the problems which made early TV experiments impractical was being solved — DeForest had developed his Audion, the first radio valve, and had shown that amplification of signals was possible. Though Campbell-Swinton was unable to build a working model at the time, Marconi constructed one in 1937 to Campbell-Swinton's original plans, and it was exhibited at the Science Museum.

The first World War put an end to television experiments as such, but had the side-effect of causing a rapid development of radio and in particular the use of amplifying valves. Amplification was no problem in the post-War era, and the ideas which Campbell-Swinton had so clearly stated were picked up once again. The brilliant engineer, Vladimir Zworykin, who had escaped from Russia to the USA, developed the use of cathode ray tubes for receivers, and also filed a patent for a camera tube which was later developed into the Iconoscope. Philo Farnsworth, working on more conventional lines, developed another type of camera tube which he called the Image Dissector. Every part of Campbell-Swinton's scheme could now be assembled — but electronic TV didn't appear.

Looking back, the reason must be the immense publicity which accompanied Baird's experiments. Using the mechanical system of Nipkow and Atkinson, Baird was able to produce crude pictures. Other experimenters, knowing the limitations of the mechanical system, dismissed these results but to the uninformed public, Baird had produced television and no-one else had. Work on electronic television suddenly became a secret operation, hindered rather than helped by secrecy, and with funds always in short supply as speculators preferred to put their money into something they could see working. Television today exists because of the far-sightedness of several large companies who refused to jump on the Baird bandwaggon and who recognised that Campbell-Swinton's scheme represented the only true TV system which could eventually be sold to the public. EMI and Marconi in the UK and RCA in the USA must share the credit for the remarkable developments which took place between 1923 and 1936. Because of the secrecy which surrounded the work of the two main teams who were developing electronic TV, it looks likely that neither was really aware of what the other was doing, but the basic scheme which had been laid down by Campbell-Swinton ensured that both were, in fact, working along very similar lines.

Need For An Electronic Camera

In the USA, the team at RCA was led by Vladimir Zworykin, and his interest in television had been aroused in a very direct way — he had been a pupil of Boris Rosing at St. Petersburg before his army service. After his escape to the USA in 1919, when so many army officers were being butchered for alleged lack of sympathy with the revolution, Zworykin joined the Westinghouse Research Laboratories. At Westinghouse, his research project was the construction of an electronic camera tube on the lines which had been proposed by

Campbell-Swinton, though Zworykin has said that at the time he was quite unaware of the work of Campbell-Swinton.

Zworykin realised that such a tube would have to incorporate the normal CRT electron gun and deflection coils, but in place of a fluorescent screen it would need to have a 'target' of photosensitive material. The method which Zworykin chose was a photoemissive layer, using a material which emits electrons when struck by light. This isn't the place to look closely at the way in which this tube worked, but briefly the idea was to use the light of an image to cause electrons to be emitted from a set of small insulated dots of photoemissive material. These electrons were then replaced as the beam from the electron gun scanned the target, and the current caused by the replacement of the electrons constituted the signal. Zworykin called this tube 'Iconoscope', and first attempted to take out a patent in 1923. At that time, however, a working model could not be constructed and the patent was not, in fact, granted until 1938. Zworykin had also put a considerable amount of work into the development of the receiver CRT, moving from a device which used both electrostatic and magnetic deflection (Fig.5) to one which in all but dimensions resembles the tube of today.

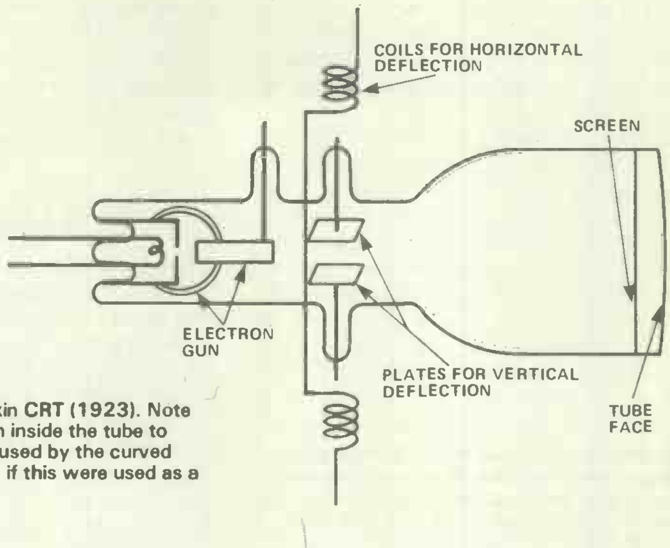


Figure 5. Early Zworykin CRT (1923). Note the use of a flat screen inside the tube to avoid the distortion caused by the curved outer face of the tube, if this were used as a screen

EMI . . . . . And The Choice Of Lines

In the UK the research and development effort centred round the newly-formed EMI group. This was a company formed by a merger of the Gramophone Company, Columbia Gramophone Company and a few other smaller companies, and this group had already achieved a mechanical system using 150 lines. At the time of the merger, Isaac Schoenberg, another Russian citizen who had studied at Kiev and had escaped to Britain (in 1915) was appointed as Director of Research. This was probably one of the best arrangements since Rolls met Royce, for Shoenberg had a remarkable ability for spotting engineering genius and for getting ideas put into practice. Two of his team have made their names many times over, A. D. Blumlein, who had the distinction of holding more patents in electronics circuitry than anyone before or since, and Dr. J. D. McGee, who is now Professor at Imperial College, and who then was concerned with the development of the Emitron camera tube.

When the EMI reseach team was originally formed, its first brief in 1931 was to improve the mechanical system, which was in fact done, first to 180 lines and then to 243 lines. By 1932, however, the engineers were convinced that the mechanical system had too many limitations to be considered seriously and the EMI team, like Zworykin's team at RCA started to concentrate exclusively on electronic methods. The Emitron camera tube was a considerably improved version of the original Iconoscope design, and the work which Blumlein did on such circuitry as timebases, synchronising pulses, video amplifiers and VHF circuits ensured rapid progress. It's worth remembering that *everything* was novel, there was no experience of such circuitry to draw on. In addition, the handicap of secrecy surrounded the project. There were several reasons for this. Shareholders of the company who had seen the mechanical system wondered why EMI did not put something on the market to counter Baird's efforts. Secondly, no-one was quite sure how far the US efforts had reached. Finally, there was a small but noisy group of left-wing MPs who opposed all forms of research which used money in times of hardship.

Fortunately, Schoenberg was able to persuade EMI's directors of the potential of his system. It's as well for us that he did, because the work of Blumlein on TV circuitry was the pioneering effort which enabled us to develop radar in such a remarkably short time. Incidentally, the development of the Merlin aero engine which was later to power the Spitfire was also carried out under strong opposition from left-wing MPs, and the project would probably have collapsed but for money donated by Lady Houston. Not surprisingly, the opposition collapsed when Germany invaded Russia!

By 1935, the EMI team had succeeded to a point where an awkward decision had to be made. They could either market a 240 line system there and then, or work on to develop a higher-definition system. Schoenberg took the brave step of deciding to go for a 405 line interlaced scan system, once again plunging into the unknown. It was a remarkably brave step, because the BBC had been broadcasting on the Baird System since 1929, and the longer EMI waited, the more difficult it would have been to overturn the established system.

Once again, Schoenberg's judgement was correct. A Parliamentary Committee had been set up in 1934 to consider the various TV systems which were available, and to decide if any could be made the basis for regular public-service broadcasting. The Baird transmissions were still experimental, and the BBC was entrusted with the job of putting out the EMI system signals as well.

Once again, EMI was stepping into the unknown. The Baird system, being low-definition and sequentially scanned (no interlace) needed a comparatively small bandwidth and could be broadcast on the short-wave band. The EMI system needed a much greater bandwidth, and had to be transmitted on VHF — a band which was little used. No-one had ever transmitted or received TV waveforms on these frequencies before, and no-one was quite certain whether it could be done or not. The transmitter side of the problem was handled by Marconi's Wireless Telegraph Company (as it was called then!).

The companies found themselves in a two-horse race. Baird's company was using three camera systems. One was a mechanically-scanned camera, using 240 lines with 25 frames per second. The second system used film as a method of televising scenes which the Baird camera could not tackle — which was most of them! The mechanical camera required the whole studio to be in darkness except for a brilliantly-lit subject, so that only face close-ups could really be televised live. The intermediate-film system was designed to patch up this immense handicap by filming the live scenes, developing and fixing the film in a time of one minute, and then using the film in a mechanical TV scanner, in which intense lighting could be used. Baird's third camera was an electronic one developed under licence from Philo Farnsworth but not sufficiently advanced to match the EMI equipment.

The tests started on 2nd November, 1936 at 3.30 PM — and there is a joke in EMI that the last joint was soldered at 3.29! Certainly, the EMI team was working frantically right up to the last moment to perfect their 405-line 50-field system which was immensely superior in quality to the pictures which the Baird system could offer. Each system was used for a week, alternating between the two.

Arrival Of Modern TV

There was little doubt about which system was superior, but in any case the Baird Company suffered a disaster — a fire at the Crystal Palace destroyed all the equipment, including the Farnsworth camera. The EMI-Marconi system was chosen at about the same time as Zworykin at RCA was announcing the 525-line system which is still used in the USA. Television as we know it had arrived.

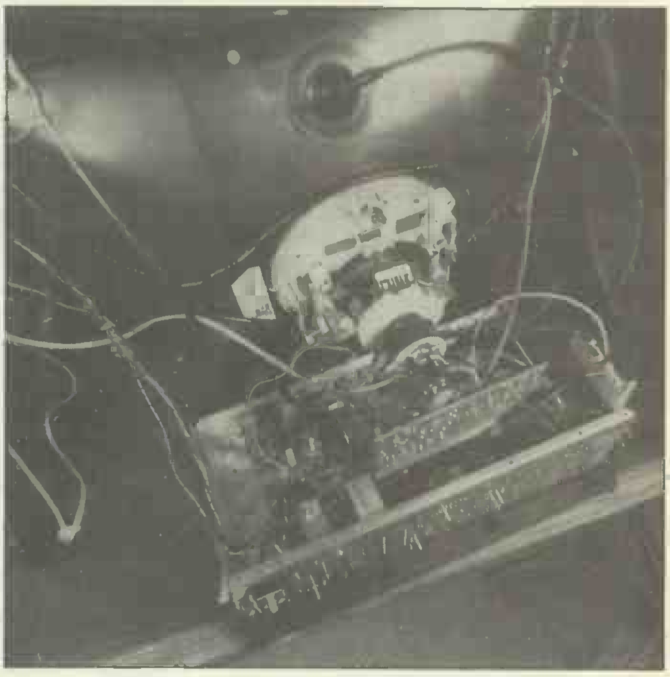
It hasn't exactly looked back. Schoenberg, always aiming to improve the system, had discussed with McGee the possibility of a greatly improved camera tube, the Super-Emitron. Once again, late working became the normal way of life in the Research Department and the Super-Emitron was ready for the Coronation broadcasts in 1937. This event provided so many 'firsts' for TV that there isn't room to list them. Every camera which could possibly be used was pressed into service and the result was an immense success. Despite the fact that there was only one transmitter, at Alexandra Palace, some 23,000 receivers were in use by 1939, and pictures were being received at distances which no-one had believed possible, from Clacton to Brighton.

Then it all ended. The Second World War shut down all work on TV in Europe, and most of it in the USA. The techniques which had been worked out in that breathless period in the 30s were turned to radar use. Tragically, A.D. Blumlein was killed when an aircraft, in which he was conducting radar trials, crashed.

After the war, TV in Britain shakily started again on 405 lines. It seems out of character that Schoenberg should not have insisted on going to a higher line standard then, but the 405 line system seemed adequate at the time, and we are, after all, only saying farewell to it now.

Who invented television, then? It's a complex story, but I'll put my money on Campbell-Swinton, whose scheme was the launching pad on which the EMI team assembled their rocket. Without his vision, we might well have had to import the whole of the technology from the USA.

View into back of Marconiphone TV receiver, model 702, 1938 (also shown at beginning of article). It has a 12" (300 mm) picture tube mounted vertically, which is viewed by means of a surface-silvered mirror mounted in the lid. This was common practice in early receivers, where the tube was too long to be housed horizontally. The tube had an EHT voltage of 5kV, was electromagnetically deflected but electrostatically focussed



Rear view of Ferguson colourstar TV, 1968. This was the first all-transistor colour TV in the world, and it uses a 25" (635 mm) Thorn-Mazda tube. It features modular construction: printed-wiring panels are removable for easier servicing. It was manufactured by Thorn Consumer Electronics in Enfield, Middlesex

Both receivers are on view in the Science Museum, London

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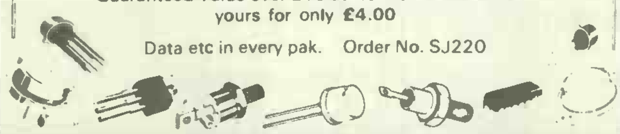

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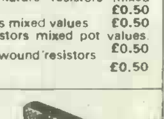

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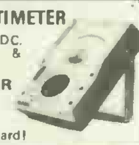

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Results of HE Electronic Games Competition

We're pleased to announce the results of the competition published in the January 1981 issue of HE. You will remember that first prize was the exciting new programmable TV game from Rowtron, with a selection of cartridges for good measure. Second prize was the hand-held Space Invader game from Entex. We offered one of the latest HE T-shirts to each of the 20 runners-up.

Now for the bad news. No, we haven't lost the entries (or the prizes!) but out of the 400-odd entries we received, only 17 (4.25%) got *all* the answers right! So there was no need for us to worry about using your suggested last line to our limerick in a 'tie-breaker'.

The Winners

1st Prize Anthony Clarke, Spondon, Derby
2nd Prize Jeff Jones, Risca, Gwent

Runners-up
Tufail A. Ansari, Southall, Middlesex
Derek Blamire, Llandudno, North Wales
R.W. Chandler, Adel, W. Yorks
P.C. Clift, Sharness, Gloucestershire
Andrew Donaldson, Harpenden, Herts
D.F. Downing, Ashford, Kent
G.U. Fenton, Falsgrave, Scarborough
T. Holt, Codsall, Staffs
Bruce C. Joslin, Henleaze, Bristol
M. Moore, Peterborough, Cambs
G.F.P Room, Corringham, Essex
John Sedgeman, Sherburn Rd. Est., Durham
E.L. Stock, Pontypridd, Mid Glamorgan
Stephen Walls, Stockton, Cleveland
David St. George, London

As you can see from the picture right, Sally Holley, HE's new Advertisement Representative, was chosen to draw the winning entries. The draw took place on Thursday 8 January, and we're glad to say that only two entries came in after the closing date of 1 January.

The Answers

Now, before the arguments start, printed below are the original questions together with the *correct* answers. As we said on the entry form, no correspondence regarding the competition will be entered into, AND the Editor's decision is final.

1) Which component is used as a 'White Noise' generator in the Chuffer project this month?
Q3 (Note that 'a BC182L transistor' or just 'a transistor' was not sufficient)

2) What is the maximum power rating of each channel in the Sound-To-Light project?
1.2kW

3) How many times is the word 'games' used in this month's feature on electronic games?
50

4) Who sells the cheapest BC 109 amongst the advertisers in this month's HE?
Watford Electronics (Note *BC109* not BC109A or other gain derivatives, nor bulk buys or assortments)

5) What is the maximum number of 'revs' that can be displayed on the HE Tachometer project?
7000

6) What is the impedance of the High-impedance Voltmeter that will be appearing in next month's HE?
In excess of 11 million ohms (also correct: over 11 million ohms, over 11 MΩ, or even $>11 \times 10^6 \Omega$)

The moment of truth: HE's Sally Holley takes the plunge for the 1st-prize winner

At last, after a few tries, out comes the winning entry

The Limerick

Most entrants had a go at the last line to this, and we must thank David St. George, one of the runners-up, for his observation: 'This is not a limerick! The last words of the 1st and 2nd lines should rhyme!'

This was confirmed by the Concise Oxford Dictionary, which states: 'Kind of humorous verse, esp. five-line form often epigrammatic or indecent, with rhymes *aabba*...'.

Well, ours wasn't indecent (nor did anybody supply an indecent ending) but it was in *abccb* form.

Enough of these technicalities: we'll simply present a selection of endings below and leave *you* to judge which are the best ... or the worst.

Right in the middle of Modmags
Clever Dick was opening his mail
As he opened one pack
It made a loud crack
....

(You'll notice that we've corrected the 'on pack' error in the original)

And now he reads "H.E." using brail
Dan Gillham, Guildford, Surrey

And out poped [!] a man from Mars
V. Stanley, Cambridge

It couldn't have been fitted with 'safe fail'
C.T. Hearne, Chalfont St Peter, Bucks

Now Modmags has something for sale
David Melvin, Sherborne, Dorset

And out fell "A PET" minus tail
Max York, Mundlesley, Norfolk

And his false teeth fell into a pail
D. Powell, Prescot, Lancs

And a voice said 'HE is now on sale'
J. Burns, Ewell, Surrey

That's a new kind of programming in brail
M. Souter, Sevenoaks Weald, Kent

And out popped Fletch with a wail
A. Woodward, Coppull, Lancs

And promptly blew off all his nails
S. O'Callaghan, Guildford, Surrey

He found a party grenad [!] from Iraq
Andrew Hodson, Kendal, Cumbria

And exploded with a siren-like wail
J. Madigan, Crick, Northampton

And his desk was awash with real ale
B. Fuller, Keighley, W. Yorks

Good Lord, its [!] short circuits, they're back!
Pete Hodges, Tyseley, Birmingham

IC said CD, and he shouted for joy,
A motto, a hat and a toy
Paul A. White, Cookridge, Leeds

'Twas a spaceship in graphic de-tail
N.N. Lindsey, Reading, Berks

Rolled over and said "Hows That!"
Nigel Schwarz, Temple Cloud, Nr Bristol

And he hosed himself down with Pale Ale
Robert Hannah, Feltham, Middlesex

And blew the Editor to rags!
P.W. Dix, Enfield, Middlesex

And out popped a little alien
Who was burnt and all black
Adrian Hallas, Midlothian, Scotland

Now his electronics are hung on a nail
Bobby Grindlay, West Calder, West Lothian

Went he as pale as a pail of pale ale!
Winston Harratt, Congleton, Cheshire

And shorted his 'Chuffer' to the rail
H. Edwards, Stockport, Cheshire

And out fell a crate of brown ale
David Shea, Old Windsor, Berks

An 'HE' project that didn't fail
D.F.Downing, Ashford, Kent

Perhaps we'll make it easier next time: see under Monitor this month for details of our next competition.

Building Site

What's important about wire? Keith Brindley advises you on the correct types to use in your projects

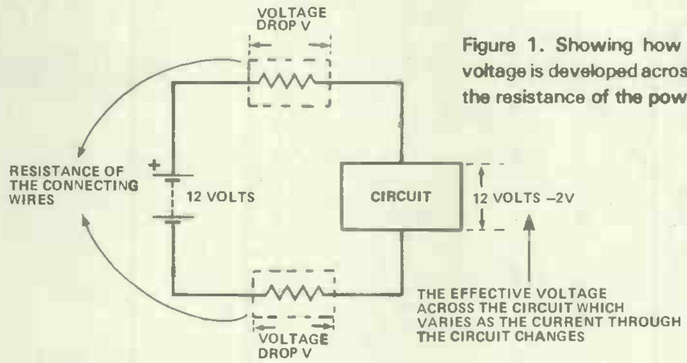

Figure 1. Showing how less than the original voltage is developed across the circuit because of the resistance of the power supply leads

IF YOU HAVE read the article on the HE Public Address Amplifier project this month then you will have come across the reference (page 13) to different types of wire (screened cable at the input and heavy gauge wire at the output and for the power supply connections). If you are an enquiring reader (and judging by the letters we receive, many of you are), then you may ask why we use one type of wire in one place and yet an entirely different type elsewhere. After all, surely the only *real* purpose of a piece of wire is to join parts of a circuit electrically, so that a low resistance exists between two points? So why are different varieties used? Well, I gave the clue when I said *low* resistance. You see, NO wire of any length can have zero resistance. A wire will always possess a finite resistance, however small, perhaps only a thousandth of an ohm (0.001R). Now, resorting to a bit of electronics theory, Ohm's Law states clearly the relationship between voltage, current and resistance, given by:

$$V = I \times R,$$

where V is the voltage, I the current and R the resistance. Putting a few numbers in this equation, say a length of wire has an overall resistance of 0.1R and the current through it is 5 A. The voltage between one end of the wire and the other will be:

$$V = 5 \times 0.1$$
$$= 0.5 \text{ volts } (0.5 \text{ V}).$$

Now, 5 A may seem to be a very large current and you could be forgiven for thinking that none of your projects would ever pass such an amount, but you would be wrong. Take the PA Amplifier for instance: although it probably draws an *average* current of only a few hundred milliamps (mA), during large-volume peaks the current *surges* can be around and over 5 A. So, with this project, it is possible that 0.5 V could be easily 'lost' along a length of cable having the above specifications.

