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SILVER ANNIVERSARY ISSUE

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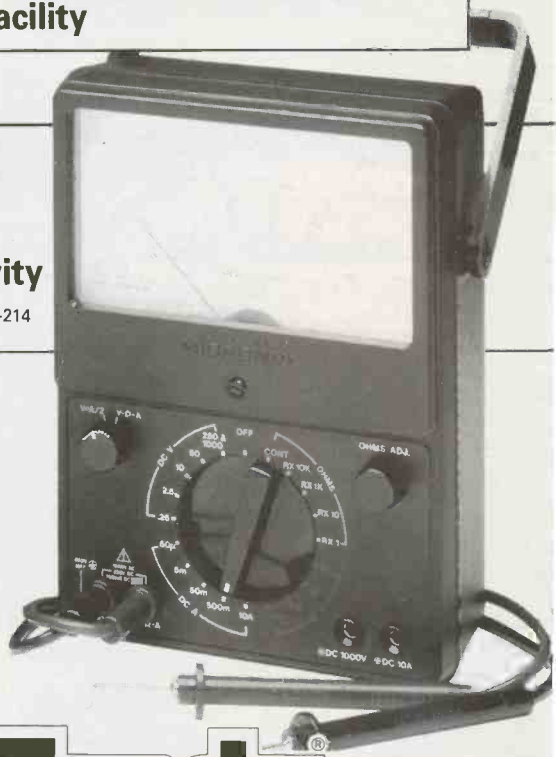

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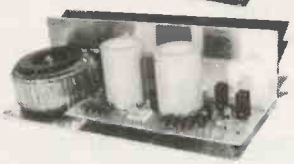
OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor, >300, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. –125dB. Size 300 × 123 × 60mm.
PRICE £39.99 + £3.00 P&P.

OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. –130dB. Size 300 × 155 × 100mm.
PRICE £62.99 + £3.50 P&P.



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. –130dB. Size 330 × 175 × 100mm.
PRICE £79.99 + £4.50 P&P.

NOTE:— MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS, STANDARD — INPUT SENS, 500mV BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATABLE) — INPUT SENS, 775mV, BAND WIDTH 50KHz, ORDER STANDARD OR PEC

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McKENZIE:— INSTRUMENTS, P.A., DISCO, ETC.

ALL McKENZIE UNITS 8 OHMS IMPEDENCE

8" 100 WATT C8100GPM GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID., DISCO. RES, FREQ, 80Hz. FREQ, RESP, TO 14KHz. SENS, 99dB. ..... **PRICE £28.59 + £2.00 P&P.**

10" 100 WATT C10100GP GUITAR, VOICE, ORGAN, KEYBOARD, DISCO, EXCELLENT MID. RES, FREQ, 70Hz. FREQ, RESP, TO 6KHz. SENS, 100dB. ..... **PRICE £34.70 + £2.50 P&P.**

10" 200 WATT C10200GP GUITAR, KEYBOARD, DISCO, EXCELLENT HIGH POWER MID. RES, FREQ, 45Hz. FREQ, RESP, TO 7KHz. SENS, 103dB. ..... **PRICE £47.48 + £2.50 P&P.**

12" 100 WATT C12100GP HIGH POWER GEN, PURPOSE, LEAD GUITAR, DISCO. RES, FREQ, 45Hz. FREQ, RESP, TO 7KHz. SENS, 98dB. ..... **PRICE £36.66 + £3.50 P&P.**

12" 100 WATT C12100TC TWIN CONE) HIGH POWER WIDE RESPONSE, P.A., VOICE, DISCO. RES, FREQ, 45Hz. FREQ, RESP, TO 14KHz. SENS, 100dB. ..... **PRICE £37.63 + £3.50 P&P.**

12" 200 WATT C12200B HIGH POWER BASS, KEYBOARDS, DISCO, P.A. RES, FREQ, 40Hz. FREQ, RESP, TO 7KHz. SENS, 100dB. ..... **PRICE £64.17 + £3.50 P&P.**

12" 300 WATT C12300GP HIGH POWER BASS LEAD GUITAR, KEYBOARDS, DISCO, ETC. RES, FREQ, 45Hz. FREQ, RESP, TO 5KHz. SENS, 100dB. ..... **PRICE £85.79 + £3.50 P&P.**

15" 100 WATT C15100BS BASS GUITAR, LOW FREQUENCY, P.A., DISCO. RES, FREQ, 40Hz. FREQ, RESP, TO 5KHz. SENS, 98dB. ..... **PRICE £53.70 + £4.00 P&P.**

