PRACTICAL ELECTRONICS

JANUARY 1988 · £1.25

SCIENCE & TECHNOELOGY

bookmark

Another selection of newly published books to while away the dark winter nights.

Power Selector Guide. J.C.J. Van de Ven. Babani BP235. ISBN 0-85934-180-1. £4.95. Many applications still need high voltage or high current semiconductors. This book is a guide to a very large selection of suitable devices. It offers a range of selection tables computer-compiled so as to be of maximum use to all electronics engineers, designers and hobbyists. Component markings, codings, standards, symbols and outlines are presented, along with specifications of diodes, bridge rectifiers, thyristors, triacs, transistors and fets.

A Concise Introduction to MS-DOS. N. Kantaris. Babani BP232. ISBN 0-85934-177-1. £2.95. If you are a PC user and want to get the most out of your computer in terms of efficiency and productivity, then you must learn its MS PC-DOS operating system. The aim of this small book is to help you do so in the shortest, most effective and informative way. It is written with the non-expert, busy person in mind and as such, it has an underlying structure based on 'what you need to know first, appears first'. It is also designed to be circular, meaning that you do not need to start at the beginning and read on to the end — the more experienced user can start from any section.

Electronics Manual to Industrial Automation. G.R. Stone. Tab Books. ISBN 0-8306-2762-6. £14.50. Despite its title this book can be of considerable value to anyone needing basic electronic theory. The author originally began by writing weekly handouts to supplement the lecture sessions of an industrial training programme. Ultimately, after minor revisions, the handouts were compiled, forming this 344 page book. Its aim is to inform the reader, regardless of background, in three main areas of industrial electronics — functions, applications, repairs and servicing.

Transmitter Hunting — Radio Direction Finding Simplified. J.D. Moell and T.N. Curlee. Tab Books. ISBN 0-8306-2701-4. £14.50. Masses of information helping amateur radio operators to set up and perform radio direction finding on HF and VHF bands. It will be of considerable value to enthusiasts, pilots, boaters, and members of search and rescue organisations.

A Handbook of Fourier Theorems. D.C. Champeney. Cambridge University Press. ISBN 0-521-26503-7. £25.00. This is a handbook comprising a collection of the most important theorems in Fourier analysis, presented without proof in a form that is accurate but also accessible to a reader who is not a specialised mathematician. It will be of particular value to most graduates and research workers in the physical sciences and electronic engineering.

Handbook of Practical I.C. Circuits. Harry L. Helms. Prentice-Hall International. ISBN 0-13-380833-5. £41.00. The book claims that its six chapters form a practical compiltion of i.c. circuits, all of which are actual working designs using popular devices. The necessary component values are included, and there are descriptions of the circuit operations, together with examples of how to modify and adapt them to desired applications. Additional information is given on power supplies, circuit interfacing, and practical trouble shooting. It is a shame that this interesting 168 page book could not have been released at a lower price.

Video Handbook — Second Edition. Ru van Wezel. Heinemann. ISBN 0-434-92189-0. £30.00. A practical handbook that is intended for serious enthusiasts, semiprofessionals, and technicians in small video production companies. It covers tv standards, the structure of the complete video signal, cameras and tubes, including a DIY monochrome camera. Control desks and trick effects are covered, as well as transceiving systems and numerous aspects of production.

Electronic Instruments and Measurement Techniques. F.F. Mazda. Cambridge University Press. ISBN 0-521-26873-7. £37.50. The book opens with an account of topics which are fundamental to instruments and measurement units: standards, measurement errors and instrument busses. It then describes the construction, operation and applications of the more commonly used instruments. Finally, an introduction to instruments which have been designed for more specialised applications is given. The book is more suited to professionals and post graduates.

Practical Microprocessor Interfacing. S.A. Money. Blackwell Scientific Publications. £20.00. ISBN 0-00-383329-1. This book is a practical treatment of microprocessor interfacing. Microprocessor principles and techniques for transfering data to or from the CPU are discussed, and practical interface circuit arrangements are examined. Software aspects of the various types of interface are also discussed, with basic machine code routines explained for the data transfer and some of the control functions. An invaluable aid for electronics engineers involved in designing systems using microprocessors.

Dictionary of Electronics, Second Edition. S.W. Amos. Butterworths. £25. ISBN 0-408-02750-9. As with all rapidly developing technologies, electronics has a continually growing vocabulary which has necessitated this second edition. About 300 new definitions have been added, and about 200 existing ones reworded or expanded. The dictionary not only provides clear definitions, but also explains many terms in depth. Illustrations and extensive cross-references are also included, as in an appendix of commonly used abbreviations and acronyms.

The Benchtop Electronics Reference Manual. Victor F.C. Veley. Tab Books. £20.25. ISBN 0-8306-2785-5. A massive 600 page manual aimed at everyone who is involved in electronics. While it has a great many mathematical derivations, basic principles and examples, regrettably it does not appear to live up to its claim to provide easy instant access to the information you need on any electronics topic. In the areas that it does cover, though, it should be of value to those interested in formulae, but it is unlikely to be of wide use to the average experimenter.

Electronics for Electricians and Engineers. I.R. Sinclair. Heinemann Newnes. ISBN 0-434-91837-7. £9.95. Written in response to the need that appears to exist for some technicians to update their skills to match the ever changing technology of electronics. The aim of the book is to explain principles and devices in clear terms, without assuming a high level of prior knowledge. It provides a practical introduction to electronics, though does not delve too deeply into the more sophisticated techniques and applications.

An Introduction to Antenna Theory. H.C. Wright. Babani BP198. ISBN 0-85934-173-9. £2.95. Deals with the basic concepts relevent to receiving and transmitting antennas in a manner which emphasises the mechanism involved, and with strong diagramatic support minimises the mathematics used. The bibliography provided offers the next stage of reading and understanding, while the outline set of original papers listed should allow a particular interest to be followed up in detail.

Microprocessor Theory and Operation. J. Wilson and E. Walls. Tab Books. ISBN 0-8306-2791-X. £12.00. A book to bridge the gap between digital electronics theory and microprocessor theory. It guides you into the central nervous system of computerised electronic equipment and explains, bit by bit, how microprocessors work with their associated circuitry. To give hands on experience, 15 easy-to-build and inexpensive experiments are featured, illustrating the various individual sections in a microprocessor.

Sound Advice – Make Better Recordings. L. Woodland. Jay Books. ISBN 0-9510086-5-X. £5.50. This is a book that Les Woodland wishes he had when he started in radio and sound recording. He felt that everything else was impossibly complicated – so he wrote it himself. (He is now a senior BBC producer.) It is intended to be a book for anyone who wants to save the sounds of a town for historical archives; record pop music or formal occasions; wants recordings of birds or badgers; or just wants to tape chat or commentary. It covers recording, interviewing, editing, compilation, and in simple terms, the history and scientific background. A very useful book.

1988 BUYER'S GUIDE TO ELECTRONIC COMPONENTS
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PRACTICAL ELECTRONICS

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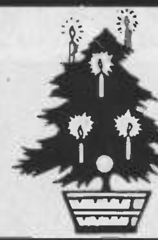
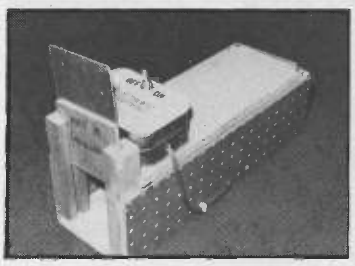
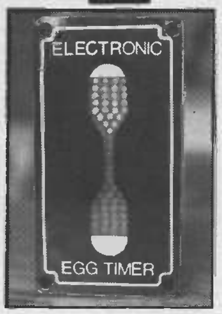
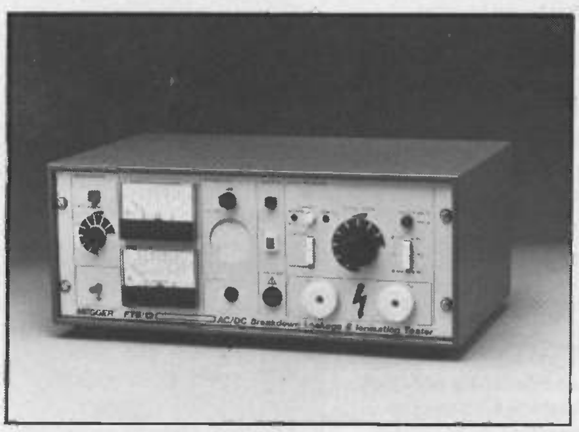






CONSTRUCTIONAL PROJECTS

SPECIAL FEATURES



REGULAR FEATURES

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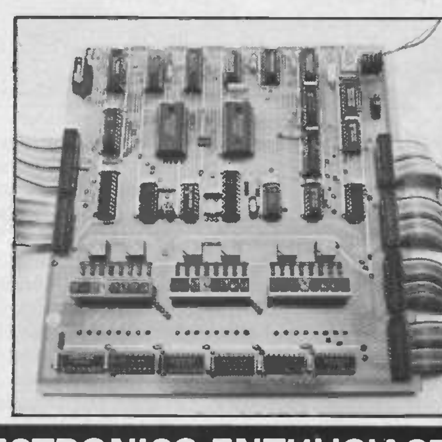
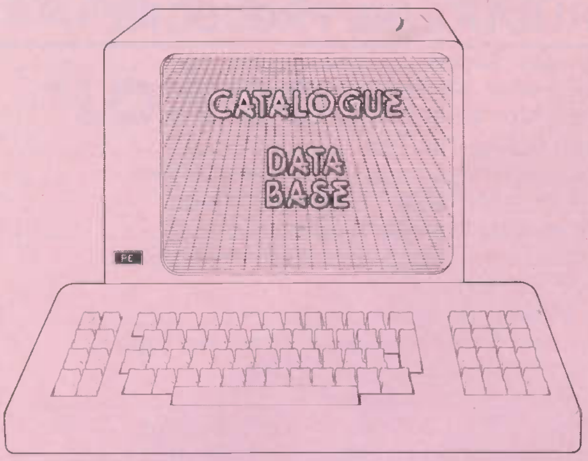


THE SCIENCE MAGAZINE FOR SERIOUS ELECTRONICS ENTHUSIASTS



We have recently received the following catalogues and literature:

Altai Electronics Catalogue. Nearly 200 pages of colour illustrated components, equipment, instruments, computers, audio-video, communications, accessories, tools and security – **electronics for practically every purpose.** This catalogue has been received simultaneously from **Pops Electronic Components,** and **Henry's Audio Electronics.**

Pops are also stockists of **Lorlin, AB** and many other product lines, and are at Studio D, Unit 9A, Atlas Village, Oxgate Lane, London NW2 7HU, 01-450 4688/9.

Henry's Audio also sent information about **Cubegate** components, and are at 404 Edgware Road, London W2 1ED.

Tandy's 1987-88 colourful catalogue of ready-made equipment and accessories has been released. Its 140 pages are **well worth examining** and can be picked up **from any Tandy store.**

Concurrent Techniques have sent us their pamplet called Concurrent News. This is a newsletter that publicises their **low cost transputer modules** and other hardware and software products. It also contains news, rumours and gossip about the transputer scene. **Concurrent Techniques,** 30 Baldslow Road, Hastings, East Sussex, TN34 2EY.

Globe Book Services have announced two new guides to the Electronic Component Industry. **The International Directory of Active Component Manufacturers** (ISBN 0333 455 401) spans 30 countries and provides comprehensive international manufacturer coverage, with 1000 entries. **The International Passive Components** report (ISBN 033 451 139) covers markets, production and trade throughout 30 countries. At £90 and £300 each respectively these guides are obviously more suited to the Trade. **Globe Book Services** are a division of **Macmillan Publishers Ltd,** Brunel Road, Houndmills, Basingstoke, Hants, RG21 2XS.

Cirkit's bright new winter 87/88 catalogue for electronic constructors is good value at £1-20. Clearly laid out and illustrated it is presented in a **livelier more exciting** and totally different style. It is crammed with new product and ideas, and also features a special competition. **Cirkit Distribution Ltd,** Park Lane, Broxbourne, Herts, EN10 7NQ.

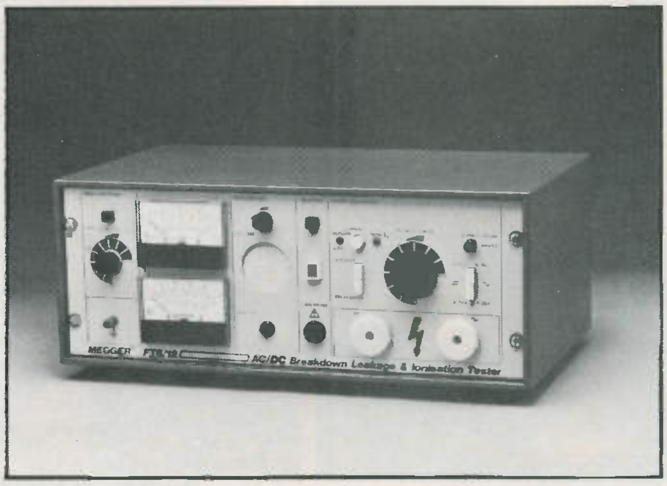
Adam's Eden

ONCE upon a time getting fittings for cases or cabinets was not easy, and even if you could locate what you wanted, it could cost you an arm and a leg. Now we take the availability of fittings for granted, and quite rightly so. We need never go back to those bad old days, when you would have to be Sherlock Holmes to track down parts for cases and cabinets.

Adam Hall Supplies is one company that has done much to change the fittings market in Europe. Now, as well as manufacturing and distributing the best quality hardware and fittings, they also claim to be the most competitive.

For more information on all their products, give the sale desk a ring at Southend (0702) 613922 and ask for Rob, Jane or John, **or write to** Adam Hall Supplies Ltd, 3 The Cordwainers, Temple Farm Industrial Estate, Sutton Road, Southend-on-Sea, Essex SS2 5RU.

WHAT'S NEW



Flash Tester

Flash testing, applied voltage and non-destructive testing are the combined capabilities of the FT6/12, the latest instrument to appear from Megger.

The FT6/12 is an a.c./d.c. breakdown, leakage and ionisation tester that truly justifies the term general purpose. As well as providing a.c. and d.c. current measurement, in-phase a.c. current measurement, ionisation detection, leakage resistance and a.c. capacitive current can also be calculated. The fully variable output voltage can be set to trip at a pre-determined leakage current level. An additional advantage is that, in the event of breakdown, the test voltage is not cut off, so allowing the operator to locate the breakdown area.

The operator is helped by clear, simple panel meters indicating voltage and current levels, and a lamp and buzzer system shows breakdown and flashover. A built-in audio detector picks up ionisation, the operator being alerted via a loudspeaker or through headphones. Voltage only appears at the output terminal sockets when a push-button – either on the front panel or on the optional probe – is pressed.

The Megger FT6/12 meets BS4743 VDE 0411/0433 and IEE 348 safety requirements.

Contact: Megger Instruments Limited, Archcliffe Road, Dover, Kent CT17 9EN.
Tel: Dover (0304) 202620

Better BBC Fax

A contract has been agreed between the BBC and Softel Ltd for the supply of a new Ceefax computer system. It will be installed at Television Centre later this year and will replace the one which began service in 1979.

The new system will enable the BBC to continue a policy of improvements to Ceefax. For example, a faster Ceefax service will be possible by using more spare lines of the TV signal. Ceefax will also be able to provide a clearer and more varied page-front during 'Pages from Ceefax' broadcasts.

The system will include direct links with other computer systems to give Ceefax staff rapid access to financial, travel and weather information.

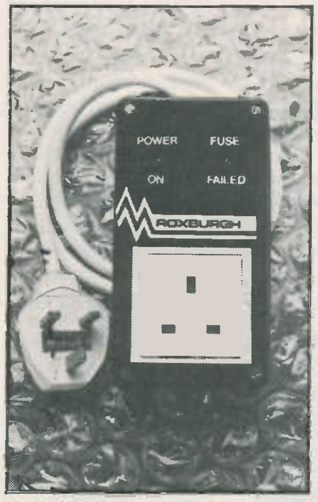
Says Ceefax Editor, Graham Clayton, "Over the past few years the teletext audience has grown enormously and the BBC now needs a teletext broadcast system which will keep up with their demand in terms of speed of up-dating breadth of coverage and reliability".

Hieroscopy

Hewlett Packard's family of 1GHz digitising oscilloscopes is available for hire from Electroplan Rental.

These high-performance instruments perform precision time-domain analogue measurements on high speed logic waveforms, with the added benefit of colour for improved efficiency. A wide range of outstanding features makes the instruments suitable for design and test of high-speed (up to ECL) logic, data communications testing and general-purpose design applications.

For a free copy of their new 1987/1988 catalogue contact: Electroplan Rental, P.O.Box 19, Orchard Road, Royston, Herts.



Portable Power Cleaner

ROXBURGH Suppressors' Portable Power Cleaner is a low-cost device which has been designed to prevent mains power surges from damaging sensitive electronics like computers, digital or analogue instruments, microprocessors and other equipment.

Suitable for use industrially, in the office, laboratory or workshop, the PPC is connected between the mains and the equipment requiring protection and can be rated at 2A or 6A, depending on the application. It is housed in a tough plastic case, 145mm x 75mm x 50mm, and is supplied ready to use with a 2m cable set and moulded 13A plug. Options include American and continental sockets and cable sets. The standard unit costs from £23.00.

Contact: Roxburgh Suppressors Ltd., Haywood Way, Ivyhouse Lane, Hastings, East Sussex, TN35 4PL. Tel: 0424 442160.

High IQ Speech Station

A NEW complete low-cost intelligent speech output station is available from STC Mercator. Named the ISAS-P, it is based on solid-state CVSD (continuously variable slope delta modulation) speech technology and designed on a single Eurocard, outputing digitally-stored speech in response to externally-activated input signals.

The system provides exceptional speech quality, on-board CPU, digital vocabulary memory and direct connection facilities to an external loud-speaker or amplifier. The 3640Kb (max.) EPROM vocabulary memory will store up to 210s of speech depending on the sampling rate (17Kb/s – 43Kb/s) used during the recording. In addition, identical phrases/words for different messages only require to be stored once as the system reconstructs phrases using the words in the appropriate sequence, thus reducing memory requirement and allowing the construction of a large set of instructions.

Typical applications for this compact system include the telephone network for PBX-messages, directory information, weather reports etc, and also for public address systems alarms and operator prompts in the industrial environment.

ISAS-P accepts ASCII code and binary information, and can be connected to the user system via either a parallel or single-line interfaces. Also available is the optional SDM 300-T speech synthesis development station which allows vocabulary generation by the end user.

Contact: STC Mercator, South Denes, Great Yarmouth, Norfolk NR30 3PX. Tel: 0493 844911

CHIP COUNT

This month's list of new component details received — mainly chips, but other items may be included.

82716. Display controller for inexpensive high performance graphics displays, providing real-time animation for industrial consumer applications. Now available in volume. **(IT).**

82786. A graphics coprocessor with four new enhanced features of Bit Block Transfer, transparency and proportional spacing, clipped Bit Blts and Character Blts, a line-without-end-point command, and a version register. **(IT).**

CQW58A, CQW89. Heterojunction infrared emitting diodes that extend the performance of IR remote control systems, with a typical response 10-15 times faster than competing products. **(ML).**

HD153108. A single chip colour palette for use in desk top publishing, CAD, CAM and similar high resolution colour graphics applications. **(HT).**

HD647180X. A highly integrated single chip ZTAT microcontroller based on the popular HD64180R microprocessor. **(HT).**

LM104L, LM105L, LM107L. Compact LCD modules that minimise wasted space. They display two lines of characters, with 16, 20 and 40 characters per line respectively. All include an integral HD44780 controller and necessary drive circuitry. **(HT).**

SCN68010. A fully implemented 16-bit microprocessor with 16 megabyte direct addressing range, providing virtual memory and enhanced instruction execution. Compatible with earlier members of the 68000 family. **(ML).**

TIMEKEEPER. A real timeclock for the IBM PC/AT/XT and compatibles. Keeps tracks of hundreths of a second through to years, months, and days with leap year correction. Accurate within one minute per month, and with data non-volatility for ten years in the absence of power. **(PN).**

Manufacturers and contact telephone numbers for further details: (HT) Hitachi, 0923 246488. (IT) Intel, 0793 696204. (ML) Mullard, 01-580 6633. (PN) Pinna Electronics, 0294 605296.

Micreau

With concern being shown for the quality of drinking, river, borehole and stored water, Kent Industrial Measurements, a Brown Boveri Kent company, have introduced a self-checking microprocessor based water quality monitor that can operate at an unmanned site for long periods without needing attention.

The monitor, model 7975, simultaneously measures up to six different parameters – water temperature, pH, conductivity, dissolved oxygen, turbidity and air temperature if required, with high and low alarm set points for each of the six channels. All this data plus other information can be automatically relayed to a central station via telemetry or landline, or fed into a local data logger.

By using microprocessor technology the monitor offers automatic two point checking of the ph measuring system at 4pH and 9pH, and automatic checking of the dissolved oxygen cell in air, plus automatic biocide cleaning of the entire system, all at customer selectable intervals. Frequent checking of the nephelometric turbidity sensor, multi-electrode conductivity sensor and PT100 temperature sensors is not necessary.

To minimize running costs the monitor can be programmed to provide a discontinuous sampling mode with a choice of frequency and duration of sampling, in addition to continuous monitoring.

A further benefit built into the system is the use of small bore piping which reduces the amount of circulating water and hence the pump capacity, leading to a further reduction in energy usage. This is achieved by using an optional filter if the system is to be used on raw surface waters. Automatic cleaning of the filter is initiated by the water quality monitor electronics on an 'as required' basis.

Another feature of the water quality monitor is a mimic diagram of the sampling flow path which incorporates leds to give the exact status of solenoid valves and pumps, the mode of operation being shown by a further series of leds.

Contact: Kent Industrial Measurements Ltd, Oldends Lane, Stonehouse, Gloucestershire GL10 3TA. Tel: (045 382) 6661

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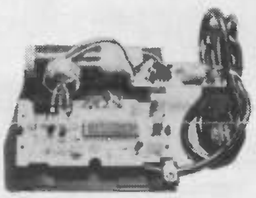
VIF-E1 Infra Red receiver only Boxed in ten's **£9-99** £3-50

VIF-K1



GRUNDIG 440 REMOTE CONTROL (cable) 8 metres 10 core cable. Brand New & Boxed .... **£3-75** P&P £1-99

GRUNDIG 2+4 SUPER (Stereo Panels) CROMA, SERVO. DFT. VIDEO Stereo/Ton Motorboard. Scanning Board. All .... **£4.95** each P&P £1

POWERPACK .... **£19.95** P&P £3

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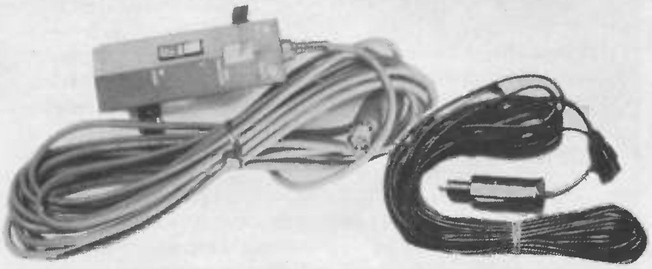
HEAD ASSESMBLY COMPLETE WITH HEADS .... **£25** P&P £4

GRUNDIG CFB190 camera lead (7 metres) 6 core cable brand new & boxed **£1-95**



GRUNDIG TELEVISION battery lead 4½ metres with car cigarette lighter plug.
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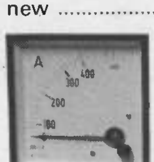

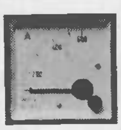

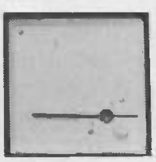

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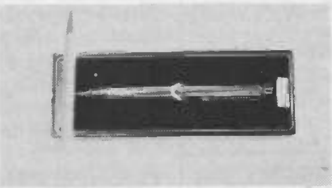

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Number One Analysis

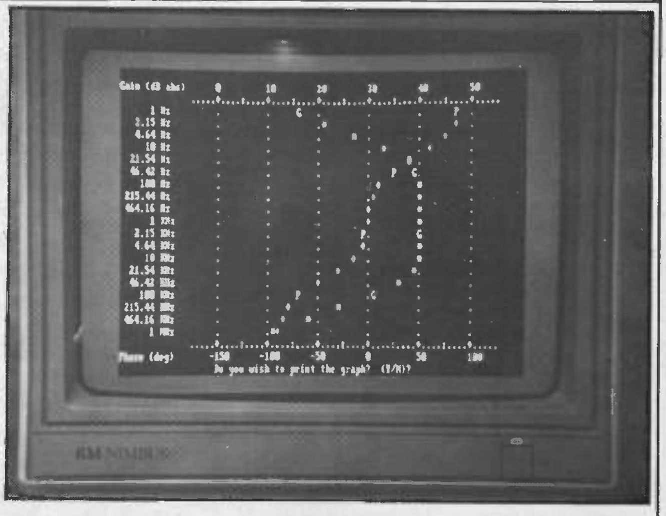
"Education and industrial training of Britain's electronics designers is being badly neglected in some fundamental areas", according to Adrian Espin, Managing Director of the Cambridgeshire-based electronics and computer-aided engineering consultancy Number One Systems Ltd. "Too much emphasis is put on a black-box approach using ICs, without exploring the basic gain and impedance interactions between simple circuit building blocks." If the engineer understands these fundamentals, Espin believes that the majority of analogue circuit applications can be tackled with designs that are significantly more cost-effective, and offer a lower component count.

To help in such training, Number One Systems has introduced a new version of its popular Analyser II electronic circuit analysis package which runs on the Research Machines' Nimbus, an 80186-based MS-DOS computer in use with a large number of educational establishments. This adds to the existing availability of analyser for the BBC micro family, and for IBM PC compatibles.

Demonstrating the vital concepts of gain, phase, impedance and group delay in analogue circuits can need expensive measuring equipment, out of the reach of many training and education budgets. However, with most educational establishments now possessing a microcomputer network with workstations for individual students, teaching these concepts need not be neglected.

Analyser allows the user to build up circuits quickly on screen from a library of active and passive components. The circuit may then be analysed for gain, phase, group delay and impedance characteristics over a range of frequencies selected by the user, in linear or logarithmic steps. Results are presented in tabular or graphic form, and may be in cartesian (real/imaginary) or polar (magnitude/angle) values.

An important feature is the ability to modify the circuit design, and make a rapid evaluation of the effects of the changes. Circuit characteristics, which may not be obvious even



to an experienced designer, such as the effect on input impedance of a change in emitter current in a transistor stage are made fully apparent by Analyser. In this way, the user can explore circuit design at his own pace, in an easily assimilated form, and without the extra expense of bread-boarding circuits.

This sort of analysis would be difficult to contemplate, except on the simplest circuits, without an aid such as Analyser, which handles circuits of up to 60 nodes and 180 components.

Educational establishments can also benefit from a special price structure for multiple user installations.

For further information, contact: Number One Systems Ltd, Harding Way, Somersham Road, St. Ives, Huntingdon, Cambs, PE17 4WR. Tel: St Ives (0480) 61778.

Rewarding Young Designers

Twenty-five enthusiastic young electronic designers, ranging from 12 to 21 in age and representing sixteen different educational institutions in virtually all parts of Great Britain took part in the finals of the 1987 Young Electronic Designer Awards contest at the Institution of Civil Engineers, Great George Street, London SW1 at the beginning of July.

Projects were designed to satisfy key requirements in everyday life and were judged on their commercial viability as well as presentation, technical competence and originality. They were created in response to the YEDA Scheme's challenge for young people to apply electronics know-how in the development of world beating products, which are so important to the future prosperity of British industry.

Organised under the auspices of the YEDA Trust, a registered charity, the annual contest is sponsored by Cirkit Holdings PLC and Texas Instruments Ltd. Winning finalists were awarded valuable trophies, cash and titles which could launch them on rewarding careers in the electronics industry, while the winning educational institution won a Texas Instruments computer system worth more than £10,000. Their project could also be taken up commercially through the help of the sponsoring organisations.

The 1987 awards were presented by Sir John Egan, Chairman of Jaguar PLC, who is a YEDA Trustee and the members of the judging panel were Professor John Eggleston of Warwick University; Sir Alec Morris, British Aerospace; John Wesley, Investors in Industry PLC; Richard Reisz, Editor BBC 'Tomorrow's World'.

For further information contact: YEDA Trust, 24 London Road, Horsham, West Sussex, RH12 1AY, Telephone: 0403 211048.

School Kits

Westex Electronics are marketing electronic kits directed at the Primary/ Secondary section of the market, and have secured a contract to supply one education authority with six Primary Electronics Kits for every Primary school for which it is responsible.

In 1986 they had the honour of meeting their Royal Highnesses the Prince and Princess of Wales at an industry exhibition, and presented them with one of their kits.

At that exhibition Westex submitted a business plan for which it won £3,000 as the most promising new business.

The products marketed by Westex have since been extended to include an Electronics for GCSE Physics kit, and two very useful timer and operational amplifier boards.

Westex Electronics was started by a group of enterprising former students and staff from West Bank High School in Skelmersdale following the success of winning the 1985 Whitbread's business challenge and a further new enterprise competition. It is a company whose primary aim is to produce electrical and electronic teaching aids, but also has the facilities for producing excellent printed material at competitive rates. All of the teaching kits have been extensively tested and have proved to be extremely popular.

Westex state that the advantages offered by their kits are: Comparatively low cost; extremely robust construction – all kits are constructed on blue printed circuit board material which is virtually indestructable; all connections are made using 4mm screw terminals, and therefore the kits are compatible with, or very easily adapted to link with, other kits; low cost 4mm or single stranded wire may be used; should transistors, capacitors, resistors etc. Become damaged, they may easily be replaced through normal component suppliers or direct through Westex. The kits may be easily adapted to the requirements of the teachers or pupil's project and may be expanded as the project becomes more complicated; finally, no soldering is required.

The kits may be used in any of the following courses: Primary Science – the Westex starter pack is also an excellent resource for children with learning difficulties; Primary Technology courses; 'Nuffield' Secondary science – years 1, 2 and 3; G.C.S.E. Electronics; G.C.S.E. Physics – (Electronics sections) – the kit may be easily adapted to verify Ohm's Law; Modular Electronics – for the less able pupil; Control Technology.

Westex electronics will also adapt, where possible, their kits to meet the requirements of a particular school and produce mounted components required for specific experiments and projects.

For further information contact: Westex Electronics, Peel House, Peel Road, West Pimbo, Skelmersdale, Lancashire WN8 9PT.

Xcelent Drive

Cooper Tools have introduced a new range of five round blade, fixed handle Xcelite screwdrivers, which can be supplied as individual tools or as a complete set with pouch.

The recommended pre-VAT price for the set, Cat.No.SDR-11 is £16.31, whilst the prices of individual screwdrivers range from £1.75 for the smallest (1/8" blade) for £4.83 for the largest (5/16" blade).

Contact: Cooper Tools Limited Sedling Road, Wear, Washington, Tyne & Wear NE38 9BZ.

THE LEADING EDGE

BY BARRY FOX

A NEW MAC IN FASHION

Yet another change in direction dogs the tortuous development of direct broadcast satellite television.

After insisting for five years that direct broadcasting by satellite in Britain must use the C-MAC transmission system, because it is best, the British government has now said that a variant called D-MAC must be used, because it is best. Britain's previous insistence on C-MAC has split Europe, with West Germany and France favouring a third variant, called D2-MAC. All this had delayed design of the microchips which are essential for the manufacture of MAC satellite tv receivers and adaptors for existing sets. Without receivers there can be no market for dbs programmes.

The Independent Broadcasting Authority developed the basic MAC technology. In 1982, when the BBC was offered the chance to run a dbs service, the Home Office said it must use C-MAC. In 1986, after the BBC ducked out of dbs and the IBA offered a franchise, the Home Office re-affirmed the need to use C-MAC. The D-MAC and D2-MAC systems were developed on the Continent because C-MAC signals have too wide a band width to carry on most cable tv systems.

All the MAC systems handle picture signals in the same way; on a frequency modulated carrier with the color and black-and-white content sent in alternate bursts. They all send sound in digital code, along with digital date such as teletext. The MAC differences are in the digital coding.

For C-MAC a quite separate radio carrier wave from the picture carrier has its phase rapidly shifted in two steps, to signify binary ones and zeros; this is phase shift keying. A data stream of 20.25 Mbit/s copes with eight separate sound channels. The snag is that the signal spreads over 15MHz which is twice the width of conventional tv and much too wide for cable tv systems. Also, for best results, the receiver needs two demodulators, one for the picture and one for the data and sound. This is expensive to the viewer.

D-MAC also handles 20.25 Mbit/s and eight sound channels, but spreads over only 8.5 MHz. Also, the receiver only needs one demodulator for both picture and sound. This is done by putting the data on the same radio carrier as the picture signal. It slots in between the picture lines. Also duobinary coding is used; the data is coded in three small steps instead of two large ones.

West Germany and France took things a stage further, with D2-MAC. This is the same as D-MAC except that the data rate is halved, to 10.125 Mbit/s. The signal has even narrower bandwidth and can be distributed through old cable systems. But it can only cope with four sound channels. This could kill the idea of using satellite for radio broadcasts piggyback on tv. It also kills the long term idea of transmitting extra picture information in the sound channels for wide screen tv displays.

In an effort to break the deadlock, and give chip and set makers security to get on with their job, the IBA proposed Euro-MAC as an acceptable alternative to C-MAC. This was actually just D-MAC under a different name and the proposal caused confusion. Now the Home Office has bitten the bullet, dropped C-MAC and endorsed D-MAC, saving face with the vague explanation that certain "technical developments have taken place" which justify the climb down from an untenable position.

There has been so much talk about Mercury as an alternative to the awesome and awful incompetence of British Telecom, that sight has been lost of what Mercury actually offers.