A voltage on the connecting wire means that a voltage *drop* occurs between the two circuits connected by the wire and Fig. 1 shows this graphically. In this example, two leads are connected between a power supply and a circuit. Any voltage drop across one lead will be mirrored in the other, because they both have about the same resistance and not all the power available is passed onto the following circuit. The result is that not only does the voltage across the circuit vary with current flow, but the earth rail of the circuit (which should be at 0 V) changes in voltage: thus it is 'floating'. In an amplifier, particularly one producing more than a couple of watts output, a floating earth can result in instability and unwanted noises from the loudspeaker.

The only solution to the above problem is to use the correct thickness of wire for the job. Make sure you choose the wire by its current rating, such as 1 A, 2 A etc. **Figure 2** shows a selection of wires ranging from 0.5 A rating to 10 A rating.

The wire recommended for most HE projects is multi-strand wire, which is a collection of strands of the conducting material grouped together and covered with insulating material. The wire can be classified by the number of strands in the group and the thickness of each one (e.g. 10/0.1 — a group of ten strands, each 0.1 mm thick). However, another category is the single-strand type, which is, as its name suggests, one single length of wire. Inevitably, single-strand wire is more brittle than its multi-strand counterpart, so if you use it to wire up one of your projects, be warned that if any movement of a connection occurs, the wire might break. I would always advise you to use only multi-strand wire to wire-up a project. You should certainly *never* use single-strand for wiring to mains plugs.

So where *do* you use single-strand? There are three main places, each using a different variety or single-strand wire:

- on a breadboard (see **Fig. 3**) where connections are made from one socket to another. You shouldn't use multi-strand here because the thin strands tend to break off and get stuck inside the sockets
- as a link on a circuit board. Tinned copper, single-strand uninsulated wire is ideal and makes really neat links
- to make a coil. Certain circuits require an inductor and often these can be hand-made by winding a number of turns of single-strand wire on an insulated former. To prevent short-circuits between the turns, the wire needs to be insulated, and the standard procedure is to use coated wire which has a layer of polyurethane on it. Making the connections at the ends is easy: you can either scratch off the last ¼" or so of insulation with a sharp knife (watch your fingers) or, with a hot soldering iron, melt it off

Finally we come to screened leads, which are normally used at the inputs of high-gain amplifiers to help prevent interference. The main cause of the interference is *capacitive* pickup and Figs. 4 & 5 show the principle of its action and how to prevent it. In the examples shown, a high-gain amplifier is used to raise the output signal of a microphone to the level required to drive a loudspeaker. The two connec-

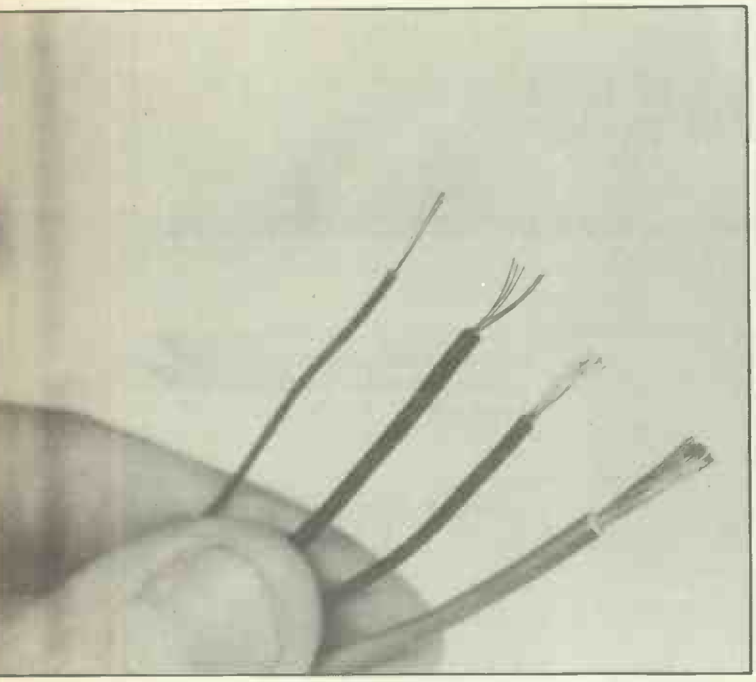

Figure 2. Examples of some different thicknesses of wire with current ratings of 0.5 A, 1 A, 2.5 A and 13 A

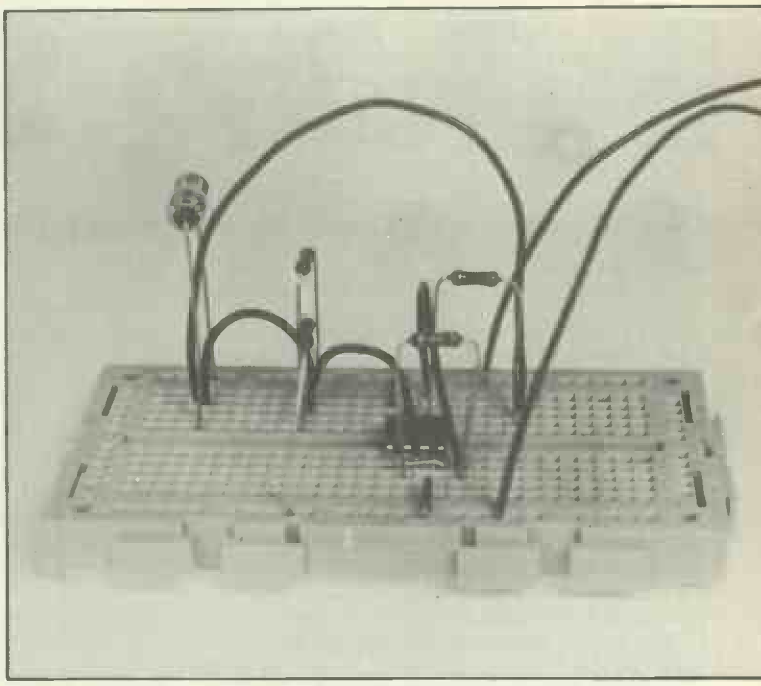

Figure 3. A breadboard circuit which use single strand wire for all connections

ting leads are separate pieces of wire. In an ideal world this simple circuit would work but, especially in electronics, the world is far from ideal. You see, any two wires *not* in electrical contact but lying close beside each other form a capacitor — usually represented by two conductive plates separated by an insulator. So between our two amplifier leads and also between the signal lead and the mains lead in **Fig. 4**, capacitances exist and are indicated by capacitor symbols. These two capacitors form a potential divider and a small part of the mains voltage is superimposed on the signal lead. The amplifier, as you would expect, amplifies this with the result that a 50 cycle-per-second (Hz) 'hum' is heard from the loudspeaker. This frequent problem is called 'mains hum'.

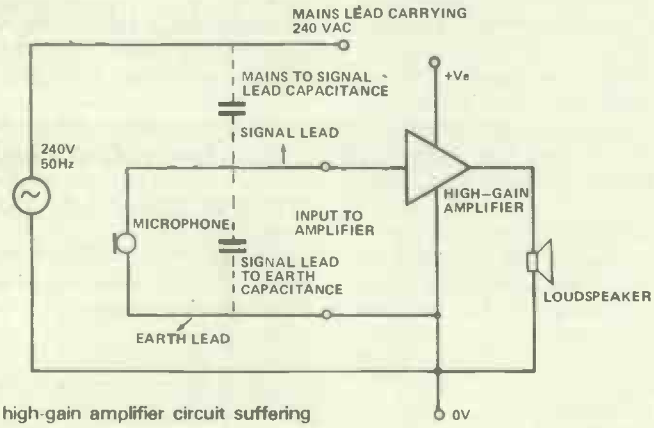

Figure 4. A high-gain amplifier circuit suffering from capacitive pickup

The earthed screen of screened cable effectively eliminates (or at least greatly reduces) the capacitance between the signal lead and mains lead because of the electrical barrier it places between the two. Thus very little superimposed mains voltage exists on the signal lead.

You might ask why we don't use screened cable everywhere, say for the speaker leads: surely they pick up interference too? Well, of course they do but remember it's just a tiny amount which won't be heard through the speaker. It's a different story at the amplifier output — any tiny amount picked up is *amplified* until it is large enough to be heard.

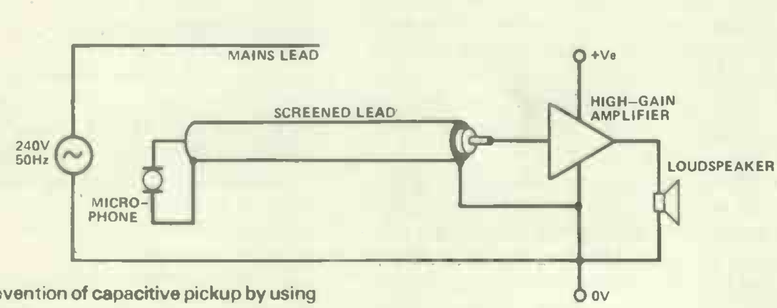

Figure 5. Prevention of capacitive pickup by using screened cable

Well, that about wraps it up for this month. We've seen most of the sorts of wire we're likely to meet in projects. The important thing is to use the right kind of wire at the right place; follow any guidance given in the text and you shouldn't go wrong

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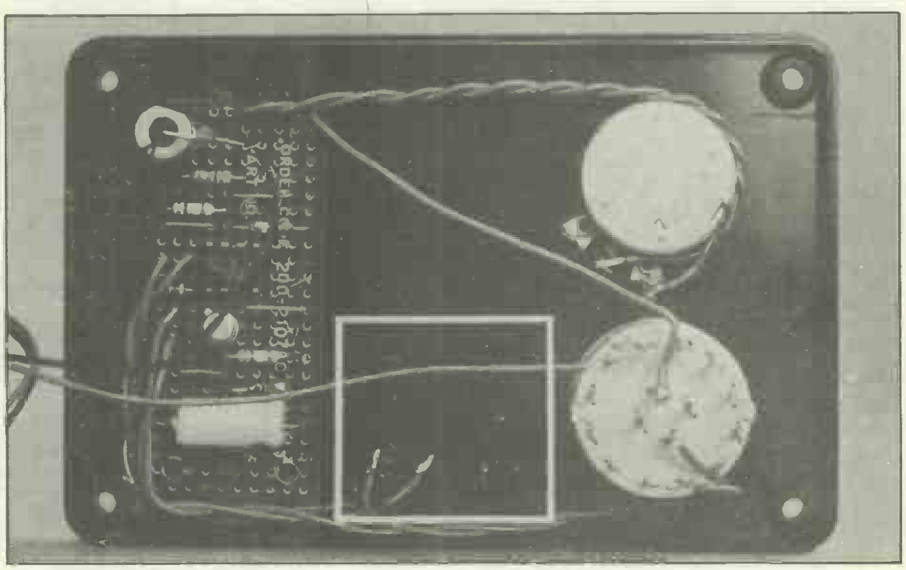


YES, ITS YET another design for a windscreen wiper controller, but in addition to giving single, intermittent wipes, this one can also be used to give several sweeps of the windscreen followed by a pause for a similar length of time. This second mode of operation can be very useful under certain conditions where single strokes of the wipers just tend to smear the screen, possibly even making things worse rather than better.

This circuit is suitable for use with 12 V positive- or negative-earth systems. The wipers are controlled by a pair of normally-open relay contacts which are wired across the ordinary wiper switch, and adding the wiper controller does not affect the operation of this switch. Continuous operation of the wipers can therefore be obtained by using the wiper switch in the usual way.

Construction

The component layout and wiring of the wiper controller are shown in Fig.2. As you can see, we have used one of our usual 10 by 24 hole pieces of 0.1" matrix Veroboards, and so the unit is constructed using the usual techniques.

The unit is small enough to fit into virtually any of the numerous plastic cases that are available these days. The relay is not mounted on the component panel, but is mounted on the case instead. Modern relays normally have plastic housings, and the most convenient way of mounting these is to simply glue them in place using a really strong adhesive such as an epoxy type.

How It Works

The circuit diagram of the wiper controller is given in Fig. 1, and the unit is based on an operational amplifier used in a simple oscillator circuit.

A popular type of oscillator is used, and with switch SW1 in the position shown there is a square wave output from the oscillator at pin 6 of the IC1. The circuit operates by first charging C2 from the output of IC1 via RV1 and R4, and then discharging it through the same path. Thus the charge (IC1 output high) and discharge times (IC1 output low) are equal, and the square wave output is generated. Integrated circuit IC1 is used to drive the relay by way of Q1. This device is used as an emitter-follower buffer stage that provides the relatively high operating current required by the relay compared with the current drawn by the rest of the circuit. A pair of normally-open relay contacts operate the wipers during the periods when the output of IC1 is high, but switch them off during the periods when IC1's output is low, giving the required intermittent operation.

If SW1 is switched to its central position, D1 and R3 are connected across RV1 and R4 and thus affect the timing of the circuit. The discharge time of C2 is not significantly affected because D1 blocks any current flow in this direction, but D1 permits a charge current to flow through R3. Because of the low value of R3 this gives a reduced charge time (and time for which the output of IC1 is high) of only about half a second. Thus the relay is only briefly pulsed on, and single, intermittent wipes of the screen are provided.

Potentiometer RV1 controls the time between single wipes of the screen, and in the other mode of operation it governs both the on and off times of the wipers. It gives a range of approximately 5 seconds to 50 seconds.

The third position of SW1 is used to switch the unit off.

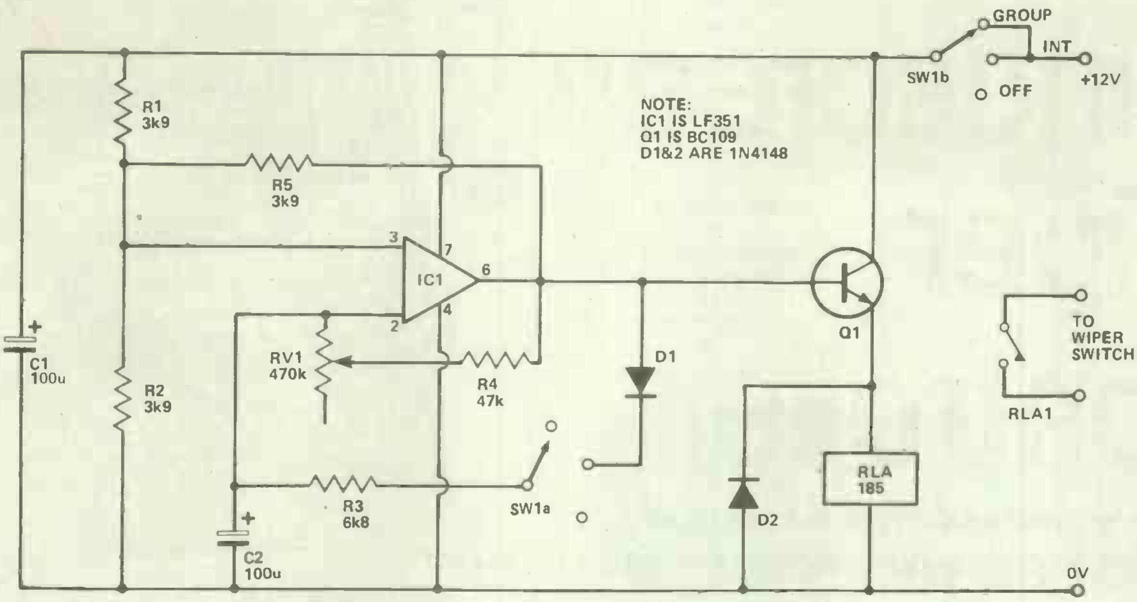
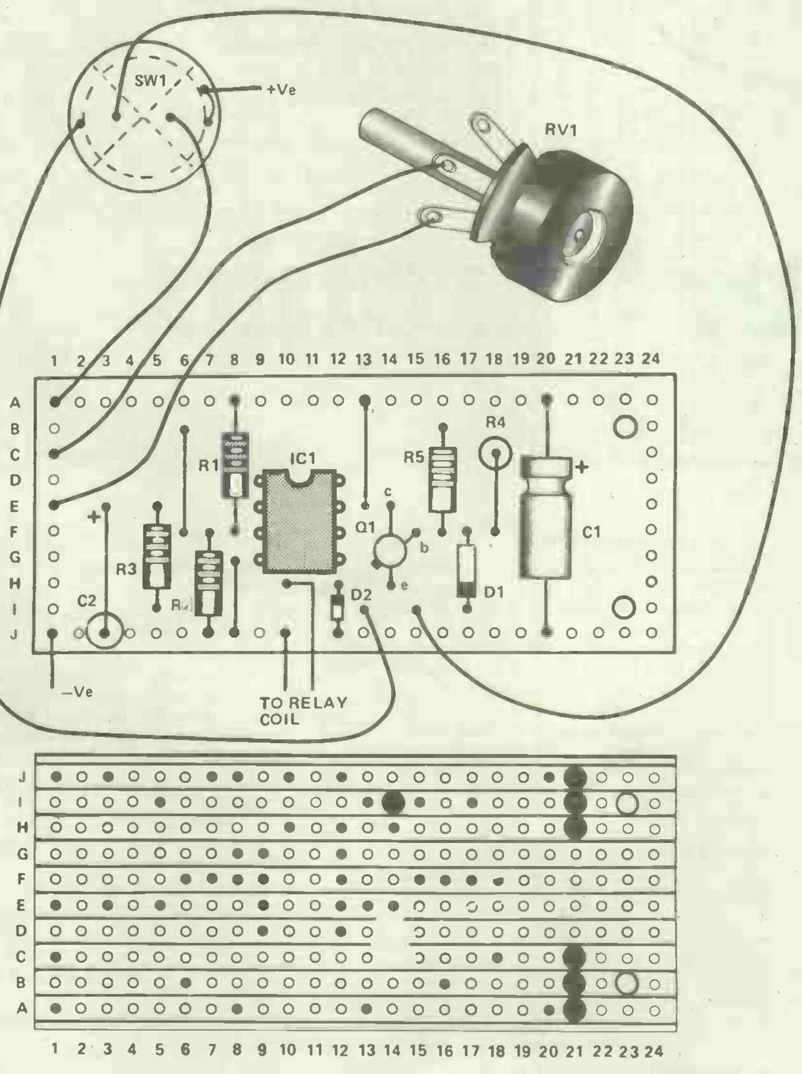


Figure 1. Circuit diagram of the HE Windscreen Wiper Controller

Figure 2. Veroboard layout, underside view and connection details



Parts List

RESISTORS (All ¼ W, 5%)

R1,2,5	3k9
R3	6k8
R4	47k

POTENTIOMETER

RV1	470k linear potentiometer

CAPACITORS

C1,2	100u, 10 V electrolytic

SEMICONDUCTORS

IC1	LF351 or TL081CP, bifet operational amplifier
D1,2	1N4148, diode
Q1	BC109, NPN transistor

MISCELLANEOUS

SW1	four-pole, three-way rotary switch
RLA	12 V relay 185R, with at least one set of heavy-duty, normally-open contacts

Case to suit
10 strip x 24 hole, 0.1" Veroboard
Knobs

Buylines

All the components are straightforward types with the possible exception of the relay. This should have a coil operating voltage of 12 V and a resistance of about 185 R or more. It must also have at least one make contact (or a changeover contact used as a make type) having a current rating of 4 A or more at 12 VDC. Suitable types are available from Maplin (eg the 'Relay Flat 12 V').

The parts for your project will cost you about £7 excluding the case.

HE

Steam Loco Whistle

This third and final part of our model train sound effects series. We provide details of how to combine steam whistle, two-tone horn and chuffer projects in one box

OUR LAST MODEL train sound generator of this very popular series (see January and February issues for Chuffer and Diesel Horn projects) is a realistic steam locomotive whistle, created electronically.

Four transistors are used to generate the whistle sound and a single integrated circuit mixes this sound with that produced by our two previous train sound effects circuits.

The whistle can be built and used individually or as an integral part of a complete sound effects unit, built in *one* case like ours.

Construction

The whistle is built on a printed circuit board (PCB) so construction is very easy. Follow the layout in **Fig. 1** inserting and soldering each component in turn, starting with the resistors followed by capacitors and finally semiconductors. The IC is cheap (a 741) so you may not feel it worth the cost of a holder. If so, solder it carefully, allowing each pin to cool before soldering the next.

Connection details for this project are given also in **Fig. 1** and this shows where the other two sound effects are connected if you put them all together in one case, as we did. Drill the case for all connections and switches and simply parallel connect the power supply ie the 9 V battery, to each circuit at the board side of the on/off switch. The output lead from the whistle board to the output jack socket should be a screened lead, with the shielding taken to 0 V.