15" 200 WATT C15200BS VERY HIGH POWER BASS. RES, FREQ, 40Hz. FREQ, RESP, TO 4KHz. SENS, 99dB. ..... **PRICE £73.26 + £4.00 P&P.**

15" 250 WATT C15250BS VERY HIGH POWER BASS. RES, FREQ, 40Hz. FREQ, RESP, TO 4KHz. SENS, 99dB. ..... **PRICE £80.53 + £4.50 P&P.**

15" 400 WATT C15400BS VERY HIGH POWER, LOW FREQUENCY BASS. RES, FREQ, 40Hz. FREQ, RESP, TO 4KHz. SENS, 102dB. ..... **PRICE £94.12 + £4.50 P&P.**

18" 400 WATT C18404BS EXTREMELY HIGH POWER, LOW FREQUENCY BASS. RES, FREQ, 27Hz. FREQ, RESP, TO 3KHz. SENS, 99dB. ..... **PRICE £167.85 + £5.00 P&P.**

EARBENDERS:— HI-FI, STUDIO, IN-CAR, ETC.

ALL EARBENDER UNITS 8 OHMS EXCEPT EB8-50 AND EB10-50 DUAL 4 AND 8 OHM. BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED FOAM SURROUND

8" 50 WATT EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. RES, FREQ, 40Hz. FREQ, RESP, TO 7KHz. SENS, 97dB. ..... **PRICE £8.90 + £2.00 P&P.**

10" 50 WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. RES, FREQ, 40HZ. FREQ, RESP, TO 5KHz. SENS, 99dB. ..... **PRICE £12.00 + £2.50 P&P.**

10" 100 WATT EB10-100 BASS, HI-FI, STUDIO. RES, FREQ, 35Hz. FREQ, RESP, TO 3KHz. SENS, 96dB. ..... **PRICE £27.50 + £3.50 P&P.**

12" 60 WATT EB12-60 BASS, HI-FI, STUDIO. RES, FREQ, 28Hz. FREQ, RESP, TO 3KHz. SENS, 92dB. ..... **PRICE £21.00 + £3.00 P&P.**

12" 100 WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO. RES, FREQ, 26Hz. FREQ, RESP, TO 3KHz. SENS, 93dB. ..... **PRICE £32.00 + £3.50 P&P.**

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5¼" 60 WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES, FREQ, 63Hz. FREQ, RESP, TO 20KHz. SENS, 92dB. ..... **PRICE £9.99 + £1.50 P&P.**

6½" 60 WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES, FREQ, 38Hz. FREQ, RESP, TO 20KHz. SENS, 94dB. ..... **PRICE £10.99 + £1.50 P&P.**

8" 60 WATT EB8-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES, FREQ, 40Hz. FREQ, RESP, TO 18KHz. SENS, 89dB. ..... **PRICE £12.99 + £1.50 P&P.**

10" 60 WATT EB10-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES, FREQ, 35Hz. FREQ, RESP, TO 12KHz. SENS, 86dB. ..... **PRICE £16.49 + £2.00 P&P.**

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PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3 watt FM Transmitter

3W FM TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP, **PRICE £14.49 + £1.00 P&P**

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★ MANUAL ARM ★ STEEL CHASSIS ★ ELECTRONIC SPEED CONTROL 33 & 45 ★ VARI PITCH CONTROL ★ HIGH TORQUE SERVO DRIVEN DC MOTOR ★ TRANSIT SCREWS ★ 12" DIE CAST PLATTER ★ NEON STROBE ★ CALIBRATED BAL WEIGHT ★ REMOVABLE HEAD SHELL ★ ½" CARTRIDGE FIXINGS ★ CUE LEVER ★ POWER 220/240V 50/60Hz ★ 390×305mm ★ SUPPLIED WITH MOUNTING CUT-OUT TEMPLATE.

PRICE £59.99 + £3.50 P&P.

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OMP MOS-FET POWER AMPLIFIERS, HIGH POWER. TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS

NEW MXF SERIES OF POWER AMPLIFIERS

THREE MODELS:— **MXF200** (100w + 100w) **MXF400** (200w + 200w) **MXF600** (300w + 300w)

All power ratings R.M.S. into 4 ohms.

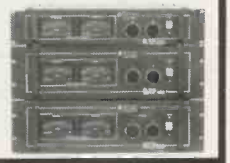
FEATURES: ★ Independent power supplies with two Toroidal Transformers ★ Twin L.E.D. Vu meters ★ Rotary indended level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases.★ MXF600 Fan Cooled with D.C. Loudspeaker and Thermal Protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.