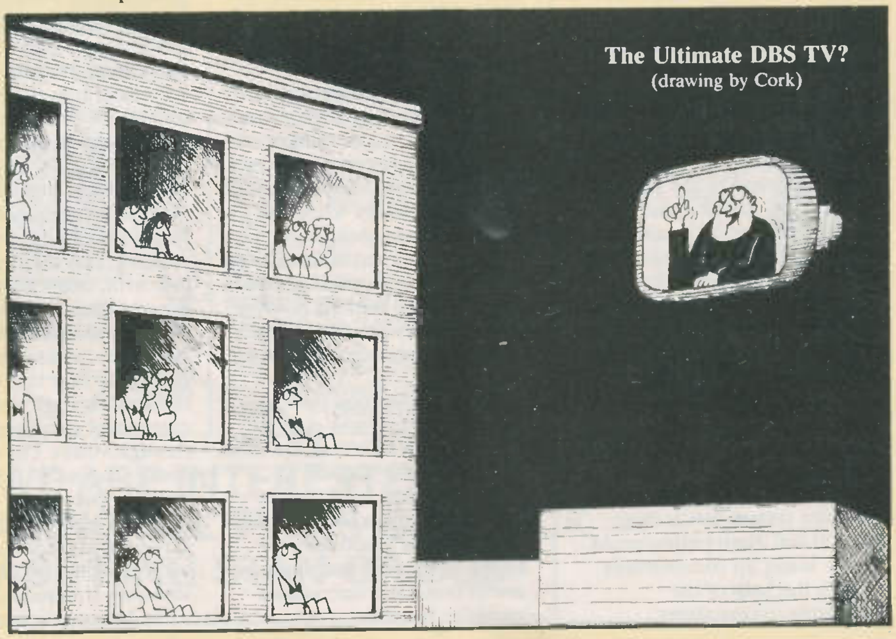
I phoned Mercury, asking what they could offer me.

I must pay £51.99 for a new telephone, and £8.62 each year for an authorisation code. The Mercury phone plugs into my standard BT phone socket and when I want to make a call on the Mercury network I press the Mercury button. The call then goes through BT's local lines to a BT exchange from where it is routed into Mercury for long distance connection.

Average savings on calls to America, Canada, Australia are 10%. Average saving on calls round Europe are only a measly 1% to 2%.

You cannot make local calls through Mercury at all and if there is a fault on the local BT line or exchange you still won't be able to make any calls.

The real breakthrough for Mercury will come if local cable tv stations start carrying telephone calls, by-passing BT lines altogether. Until that happens a small business would have to make a lot of long distance calls to save the costs of the Mercury phone and annual code fee. PE



The Ultimate DBS TV?
(drawing by Cork)

PE SCIENCE AND TECHNOLOGY

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Editor:
John Becker
Sub-Editor:
Helen Armstrong
Technical Illustrator:
Derek Gooding
Advertisement Sales:
Ian Forbes, Mike Thorburn,
Publisher's Assistant:
David Hewett
Publisher:
Angelo Zgorelec
Editorial and Advertising Address:
Practical Electronics,
Intra House, 193 Uxbridge Road,
London W12 9RA
Tel: 01-743 8888

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Jim Naylor. From an original doodle by John Becker

WEATHER BEATEN

THE havoc wreaked across the south of England by the disastrous storm in October is unlikely to be forgotten easily, and its effects will mar the countryside for many years. It was a strong reminder that the brute force of nature still surpasses many of our technological abilities.

The resulting extended power failures firmly brought home the saying that you don't know what you've got till you've lost it. We have become so accustomed to the conveniences offered by mains operated appliances that few of us take action to avoid the problems associated with prolonged deprivation of electrical power.

Compared with many who suffered, I got away lightly, but despite my technological interests, even I was unprepared for such unexpected inconvenience.

When not compiling your epic monthly I'm usually working with equipment that can only run from the mains. In one workroom alone there are thirty five 13 amp sockets, and even more equipment-connected plugs. Following the storm, none of them could be used, and it was frustratingly obvious that the circuit I had intended to work on could not be pursued, since at the very least the soldering iron would not heat up. Even if I had a butane iron, the scope, psu and sig gen could not work, and both dvm's were without batteries. So that ruled out practical electronics.

Writing the lengthy text for the project was also impractical as the word processor had become illiterate, and the low tech typewriter had gone to a jumble sale years ago.

Nor could I do those things that normally fill idle-hours, like watching The Box, playing Mahler or Madonna, patching up the synth, or once more keeping Earth free of pixelled Aliens. Thankfully, cutting the grass was also off.

In fact nearly everything around the house was off – lights, telephone, freezer, microwave, washing machine, spin dryer, vacuum cleaner, the clocks and time switches. The central heating was dead, the fan heater immobile and the electric blanket stone cold. The toaster couldn't feed me, the shower wouldn't heat up, and I was unable to shave. At least the burglar alarm batteries were in good nick, and I could have securely gone out somewhere in the car; if only the drive had been free of a fallen tree. The power saw was off too.

There were only two things I could think of doing without hard physical labour; make coffee on the camping stove, and to draft this – in long hand. Such technological indignity!

Hopefully, by the time you read these lamentations, power supplied will be stablised and you can while away your Christmas boardom by tracking through the current circuit line-up in this seasonal issue. Most are battery powered – a supply source that has a lot to recommend it!

Our practical publishing guardian Angelo joins us all in sending festive greetings to you, with the hope that your stockings will be well charged.

THE EDITOR

OUR FEBRUARY 1988 ISSUE WILL BE ON SALE FRIDAY, JANUARY 8th 1988 (see page 2)

Christmas comes but once a year, but the frequency of this festive light flasher is variable.

SANTALITE

BY JOHN BECKER

Gifts in sight with a Santalite or, has your Ed gone crackers?

NO doubt you've noticed an appalling pun or two on the front cover of this Christmas celebratary issue. One of them plays on the similarity between the two words satellite and Santalite. The picture shows of course, a PE addict calling a high-tech Santa via a masing satellite communicator (or so I said to Jim Naylor, who drew it for me), though I think that gravitational anomaly interaction has not been totally overcome, looking at how the zigs are zagging. A shame about poor cyborged Rudolf!

Well, I regret that in one respect I'm going to disappoint you, the Santalite project I'm about to describe has nothing at all to do with expediting placement of your order with Father Christmas. Though he may well have micro controlled stock processing, orders must still be placed through the time honoured channels of notes up the chimney, visits to the Grotto, or trusting the GPO with North Pole letter delivery.

None the less, I couldn't let a nice project title slip by without designing something that could be so named. Thumbing through the Thesaurus the answer came to light – Strobed Active Novel Tree Adorning Light Intensity Trigger Emitter – SANTALITE. How contrived can one get?

NIT BITS

Incidentally, I was amused to see in the science dictionary that there is a unit of luminance equal to one candle per square metre known as a Nit! Your editor may be full of illuminating ideas, but don't anyone dare define my brilliance...

So what does this novel Noel nicety do I hear you carol in chorus. It flashes the Christmas tree lights of course.

Yes, I know that you can nip down to Woolies and buy a splendid set of lights that have their own built in flasher, or even wire up a car direction indicator unit to blink coloured bulbs on and off, but some might think the effect is a bit monotonous. Off-on-off-on-off, as regularly as the cork of the seasonal beverage bottle. How about a bit of blinking randomness to break the rhythm?

Right then, put down the cork screw for a moment, and concentrate on a few paragraphs of seriousness, starting with –

DISPARATE BI-METALLURGIC FOILS IN RECIPROCATING THERMAL DEPENDENT CIRCUIT BREAKING APPLICATIONS WITH SPECIAL REGARD TO FUNCTIONAL INSTABILITY

No, that's too serious, let's try –

HOT BLINKERS

That's better.

With normal automatic flashing light controllers as found in car indicators and commercial Christmas lights, it is usual for some kind of thermally dependent device to be used to create the switching action. Sometimes this may simply be a special bulb in circuit, or a separate unit, but in both instances a bi-metallic strip is involved.

As most of you must be aware metals expand when they are heated, and different metals have different expansion coefficients, meaning that they expand by dissimilar amounts. If two different metal strips are joined in parallel and are heated, both will try to expand by the required amount, but because they are joined, the expansion causes the strip to bend. If the heating is due to a current flowing through the strip, this bending can be used to open a contact which, when open, will stop the flow of current through the strip. Once the current ceases, the heating effect will also stop, and the strip will cool down again. Of course, as it does it will contract and straighten once more, to eventually remake the electrical contact. The cycle will then repeat itself, ad infinitum, power cuts permitting. If a lamp is in series with the current, then it will naturally flash synchronously with the opening and closing of the contact.

ARCHEOLOGY

There are problems though. First, if the current being drawn is fairly significant, arcing can take place across the opening and closing contacts. Sometimes this can result in the contacts actually welding themselves together, so forming a permanent connection. The arcing can also cause a build up of contaminants around the contacts. This can have the opposite effect, and prevent the contacts from making electrical connection, causing a permanent open circuit to occur. Thirdly, when metal is subjected to stresses, fatique eventually sets in, cracks develop, and in extreme cases the metal can break. For any of these reasons, bi-metallic switching can be unreliable.

ELECTRON AND OFF

On the other hand, if the switching is done electronically, the life expectency of an automatic switch can be regarded as potentially much longer. With electronic control, there is also the additional advantage that the rate of switching can be readily varied.

Christmas tree lights are usually powered by an a.c. supply of some sort. This is frequently supplied direct from the normal mains circuit, or sometimes comes from a low voltage transformer to provide isolation from the mains and give added safety.

In either instance, the electronic control can easily be performed using a thyristor or a triac. Thyristors simply conduct the a.c. supply during the positive going excursion of its waveform. Triacs though will conduct both the positive and negative going halves of the cycle. The advantage of using a triac for lamp control is that since it conducts on both sides of the cycle, it will be triggered at twice the rate of the single sided thyristor. Since in the U.K. the mains supply operates at 50Hz, a triac will conduct 100 times per second compared with 50 for a thyristor. The greater switching frequency of 100Hz is less noticeable to the eye than a rate of 50Hz, and so the resulting lamp flicker is less obvious. For this reason the use of a triac for controlling the Christmas lights from the Santalite is preferable.

A triac has three terminals, two of which conduct the a.c. supply and are usually known as MT1 and MT2. The third terminal is the gate, which as the name implies can control whether or not the triac will conduct. Unlike a transistor, a triac needs to be continually triggered to respond to each cycle, and so needs be driven from a pulse generator of some type. It is perfectly possible to use the a.c. supply itself, with suitable precautions, to perform the necessary triggering. For safety reasons though, it is best to keep the mains and the control circuit isolated from each other.

LIGHTLY LINKED

This isolation is often carried out by using a transformer between the two parts of the circuit. However, there are numerous devices available which can isolate circuits by optical methods. All that this means is that a light sensitive device can be connected to the gate of the triac, and then to send a pulse of light to switch it on.

Such a device is known as an opto-coupler, and is simply an enclosed unit within which are an led and a light sensitive electronic switch.

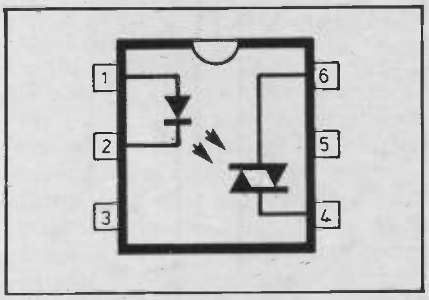


Fig. 1. *MOC3020 Optotriac.*

In some devices the light sensitive switch may be a transistor, and these are ideal for switching d.c. supplies. For a.c. switching other devices that contain low power triacs are available. The device chosen for the Santalite is one of the latter (IC2 in Fig 2.) and is capable of switching up to about 50mA of current. Regretably this is insufficient to control the Christmas lights directly, but it is sufficient to gate the main triac CSR1 in Fig 2.

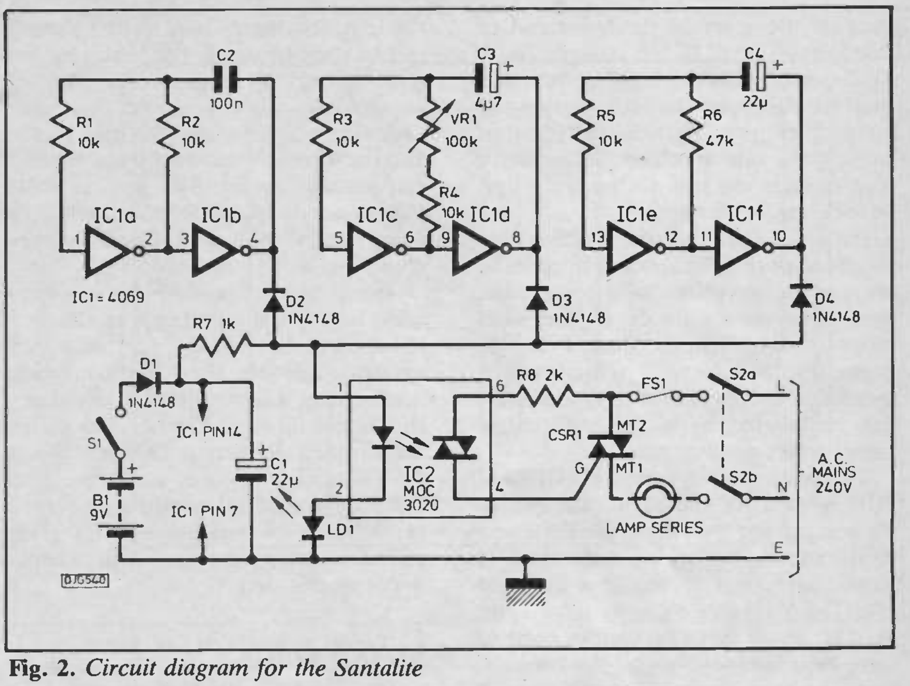


Fig. 2. *Circuit diagram for the Santalite*

The triac I used (as it was readily to hand) is capable of driving 3.5 amps of lamps, around 750 watts, but I've really only intended the Santalite to drive around 100 watts. If you propose to drive more, a bigger box than the one shown must be used, and suitable ventilation holes will be required, plus a heat sink for CSR1. A lower current triac may be substituted if only low wattages are to be controlled.

VIBRILATION

Ignoring for the moment that we want a random flashing sequence in this unit, the triggering of the lamps can be done by simply sending a constant stream of pulses to the led in IC2. This will turn on at each pulse, and so remotely control the main lamps. Here the basic oscillator that generates the pulse stream is formed around IC1a and IC1b.

These are simply two CMOS inverting gates which when coupled in the fashion shown form an oscillator running at a frequency set by C2 and R2. The actual frequency produced is around 500Hz, but it is not critical as long as it is fairly well above twice the mains frequency of 50Hz.

Obviously it is no use having a gating frequency being constantly applied to the optocoupler. This would naturally keep the lamps on until either the mains was switched off, or the oscillator stopped. For practical use, the pulse stream has to be gated.

The main gating signal is produced by another oscillator, around IC1c and IC1d. The principle of oscillation is identical to that used with the first oscillator. The difference though is that the capacitor C3 has a larger value than C2, and that a variable control, VR1, has been included. This allows for different resistance values to be set from the control panel, and which affect the rate at which C3 will charge and discharge. A low resistance setting will produce a higher speed than a large resistance.

AND ALTOGETHER NOW

The outputs of both these oscillators are fed to an AND gate. This could quite readily be a chip gate, but here it is just as simple to use a discrete gate formed around D2, D3 and R7.

If either of the oscillator outputs is in a low state, current from R7 will flow

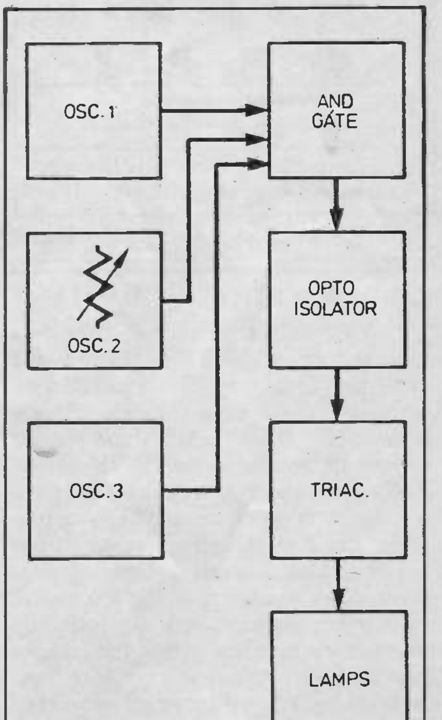


Fig. 3. *Block diagram for the Santalite.*

through the relevent diode instead of through the led of IC2. If however, both oscillator outputs are high, current will then flow through the led, causing the lamps to turn on. By turning VR1, thus varying the rate at which the oscillator toggles high and low, so the lamp turn on rate can be changed.

Earlier, I said that the flashing rate should appear to be random in order to remove the monotony of a preset rate. True randomness needs a somewhat more complex circuit than I feel is necessary to achieve a similar effect. Instead, the appearance of randomness can be created by gating the control signal at yet another rate.

The third oscillator around IC1e and IC1f is used for this additional gating. As you can see it works in the same way as the others, but with a different C-R value, causing it to run at a different rate. The AND gate is given a third input, via D4, so all three oscillators need to have their outputs high for the lamps to be turned on.

Since they are all running at different rates, the on-off timing points are constantly changing, which, although will be in a pattern that repeats itself, will not over the long length of time involved be noticeable to the casual observer. (Fig 4.)

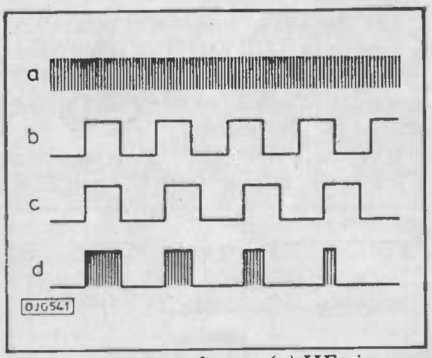


Fig. 4 *Timing waveforms: (a) HF trigger oscillator; (b) second oscillator; (c) third oscillator; (d) output of the AND gate with (a), (b) and (c) applied.*

GUIDING LIGHT

Led D5 has been included for two reasons, one of which is so that a visual indication of the trigger rate can be seen without the main lamps being connected. The other, and more important reason is due to the diode AND gate nature. Since the diodes have a voltage drop of around 0.7V across them the lowest voltage never drops below that level. Consequently satisfactory switching of the led in IC2 cannot be accomplished. By including another led in series with it the relative bias levels are raised and the gate logic level changes then do their job properly.

POWER LESS

The CMOS chip IC1 hardly takes any current, and most of the power consumption is due to that required by the leds, less than 10mA. A PP3 battery can be used to supply the circuit power, and should last for several days of regular use. However, CMOS is also very forgiving of voltage supply levels, and the 4069 chip used will quite happily run from about 3V up to 18V. Consequently you are not limited to using just a 9V battery, and a 12V battery could just as well be used.

Also, I have allowed for the supply to come from a mains unit such as a battery eliminator, like those for use with cassette recorders. There is also no basic reason why a low voltage transformer should not be used. Virtually any mains transformer delivering between about 4.5V a.c. and 12V a.c. could be used. The inclusion of D1 provides half wave rectification of the a.c. and C1 gives sufficient smoothing to suit the simple needs of this circuit.

BOARD ALIGN

Two chips, eight resistors, four capacitors, four diodes, a triac, led and a handful of hardware, how much simpler can anything be? You should be able to put this lot together on the kitchen table somewhere between the mince pies and the turkey stuffing. Keep it away from the cake though, to minimise currant consumption.

Fig. 4 shows how well I've presented the board for you; just slot in, solder on, clip joints and box cleverly. You could also socket well, if you prefer to use miniature mains sockets instead of soldering the mains leads to the PCB. If you don't use sockets, you must use grommets and cable clamps to secure the mains leads safely. Keep all leads well away from the triac, which may get a bit warm.

But wait – don't plug in yet! Check your handiwork first; thoroughly; in Sherlock Holmes style, with a magnifying glass. Look out for bad joins, solder shorts across tracks, chips in the wrong way round, and is the triac disorientated? Remember, it's mains that you're dealing with on part of the circuit. Your abilities may be strong, but we don't want you getting too powerful – it's the lamps that are meant to light up, not you. So please be sure of what you've done, and if in doubt ask someone who is qualified to help.

With the 4069 chip, which is CMOS, take the usual precautions, discharging static from yourself by touching something earthed (but a potted plant in not suitable). When you're sure of everything you can then check out that the circuit works, but initially just concern yourself with the battery operated section.

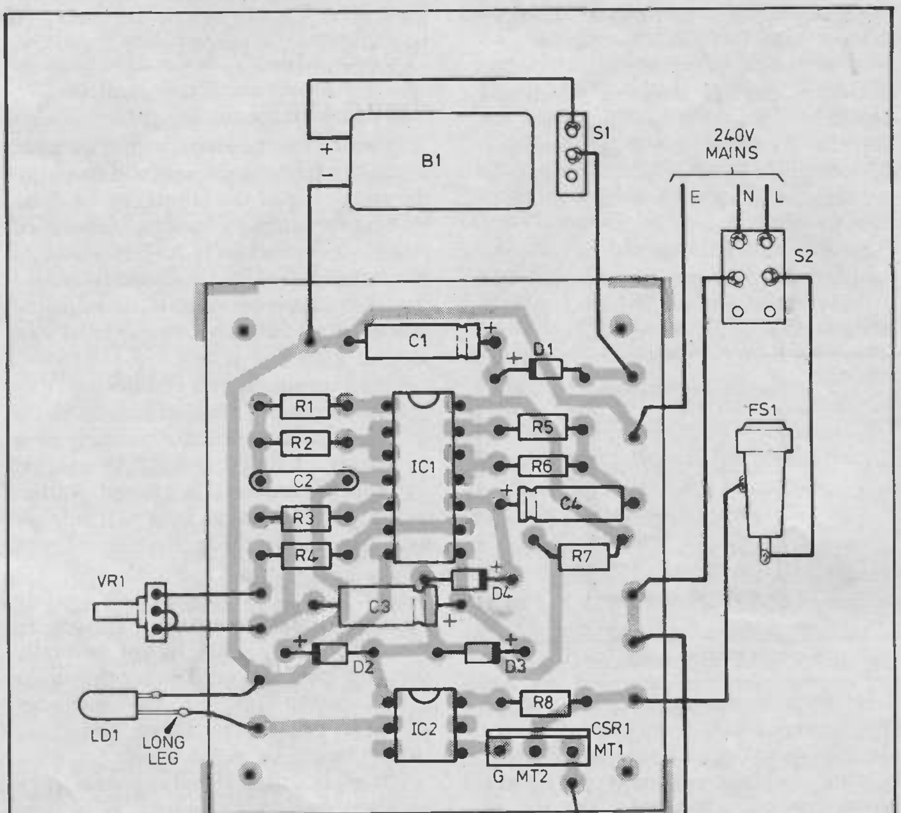


Fig. 5. *Printed circuit board and wiring details (not to scale).*

COMPONENTS

RESISTORS

R1-R5	10k (5 off)
R6	47k
R7	1k
R8	2k

(All ¼W 5% carbon film)

CAPACITORS

C1,C4	22µ 16V electrolytic (2 off)
C2	100n polyester
C3	4µ7 16V electrolytic

POTENTIOMETER

VR1	100k lin mono rotary

SEMICONDUCTORS

D1-D4	1N4148 (4 off)
D5	LED
IC1	4069
IC2	Optotriac MOC 3020

SWITCHES

S1	min s.p.d.t.
S2	mains d.p.d.t.

MISCELLANEOUS

Box 120 x 65 x 40mm, PP3 battery clip, fuseholder and fuse to suit lamps, cable clamp, grommets, knob, LED clip, PCB, 6-pin I.C. socket (or 8-pin), 14-pin I.C. socket, triac (see text), wire and solder.

CONSTRUCTOR'S NOTE:

The PCB is available from Phonosonics at £3.90 each incl. U.K. p&p and VAT, order as PCB 282A.

GIFTOMETER

I hope you've got a multimeter, and if you haven't why not put it on the presents list? If you're serious about electronics you really should have a meter. It need not be expensive, and lots of PE advertisers sell them. Get one of at least 20k ohms per volt, with at least the basic ranges for measuring resistance, a.c. and d.c. voltages, and current in milliamps. If it has other facilities, so much the better. There's no need to go to the expense of a digital meter until you are past the novice stage; an analogue one with a moving needle meter will be quite enough until then.

It's not vital to have a meter for this unit, but if you have you will be able to check that the second and third oscillators are functioning by watching the meter needle swing up and down. Also check the junction of the three diodes to see that a small voltage swing occurs there. Varying VR1 should alter the swing rate. You also have led D5 to give you a visual indication that things are swinging. Oscillator one will probably not register on the meter except possibly as a half level voltage.

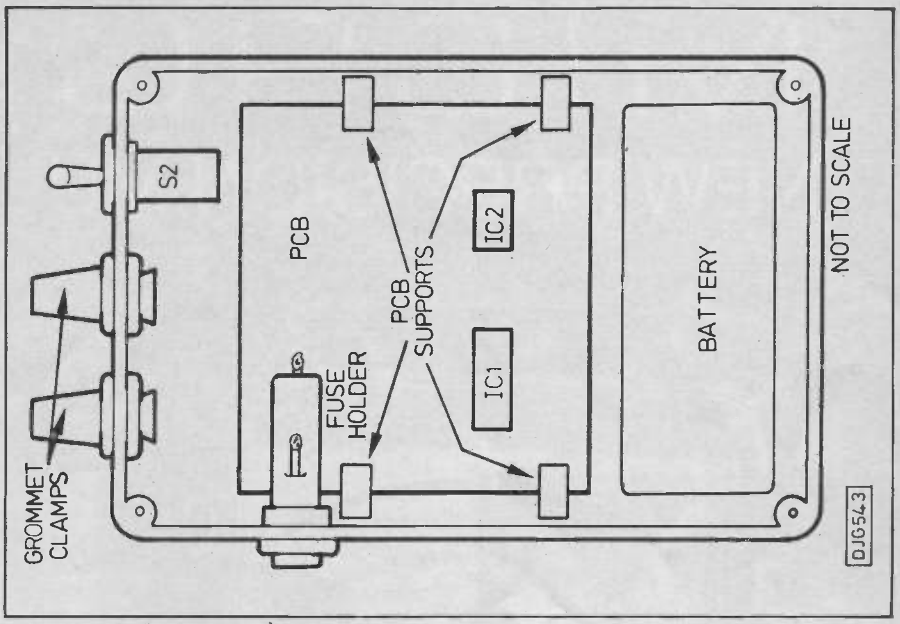


Fig. 5. *Interior Santalite box layout.*

LIGHTENING

OK, go ahead, plug in to the mains, the functioning of this side of the circuit will be self evident. **Do not touch anything inside the box whilst it is connected to the mains.**

If your darkness is not intermittently brightened by festive flashing then you've probably not done your assembly and checking well enough. If the error is on the oscillator side it's unlikely that anything will have demised. On the mains side though, if you find that the triac is in the wrong way round you will probably have killed it and also IC2. (Please use DIL sockets for both chips). It doesn't matter if MT1 and MT2 are reversed, but if the gate leg is in the wrong hole, you will need replacements. There is a possibility of course that if your Christmas lamps are joined in series, then if one of them is dead, none of the others will work. In that case all you need is another bulb.

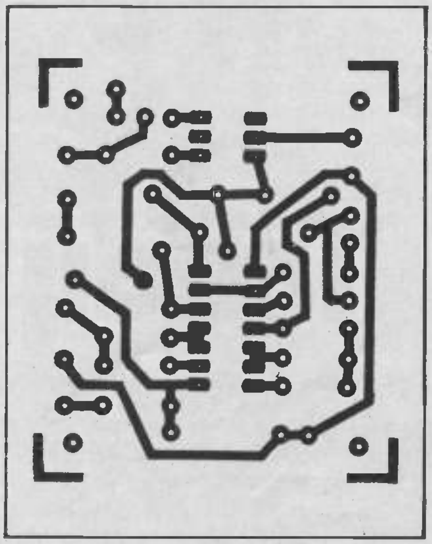


Fig. 7. *Printed circuit board track layout.*

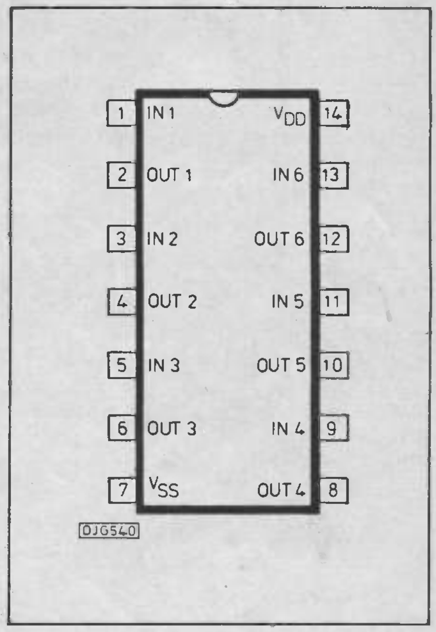


Fig. 8. *Pin connections for IC1 4069.*

UNFUSED MUSE

However, I'm certain you've heeded my hints and checked things first, so I feel sure that your flickering festoon within the festive fir will, like a lighthouse in a sea of darkness, signal out its seasonal silent call. Who knows,

Even Santa's eye may light
Upon that message flashing bright,
And rain dear gifts this Noel's night,
So then yule know you've got it right,
Without a chatty satellite,
And that PE is surely quite
The finest mag to have in sight.
Please thank its Ed (so erudite?)
For his blinking Santalite.

Enjoy your gifted mod-tech yule tide optic communicator, (I'm hoping to be given a better poetry and pun prog for the PET micro)! PE

TEACHER TALKBACK

PART ONE BY TIM PIKE

The fifth in a series of articles aimed at students taking one of the new GCSE examinations in Electronics in 1988.

No – Not an excuse for one-way cheek, but a master-plan for one-way and two-way intercoms and their amplifiers — and how to bias a transistor.

When I started thinking about an introduction to this article I was prompted to check on the origin of the word 'Intercom'. Interestingly the five dictionaries to which I went for guidance are of very different publication dates.

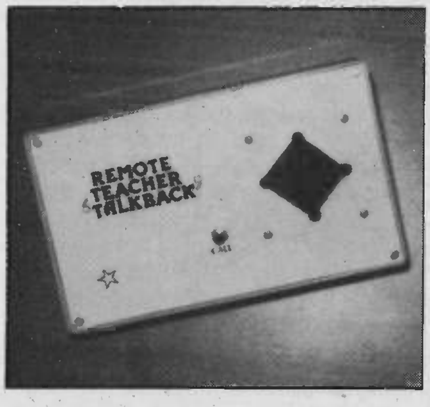
The oldest – Collin's Westminster Dictionary – was published in 1960. Perhaps not surprisingly, 'intercom' does not feature as a separately listed item. Instead the main reference is headed 'intercommune', from which the somewhat different verb 'intercommunicate' is developed. 'intercom' has a mention and is defined as 'internal telephonic system – generally of aircraft". By the late 1960s, copies of 'Chamber's Essential Dictionary' and 'The Penguin English Dictionary' both have a listed reference to 'intercom' as an 'internal telephone system'.

(PE first used the word in December 1964 in "The Two Way Intercom Unit" by K. Berry. Ed.)

The Concise Oxford Dictionary of 1976 has 'system of intercommunication by radio or telephone'. By 1987 the Readers' Digest Universal Dictionary describes 'intercom' simply as 'an internal communication system, as between two rooms'.

By now some readers may be wondering whether this is indeed a copy of PE or perhaps a new magazine of lexicography.

There is a point to all this, however. Dictionaries by their nature reflect the thinking and understanding of the times in which they are compiled. Bearing in mind that it is generally reckoned to take several years to put a new dictionary together, each of the examples quoted above gives a valuable insight into how the concept of an intercom has changed over the last thirty years or so. No longer is it regarded as a highly specialised piece of equipment found mainly in aircraft. No longer is it necessarily a hard-wired system joining two communicators. Indeed the use of radio techniques is now commonplace.



Very sophisticated hi-fi devices are now produced at incredibly low prices. Clearly our purpose is not to explore the latest developments but rather to go back to the beginnings of circuit design and to consider the minimum features of a system which can claim to be an 'intercom'.

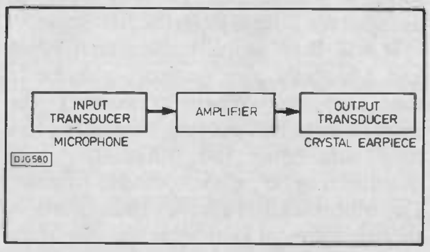


Fig. 1. *Minimum system specification for a one-way intercom*

MINIMUM FEATURES

A simple analysis of the requirements of a one-way intercom leads us to conclude that it possesses the same minimum features as many other basic audio systems. An input transducer (in this case a microphone) converts acoustic energy (pressure waves) into an electrical signal. The signal must then be amplified sufficiently to drive the output transducer (in this case a crystal earpiece). All one-way intercom systems will share at least these three features (Fig.1).

Given that we can acquire the input and output transducers, the design emphasis is placed wholly on the amplifier which will link them together. The very simplest amplifier consists of little more than a single transistor, for it is this one device which contains the inherent ability to amplify small signals. Let's use this as our starting point.

TRANSISTOR BEHAVIOUR

If we connect an npn transistor in common emitter configuration, then we are using the base as the input, the collector as the output and the emitter as the common or grounded connection. A base resistor must be included to protect this most vulnerable part of the transistor from excessive currents. A collector resistor or load resistor is clearly necessary to allow the output to change as the transistor responds to the input. Fig.2 shows what will happen.