If you intend to connect your projects together, you will need to make a slight change to the Two-tone Train Horn board, and this modification is shown in **Fig. 3.** Simply unsolder and take out capacitor C5 and insert the two resistors Rx and Ry as shown. The output from this board was originally fed to a loudspeaker and the resistors simply act as a potential divider, dropping this output level to one which suits the input of the mixer formed by IC1.

Buylines

All components should be easily obtained and the total cost (excluding case and PCB) should be around £12.

The case we used is from the Samos range stocked by West Hyde and its number is 006.

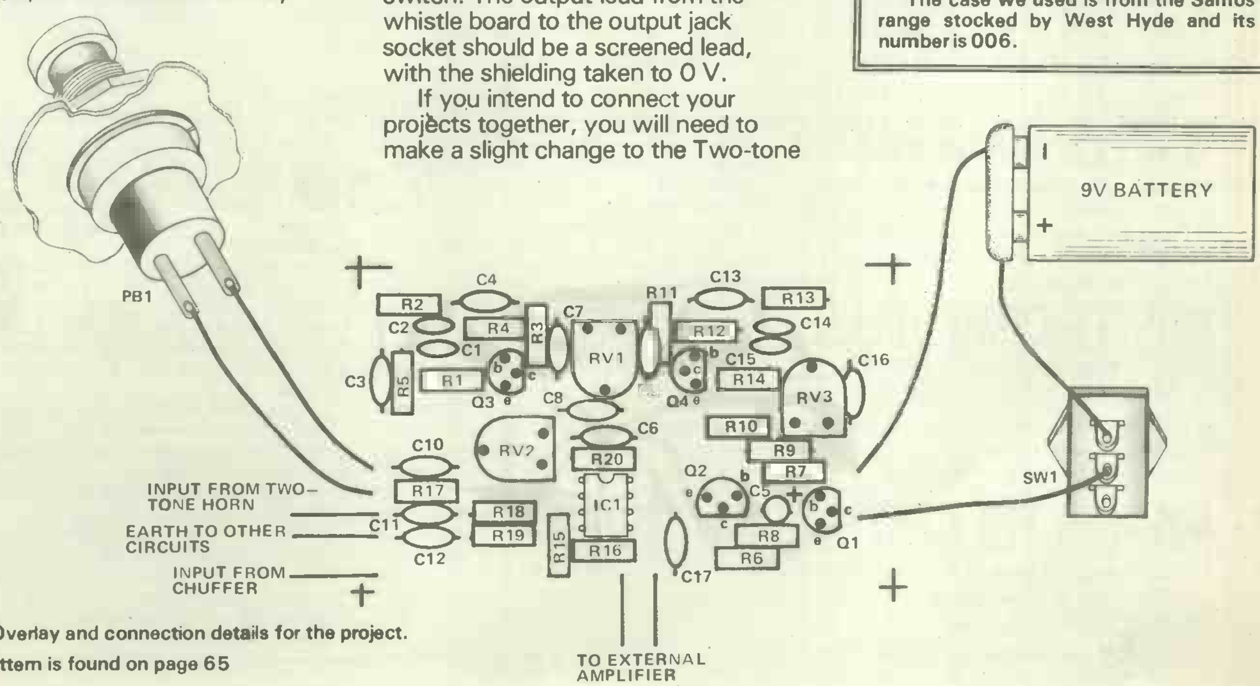


Figure 1. Overlay and connection details for the project. The foil pattern is found on page 65

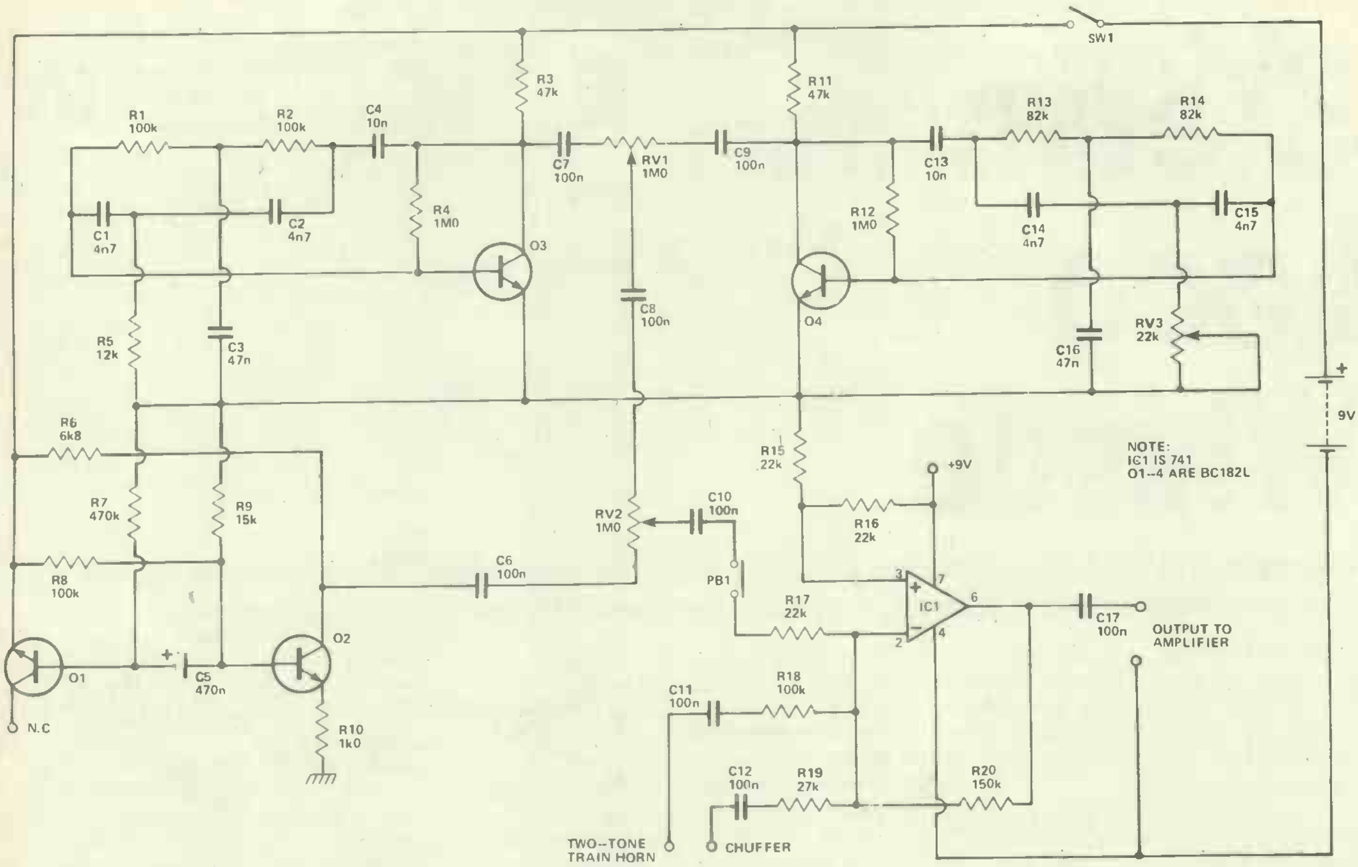
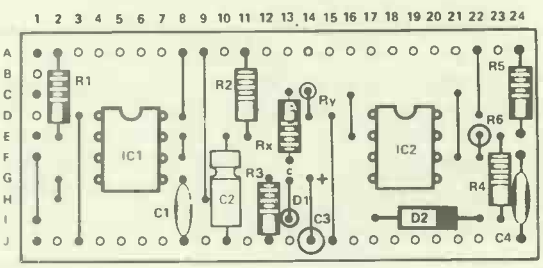


Figure 2. Circuit diagram of the Steam Loco Whistle

Figure 3 (right). The modification to the Two-Tone Train Horn board — take out C5 and insert Rx and Ry



Rx = 10M
Ry = 15k

HE

Parts List

RESISTORS (All ¼ W, 5%)

R1,2,8,18	100k
R3,11	47k
R4,12	1M0
R5	12k
R6	6k8
R7	470k
R9	15k
R10	1k
R13,14	82k
R15,16,17	22k
R19	27k

POTENTIOMETERS

RV1,2	1M0 miniature horizontal preset
RV3	22k miniature horizontal preset

CAPACITORS

C1,2,-14,15	4n7ceramic
C3,16	47n ceramic
C4,13	10n polyester
C5	470n, 35 V tantalum
C6,7,8,9,10,11,12,17	100n polyester

SEMICONDUCTORS

IC1	741 operational amplifier
Q1-4	BC182L NPN transistor

MISCELLANEOUS

SW1	single-pole, single-throw toggle switch
PB1	push-to-make switch

Case to suit (see Buylines)
Battery + clip

How It Works

The waveform of a steam whistle is a complex combination of two main things: white noise and an audio frequency oscillation. Both are fairly easy to recreate electronically.

White noise is usually made by a 'noisy' zener diode, the output being amplified to the required level. The generator we used is of the same type as in the 'Chuffer' project of January's issue; ie, a transistor (Q1) biased into zener mode and a simple transistor amplifier (Q2).

The audio frequency oscillation is a straightforward mixture of two similar (but not identical) sinewaves, which after their addition produces a more complex waveshape than either of the two individual waves. The sinewave generators are known as 'Twin-T' oscillators because the feedback components (eg R1,2 and C3, and C1,2 and R5) around the transistor (Q3) are in the shape of two letter Ts. The frequency is set by the values of the feedback components and in this circuit is fixed. The other oscillator frequency is variable because one of the resistors is replaced by a preset (RV3). At RV3's mid-position the frequency is about the same as that of the other oscillator.

Preset RV1 mixes the two sinewaves so that an appropriate waveform is obtained. Similarly, RV2 mixes this waveform with the white noise produced elsewhere in the circuit. Adjustment of the three presets will result in the required sound.

Integrated circuit IC1 is an operational amplifier used as a simple mixer/amplifier which combines the steam whistle, chuffer, and two-tone horn sounds into one, suitable for amplification by an external amplifier (say your stereo system).

The gain of the mixer is determined by the ratio of R20 to the input resistances, R17,18 or 19, of the channel concerned and so by varying the chosen resistor the levels of the individual sounds in the mix can be altered to suit.

POPULAR KITS AND PARTS

TRANSMITTER SURVEILLANCE
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox – all electronic parts and circuit £2.30.

RADIO MIKE
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp £6.50.

SAFE BLOCK
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit £1.95.

LIGHT CHASER
Gives a brilliant display – a psychedelic light show for discos, parties and pop groups. These have three modes of flashing, two chase-patterns and a strobe effect. Total output power 750 watts per channel. Complete kit. Price £16. Ready made up £4 extra.

FISH BITE INDICATOR enables anglers to set up several lines then sit down and read a book. As soon as one has a bite the loudspeaker emits a shrill note. Kit. Price £4.90.

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit, includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy, if you have an amplifier to connect it to on a pair of high resistance headphones. Price £11.95.

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 65p. High resistance headphones (give best results) £3.75. Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy to fault find – start at the aerial and work towards the speaker – when signal stops you have found the fault. Complete kit £4.95.

INTERRUPTED BEAM KIT
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components – relay, photo transistor, resistors and caps, etc. Circuit diagram but no case. Price £2.30.

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £11.50 + £2.50 post.

G.P.O HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5¼in x 3¼in x 1¼in is an extremely high gain (70DB) solid state amplifier designed for use as a signal tracer on GPO cables etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp etc. An absolute bargain at only £1.85. Suitable 80 ohm, earpiece 69p.

VU METER
Edgewise mounting through hole size 1¾" x ⅞" approx. These are 100 micro amps f.s.d. and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale is not calibrated but has very modern appearance. Price £2.88.

BALANCE METER. Edgewise mounting 100 UA centre zero. Price £2.30.

1⅞in SQUARE PANEL METER. Eagle full vision plastic front, 50 UA. Price £4.60. 1mA Price £4.03.

WATERPROOF HEATING WIRE. 60 ohms per yard. This is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses – around water pipes, under grow boxes, in gloves and socks. 23p metre.

DIAL INDICATOR. As used in toolmaking and other precision measuring operations, the famous John Bull accurately shows differences of .01mm. A beautifully made precision instrument, price in most toolshops would be £12-£15. We have a fair quantity. Price £9.20.

COMPONENT BOARD Ref. W0998
This is a modern fibreglass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including four 3 amp 400v types (made up in a bridge), 8 transistors, type BC107 and 2 type BFY51, electrolytic condensers, SCR ref. 2N 5062 25 Ouf 100v DC and 100uF 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at £1.15.

FRUIT MACHINE HEART. 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot". £9.95 + £4 carriage.

DESOLDERING PUMP
Ideal for removing components from computer boards as well as for service work generally. Price £6.35.

4-CORE FLEX CABLE
White pvc for telephone extensions, discolights, etc. 10 metres £2, 100 metres £15. Other multicore cable in stock.

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

HUMIDITY SWITCH
American made by Honeywell. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive microswitch. Very sensitive breathing on it for instance will switch it on. Micro 3 amp at 250V a.c. Only £1.95.

MINI-MULTI TESTER

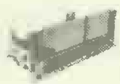
Deluxe pocket size precision moving coil instrument, jewelled bearings–2000 o.p.v. mirrored scale.
11 instant ranges measure:
DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0-100 mA.
Continuity and resistance 0-1 meg ohms in two ranges.
Complete with Test Prods and instruction book showing how to measure capacity and inductance as well.
Unbelievable value only £6.75 + 50p post and insurance.

FREE Amps ranges kit to enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini-tester and would like one, send £2.50.

SUPER HI-FI SPEAKER CABINETS.

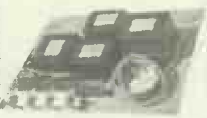
Made for an expensive Hi-Fi outfit – will suit any decor. Resonance free cut-outs for 8in woofer and 4in tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs. Price £6.90 per pair (this is probably less than the original cost of one cabinet). Carriage £3 the pair.

RADIO CHASSIS BARGAIN



3 waveband radio with stereo amplifier. Made for incorporation in a high-class radiogram, this has a quality of output which can only be described as superb. It is truly hi-fi. The chassis size is approximately 14". Push buttons select long, medium, short and gram. Controls are balance, volume, treble and bass. Mains power supply. The output is 6+6 watts. Brand new and in perfect working order, offered at less than value of stereo amp alone, namely £6.90. Post £2.00.

MULLARD UNILEX

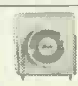


A mains-operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy-to-assemble modular form this should sell at about £30 – but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16 including V.A.T. and postage.
FREE GIFT – Buy this month and you will receive a pair of Goodman's elliptical 8" x 5" speakers to match this amplifier.

THIS MONTH'S SNIP

THERMOSTAT ASSORTMENT
10 different thermostats, 7 bi-metal types and 3 liquid types. There are the CURRENT STATS which will open to protect devices against overload, short circuits etc. or when fitted say in front of the element of a blower heater, the heat would trip the stat, APPLIANCE STATS, one for high temperatures, others adjustable over a range of temperatures which could include 0-100C. There is also a THERMOSTATIC POD which can be immersed, an oven stat, a calibrated BOILER STAT, finally an ICE STAT which fitted to your waterproof heater element up in the loft could protect your pipes from freezing. Separately these thermostats would cost around about £15 – however, you can have the parcel for £2.50.

WALL MOUNTING THERMOSTAT. The Danfoss, a handsome 2 tone, intended for living rooms but is just as efficient in a greenhouse or store. It is suitable for normal air temperature range 32F-80F. Price £4.60.

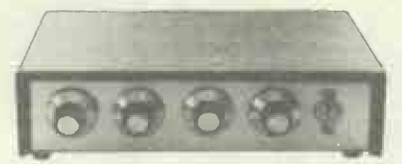


TANGENTIAL HEATER UNIT

3KW MODEL

£6.95 + £1.50 P & P

A most efficient and quiet running blower-heater by Solatron – same type as is fitted to many famous name heaters – comprises mains induction motor, long turbo fan, split 2kw heating element and thermostatic safety trip. Simply connect to the mains for immediate heat. Mount in a simple wooden or metal case or mount direct onto base of, say, kitchen unit. Price £5.95, post £1.50. Control switch to give 2kw, 1kw, cold blow or off available 60p extra. 3kw model £6.95. Control switch 95p.



3-CHANNEL SOUND TO LIGHT KIT

Complete kit of parts for a three-channel sound to light unit controlling over 2,000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for Disco work.
This unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is £[illegible] in kit form or £[illegible] assembled and tested.

SUPER CONSTRUCTOR'S SNIP

Here's a super bargain for you. 100 twist drills, regular toolshop price over £50, yours for only £11.50. With these you will be able to drill metal, wood, plastic, etc. from the tiniest holes in P.C.B. right up to about 5mm. Don't miss this snip – send your order today.

TERMS: Cash with order–but orders under £10 must add 50p to offset packing, etc.
BULK ENQUIRIES INVITED - PHONE HAYWARDS HEATH 54563
ACCESS & BARCLAYCARD WELCOMED

J. BULL (Electrical) LTD.

(Dept. HE), 34-36 AMERICA LANE
HAYWARDS HEATH, SUSSEX, RH16 3QU

IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived – often bargains which sell out before our advertisement can appear – it's an interesting list and it's free – just send S.A.E. Below are a few of the Bargains still available from previous lines.

DUE TO THE HIGH & RISING PRICES OF FUEL many companies and probably many householders are looking around for ways of saving some of this cost. One Company bought a number of fans from us and fitted these in the ceiling of their workshops where the hot air tends to collect and they blow this hot air downwards. Another Company has bought fans from us to suck the exhaust from their oil fired central heaters through a zig zag of asbestos pipes, the asbestos pipes being in a separate chamber which becomes a hot air chamber, the hot air from this is blown through ducting to wherever it is needed. Basically, they have cut out the normal chimney and replaced this with one of our high power extractor fans. If you have any other good ideas on heat cost saving, let us know and we will pass it on to other readers.

EXTRACTOR FANS

Ex-computer made by Woods of Colchester; ideal also as blower; central heating systems, fume extraction, etc. Easy fixing through panel, very powerful 2,500 r.p.m. but quiet running. Choice of 2 sizes, 5" £5.50, 6" £6.50; post £1 per fan. All mains operated.

PING PONG BALL BLOWER-UPPERS
Have you got to organise a party or charity fund-raising event? Then one always popular way is to have ping pong balls going up and down and being caught. We have some powerful blowers and these should be ideal for this, and of course for more serious purposes. They are 4-stage blowers, coupled to synchronised AC mains motors of approximately ⅛ h.p. They have a terrific suction as well as a high velocity blow. Ex-computers, price £26.

RECHARGEABLE SOLID GEL BATTERY. 12V 5AH, new and unused, made by or for Elpower Corporation of California. Dimensions 6in. long, 3¾in. high and 2½in. wide. Regular price of similar batteries, R.S. Components, is £26. Limited quantity available at £15.80.

E.H.T. UNITS. One of our specialities has always been E.H.T. transformers, and we probably have bigger stocks than most of our contemporaries. It is surprising what uses these high voltages can be put to – killing flies and weeds, lighting central heating boilers, lifting paper, extracting dust, etc. A new one this month is 14.5 KV (dc) 0.5mA. Made by ADVANCE ELECTRONICS, this unit is completely enclosed and has input and output sockets – size of the unit is approximately 6in. x 3in. x 3¾in. Price is £15.38, post £1.
To remind you of the E.H.T. Transformers we stock, here is a list:

3-4 KV 3 mA ex equipment	£2.90
5 KV 5 mA ex new equipment	£7.15
5 KV 5 mA with outer casing and E.H.T. outlets	£9.45
8.5 KV 10 mA totally enclosed with E.H.T. outlets	£13.50

LEDS are used increasingly and are now being recommended for nearly all indicators and for games and novelties. Due to a fortunate purchase, this month we are able to offer 10 red led's for £1. These are the small ones equivalent to the TIL 209. Bulk price £60.00 per 1,000 + V.A.T.
FIG. 8 FLEX is always in demand. We are able to offer white Fig. 8 5 amp type on 50 metre roll for £2.00, ditto but dark grey with tracer lead, suitable for speaker extensions, 50 metres £3.38.

300 WATT MERCURY VAPOUR LAMP. Mazda, ref 90-5104 MAT/V blended. These give a really powerful light but, of course, have to be used with their correct control gear. We are expecting to get this control gear early in the New Year. Price of the lamp is £3.38 +25p. Post 50p.

ANTI-FROST THERMOSTAT. The normal refrigerator type thermostat switches off as the temperature falls and so is not suitable for anti-frost devices. However, we have the Ice-stat – this switches on as the temperature falls and is set to switch on just above freezing point. It is a skeleton type stat so would require boxing but the price is modest at £1.10.

THIN CONNECTING WIRE 500 metre drums, 7 stranded copper core p.v.c. covered available in 10 different colours. Price £7.15.