SIZES:— MXF 200 **W19"×H3½" (2U)×D11"**
MXF 400 **W19"×H5¼" (3U)×D12"**
MXF 600 **W19"×H5¼" (3U)×D13"**

PRICES: **MXF200 £171.35**
MXF400 £228.85
MXF600 £322.00

SECURICOR DELIVERY £12.00 EACH



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THE VERY BEST IN QUALITY AND VALUE

MADE ESPECIALLY TO SUIT TODAY'S NEED FOR COMPACTNESS WITH HIGH OUTPUT SOUND LEVELS, FINISHED IN HARDWEARING BLACK VYNIDE WITH PROTECTIVE CORNERS, GRILLE AND CARRYING HANDLE. INCORPORATES 12" DRIVER PLUS HIGH FREQ. HORN FOR FULL FREQ. RANGE. 45Hz-20KHz BOTH MODELS 8 OHM, SIZE H18" × W15" × D12".

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POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET

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OMP SLIDE DIMMER 1K WATT & 2.5K WATT

CONTROLS LOADS UP TO 1KW & 2.5KW. SUITABLE FOR RESISTIVE AND INDUCTIVE LOADS BLACK ANODISED CASE. READILY FLUSH MOUNTED THROUGH PANEL/CABINET CUT-OUTS. **ADVANCED FEATURES INCLUDE:—**

★ FULL 65mm SLIDE TRAVEL
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SIZES:—
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PRICES:— **1K WATT £15.99**
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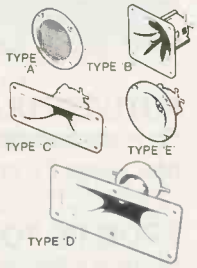
PIEZO ELECTRIC TWEETERS-MOTOROLA

PIEZO ELECTRIC TWEETERS — MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each** + 50p P&P.

TYPE 'B' (KSN1005a) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.00 each** + 50p P&P.

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STEREO DISCO MIXER with 2 × 5 band L & R graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features** 5 Inputs with individual faders providing a useful combination of the following:—
3 Turntables (Mag). 3 Mics. 4 Line including CD plus Mic with talk over switch Headphone Monitor. Pan Pot L. & R. Master Output controls. Output 775mV. Size 360×280×90mm. Supply 220-240v.
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PRACTICAL ELECTRONICS

Volume 25 Number 11 -November 1989

1964-1989

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COMPETITIONS!

CELEBRATORY FEATURES

CONSTRUCTIONAL PROJECTS

SPECIAL FEATURES

REGULAR FEATURES

PRODUCT FEATURES

NEXT MONTH

Robert Penfold presents a project specially for devoted goggle-box watchers, it can help stabilise hired video tape playback! John Becker completes the Echo Station begun in PE Oct 89, and Vivian Capel shows how to repair the old-time favourite AL80 amplifier module. All this and more in our first post-25th Anniversary issue! We even hope to tell you about our fabulous Birthday Party Celebrations!

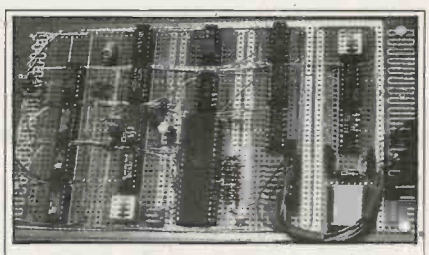
PLUS:

8 PAGE DISPLAY ELECTRONICS CATALOGUE

SO DON'T MISS OUR DECEMBER 1989 ISSUE

ON SALE FROM FRIDAY NOVEMBER 3RD.

YOU CAN'T BEAT OUR VALUE OR OUR CELEBRATED OFFERINGS!



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PE GOES DTP

Making history yet again in its first 25 years, PE becomes the first magazine in its field to introduce in-house desk top publishing. The entire editorial contents and much of the advertising material in this celebratory issue have been typeset and pages designed on our own DTP system (two Macintoshes SE with Radius Big Screens and Apple Laser printer, supported by several Amstrad PC's, using Quark Xpress software). The whole issue was done very quickly, in a few days, due to sterling work of our Production Manager David and our publisher Angelo.

The DTP system was installed at Intra Press almost three years ago (we were one of the first publishing companies in the UK to use DTP). First our sister magazine *Program Now* was brought in-house and a bit later *Astronomy Now*. For over a year, increasing amounts of PE material have been DTP'd, now to commemorate our Silver Anniversary, it's fully **"off with the old, on with new"!**

PE is truly keyed up for the next 25 years!