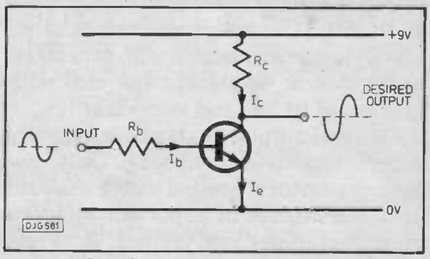


Fig. 2. *Single transistor amplification*

Small changes in input voltage cause correspondingly small changes in base current, I_b. The transistor responds to these changes by altering its conductivity in the collector-emitter path. Large changes (typically one hundred times larger than base changes) now occur in collector current I_c, and therefore in the collector voltage. Notice one other feature of the transistor's behaviour: as the output voltage is being taken at the collector, it will always be low when the input voltage is high and vice versa. This property of inherent inversion is one which we have come across in previous articles.

THE NEED FOR BIASING

One problem which is immediately apparent from Fig.2 is that any input changes which take the base voltage below about 0.7V will cause the transistor to stop conducting. By the same token any changes which would take the output below 0V will be lost. The output must lie between 0V and 9V at all times. Furthermore, if the output is to be allowed to swing both up and down in response to input signals then the starting point must be half-way between the power supply rails – in this case at about 4.5V. This process of setting the collector voltage at a specified level before the signal comes along is known as 'biasing' the transistor.

One way of achieving the correct biasing is to use a pair of resistors connected across the base to form a potential divider (Fig.3). By choosing the values for R_1 and R_2 carefully we can set the transistor so that it is neither switched ON nor OFF, but somewhere in between.

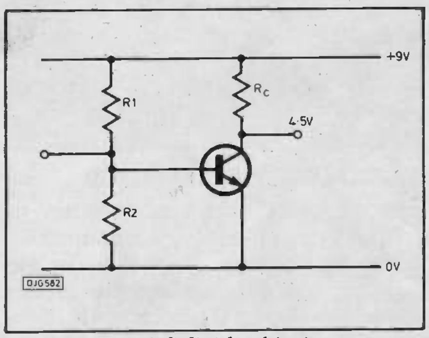


Fig. 3. *Potential divider biasing*

In practice the actual values needed for R_1 and R_2 will vary, depending upon the particular transistor used. For example, the BC108 with which we are probably all so familiar can have a current gain anywhere in the range from 40 to 200. If we chose our values of R_1 and R_2 to suit a transistor with gain equal to 40 then it would not suit one with gain equal to 200 and vice versa.

One way around this is to use a slightly different method of biasing. Only one biasing resistor is needed and this should have a resistance of about one hundred times that of the load resistor, R_c. Fig.4 shows this arrangement with a suitable microphone and an earpiece connected correctly to input and output respectively.

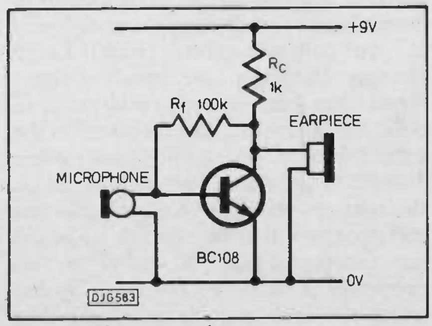


Fig. 4. *Alternative biasing*

The inclusion of the one biasing resistor, R_f, will provide some negative feedback between output and input which will help to control the behaviour of the transistor. Suppose that the input signal is too high; this will cause the transistor to conduct more heavily and so allow a larger current through the load resistor, R_c. The output voltage will therefore drop below a reasonable level and current will be diverted from the input towards the output rather than into the transistor-base. This will have the desired effect of shutting down the transistor and therefore limiting the size of output which can be obtained.

If you build this circuit you will find that you might just be able to hear the output when someone speaks into the microphone, but it will certainly not be very loud. We need more amplification.

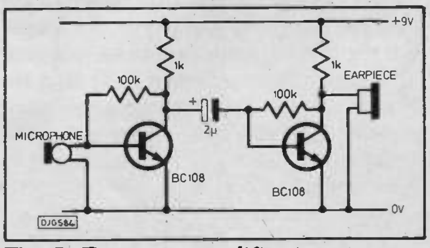


Fig. 5. *Two-stage amplification*

OBTAINING MORE AMPLIFICATION

More amplification means amplifying further the signal that we have produced so far. A second transistor will accept as its input the output from the first stage.

It will then amplify the signal again and hopefully give us more volume in the earpiece. When transistors (or amplifiers in general) are connected like this, one after the other, they are described as being connected in cascade. The amplification factors then multiply to give the total gain achieved. So, if for instance our transistors will each give a gain of 50, then connected in cascade we can get 50 x 50 or a gain of 2500 from the pair.

We cannot just feed the output from the collector of the first transistor directly to the base of the second one. This is because they are at different bias voltages and we would upset the biasing if we did this. We need instead to link them through a component which will allow easy passage of the varying signal but which will block direct current from flowing between the two stages. The obvious choice is a capacitor. The capacitor will couple the two stages as far as the signal is concerned but it will also decouple the dc components.

You should certainly find that if you build the circuit of Fig.5 a much louder sound than before is heard when someone speaks into the microphone..

Depending on the results which you have achieved so far you may like to try adding a third stage of amplification, exactly as before. Even if you are happy with the output from two stages it would be worthwhile trying this out because some new effects may well become evident. (Fig.6).

When you come to test the overall amplification with three stages you might find that strange noises appear in the earpiece – bumping noises or high-pitched whistles. This means that you now have too much amplification. The slightest sound is being picked up by the microphone, amplified perhaps ten thousand times and pushed out through the earpiece. In turn this output is detected by the microphone and re-amplified by this huge amount. Almost immediately (because, remember, that electricity travels at almost the speed of light) the circuit can no longer cope with the input and it goes out of control. This is an example of positive feedback and it is the principle on which oscillators work.

If you do discover this problem then the solution is not simply to remove the third stage but rather to add in a volume control. This is no more than a variable resistor placed between stages 1 and 2. An extra capacitor is needed as well to prevent direct current from flowing through the variable resistor from either stage 1 or 2. If this capacitor is omitted then two problems can occur. Firstly, we again upset the biasing of the second stage by introducing another route for current from the +9V rail to the 0V rail. Secondly, the variable resistor is likely to become very noisy as it is turned. Fig.7 gives the complete circuit so far with three stages of amplification and the volume control.

The practical circuits given so far have used a crystal earpiece as the output device. Since it has a very high resistance (about 10M) it does not affect the proper working of the transistor.

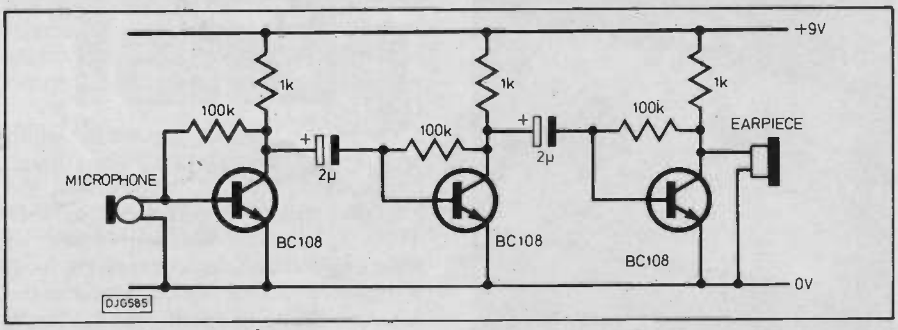


Fig. 6. *Three-stage amplification*

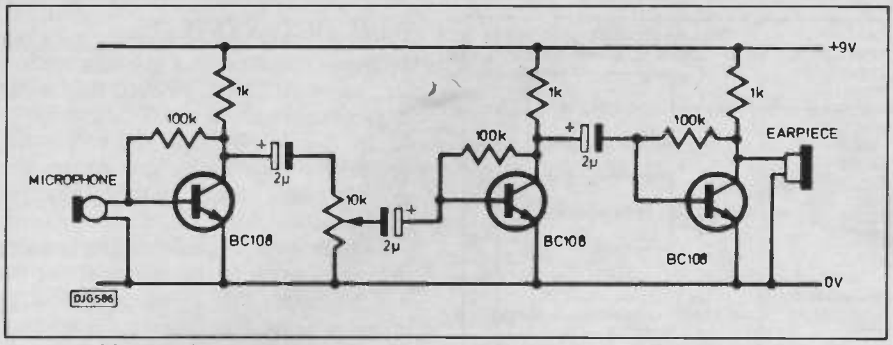


Fig. 7. *Addition of a volume control*

CHANGING THE OUTPUT TRANSDUCER

If, however, we wish to use a magnetic earpiece which has a resistance of only about 1k or a loudspeaker which has a resistance of 80 ohms less then some changes are required.

The first problem is that with a load resistor of 1k in the output stage hardly any voltage would be developed across a loudspeaker say of 80Ω connected between the collector and the emitter. Instead we must replace the load resistor by the loudspeaker thus making the loudspeaker into the load. The problem now is that much higher collector currents are possible and we may well need to upgrade the transistor to cope with this. A BFY51 for instance, in place of the BC108 will certainly handle enough current to drive an 80Ω loudspeaker from the 9V supply. It is now necessary to change the biasing resistor on the third stage as well as to match the new output conditions. Fig.8 shows just the output stage adapted to accommodate a loudspeaker.

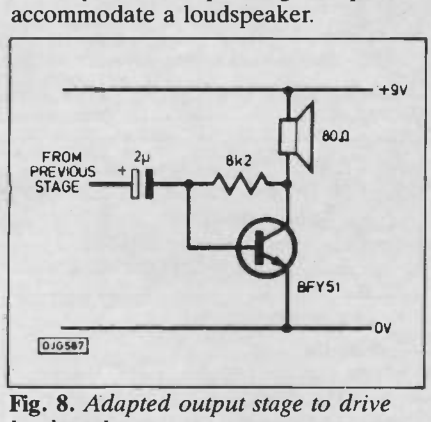


Fig. 8. *Adapted output stage to drive loudspeaker*

TWO-WAY OPERATION

So far we have considered only a one-way communicator. There is no facility in any of these circuits for a proper two-way conversation to take place. If we wish to introduce this facility then perhaps our first approach would be to use two circuits, one having its microphone at the 'main station' and its output at the 'slave' or 'remote station'; the other having the input and output transducers swopped over. This system would then be represented by the block diagram of Fig.9. This will work perfectly well but it is unnecessarily complicated and expensive in parts. Furthermore as it has an amplifier in both the master and remote stations, there would need to be an energy supply at both ends.

We can solve this problem if we move both amplifiers to the master station (Fig.10). Having done this it now becomes even more obvious that we are still duplicating each of the three main features that we looked at in Fig.1. The nature of a conversation between two people is that (usually) only one of them is speaking at a time.

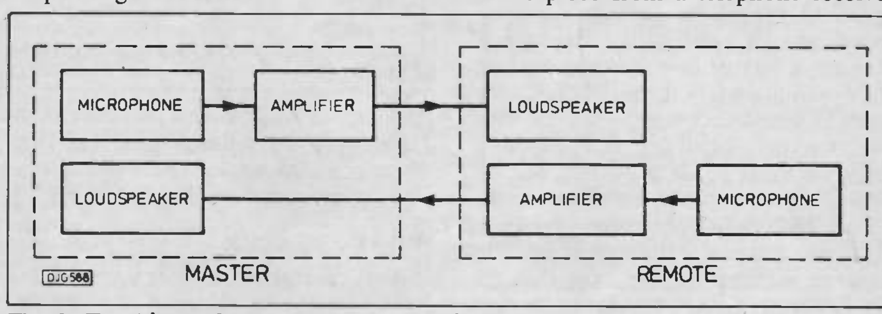


Fig. 9. *Two identical systems as master and remote*

Therefore the same amplifier could be used to amplify the signal in each direction but we would need to be able to switch over the inputs and outputs. A double pole, double throw (dpdt) switch will enable us to do this. In Fig.11 the master station contains a microphone, a loudspeaker, the amplifier and the switch. The remote station contains just a microphone and a loudspeaker.

As the switch is only at the master station, a special code is needed so that the two users know when one has finished speaking and is therefore ready to listen. This, traditionally, takes the form of saying "over" at the end of each passage. "Out" is used to indicate that the whole conversation is concluded.

BI-DIRECTIONAL TRANSDUCER

As one of our design aims is always to find the simplest (and cheapest) acceptable solution to a problem, we might now look for ways of doing away with the need for both a microphone and a loudspeaker at each station.

Bearing in mind that we are not concerned with high quality sound reproduction and that the only use of the system will be to convey speech, the range of frequencies which need to be handled is very limited indeed. Human speech has a frequency range from about 100Hz to 10kHz, but is quite intelligible when limited to a bandwidth of about 300Hz to 3kHz.

Since we are transmitting directly through a cable system, there is no modulation process involved and therefore the minimum bandwidth which needs to be transmitted corresponds to this reduced speech bandwidth, just as in our public telephone system. We will find then that either a small loudspeaker or the mouthpiece from a telephone receiver will perform adequately as both microphone and loudspeaker. Fig.12 shows the simplified system requirements of a basic two-way intercom. You may like to compare this with Fig.1, and note that the only differences are in the addition of the dpdt switch and the bi-directional flow of information.

INTRODUCING A 'CALL' SYSTEM

Apart from perhaps a more sophisticated amplifier which will give a better quality of sound than the simple cascaded three stage circuit of Fig.6, the only other particularly useful development would be to introduce a

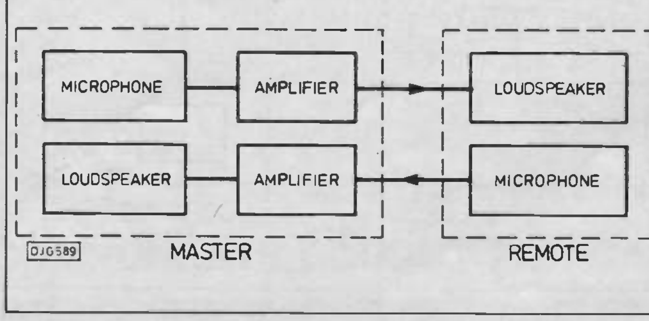


Fig. 10. *Amplifiers kept to master station*

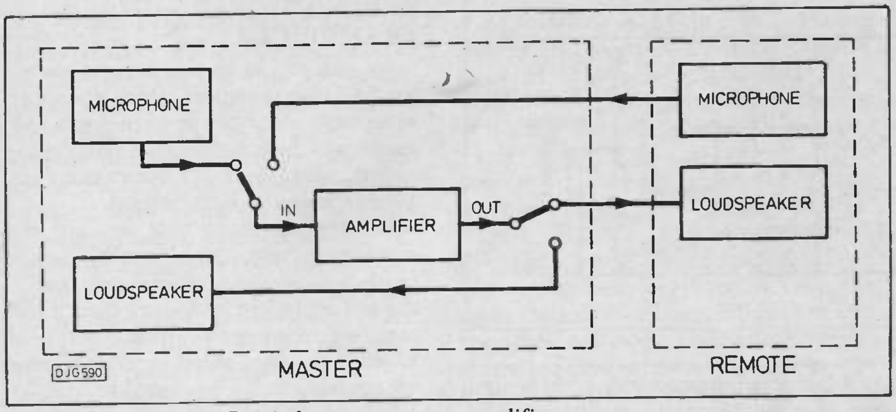


Fig. 11. *Use of DPDT switch to accept one amplifier*

system for "calling" one station from the other.

Clearly the purpose of this facility is to gain the attention of the person at the receiving end before any conversation is started. According to the exact situation in which the device is being used, this may or may not be essential. Let's suppose that we do need a "call" facility and that it must be available from either of the two stations. A simple press switch (push to make) or a touch sensitive switch at either end of the system will activate a buzzer or a lamp or both at the opposite end. In the master unit, the same power source can be shared with the amplifier circuit but in the remote unit, we must either provide a second power source or bring an extra wire to carry this supply from the master unit. On balance, I prefer the former solution because we need to give some thought to minimising the number of wires needed to run between units.

Already we must have the two connections necessary for the loudspeaker/microphone. One of these would be the 0V line for the battery as well. If we introduce a second battery to enable the remote station to call the master station regardless of the status of the other switches on the master station, then only one more wire between stations is required. If, however, we try to use the master station battery then *two* more wires will be needed to link the remote "call" switch into the circuit. The preferred solution then has only three intercon-nections between units as shown in the system diagram of Fig.13.

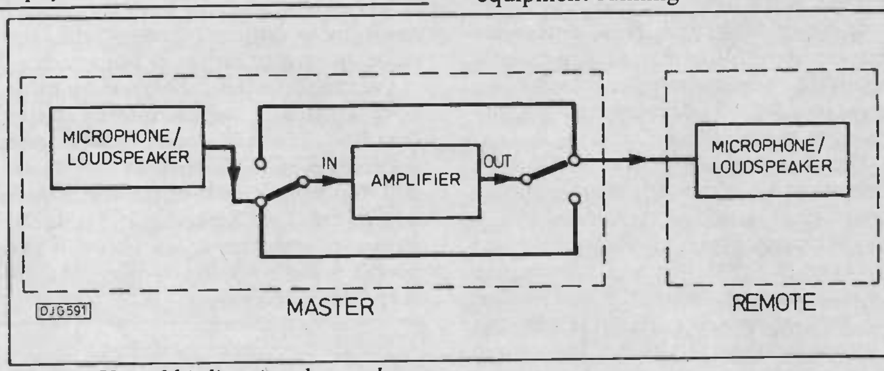


Fig. 12. *Use of bi-directional transducers*

BRAIN TEASER

Very careful use of more sophisticated "call" switches could result in saving one more interconnection by using the same line for the signal and for the calls.

Clearly the buzzer must not be in circuit when the amplifier is working, nor must the loudspeaker/microphone be connected when the buzzer is required. I will leave it to the reader to sort out how this could be achieved. It is possible and it would cut down the interconnections to just two.

(This is a problem that beset Alexander Graham Bell, as discussed in last month's article on telephone history. Ed.)

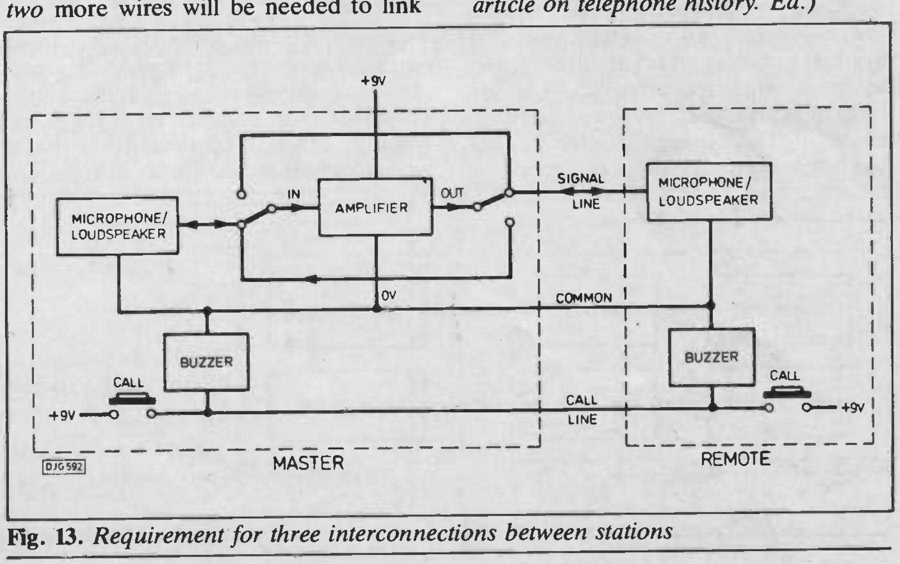


Fig. 13. *Requirement for three interconnections between stations*

WIRE-LESS SYSTEMS

These days there is a growing market for intercom units which require no interconnections at all. One way in which this can be achieved within the confines of one building is to use the existing mains electricity cables to carry the signals.

Certainly there is no problem in using the mains earth as the common line for the intercom. The problem is how to make at least one connection without adding a signal to your domestic mains supply which might cause great problems for some other piece of equipment running from the mains.

There might also be unforeseen difficulties if your mains supply runs through a sensitive residual current device or an earth-leakage circuit breaker. I would have to advise strongly against dabbling with these ideas unless you know exactly what you are doing.. In any case the level of understanding required to implement such a system is well beyond the scope of GCSE and therefore of this article.

(For those with an interest in the subject, a project is scheduled for the near future. Ed.)

NEXT MONTH Tim Pike will look at further improvements that can be made, and describe a practical working intercom unit

WATT NO SINKS?

Dear Ed,

I should like to clarify a couple of points about Tim Pike's psu in the November issue. I believe that the current in the common line of the 7800 series is of the order of 5mA so an ordinary 400mW zener or 1N4148 diodes can be used to raise the voltage thresholds in Fig 13 and 14. Also, the regulators may need to be used with heat sinks if the dissipation rises above 2.5 watts.

Please don't think I'm being critical – I think the articles are excellent and very practical – I only wish to be helpful.

W.A. Sawyer, Beaconsfield.

Thanks, you have been helpful. One extra point though, if heat sinks are used, they must not electrically connect to any other part of the circuit and the ics should have insulating washers if the chassis is used as the sink. **Ed.**

CONSIDERATE MOUSETRAP

BY TERRY PINNELL

LIFE OR DEATH IN THE PANTRY?

How to show unwanted visitors the door without bloodshed. Our device is powered by a 24V solenoid, 2 x fresh PP3 batteries, and a well aged piece of cheese.

A sunny Sunday lunchtime at the village pub.

"We definitely have a mouse," said our neighbour. "It keeps getting into the pantry. But I haven't the heart to kill it," she added "Even if I *could* bring myself to put a mousetrap down, the children certainly wouldn't let me."

"I'll have to make you an electronic mousetrap." I said, ever alert for a chance to slip into my Mad Inventor role. I didn't see the tolerant smiles exchanged with my wife...my mind was already on the grand design as I reached for my lager.

TO CATCH A MOUSE

The problem was not really all that complex, but I thought I might stretch it out into a day or two if I worked at it.

Obviously I was going to need a box of some kind, into which I would lure the mouse with a traditional piece of cheese. The Sound Effects section of my reference files had yielded no Rodent Attractors or such-like. The closest was a "Fish Caller," in a late 70s magazine, but I quickly dismissed that multivibrator in its watertight jar as unpromising for my more discriminating mammal target.

Needless to say, the device had to be electrically operated. A merely mechanical contrivance was not in the running...the merits of my hobby itself were at stake. Battery operation was another obvious criterion; mains sockets aren't usually sited with mouse catching convenience in mind and the idea of using an extension reel was dismissed rapidly.

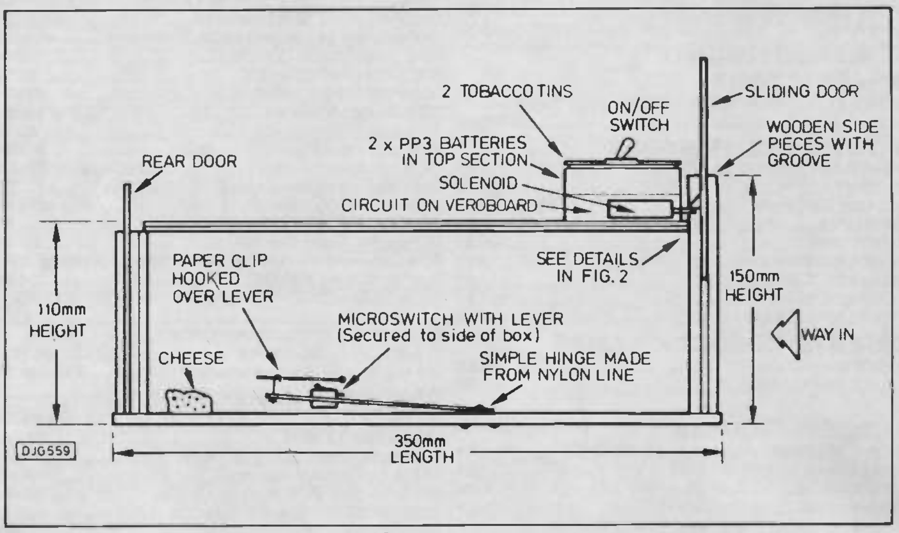


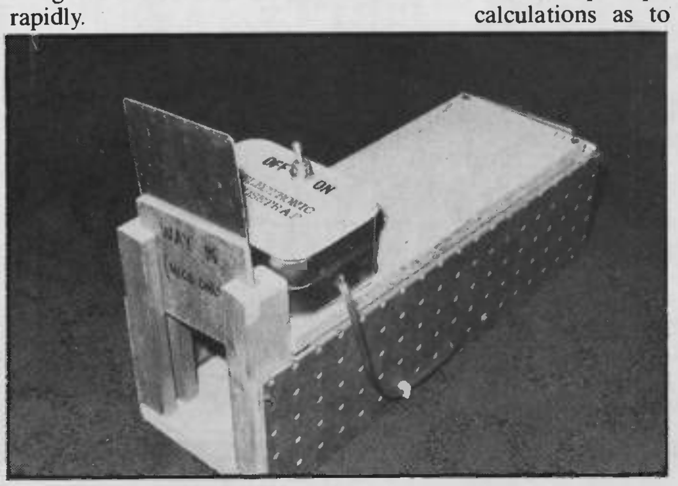
Fig. 1. *Side view of mouse trap mechanics.*

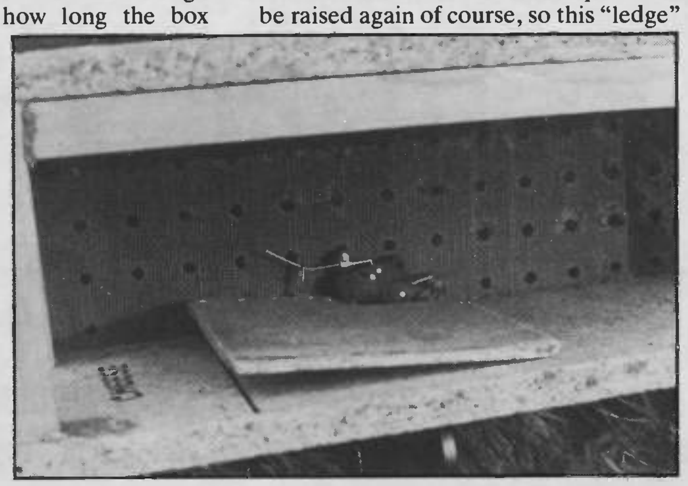
It was clear that I would need a door of some sort which would close when the mouse was starting its one course meal, remaining shut until its merciful release by A Kind Human some time later, presumably the following morning. So the first interesting design question was how to close the door.

A vertical, freely-sliding trapdoor was the obvious choice, given that it had to close quickly...our mouse was unlikely to linger over the cheddar, watching with interest while a conventional hinged door slowly shut. I decided to use a piece of hardboard or aluminium suspended at the sides in grooves, so that when suitably released it would fall sharply downwards.

This prompted some rough calculations as to how long the box should be. I did not want news of the successful capture of a mouse to be marred by hearing that its nether extremity had been amputated...a sting in the tail as it were. Unsure as to the upper size bounds of the local mouse populace, I was inclined to be generous. After all, I could limit the width of the box to discourage inquisitiveness from larger nocturnal prowlers (like Susie our cat or the occasional hedgehog). As you can see from Fig.1 the box eventually built was about 35cm long.

I then considered how to contrive some release method for the trapdoor. A small strip of wood, glued to the trapdoor and resting on a sliding rod of some kind, was the obvious approach. It would have to allow the trapdoor to be raised again of course, so this "ledge"





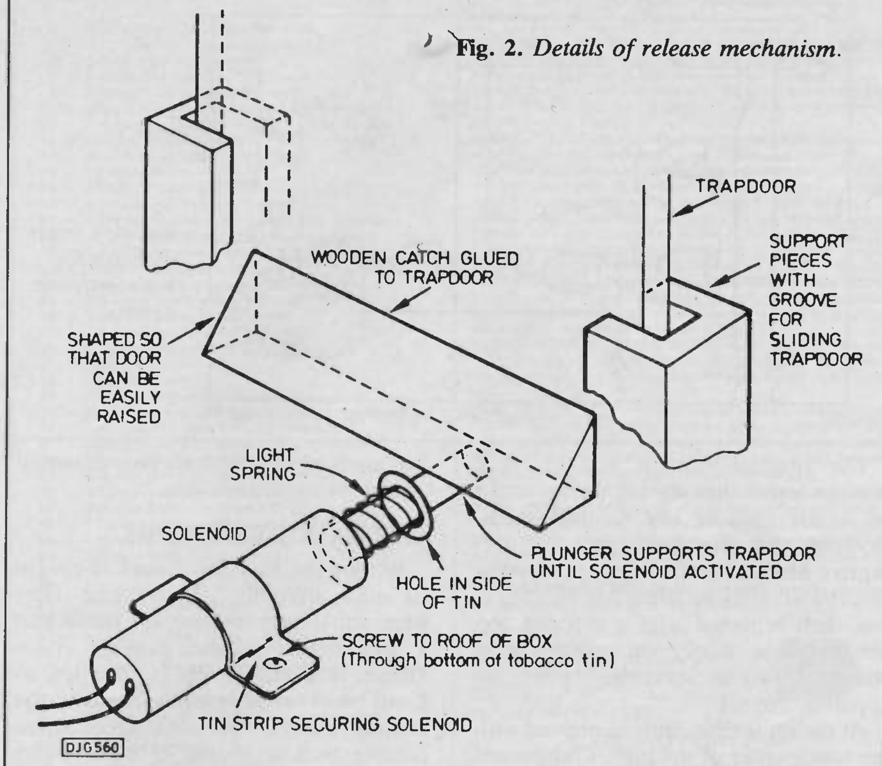


Fig. 2. *Details of release mechanism.*

was bevelled as shown in Fig.2.

Next – how could the rod be withdrawn, allowing the trapdoor to fall under its own weight? Although a solenoid was my first choice, I knew that the only ones I had were specified as 24V types. I therefore thought about using a small dc motor, winding a length of nylon line around its spindle so that on powering the motor the line would pull in the rod. But the snag was, the rod would not return unaided to its holding position. A light spring was not strong enough to pull it back against the motor's resistance. A stronger spring would have prevented it pulling it inwards. Apart from that, this approach *was* basically inelegant and error prone anyway.

I therefore experimented with a solenoid and found that satisfactory operation could be obtained with 18V, despite the 24V specification, provided that friction between the solenoid's rod and the wooden catch was minimised by careful smoothing of the latter's surface and avoiding too heavy a trapdoor.

I turned next to the method of triggering the solenoid and listed these requirements.

1. To minimise current comsumption (and hence maximise battery life) the solenoid should only be held in long enough to fully release the trapdoor. A monostable was probably needed therefore.
2. It should only be triggered once. Further operation once the door was shut would be redundant and waste power. This indicated using a bistable.
3. Triggering should occur when the mouse was fully inside, so that its tail would not be under the falling door. This meant positioning whatever switch was chosen well inside the box and ensuring reliable triggering.

Simplicity and reliability were the main reasons for quickly selecting a microswitch as the method of activation. An interrupted light beam was one alternative briefly considered, but widely varying expected ambient light levels would add complexity and possible spurious triggering, so this was rejected.

One other option, which had some attraction because it could be made relatively unobtrusive, was a proximity switch. This would be similar to those I'd built into lamps etc around the house. On touching or coming very close to a piece of metal or metal foil, the circuit is triggered by capacitive attenuation to ground of an hf oscillator (around 100 kHz). So a small piece of aluminium cooking foil covered with some cloth could possibly activate the solenoid circuit. However, although I was familiar with the sensitivity of this circuit to human proximity, I was by no means certain about mice. What is the capacitance of the average mouse anyway? (In MICEofarads of course.) In any case this rather high-tech trigger circuit would have needed continuous current, limiting useful battery life. It was better to go for a circuit with negligible standby current.

So as seen in Fig.1, I arranged a microswitch with its lever in such a way that when the mouse was on the hinged base section it would close the contacts.

CIRCUIT

A block diagram appears in Fig.3 and the circuit itself in Fig.4. It is very simple and operates as follows.

A dpdt switch supplies 9V to the logic circuits and 18V for the solenoid. When the power is applied a positive going pulse resets the bistable, ensuring its output does not therefore trigger the monostable.

When the microswitch is closed as a result of the mouse's weight, the bistable is set, triggering the monostable, the output of which goes high for a brief period set by R4 and C2. The preset allows adjustment to the shortest time consistent with reliable release of the trapdoor. In the prototype this was about 0.3 seconds.

As a further precaution against spurious triggering on power up, the monostable has a simple RC network on pin 13 to keep the output low for a short time.

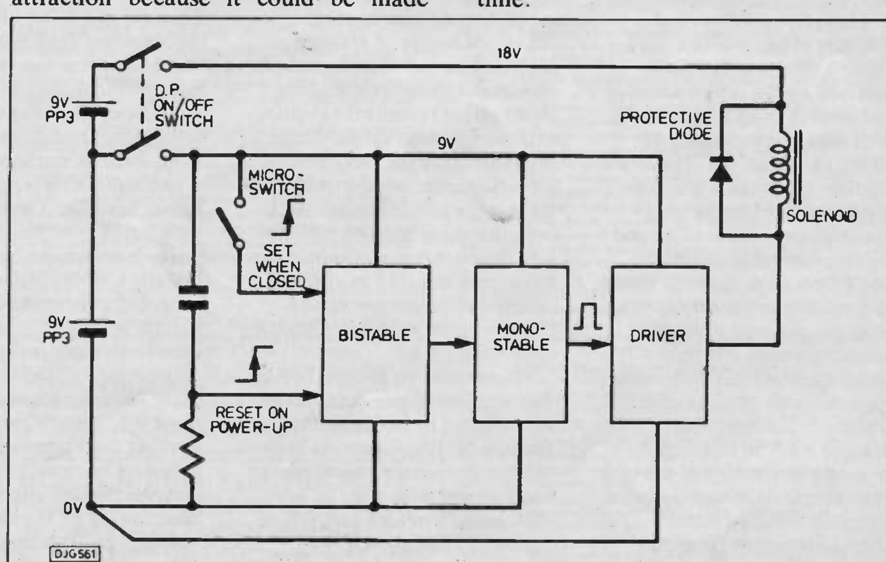


Fig. 3. *Block diagram of the mousetrap control.*

The high monostable output drives a darlington pair common emitter via R5, activating the solenoid. Diode D1 provides protection against possible high induced reverse voltages.