SUPER BREAKDOWN PARCEL with free gift of a desoldering pump, perhaps the most useful break-down parcel we have ever offered. Consists of 50 nearly all different computer panels on which you will find: over 300 ICs, over 300 diodes, over 200 transistors and many hundred other parts, resistors, condensers, multi turn pots, rectifiers, SCR etc. etc. for only £8.50, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel, +£1.27 VAT +£2 post (it's a big parcel).

TIME SWITCH BARGAIN. Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with dials. Complete with knobs £2.50.

EXTENSION LEAD BARGAIN. We all know how especially in the cold weather, p.v.c. leads lose a lot of their flexibility, in fact some poor grade p.v.c. can be quite stiff and awkward, and will not stay put. We have an extra flexible twin round cable. This is highly suitable for lead lamps, vacuum cleaners, in fact any portable device which does not need an earth. The regular price of this very flexible cable which is suitable for up to 7.5 amps is 30p per metre, and that is buying 1,000 metres at a time. However, this month you can buy 50 metres for £5.00 + 75p + 60p post or 250 metres for £22.00 + £3.30 + £3.00 post.

EXTRA LIGHTWEIGHT HEADPHONES. Stereo, but these weigh only 50 grams (approx. 2oz.) Intended for use whilst playing your instrument in a band, or in normal headphone operation. Japanese made, and extremely good quality. £7.00 + £1.10.

COMPUTER CORNER. PRINTER TERMINAL UNIVAC reference DCT1000, this is a floor standing mains operated printer, which takes a 14" wide paper complete with electronics – in a good clean condition, but untested. price; £75 + £11.25, plus delivery at cost.

8-BIT PUNCH AND READER UNIVAC. Combined is a neat case, this is their model no. 0925-15. Made by the Roytron Company of America, Roytron number being 572-1. This is a desk standing instrument with input and output leads made for 115v operation. The case has a perspex view window and drawer below to hold the tape. Complete with electronics and in very clean condition. Price £25 + £3.75. Post £4.50.

UNIVAC KEYBOARD MODEL NO. F1308-00. A neat keyboard, probably made to be used with the 8 bit punch and reader. Has 57 encoded keys and 10 function switches on a line along the top. The legends on these switches are: auto-manual, monitor off, run-stop, on-line-off-line, keyboard off, printer off, reader off, punch-off, card reader-off, card punch-off,. We have only a few of these, in as new condition. Price £20 + £3. Post £2.

BIG ELECTROLYTICS. Bargain parcel of big electrolytics 8 for £3.30 inc. VAT & P/P.

Bicycle Speedometer

0 — 99 MPH in sixty minutes — that's how long it will take you to build this all electronic, solid-state speedo

WITH PETROL getting dearer, the world's oil supply running out and gas disappearing in a puff of smoke, it can't be long now before pedal-power makes a comeback. We can see it now; CB freaks with pillion-mounted rigs and six-foot whips on the back. Of course there will be lots of research into optimum wheel size, cruising speed etc. That's where this dandy little project will come to your aid. Featuring a two-digit readout, bright red LED display with 1 MPH resolution updated every few seconds it can be built in a trice (ideal if your bike has three wheels) and powered from a single 9 V battery.

Swift And Silent

There have been many bike speedo designs published over the years but never before has so much been brought to so many with so little. Yes, only Hobby Electronics can do this for you! No seriously, before this gets totally over the top, we'll explain. Only three ICs are required plus the two displays and a handful of passive components. The whole thing is very easy to put together so you can assemble it whichever way you like best.

The speedometer works by detecting each revolution of the bike's wheel using magnetically-sensitive reed switches with one or more bar magnets mounted on the wheel. The faster you go, the more pulses are counted and the speed displayed increases. The display blanks out while the counters are advancing to avoid a distracting flicker and the count period is set up by adjustment of a single resistor when the speedo is mounted on your bike.

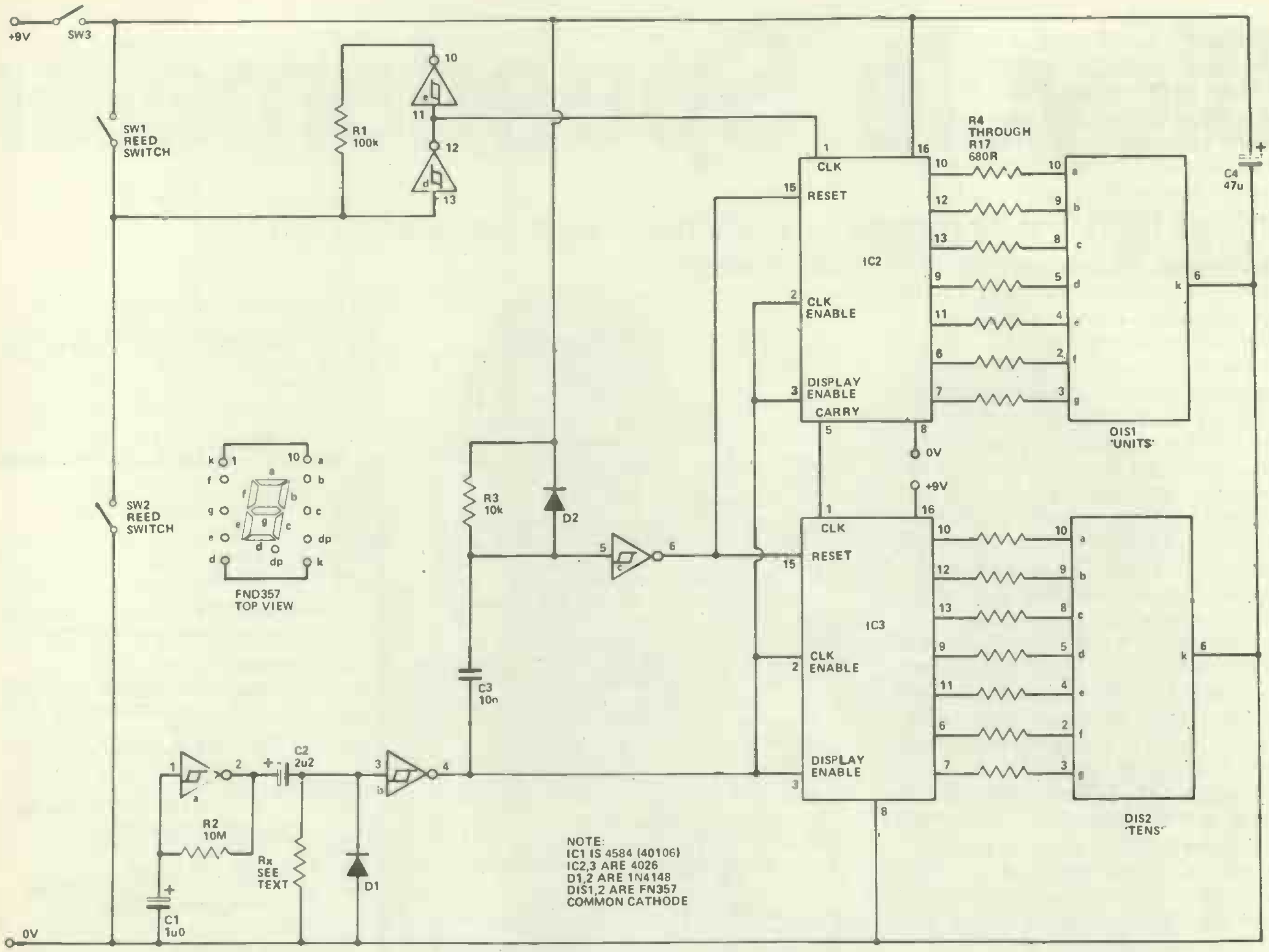


Figure 1. Circuit diagram of the HE Bicycle Speedometer

Okay, so it doesn't speak your weight, but it won't burn a hole in your pocket either!

Construction/Setting Up

Nothing to cause any problems here. As usual we'd recommend you use sockets for the ICs. If you use our PCB design you should have success first time though the circuit is simple enough to be put together on Veroboard or whatever comes to hand . . . . except for the original breadboard which went out of fashion when ICs arrived. You try knocking nails into a piece of wood the size of a postage stamp and anyway, you would look silly with a breadboard between the handlebars!

Reed switches come with two main switch actions, either single-pole, single-throw or single-pole, double-throw (changeover). You can use two of the former or simply one of the latter (with its centre contact connected to the common point on

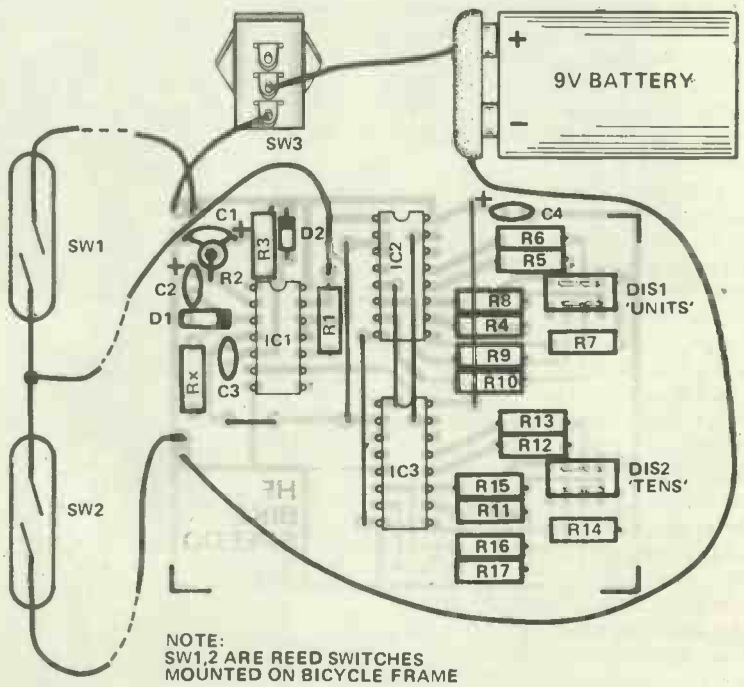


Figure 2. Overlay and connection details. Remember that SW1 and SW2, the reed switches, can be combined as one changeover type reed switch

the circuit board for the two switches (see Fig.2).

Reed switches are usually supplied as glass tubes with the switch contacts brought out to tags at either end. For better protection against the elements we used a single-pole, double-throw type which is sealed inside a waterproof housing (see Buylines). This is more expensive than the open-wired types, but it comes complete with a moulded mounting tab.

The relationship between wheel diameter, gate period and number of magnets required is not a simple one. Toy bikes and bikes with 'baby' wheels will get away with one or two magnets. To obtain a reasonable gate period with larger wheels you'll need to use more magnets. In practice, fix between five and 10 small magnets (the type usually supplied with reed switches) around the rim of the wheel (the more the merrier). To stop them falling off it's best to glue them in place or secure them with pads of double-sided foam tape. Once fixed, a dab of paint or varnish will prevent them from going rusty.

Connect a 1M0 potentiometer or preset at the Rx position, get on your bike and adjust the pot until you get the right speed reading. Now, measure its value and make it up from fixed value resistors or just fasten the pot or preset onto the board — there's plenty of room.

If you use separate reed switches, make sure that both are never on at once or the battery will be short — circuited through them. To safeguard against this you can connect 10k resistors in series with the wires from the battery.

Ideally you'll need a box with a clear lid (like ours — see Buylines) so you can see the display without having to cut holes in the box, which would let in water. It's best to mount the box using a Terry Clip, centrally on the handlebars so that, if the bike takes a tumble no damage will be done. Lacquer the back of the board so that if any condensation appears in the box no shorts will result. The circuit takes about 40 mA of current when running so two batteries in parallel are advisable and there's just enough room under the PCB to site them.

Alternatively, you might like to make a proper facia panel to hold a whole set of instruments (oil pressure, ammeter, etc!?) Watch this space!

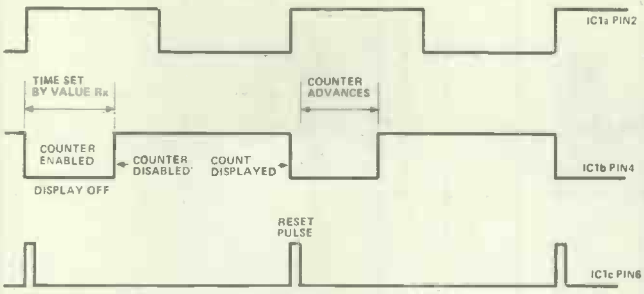


Figure 3. Waveforms within the circuit, not to scale

How It Works

A low-frequency astable oscillator provides the master clock for the circuit. IC1a, R2, C1 take care of this. Pulses are then differentiated and squared up by IC1b and IC1c to provide clock enable and reset signals. Figure 3 shows this in detail.

Integrated circuits IC2 and 3 form a two-digit counter and display driver, which needs only correct timing and clock pulses to operate both 7-segment displays. While IC1b's output is low the counters are enabled and clock pulses from IC1d cause the counters to advance. When IC1b goes high the counters are disabled and the count is displayed on the 7-segment displays. The combination of IC1d and IC1e forms a simple but effective de-bouncing circuit. Some form of signal conditioning circuit like this is nearly always required when mechanical switches are interfaced to digital counters. Resistors R4 through R17 limit the current in the displays and C4 provides overall decoupling.

Parts List

RESISTORS

R1	100k
R2	10M
R3	10k
R4-R17	680R

POTENTIOMETER

Rx	1M0 linear potentiometer

CAPACITORS

C1	1u0, 16 V tantalum
C2	2u2, 16 V tantalum
C3	10n ceramic
C4	47u, 16 V tantalum

SEMICONDUCTORS

IC1	4584 or 40106 hex inverting, Schmitt trigger
IC2,3	4026
D1,2	1N4148 diode
DIS1,2	FND357, common cathode, 7-segment displays

MISCELLANEOUS

SW1,2	reed switch inserts
SW3	single-pole, double-throw toggle switch

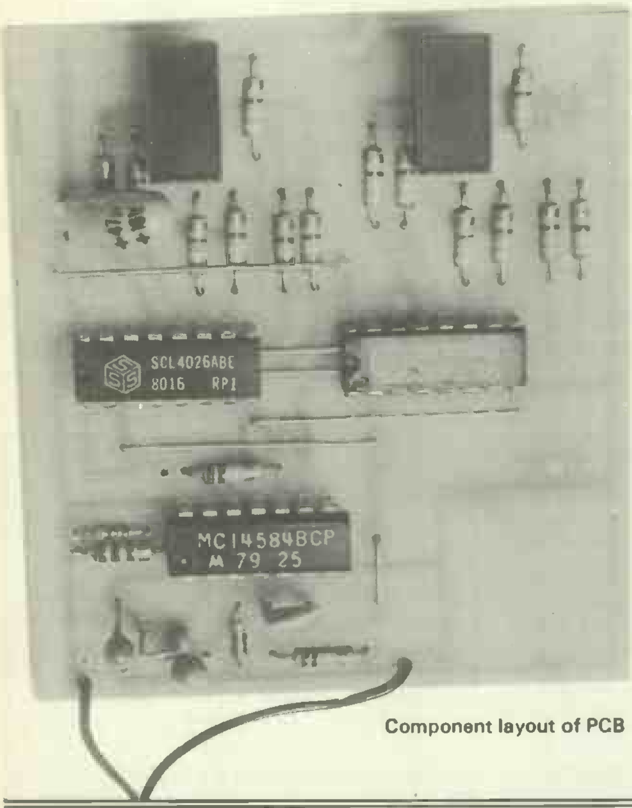
Magnets
Battery and clip
Case to suit

Buylines

The semiconductors for this project are obtainable from Technomatic. All other parts should be easily found. One exception could be the hermetically-sealed reed switch mentioned under Construction/Setting Up. This is an RS Components type but it can be ordered through your component stockist. Stock number 339-213.

Approximate price for components (excluding case) is between £10 and £15. The case we used is from West Hyde Developments (tel no. Aylesbury 0296 20441) and is type BOC 430G.

Side view of speedometer, showing the two batteries mounted under the PCB



Component layout of PCB

Rider's view of speedometer

HE

Clever Dick

A good variety this month: from geiger counters to motor bikes, and from Bristol to black chips

Letters, letters, letters, still flooding in . . . I must ask HE's Editor to add 50p to my weekly wage for the trouble.

Let's start off with a nice friendly one from someone who really *appreciates* HE:

To whom it may concern,

My wife purely by an accidental, act of fate bought Hobby electronics instead of E.T.I. Man I have never read such rubbish. Who the hell wants to build a 'background noise simulator', the idea is totally useless and as for the Heart beat Monitor that has to be operated by a push Button Switch, well!

And what about that stupid idiotic cartoon that page could have been used for adverts of which there are already ⅓ of the magazine given over to.

Then there's the "pocket" M.W. Radio, very novel ½ foot long, two 109s and cost £7?

Why is your magazine made up from Everyday electronics throw outs?

The only thing worth looking at was the T.shirt ad. and even she was a flop!

D.S. Nightingale,
Essex

All I can say is that, in a forthcoming issue, we'll have an *electronic* probe for use with the Heartbeat Monitor project. And no, our magazine is *not* made up from Everyday Electronics' throw-outs — we're sure EE can't *afford* to throw its articles away.

The next letter definitely 'cheered' us up:

Dear CD,

In your February edition of HE you printed my letter and called me a nutter — you also told me next time I was feeling rich to send my money to your beer fund, so here it is: it should be enough to buy someone a pint. Onto more serious matters — In your electronics digest volume 1 number 1 (p.67) you show the circuit for a geiger counter. I have built it but cannot find a Geiger tube. Please tell me who sells them. (Type CV2249)

M. Broughton
S. Yorks

You've embarrassed us with your contribution to our fund: cheers.

As to who sells a Geiger tube, we found that Henry's, 404 Edgware Road, London W2 1ED, stocks two types: CV2246 and CV2247. We understand that they are both 350 VDC working and cost £3 each.

On to two wheels for the next one:

DEAR Richard of the High I.Q.

I have a single cylinder 4-stroke motor cycle with a six volt electrical set-up. Is there any way I can adapt your car speedometer or tachometer to work on my bike It need onley work in top gear, the speedo that is.

K. Lawry
Bristol
P.S. Thanks for a great mag.
P.P.S. Letter short enough?

First things first: no, the speedometer circuit won't work from a 6 V supply because its pre-amplifier is biased for 12 V operation. But the rev counter (tachometer) *will* work from 6 VDC. (Why onley in *top* gear we wondereyd.)

Second: yes, nice and short thanks very much.

The next one has been buried under the heap for a few weeks, but I thought it worth including as a comment on the 'why are ICs black?' debate.

Dear C.D.

I have long suspected that the alleged superiority of you whiteys is a load of bluff and adequately described as 'white noise!' Will your ego be upset if a poor ignorant black girl from South Africa puts you right on black ICs?

The modern ICs are part of a world of fantasy and if a member of this world says "That is a black IC" it is merely a part of his mode of living since black is not a colour and as such his claim to see it is balmy. As I know from personal experience a matt black package has the advantage/disadvantage of reducing the temperature differential between the inside and outside.

I know of at least three types of binder but your type will suit me well.

Ms. S. Mayekiso
South Africa

I think that explanation deserves a long-distance binder.

Finally, another one from Bristol:

Dear C.D.

Are you a Circuit Diagram?, or maybe a C.M.O.S., I.C, (e.g CD 4001) Or are you just some common or garden reserchist siting in an office staring at boring letters written by readers?

Anyway, down to the question, Does R. behind a resistor value stand for ohms? and if so why not just put Ω or ohms? Question number 2, is there a simpler way of inserting a C.M.O.S. I.C than using an insertion tool? If so please specify. I think Beasties are superb and want to see more. Thanks for an Excelent mag.

A. Ellis
Bristol
P.S. I don't suppose there is an easier way of getting a binder than spending all that money? (Hint, Hint)

Where a resistor is specified as, for example, 10R then yes, the R stands for 'ohms'. On the other hand, the R can take the place of a decimal point, such as in 2R2 (equivalent to 2.2 ohms). The R is clearer than the Ω (omega) sign for low values and decimal points have a habit of disappearing.

You *can* insert CMOS devices without an insertion tool: most modern CMOS devices are a lot less susceptible to damage by static or other electrical discharges to their pins than some of the earlier types. To be safe, make use of the plastic holder or conductive foam in which the device is supplied. Full details were given in Building Site, HE, September 1980, pages 57 to 58.

We *may* see Beasties again in HE. True: there isn't usually an easier way of getting a binder than spending all that money.

And that's it for this month. Perhaps next month we'll try and assess from all the letters we've received who *is* HE's youngest reader. Cheers for now. **HE**

Into Digital Electronics

This is the seventh — and last — part of this series. To round it off, Ian Sinclair outlines the operation of the microprocessor

The microprocessor is the big chip of all digital chips, and although it's way and above all others in its complication, we've reached the stage where we can understand what it does. This final part, then, is devoted to the microprocessor. There's no practical work this month, because we would need a lot more space to describe a practical layout. One way to get thoroughly acquainted with practical microprocessing would be to refer to the series 'MPUs by experiment' in back numbers of Computing Today. This series ran from July 1979 to June 1980.