PE TAKES TECHNOLOGY FURTHER - BE PART OF IT!

MAGENTA ELECTRONICS Ltd

PROJECT KITS

Magenta supply Full Kits: Including PCB's (or Stripboard), Hardware, Components, and Cases (unless stated). Please state Kit Reference Number, Kit Title and Price, when ordering. REPRINTS: If you do not have the issue of P.E. which includes the project, you will need to order the instruction reprint as an extra: 80p each. Reprints are also available separately – Send £1 in stamps. Magazine dates refer to Everyday Electronics.

REF NO.	KIT-TITLE	PRICE
816	STEPPING MOTOR DRIVER As featured in Aug P.E. Superb controller with half-step ability Offer Price with MD35 Motor	£7.94 kit only £14.99
812	ULTRASONIC PET SCARER May 89	£13.80
807	MINI PSU Feb 89	£22.71
806	COMMUNITY TESTER	£10.28
803	REACTION TIMER Dec. 88	£31.93
801	DOWNBEAT METRONOME Dec. 88	£18.71
800	SPECTRUM EPROM PROGRAMMER Dec. 88	£28.72
796	SEASHELL SYNTHESISER Nov. 88	£26.61
795	I.R. OBJECT COUNTER Nov. 88	£31.56
790	EPROM ERASER Oct. 88	£26.57
786	UNIVERSAL NICAD CHARGER July 88	£7.44
780	CABLE & PIPE LOCATOR April 88	£16.35
775	ENVELOPE SHAPER Mar 88	£15.96
769	VARIABLE 25V-2A BENCH POWER SUPPLY Feb 88	£52.96
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739	ACCENTED BEAT METRONOME Nov 87	£22.31
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745	TRANSTEST Oct 87	£10.33
734	AUTOMATIC PORCH LIGHT Oct. 87	£18.29
736	STATIC MONITOR Oct. 87	£9.22
723	ELECTRONIC MULTIMETER Sept 87	£50.01
728	PERSONAL STEREO AMP Sept 87	£15.24
730	BURST-FIRE MAINS CONTROLLER Sept 87	£14.45
724	SUPER SOUND ADAPTOR Aug 87	£40.89
718	3 BAND 1.6-300MHz RADIO Aug. 87	£28.25
719	BUCCANEER I.B. METAL DETECTOR inc. coils and case, less handle and hardware July 87	£28.17
720	DIGITAL COUNTER/FREQ METER (10MHz) inc. case July 87	£71.43
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707	ACTIVE I/R BURGLAR ALARM Mar. 87	£37.97
581	VIDEO GUARD Feb. 87	£8.94
584	SPECTRUM SPEECH SYNTH. (no case) Feb. 87	£22.28
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493	DIGITAL CAPACITANCE METER Dec. 85	£44.25
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392	BBC MICRO AUDIO STORAGE SCOPE INTERFACE Nov 84	£38.61
387	MAINS CABLE DETECTOR Oct. 84	£5.89
386	DRILL SPEED CONTROLLER Oct 84	£9.24
362	VARICAP AM RADIO May 84	£14.00
337	BIOLOGICAL AMPLIFIER Jan 84	£25.71
263	BUZZ OFF Mar. 83	£6.05
242	2-WAY INTERCOM no case July 82	£6.06
240	EGG TIMER June 82	£7.31
205	SUSTAIN UNIT Oct 81	£18.78
108	IN SITU TRANSISTOR TESTER June 78	£10.03
106	WEIRD SOUND EFFECTS GEN. Mar. 78	£8.33
101	ELECTONIC DICE Mar. 77	£6.67

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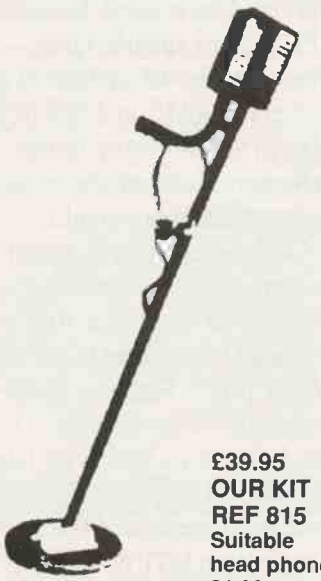
A superb design giving 0-25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V.
Current-Limit control allows Constant Current charging of NICAD batteries, and protects circuits from overload. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

OUR KIT REF. 769 £52.96

COMPONENTS, KITS, BOOKS, TOOLS, MOTORS, GEARS, PULLEYS, OPTICAL FIBRES, ROBOTICS, AND MUCH MUCH MORE–IN OUR CATALOGUE £1.00

EE TREASURE HUNTER



£39.95 OUR KIT REF 815 Suitable head phone £1.99

P.I. METAL DETECTOR
A sensitive pulse induction Metal Detector. Picks up coins and rings etc. up to 20cms deep. Low "ground effect". Can be used with search-head underwater. Easy to use and build, kit includes search-head, handle, case, P.C.B. and all parts as shown.