POWER SUPPLY

I experimented for a while with voltage multiplier circuits, trying to get the necessary 18V minimum for say 9V or even 6V. However the surplus solenoid I was using was a current hungry specimen consuming some 600 mA at 18V and such multipliers were not up to this sort of load.

Settling on 2 x 9V, I was indeed initially doubtful as to whether the small PP3 types would be adequate. While trials with some slightly used ones gave unreliable operation, fresh ones (especially alkaline) worked well. After all, they only had to deliver one good short burst, once a night.

CONSTRUCTION

Construction was straightforward and should be clear from the figures and photograph. Any reader actually making one of these would use materials to hand, adapting details as appropriate.

A few particular points might be helpful.

A rear door was incorporated to assist in placing the cheese and cleaning out after the one night's unsolicited bed & breakfast.

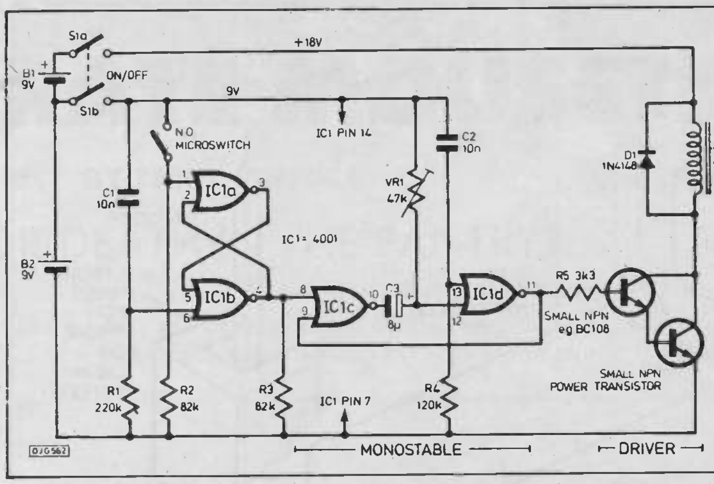


Fig. 4. *Circuit diagram for the mousetrap control*

The original version was given a perspex top so that any inhabitant could be clearly seen by The Kind Humans. However on the first night of use, captive Mouse Number One proceeded to eat this, thus securing his escape. It was then replaced with a wooden top some 1 cm thick, on which Mice Numbers Two to Seven have made no apparent impact.

At the same time, duly impressed with the toothpower of my prey, I reinforced the trapdoor and the rear door with aluminium linings. This lead to some problems with the solenoid sticking, because of the increased friction, but sand-papering of the catch cured it.

In my case the battery compartment was made of two tobacco tins, mounted conveniently on top.

THE GADGET AT WORK

Within the first three days it caught six mice, excluding the escapee. They were apparently transported about half a mile before release. Scaling up to human levels this is about 10 miles, so I can be reasonably confident with the assurance that it was not the same mouse coming back a couple of times every night.

Anyway, the word must have spread because the pantry was mouse-free from then on.

And everyone lived happily ever after! PE

IMPRESSIVE PCW SHOW

THE Tenth Personal Computer World Show held at Olympia during September was a huge success. There can be little doubt that it was the biggest yet, and of great benefit to visitors and exhibitors alike.

Your Editor was especially impressed by the proliferation of word processors and the extent to which desk top publishing is making its impact felt. The latter is rapidly becoming a feasible proposition even for small organisations, such as clubs and societies who produce regular news letters or magazines. Even dtp programs for use with existing computers are now capable of producing remarkable results. It's easy to speculate that the humble typewriter may have its days numbered. Similarly, cad packages seem to threaten even the pencil as a means of drawing circuit diagrams, designing pcbs, or just doodling pictures!

Not surprisingly, computer games had a strong attraction, and many stalls drew the enthralled attention of both young and old visitors. The quality of the graphics in many begins to rival live action video images in its colour and definition. Interactive participation of players and games is also coming into its own, offering a degree of realtime involvement that challenges both mental and physical capabilities. I must say that I admire the abilities of those who think up and design both the hardware and software for these games, whether they are for home or arcade use. Indeed I hope that many who enjoy playing with the machines may be inspired to become involved in systems design and programming as a career – there must be enormous satisfaction in it.

PE was also on display, hoping that we could inspire even greater involvement in the fascination of electronics. It was good to have the chance to chat personally with many of you who came to buy back issues and look at a few of the projects on show. I was pleased that several newcomers seemed to become enthusiastic converts to electronics.

PE is owned by Intra Press, under the auspices of Angelo Zgorelec. It was he who started the magazine Personal Computer World ten years ago, and also initiated the annual PCW exhibitions. The obvious success of the exhibitions is a real tribute to his interest and foresight.

Two of the other magazines that he has introduced were on equal prominence with PE. One of them, Astronomy Now, is edited by Patrick Moore and is a monthly magazine well worth taking by anyone interested in knowing what's happening in the Universe.

The other, Office at Home, is a really interesting magazine for those who are self-employed or working from home. For anyone intent on being successfully independent the information presented in its feature articles will be a valuable help.

In addition to the three already well established magazines, a new publication was being launched – Program. This is a brand new magazine introduced for the benefit of advanced programmers working in industry, education, or at home. It covers all aspects of a programmer's work, whatever the programming language being used, and its accent is on improving the techniques specific to any area of programming. As one who loves programming I highly commend it to you.

Inevitably, apart from showing off our magazine wares, some of us were there for scrutiny as well. For light amusement the photos prove part of the case in point. From left to right, top to bottom, the Intra Press Gang are Angelo (publisher), John (PE), David (All!), John (Astronomy Now), Mary-Ann and Jane (Office at Home), John (again – he cuts into everything!).

We look forward to meeting more of you again at PCW in 1988. ED.

£1 BAKERS DOZEN PARCELS

Price per parcel is £1.00, but if you order 12 you get one extra free.
All the parcels listed below are brand new components. Unless marked s.h.

1 – 5 13 amp ring main junction boxes
2 – 5 13 amp ring main spur boxes
5 – 3 flush electrical switches
7 – 4 in flex line switches with neons
8 – 2 80 watt brass cased elements
9 – 2 mains transformers with 6V 1A secondaries
10 – 2 mains transformers with 12V ½A secondaries
11 – 1 extension speaker cabinet for 6½" speaker
12 – 5 octal bases for relays or valves
13 – 12 glass reed switches
14 – 4 OCP 70 photo transistors
16 – 4 tape heads, 2 record, 2 erase
17 – 1 ultra sonic transmitters and 1 ditto receiver
18 – 2 15000 mfd computer grade electrollics
19 – 2 light dependent resistors
20 – 5 different micro switches
21 – 2 mains interference suppressors
22 – 2 25 watt crossover units 2 way
23 – 1 40 watt 3 way crossover unit
28 – 1 6 digit counter mains voltage
30 – 2 Nicad battery chargers
31 – 1 key switch with key
32 – 2 humidity switches
33 – 2 aerosol cans of JCI Dry Lubricant
34 – 96 x 1 metre lengths colour-coded connecting wires
36 – 2 air spaced 2 gang tuning condensors
37 – 2 solid diaelectric 2 gang tuning condensors
38 – 10 compression trimmers
41 – 6 Rocker Switches 10 amp mains SPST
43 – 5 Rocker Switches 10 amp SPDT Centre Off
44 – 4 Rocker Switches 10 amp OPDT
45 – 1 24 hour time switch mains operated (s.h.)
46 – 1 6 hour clock timeswitch
48 – 2 6V operated reed switch relays
49 – 10 neon valves – make good night lights
50 – 2 x 12V DC or 24V AC, 4 CO relays
51 – 1 x 12V 2C O very sensitive relay
52 – 1 12V 4C relay
53 – 2 mains operated relays 3 x 8 amp changeovers
55 – 1 locking mechanism with 2 keys
56 – Miniature Uniselector with circuit for electric jigsaw
57 – 5 Dolls' House switches
60 – 5 ferrite rods 4" x 5/16" diameter aerials
61 – 4 ferrite slab aerials with L & M wave coils
62 – 4 200 ohm earpieces
63 – 1 Mullard thyristor trigger module
64 – 10 assorted knobs ¼ spindles
65 – 5 different thermostats, mainly bi metal
66 – Magnetic brake – stops rotation instantly
67 – Low pressure 3 level switch
69 – 2 25 watt pots 8 ohm
70 – 2 25 watt pots 1000 ohm
71 – 4 wire wound pots – 18, 33, 50 and 100 ohm
73 – 4 3 watt wire wound pots 50 ohm
77 – 1 time reminder adjustable 1-60 mins
78 – 5.5 amp stud rectifiers 400V
85 – 1 mains shaded pole motor ⅜" stack – ¼ shaft
86 – 2 5" ali fan blades fit ½" shaft
87 – 2 3" plastic fan blades fit ⅜" shaft
88 – Mains motor suitable for above blades
89 – 1 mains motor with gear box 1 rev per 24 hours
91 – 2 mains motors with gear box 16 rpm
93 – 4 11 pin moulded bases for relays
94 – 5 B7G valve bases
95 – 4 skirted B9A valve bases
96 – 1 thermostat for fridge
98 – 1 motorised stud switch (s.h.)
101 – 1 2½ hours delay switch
103 – 1 6V mains power supply unit
104 – 1 4½V mains power supply unit
105 – 1 5 pin flex plug and panel socket
107 – 1 5" speaker size radio cabinet with handle
109 – 10 ¼" spindle type volume controls
110 – 10 slider type volume controls
112 – 1 heating pad 200 watts mains
114 – 1 1W amplifier Mullard 1172
115 – Wall mounting thermostat 24V
118 – Teak effect extension 5" speaker cabinet
120 – p.c.b. with 2 amp full wave and 17 other recs
122 – 10 mtrs twin screened flex white p.v.c. outer
132 – 2 plastic boxes with windows, ideal for interrupted beam switch etc
155 – 3 varicap push button tuners with knobs
188 – 1 plastic box, sloping metal front, 16 x 95mm, average depth 45mm
241 – 1 car door speaker (very flat) 6½" 15 ohm made for Radiomobile
243 – 2 speakers' 6" x 4" 15 ohm 5 watt made for Radiomobile
266 – 2 mains transformer 9V ½A secondary split primary so OK also for 115V
267 – 1 mains transformers 15V 1A secondary p.c.b. mounting
330 – 2 6V 0.6V mains transformer .3A p.c.b. mounting
350 – 40 double pole leaf switches
365 – 1 7uf 660V 50hz metal cased condenser
453 – 2 2¼in. 80ohm loudspeakers
454 – 2 2¼in. 8ohm loudspeakers
463 – 1 mains operated relay with 2 sets c/o contacts
464 – 2 packets resin filler/sealer with cures
465 – 3 5A round 3 pin plugs will fit item 193
466 – 4 7 segment l.e.d. displays
470 – 4 pc boards for stripping, lots of valuable parts
473 – 1 5" 4ohm speaker with built in tweeter Radiomobile
480 – 1 3A double pole magnetic trip, saves repairing fuses
498 – 4 1000uf 25V axial electrolytic capacitors

TELEPHONE BITS

Master socket (has surge arrestor – ringing condenser etc) and takes B.T. plug £3.95
Extension socket £2.95
Dual adaptors (2 from one socket) £3.95
Cord terminating with B.T. plug 3 metres £1
Kit for converting old entry terminal box to new B.T. master socket, complete with 4 core cable, cable clips and 2 BT extension sockets £11.50
100 mtrs 4 core telephone cable £8.50

COMPACT FLOPPY DISC DRIVE EME-101

The EME-101 drives a 3" disc of the new standard which despite its small size provides a capacity of 500k per disc, which is equivalent to the 3½" and 5¼" discs. We supply the Operators Manual and other information showing how to use this with popular computers: BBC, Spectrum, Amstrad etc. All at a special snip price of **£27.50** including post and VAT. Data available separately **£2**, refundable if you purchase the drive.

DON'T FREEZE UP! – We have had the strongest winds for over 200 years and who knows we may be in for the coldest winter, so if you have not already protected your water pipes you should do so now – our heating wire wound around the pipes will do this and will cost only about 50p per week to run – 15 metres (minimum length to connect to 230/240 v mains). Price £5. Our Ref. 5P 109.

PIEZO ELECTRIC FAN an unusual fan, more like the one used by Madame Butterfly, than the conventional type, it does not rotate. The air movement is caused by two vibrating arms. It is American made, mains operated, very economical and cause's no interference. So it is ideal for computer and instrument cooling. Price is only £1 each. Ref BD605.

SPRING LOADED TEST PRODS – heavy duty, made by the famous Bulgin company. Very good quality. Price four for £1. Ref. BD597.

CURLY LEAD four core, standard replacement for telephone handset, extends to nearly two metres. Price £1. each. Ref. BD599.

TELEPHONE BELLS – these will work off our standard mains through a transformer, but to sound exactly like a telephone, they then must be fed with 25 hz 50v. So with these bells we give a circuit for a suitable power supply. Price 2 bells for £1. Ref. BD600.

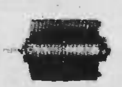
ULTRA SENSITIVE POCKET MULTIMETER – 4k ohms per volt – 11 ranges – carry one of these and so be always ready to test ac/dc volts to 1000, DC milliams and have an ohms range for circuit testing – will earn its cost in no time. Price only £7. Ref. 7P2.

BLOW YOUR ROOF OFF – 140 watt speaker systems – new type you must not hide! they have golden cones and golden surrounds and look rally "Bootiful" 12" Woofer, Midrange and Tweeter and comes with a crossover at a special introductory price of £49, carriage paid. Two sets for £95 carriage paid. 140w Woofer only £35 carriage paid.

3½ & 5¼ FLOPPY DISC DRIVES now in stock all are new and made by famous Epson company. All are double sided drives with storage capacity of 1 meg byte. They have standard connections and are fully compatible with conventional systems. Both are small size and light weight. Price – either model is £57.50 plus £3 post. Price includes copy operating data.

APPLIANCE THERMOSTATS – spindle adjust type suitable for convector heaters or similar price 2 for £1. Ref. BD582.

12 volt MOTORS BY SMITHS
Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" spindle –
1/10 hp £3.45
1/8 hp £5.75, 1/6 hp £7.50



SOUND TO LIGHT UNIT

Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The 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 price is £14.95 in kit form.

This Month's Snip

9" VDU OR MONITOR ideal to work with computer or video camera uses Philips black and white tube ref M24/306W. Which tube is implosion and X-Ray radiation protected. VDU is brand new and has a time base and EHT circuity. Requires only a 16V dc supply to set it going. It's made up in a lacquered metal framework but has open sides so should be cased (if you are handy with a drill and file you could make a case out of two of our 6½" speaker cabinets). The VDU comes complete with circuit diagram and has been line tested and has our six months guarantee. Offered at a lot less than some firms are asking for the tube alone, only £16 plus £3 post. We also have some that failed the line test, again brand new but offered without guarantee at £8 plus £3 post. We do a kit for the 16V 2A psu to operate this monitor price is £3 our ref 3P26.

LIGHT BOX

This when completed measures approximately 15" x 14". The light source is the Philips fluorescent 'W' tube. Above the light a sheet of fibreglass and through this should be sufficient light to enable you to follow the circuit on fibreglass PCBs. Price for the complete kit, that is the box, choke, starter, tube and switch, and fibreglass in £5 plus £2 post, order ref 5P69.

TANGENTIAL HEATERS

We agin have very good stocks of these quiet running instant heat units. They require only a simple case, or could easily be fitted into the bottome of a kitchen unit or book case etc. At present we have stocks of 1.2ks, 2kw, 2.5kw and 3kw. Add post £1.50 per heater if not collecting.
CONTROL SWITCH enabling full heat, half heat or cold bow, with connection diagram, 50p for 2kw. 75p for 3kw.

COMPUTERS

The Acorn "Electron" as used in many schools for games and serious jobs. Works into colour or Black and White TV. Proper price was £199, our Price, tested and working £45 + £3 post, tested but slightly faulty £36 + £3 post and lastly tested but not working £20 + £3 post, all are new and complete with: mains P.S.U., 300 page handbook, TV lead, and starter cassette. Full range of Software also in stock at very low prices.

TELEPHONE LEAD

3 mtrs long terminating one end with new BT, flat plug and the other end with 4 correctly coloured coded wires to fit to phone or appliance. Replaces the lead on old phone making it suitable for new BT socket. Price £1 ref BD552 or 3 for £2 ref 2P164.

POWERFUL IONISER

Generates approx. 10 times more IONS than the ETI and similiar circuits. Will refresh your home, office, shop, work room etc. Makes you feel better and work harder – a complete mains operated kit, case included. **£11.50 + £2 P&P.**

J & N BULL ELECTRICAL
Dept. P.E., 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £20 add £1 service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted. Brighton 0273 734648 or 203500.

NEW ITEMS

Some of the many described in our current list which you will receive with your parcel

£2 POUNDERS*

2P122 – 1 30a rotary switch, surface mounting with pointer knob
2P123 – 1 25a rotary switch, surface mounting, cover engraved, high, medium low and off
2P124 – 1 28kv .001mfd block condensor
2P127 – 1 30a bridge rectifier assembly on heat sinks
2P129 – 1 10rpm motor 115V so supplied with adaptor for 230V
2P131 – 1 Crouzet motor 230V fits the Crouzet gearbox
2P132 – 1 ceiling heat-stat for fire warning or protection
2P133 – 1 Circuit breaker 20a, Crabtree ref C50
2P134 – 1 9V 500mA psu, plugs into 13a socket
2P135 – 10m 10 conductor intercom cable
2P136 – 1 2½kw element made for tangential blowers
2P137 – 1 Thermo couple, stainless steel tipped for measuring internal heat
2P138 – 1 Mains transformer 20V-0-20V 1a upright mounting
2P141 – 1 rechargeable battery D size (4 AH) solder tag ended
2P142 – 10m 4 pair intercom cable White PVC outer
2P144 – 1 mains operated relay with 4 x 8a c/o contacts
2P147 – 1 10w 100ohm line matching transformer
2P148 – 1 Technical information on 3" FDD refundable if you buy fdd
2P149 – 5 diff battery operated model motors
2P150 – 1 PSU chassis with all components for 24V 2A d.c. unwired
2P151 – 1 Metal box 14½ x 14 x 4 with lid add £2.00 post
2P152 – 1 Motor start capacitor 80uf 250V
2P153 – 1 Two station intercom unused but line reject
2P154a – 1 Nicad charger — plug into 13a socket 5.2V .7UA output
2P154b – 1 Nicad charger — plug into 13a socket 6V .9VA output
2P155 – 1 Mains transformer giving 16, 17, 18 & 20V 60W
2P158 – 1 Oven thermostat with temp calibrated knob
2P159 – 1 9V 500ma cased with mains lead and output lead
2P160 – 1 13a plug adaptor fused takes 3 x 13a plugs
2P161 – 1 6" diagonal side cutters
2P162 – 1 Stereo Matrix PCB mounting deemphasis K35
2P163 – 1 AC Working capacitor 12uf 660V AC or 1500V dc
2P163a – 1 AC Working capacitor 14uf 350V AC or 800V dc
2P164 – 3 Phone leads 3 mtrs long tags one end B.T. plug other end

£3 POUNDERS*

3P7 – 1 DC voltage, doubler or halver for 12V to 24V 12 to 6V 24 to 12V
3P8 – 1 24hr time switch Sangamo, new condition Guaranteed 1 year
3P9 – 12V 500mA psu plugs in 13a socket
3P10 – 1 Mains transformer 50V 2A with 6.3 pilot light winding, upright mounting, fully shrouded
3p13 – 1 Noise filter to fit in mains lead of appliance up to 25a
3P15 – 1 waterproof case will take 200 watt transformer
3P16 – 1 signal box, 3 lamps on face plate of metal box size 5½ x 3½
3P17 – 1 choke and starter to work 8" fluorescent tube at 125W
3P18 – 1 22V 3a mains transformer with bridge rect fitted on top panel
3P20 – 1 0-5a ammeter 3½ ac/dc ex equipment
3P21 – 1 power factor correction condenser 35uf 350ac
3P22 – 1 200va – auto transformer 230 to 115V torroidal encapsulated £1.50 post
3P24 – 1 3" floppy disc for Amstrad etc.
3P25 – 1 7" Electricians pliers

SUPER WATER PUMP – Approx ⅓ hp mains operated originally intended to operate a £300 shower unit at a controlled pressure – but of course suitable for many other water or liquid moving operations – where a good flow at a constant pressure is required – Price £25 each V.A.T. and Post Paid. Our Ref. 25P2.

VERY USEFUL MULTI TESTERS – These have all usual ranges AC & DC volts – DC MA and OHMS etc but an unusual and very useful feature is a "low OHMS" range. Very useful for checking dry joints etc. They are ex G.P.O., and may have faults but we test and guarantee the movement to be O.K. Price £3 each. Ref. 3P30, or two, same make and type, Price £5. Ref. 5P.110.

AGAIN AVAILABLE – 12" mini fluorescent tubes – Price £1 each. Ref. BD314.

POWER PACK OR AMPLIFIER CASE – Size approx 10" x 8¼" x 4¾" plated steel – with ample perforations for cooling. Front panel has on/off swtich and E.E.C. mains inlet plug with built in RF filter – undoubtedly a very fine case which would cost at least £50 from regular sources, our price is £5 each and £3 post. Ref. 5P.111.

MINIATURE BCD THUMB WHEEL SWITCH – Matt black edge switch engraved white on black – gold plated, make before break contacts – size approx. 25mm high 8mm wide 20mm deep – made by the famous Cherry Company and designed for easy stacking – Price £1 each. Ref. BD601.

EDGE METER – miniature, whole size approx 37 mm x 13mm 100 ua fsd – centre zero scaled 0 to –10 and 0 to +10. Price £1 each. Ref. BD602.

LARGE 2 SPEED MOTOR – 1 hp at 250 rpm and ¼ hp at 200 rpm – continental make, intended originally to power an industrial machine – regular price over £60, our Price £15 plus £5 carriage. Ref 15P5.

RUBBER FEET – Stick on – Ideal for small instruments and cabinets – pack of 56 for £1, Ref. BD603.

CLEANING FLUID – Extra good quality – intended for video and tape heads – regular price £1.50 per spray can – our Price – 2 cans for £1. Ref. BD 604.

£4 POUNDERS*

4P11 – 1 Car Radio aerial
4P12 – 50m low loss co-ax 75ohm + £1 post
4P13 – 3 Hortsman time and set switches 15amp
4P14 – 1 150w mains transformer "c" core 43V 3.5A secondary
4P15 – 1 powerful motor 2" stack fitted with gearbox final speed 60rpm mains operated, could operate door opener etc.
4P17 – 1 Uniselector 3 pole 25W, 50V coil standard size
4P18 – 1 Volt meter with digital display (DIGIVISOR)

£5 POUNDERS*

5P86 – 1 Transformer upright mounting 230/240V primary 2 x 100 1a secondary
5P88 – 1 Transformer in waterproof metal box 24V 5A add £2 post
5P89 – 1 4 bank heating element each 2kw ideal convector heater
5P90 – 1 18" long tangential blower with motor at one end
5P91 – 1 14" blower, motor in middle
5P92 – 10m Audio co-ax double screened 75ohm super low loss for TV
5P93 – 1 6" Alarm bell 24V dc or ac
5P94 – 1 Current transformer 14V out with 1a dc input
5P95 – 1 Vintage photo cell
5P97 – 1 Impedance matching transformer 0-4-5-8-160 ohm 100 add £150 post
5P98a – 1 0-90a ammeter for mounting outside control panel
5P98b – 1 0-180a ammeter for mounting outside control panel
5P99 – 1 Mains operated blower centrifugal output size app. 5" x 1½"
5P100 – 1 Mains splitter 45a switch 3 x 15a fused circuits
5P101 – 1 Model motor 1 rpm from 6V reversible

£8 POUNDERS*

8P1 – 1 Charger transformer 10a upright mounting 230/240 primary 16v 10a secondary
8P2 – 1 6" underdome alarmbell suitable for a fire alarm or burglar alarm mains operated.
8P3 – 1 heat sink big powerful so ideal for power transmitter
8P6 – 1 24hr time switch – 2 on offs 16a c/o contacts 3" x 3" x 1½"
8P7 – 1 Silent sentinel invisible ray kit
8P8 – 1 Papst fan 3½ x 3½ x 1½ 230V metal bodied

£10 POUNDERS*

10P14 – 1 100a time switch 1 on/off per 24hr extra triggers £1 pair
10P15 – 1 Max demand meter 230 ac mains
10P16 – 1 powerful air mover 2 small type blowers with motor in middle
10P18 – 1 mains operated klaxon
10P19 – 1 12V alarm bell really loud, mains operated, in iron case + £5 post
10P21 – 1 super metal box size 19" x 20" x 7" deep lockable + £3 post
10P22 – 1 sensitive volt meter relay
10P23 – 1 fruit machine heart 3 fruit wheels each stepper motor operated
10P24 – 1 big panel meter face size 4¾ x 2½ 200uA movement scaled 1-10
10P25 – 1 100W audio transformer 50-0-50W primary 8 ohm secondary
10P31 – 1 7 day time switch 16a c/o contacts sep switches for each day
10P32 – 1 68 rpm 1/6th hp motor reversible

LEGO BUGGY DRIVER

BY ROBERT MACFARLANE

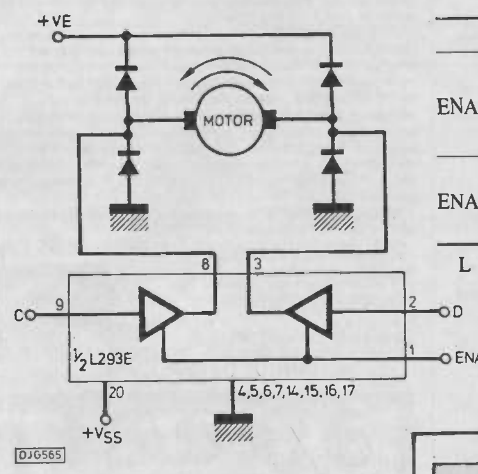
BACK AND FORTH

This Spectrum-controlled motor driver will drive two small dc motors between 3V and 36V, using pulse width modulated square waves to control the speed.

This project will allow the ZX Spectrum to drive two independent dc motors in either forward or reverse directions and was originally designed to power the two 4.5V motors which form part of the Lego Buggy. The circuit will however drive any small dc motor provided the the 1A/36V rating of the bridge transistors in the output stage is not exceeded.

IC3 is a monolithic bridge driver which is used in full bridge configuration to drive a motor in both directions as shown in Fig.1. Using the logic inputs of the two channels as shown, the motor can be made to run clockwise, anti-clockwise or stop rapidly. The enable/inhibit input is used for a free running stop as it turns off all the four transistors of the bridge when low.

The motor speed can be controlled by switching the drivers with pulse width modulated square waves and this approach is particularly suitable for microprocessor control.



	INPUTS	FUNCTION
ENA=H	C=H D=L	TURN RIGHT
	C=L D=H	TURN LEFT
	C=D	FAST MOTOR STOP
ENA=L	C=X D=X	FREE RUNNING MOTOR STOP

L = LOW H = HIGH X = DON'T CARE

Fig. 1. *Bi-directional motor control*

CIRCUIT DESCRIPTION

IC1a is one half of a five input NOR gate and is used to decode the IORQ, WR, A7, A6 and A5 signals from the Spectrum bus to the output port address of 1F hex (decimal 31).

On receipt of an OUT instruction to address 1F hex, pins 1, 2, 3, 12 and 13 of IC1 will be at logic zero and the output at pin 5 will go high. Pin 11 of IC2 therefore goes high enabling the contents of the data bus to appear on its output. When pin 11 returns to zero at the end of the write cycle the contents are then latched.

The 5V supply for IC1, IC2 and IC3 is derived from the Spectrum 5V line and is decoupled by C1. However, the motor supply is external and may be in the range 3V to 36V.

SYSTEM OPERATION

Independent control of the two motors can be achieved by driving the logic inputs of IC3 in accordance with Table 1. For example, if the motor driven

TABLE 1

	D3	D2 IN2	D1 IN1	D0 ENA	FUNCTION	
0	X	0	0	0	OFF	SLOW STOP
1	X	0	0	1	ON	FAST STOP
2	X	0	1	0	OFF	SLOW STOP
3	X	0	1	1	ON	FORWARD
4	X	1	0	0	OFF	SLOW STOP
5	X	1	0	1	ON	REVERSE
6	X	1	1	0	OFF	SLOW STOP
7	X	1	1	1	ON	FAST STOP

2nd MOTOR = VALUE x 16 X = DON'T CARE

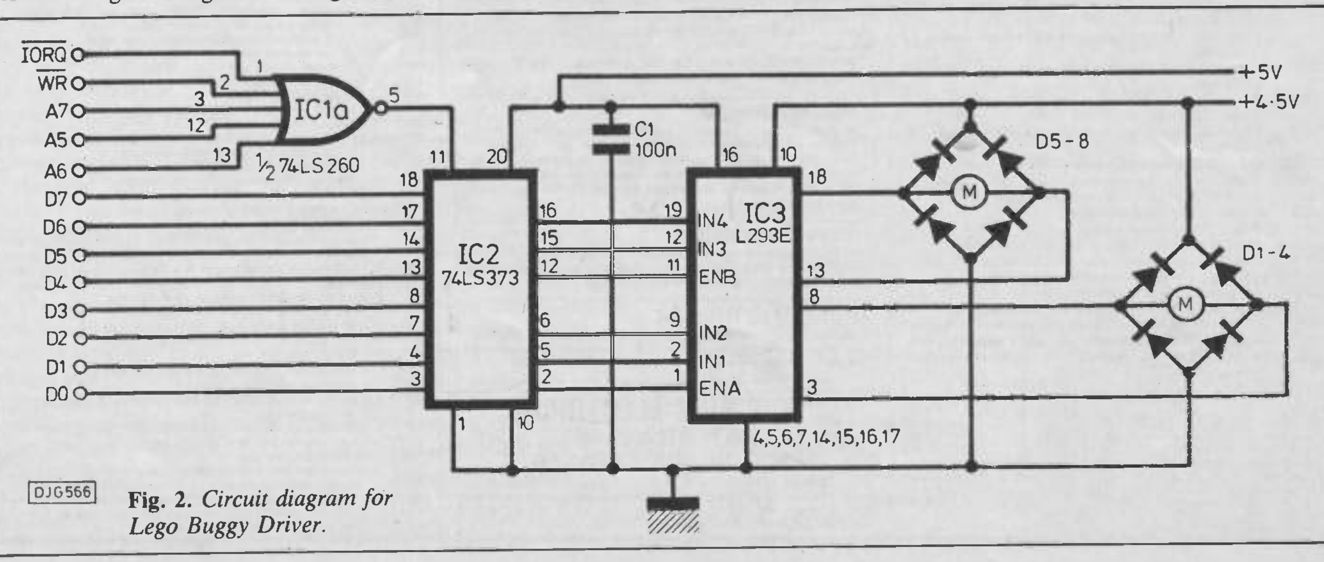
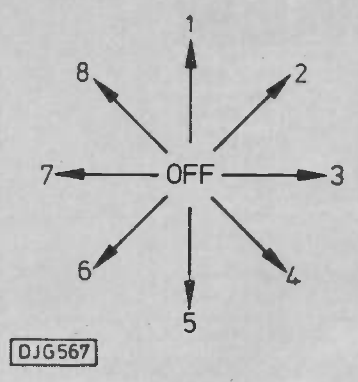


Fig. 2. *Circuit diagram for Lego Buggy Driver.*



	MOTOR L	R	HEX	DEC
1	FWD	FWD	33	51
2	FWD	OFF	30	48
3	FWD	REV	35	53
4	REV	OFF	50	80
5	REV	REV	55	85
6	OFF	REV	05	5
7	REV	FWD	53	83
8	OFF	FWD	03	3
0	OFF	OFF	00	0

TABLE 2

by the lower half of the data bus is to run forward, then D0=1, D1=1 and D2=0 which is equivalent to 3 hex, or 3 decimal. Similarly, if the other motor has to run forward then, due to symmetrical connection to the upper half of the data bus, D4=1, D5=1 and D6=0 which is equivalent to 30 hex or 48 decimal. It follows therefore that to drive both motors in the forward direction the value which is required to be output onto the data bus with the OUT instruction is the sum of both the upper and lower data bit values. In this case 33 hex or 51 decimal.

A table of hex and decimal values which would drive the Lego Buggy in 8 compass directions is shown in Table 2.

CONSTRUCTION

The Spectrum 58 way edge connector should first be soldered to the upper and lower connections on the double sided printed circuit board taking care to align the polarising slot. The dil sockets for IC1 and IC2 can then be fitted followed by the decoupling capacitor C1, the legs of which must also be soldered on the component side. Similarly D1 – D8 should be soldered on both sides where necessary to complete the through board connections. IC3 is soldered directly to the pcb where the large areas of copper track form some measure of heatsinking. pcb linking pins are then soldered to the remaining holes and either pcb connectors or flying leads are taken to the 4.5V and motor outputs.