What is a microprocessor then? It's a chip which is filled with gates and registers arranged in groups of eight (usually), and with lots of internal connections. What makes it so useful is that the gates can be controlled by signals fed into the microprocessor and can then in turn decide what happens to the next signal or signals along. Everything about a microprocessor is arranged to fit a time sequence, controlled by clock pulses. The sequence never changes — it consists of a set of eight signals which open some gates and close others, followed by more signals which then pass through the open gates. The first set of eight signals is a program instruction, the next lot is data. What's the difference? Only the sequence!

First Mouthful

A group of eight digital signals is called a byte. There's no special reason for having eight. Pocket calculators operate quite happily with four bits at a time, but things can operate faster when we deal with 8 at a time. Large computers deal with 16, 32 or even 64 bits at a time, which speeds some operations up a lot more. Eight just happened to be a useful increase from four without needing a lot more pins on the package.

What can you do with eight bits, then? The answer is eight times as much as you can do with one. You can carry out eight ANDs, eight ORs, add eight-bit numbers, shift left or right — just the sort of digital operations we should be accustomed to by now. Everything the microprocessor does is based on these straightforward digital operations plus one more — the ability to copy a set of eight bits from one register to another. There's nothing novel about the copying (or transfer) action either, it's just an example of using the output of one register as the input of another.

Force-feeding

The microprocessor, then, doesn't do anything which wasn't done by separate chips previously but it takes up a lot less space and costs a lot less as well. For the guy who was familiar with the way computers were designed long before ICs came along, the microprocessor is a simple way of doing what needed a whole lot of circuitry before. When you've come along a different path, however, from linear ICs into digital ICs, it all looks a bit (sorry!) bewildering, with a language of its own which was borrowed from computing. Let's explain, simplify, and cast a little light.

Suppose you want to AND two bits. Simple, use a two-input AND gate (Fig. 7.1a) and the job is done. If you want to AND eight lots of two bits it just means that you use eight lots of AND gates which will have a total of sixteen inputs and eight outputs, as shown in Fig. 7.1b. That's 24 pins to be connected to a PCB, 24 joints to go wrong and probably two chips on the board. Now the key to the difference between this conventional digital method of gating and the use of a microprocessor is the timing. With eight 2-input AND gates, you can put in all of your sixteen signals together — you'll have to, otherwise the gates won't operate correctly. The microprocessor will accept only eight

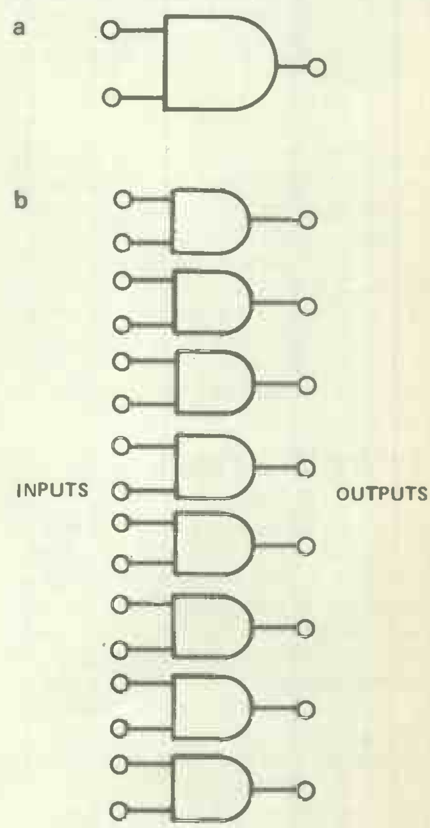


Figure 7.1 One operation — ANDing. A single AND gate (a) can AND two bits. To AND a set of eight bits (b) would need eight AND gates, with sixteen inputs and eight outputs

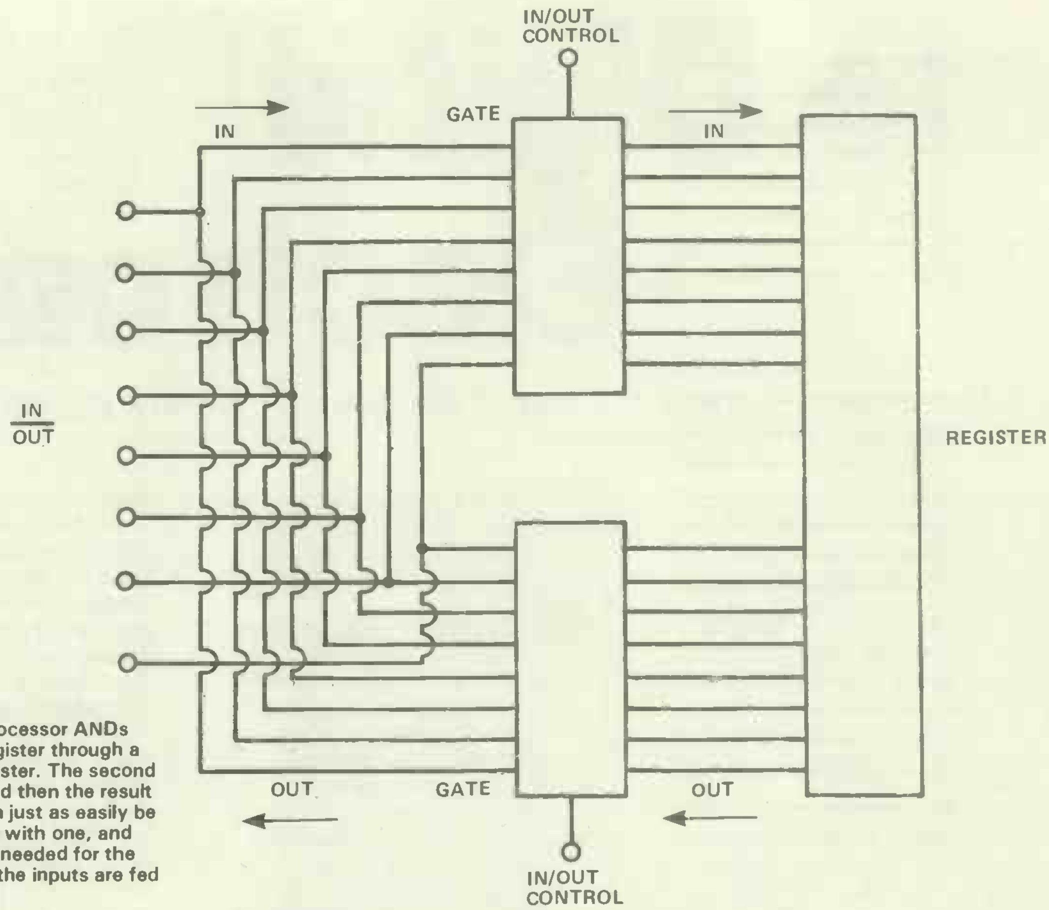


Figure 7.2 How the microprocessor ANDs bits. One bit is fed in to a register through a gate and is stored in the register. The second bit is then fed in, ANDed, and then the result is fed out. The operation can just as easily be performed with eight bits as with one, and only the eight input pins are needed for the inputs and output, because the inputs are fed in at different times

signals at a time, so the only way we can AND two lots of eight is to feed in one lot, store it in a register, feed in the next lot of eight, store that, and then AND the two lots, and feed the results out. It sounds complicated but in a lot of ways it's simpler. For one thing, we need only eight pins for our eight bits, and we can feed in or out of the same set of eight pins (see **Fig. 7.2**).

Timing The Feeds

Let's look in detail at what has to be done to AND two lots of eight bits. First of all we need to store the first set of eight bits, the first byte of the mouthful, in a register. There has to be an instruction for this, which will open the correct gates within the microprocessor to transfer our first byte into a register (see **Fig. 7.3**). For this operation, the register will usually be the main working register of the microprocessor and is called the accumulator. One instruction byte will therefore prepare the path from the eight data pins to the accumulator, and the next byte will be our first set of eight bits which are to be ANDed. Having loaded them in, we now need to tell the microprocessor what it has to do next. The next byte is therefore another instruction which calls on the microprocessor to AND the bits in the accumulator register with the next set of bits which will be fed in, and to store the result in the accumulator. Quite a mouthful that, so we abbreviated it to AND-immediate.

Following that instruction, the microprocessor expects to find the next set of bits we want to AND with the first lot.

The last operation is to deliver the results, so another instruction has to be sent to the microprocessor calling on it to connect the accumulator to the eight pins which we used to enter each byte, and so transfer the resulting byte out again. At the end of this instruction, the byte appears on the eight pins (the data pins) and the process is completed. The total score is three instructions in, two bytes of data (the bytes we wanted to AND) input and one byte (the result) output: a total of six steps.

Now, for ANDing two bytes of bits together, you might think that six steps of microprocessor action is a pretty poor exchange for just having a couple of AND chips working on two lots of eight bits. You would be

1. INSTRUCTION: Read a set of data bits
2. DATA (8 bits = 1 byte) IN
3. INSTRUCTION: AND this byte with the next set
4. DATA (second byte) IN
5. INSTRUCTION: STORE — send the result out
6. DATA (byte sent out) OUT

Figure 7.3 Sequence of operations for an 8-bit AND. A similar sequence would be used for any other 8-bit logical operation

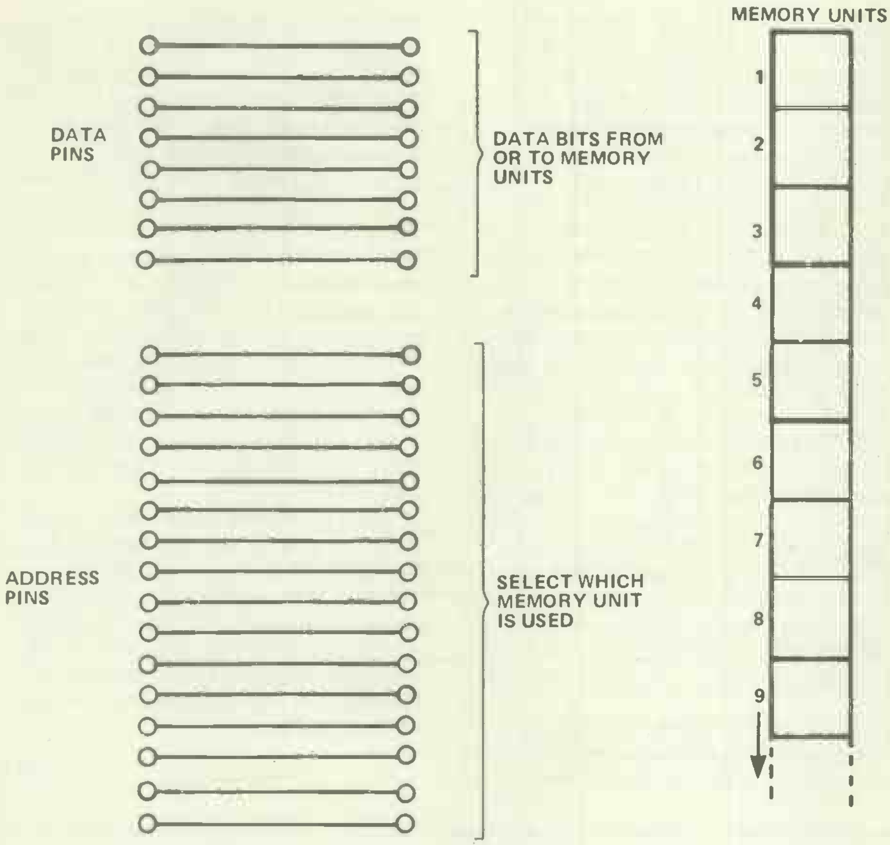


Figure 7.4 Using memory to ensure that instructions and data follow each other in the correct sequence. It is impossible to tell without knowing the sequence, whether a byte is an instruction or data

quite correct, it is a pretty poor exchange, and if you only ever had to AND two bytes together you'd be a mug to go to all the expense and bother of setting up a microprocessor to do it.

Where the microprocessor starts to score is in applications which need more than just a couple of bytes ANDed together. A lot of machine-control units would need several boards full of ICs just to carry out one of the operations which they do. Because the microprocessor operates on instructions, you can add more tasks just by adding more instructions. In addition, you can change the instructions without having to change the microprocessor. If you have a digitally-controlled machine which turns out one part, and the controller uses separate gates, then to make it turn out a new part means swopping boards around. That's what's called a hardware exercise. If the same machine were microprocessor-controlled then only the instructions would need to be changed, and that can be a whole lot simpler.

Once Upon A Time . . . .

You'll have started to suspect that this microprocessor caper probably calls for close timing, a bit of the old strict tempo. How right you are! Each stage of microprocessor action is started by a clock pulse, and the clock pulse generator is usually a crystal-controlled oscillator working at 1 MHz or more, so that the instructions are carried out pretty quickly. Now that speed, gratifying though it is, leads to further complications. Remember what the sequence of events was? First of all came the instruction (load) which set up the accumulator to receive the first data byte, then the data, another instruction (AND-immediate), more data, the output instruction and data out. If the clocking rate is as high as a 1 MHz oscillator suggests, how do we make sure that we are feeding the correct byte on to the pins at the correct time? Whether we are feeding in an instruction or a piece of data, it's just one byte at a time, and so the sequence just has to be right. How is it all synchronised?

Thanks For The Memory!

Memory is the answer to the problem. Memory is not something mysterious and new, it's just a word for a set of registers. As far as most microprocessor circuits are concerned, a memory will consist of a set of 8-bit registers, with gates to ensure that only one set of eight bits is connected to the data lines at one given time. The gating system is called addressing, so that when we talk of addressing memory what we mean is passing signals to gates so that one particular register is connected and eight bits can be stored in it or copied from it (see **Fig.7.4**).

In the early days, addressing was rather primitive and a lot of memories used a sequence principle, so that the first byte stored in was the first byte out, and the rest followed in sequence. We still use this idea for cassette-tape storage — you start at the beginning of the tape and you record or replay until you are finished. For a lot of purposes, though, it can be very much more useful if you can pick a byte out of any part of memory without having to go through all the bytes which were placed there earlier. This idea is called 'random access', and all the IC chip memories that we use nowadays have random access.

It's addressing which makes this random access possible. If you make your gates so that each binary number placed on a set of inputs — the address inputs — will connect a different register on to a set of data lines, then you have the random access you need, because you don't need to go through the binary numbers in sequence. The old memory system which didn't use address lines (one byte was connected in or out at each clock pulse) is never used these days.

Getting It All Together

Now we can start to see how the microprocessor can carry out its instructions. To start with, all the signals which it's going to need will be stored in memory chips. Taking our example of the ANDing of two bytes, we would need all six bytes stored in memory. The simplest way to do this would be to store them in the same order as they are used, with the 'load first byte' instruction first and the 'store answer' byte last. All we need then is some method of arranging that a byte is connected to the data lines of the microprocessor at each clock pulse, and this is done by 'address lines' from the microprocessor. The address lines come out on pins, usually sixteen of them, which can be connected inside the microprocessor to various counting registers. Their job is to signal to memory which memory byte is wanted.

Sixteen lines allow us to use binary numbers of up to 16 digits, which in familiar terms means a range of 0 to 65,536. Being able to select up to 65,536 different bytes sounds good, and most microprocessor systems need a lot less, but it's worth remembering that large computers need a lot more memory, which is why microprocessor chips with 24 or even 32 address lines are being developed.

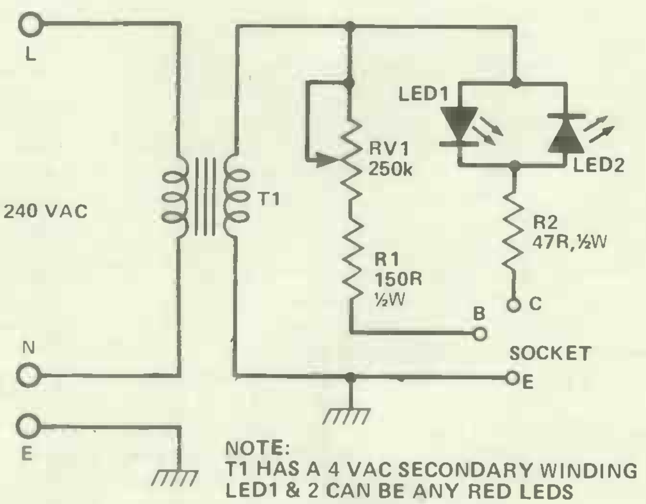
For our ANDing, then, we could arrange things so that the first instruction was connected to the data lines of the microprocessor when the address was 1. (You don't want me to write out fifteen 0s and a 1, do you? I'll stick to ordinary scale-of-ten if you don't mind!) This address is obtained by a counting register inside the microprocessor whose name is, appropriately enough, program counter. At each clock pulse, the program counter simply advances by one digit unless we instruct it otherwise. When the 'load a byte' instruction has been digested, therefore, the next clock pulse will advance the program counter to 2, and this has to be the memory address for the first of the two bytes we want to AND. At the count of three, the byte which is stored is the AND—immediate instruction, and address number four brings in the second byte to be ANDed. At step 5 another instruction comes in — an instruction which has quite a different effect, because it commands the microprocessor to send a byte out on the next clock pulse. Clock pulse number 6, then causes a byte to be stored — in this example in memory location number 6.

How do the registers tell the difference between sending a byte from memory to microprocessor (reading) and sending a byte from microprocessor to memory (writing)? Easy, there's a pin which carries a read/write signal. The signal from this pin is normally logic 1, so that the microprocessor reads from whichever part of memory has been activated by the address signals. When the WRITE instruction is received the next clock pulse puts the read/write pin to logic 0, and holds it like that until another clock pulse restores it. That way, a similar pin on each memory chip can be held low to ensure that the gates inside the memory chips are arranged to receive a signal (at the register inputs) rather than send one out (from the register outputs).

Yes, of course there's a lot more to it, but this outline should dispel some of the mystery and explain some of the new words which fly around the microprocessor business. The important point is that once you have swallowed the ideas of digital electronics, microprocessors are just one more byte!

HE

Short Circuit



Diode-Transistor Tester

No apologies are made for including this circuit — there is nothing particularly new about it, but it is very useful when checking diodes and transistors and can save a great deal of time.

Potentiometer RV1 is kept at maximum resistance when a transistor is plugged into the socket, then slowly decreased until one of the LEDs glows brightly depending on the type of transistor (NPN or PNP). If both LEDs light up, the transistor has a short-circuit: if neither LEDs light the device has an open-circuit.

The same method applies to diodes. If the two leads of the diode are plugged into E and C (anode to E) the PNP LED will light up. If reversed the other LED will glow. As with transistors, if both LEDs light the diode is open-circuit.

By plugging in a new transistor with a known gain and observing the brightness of the LED and the position of RV1, you will get a rough idea of the gain of unknown devices.

If a metal box is used to house this project then it should be connected to the earth point in the circuit.