DIGITAL FREQUENCY 200 MHz METER

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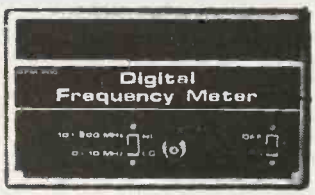

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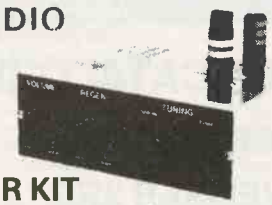

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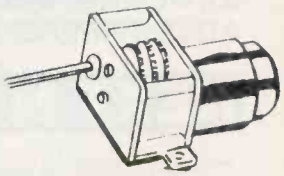

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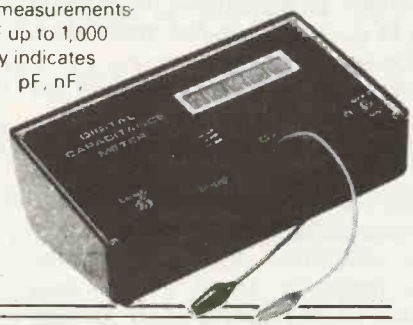

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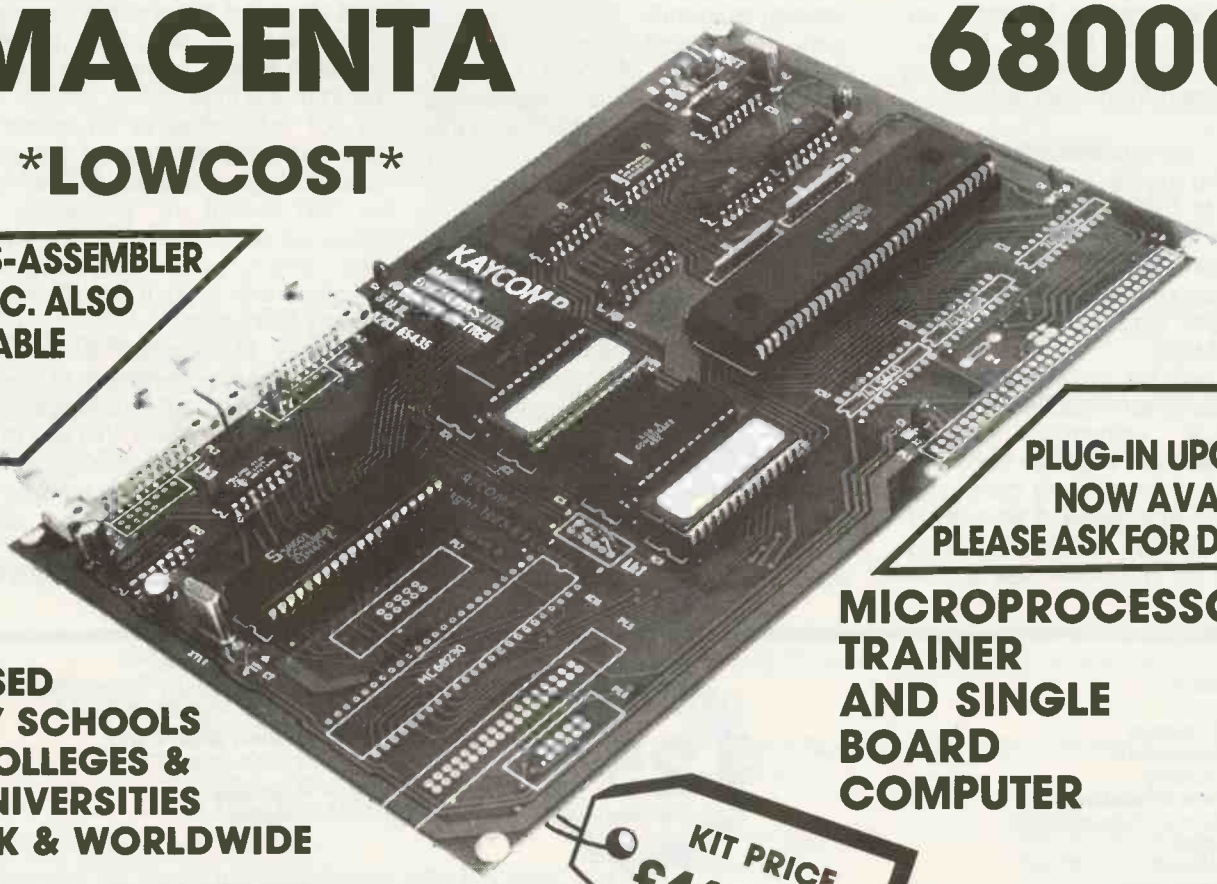