COMPONENTS LIST

SEMICONDUCTORS

IC1	74LS260
IC2	74LS373
IC3	SGS L293E Signetics
D1-D8	IN4148

CAPACITORS

C1	100n ceramic

MISCELLANEOUS

14 Pin dil Socket, 16 Pin dil Socket, Spectrum edge connector, printed circuit board, pcb Link Pins.

TESTING

With the power turned off, the board can be plugged into the ZX Spectrum and a short Basic program which controls the Lego Buggy using the Spectrum keyboard for directional control is shown in Table 3. Control of motor speed can be achieved by pulsing the enable inputs of IC3 with a square wave of variable mark to space ratio, but would require the use of faster machine code programs. PE

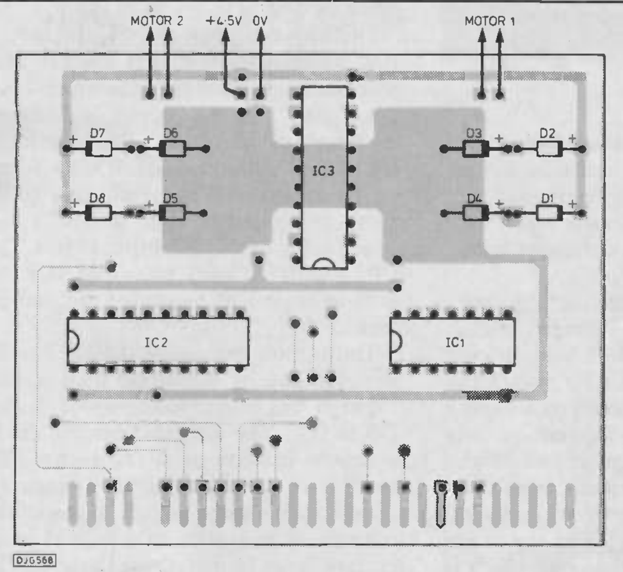


Fig. 3. *Printed circuit board details.*

BASIC LISTINGS FOR ZX SPECTRUM

```
10 IF INKEY$ = " " THE GOTO 10
20 IF INKEY$ = "o" THEN OUT 31,0
30 IF INKEY$ = "i" THEN OUT 31,51
40 IF INKEY$ = "m"THEN OUT 31,85
50 IF INKEY$ = "k" THEN OUT 31,53
60 IF INKEY$ = "j" THEN OUT 31,83
70 GOTO 10
```

FLASHY EGG-TIMER

BY CHRIS BOWES

TAKE 58 LEDS (HALF A CUP)

Any old egg timer can tell you when your eggs are ready, but how many can tell you when your eggs are only half ready? The leds of time are flowing...

Although there are a number of designs for electronic egg-timers which sound an alarm when the cooking time is over, most of them give little indication of the passage of time. This feature was a characteristic of the old fashioned sand glass type of egg-timer. The project described in this article combines the advantages of an electronic circuit, which sounds an alarm, with a display and method of operation which is very similar to that found in the old fashioned type of egg-timer.

The sand of the old fashioned egg-timer is mimicked in this design by a display which consists of a number of leds arranged so as to be like the sand in the traditional egg-timer glass. Electronic "sand", in the shape of leds illuminated in sequence, is seen to "flow" from the top section to the bottom section, starting when the timer is raised to an upright position. When the correct time for the eggs to have cooked is reached an alarm sounds and the "sand" stops flowing, although the alarm continues until the egg-timer is laid down.

CIRCUIT DESCRIPTION

The circuit diagram for the Electronic Egg-Timer is shown in Fig. 1. The circuit is controlled by S1 which is a mercury position switch. This component is mounted so that when the egg-timer is stood upright the switch closes and the circuit starts to function. In any other position the switch is open and the circuit is deactivated.

The timing for the entire circuit is obtained from IC1 which is a 555 timer configured as an astable multivibrator, with frequency set by VR1, R1, R2 and C1. With the values given, this frequency is approximately 2.5Hz but this is adjustable by altering the setting of VR1. The ability to adjust the operating frequency has been incorporated to enable the time between the egg-timer being set in operation and the alarm sounding to be varied. This allows the egg boiling time to be adjusted to suit the particular taste of the user.

The output pulses from the astable circuit are fed to two counter circuits each of which controls a different part of the electronic "sand" display.

FLOWING SAND

The effect of sand flowing from the top chamber to the bottom chamber of the "glass" is created by a six stage chase circuit driven by IC2. This is a 4017 Johnson counter which drives six leds (LED 1 to 6).

The clock pulses from the 555 timer circuit are fed to the CP0 input of IC2, the CP1 input of which is held at logic 0. Each clock pulse at CP0 causes the outputs 0 to 9 to be forced to a logic 1 state in succession. In this circuit only outputs 1 to 6 are used to imitate the sand. To prevent the circuit from over-running, output 7 (pin 6) is connected to the MR input (pin 15) of the ic via D1. R3 is a pull down resistor which is included to prevent the input floating to an indeterminate logic state when not connected to logic 1 through D1 or D2. As soon as this input goes from Logic 0 to logic 1 the ic resets to zero (with output 0 at Logic 1) within a very short time (typically 9 nano-seconds). The counter, as a result, goes through the sequence of outputs 0 to 6, each in turn going to the logic 1 in a continuous sequence. As output 0 is not connected to any led (for a reason which you will see later) this produces the effect of LEDs 1 to 6 being illuminated in sequence, followed by one "count" when none of the leds in the "tube" between the two glasses are lit.

FALLING SAND

In effect this display is a slower, and more complex, version of the flowing sand display. The clock pulses produced by the 555 timer are first fed to the CP0 input of one half of a 4518 dual BCD counter (IC3). Output 3 of the first half of the counter is connected to the CP0 input of the second half of the ic and the output pulses from output 3 of the second counter are fed to the rest of the circuit. R10 is included to provide a logic 1 level to the CP1 inputs of both halves of the 4518, and is necessary to enable the circuit to count. The effect of IC3 being connected in this manner is for it to divide the clock pulses from the 555 timer by 100.

The slowed down pulses are fed to IC4, which is another 4017 counter. This ic is used to control the leds which form the "sand" in the upper and lower chambers of the "glass". This counter is set to zero when the circuit is switched on by means of a short positive going pulse generated by R11 and C3, and which is fed to the MR input of IC4. The CP1 inputs of both halves of IC3 are held at logic 1 by means of the pull up resistor R10.

The display formed by LEDs 7 to 58 is controlled by outputs 0 to 8 of IC4 through the matrix made up of diodes D3 to D72. The outputs from the diode matrix is used to drive transistors TR1 to TR16 through their associated dropping resistors. When one of the outputs of IC4 goes to a logic 1 state current flows from it, through the diodes in the matrix and the appropriate dropping resistor to the base of the transistor associated with the particular row of leds. Since the transistor acts as a switch the current flowing into its base causes the leds to light in sequence. In some of the led chains a resistor is connected in series with them, so dropping the voltage across each led to the correct working level.

The diodes in the matrix prevent the direct connections, which would otherwise occur between the outputs of IC4 at each transistor, from interfering with each other. In each case the one-

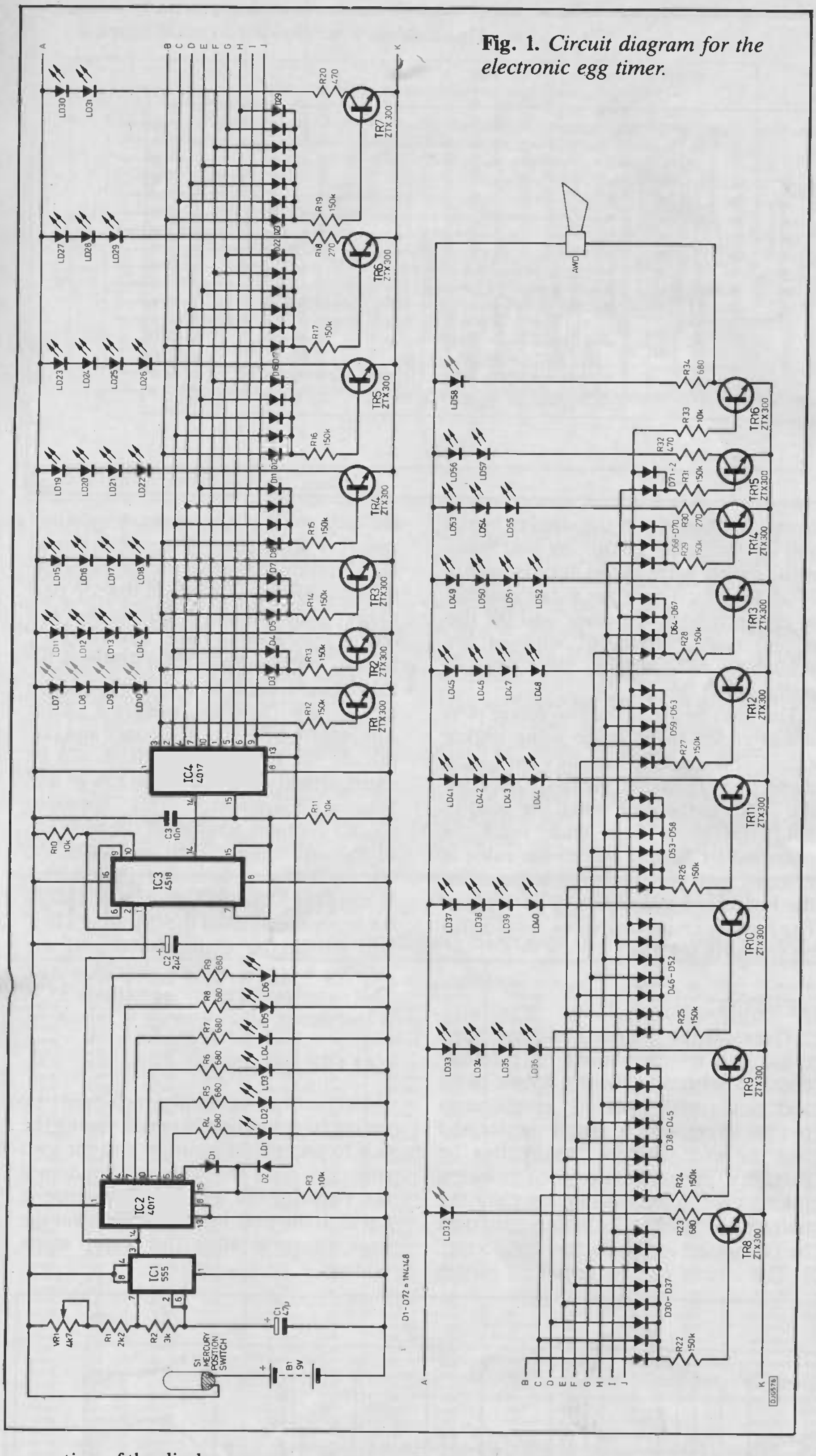


Fig. 1. *Circuit diagram for the electronic egg timer.*

way action of the diodes prevents current from the outputs flowing back through the other connections made to an associated transistor.

Output 8 (pin 9) of IC4 is connected to the CP1 input of IC4. This input controls the counting action of IC4. As long as the CP1 input is at logic 0 the ic counts. When this input is forced to logic 1 the counter stops counting. The counter is set to zero when the circuit is first switched on. This sets all of the counter outputs, except the first, to logic 0. The CP1 input is thus set to logic 0 and remains in that state until the counter reaches the point at which output 8 switches to the logic 1 state. This only occurs when the time allowed for the egg to cook has elapsed and the timing sequence is complete. The change of state at the CP1 input causes the counter to stop and the display freezes with all the "sand" in the bottom of the "glass".

Output 8 of IC4 is also connected, through D2, to the MR input of IC1, forcing it to logic 1, so resetting the counter. This has the effect of extinguishing the leds in the "tube" between the two "sand glasses", thus the "sand" ceases to flow from the top of the "glass" to the bottom.

THE ALARM CIRCUIT

Output 8 of IC4 is additionally connected through resistor R33 to the base of TR16. When this output goes to logic 1, current from it flows through R33 and causes TR16 to conduct, illuminating LED 58 and activating the awd.

C2 is a decoupling capacitor which is provided to help prevent false counting problems in the logic ics created by "glitches" which can occur as the circuits switch.

EGG-TIMER COMPONENTS

RESISTORS

R1	2k2
R2	3k
R3	10k
R4 to R9	680 (6 off)
R10, R11	10k (2 off)
R12 to R17	150k (7 off)
R18	270
R19	150k
R20	470
R22	150k
R23	680
R24 to R29	150k (6 off)
R30	270
R31	150k
R32	470
R33	10k
R34	680

(All ¼ watt 5%)

POTENTIOMETER

VR1	4k7 min horiz preset

CAPACITORS

C1	47μ 16V miniature pcb electrolytic
C2	2μ2 16V tantalum, 16 volt
C3	10n polyester or ceramic

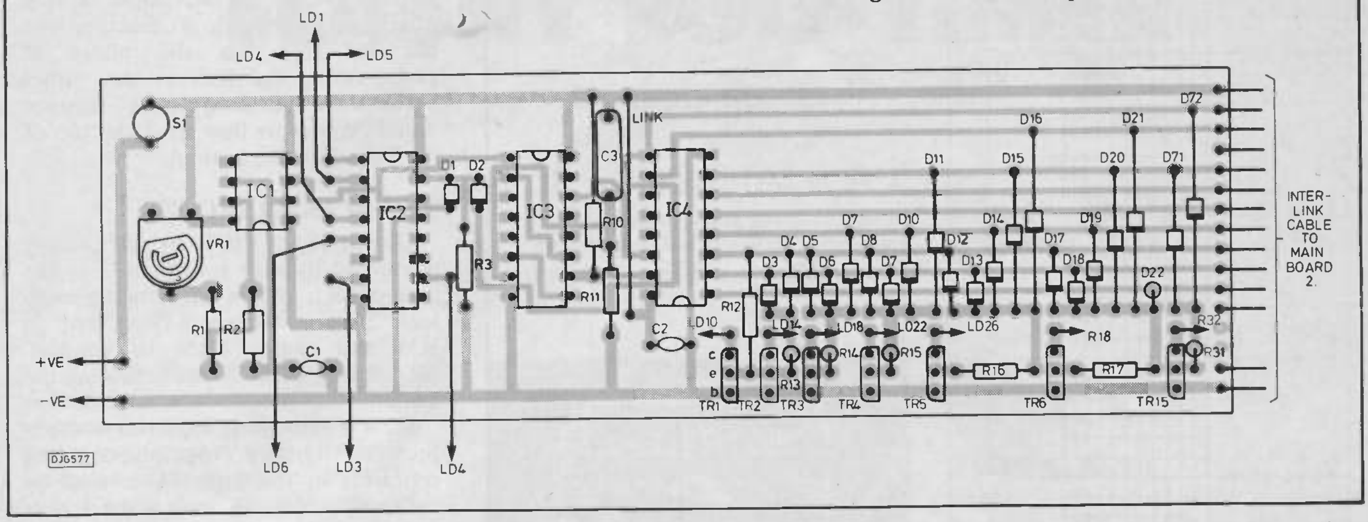
SEMICONDUCTORS

D1 to D72	1N4148 (72 off)
LD1 to LD58	miniature yellow led (58 off)
TR1 to TR16	ZTX300 (16 off) or similar
IC1	555 cmos timer
IC2, IC4	4017 decade counter
IC3	4518 dual bcd counter

MISCELLANEOUS

S1 mercury position switch, B1 PP3 battery and clips, case to suit 150 x 80 76 mm, (RS 507-674) lettering and fixings for case, printed circuit boards (3 off), ribbon cable (20 way, 0.1in pitch).

Fig. 2. *Main control printed circuit board.*



CONSTRUCTION

The circuit occupies a fairly large area and is built on three single sided printed circuit boards in order to fit the design into the case. One pcb is used for the display leds and associated series resistors, while the other two pcbs are used to carry all the other components. The foil patterns of these pcbs and their associated component layouts are shown in Figs. 2, 3 and 4.

Although component insertion and soldering can be carried out in any convenient order, you will probably find that it is easier to do this in ascending order of component size. When inserting the mercury position switch (S1) it is necessary to leave sufficient length on its wires so that its position can be adjusted to ensure that the circuit is turned on when the board is raised with S1 uppermost.

The ics are best accommodated in sockets which are soldered in place along with the other components, but only insert the ics as the last task before testing out the unit.

WIRING UP

The boards are best not wired up until all the components, except for the ics, have been inserted and soldered. The connections between the display board and the two other boards are best made with flexible wires cut to approximately 20cm lengths. There are a fair number of connections to be made and the use of as many colours of wire as are available will reduce the risk of confusion at this stage.

The links between the two driver pcbs are intended to be made using ribbon cable. This must be *carefully* cut to the correct length to span the space between the slides in the case which are used to hold the pcbs. The ends must be prepared by tinning before the cable is inserted into the appropriate holes on the board and then soldered into place. The battery connector wires should also be similarly soldered.

TESTING

Once all the connections have been made the boards should be carefully checked for broken tracks, solder blobs and incorrectly placed components before attempting to insert the ics and test the unit. The ics should then be carefully inserted into their sockets, taking care to ensure that they are the correct way round. The battery may then be connected to the battery connector.

The circuit can be tested by raising the pcb so that the mercury position switch is uppermost. The switch should then be adjusted so that the display starts to light. All rows of leds in the top part of the "glass" should be illuminated and one of the "flowing sand" leds (LEDs 1 to 6) should also light. After a short delay they should begin to switch off and on in a slow chasing pattern.) After somewhere between 30 seconds and one minute the top row of leds should be extinguished and the bottom row of leds become illuminated. This sequence should continue until all of the top rows of leds are extinguished and all of the bottom rows of leds are illuminated. When the last of these (LED 58) becomes illuminated the "flowing sand" leds should be extinguished and the audible warning device should sound. This state should continue until the PCB is laid down.

CALIBRATION

Calibration is easily achieved by timing, the duration between raising the pcb to an upright position and the awd sounding. VR1 should be adjusted until the time for the complete sequence is equal to the time for which you want the eggs to cook after the water starts boiling.

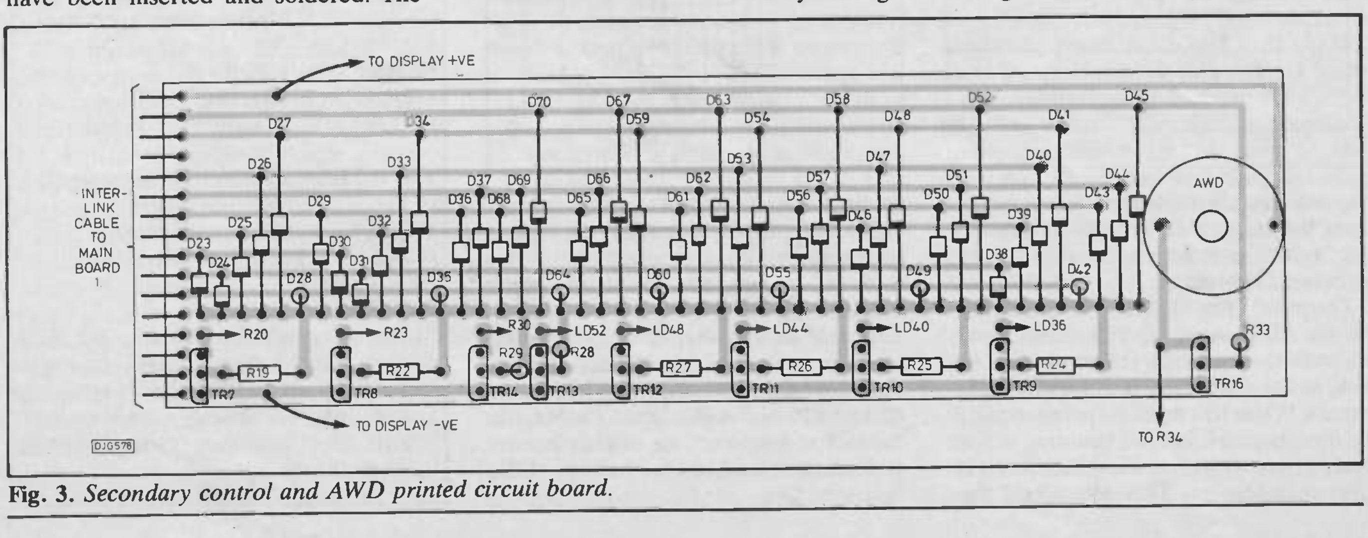


Fig. 3. *Secondary control and AWD printed circuit board.*

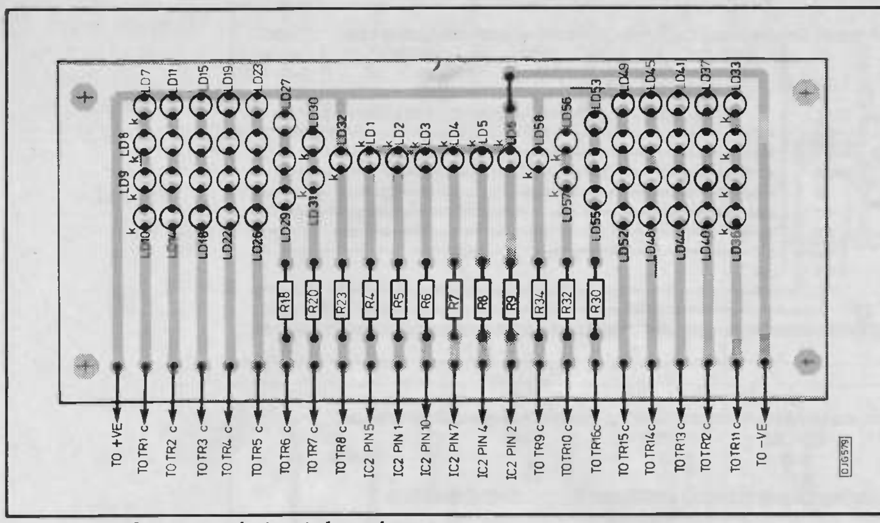


Fig. 4. *Display printed circuit board.*

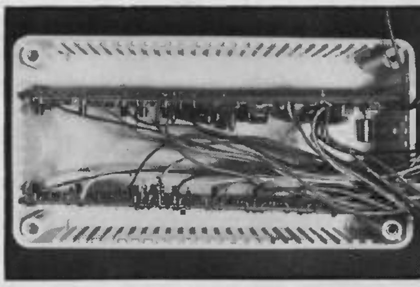
CASING THE UNIT

The suggested case has been chosen because it has a transparent lid. This avoids the necessity of drilling 58 holes in the case lid for the display leds. If this case is used for fitting the display simply becomes a matter of marking the four mounting holes on its lid, so that the egg glass shape is in the centre. The holes are then drilled with a 3.5 mm drill and countersunk.

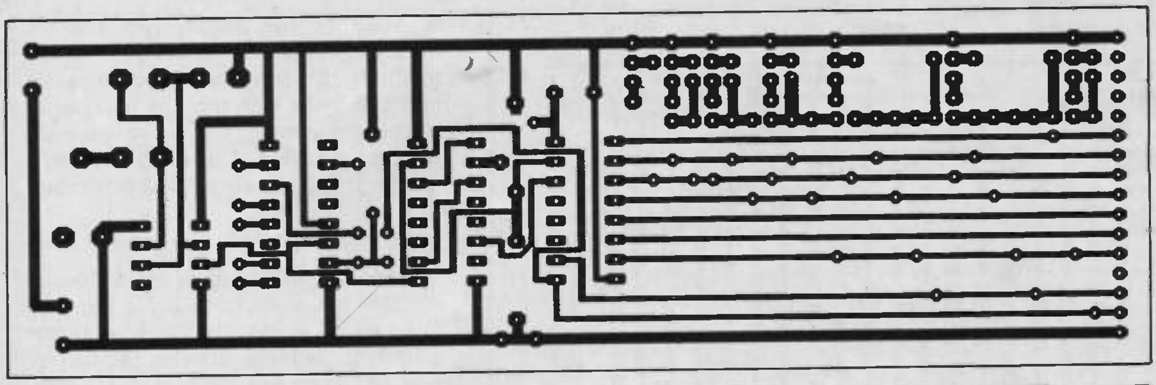
The front panel for the prototype was made by means of a photosensitive labeling system with the lettering and the egg-timer "glass" exposed so as to be clear. The front panel produced by the system was then stuck to the case lid with coloured transparent double sided adhesive sheets. This system has the advantage of masking the heads of the mounting bolts. However, if you do not have access to the means of making this type of label an alternative method which produces acceptable results is to carefully cut out the egg glass shape on a piece of black card with a craft knife. The card is then lettered and positioned inside the case lid, where it will be held in place by the display pcb and it's mounting nuts. Irrespective of which method of lettering used, care should be taken to make sure that the lettering is placed the correct way up to coincide with the direction of flow of the "sand", or else it will appear to flow upwards!

EGG TIMING

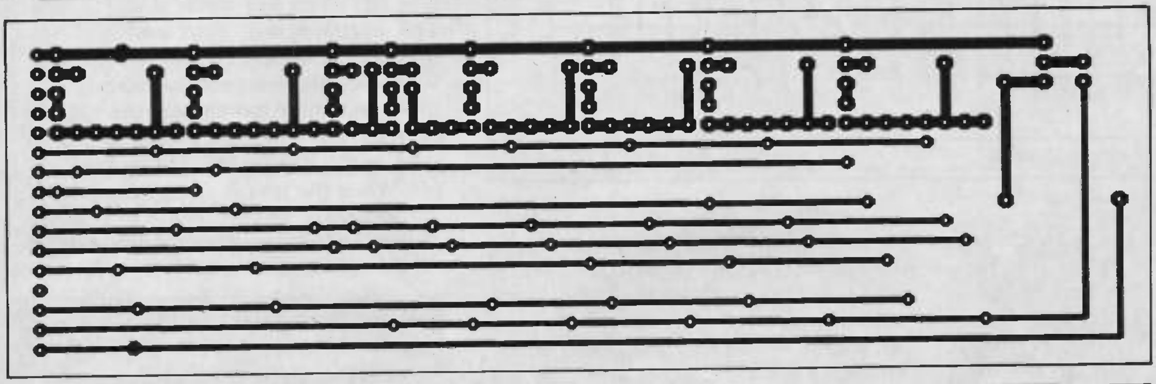
This timer is extremely simple to use. All that has to be done is for the case to be raised so that the egg-glass shape is upright, with the lettering the correct way up, when the water starts to boil. The eggtimer will start and will run through the display and alarm sequence. When the alarm sounds to indicate that the correct time has elapsed the egg can be removed from the pan. The unit is then laid down on its side to switch it off. When the unit is again raised it will automatically be reset ready to start the display and timing sequence again. PE



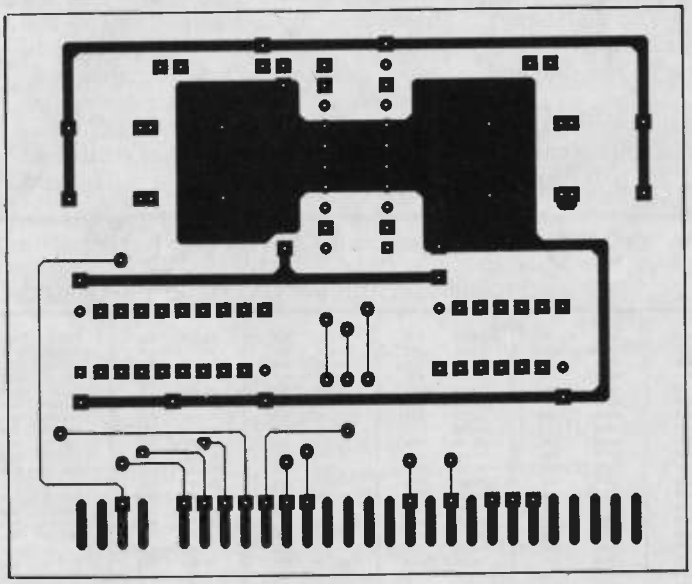
TRACK CENTRE



PE 162A

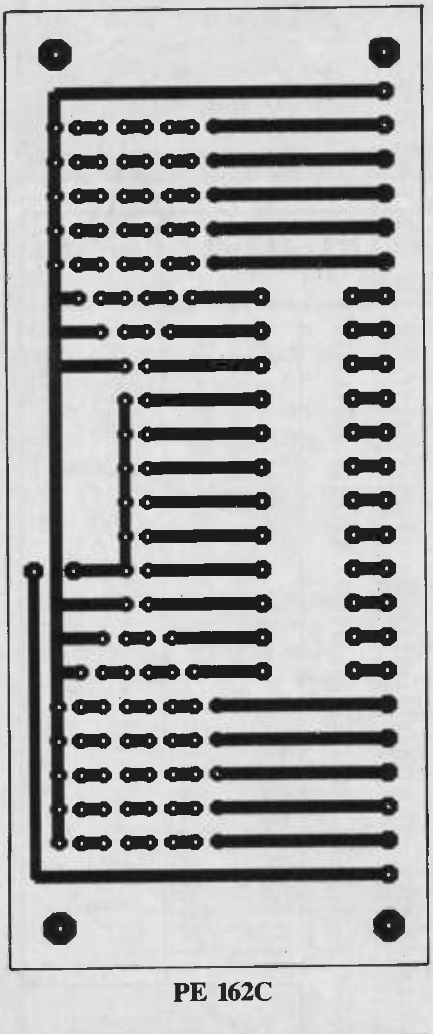


PE 162B

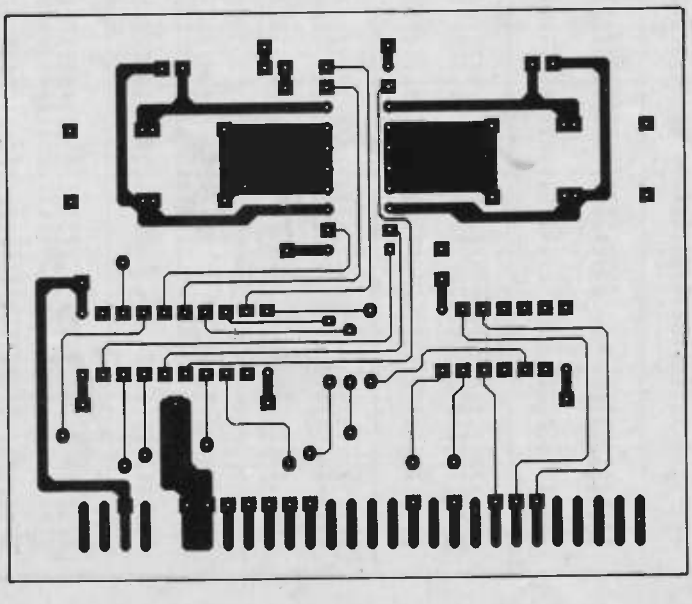


PE 163 (COMPONENT SIDE)

NOTE THAT PE 163 IS A DOUBLE-SIDED PCB



PE 162C



PE 163 (REAR SIDE)

THESE PRINTED CIRCUIT BOARDS MAY BE BOUGHT THROUGH THE PE PCB SERVICE (SEE PAGE 60).

1988 CALENDER

JANUARY

SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

FEBRUARY

SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29					

MARCH

SUN	MON	TUE	WED	THU	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

APRIL

SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

MAY

SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

JUNE

SUN	MON	TUE	WED	THU	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

JULY

SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

AUGUST

SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	17	19	20
21	22	23	24	25	26	27
28	29	30	31			

SEPTEMBER

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

OCTOBER

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

NOVEMBER

SUN	MON	TUE	WED	THU	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

DECEMBER

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

PE is normally published on the first Friday of each month (with exception of January this year due to New Year's Day). Advertising copy closing date is the first Monday following publication date for the preceding issue.

PERENNIAL CALENDER PROG

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100 PRINT"PE CALENDER MAKER":DIMM(12),M$(12):D$="SUN MON TUE WED THU FRI SAT"
110 DATA31,28,31,30,31,30,31,31,30,31,30,31,JANUARY,FEBRUARY,MARCH,APRIL,MAY
120 DATAJUNE,JULY,AUGUST,SEPTEMBER,OCTOBER,NOVEMBER,DECEMBER
130 FORM=1TO6:M$=M$+CHR$(160)+CHR$(160)+CHR$(160)+CHR$(160):NEXT
140 FORM=1TO31:M$=M$+RIGHT$("   "+STR$(M),4):NEXT
150 FORA=1TO12:READM:M(A)=M*4:NEXT:FORA=1TO12:READM$(A):NEXT:PRINT
160 INPUT"FROM START OF WHICH YEAR";S$:PRINT:INPUT"TO END OF WHICH YEAR";E$
170 S$="19"+RIGHT$(S$,2):E$="19"+RIGHT$(E$,2):PRINT
180 INPUT"WITH PRINTER Y/N";P$:IFP$="Y"THENP=1:OPEN4,4:PRINT#4
190 FORY=VAL(S$)TOVAL(E$):X=X+1:Y$=STR$(Y):B=VAL(RIGHT$(Y$,2)):IFX>1THEN220
200 L=INT(B/4):IFB/4<>LTHENL=L+1
210 C=(B*365)+L:D=C/7:E=INT(D)*7:F=C-E+1:L=30-(F*4)
220 PRINT:PRINTY:IFPTHENPRINT#4:PRINT#4,CHR$(1)MID$(STR$(Y),2):PRINT#4
230 FORC=1TO12:MM$=LEFT$(M$,24+M(C)):PRINT:PRINTM$(C);Y:PRINT:PRINTD$
240 IFPTHENPRINT#4:PRINT#4,CHR$(1)M$(C):PRINT#4:PRINT#4,CHR$(1)D$
250 IFC=2ANDY/4=INT(Y/4)THENMM$=LEFT$(M$,24+(29*4))
260 FORB=LTOLEN(MM$)STEP28:PRINTMID$(MM$,B,28):N=LEN(MM$)-B
270 IFPTHENPRINT#4,CHR$(1)MID$(MM$,B,28)
280 NEXTB:L=26:IF26-N<>0THENL=24-N
290 NEXTC:NEXTY:IFPTHENPRINT#4:PRINT#4:CLOSE4
300 RUN
310 :
320 THIS PROG HAS BEEN WRITTEN IN COMMODORE PET BASIC, BUT SHOULD BE READILY
330 TRANSLATABLE FOR OTHER MACHINES. THE PRINTER CODES (OPEN4,4 AND PRINT#4)
340 MAY NEED CHANGING FOR PRINTERS OTHER THAN THE COMMODORE 3022.
350 THE DATA IS VALID FOR ANY YEAR FROM 1900 AD TO 2000 AD. INCL LEAP YEARS.
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SEMICONDUCTORS

BY ANDREW ARMSTRONG

PART 3: JUNCTION TRANSISTOR APPLICATIONS

A short episode this month — but powerful. Power applications are the field in which junction transistors reign supreme.