GUITAR PHASER	ZD85	Sept. '80	£9.60
BENCH POWER SUPPLY UNIT	ZD87	Sept. '80	£25.00
DEVELOPMENT TIMER	ZD86	Sept. '80	£8.75
TOUCH SWITCH (on Vero)	ZD84	Sept. '80	£4.50
AUTO PROBE	ZD83	Sept. '80	£3.00
REACTION TIMER	ZD82	Sept. '80	£26.50
MICROMIXER (on Vero)	ZD81	Sept. '80	£8.50
EQUITONE CAR EQUALISER	ZD52	Aug. '80	£13.30
GAS DETECTOR	ZD55	Aug. '80	£22.00
PASS THE LOOP GAME	ZD56	Aug. '80	£12.00
RADIO TIMER (on Vero)	ZD57	Aug. '80	£5.50
MOVEMENT ALARM (on Vero)	ZD54	Aug. '80	£5.00
OP. AMP CHECKER (on Vero)	ZD53	Aug. '80	£4.00
CAR BOOSTER (no speakers)	ZD50	July '80	£18.00
HAZARD FLASHER	ZD48	July '80	£10.50
★PUSH-BUTTON VOLUME CONTROL	ZD47	July '80	£19.50
SOUND FLASH TRIGGER (on Vero)	ZD49	July '80	£3.50
2 WATT AMPLIFIER (on Vero)	ZD46	June '80	£3.90
METRONOME (on Vero)	ZD51	June '80	£3.50
MICROBE R/C SYSTEM (less Servos)	ZD45	June '80	£17.50
FOG HORN	ZD44	June '80	£4.50
★EGG TIMER	ZD43	June '80	£6.50
MINI CLOCK	ZD10	May '80	£26.00
5080 PRE-AMP	ZD11	May '80	£32.00
TRACK CLEANER	ZD12	May '80	£7.75
★R/C SPEED CONTROLLER	ZD3	April '80	£9.60
HOBBY COM	ZD8	April '80	£28.60
ELECTRONIC IGNITION	ZD2	April '80	£18.25
DIGITAL FREQUENCY METER	ZD9	April '80	£27.75
SHORT WAVE RADIO	ZD80	March '80	£19.50
TOUCH SWITCH	ZD79	March '80	£5.00
5080 PSU MODULE	ZD78	March '80	£29.50
SYSTEM 5080A	ZD77	March '80	£15.00
PASSION METER	ZD6	Feb. '80	£5.00
WIN INDICATOR	ZD42	Feb. '80	£9.00
INFR RED REMOTE CONTROL	ZD7	Feb. '80	£19.35
SCALEXTRIC CONTROLLER	ZD41	Jan. '80	£52.50
CROSSHATCH GENERATOR	ZD4	Jan. '80	£11.25
DIGI-DIE	ZD5	Jan. '80	£5.50
RING MODULATOR	ZD1	Dec. '79	£8.50
SCALEXTRIC CONTROLLER	ZD39	Dec. '79	£21.50
BARGRAPH CAR VOLTMETER	ZD40	Dec. '79	£6.60
GUITAR TUNER	ZD38	Nov. '79	£8.50
★R2 D2 RADIO	ZD37	Nov. '79	£8.60
TANTRUM	ZD33	Oct. '79	£37.50

HOBBYTUNE	ZD34	Oct. '79	£18.00
MULTI OPTION SIREN	ZD36	Oct. '79	£10.50
ANALOGUE AUDIO FREQUENCY METER	ZD35	Oct. '79	£15.00
COMBINATION LOCK	ZD29	Sept. '79	£12.50
★STARBURST	ZD30	Sept. '79	£14.50
LAMP DIMMER	ZD31	Sept. '79	£6.50
ULTRASONIC SWITCH	ZD32	Sept. '79	£21.00
CONSTANT VOLUME AMPLIFIER	ZD28	Aug. '79	£11.50
INJECTOR TRACER	ZD27	Aug. '79	£4.50
LED TACHOMETER	ZD26	Aug. '79	£14.75
BABY ALARM	ZD25	July '79	£13.50
POINTS SWITCH	ZD24	July '79	£12.50
LINEAR SCALE OHMMETER	ZD23	July '79	£14.00
SHARK	ZD22	July '79	£22.75
G.S.R. MONITOR	ZD19	June '79	£10.50
ENVELOPE GENERATOR	ZD20	June '79	£11.79
DRILL SPEED CONTROLLER	ZD21	June '79	£7.00
WHITE NOISE EFFECTS UNIT	ZD18	May '79	£16.85
PARKING METER TIMER	ZD17	May '79	£6.70
DIGIBELL PROJECT	ZD16	May '79	£5.00
VARIABLE POWER SUPPLY 0.30V 1 AMP	ZD15	May '79	£30.00
TRANSISTOR GAIN TESTER	ZD76	April '79	£6.50
CISTERN ALARM	ZD75	April '79	£5.50
MODEL TRAIN CONTROLLER	ZD74	April '79	£26.00
PHOTOGRAPHIC TIMER	ZD73	March '79	£14.50
TONE CONTROL	ZD72	March '79	£9.00
CASANOVA'S CANDLE	ZD71	March '79	£7.50
SHORT WAVE RADIO	ZD66	Feb. '79	£12.50
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O Level Q & A

Test gear's the topic this month, and Nick Walton discusses moving coil meters and oscilloscopes

We will take a rest from high flying theory this month and consider test gear, in other words the basic instruments used by the hobbyist or the electronic engineer, namely the ammeter, voltmeter, and the ohmmeter as well as that highly versatile and useful device the 'scope or cathode ray oscilloscope to give its full mouthful.

Moving-coil Meters

The most common type of meter today (apart from the ever-increasing range of electronic digital meters) is based on the moving-coil movement. This consists of a small coil of wire free to twist within the magnetic field of a permanent magnet. When the current passes through this coil you will know from a previous article that it creates its own magnetic field. This interacts with the permanent field, resulting in the movement indicated by the pointer. One such meter widely used has a coil resistance of 1000 ohms and a full scale deflection produced by a current of 0.1 mA. This, by Ohm's law, implies a required voltage of 0.1 V for full deflection.

Measuring Amps, Volts and Ohms

You use this basic meter to give you an ammeter which reads currents greater than 0.1 mA by connecting a low value of resistance (called a shunt) in parallel with the coil. For instance, to read up to 1 mA you would choose a shunt resistance value which, for 0.1 V, took all the current except the 0.1 mA you wanted through the coil (see **Fig. 1**).

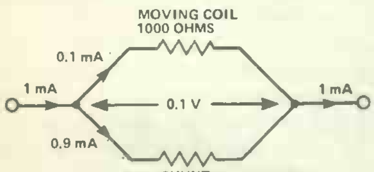


Figure 1. To convert a moving-coil meter into an ammeter, you connect a low-value resistance in parallel with it

Thus if the shunt has to take 0.9 mA for a voltage of 0.1 V it works out to be 111 ohms. Measurement of higher current would need lower-resistance shunts whose value can again be calculated by using Ohm's law.

Whereas the moving coil meter becomes an ammeter by adding a low resistance in parallel, it can be used as a voltmeter by adding a high resistance in series. For instance, to measure a voltage of up to 1 V, we need the resistance in series to account for 0.9 V to leave the desired 0.1 V across our coil. The current in this resistor, which remember is in series with our meter, must be 0.1 mA and the voltage across it is 0.9 V, all of which is shown in **Fig. 2**. So again with the help of George Simon Ohm we can deduce that it needs to have a resistance of 9k.

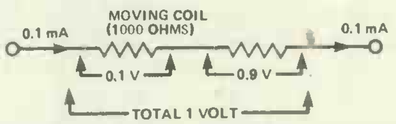


Figure 2. To convert a moving-coil meter into a voltmeter, you add a high-value resistance series with it

When it comes to making connections in the circuit, it is the ammeter you need to be most careful with. A mistake with it can cost you the instrument, whereas with a voltmeter connected wrongly nothing very much happens. You need not think very deeply to realise why the ammeter is vulnerable. When you want to measure a current in a circuit as in **Fig. 3**, it is as though you need to cut the wire and rejoin it through the ammeter. Since you do not want to reduce the current by the act of measuring it the ammeter must have as low a resistance as possible (ideally zero, though in practice this cannot be achieved) and this really is the trouble.

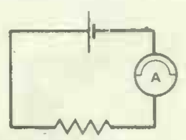


Figure 3. How an ammeter is connected into the circuit

For instance, suppose as previously you needed only 0.1 V to drive the pointer to full-scale deflection and in a moment of aberration you connected it *across* the resistor where there existed a voltage of 5 V, you would be putting 5 V across a meter designed to take 0.1 V; ie, fifty times too much. This would be the sad end of your instrument so watch out. Actually many ammeters these days are protected by two diodes connected across the ammeter as shown in **Fig. 4**. At first sight this looks pretty pointless till you remember that even in forward bias a diode needs a definite voltage to make it conduct, for example 0.3 V. Given that the little coil of the meter still needs 0.1 V for full scale deflection, it could probably survive being overloaded to 0.3 V for short periods. Any further overloading will result in one of the diodes conducting quite heavily if necessary thus protecting the instrument itself. But remember the law of nature (Sod's Law) which, when applied here, says that the one ammeter *you* overload is the one that is unprotected.

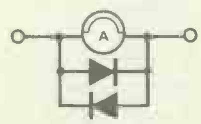


Figure 4. An ammeter fitted with diode protection

The voltmeter is not vulnerable like the ammeter. Since voltage is a difference in potential between two points you always connect it in parallel with the component across which the voltage exists. But there is a problem you need to watch and it is called the loading effect. It is tied up with the fact that connecting everything (even a high resistance voltmeter) in parallel with a component does actually provide an alternative route for the current and on occasions this can lead to damage resulting from a bigger current flow than was intended.

Suppose for instance you had a transistor with a resistance of 20k on the base to keep down the base current to, say, 0.1 mA. If you put your voltmeter — whose resistance could be 20k — across the 20k resistor, between A & B in **Fig. 5**, the resistance of the combination (voltmeter in parallel with R1) will be only 10k. This could allow too much base current to flow into the transistor which could cause damage. Manufacturers specify what they call a 'figure of merit' for voltmeters which is expressed in terms of ohms per volt and is actually the reciprocal of current at full-scale deflection. Generally, the ohms per volt rating needs to be much higher (at least, say, ten times) than the value of any resistance across which you might want to measure a voltage. The higher the ohms per volt rating of a voltmeter the more it costs, but electronic voltmeters are now available with figures of merit in excess of 1 Megohm per volt (ie a million ohms per volt).

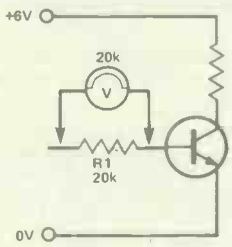


Figure 5. A voltmeter 'loading' the base resistor of a transistor

Ohmmeters are also useful things to have around and the simplest can work using Ohm's Law in the following way. Looking at the circuit in **Fig. 6** the unknown resistance is connected between A & B. Suppose the meter reads up to 1 mA, then if there is no resistance between A and B (ie A and B connected together) the pointer will indicate 1 mA (1 V from the battery and 1k in the circuit). So this will be marked out on the scale as zero. If the resistance across AB is now 1k, the total resistance in the circuit will be 2k so the current will be 0.5 mA on the scale which is where 1k will be marked on it. It turns out that the scale is back-to-front and not evenly spaced. Even-spacing on an ohmmeter scale needs sophisticated electronics and costs a lot.

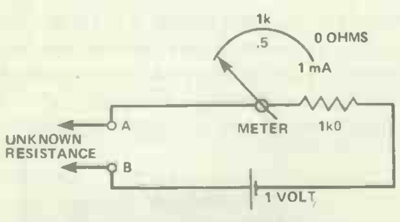


Figure 6. A design for a simple ohmmeter

Oscilloscopes

Our final topic is the cathode ray oscilloscope and the fact that it can fulfil so many functions is what makes it so useful. (See The Oscilloscope, HE, February 1981, pp 18 to 22.) Cost varies from about £100 to several thousand pounds. If you're thinking of buying one then it would be worth looking out for HE's repeated special offer next month.

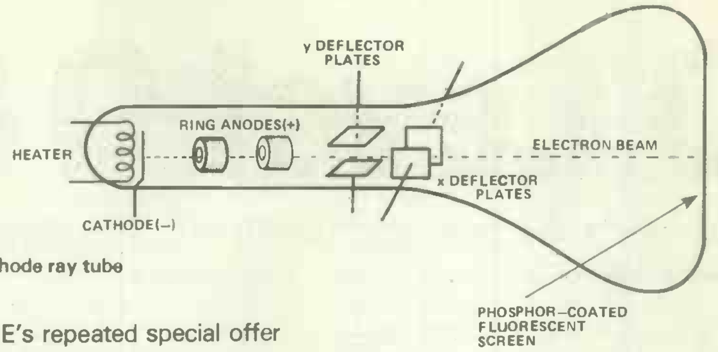


Figure 7. A cathode ray tube

Common to every scope is the cathode ray tube which is illustrated in **Fig. 7.** At the left-hand end you have a heated cathode from which you are boiling off electrons. Persuade these to move in a stream by applying a high positive voltage at the anode and you have what the early workers called cathode rays (since they originated from the cathode.) Now you play a dirty trick on the electrons which were so keen to reach the attracting anodes. The anodes are in fact ring shaped so the electrons go flying through and hit the screen which is coated with a phosphor compound and which emits light when struck by an electron. The function of the second ring is for focusing purposes.

Deflecting The Spot

Having got a sharp little point on the screen, what shall we do with it? Move it around. Indeed it is the movement which lies behind its usefulness. The movement is achieved by the two pairs of deflector plates. If you know the fundamental principle of electrostatics, namely that unlike charges attract, (that is, a positive charge attracts a negative charge) and that like charges repel, then you will have no difficulty in understanding how the deflector plates do their job. If you apply a voltage between a pair of plates, then this is actually identical to putting some excess positive charge on one plate and negative charge on the other. So when the (negative) electrons of the beam enter this region (called, incidentally, an electric field) they will be attracted to the positive side and repelled from the negative side. Looking at **Fig. 7** once again, if we suppose the first set of plates are charged so that the top plate is positive and the bottom negative then the electrons will be deflected upwards. They will not actually hit the deflector plates because they are travelling too fast and are out of the field before they have undergone any more than a few degrees change of course. The first pair of plates is called the Y-plates after the graph-drawing convention which says that when plotting a graph of y against x the vertical axis is y and the horizontal axis is x. Thus you can see from **Fig. 7** that the second set of plates is positioned to deflect the plate horizontally which is why they are called the X plates. Thus the two knobs marked 'X shift' and 'Y shift' on the front panel of the instrument (see **Fig.8**) simply alter the voltage on the X and Y plates.

But the story does not quite end there and we need to consider refinements to both these controls. In most applications the spot is actually swept across the screen from left to right. It then nips back very smartly and repeats rather like the motion of your eyes as you read this article. The control responsible for this is called the timebase and its settings indicated on the front panel by the control knob are expressed in terms of time taken to cover one centimetre. For instance, a typical setting might be labelled 2 ms/cm which means that the spot takes two milliseconds (that's two thousandths of a second) to cover one centimetre of the screen. Mathematical genii will notice that the units are the reciprocal of speed and it is fun to work out how fast the dot is travelling — in this example a mere 500 cm per second. On good oscilloscopes the maximum timebase setting is around one microsecond (ie a millionth of a second) per centimetre. Faster than about 50 ms/cm the dot just appears as a solid line as your eye cannot keep up

Figure 8. Front panel of an oscilloscope (Kikusui 538A) showing the various controls

with it. It's the timebase control which enables you to time things since you can relate distance across the screen to time in seconds, milliseconds or microseconds. In one particular application shown in Fig. 9 the bunched-up waves on the left hand side of the screen indicate the time for which a hammer was in contact with a metal rod. Contact ceased when the trace went flat. The bunched-up waves occupy 4 cm of screen and, on a timebase setting of 100 us/cm we can conclude that 4 cm across the screen accounts for 400 us, the contact time for the hammer.

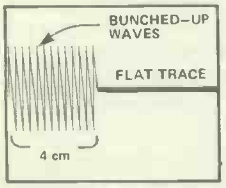


Figure 9. Using an oscilloscope to time how long a hammer was in contact with a metal rod

Additionally if you measure time intervals, you can measure the time for one complete wave to be displayed on the screen, from which you can find the frequency.

You can also measure voltage on the oscilloscope by using what is called the voltage sensitivity control. This control is calibrated in volts per centimetre on the front panel and it simply indicates how far the spot is deflected for a given voltage. So if you were on 5 V/cm setting and the spot jumped up a couple of centimetres as a result of a signal you put in, you would know you had a voltage of 5 x 2 = 10 V.

Two great advantages of the oscilloscope as a voltmeter are that it has a high resistance (about a megohm) and secondly that it does not care whether it is looking at DC or AC (any frequency). Perhaps you can see now why anyone with any serious interest in electronics would find an oscilloscope so useful.

That just about rounds things off for this month. Space and time do not permit me to cover logic even though our syllabus requires knowledge or the NOT gate together with the AND, OR, NAND and NOR gates. These are superbly dealt with by Ian Sinclair in the October 1980 issue of HE. Similarly, the multivibrator (astable and bistable) will be dealt with elsewhere in HE, so there's lots to read. Cheers!

CORRECTIONS

The gremlins were going strong in the November 1980 article and corrections should read as follows:

The resistance R_{AB} of two resistors R1 and R2 in parallel should read:

$$\frac{1}{R_{AB}} = \frac{1}{R1} + \frac{1}{R2}.$$

The Ohms' rating (reactance) of a capacitor is given by:

$$\frac{1}{2\pi fC}$$

where $\pi = 3.14$ as in circles, f is the AC frequency and C is the capacitance.

Also,

$$\text{Farads} = \frac{\text{coulombs}}{\text{volts}}$$

$$C = \frac{Q}{V}$$

A microfarad is one millionth of a farad, and in the December 1980 article the formula relating impedances to turns ratio should read:

$$\frac{Z_1}{Z_2} = \left(\frac{N_1}{N_2}\right)^2,$$

and in the resonant frequency formula, a square root sign escaped, and it should read:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

HE

HI THERE, H.E. MEN! WE'RE OFF TO SEE ANOTHER READER'S INVENTION
THIS TIME WE'RE IN THE BIG CITY...
WHERE VIOLENCE AND VANDALISM REIGN SUPREME
TUFF STREET
SO THEY SAY... WHAT ROT!
I'VE COME TO SEE THE INVENTION OF MR. IVOR YELLASTREEK
WHO CLAIMS HE USES IT TO ESCAPE VANDALISM AND VIOLENCE
NO CALLERS
THIS MEANS YOU!
I'LL CALL THE POLICE!
GO AWAY
AH! HERE'S HIS HOUSE NOW
IDENTIFY YOURSELF
MR. YELLA-STREEK IT'S ME THE PROF
LET ME IN
HMMM... DOESN'T DO YOU JUSTICE
SEE - HERE'S A PICTURE OF ME
PLEASED TO MEET YOU MR. YELLASTREEK
HELLO
NOW WOULD YOU EXPLAIN YOUR NEW INVENTION TO OUR READERS
THEY WON'T HIT ME?
THERE IT IS...
THAT'S A SUBMARINE! DID YOU BRING ME TO THIS FOUL NEIGHBOURHOOD TO SEE A SUBMARINE!
DON'T HIT ME
IT'S NOT A SUBMARINE - IT'S A SUB-TERRAIN!!
COME FOR A TEST RUN
BUT, DON'T HIT ME
FLETCH
WE'RE IN CLAY STRATA NOW...
IT WILL TRAVEL THROUGH ANY SOLID
...USING THIS I CAN GO TO THE LIBRARY SAFELY
YOU PROMISE YOU WON'T HIT ME?
BY USING THE EXCAVATOR ROTORS I CAN EVEN DIG A TUNNEL AND WALK MY DOG!
GRRRRRR (DON'T HIT ME)
FASCINATING MR. YELLASTREEK - BUT WHAT IF SOME VANDALS GET HOLD OF ANOTHER SUBTERRAIN??
I DEAL WITH THEM LIKE THIS... FIRE 1, FIRE 2
YES PROFESSOR THIS INVENTION IS ALMOST PERFECT
ALMOST?
WHAT'S WRONG WITH IT?
JUST ONE THING
IT'S NOT (GLUB GLUB)
WATERTIGHT
AAAH
YOU SAID YOU WOULDN'T HIT ME!

What's In A Name

To end this series, Rick Maybury discusses electronic equivalents to our sensation of touch

THIS MONTH we look at systems and components that duplicate our sense of touch. From the outset it must be said that touch is a fairly empirical term: for instance, it includes the ability to detect temperature change and to sense changes in pressure. By comparison, electronic detectors allow these changes to be *measured*. Although these measurements may be accurate, they are crude compared with the total sensation of touch at the fingertips. The information transmitted from the fingertips through the nervous system to the brain enables us to *process* these minute sensations, localise them and, for example, set limits on the temperatures or pressures that we can safely endure. The built-in alarm system associated with these limits is pain!

In this final part of the What's In A Name series we will look at one electronic equivalent of touch sensation, namely that of pressure.

We can detect very small pressure changes with our own senses. For example, we can 'feel' a feather as it is brought in contact with the hand. (Our response to small changes in atmospheric pressure is another example.) Electronic devices have the edge on our own sensitivity, because devices known as strain gauges which detect *movement* due to a change of pressure or force can measure down to about one millionth of a gram or less. We'll have a look at these first.

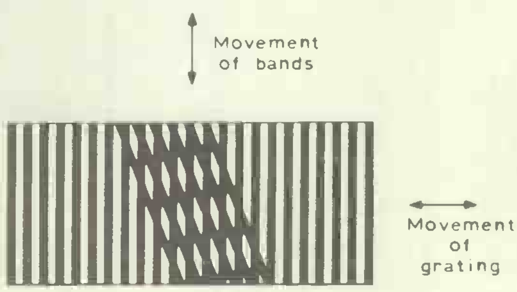
Sadly, most electronics enthusiasts will never make use of strain gauges. Sad because these devices are highly versatile measuring transducers which could have many interesting applications for the hobbyist. (Perhaps we'll think of one or two for you to build as future projects in HE.) The most common form of *industrial* strain gauge uses the now familiar piezo-electric effect. You may remember that we dealt with piezo-electric devices when we looked at microphones. The transducer works by mechanically transmitting movement to a piece of quartz crystal. The structure of the crystal is such that any distortion 'frees' a number of electrons, within the structure, which can then be fed to an electronic circuit for measurement. The number of electrons, or current, that will flow is directly proportional to the amount of movement so we can obtain a direct measure of that movement.