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GOLDEN FUTURES

On other pages in this 25th Anniversary celebratory issue, we look back over the last twenty five years. The historical copies of *PE* piled around my room reflect the enormous changes brought about in society through advances in technology. *PE* has witnessed the change from transistor to transputer, from slide rule to pocket computer, from valve radios to satellite tv.

What changes will *PE* see in the next twenty five years? Barry Fox reflects that predictions are fragile. He, I and many others who contribute to *PE* are inundated with manufacturers' data on new chips, new systems, new applications, new research. Much of the data relates to a faster *this*, a smaller *that*, another way of using something else. Truly different innovations are few and far between; but they happen. Until they do, though, one can only extrapolate what *might* happen from what is happening.

Wider microprocessed control around the home will undoubtedly be seen to have taken a firm hold when we look back in twenty five years' time. Stricter regulation of energy consumption will make this a necessity, irrespective of convenience factors.

There will be increased use of electronics in automobiles, to maximise fuel efficiency, radically reduce pollution, improve control of traffic flow on ever more congested highways. Autoguide traffic guidance is already available experimentally; we may well see expansion of the system to include total remote guidance of vehicles on some major routes by 2014. The chief executive of Ford recently confirmed that the technology exists, it only needs the will and the finance to implement it.

Will computer technology have led to artificial intelligence by 2014? Parallel processing already exists, and what more is an intelligent brain other than a sophisticated parallel processor? Therein lies philosophy as much as technology! Can human intelligence coax inanimate matter to behave intelligently? "They're working on it", is as far as I'll stick my neck out to say!

Speech recognition techniques are already well advanced. Vocal control of computerised systems should have become commonplace, in the home, in the office, in industry, by the time of *PE's* golden anniversary. My review of *PE's* 50 years of history will be *spoken* into computer memory, not *typed*. (Unless an AI device is editing *PE* by that time!)

There will be further sophistication of automatic language translation systems. Direct document translation should have become commonplace by 2014, as should real-time conversational translation. Semantics and cultural nuances may still be causing problems for total linguistic translation, but the use of standard vocabularies should minimise the problems. Anyway, if human intelligence can frequently deduce ambiguous meanings, why can't AI come up with equivalent micro-neural algorithms?

I shall be presumptuous, and say that anything Nature can do, Homo Technologicus will find ways to emulate it, and sometimes improve upon it. It's imperative, though, that in our technological advances we maintain a strict regard for social and ecological factors. But, whatever the extent of emulation and advancement over the next twenty five years, *PE* will keep you involved with it. As it has for the first twenty five years.

Finally, thank you Fred Bennett, thank you Mike Kenward, thank you everyone for your contributions to *PE* over those years. We are proud to belong to the *PE* you have helped create. And now we plan the future history, turning Silver Jubilees to gold!

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First, I'd like to take you back a few weeks to when the Publisher and I were discussing PE's 25th Anniversary issue.

"Barry Fox is looking to the future of technology in his *Leading Edge* column", I recapped, "Tom Ivall's looking back at it for *Industry Notebook*, and Wayne Green's facing both ways - from an American viewpoint. I'm browsing through PE's history. Who or what else would you like, Angelo?"

"Run a survey of readers", was the instantaneous response, "ask who they think has done the most for technology."

"Right! And ask that personality for a few predictions."

"Let's make an award," beamed Angelo, "the PE Award to the personality who has done the most to promote technology over the last twenty five years.

"The PE Silver Tech Award!"