In this second part of the section on junction transistors, we shall look at some power (as distinct from small signal) applications. Although ics are produced to perform more and more tasks which previously required discrete transistors, in high powered applications discrete transistors are still supreme.

SWITCHED MODE

An application in which speed is essential, but where cascode is not appropriate, is the switching element of a switched mode power supply. An example of such a supply is shown in Fig. 29. This is a series regulator, sometimes called a buck regulator. The particular design from which this section is taken was required to operate with a toroidal mains transformer over a wide range of mains voltages.

The required operating range for mains input was 150V to 280V, a ratio of 1.8666:1. Because the transformer was less efficient at low voltages, and because the switched mode regulator draws more current at low voltages to maintain the power at the required level, the d.c. input range was approximately 3.5:1 including ripple on the reservoir capacitors.

One great advantage of a switched mode supply is that it can maintain its efficiency over a wide range of voltages. A conventional linear regulator gives good efficiency over a wide range of voltages. A conventional linear regulator gives good efficiency when regulating from 8V to 5V, but is woefully inefficient when it must regulate an input of 25V down to 5V, when the regulator must dissipate at least four times as much power as the load.

In this switched mode design, the series pass transistors dissipate very little power, but Q5 can dissipate significant power. The normal requirement to saturate switching transistors (switch them on so hard that the collector/emitter voltage falls to a minimum value, typically 0.1V to 0.2V) is to supply a base current of 10% of the maximum required collector current. If R6 is chosen to provide this current at the lowest specified input voltage, then the base current of Q1 to Q4 is much higher than necessary, and

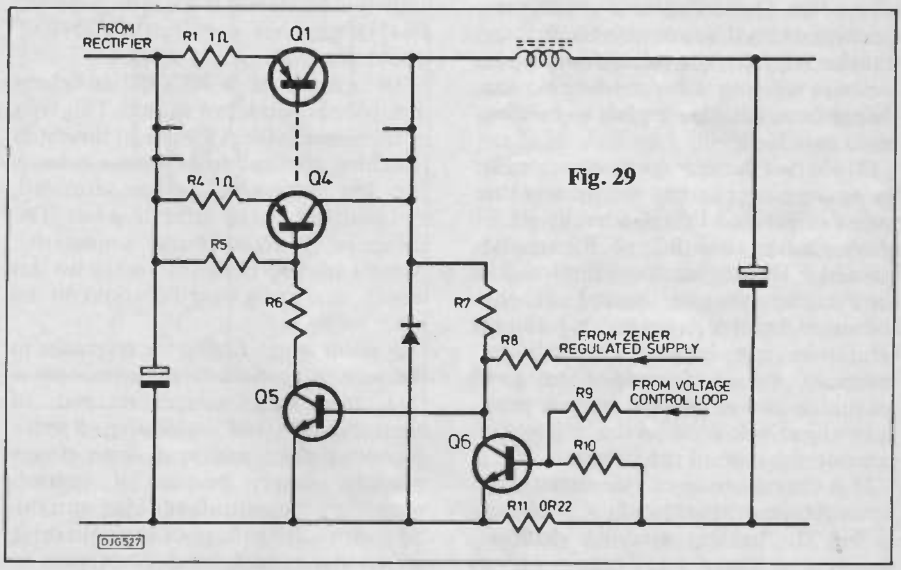


Fig. 29

is a significant fraction of the input current, at the maximum specified voltage.

The solution adopted in this design to reduce the inefficiency was to choose switching transistors which can switch reasonably efficiently at lower proportional base currents. By using four ZTX550 transistors in parallel, with separate emitter resistors to ensure even current sharing, each transistor is operated at a low enough current to have a high gain at low collector voltages. This particular transistor type is optimised for saturated switching, and the four E–line transistors may be used without heatsinks, with a minimum base current of about 3% of the collector current.

If, instead, more ordinary transistors, such as BCY70s, were to be substituted, then no reasonable heatsink would prevent their destruction. This is one circuit design in which choice of transistor is crucial.

There are other solutions to the problem, of course. The configuration of Fig. 25 or of Fig. 30 (which is a variation on Fig. 26) could be used for the series pass element. In either case, the second transistor of the configuration, which carries most of the current, will not be saturated, and will therefore drop a considerable voltage and will require a substantial heatsink. Whichever design strategy is used, the overall efficiency is about the same.

FLYBACK

Perhaps the simplest switched mode power supply is the self oscillating flyback converter. The basic configuration for this is shown in Fig.31. When the power is first applied, the base bias is sufficient to switch the transistor on to a moderate extent. The current in the collector rises at a rate determined by the supply voltage and the inductance of the winding in series with the collector. This generates a voltage in the base feedback winding, which adds to the base current.

Eventually the collector current rises to the point where the base current is no longer adequate to keep the

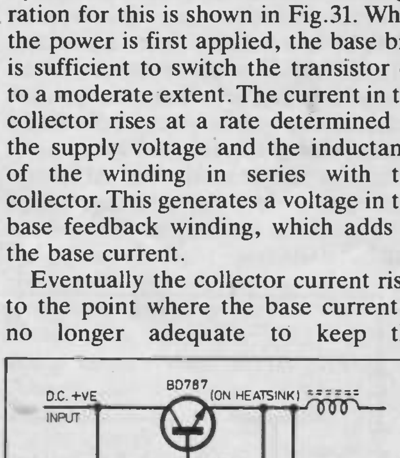


Fig. 30

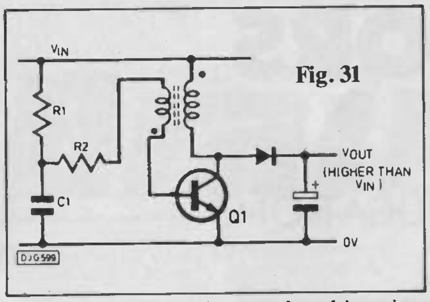


Fig. 31

transistor in saturation, and at this point the transistor starts to turn off. As the collector voltage rises, the rate of rise of collector current slows, which reduces the base drive, which speeds the switch-off process. The transistor snaps off very quickly and, as the current in the flyback transformer falls, the voltage induced in the base winding is reversed, removing charge from the base region and aiding rapid switch off.

Of course, the *average* base current is set by the power supply voltage and the values of R1 and R2. (Generally R1 is much greater than R2, so R2 can be ignored.) The higher the value of R1, the shorter the on period of the transistor before it cannot remain in saturation any longer. There is an optimum value of resistor to give maximum power output, with a peak current just below the level which would saturate the core of the inductor.

This characteristic of the circuit may be used to regulate the output, as shown if Fig.32. In this circuit, which is designed to give a +12V output with a −5V supply, the bias current of the switching transistor is reduced as the output voltage rises slightly above the optimum level. This lowers the mark/space ratio and hence the power output.

This circuit is taken from a working unit, and should work as shown. Some experiment may be required to get the best efficieny in any given application, in the choice of R2, R3, and the number of turns on the base winding. At switch on, Q1 is held firmly on by the current flowing in R1. When the output voltage rises above 12V, D1 and D2 start to conduct, and remove some of the bias from Q1, cutting down the collector current and hence the base bias to Q2. D2 is needed to take account of the fact that the base of Q1 is normally at a potential one diode drop below 0V.

Heavy circulating currents flow in this circuit, so it is important that the connections to C2 and C3 are short, and that they are connected to 0V near to the same point on the track. The use of a 1N4148 for D3 limits the maximum output current to 75mA, but within this limit the efficiency is high because the 1N4148 switches very fast. A 1N4001 would not work nearly so well.

The choice of a ZTX450 switching transistor is of interest as well. This type of transistor is ideal for use in saturated switching applications, because it has a very low voltage drop when saturated, and switches out of saturation fast. The choice of Q1 is, of course, immaterial. Almost any pnp transistor on the list last month, and many weren't, would do the job.

A point worth noting for reference in the section on field effect transistors is that this very simple method of controlling a self oscillating flyback converter does not work with power mosfets, simply because it controls saturation by controlling drive current. To control the voltage of the gate drive pulses in a mosfet circuit is not quite so simple.

LINEAR POWER

Though often less efficient, the linear series voltage regulator is simpler to design and understand than the switched mode equivalent. With the easy availability of various types of regulator IC, there is little reason to design a discrete regulator for moderate currents and standard output voltages. It can still be useful to use a substantial power transistor as the series pass element for a regulator if heavy current or a non-standard voltage is required.

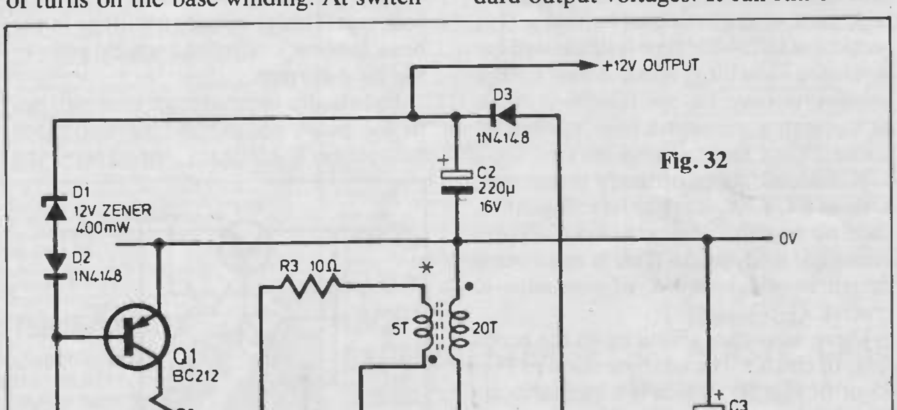


Fig. 32

Some of the same limitations apply to such designs as to switching regulators. Very often it is necessary to use darlington transistors, which raise the minimum forward drop of the regulator. This can cause a serious loss of efficiency in low output voltage circuits. For example, an extra one volt drop across a 5V regulator may force the use of a higher voltage, higher VA rating transformer than would otherwise have been required.

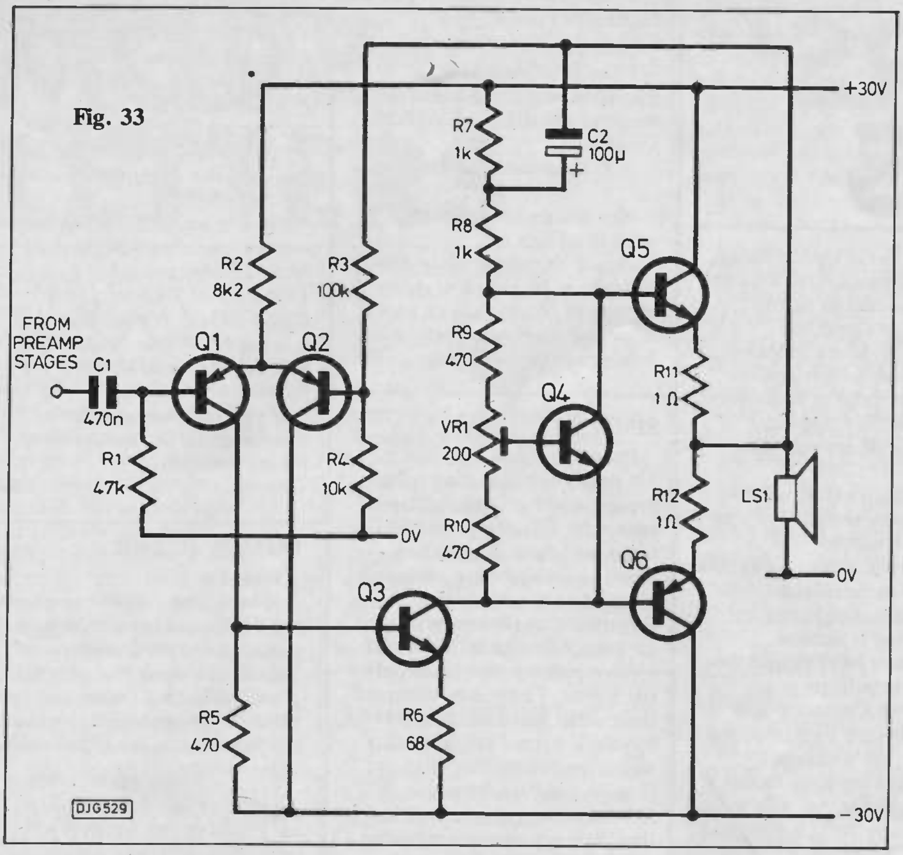
The switching speed of the series pass transistor(s) is no longer at issue, but if they are too slow, the delay in the control loop may cause oscillation unless the speed of response of the regulator is slowed down to the point when it cannot cope with sudden transient demands.

The same sort of problem applies to audio amplifiers, but here it is worse because of the wide range of frequencies to be handled, and the fact that small amounts of inaccuracy, which would cause a few millivolts error on the output voltage of a regulator, can cause unacceptable distortion in an audio amplifier. Just for the purpose of example, a simple audio power amplifier is shown in Fig. 33. The circuit, as it is drawn, would not work very well, because certain important refinements have been omitted. The circuit is suitable to illustrate the principles, though.

The first part of the circuit to design is the output stage, consisting of Q6,Q5, and the biasing transistor Q4. This stage is biased so that Q5 supplies current during positive parts of the output waveform, while Q6 is switched off, and the reverse happens during the negative part. At a precisely defined voltage in the middle, one transistor switches off and the other takes over cleanly. At least, that is what one would like to happen. It is not possible because, apart from the difficulty of maintaining such a precise bias point without drift, the transistors do not provide as much gain near the zero point as they do at several volts output.

To make the amplifier work reasonably well, Q5 and Q6 are biased so that at zero volts out, both transistors are conducting to some extent. The aim is to set the bias point so that the conduction of one transistor ceases at the point that the other one has taken over properly, and it is possible to make a fair approach to this in practice. Once the bias point is set, it will be maintained over a wide range of temperatures so long as Q4, Q5, and Q6 are all the same temperature. To this end, Q4 is normally mounted on the same heatsink as the other two transistors.

This class of operation of the output stage is referred to as class AB operation. In class B, the transistors switch



off completely at zero, and in class A they never switch off completely. The effect of bias on the transistor conduction curves is illustrated in the graphs of Fig. 34.

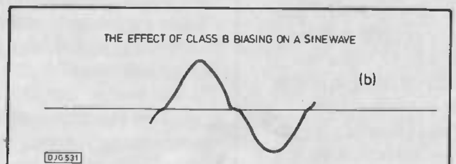
The transistor chosen for Q5 and Q6 should be rated at a current somewhat in excess of that which would be drawn by the lowest load resistance to be used with the full power supply across it. For example, if a 4R load is the minimum, a maximum rating for Q5 and Q6 of 10A would give a small safety margin.

The voltage rating of the output transistors should be equal to the rail to rail supply voltage plus a safety margin, so a rating of 80V would be reasonable. The maximum power rating of the transistors should be chosen to exceed the maximum amount they will be called on to dissipate. A reasonable figure would be about half the total power consumption of the unit for each transistor. This will allow for some overload without immediate destruction of the amplifier, so long as the heatsink is adequate.

The voltage rating of Q4 is not important, but it must maintain its gain to low voltages and currents to keep the bias point stable. Q3, on the other hand, should have the same voltage rating as Q5 and Q6. With the component values shown, its quiescent state will be with 15mA flowing through it and 30V across it, which gives an average power dissipation of 450mW, so a transistor rated at 1W should be adequate. Q3 may need a small heatsink.

Q1 and Q2, connected as a long tailed pair, will not have over about half the rail to rail power supply across them, so a rating of 50V or greater should be safe.

Although the design shown here leaves something to be desired, certain features of the circuit deserve mention.



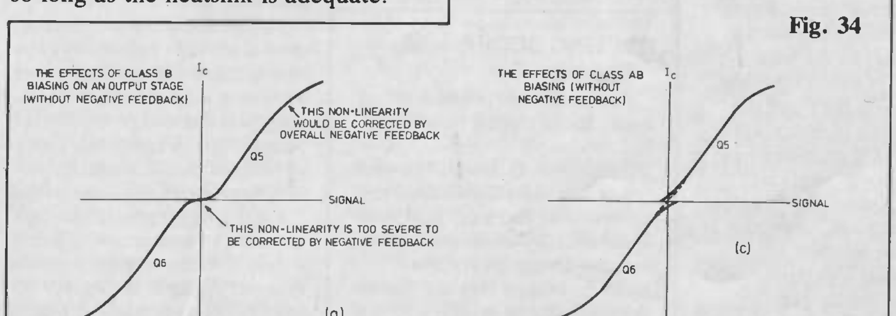


Fig. 34

The use of two resistors, R7 and R8, in conjunction with in-phase feedback via C2, is referred to as bootstrapping. It is a means to keep the voltage across R8, and hence the current through it, nearly constant over the entire output voltage range of the output signal. This ensures a more even response at the extremes.

FEEDBACK

Overall feedback to set the gain of the amplifier, and to improve its linearity, is via R3 and R4, very much like the case of an op–amp. The output stage and the driver stage both have local feedback via emitter resistors, and are therefore inherently fairly linear. The long tailed pair has no such feedback, and this could cause problems in some situations. Q1 and Q2 provide a lot of gain, and will act linearly if the feedback from the output is in step with the input signal. If there is too much time delay between an input signal and the corresponding feedback, the long tailed pair may momentarily become very non–linear. It is non–linearity internal to a feedback loop which causes transient intermodulation distortion among other things.

Even though the output stage is biased to be fairly linear on its own, the gain of the stage is dependent on current. It is highest at medium currents, and lowest at zero and at the extremes of the signal. The speed of operation of the transistors is also affected by current. As a result, the overall feedback has a certain amount of non–linearity to correct for, and if the loop gain (total gain of all stages divided by the attention of the feedback components) is not high enough then significant overall non–linearity will persist.

Because of the change in speed of the transistors as the current changes, it is not unusual for such a simple design to burst into high frequency oscillation at some point on the waveform, unless capacitors are added to prevent this. Such capacitors are not shown here because this is just the skeleton of a design to enable explanation of the principles. By the same token, no protection circuitry is shown even though most practical amplifier designs would feature short circuit protection. Though the design as shown is just workable, do not try to build it.

OOP (SINGULAR)

It has come to my notice that I failed to include the "vanilla" transistor specification in the table which I included last month. Apologies. The BC108 is a suitable approximation for an npn standard type, and the BC212 for a pnp type.

Well that about wraps it up for junction transistors. This part is shorter than standard because a lot has to be fitted into this Christmas issue, so fets will have to wait until next month. Merry Crimble. PE

READERS' LETTERS

DAT COPYCODE

Barry Fox in his Leading Edge column of our September 1987 issue commented on the DAT Copycode proposals. The following statement throws further light on the situation. It is not a reply to Barry Fox, but was received as a normal press release from the IFPI secretariat. **Ed.**

Through its President, Nesuhi Ertegun, Chairman and Co-Chief Executive Officer ofWEA International, the Board of Directors of IFPI, representing the world recording industry, recently issued the following statement from its meeting in Hamburg:

"The master-quality copying of our copyrighted sound recordings by Digital AudioTape (DAT) recorders threatens the future ability of our industry to create and produce recorded music. To defend the rights, careers, and incentives of all artists, composers, music publishers and record producers against the encroachments of DAT, the "Copycode" system was developed as an impediment to unauthorised DAT copying.

"Despite the fact that eminent scientists have developed the system, the makers of DAT equipment have launched a multi-million dollar world campaign of lobbying and advertising that misrepresents Copycode and its effects on recorded music.

"By false statements and contrived demonstrations the DAT industry maintains that Copycode will distort recorded music and thus will cheat consumers who buy it. Wrong! The Copycode encoding of a given recording is a totally controllable process. Yes, certain skilled encoding engineers can specifically avoid such sensitive passages and readily encode other non-vulnerable portions of a recording. DAT spokespersons avoid communicating those facts and avoid acknowledging that Copycode can guarantee uncompromised sound quality.

"Our business is to make fine recordings that faithfully reflect the intents and talents of our musicians and vocalists. We have not and would not jeopardize that mandate or trifle with the trust of our comsumers. Yet, the DAT makers claim otherwise in pursuit of their own commercial objectives. In the United States, they have demonstrated a system which is claimed to be the equivalent of Copycode technology. It is not authentic, nor are the demonstrated applications valid or equivalent to the intended Copycode applications of any recording company.

"Our industry is accused of thwarting new technology and consumer access to improvements. Wrong again! We prosper from beneficial technological change but not when we find it suicidal.

"The intent of IFPI and the world music industry is to proceed with Copycode and continue to seek implementing legislation. We welcome objective and impartial technical appraisal, such as that soon to be undertaken by the U.S. National Bureau of Standards.

"Although our confidence in the viability of Copycode is staunchly reaffirmed, we remain open to other alternatives that will protect our intellectual property. It seems incomprehensible, for example, that the genius of Japan's electronic industry that concieved DATcannot or will not produce technology that can protect the intellectual property and talent of the music constituencies on whose creativity they depend.

"Instead, the Japanese hardware industry declines even to address our concerns, masking its self-interest with a spurious "consumer interest". But where is that "consumer interest" where DAT is concerned? Press articles already report that one manufacturer's DAT cassettes are not necessarily compatible or interchangeable with other companies' DATcassettes. Until this problem is solved, why are the DATmakers so intent on the equipment's early introduction and marketing, to the total disregard of "consumerinterest"?

"In summary, IFPI and the world recording industry will welcome DAT if its conceivers will reasonably protect our copyrighted works, our creators and our producers. Copycode is an achievable solution to accomplish this objective – with no musical compromises."

For further details, contact:
Dave Laing,
Press and Information Officer
IFPI Secretariat, 01-434-3521.

IRRESISTIBLE

Dear Ed,

I like your 'new-look' magazine, and am also glad that resistors are still zig-zag lines! Good luck.

P. Ceighton, Radlett, Herts.

Any masterpiece needs an occasional face lift!

British Standards allow for resistors to be shown as either zig-zag or blocks; just as well since our illuminated artist says he's resistant to block-outs... **Ed.**

SIMPLY-FI

Dear PE,

I have been searching for a preamp which excludes all inputs except for CD player and FM tuner, and have approached many audio suppliers, including some of your advertisers. Eventually, one company offered me a simplified kit in the form of a valve preamp that takes only flat inputs. I have now accepted their offer, and shall probably buy their hybrid amplifier as well. Apart from this offer though, I drew a blank.

I am writing to you as I feel that I may not be alone in having entered into DIY electronics through normal hifi interest, arising from buying a CD player to supplement radio listening. There must be other people like myself who do not wish to involve themselves in the tortuous machinations of vinyl records or tape, and I hope that in time amplifier circuit designers may cater for our simpler needs.

Otherwise, I find that some of your articles and information are understandable and occasionally helpful to me. Any features dealing with audio hifi amps, speakers, and also aerials will be particularly well received.

Hugh Haines, Sunderland.

No doubt your comments may set a few designers thinking, but I hope they won't totally forget that some of us still have favourite recordings from Noah's studio. He was one of the first to recognise the importance of stereo reproduction. **Ed.**

BATTING SCORE

Dear Ed,

I am interested in constructing a unit for detecting bats. Have you any info?

W. Bond, Warwick.

The Natural History Museum tells me that bats emit their cries in the so-called ultrasonic regions, between about 20kHz and 200kHz, though they are known to shriek as low as 4kHz, especially when some cries die away. Consequently, all you need is a microphone and an amplifier that can pick up these frequencies.

The Prof has at various times designed ultrasonic units, such as the Tape Measure in PE March 1987. I would think that its receiver could be used, feeding the output to a counter, like for example, the Event Counter in PE July 1987.

There is also a book that may interest you called 'Just Bats', by M.B. Fenton, published by the University of Toronto, ISBN 0-8020-2452-1. It gives details of a bat detector, and I expect that your library could obtain a copy for you.

If you vampire up either of these ideas, it's best to make them battery powered.

Ed.

MAINLY BLANK

Dear Ed,

Would it be possible to print the PCB track layouts on pages that are blank on the other side? This would mean that people could settle on a common effective transparentiser and use the page directly as a photo mask.

James Main, Glasgow

Certainly this could be done, but wouldn't you feel that you were getting less value out of your magazine? I am open to correction, but I don't think people want to pay for blank pages. It's true there is a trend towards the use of 'creative white space' in other magazines, but I believe that readers prefer to have pages full of interesting material.

Ed.

PUNCH LINE

Dear 'ead 'itter,

I must set the record straight about electronic engineers. Most of us are real humane and caring people, with a sense of humour. Adopt one today!

Too much flippancy indeed, Mr Duffill. Please have a sense of perspective. A little humour in the choice of a side heading, or in the writing of an article, normally serves to leaven a sometimes heavy subject matter. In no way does humour detract from the factual content – nor would contributors or editorial staff wish it to.

I would further argue that the mental attitude needed to gain new insights and develop novel designs is similar to that which generates humour. In the field of politics, too, a cartoonist can sometimes punch through the film-flam better than anyone else.

Finally, any engineer who had no sense of humour would find it very difficult to cope with the real world where the only completely dependable physical law is Murphy's.

Andrew Armstrong BSc.,
Leighton Buzzard.

MORE LETTERS

COVER UP

Dear John,

I have a few, hopefully constructive, criticisms about the way PE looks on the newsagent's shelf.

I think the magazine itself is very good, but the covers do not do the contents justice. I know that this is a matter of taste, but the peculiar choice of background colours and the relatively small cover picture does make the magazine look less attractive and exciting.

This may not affect regular readers too much, but it means that new ones may less likely be attracted. Unfortunately this undersells the magazine to people who may not be serious electronics hobbyists. PE has a lot of appeal as a more general science and technology journal and it should be specifically setting out to attract these new readers.

Also, all readers, whether regular or occasional, would prefer to be associated with an exciting journal, an impression that the cover does not live up to. Given that there are limits to the extent to which you can dress up a project case, why not illustrate one of your feature articles on the cover. Say something taken from Spacewatch or one of the science-technology articles. Maybe it would be possible to commission an interesting piece of design artwork for its own sake.

Another problem seems to be that the magazine is not as stiff as others. It tends to end up flopping over on the shelves, which makes it less appealing generally, and creases it. I don't understand why this happens as it seems to have better quality paper than most. None the less, it does detract from the 'image' of the magazine.

Richard Mishra, Cambridge.

Many thanks Richard for such a forthright criticism. (And incidentally, let me repeat my thanks for your splendid article 'Microbutler' in our July 87 issue.)

As many readers will have noticed, various interesting changes have been taking place within the pages of PE over the last several months. Further changes are still planned and will be introduced gradually. Amongst these plans is the intention to uplift the cover image, and active steps have already been taken. The cover of this January 88 (Christmas 87!) issue is one example of what could be done, though in fact that cover is only a one-off and our plans encompass rather different ideas.

We were not aware about the 'floppy' problem and are grateful for your comments. Practising bad-puns again, it seems that cover-ups are more revealing!

Ed.

INFLUENTIAL EVENT

Dear John,

I bought the PE July issue and spotted your Event Counter, had an idea and so started my hobby in electronics. I then put the counter together and it worked! My first ever circuit as well.

Since then I have bought what books I can afford on dole money. With time on my hands I am eager to learn as much as I can.

I should also like to make the counter count for a fixed time, then display the result, reset the counter to zero leaving the count displayed, and repeat. I am hoping to connect this to my old car as a rev counter. A few experiments have been carried out but my knowledge is as yet insufficient to achieve my idea. Also, can pulses from different parts of the circuit be used to control additional gates?

I know you must be very busy, but a reply from you might just pave the right road to a new future for me. Please help!

C Gregory, Doncaster.

I am delighted that my influence has so well inspired you. It is a shame that space does not permit me to reply in as much detail as I would prefer.

Basically, it seems that you should take advantages of the Transfer and Reset pins of IC1. Using a squarewave oscillator or pulse generator (of which there are many examples in previous issues of PE), set the required period to trigger a monostable to give a short positive-going Transfer pulse to IC1 pin 23. Then use the trailing edge of the ending pulse to trigger another monostable to reset the counter with a brief pulse. The displays will continue to show their last count until Transfer goes high again, whereupon the new value will be displayed.

A 4528 is a suitable dual monostable, and has a choice of input and output logic levels – ask your supplier to sell you a data sheet at the same time that you order the chip.

You can feel free to use any part of the circuit to drive any other circuit provided the logic levels and currents are satisfactory. A word of caution though – car electrics can generate very high voltage spikes so take suitable precautions to stop these reaching your counter and killing it.

You obviously love the satisfaction of experimenting with electronics, and I wish you as much pleasure and success with your interest as I have found.

Ed.

SPEAKING OUT

Dear Sir,

I was appalled to read in the News and Marketplace of PE October 1987 that Binatone International are marketing an amplifying speaker device to enable users of personal stereos to dispense with the need for headphones.

There are already far too many people inflicting their musical tastes on everyone within earshot. It seems to me that such people who apparently cannot exist without a continuous diet of pop 'music' should be encouraged to use headphones.

J.E. Lawson, Ossett.

...which leads us straight on to Mr Gough...

RAM OR JAM?

Dear Sir,

I am being gradually driven to despair by excessively loud music from a nearby radio, despite numerous and courteous appeals to turn it down.

Is there such a device available that I can build or buy that would transmit noise, or jam the offending station from around 20 to 30 feet?

Please say 'yes' and spare me some sore ribs (he's bigger than me)!

S.W. Gough, Morton.

It's the age old question of how to balance two contradictory rights to personal freedom – freedom for one's own actions, and freedom from the actions of others. In an ideal world, we should all consider the rights of others when implementing our own rights of action.

Using speakers with personal stereos seems like a good idea, providing they are used with regard to avoiding inconvenience to others. Even the use of headphones though, can be aggravating to others when the sound is not fully contained – as I sometimes find when travelling in to PE by train.

Despite this, there is no way that I could condone interfering with another's right to play music, by for example, jamming the offending receiver or transmitter. Even if such action were practical, it would be illegal to do it. Seeking remedy under the Noise Pollution Act is probably the best solution when polite requests fail. The Environmental Health Officer at the local town hall is the person to contact when you have a problem of this nature. Should the interference come from a transmitter directly affecting your radio or TV receiver, then contact the Radio Investigative Service of the Department of Trade and Industry. Local post offices should be able to advise how to do this.

The RIS can also advise on any reception problem, and have recently published a well set out booklet called How To Improve Television and Radio Reception. My local sub-post office gave me a copy, and it has a great deal of information and practical advice on the subject. **Ed.**

CADS ABOUND

Dear Editor,

I read with interest your comments made to the anonymous reader with reference to the use of CAD systems to design printed circuit board artwork (PE Oct 87). Since a majority of your readers own microcomputers, I'm surprised that the writer implies that CAD is out of reach of the average reader. Several good PCB CAD programs are already available for use on various computers, including one written by myself for use on the Amstrad CPC464, 6128 machines which can be bought for under £20.00. Anyone wishing for details of this program may contact me at the address below. I realise that this letter may technically constitute an advertisement, but I feel that it should be known that these programs do exist at very reasonable cost.

A. Dean
18 Ley Cresent, Astley,
Tyldesley, M29 7BD

ON FORM

Dear Ed,

I have been an avid reader of PE practically since its inception and I must say that I like the new format. Long live constructional projects.

S. Gale, Felpham.

RECALLING HISTORY

PART TWO BY BARRY DRAKE

SYSTEM-X WILL GET US OFF THE HOOK

Digital high speed communications will provide a total network solution far surpassing the abilities of Crossbar and the familiar 706 telephone.

During the 1960s an improved type of exchange known as "Crossbar" became standard for new installations. Although within 10 years Crossbar was obsolescent with electronic exchanges being introduced, it deserves a mention, if only because according to Telecom engineer's gossip, Crossbar has the highest reliability of any exchange system, including the more modern electronic exchanges.

Fig. 8 gives an idea of the basic element of Crossbar, the so-called cross bar switch. In place of a uniselector or multiselector, a matrixed relay is used. One large solenoid selects the required row, and a second solenoid the column. While a simple matrix of ten by ten could be, and has been used to replace multiselectors in a design similar to the Strowger principle, it is more usual to have large scale switches; and switches having up to seventy or so rows, with up to twenty columns, are by no means unknown.

Referring to Fig. 8, operation first of row-select magnet M3, followed by bridge magnet Ma, will cause the contact at cross-point 3A, and that alone to be closed. (In a practical switch, each cross-point comprises a set of contacts rather than just a single contact as shown in the schematic.)

Crossbar has an advantage both in terms of speed, and of the number of connections that can be uniquely addressed by one switch, over all previous exchange architectures.

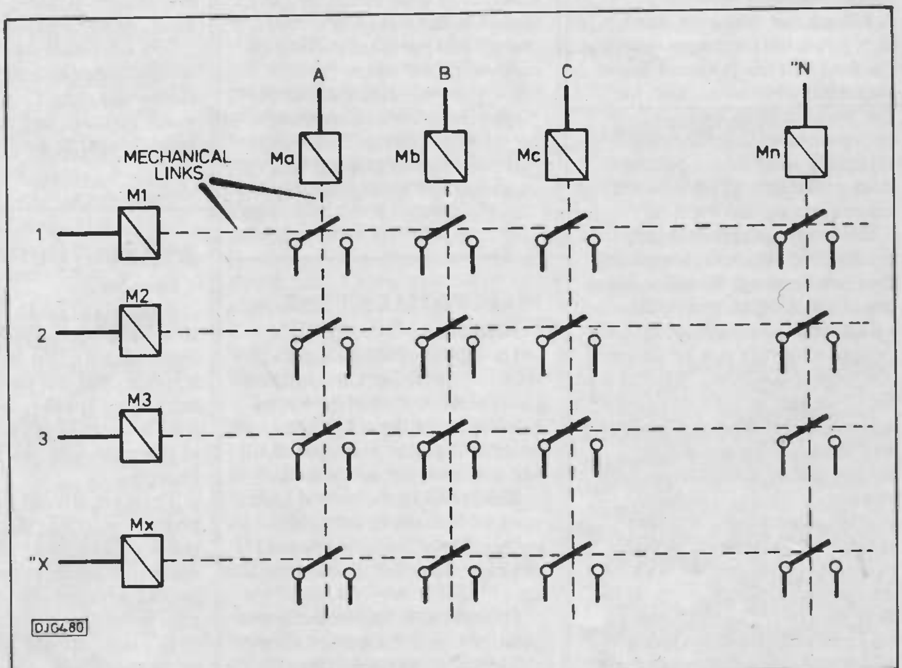


Fig. 8. *Schematic arrangement of cross bar switch showing a selection of "select" magnets (1 to X) and "bridge" magnets (A to N) with "cross points".*

TONE DIALLING

There is an alternative signalling system to the impulse, or loop-disconnect system in use. This is the so called "Tone Dialling" system, (jargon term – DTMF; "dual tone multi frequency), which is becoming available to subscribers along with the gradual replacement of Strowger equipment by electronic exchanges. The tone system being used is the dual-tone system; each digit being represented by a combination of two audio-frequency tones (Table 1). The principle of tone dialling is old, however, and to see the origin of this, a bit more history is in order.