Leaving aside piezo-electric transducers there are a number of other quite familiar components that can be used to detect the movement due to a force. Our old friend the potentiometer is actually a case in point. In its most usual form it can measure a rotary motion in terms of changing resistance. Simple mechanical linkages can change the motion into a linear (straight line) or angular motion that is directly measured as a resistance.

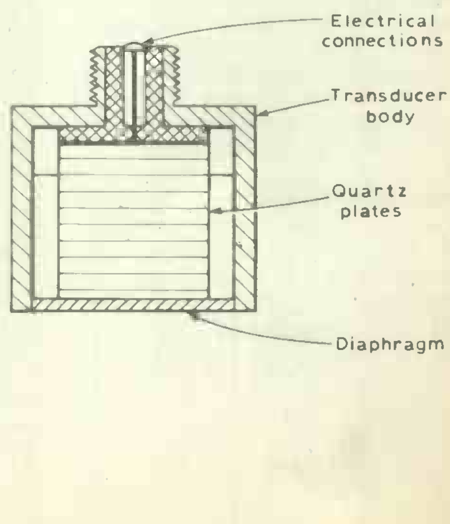
Pressure or force can also be detected simply with the common-or-garden mechanical switch. Of course, a push button or toggle switch will not tell you *how* much force is being exerted but it will tell you whether the force is there or not. Simple microswitches, for instance, are used in their millions on many types of machinery that require some kind of sensor to detect a predictable force and that is in essence what the basic touch receptors found on our own bodies do.

The last type of detector we shall look at is not exactly a purely electronic device but it is worth a mention because of the incredibly small changes it is capable of measuring. The interferometer uses the properties of coherent light to resolve unbelievably small movements between two optical sensors. At present it is possible to detect a movement less than 0.1 um. That's difficult to imagine, isn't it? In terms we *can* understand, it will measure a movement between two bodies about the size of an atom. Human senses are pretty efficient but it is doubtful whether anybody could feel an individual atom falling onto their skin! We do have one advantage however, the touch receptors in our own skin are about the size of a pin head, and even the wizardry of the silicon chip has a long way to go before it can come up with a transducer as small as that.

HE



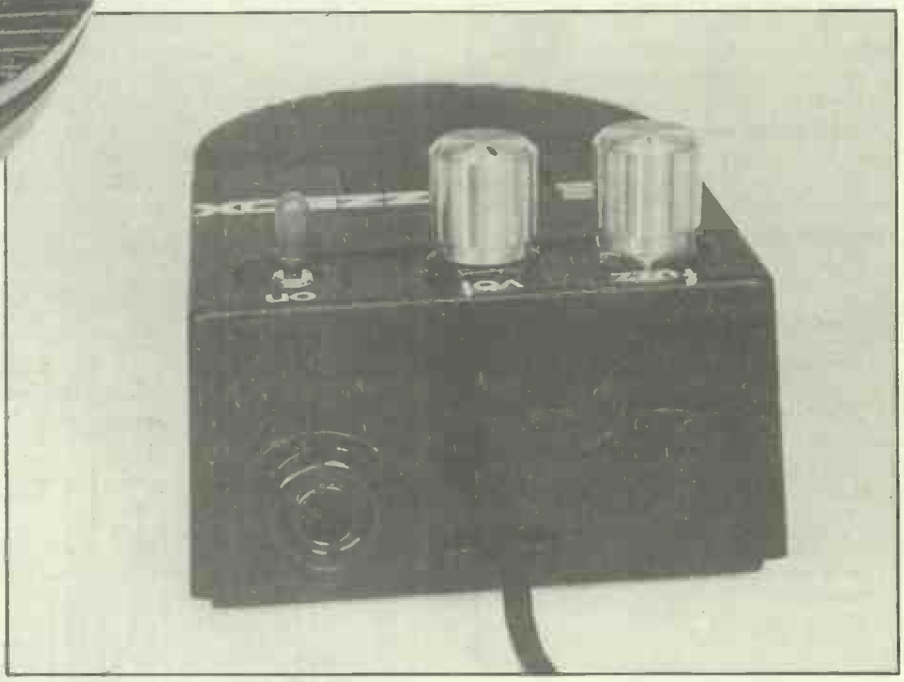
Left. Measurement of movement by optical means. Two gratings placed above one-another will produce interference patterns that can be used to determine movement



A piezo-electric pressure sensor. Any movement on the diaphram will be mechanically transmitted to the piezo-electric elements which in this case are made of quartz. The electrical signal is monitored at the top of the transducer

Guitar Fuzz Box

Produce delightful distortion from your electric guitar in a novel way. A cheap and simple-to-build project with foot-pedal control



THE STORY GOES that the first group to use a 'fuzz' effect in their music was the Kinks. Apparently, one of their loudspeaker cones was split and they couldn't afford to replace it so they simply made use of it — and fuzz was born.

Now whether the story is true or not, we don't really know. One thing for sure is that the effect has been recreated electronically in many different ways, but none with the controllability, or the simplicity of the HE Fuzzbox.

The design of our fuzz evolved with a lot of thought. We studied how the effect is normally made and all the consistent disadvantages with such methods, till eventually we came up with a new concept around which our design is built. A single integrated circuit, of the operational amplifier family, together with only a handful of passive components (ie resistors and capacitors) are used in the fuzz unit to produce a very 'smooth' sound which we feel is much superior to the usual harsh fuzz.

From the photographs you will see that our prototype is housed inside a brand-new style of box, complete with a pedal to operate an internal switch. We just couldn't resist being the first magazine to use it for a project and a fuzz box seemed ideal. There's just enough room inside to fit the circuit, battery, a jack socket and controls, and we can tell that it's going to be a very popular type of housing for projects, particularly in the musical effects line.

Quiescent current drain of the HE Fuzzbox is only 2 mA, so long battery life can be expected and a single PP3-type battery should last for months with normal use.

Because our Fuzzbox operates in an unusual manner we have been able to design it as a low-distortion (hi-fi quality) preamplifier which will amplify the guitar signal level to about four times its original size — this can be useful in itself.

Construction

The usual constructional precautions should be taken, consistent with the use of Veroboard (ie make track breaks where indicated and check that no short circuits between adjacent tracks occur). Breaks in track can be made by gently twisting either the correct tool for the job, or alternatively a hand-held, small drill bit (about ⅛"), against the hole in question until a neat break is formed through the copper strip and the two sides are no longer in electrical contact.

Insert and solder all the components, starting with resistors,

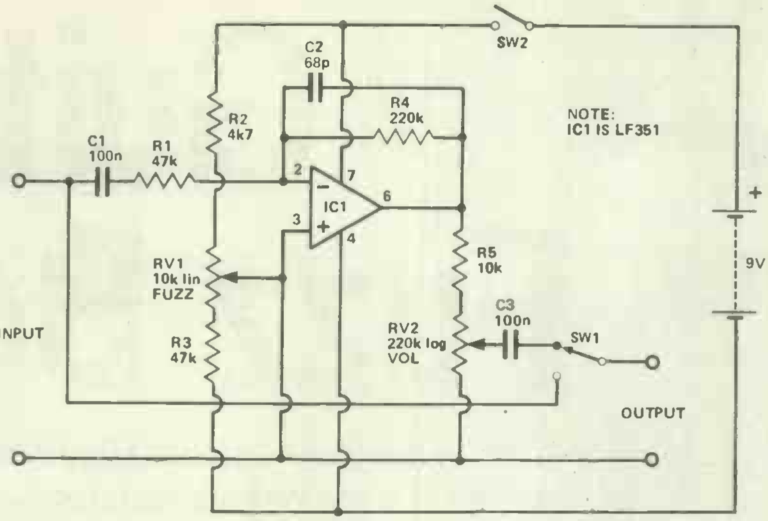


Figure 1. HE Fuzzbox circuit diagram. The simplicity of the project makes it ideal for the beginner

Figure 2 (below). Veroboard layout, connection details and underside view of the board showing track breaks

Parts List

RESISTORS (All ¼ W, 5%)

R1,3	47k
R2	4k7
R4	220k
R5	10k

POTENTIOMETERS

RV1	10k linear potentiometer
RV2	220k logarithmic potentiometer

CAPACITORS

C1,3	100n ceramic
C2	68p polystyrene

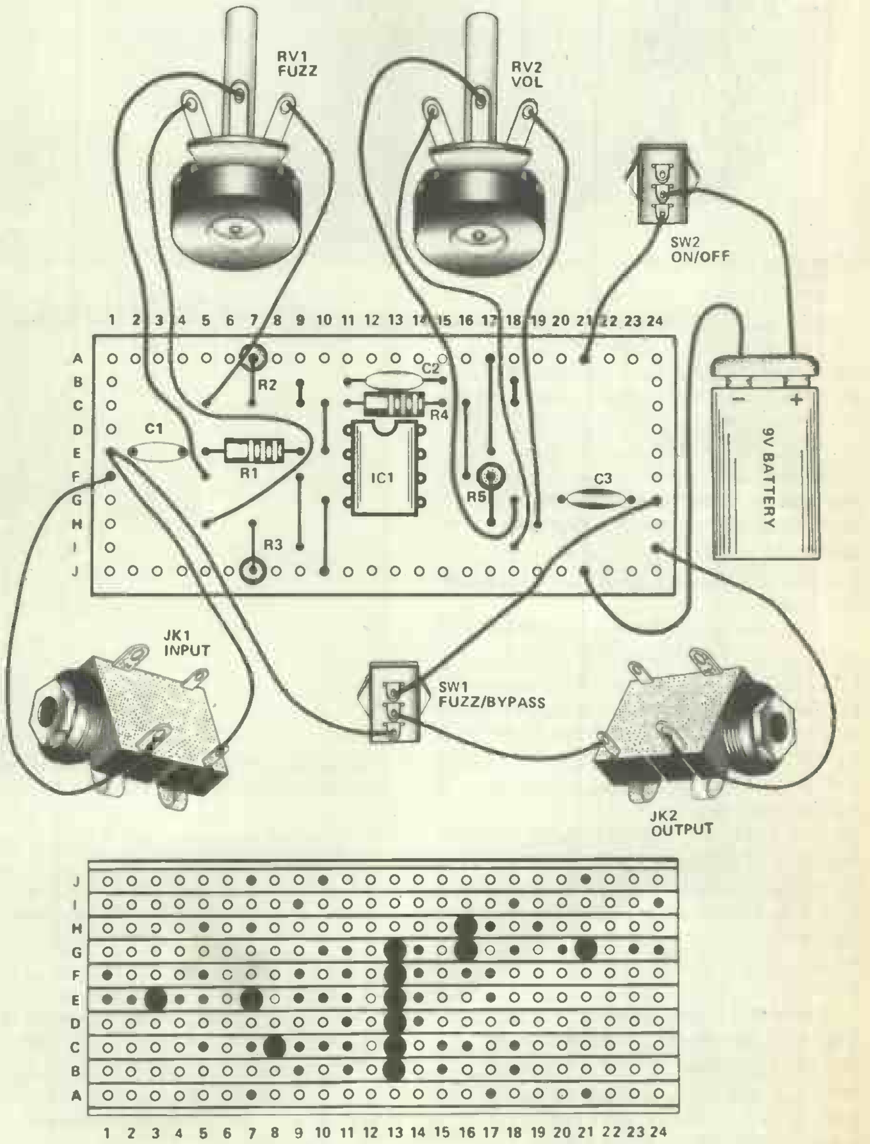
SEMICONDUCTORS

IC1	LF351 JFET operational amplifier

MISCELLANEOUS

SW1	single-pole, double-throw slide switch (included in case — see Buylines)
SW2	single-pole, single-throw toggle switch

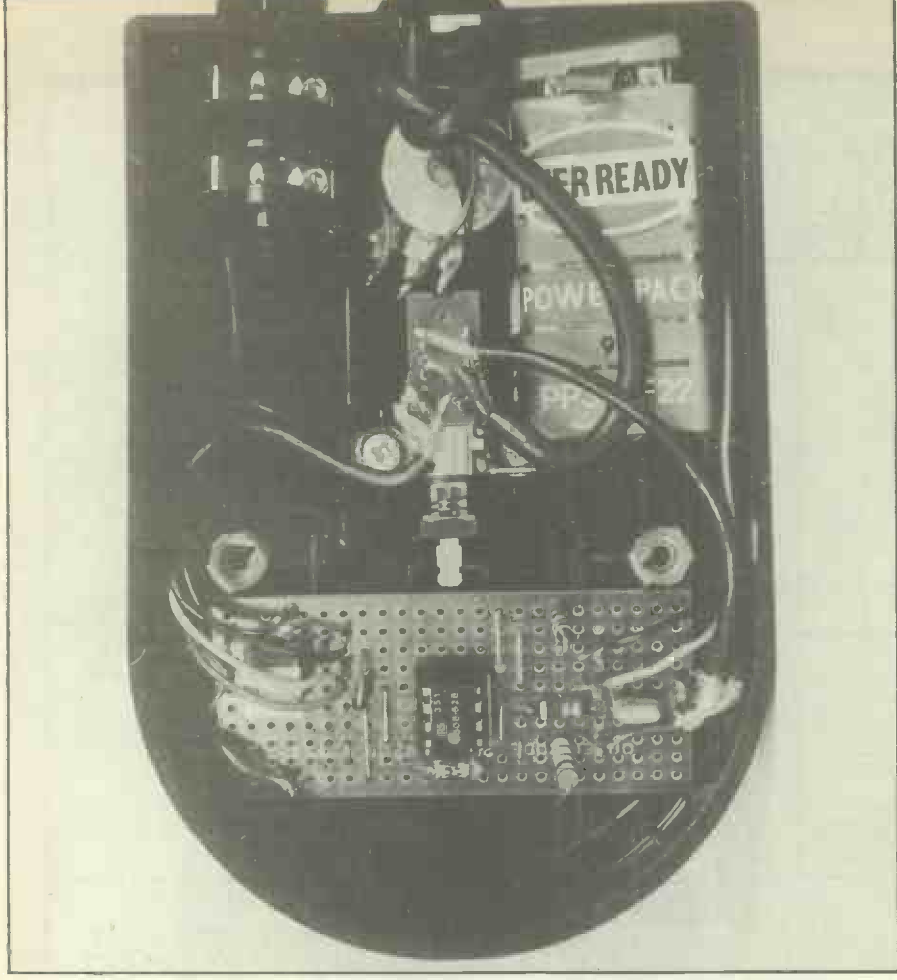
2 x ¼" jack sockets (only one needed if case is used)
Battery and clip
Knobs
Case to suit (see Buylines)
10 strip x 24 hole, 0.1" Veroboard



then capacitors and finally the IC as shown in Fig.2. Wiring up should be done as per connection details and then you can test your project. There is little to go wrong so providing your constructional skills are up to scratch the fuzz should work first time.

Although this project was designed to suit the case featured it will, with care, fit into almost any small case. In the connection diagram in Fig.2 we have included a jack socket for output, but this is optional. If you use the same case as us which comes complete with output lead, the second jack socket is not necessary, just connect the lead to SW1 as shown.

Guitar Fuzz Box



Internal photograph of the project showing how tight a fit it all is. Everything should fit neatly into the case with care

Use screened lead for input and output connections (the screen should be connected to 0V) thus keeping interference to a minimum

Buylines

The components for this project should cause few problems. IC1, the LF351, will be obtainable from most mail order companies. The smart case which we used can be bought from Magenta Electronics, and the price, which is complete with lead, plug and switch is £5.65 (inc. VAT), p&p 40p.

Magenta can also supply a complete kit of parts (including case) for HE Fuzzbox for £9.41. This price includes VAT but please add 40p for p&p.

How It Works

Most fuzz circuits use a high-gain amplifier to boost the output signal of your guitar to a greater level than the amplifier can supply without severe distortion. Figure 3 shows this effect graphically. Distortion (fuzz) occurs purely because the output is clipped by the amplifier saturating and cutting off. Two distinct disadvantages occur with this method — the distortion is very harsh and a lot of background noise can get in the way because of the amplifier's high gain.

Now, it might seem odd to you that we're complaining about too much distortion and noise in a circuit, that at first sight should do nothing but create distortion and noise. The reason for our complaint lies in the fact that the device is supposed to be a *musical* effect. If you distort the sound *too* much the musical part of it is overshadowed by the harshness.

So, a fuzz with not quite the distortion (or at least a more controlled distortion) and preferably lower amplification (to keep down the level of background noise), is required. HE Fuzzbox is just that!

Integrated circuit IC1 is an operational amplifier (op amp) connected as an inverting amplifier with a gain of about five. This means that for an input signal of say, 10 mV from your guitar, the IC's output is 50 mV. The potential divider of R5 and RV2 reduces this to a variable amount of between zero and about four times.

Potentiometer RV1 biases pin 3 (the non-inverting input) of the amplifier and hence the amplifier itself into AC operation, and also provides an earth point for the input and output. By altering the position of RV1 the circuit's earth moves in relation to the power supply rails and therefore the AC signal at the output of the op amp moves up and down with a DC bias. At the lower end of the pot, ie fuzz effect at minimum, the output signal suffers no restrictions from amplifier saturation. The output is merely an inverted, amplified replica of that at the input — and the device functions as a pre-amplifier. As the fuzz control is moved clockwise the earth moves positive until the output become clipped on the larger positive half-cycles. Figure 3 shows this effect. Further increases in earth voltage, as the pot is turned more clockwise causes an increase in the clipping effect.

The important points to note are that no further gain is required to increase the fuzz effect and clipping only occurs on one half cycle of the waveform. A very 'clean' and controllable distortion occurs which is more musical and more adaptable to the needs of the individual guitarist.

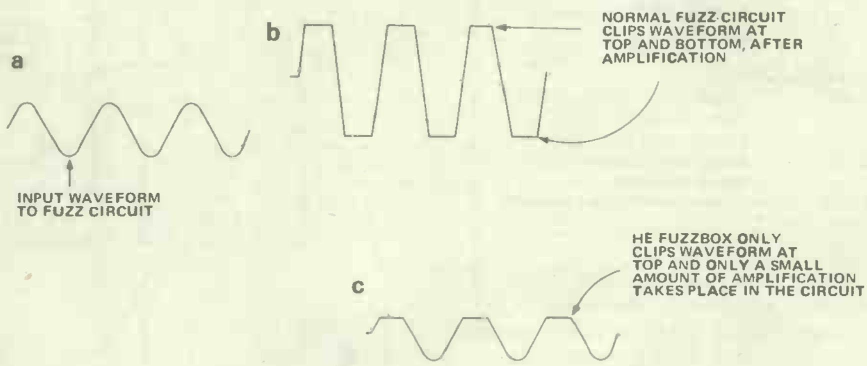


Figure 3. a) A possible input signal b) The output of a conventional fuzz circuit c) The output of the HE Fuzzbox

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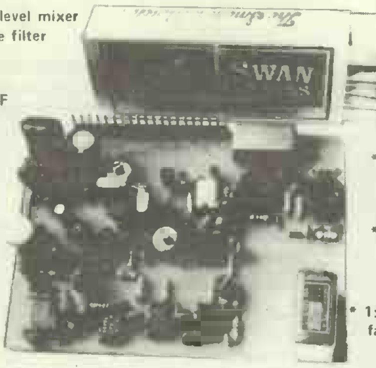

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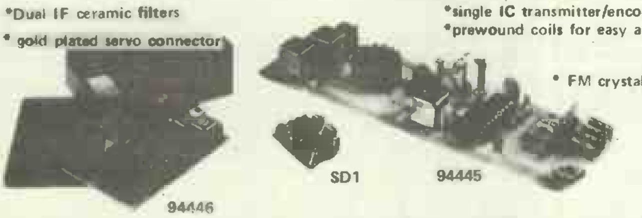

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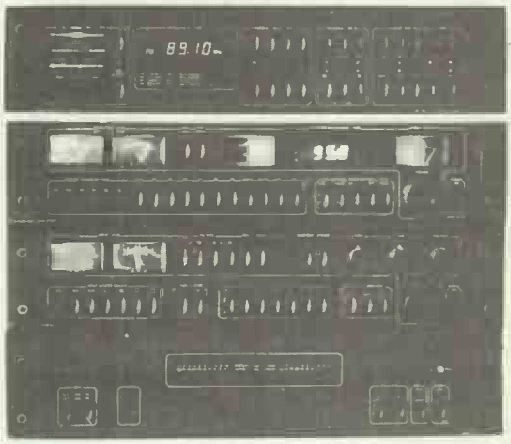

The Mark III series of HiFi is the ultimate DIY audio system. There are probably more features and facilities to the square inch of front panel than any other commercial HiFi around - let alone DIY systems. From the twin 500VA PSUs of the HMOSFET 100W power amp, to the 1dB tracking of the DC controlled preamp and the versatility of the CMOS MPU controlled tuner, there is no match for performance, style or sound quality - come and hear for yourself in our foyer.