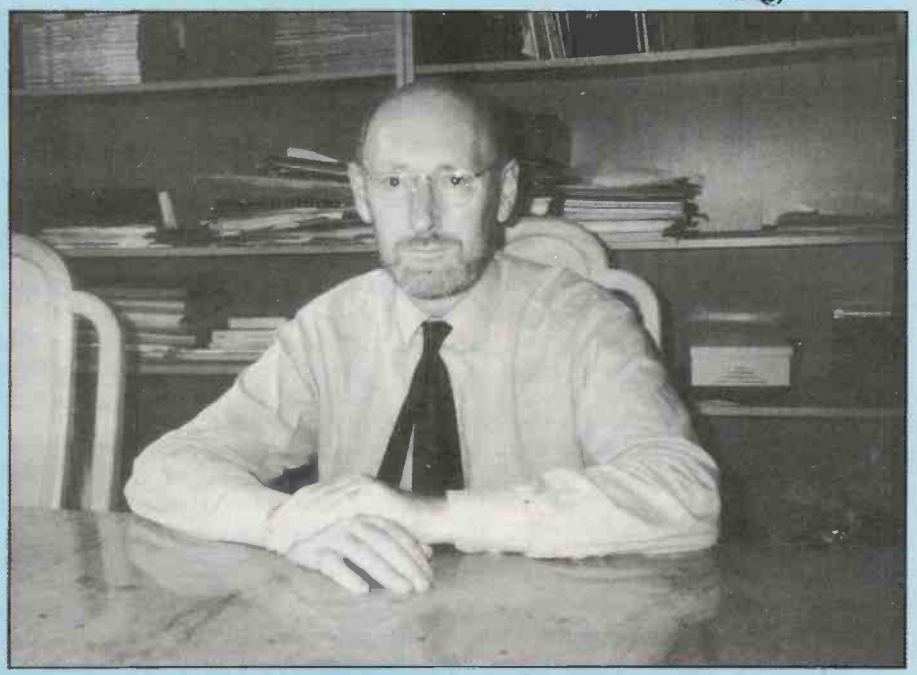
TOP OF THE POLLS

So we ran a poll of a random selection of readers. "Who do you nominate for the award?" and, just for interest, "Which product has had the greatest impact in the last 25 years?"

A variety of products were suggested by the readers polled, ranging through Veroboard, video cassette recorders, transputers, lasers, personal computers, pocket calculators, colour television, integrated circuits, transistors, and microprocessors. The latter, by far, came out on top, followed some way behind by transistors (yes, we know they're more than 25 years old, but they are still having a huge impact).

A handful of readers suggested personalities such as John Kemeny and Thomas Kertz (inventors of Basic), Steve Jobs (founder of Apple Computers), Akio Morita (founder of Sony). Many more suggested Alan Sugar of Amstrad fame. The vast majority, though, said, "Sir Clive Sinclair!"

"Editor," proclaimed the Publisher, "interview him!"



Sir Clive Sinclair, entrepreneur extraordinaire, and voted by PE readers as the personality who has done the most for technology in the last 25 years.

PARALLELING SIR CLIVE

A short history of PE's favourite man of technology - and a few of his views, as told to John Becker in an exclusive interview.

SINCLAIR RESEARCH

I thought this would mean a pleasant day's outing to Cambridge, but no, Sir Clive has a spacious set of offices in London's West End. The entrance plaque said Sinclair Research Ltd.

Sir Clive greeted me kindly and invited me into his office, well stocked with books and piles of documents. There too, I thought, must be history past, and in the making!

"Congratulations, Sir Clive, on being nominated by our readers as the personality who has done most to promote technology over the last twenty five years. They voted three to one in your favour."

"Oh, that's nice to know! Thank you!"

EARLY DAYS

Sir Clive was born 30th July 1940. Even from his early days he showed a marked interest in mathematics and all things mechanical. His enquiring mind compelled him to investigate anything new. If he did not know how a thing worked, he had to find out!

Probably a foretaste of what the future would eventually hold for him was his independent discovery that any number could be converted into a series of 0s and 1s. He recognised that a machine could handle addition and subtraction more readily in this form. He had discovered binary maths - albeit, a couple of hundred years after someone else! This, along with his increasing understanding of log tables, allowed him to progress to more complicated functions such as multiplying and dividing, just by adding or subtracting.

From this developed his fascination with the thought of inventing a calculating machine. By the age of ten, his knowledge of maths had outstripped even that of his prep-school teachers.

SCHOLARLY APPROACH

After a succession of different schools, he passed his A-level exams, but pursued scholastic qualifications no further. He regarded going to University a waste of time!

"Sir Clive, how did you become interested in electronics?"