As soon as telephony was required to take place over long lines, line-losses became a problem. In telegraphy with its even longer history, a device called the "repeater" had long been in use. Because of the slow digital nature of the signal, a repeater needed only to be a relay with a further power source. With audio frequencies to be handled however, something different was required. The recently invented thermionic valve was the answer, and by the time trunk lines were introduced soon after the turn of the century, a valve amplifier – still known as a repeater – had been developed.

The repeater was a transformer-coupled device with a cunning

TABLE 1A

	Tone A	Tone B
1	900 Hz	–
2	750 Hz	–
3	900 Hz	750 Hz
4	600 Hz	–
5	500 Hz	–
6	900 Hz	500 Hz
7	750 Hz	500 Hz
8	900 Hz	600 Hz
9	600 Hz	500 Hz
0	750 Hz	600 Hz

Old tone signals. All digits are formed from four tones – either singly or in combination.

TABLE 1B

TONE B \ Tone A	1209 Hz	1336 Hz	1477 Hz
697 Hz	1	2	3
770 Hz	4	5	6
852 Hz	7	8	9
941 Hz	*	0	#

Current System. All digits are now a combination of two tones arranged in the above matrix.

VOICE-FREQUENCY DIALLING (TONE DIALLING)

Tables showing frequence combinations in use.

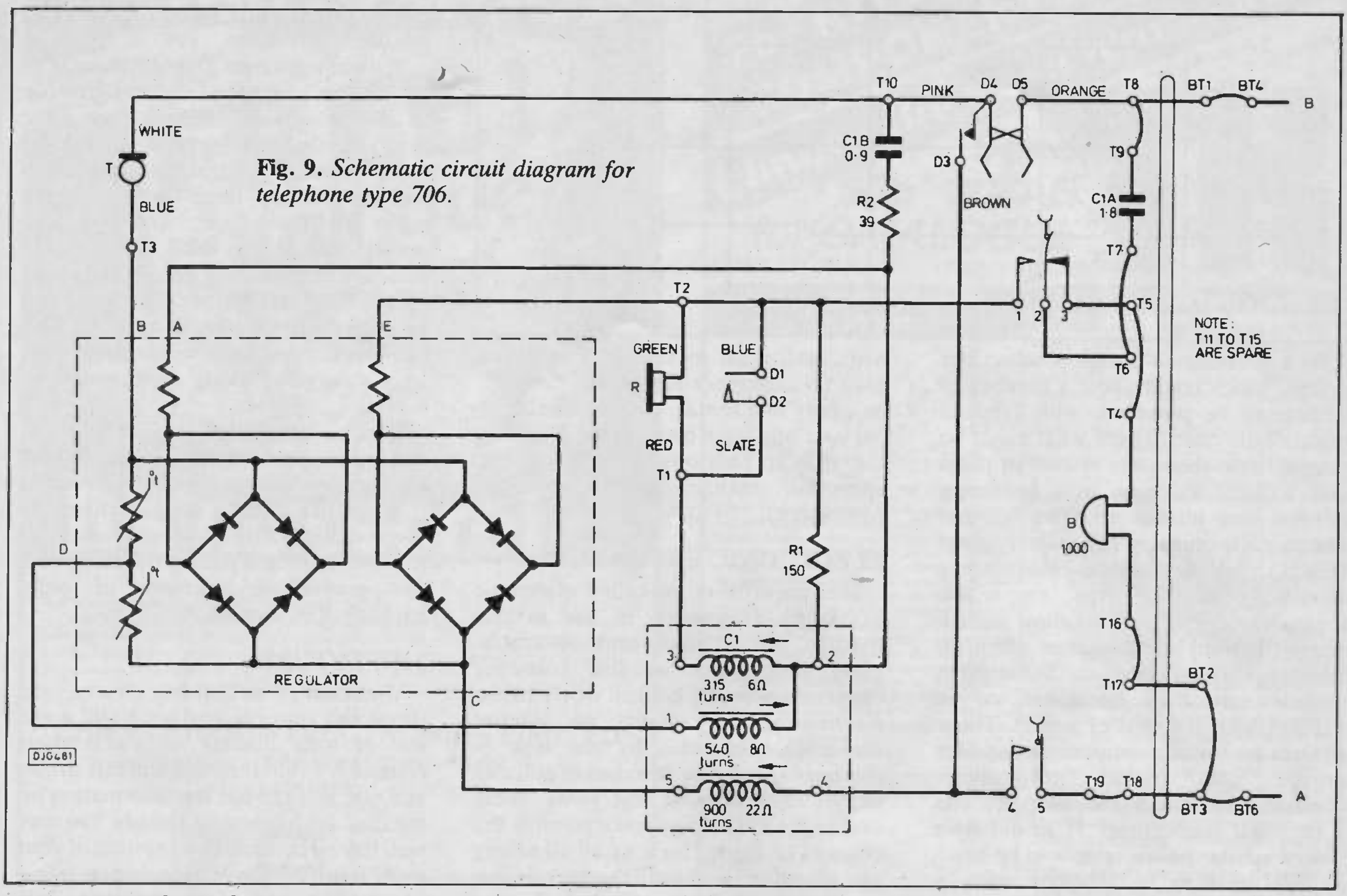


Fig. 9. *Schematic circuit diagram for telephone type 706.*

arrangement of transformers to ensure that the amplified signal was not fed back – bearing in mind we have just one pair of wires carrying signals in both directions (Duplex operation). As such a device was not able to transmit the low frequency of the dialling pulses, a system of four tones in combination was used to transmit numbers as shown in Table 1a. At the distant exchange, four tuned relays responded to the tones, and contacts were wired in such a way that each of ten digits produced a unique condition. The two tone system in use today, shown in Table 1b is a development facilitated by today's technology, but the principle is otherwise the same.

THE TYPE 706 TELEPHONE

At this point, a detailed description of a subscriber instrument is in order. Although becoming obsolescent, the 706 telephone is familiar to us all, and will be used for this purpose.

In Fig. 9, the dial contacts (D1, D2, D3, D4 and D5) are shown with the dial at rest, and the cradle–switch, (1,2,3,4 and 5) shown with the receiver in position on its rest. As 4/5 is open, the circuit is effectively that of Fig. 10. There is no DC path but the 17Hz ringing signal can flow via capacitor C1a to the bell. On picking up the receiver, DC flows through the transmitter T, via the primary winding of the transformer. The DC thus flowing signals to the exchange that the call has been answered, and the connection is then established.

If a call is being made rather than answered, dial tone will be heard when the receiver is picked up. On operating the dial, contacts D1/D2 and D3/D4 close as soon as the dial begins to rotate, remaining in the closed position until the dial has completely returned. This shorts out the receiver and the transformer so that no excessively loud sounds, which might damage the ear of the user, can be produced in the receiver. Neither can high voltages be induced in the coils of the transformer due to the interruptions caused by the dialling impulses. The low impedance of the transformer winding across the bell coil prevents the bell from tinkling in step with the dialled pulses.

As the dial is released, it repeatedly breaks the circuit through D4 and D5 causing the dialling impulses to appear on the line. The internal capacitor is substituted by the capacitor in the Telecom master socket when the new plugs and sockets are used, but it will be found that the external capacitor appears in precisely the same place in

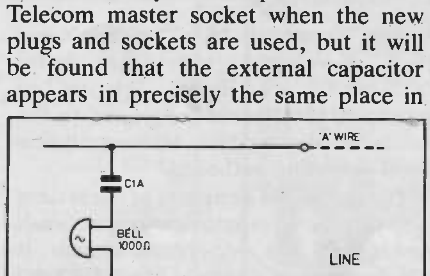


Fig. 10. *Ringing circuit of 706 telephone.*

the circuit. The transformer winding will always be in parallel with all the bells in an installation with more than one instrument, when any receiver is picked up. This prevents bell–tinkle on all the instruments when a dial is operated. The three windings of the transformer provide the 'anti–sidetone' arrangement mentioned above, and the regulator, which is a small printed circuit card which may be reversed when not required, serves to limit microphone current where the lines are short.

MULTIPLE PHONES

Up until the very recent introduction of the "Inphone" sockets by British Telecom, all phones were owned by BT and its predecessors (with the exception of Hull, but that's another story). All phones previously contained a terminal strip with a number of links. These were used to adapt the phone to the various "plans" that could be provided. Referring to the 706 telephone diagram, in Fig. 9, you will see that a capacitor is shown between terminals 7 and 9, and is normally placed in series with the bell. Additional instruments (or extension bells) would have their internal links changed, and would be wired such that T8 and T19 would be in parallel with the main phone, across the line pair, but the bells in all subsequent instruments would be placed in series with the bell in the main instrument – the only capacitor used being the one in the main instrument. Up to six bells in series with one capacitor were permitted.

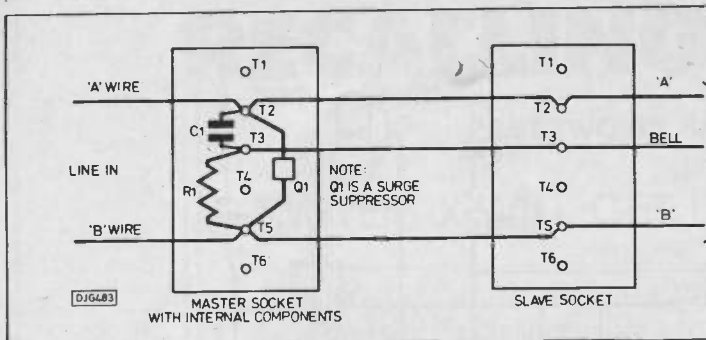


Fig 11. *Telecom socket wiring.*

With pressure to design a subscriber system which could allow a number of sockets to be provided, with Telecom having little control over what might be plugged into them, the system of plugs and sockets which is now becoming familiar was introduced. The Telecom line pair is terminated in a master socket (Fig.11), which contains the ringing capacitor and a surge suppressor, together with a resistor to allow a small ringing current to flow even when no telephone is plugged in. Subsequent sockets may then be connected in parallel with the master socket. These contain no further components, and for normal use, require only three connections, 2 and 5 (the line pair), and 3 (the bell connection). If an old style 706 or similar phone is now to be used, it will need to be adapted using a Telecom plug and lead. Fig 12 shows the connections required. It will be seen that the internal capacitor is not now used. Instead, all bells are now in parallel (but they each have a 2k2 series resistor), and take their ringing current from the capacitor in the master socket.

wish, additional sockets. You will then have no subscriber equipment rental to pay, only line rental, and are free to go out and buy your own phone. You may also wire up your own extension (in the approved manner with approved equipment).

ELECTRONIC EXCHANGES

The majority of so called electronic exchanges at present in use in this country are in fact semi–electronic, using reed–relays as the switching element under the control of transistor electronics. Very much an interim measure, occasioned by the lack of electronic analogue switches of suitable design until the last few years, these exchanges did at least make possible the concept of digital logic of all signalling and selection, with only the speech connection needing a mechanical element (the reed relay). With recent monolithic circuit techniques making available fully electronic analogue switches, the way was clear for the development of the current standard – System X.

Sales literature from Plessey about

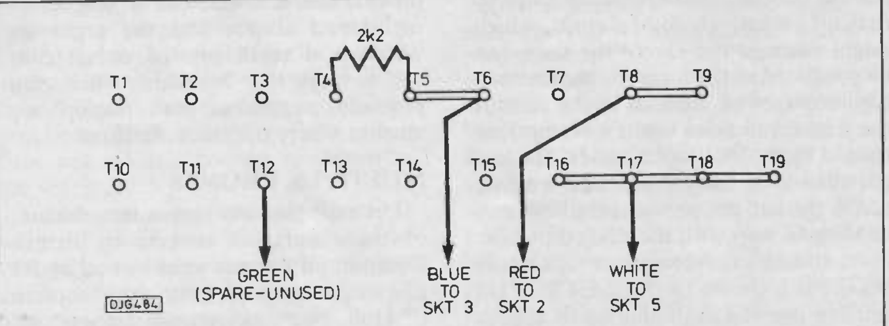


Fig. 12. *Method of connecting 706 telephone to Telecom plug.*

THE R.E.N.

BT has introduced a concept called the Ringing Equivalence Number (R.E.N). This is a unit in which an R.E.N. of one is the loading given by one 706 telephone bell. Different telephones may well have different R.E.Ns – modern electronic ones are likely to be much lower than one for example. The rule is simple. No more than a total of four R.E.Ns may be connected to a line at any one time.

It is now possible to ask Telecom to remove any equipment which you at present rent from them, and to have them install a master socket and, if you

System X states boldly: "System X has been developed with the active involvement of British Telecom to provide a total network solution to the needs of the modern telecommunications operating authority."

The aim of the designers of the system is to provide a communications network rather than just a telephone system. It is something of a radical approach, and tends to look at the entire communication requirements of this country as an integrated whole. Computer data, facsimile, telex, and even video information as well as audio data, all these needs have been put into the melting pot and System X is seen as the ultimate result.

Transmission over long distances is by means of a high speed digital signal (up to 40 Mb/s being used on fibre optic links). Ordinary telephone signals and other types of information are time–multiplexed into large capacity digital paths of this form, and are de–multiplexed at the local exchange. In addition to providing greatly improved speech paths, paths for computer generated information at up to 64 Kb/s can be provided from within the system to a subscriber along existing copper wires.

While signalling can easily be converted electronically from impulse (loop disconnect) to tone and vice-versa, it seems likely that a gradual change to tone dialling will continue until all impulse dialling is phased out along with the gradual replacement of older exchanges by System X.

THE FUTURE

Your bank, your building society, your shops and your place of work will make use of tone dialling to access their computer – the computer will talk to you and you will tap out the information on the dial. It's happening already. You may well have a computerised system of your own, but how convenient to pop into a phone box and carry out that little transaction on a computer that you forgot to do before you left home.

Finally, a little fantasy. You phone the railway station. A pleasant computer generated voice offers you first the North of England; there is a tone; you wait. You are offered the South. Another tone. You press the "#" key on your phone – area by area you are quickly led to the station which is to be your destination. Do you require information or do you wish to book a ticket? You press "*" for information – you are immediately told the time of departure of the trains – and so on ......

Of course, the above is very cumbersome compared with a menu–driven program on your VDU – so how about this one:

You insert your credit–card (plastic money) into a slot on the outside of the communication kiosk. You identify yourself on a keypad (or maybe a finger-print scanner, or even a retinal pattern recognition unit). The kiosk opens. You make use of a full communication facility – which includes a VDU; and of course, everything is automatically billed to you later.

What I am saying is simply that System X holds the communication technology for all of the above and a great deal more. The changeover to a fully digital system is expected to be completed in the first quarter of the next century – that should be in plenty of time for the humble telephone's two–hundredth birthday party. PE

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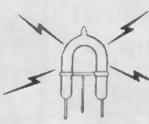
One of the best deterrents to a burglar is a guard dog and this new kit provides the barking without the bite! The kit when assembled can be connected to a doorbell, pressure mat or any other intruder detector and will produce a random series of threatening barks making the would-be intruder think you have a guide dog and try his luck elsewhere. The kit is supplied complete with high quality PCB, mains transformer, all components and instructions. The kit even includes a horn speaker which is essential to produce the loud sound required. The "dog" can be adjusted to produce barks ranging from a Terrier to an Alsatian and contains circuitry to produce a random series of barks giving a more realistic effect. Don't delay, fit one before you go on holiday and let our dog help you guard your home.

XK125 Complete kit of parts £21.95

POWER STROBE KIT



Designed to produce a high intensity light pulse at a variable frequency of 1 to 15Hz, this kit also includes circuitry to trigger the light from an external voltage source (eg. a loudspeaker) via an opto isolator. Instructions are also supplied on modifying the unit for manual triggering, as a slave flash in photographic applications or as a warning beacon in security applications. The kit includes a high quality pcb, components, connectors, 5Ws strobe tube and full assembly instructions. Supply: 240V ac. Size: 75x50x45.

XK124 Stroboscope Kit £12.50

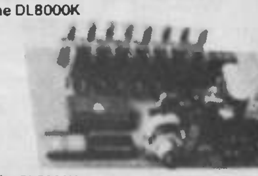
VERSATILE REMOTE CONTROL KIT

This kit includes all components (+ transformer) to make a sensitive IR receiver with 16 logic outputs (0-15V) which with suitable interface circuitry (relays, triacs, etc – details supplied) can be used to switch up to 16 items of equipment on or off remotely. The outputs may be latched (to the last received code) or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits.
Supply: 240V AC or 15–24V DC at 10mA.
Size (excluding transformer) 9 x 4 x 2 cms.
The companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available MK9 (4-way) and MK10 (16-way), depending on the number of outputs to be used.

MK12 IR Receiver (incl. transformer) £14.85
MK18 Transmitter £7.50
MK9 4-Way Keyboard £2.00
MK10 16-Way Keyboard £5.95
601 133 Box for Transmitter £2.60

DISCO LIGHTING KITS

DL1000K This value-for-money 4-way chaser features by-directional sequence and dimming. 1kW per channel. £17.50
DLZ1000K – A lower cost uni-directional version of the above. Zero switching to reduce interference. £9.85
DLA/1 Optional opto input allowing audio 'beat'/light response 70p
DL3000K –3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone. 1kW per channel. £14.25
The DL8000K



The DL8000K is an 8-way sequencer kit with built in opto-isolated sound to light input which comes complete with a pre-programmed EPROM containing EIGHTY—YES 80 different sequences including standard flashing and chase routines. The KIT includes full instructions and all components (even the PCB connectors) and requires only a box and a control knob to complete. Other features include manual sequence speed adjustment, zero voltage switching, LED mimic lamps and sound to light LED and a 300W output per channel. And the best thing about it is the price: DNLY £28.50.

HIGH SECURITY LOCK KIT

Designed for use with our lock mechanism (701 150) this kit will operate from a 9V to 15V supply drawing a standby current of only 50uA. There are over 5000 possible 4-digit combinations and the sequence can be easily changed. To make things even more difficult for an unauthorised user an alarm can be sounded after 3 to 9 incorrect entries – selectable by means of a link. The alarm can sound for a few seconds to over 3 minutes during which time the keyboard is disabled preventing further entries. A latched or momentary output is available making the unit ideal for door locks, burglar alarms, car immobilisers, etc. A membrane keyboard or pushbutton switches may be used and a beep sounds when a key is depressed. Kit includes high quality PCB, all components, connectors, high power piezo buzzer and full assembly and user instructions.

XK121	LOCK KIT	£15.95
350 118	Set of keyboard Switches	£4.00
KB12S	12-Way Membrane Keyboard	£9.98
701 150	Electric Lock Mechanism	£16.50

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K	Remote Control Dimmer	£16.45
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TDE/K	Extension kit for 2-way switching for TD300K	£2.70
LD300K	Light dimmer	£4.35

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MIM (metal-insulator-metal) LCD technology gives the small screen a new high standard of brightness and contrast, highlighted by a "black" filter.

LCD COLOUR TV

A Special News and Marketplace Report

A NEW TWIST IN PORTABLE ENTERTAINMENT

Ferguson have launched the PTV01, a new pocket sized LCD colour television, the first to be on sale in this country. This is a most exciting area of product development and the sets will become available through retailers of Ferguson products from November.

The PTV01 is priced at around £250, and its launch is timed to benefit from the Christmas gift market. In addition to its use as a watch-anywhere television, it can also be used as a colour monitor for Ferguson Videostar camera cassette recorders with playback capability. The comprehensive range of accessories comprises a rechargeable battery pack, a car adaptor, an external aerial adaptor, and an a.c. adaptor/charger.

THE FACILITIES

It is a smart, compact set, measuring only 85mm × 145mm × 35.33mm and very light, weighing just 330g. It has a 52.4mm × 39.6mm screen using the new TN liquid crystal, and can be viewed from a wide angle, enabling more than one person to watch simultaneously.

There is automatic channel selection by press button electronic sweep tuning; on-screen indication of channel tuning; press button adjustment of volume; a socket for private listening through the earphone supplied; built-in telescopic rod aerial with socket for connecting an external aerial in difficult reception situations; a socket for connecting a mains adaptor or 12 volt battery adaptor (optional accessories); a socket for audio-visual input from Ferguson Videostar camera cassette recorders.

The set is truly portable. Using the a.c. mains adaptor/charger, it can be plugged into the main, or run off the car battery via the cigarette lighter socket (but it's strictly for passengers when the car is in motion!). Six 'AA' size alkaline batteries will give up to two and a half hours of operation, or there is a rechargeable battery pack available which can be charged by the a.c. mains adaptor/charger, giving one and a half hours of use.

A soft carrying case, complete with a carrying strap which loops into an anchor point on the case, and six standard batteries are included in the price. There is also a tilt stand at the rear of the unit which, when pulled out, enables the television to stand freely, so allowing comfortable viewing.

LCD TECHNOLOGY

The PTV01 uses the latest tried and tested LCD technology to achieve a high resolution, quality colour picture. In order to appreciate the benefits of this technology it is appropriate to explain briefly how LCD screens work.

Current liquid crystal display television technology uses TN (Twisted Nematic) liquid crystal, the name referring to the arrangement of molecules in the crystal. There are two types of TN liquid crystal: 'Normal' which is rela-tively unsophisticated and inexpensive and 'Super-twist'. Normal TN together with an active drive matrix can be used on LCD television screens.

In its passive state, TN liquid crystal consists of twisted molecules which similarly twist the polarisation of light so that it will not pass through a polarised filter. When an electric field is applied, the molecules align and in effect become transparent, so allowing polarised light to shine through.

There are two ways in which an electric field can be applied to liquid crystal.

PASSIVE MATRIX

With the passive matrix method, the liquid crystal is sandwiched between two pieces of glass. On each inner side of the glass, in contact with the liquid crystal, there is a coating of almost transparent indium tin oxide which acts as a conductor, passing the voltage to the liquid crystal.

The oxide is laid on horizontally on one side and vertically on the other, forming a grid. Where the rows and columns cross and a voltage is passed to the liquid crystal it allows the picture element (pixel) to become transparent.

This works well on a small area, where the number of pixels is limited, as with a watch, but as the number of pixels increase the process starts to break down.

THE ACTIVE MATRIX

The active matrix system imposes another layer on the glass, this time of silicon semiconductors. The original conductor crosspoint no longer controls the pixel directly through the liquid crystal, but activates the semiconductor allowing more rapid switching, or lighting up, of the pixels.

There are two technologies currently used in active matrix systems: TFT (thin film transistor) which uses transistors as the semiconductor, and MIM (metal insulator metal) which uses a diode-like device. The metals and insulator are tantalum, tantalum oxide and chromium. It is thought that MIM is less likely to produce chemical faults in the production process, due to impurities for example. These could render the entire product useless, and therefore MIM is more cost effective.

COLOUR FILTERS

In order to achieve a colour picture, red, blue and green filters are laid over each group of three pixels and when the liquid crystal is transparent the colour shines through.

The PTV01 has the colours arranged in a triangular pattern with an additional new high degree colour filter which fills each gap with black. This gives brilliant reproduction of primary colours and a screen without patches.

BACK LIGHTING

Because the active matrix system needs yet another semiconductor layer on the glass, the screen has to be lit from behind to ensure that it can be viewed, especially in dim light. Consequently this TV has a highly efficient back light to give a brilliant picture even in a darkened room.

PIXEL QUANTITY

High level resolution on an LCD screen depends on the number of pixels. Some early monochrome models had only 10,000 pixels on a 2½ inch screen. With a colour picture, this would need to be tripled to introduce the three colours just to stay at the same level of resolution. The PTV01 screen however, has 56,000 pixels.

GREY SCALE

Many criticisms of monochrome LCD screens have been targetted at their low level grey scales. This does not render the picture unwatchable, but it would provide problems for colour development where grey scale performance is paramount.

The MIM device secures an active grey scale by virtue of the fact that by varying the amount of voltage applied to each pixel via the twisted molecule, differing shades of light can pass through. This helps to achieve greater contrast and more faithful colour reproduction.

MORE INFORMATION

Your local Ferguson dealer will be pleased to tell you more about the PTV01. Should you have difficulties finding a stockist, contact either Claire Dickson at Copeland Turner PR, 6 Rickett Street, London SW6 1RU, tel: 01-381 8811, or Anne Waterman, Ferguson, Cambridge House, Great Cambridge Road, Enfield, Middlesex, EN1 UL, tel: 01-363 5353. PE

PE BAZAAR

Oscilloscope with LED screen (unmade kits) £29.99. Also case kit £9.99. Scope lead £3.95. J.E. Ellis, The Flat, 18 Butter Hill, Wallington, SM6 2JD.

Wanted. Unfinished projects or kits with instructions and diagrams. Anything considered. Also unwanted components for beginner. C. Barron, 54 Gerrard Street, Newtown, Birmingham, B19 2BS.

I suggest Messers Barron and Ellis get together! Ed.

Electronic equipment and components for sale. Tel: Histon 3095. Mrs D. Nettleship, 22 Longstanton Road, Oakington, Cambridge, CB4 5BB.

Two 'Early' oscilloscopes, Cossor 1049 with spare tube and Hartley electromotives, working (just!). Offers. S. Gaskin, 6 Chevening Close, Tollgate Hill, Crawley, RH11 9QU.

Wanted – BBC Micro issue seven circuit diagrams, components, data sheets and any technical information. 0737 355140. S. Adams, 10 Downland Way, Epsom, Surrey, KT18 5SG.

Spectrum Music Fanzine for electronics enthusiasts. Ideas for music add-ons. Contact J.H. Robinson, 34 Kingston Road, Romford, Essex.

30+ Amplifier, enhanced version, PE design, superb quality, fully built and tested. Surplus to requirements. Offers? R.G.C. Asher, Nottingham, 0602 253916.

Sharp GF800, radio, high speed dubbing, ten bar graphic equaliser, clock-timer, double cassette. £200 o.n.o. R. Smith, 1 Huberd House, Manciple Street, London SE1 4DN.

Interested in swapping colour TV and electronic components for Zimbabwe curios of equivalent value. Please contact A.J. Renders, PO Box 72, Harare, Zimbabwe, Africa.

PCBs filled with 2716 and other useful ics for sale (not new but ok). R.A. Raza, PO Box 17930, Jeddah, Saudi Arabia.

Wanted: Editor Assembler cartridge and eprom programmer for Tandy colour computer. Urgently required to complete project. G. Moodie, 44 Seafield Road, Edinburgh, EH6 7LQ.

Required urgently: circuit diagrams and-or service manuals for Sinclair Spectrum computers. T. Lawlor, College Gardens, Callaw Road, Kilkenny, Eire. Tel (056) 21301.

17 computer pcbs for sale. Memory, CPUs, support chips, £25 the lot. Details – 0625 873874 (eves). M. Belham, 100 Towers Road, Poynton, Stockport, Cheshire, SK12 1DF.

Spectrum 48K computer and extras £73. Tradiper grid dip meter £25. Nombrex C-R bridge £25. R. Hearn, 10 Speedwell Close, Pakefield, Lowestoft, Suffolk, NR33 7DU. Tel: 0502 66026.

Wanted: Acorn Atom, or Oric-1, or Atmos computer hardware and add-ons, broken and working. (Electronics student). J. Bull, Woodcroft House, Comeytrowe Road, Trull, Taunton, Somerset, TA3 7NF.

PE, ETI, RW, WW, 1967-1980. RadioTV servicing 1953, 1959, 1965, 1969, old diagrams. Offers. T. McGhee, 86 Haldane Terrace, Dundee, DD3 0JF. Tel: 0382 817013.

HELP. Spectrum, ULA (OC001E-7). Will consider ANY broken Spectrum or just ULA. Will pay postage. M. Whitcombe, 1 Pen-y-waun Road, Trinant, Crumlin, Gwent, WP1 4JS. Tel: 0495 214994.

Wanted. Language card for an Apple II. R. Bolton, 29 Ballineaspig Lawn, Bishopstown, Cork, Ireland.

Circuits and service data required for Sony TC250A reel to reel tape deck. R. Clarke, 2 Northlands Street, Camberwell, London SE5 9PL. Tel: 01-737 4096.

Ultrasonic cleaner project PE or PW, any info appreciated. Would pay for relevent issues. I. Spearman, 18 Queensway, Shelley, Ongar, Essex, CM5 0BN. 0277 362197.

George Bray Ltd, brass encased heating elements, total qty 18, assorted lengths and wattages. Offers wanted. E.G. Priestly, 6 Lynden Avenue, Windhill, Shipley, W. Yorks, BD18 1HF. 0274 593382.

Heathkit AO-1V AF signal generator £27, Nombrex C-R bridge £22, Tech grid dip meter £20. R.W. Hearn, 10 Speedwell Close, Pakefield, Lowestoft, Suffolk, NR33 7DU. 0502 66026.

Hello again Mr Hearn - I hope you're not giving up electronics! Ed.

Oscilloscope with LED screen (unmade kit) £29.99, also case kit £9.99, scope lead £3.95. Working Phonosonics Cybervox Robot Voice £25.00. J.E. Ellis, The Flat, 18 Butter Hill, Wallington, SM6 2JD.

Good homes wanted for Seikosha GP-100 graphic printer and PE magazines 1978-86 in binders. Offers please. R. Hooton, 28 Market Place, Cromford, Matlock, Derbyshire (eves only). 0629 822953.

Oscilloscope dual trace Gould OS300 with case and probes. Hardly used, condition as new. £250. W. Mackay, 77 Erskine Hill, Polmont, Falkirk, Stirlinghsire. 0324 713037.

Power supply 150W +5V @ 8A, +12V @ 4A, −12V @ .2A, +24V @ 1.7A, Overvoltage, overcurrent protection. Excellent value at £19. S. Cramp, 68 Heath Drive, Chelmsford, Essex, CM2 9HF. 0245 259027.

8080A and 8224 chips unused £5 the pair, o.n.o. R. Fletcher, 29 Hirst Close, Long Lawford, Rugby, Warks.

For sale: two Textronix 453 dual channel scopes, not working. Offers. B. Nicholson, Warley, W.Mids. 021-422 1999.

OUR REGULAR LOOK AT ASTRONOMY

SPACEWATCH

BY DR PATRICK MOORE

The supernova in the large cloud of Magellan is still a mass of strange, unexplained phenomena. Appropriately, it has been named after a night-club!

TESTS on two major new telescopes one optical (the William Herschel Telescope at La Palma) and one microwave (the James Clerk Maxwell Telescope on Mauna Kea, in Hawaii) are continuing. In each case all seems well; the tests have proved to be absolutely satisfactory, and before long we may expect major new developments from each instrument. On the debit side, it now seems certain that the Royal Greenwich Observatory is to lose its headquarters at Herstmonceux Castle, in Sussex. Astronomers have fought long and hard to save it, but it seems that the final decision by the Science and Engineering Research Council will now be implemented, so that Herstmonceux will close in 1990 or even before. It is not too late for common-sense to prevail, but it does appear to be most unlikely.

One casualty of the Challenger shuttle disaster was the Ulysses space-probe, which was due to explore the polar regions of the Sun — regions which have so far been on its way by now (as would also the Galileo mission to Jupiter). However, Ulysses has now been rescheduled for October 1990, provided that there are no further troubles with the shuttle; it will be 1994 before results from Ulysses start to come in.

SN 1987A: CONTINUING PROBLEMS

There can be little doubt that the outburst of the supernova in the Large Cloud of Magellan, seen in February of this year, has been the most exciting astronomical event for many years - certainly much more important than Halley's Comet. Instead of beginning to fade immediately after the outburst, as most supernovæ do, this one brightened slowly to a maximum of almost the second magnitude, and when the fading began it was very gradual. By the beginning of October the magnitude was still almost as bright as 5, which means that

The Sky This Month

Mercury, which was favourably visible during November, is out now out of view, but Venus is becoming more and more obstrusive in the evening after sunset. It is still a long way south of the celestial equator, and is therefore rather low down, but the magnitude rises to -4 — much brighter than any other star or planet — and Venus cannot be mistaken. The phase is still well over 90 per cent, and no telescope will show anything definite upon its surface; what we are seeing is merely the upper cloud-layer.

Whenever Venus is brilliant around Christmas-time, many people ask "Can it have been the Star of Bethlehem?" The answer is an emphatic 'No", because Venus was a familiar object, and if the Wise Men had been deceived by it they would hardly have been very wise. On the same grounds we can also dismiss other familiar bodies, and the theory of a planetary conjunction has been discredited, so that we can give no scientific explanation - even if the Star were really seen!

Mars is now a morning object, passing from Virgo into Libra. Its magnitude is 1+1.7, not a great deal brighter than the Pole Star, and the apparent diameter is still below 5 seconds of arc Jupiter, however, remains on view almost throughout the night. It is Pisces, well north of the celestial equator, and reaches magnitude -2.7, so that it dominates the entire area. A small telescope will show its belts, zones and bright satellites. Of the 'Galilean' satellites the inner three (Io, Europa and Ganymede) may be followed as they exhibit transits, shadow transists, occultations, and eclipses by Jupiter's shadow; but the fourth Galilean, Callisto, is further from Jupiter, and at present escapes these phenomena.