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The FC177 (alongside) displays AM LO's up to 3.9999MHz directly - and with the prescalar unit (DFM7) the system displays SW and VHF in 1kHz and 10kHz resolution resp. FC177: £26.16; DFM7:£36.22 (prices include VAT)

Photographic Timer

You won't get caught in the dark with this one — time your photographs to perfection with this cheap-to-build, simple project

The HE Photographic Timer will fit into any suitable-sized small case and when finished will be a valuable addition to the darkroom

We could not be accused of overcomplication with this simple photographic timer project, which uses only about half a dozen components. The unit has a LED indicator which flashes regularly at one second intervals, and it can be employed as a simple enlarger timer, to time exposures lasting several seconds with the camera set to 'B' or 'T'. There are many other uses for this timer.

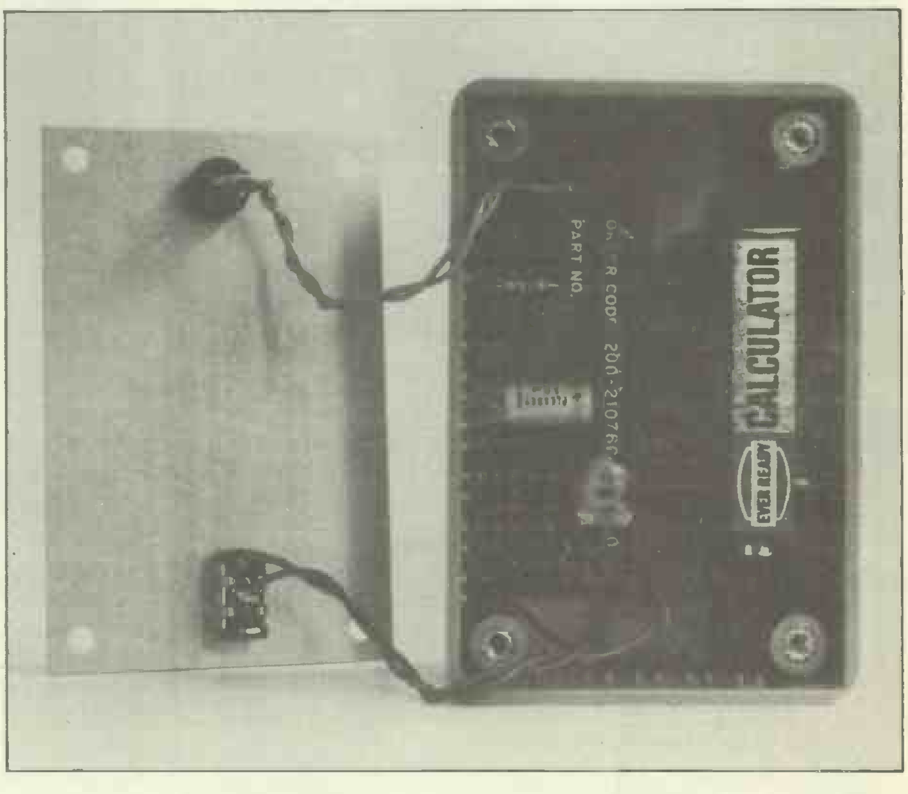
It is inexpensive and extremely simple to construct, being well within the capabilities of even a complete beginner: it makes an ideal first project.

Construction

The few components fit easily onto one of our standard size (24 holes by 10 strips) 0.1" pitch Veroboards, as shown in Fig. 2. Building the component panel could not be easier, but be careful to connect LED1, Q1 and C1 the correct way round, and be sure to connect the battery clip with the right polarity.

Practically any small metal or plastic case should be adequate to house the timer. Indicator LED1 is mounted on the front panel using one of the special panel holders available for the device. This panel holder can provide the mounting for the component board.

Potentiometer RV1 is given the correct setting by trial and error, comparing the flash rate of LED1 against a clock or watch which gives seconds' indication. In use the unit is started by closing SW1. The shutter is opened or the enlarging lamp is switched on at the first flash, and then the appropriate number of flashes are counted. On the last count, the shutter is closed or the enlarging lamp switched off. The period from switch-on to the first flash is slightly more than one second, and should not be used as part of the timing period.



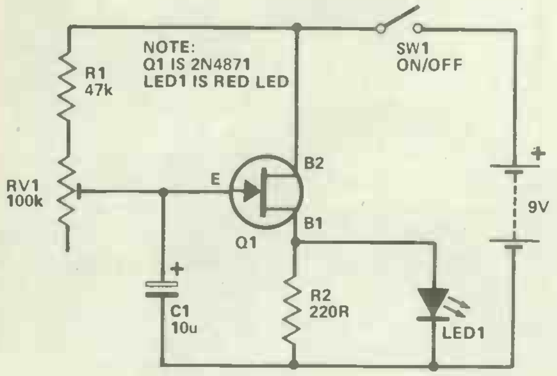
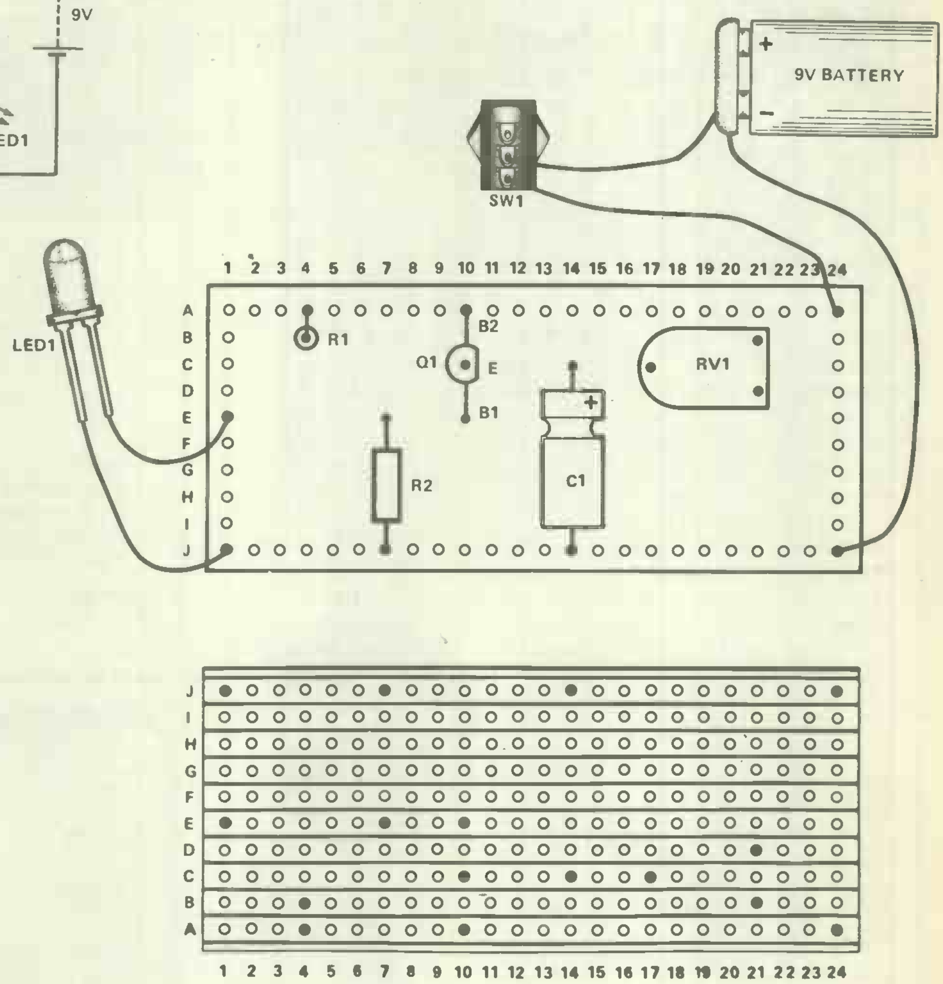


Figure 1 (left). Circuit diagram of this simple project

Figure 2 (below). Veroboard layout, underside view and connection details. Note there are no track breaks



Parts List

RESISTORS (All ¼ W, 5%)
R1 47k
R2 220R

POTENTIOMETER
RV1 100k miniature horizontal preset

CAPACITORS
C1 10u, 25 V electrolytic

SEMICONDUCTORS
Q1 2N4871 unijunction transistor
LED1 0.2″ red LED

MISCELLANEOUS
SW1 single-pole, double-throw toggle switch
Case to suit
10 strip x 24 hole 0.1″ Veroboard
Battery and clip

Buylines

All the components used in this project are standard readily obtainable items, and the total price (excluding the case) should be approximately £4.

HE

How It Works

A unijunction relaxation oscillator makes a good basis for a project of this type since it gives the necessary short pulses of current required to give brief flashes of a LED indicator, and it does not need a stabilised supply to give good frequency stability. A circuit of this type is also simple, as can be seen from the circuit diagram (Fig. 1).

There is normally a resistance of a few thousands of ohms between the base 1 and base 2 terminals of a unijunction transistor, and a potential divider circuit is therefore formed by the unijunction device Q1 and resistor R2. Because of the comparitively low resistance of R2 the voltage appearing across this component is well below the threshold voltage of LED1, and the latter will not light up. The input impedance at the emitter of a unijunction is very high under normal operating conditions, and at switch-on C1 charges by way of R1 and RV1.

Capacitor C1 continues to charge until it reaches a charge voltage of about 80% of the supply voltage, and Q1 then triggers. This results in the emitter-to-base 1 impedance of the device dropping to a level of just a few ohms. A rapid discharge takes place through Q1 and the parallel impedance of R2 and LED1, the latter being brought into the state of conduction by the current flow through R2 and the consequent rise in the voltage across this resistor. Because of the low impedance of C1's discharge path its charge diminishes very rapidly to the point where Q1 is no longer maintained in the 'triggered state', and Q1 quickly reverts to its original state. Thus there is only a brief pulse of current through LED1, and it produces only a brief flash.

With Q1 back in its original state C1 is free to charge up once again, but the charge on this component soon reaches the trigger potential of Q1 once again, causing the device to trigger and discharge C1. This cycle is repeated indefinitely, giving a regular series of flashes from LED1. Potentiometer RV1 controls the charge rate of C1 and in practice it is adjusted to give the required flash rate of one per second.

The current consumption of the circuit is only about 1 to 2 mA, and each PP3-size 9 V battery gives many hours of use.

CB Breaker One Four

The publishers of HOBBY ELECTRONICS would like to point out that it is at present a contravention of the Wireless Telegraphy Act of 1949 and 1968 to use, manufacture, install or import CB transmitting equipment. It is not the intention of Modmags Ltd to incite, encourage or condone the use of such equipment.

Rick Maybury reports on the response to the Open Channel Green Paper. He has some interesting news snippets too

I'M NOT NORMALLY given to rumour-mongering. In fact, as I've said on many previous occasions, I'm dead against it. But for once, I'm going to do a little crystal gazing, based on several very interesting snippets that have found their way into the HE office. It would seem that our friends in the good old Home Office are a little tired of CB. To them it is a nagging irritant that is not going to disappear: their Open Channel proposal fell on totally uninterested ears. The response to the Green Paper was, according to the HO, in the region of 12,000 responses. This figure is made up of group responses, clubs etc which only count as one response, so the overall figure is probably much higher.

The responses fell roughly into two categories, those from potential industrial and commercial users and those from private individuals. Not surprisingly the commercial and industrial users were not wholly against the infamous 928 MHz OC system, so we might see some developments in that area after all. The responses from private individuals, clubs etc were also predictable in their content. They were almost unanimously in favour of using a 27 MHz system.

Now, the two other snippets that connected together concerned the recent introduction of a CB system in France, very similar to the Dutch system introduced last year, and the hint from someone well connected with the HO that an internal directive had been issued to 'sort it out fast'. The two broadcasting organisations that still occupy the 41 to 49 MHz band (ie the IBA and BBC 405-line TV transmissions) have made it clear that they will not discontinue their service before the appointed date — sometime in 1985 — so it doesn't take much intelligence to work out that there are only a limited number of options open to the authorities.

The most logical step now would be for them to follow the French and Dutch with a rationalised CB system on 27 MHz using a low power output (possibly 2 watts?) and to ease the problems of interference, adopt FM (frequency modulation). It is also worth pointing out that both the French and Dutch have opted for a limited number of channels, around 20 or 22.

Now, all this is pure conjecture: if I'm wrong I apologise but my sources indicate that some kind of announcement will be made around February or March. I'll say no more, just sit back and wait with everything crossed.

Club Happenings

Back to the more mundane matters now with a round-up of the month's events. Just around early January the Big E club from Tottenham held a 'Come As Your Handle' fancy dress party. The results were, as you can imagine, pretty incredible. I had hoped to show you some pictures of the event but they did not arrive in time. As a postscript to this story, the caterers hired for the party presented the club with an enormous cake complete with a rig made out of icing. Rather than eat it themselves, and I'm sure the temptation was enormous, they generously donated it to the Great Ormond Street Hospital for Children.

'A simple call of 'Hey, Waiter', would have been more than enough,Sir!'

Still with the clubs, the Colwyn Bay CB Club organised a New Years' Day pram race and swim. The proceeds from the sponsored swim went to a local childrens' home. In the pictures below you can see the intrepid contestants nearing the end of the race.

We now have well over 100 CB clubs on our files and for a complete list of the major clubs see the club directory in this month's edition of Citizens' Band magazine.

Competitive Accessory Prices

The accessory scene is really hotting up now. An average of two shops each week open up in London alone. This is obviously good news for the breakers as the inevitable price-cutting war has led to some impressive bargains. Only a year ago the average price for a DV27 antenna was around £15.00. Now you can pick one up for as little as £5.75. Inflation does not seem to be affecting this particular part of the British economy. Anyway, the point of all this is to offer a small prize to the sender of the price of the cheapest DV27 currently available. A genuine HE tee shirt will be dispatched to the sender of the name and address of the company that offers this popular antenna under the cheapest price tag — any offers?

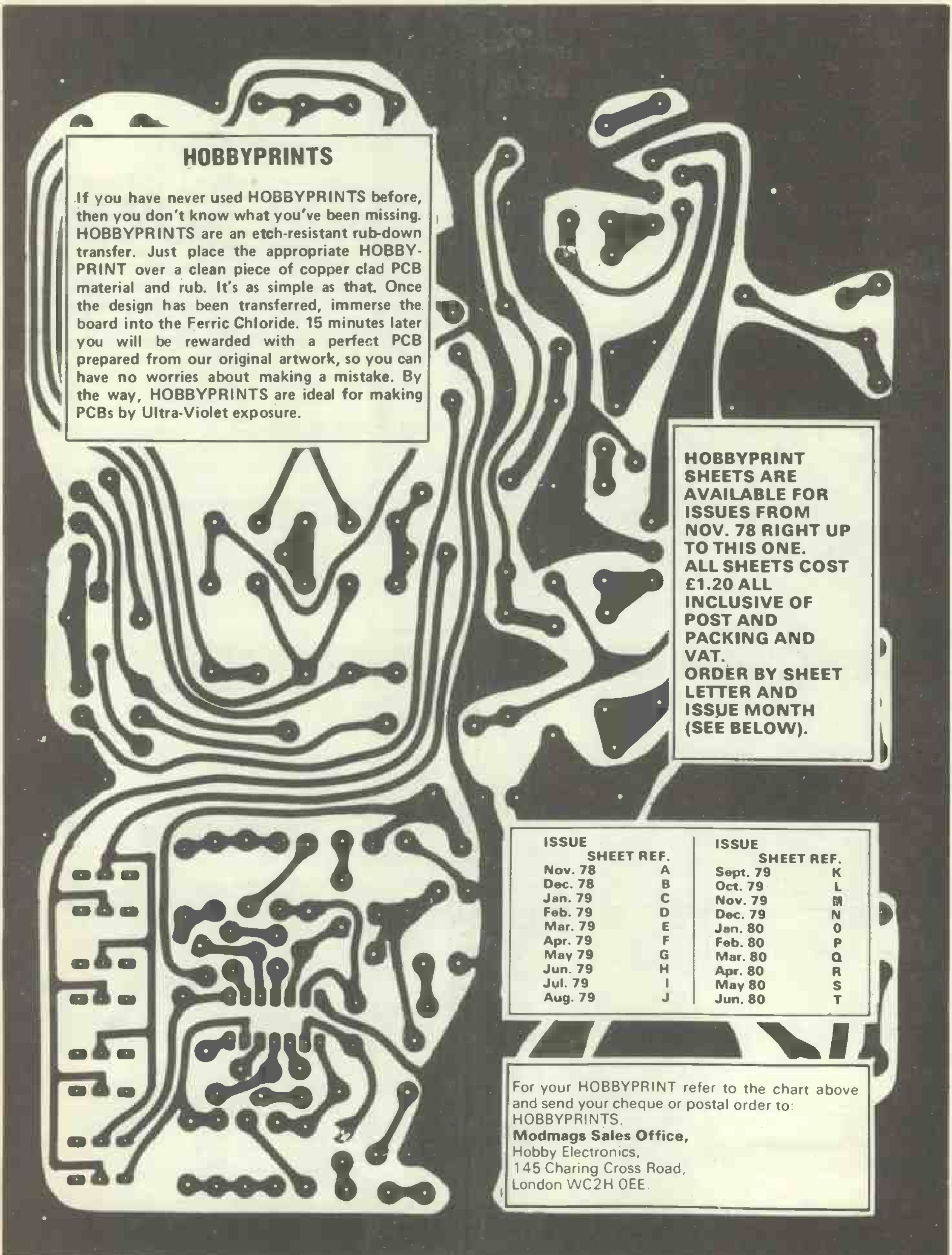
Press Support For CB

Last item this month concerns the impressive coverage given to CB by one of this country's leading daily papers. Many of you will have seen the campaign published in the Star newspaper. The small petition form is a step in the right direction but there is one nagging doubt, are they just jumping on the bandwagon. Their inestimable help would have been much more appropriate six months ago. Oh well, any publicity is good publicity so thanks to the people concerned at the Star and I hear that Andy Donovan (Disco One), president of the UBA, had a hand in this particular campaign — well done to all concerned.

Time's up once again, keep your fingers crossed and with a little luck I'll have some good news for you next month.

Is CB worth this? Galloping breakers compete in Colwyn Bay CB Club's New Year pram race

Hope there's not a rig in that handbag! Club members hurtle toward the end of the pram race



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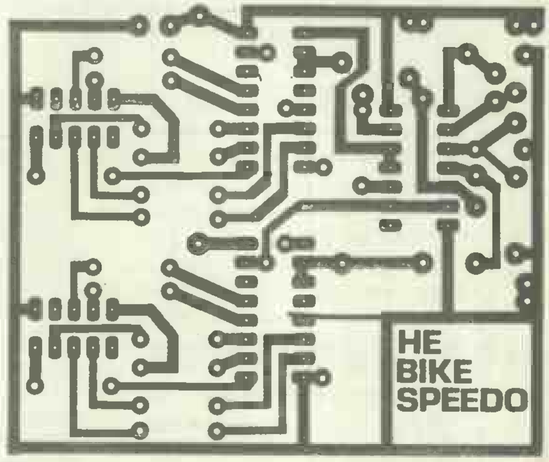

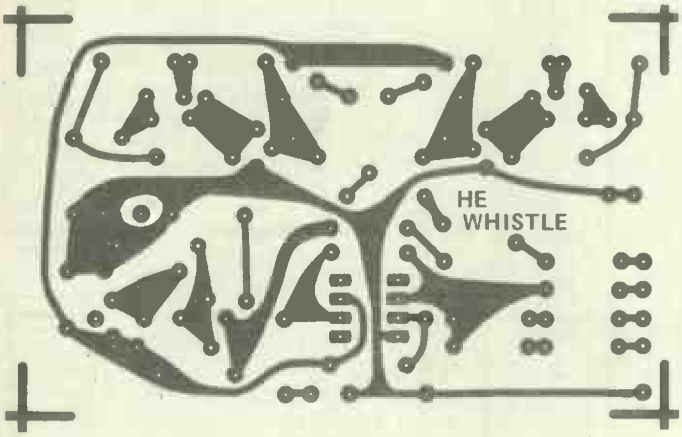

Above: The PCB foil pattern of the HE Bicycle Speedometer

Left: The HE Steam Loco Whistle foil pattern

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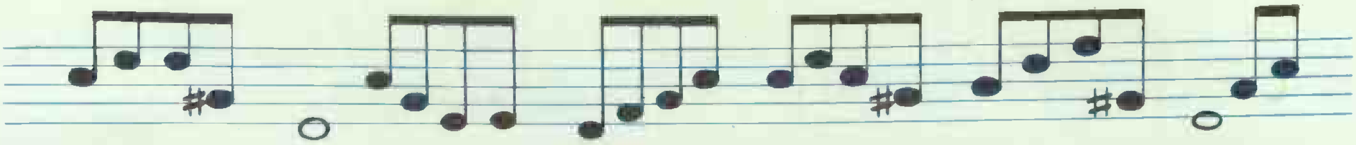

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