Saturn is in conjunction with the Sun on 16 December, and is not visible. Of the three outer planets, Uranus and Neptune are in the Sagittarius area, and out of view; Pluto is in Virgo, but its magnitude is only 14.

Two major meteor showers are active during December. The Geminids extend from the 7th to the 15th, with a maximum on the 14th; the ZHR (Zenithal Hourly Rate) is about 70, and the Geminids can usually be relied upon to provide a good display particularly when — as this year — moonlight does not interfere (The Moon is full on the 5th, and new on the 20th.) The Geminids are rich in fireballs, with many faint meteors also. The Ursids extend from the 17th to the 25th, with maximum on the 23rd; the maximum is not particularly sharp and the ZHR is usually no more than about 12.

There are no eclipses in December.

Orion has now come well into view, and , dominates the night sky. Of its two leading stars, Rigel is brilliant white while Betelgeux is orange-red; Betelgeux is variable, and this month it is not much below maximum, so that there is not a great deal of difference between it and Rigel. Below the three stars of the Hunter's Belt, look for the Great Nebula, Messier 42 — a stellar birthplace; the hazy cloud is easily visible with the naked eye. Also in the Orion-Taurus area are the sky's two most famous open clusters, the Hyades, round Aldebaran, and the Pleiades or Seven Sisters. Capella, one of the brightest stars in the sky, is almost overhead; the Square of Pegasus, the main autumn constellation is descending in the west.

Mira Ceti, the first-known variable star, can reach the second magnitude when at maximum, as it almost did when it was last at its brightest in February of this year. Since its period of variation is 332 days, it is now increasing, and may well become a naked-eye object during December, below Jupiter. Like all stars of its kind, it is very red.

the supernovæ could still be seen with the naked eye.

Supernovæ are of two types. With Type I we are dealing with a binary system, of which one member is a very old star of the kind known as a white dwarf. A Type II supernovæ is due to the collapse and subsequent explosion of a single, very massive star, which blows most of its material away into space and leaves a small, super-dense core made up of neutrons. 1987 was certainly of Type II, but it did not follow the usual rules, and we now know it as the Mystery Spot — named, we are told, after a well-known bar and night-club!

Mystery Spot was discovered by a team from Imperial College, London, who went to Siding Spring Observatory in Australia to make speckle interferometry observations of the supernovæ. They hoped to measure the diameter ofthe supernovæ, but instead they found a 'blob' about two light-weeks from the main outburst, and we have to admit that we still do not know just what it is. Initially it was thought to be a cloud of gas which had been illuminated by the explosion — certainly it could not be material from the supernovæ itself, but it must have been associated, because it was brighter than any object seen in the region before the outburst.

Professor Martin Rees, of Cambridge, has now suggested that the pre-outburst supernovæ (the progenitor) had a binary companion. As the material from the outburst spread outward, some of it was "blocked" by the companion. Then, as the companion moved along in its orbit, there was, so to speak, a "hole" left in the expanding shell — and radiation from the super-novæ poured through this "hole" falling upon a cloud of gas and lighting it up. This could well explain Mystery Spot, but it is no more than a theory at the moment.

Neither do we know whether the outburst will produce a pulsar or a black hole. Some astronomers are pinning their faith in a black hole; but we must simply wait and see. Since the supernovæ is declining slowly, we may hope to keep track of it for some years, and within reasonably short time we may well know just what its end product will be. PE

Space Watching

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ELECTRONIC LOCKS

PART ONE BY THE PROF

LOCK BEFORE YOU LEAP

There are more ways of securing property with electronics than is generally realised. The Prof. looks at lock-and-key methods, opto-locks, capacitor-resistor operated locks and active-oscillator circuits.

At the mention of electronic locks, I suppose most people think of electronic combination locks. These have now become quite commonplace, and while they are far from the stage at which they could be said to have ousted mechanical locks, they seem to be steadily gaining in popularity. You could be forgiven for thinking that push button combination locks are the only form of electronic lock, but there are actually numerous other types. In fact there are almost limitless possibilities for anyone interested in designing this sort of thing. A number of push button combination and "tumbler" style electronic lock circuits have been published in the past including Tim Pike's GCSE idea in PE September 87. In this month's article we will continue the policy of exploring the less well known aspects of electronics by looking at alternatives to these.

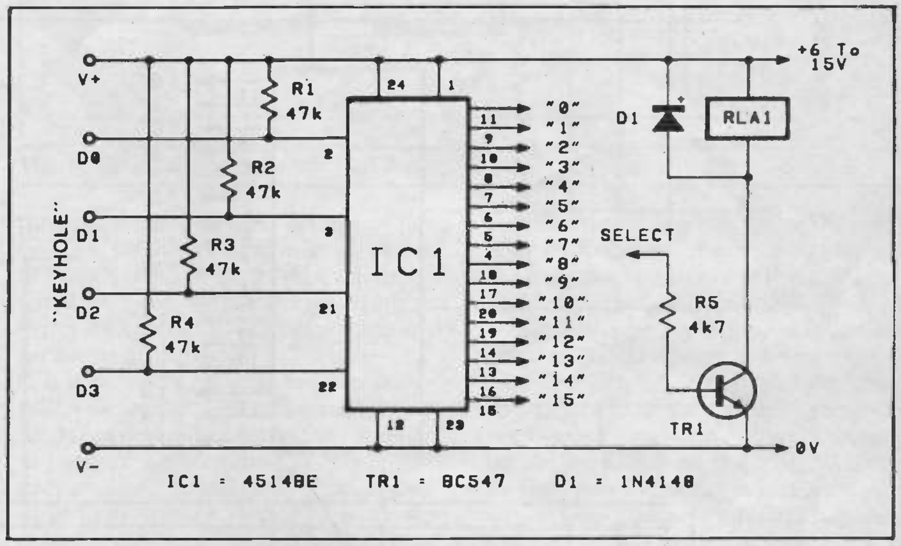

Fig. 1. *A simple "key" operated electronic lock.*

KEY TO SUCCESS

The types of lock we will be concerned with here are mostly of the "key" in "keyhole" variety. We are not necessarily talking in terms of something directly comparable to a mechanical key and lock mechanism, although devices which are directly analogous to these are possible. However, most electronic "key" style locks consist of a plug containing some electronic components, and a "mechanism" that is actually a matching socket plus some electronics. There are other possibilities though, as we shall see later.

Systems of this type can offer a level of security at least as good as a push button combination lock, and can probably be better in this respect. There is the obvious drawback of having to carry the key around, and it can become stolen or lost. On the other hand, people have been known to forget combination numbers, and writing them down is probably a greater security hazard than the possible loss of a key.

A basic "key" and "lock" system could consist of nothing more than a multi-pin plug with two of the pins short circuited, and a matching socket wired so that with these two terminals short circuited power is supplied to a relay, solenoid, or whatever. This approach is slightly over simplistic though, and anyone trying short circuiting a few terminals of the socket together would, in all probability, soon chance across the right two pins and "crack" the system. However, with the addition of some simple electronics it is not difficult to produce a virtually crack-proof lock.

What is needed is a system whereby the lock is only opened if the terminals of the socket are wired together in the appropriate manner. This can be easily achieved, and a simple circuit of this type is given in Fig.1.

IC1 is central to the operation of this unit, and it is a four to sixteen line demultiplexer. In other words, it has four inputs numbered 0 to 3, and sixteen outputs, numbered 0 to 15. All but one of the outputs are at the low state, and which output goes to the high state depends on the binary number fed to the inputs. For example, if inputs 0 to 3 are taken (respectively) to logic levels 0, 1, 0, and 1, this 1010 in binary, or ten if converted to decimal. Therefore, output ten is the one that assumes the high state.

In this application the basic idea is to feed a simple relay driver circuit from one output of IC1, and to use resistors to take the inputs to any state that causes this output to assume logic 0 under stand-by conditions. The "key" must be wired so that it takes the four inputs to the correct logic levels to send this output high, switching on TR1 and activiating the relay. As wired in Fig.1, all four inputs of IC1 are taken to the high state by the input resistors (R1 to R4). This renders output 15 unusable as this is the one which will go to the high state under standby conditions. For the sake of this example we will assume that output 4 is connectd through to R5. The "key" should therefore be a plug wired so that it connects D0, D1, and D3 to V−, and D2 to V+. Actually, D2 could simply be left unconnected, since it is pulled to logic 1 by R3 anyway.

This simple system gives quite good security, although I suppose it is far from crack-proof. Someone who got lucky might just find a suitable method of connection fairly quickly, and someone prepared to work methodically through all the possible methods of connection would presumably manage to activate the unit sooner or later.

One way of obtaining improved security is to use the same basic system, but with more inputs. The circuit diagram of Fig.2 shows a simple means of achieving this.

The front end of the circuit is essentially the same as the original circuit of Fig.1, as is the relay driver. However, two 4514BE demultiplexer chips are used, and their outputs are combined by an AND gate formed from two of the NAND gates in IC3. Thus, in order to activate the unit the selected output of IC1 and the selected output of IC2 must both be high. By increasing the number of "key" terminals from six to ten, the chances of fortuitous or consciencious "cracking" of the lock are greatly reduced. Something that is worthwhile remembering with any electronic lock is that dummy terminals, keys, or whatever, can make the unit much more difficult to "crack" without the need for any additional components whatever. For instance, retaining the original circuit of Fig.1 but adding half a dozen extra (unconnected) pins on the "keyhole" socket would probably be just as effective as using this improved version of the circuit.

OPTO-LOCK

The circuits of Fig.1 and Fig.2 can be used as the basis of a simple optical lock. The idea with these is to have a number of small lights opposite photo-sensors. The "key" is simply a piece of thin card or plastic with a number of holes drilled in it. The photocells are used in the manner shown in Fig.3. A photo-transistor with a built-in lens is a good choice for this application, as it gives a suitably narrow angle of view together with good sensitivity. In this case a TIL81 has been specified, and this represents a relatively inexpensive and readily available choice. However, similar devices such as the BPX25 should work just as well. The collector to emitter resistance of TR1 is used as a sort of light dependent resistance. Under dark conditions the leakage level through TR1 is the very low level (typically under 1 microamp) that is normally associated with silicon transistors. Under bright conditions the leakage level increases substantially, and can become as high as a few tens of milliamps. Under quiescent conditions the light output from D1 causes TR1 to switch on and then produce a very low output voltage. With the light output from D1 blocked, TR1 switches off and the output goes high. D1 is an infra-red LED having a narrow dispersion angle. The lack of any output in the visible light spectrum aids security by not giving away the nature of the lock. A narrow angle infra-red LED also enables a low LED current to be used successfully. Remember that most photo-transistors have peak sensitivity at wavelengths that are a good match for the output from an infrared LED.

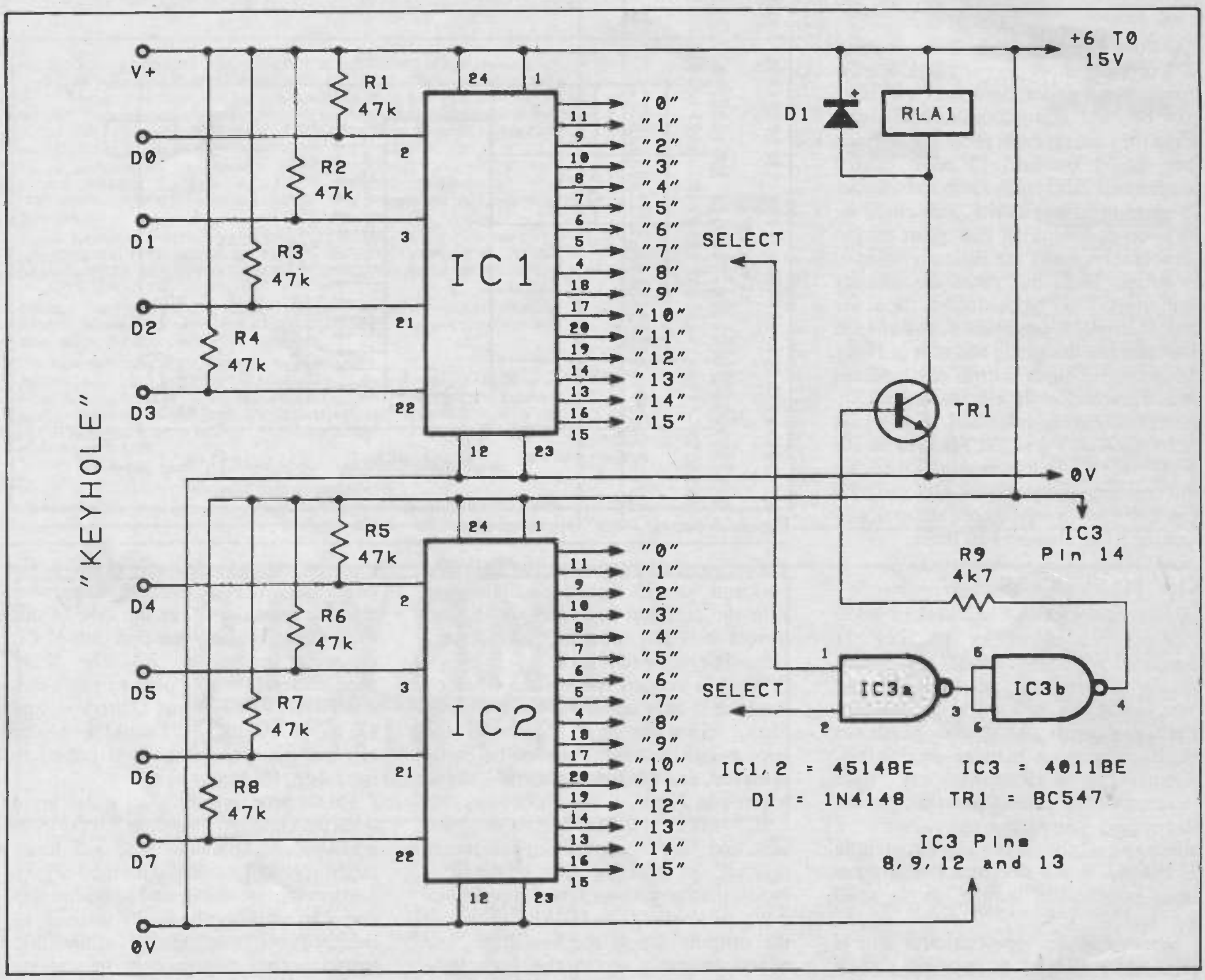

Fig. 2. *An improved version of the electronic lock.*

As the circuit stands, the "key" must be kept in the lock in order to keep RLA1 activated. This might be perfectly satisfactory in some applications, but in others it could be much more convenient to have sequential operation. In other words, inserting the "key" and removing it would activate RLA1, inserting and removing the "key" again would switch it off, and so on. This merely requires the addition of a flip/flop divide by two circuit between the output of IC3b and R5/R9, plus possibly some debounce circuitry. A circuit described later on in this article shows how a CMOS 4013BE can be used to give successive operation of an electronic lock.

The photocell circuits are coupled to the inputs of a logic circuit of the type described previously, and if the card has holes at the appropriate points, the photocells will produce the correct combination of output levels to activate the lock. Note that the pull-up resistors in the original circuits are not needed if the opto drivers are added (they are effectively replaced by the collector load resistors in the driver circuits). I suppose that the basic concept behind this form of lock is essentially the same one that is used in paper tape readers for computers, or perhaps that should be *were* used

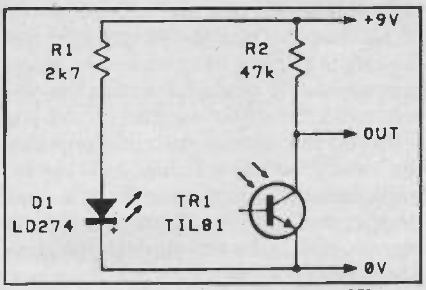

Fig. 3. *Optical inputs for circuits of Figs 1 and 2.*

in paper tape readers, as these are now pretty well obsolete.

This is a very simple idea, and is obviously not a particular new one, but it is one which has definite attractions. The key is very straightforward and is the type of thing that can be carried around with you without being a major inconvenience. Security is aided by the fact that few people would recognise it as a key at all. From my experiments it would seem that even the most simple locks of this type are very difficult to "pick". It is a system that is perhaps better suited to locks than to data storage. It is certainly an interesting idea that is well worth trying, and costs very little. The main point to watch is that ambient light cannot get into the lock at a high enough level to block the circuit and hold it in the off state.

C-R LOCK

The circuits described so far could be considered as just a variation on the combination lock theme, but this next design certainly is not. Any electrical quantity, or anything that can be measured electronically, is a potential basis for electronic locks. Many types of lock that would be possible would also be rather impractical. As an example, it would be possible to have a circuit with a number of temperature sensors, with each one having to be taken to the right temperature in order to unlock the device. It would be possible to produce a "key" to do this, but it would hardly be worth the effort. While being virtually "crack" proof, the more way-out set ups of this type are likely to be inconvenient from the user's point of view. Also, reliability could be poor, with the user being as firmly locked out as potential intruders for much of the time!

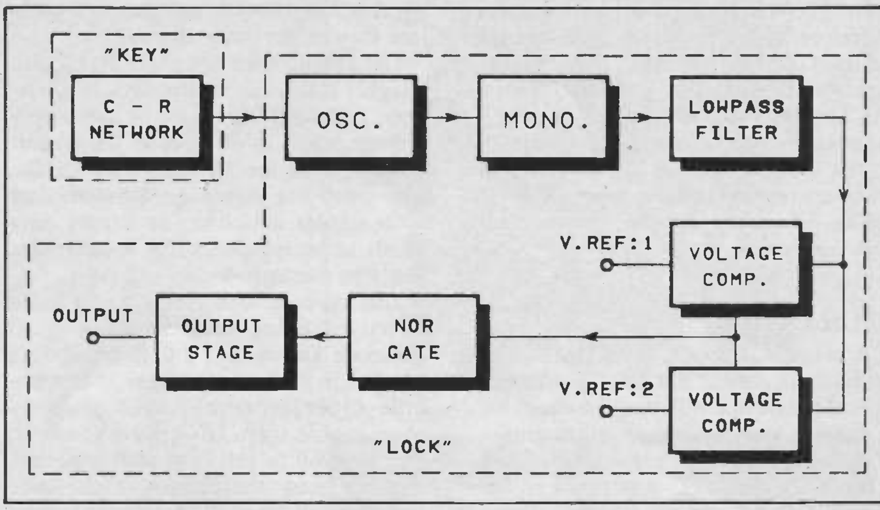

Fig. 4. *Block diagram for the C-R lock.*

It is probably sensible to keep things relatively simple. This aids good reliability, keeps down the cost, makes it easier to produce a system that is convenient in operation, and still gives a high degree of security. Simple electronic locks are quite easy to "pick" when you know how they work, but potential intruders are unlikely to have any idea what particular principle a given lock works under. With no idea where to start, successfully "picking" such a lock is highly unlikely.

The design featured here uses a resistor and a capacitor as the "key". It is not specific resistor and capacitor values that activate the unit, but a particular time constant. The block diagram of Fig.4 shows the basic arrangement used in this system.

The "key", as explained above, is a resistor and capacitor with values that give the appropriate time constant. When connected to the "lock", these form the main timing elements in a C-R oscillator. The purpose of the rest of the unit is to detect whether or not the oscillator is operating at (or very close to) the frequency produced with the correct C-R time constant connected.

A monostable multivibrator is the first stage in the frequency determining circuit. This is triggered by the brief negative pulses from the oscillator, and the mark-space ratio at its output depends on the frequency of the trigger pulses. As the input frequency is increased, the output pulses become bunched together, and the average output voltage rises. A lowpass filter at the output of the monostable smooths the output pulses to give a reasonably well smoothed d.c. signal at the average output voltage of the monostable. The monostable and lowpass filter thus provide a basic but quite effective frequency to voltage conversion.

Two voltage comparators fed from separate reference voltages monitor the signal from the lowpass filter. The voltage comparators feed into a NOR gate, and these three stages combine to form a window discriminator. The output of the NOR gate goes high when the input voltage is between the two reference voltages, and in practice these are separated by only a couple of hundred milli-

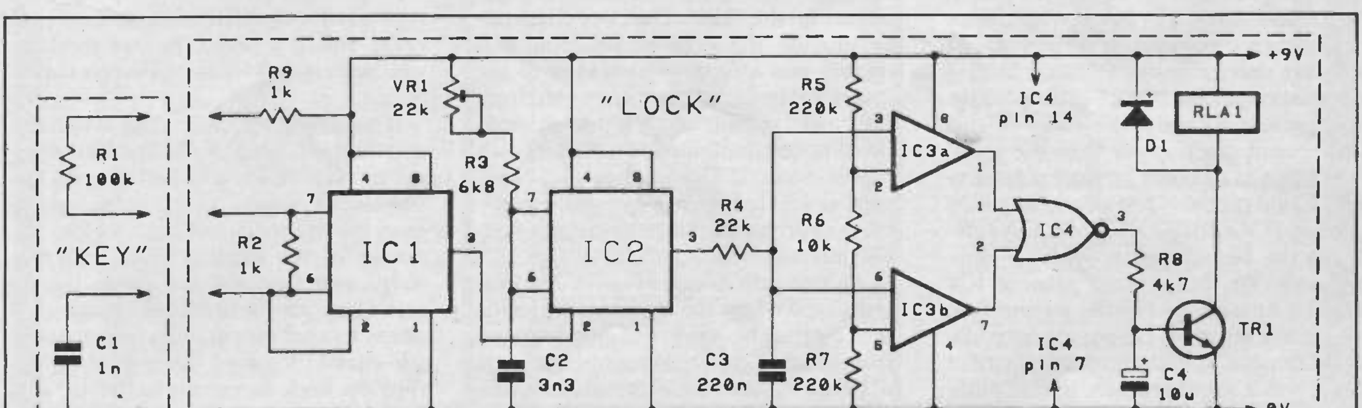

Fig. 5. *The circuit diagram for the C-R lock.*

volts. The frequency from the oscillator therefore has to be within quite narrow limits in order to produce an output voltage from the lowpass filter that will send the output of the NOR gate high and activate the output stage. The accuracy of the C-R network in the "key" needs to be correspondingly accurate.

The full circuit diagram for the C-R lock appears in Fig.5.

OSCILLATOR

A standard 555 oscillator forms the basis of the circuit, but a low power version of the device will often be desirable in order to keep the current consumption of the circuit down to a reasonable level. R1 and C1 are the C-R network in the "key", but they are not the only timing components for IC1. A standard 555 astable requires two resistors, and R2 is the second one. It has been given a low value so that the discharge period is kept very short, and the output waveform is the series of brief negative pulses needed to operate the monostable stage properly. R9 forms part of the charge resistance, but it is really only included as a safety measure. With this resistor included, anyone connecting pieces of wire across the "keyhole" terminals will be unable to short circuit the supply lines.

A second low power 555 acts as the basis of the monostable, and this is again a standard configuration. VR1 is adjusted to give the correct output voltage from the lowpass filter when the correct "key" is connected to the unit. The filter is a simple single stage passive type (R4 – C3). Note that if more than one "key" is made, it is essential to use 1% tolerance components for both R1 and C1 in each "key", or it is quite likely that it will not be possible to adjust the unit so that it will respond properly to every "key". Alternatively, the resistor could be replaced by a preset type so that it could be trimmed to give precisely the required time constant.

Two operational amplifiers are used as the voltage comparators, and the potential divider formed by R5 to R7 provides the reference voltages. It is the value of R6 that determines how discriminating (or otherwise) the "lock" is. In practice it is unwise to make the value of this component much lower than the specified value as this could reduce reliability and would probably not aid security very greatly. IC4 is the NOR gate which combines the outputs of the voltage comparators. The other three gates of IC4 are left unused. TR1 is the relay driver, which is a standard type apart from the inclusion of C4. With the original circuit there was a slight problem in that pushing bits of wire into the "keyhole" in an attempt to pick the lock resulted in TR1 switching on momentarily. These output pulses were so brief that they failed to operate the relay, but C4 totally suppresses them and avoids any possible problem they might otherwise cause.

The circuit does not seem to require a highly stable supply for reliable operation. Although variations in the supply voltage result in changes in the output voltage from the frequency to voltage converter, the reference voltages alter by a similar amount. The supply only needs to be regulated if it is otherwise likely to fluctuate by several volts.

This type of lock seems to be quite effective. Being realistic about it, if someone knows that a C-R network is needed in order to operate it, then a little experimentation would probably soon enable them to activate the unit. The solution to this is to simply not let anyone know the nature of the lock (which applies equally to any electronic lock). It is then virtually pick-proof. Also bear in mind that a few dummy pins on the "keyhole", as described previously, will help to make the unit more difficult to defeat.

ACTIVE-KEY LOCKS

For the ultimate in electronic lock security, without resorting to anything highly exotic (such as finger print or retina pattern identifiers), there is probably nothing to better active-key circuits. These differ to the circuits described earlier in that the "key" is not merely a plug plus a few wires or other passive components, but instead contains an active circuit such as an oscillator.

The circuit of Fig.5 could easily be changed to make it operate as an active lock. This is really just a matter of transferring IC1 and its associated components into the "key". The "key" then has to provide the appropriate input frequency and a suitable waveform to pin 2 of IC2. The "key" can be powered from the "lock" circuit, and it is preferable to do so rather than provide it with its own power source. This makes the "key" smaller and lighter, and avoids the possibility of problems due to any supply voltage mis-matches.

An interesting form of active-key lock is the type where the lock is on the inside of the car or building, and it is operated from the outside. The three obvious ways of doing this are to use ultrasonics, infra-red, or radio links. Ultrasonics has the disadvantage that the high frequency sound waves are not very good at passing through even quite thin materials, and this method is probably not practical. A radio link would be a perfectly good way of tackling the problem, but might not licensable (I have not checked to ascertain whether it would fall within the current radio control license provisions). An infra-red link almost certainly provides the most practical solution, as it can be implemented using quite simple and inexpensive circuitry. Infra-red signals seem to pass quite well through the glass used in ordinary windows, and even lace curtains might allow sufficient signal through to allow the lock to be activated. A range of as little as 150 millimetres could be quite usable in this application.

The block diagram of Fig.6 shows the arrangement used in my infra-red lock design.

The "key" is merely on audio oscillator driving an infra-red LED Note though, that the frequency of the oscillator must be within quite narrowly defined limits if it is to operate the lock. This is an important factor, since there would otherwise be a strong possibility that aiming any infra-red remote control transmitter at the lock would activate the system!

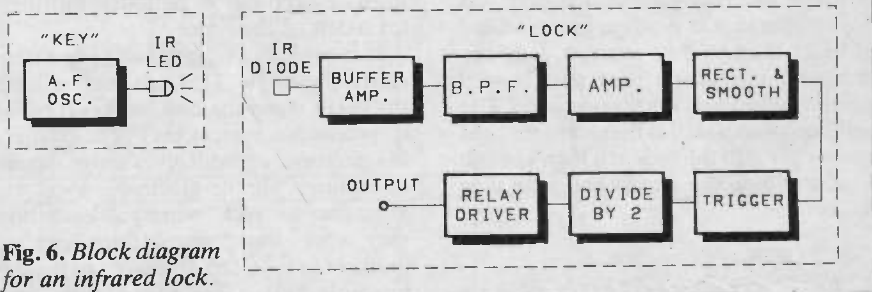

Fig. 6. *Block diagram for an infrared lock.*

The lock circuit has an infra-red detector diode feeding into a buffer amplifier. A high Q bandpass filter then boosts the signal, provided it is within the appropriate frequency range, of course. A voltage amplifier then further boosts the signal, prior to it being fed to a rectifier and smoothing circuit. This circuit gives a strong d.c. output when the signal is present, and no significant output when it is not. A trigger circuit is used to convert this signal into a logic compatible type which can drive the next stage properly. This is a divide by two flip/flop, which operates a relay via a simple driver circuit.

If we assume that the relay is initially switched off, aiming the transmitter at the receiver and briefly switching on the transmitter results in an output pulse from the trigger circuit. This toggles the output of the flip/flop to its opposite state, switching on the relay. Briefly activating the transmitter again produces another output pulse from the trigger circuit, toggling the output of the flip/flop back to its original state, and switching off the relay. In other words, each operation of the transmitter changes the state of the relay.

I shall describe the circuit more fully next month.

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INDUSTRY NOTEBOOK

WHEN IT ALL STARTED

In 1888 – almost 100 years ago – Hertz discoverd electromagnetic waves. Since then a huge industry has grown up to bottle and can them for our consumption – and Hertz has received a capital acknowledgment

REPORT BY TOM IVALL

The year 1988 which we are just moving into is the centenary of the world electronics industry. A hundred years ago Heinrich Rudolf Hertz, the German physicist, announced to the world in the *Annalen der Physik* (Annals of Physics) that he had produced electromagnetic waves and detected them at a distance. Actually he called the phenomenon an "outspreading of electric force". It was Lord Kelvin, in a translation of Hertz's work, who introduced the word 'waves', and in the English-speaking world they were initially known as 'Hertzian,' 'electric' or 'aether' waves.

Thus Hertz proved experimentally the actual existence of something that James Clerk Maxwell had shown mathematically, in 1865, to be theoretically possible. And fairly soon the new Hertzian waves were found to have the properties of light. This too was an experimental proof of Maxwell's electromagnetic wave theory. Maxwell had said that there were "strong reasons to believe that light itself .... is an electromagnetic disturbance in the form of waves" propagated as in his theory.

Some people might disagree that Hertz's discovery was the birth of the electronics industry. They might argue that it really began in 1882 with Edison's discovery of thermionic emission – the Edison Effect. Or they might say that everything started with the invention of the thermionic valve – Fleming's diode of 1904. Or they might point out that the diode didn't permit amplification or control and only became really significant when, in 1906, Lee de Forest added a third electrode to produce the triode valve.

TURNING POINTS

These were undoubtedly great turning points in the development of electronics technology. And one could reasonably go right back through the history of electrical science to the ancient Greeks rubbing pieces of amber (elektron in their language) to produce negative electric charges. But here I'm not concerned with the science or technology but with the electronics industry – the social activity of manufacturing useful things. And in arguing for 1888 as the true birth year of this industry I'm really saying that Hertz's discovery of electromagnetic waves led directly to the formation of the radio industry (in the late 1890s) and it was the radio industry, that gave birth to the electronics industry.

But if we look at the hard, irrefutable facts of history, what made the electronics industry possible as a manufacturing and trading business was the ready availability of cheap, mass-produced radio components. Valves, resistors, capacitors, inductors, and transformers used in manufacturing domestic radio sets on a large scale in the 'twenties and 'thirties suggested other kinds of applications.One early definition of electronics was: "Radio-like techniques applied to non-communication purposes." As a young boy I remember leafing through back copies of the American magazine *Electronics*, which started up in the 1930s, and seeing lots of articles on the use of photoelectric cells and valve amplifiers for industrial control purposes.

UNRESPECTABLE

Of course, electronics was not "respectable" in those early days. One reason was that it wasn't recognised and taught as a legitimate subject in colleges and universities. Consequently it was largely pushed forward by untrained experimenters and entrepreneurs – at any rate in the industrial field. That't not to say these people lacked intelligence, intellect or resourcefulness. Often they were much brighter than the official qualified engineers and technicians of the electrical world.

Another reason why electronics was initially considered slightly disreputable was that its products were often unreliable in use. In industrial environments especially, radio valves were fragile devices, connections proved to be vulnerable to shock, vibration, humidity and corrosion, capacitors became short–circuited and resistors went open–circuit.

No wonder that the electrical engineering establishment looked askance at electronics in those early days. Perhaps, too, they saw its brash liveliness as some kind of threat. In a sense they were right, for the electronics industry is now expanding faster, both in market size and rate of innovation, than the conventional electrical industry. In some big electrical companies and in professional bodies like the IEE and IEEE it has become the tail that wags the dog.

What brought about the change and finally transformed electronics into a serious industrial business that nobody could afford to ignore was the sheer impact of three developments in the late 1930s – television, radar and computers. Surrounding these were numerous other innovations from that period which we now take for granted, such as the use of sensitive electronic amplifiers to provide diagnostic medical instruments like the electrocardiograph and the electroencephalograph.

1948 REVOLUTION

The more recent history, especially the semiconductor revolution started by the invention of the transistor in 1948 and leading to the integrated circuit, must be well known to all readers of PE. What seems to be happening now is that the original "hardware" part of the electronics industry is merging with the old telecommunications industry and with the new software industry that arose from the digital computer. All are concerned with processing and transmitting information.

So in a sense the wheel has turned full circle. From its early beginnings in simple control devices, electronics has emerged as an industry which makes a living by handling much of the world's information. The first impact of Hertz's discovery was that it led straight to a new way of transmitting information. Appropriately, one of the most familiar names for measurement units in the electronics industry is the hertz. His name has acquired the ultimate distinction of becoming a generic term, written with a lower-case initial letter in its full form.

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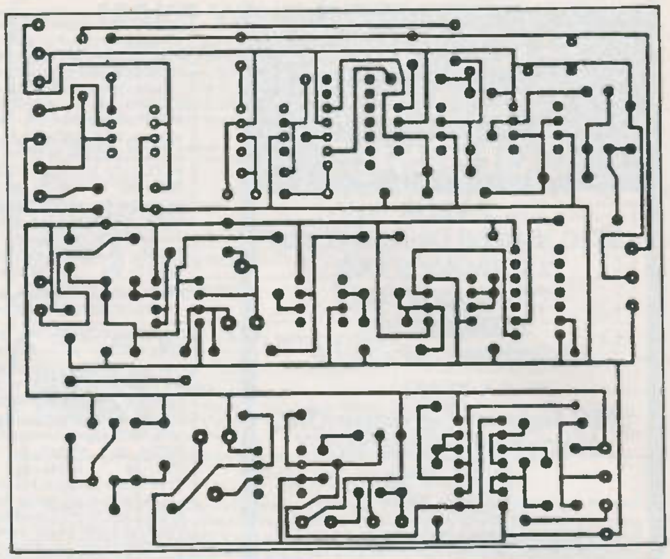

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