"Well, it was a hobby at school. Had been for a long time. I taught myself electronics. With valves to some extent, though transistors came along while I was still at school."

Transistors came along in 1948, when Sir Clive was still only eight years old. It's thus unlikely that he was any more than seven when his interest in electronics began to emerge.

"Did you learn much of your electronics from the electronics magazines of the day?"

"Oh yes, and with books and everything! Whatever was at hand!"

In those days the principle magazines would have been Wireless World, Radio Constructor, and Practical Wireless. By his late teenage, Sir Clive's electronic abilities had already been recognised professionally, by Practical Wireless. PW published some of his designs, and even featured his photo on the front cover. His first employment was to be on their staff.

"Yes, about 1958. I joined PW from school, when I was 17."

Soon, he was to join the audio and hifi book publishers, Bernards Publishers, first as a technical writer, then as editor from 1958 to 1961. Bernards are, of course, better known today as Bernard Babani Publishing. Sir Clive's first book, *Practical Transistor Receivers*, was published in 1959. He was to write others, including *Modern Transistor Circuits for Beginners*, and the *Practical Stereo Handbook*.

PRIME PRODUCTS

But although well established in publishing, Sir Clive's entrepreneurial ambitions had taken hold. In 1962 he founded the company Sinclair Radionics, running the mail order electronic kit supply operations from a friend's garage!

"What was the first product you designed and marketed?"

"The first product that we ever did was a little tiny amplifier, the 'micro-something or other'! It went very well. The first magazine I ever advertised in was Radio Constructor."

His adverts began to appear in Practical Wireless as well, and soon in another one, too.

"You were one of our first advertisers in PE, when it began in 1964.", I said, passing over a copy of PE Dec 64, open at Sir Clive's advert for the X10 amplifier. "Did that advertising go well?"

"Oh yes, very well. Yes!"

Many of the early adverts were for increasingly miniaturised and improved amplifiers and radios. The passion for inventing a 'calculating machine' had not left him, though, and his ambitions were soon realised.

"I remember building your electronic pocket calculator, the first one ever to be introduced."

"Yes indeed. In the world! We were certainly the first in the world with the pocket calculator. And the first one we did is in the Museum of Modern Art in New York."

"The Black Watch was significant too, the first digital watch in the world, wasn't it?"

"Oh, yes! And there was no lid, no moving buttons, just a pad to touch."

Interest in calculators took Sir Clive further into the world of computation. The Sinclair Scientific calculator was developed, using an existing integrated circuit for its main control functions. But he had the control program modified, using specific algorithms of his own devising to carry out the scientific calculations.

HIGHEST RECOGNITION

That experience would have stood him in good stead when he actively researched into his first computer, the ZX80. Home computers were to become arguably Sir Clive's best selling products to date. The ZX81 achieved success not only financially, but in other ways too.

"Is it true that your ZX81 computer used to be presented to visiting overseas dignitaries by the Prime Minister, as an example of British hi-tech products?"

"Yes. By Margaret Thatcher."

The PM's admirations for Sir Clive's achievements were to result in his being knighted. But he's very modest about it.

"I think it was in 1983. It may have been 1985. I'm not sure about it to be honest."

In fact it was in 1983; about a year after the hugely successful Spectrum had been launched.

Sir Clive with his latest computer, the Z88

POCKET TVS

In the intervening years, Sir Clive had also taken his interest in radio a step further - into television. With his compulsion to produce ever-smaller products, he embarked on producing a portable tv set, with a screen just two inches across. This was launched at the Radio and Television Exhibition at Earls Court in 1966, though never went onto retail sale. Some years later, in 1977, he followed up with another miniature tv, and still another in 1983. Selling the latter at just under £80, he achieved this remarkably low price by using a single chip for the entire control circuitry, and by manufacturing the tube on an innovatory and almost totally automated system.

Although these miniature tvs never achieved the success that might have been hoped for, interest in communications systems of various sorts is still very dominant in Sir Clive.

POCKET PHONES

"What sort of product is likely to have its impact over the next twenty five years?"

"Well, I think the pocket telephone, which of course, one of the companies we founded is bringing out. I think that the truly personal pocket telephone is going to bring a very, very big and important change in the way we live and do business."

Sir Clive was referring to the brand-named 'Forum' Telepoint telephone from Shaye Communications.

"The Forum personal phones have recently been featured as the prizes in one of our recent competitions."

"Oh, right, good! Oh, excellent!"

"We've had other products of yours as prizes as well. The 'Squish' Astra satellite tv square aerials, and your Z88 computers were given away as prizes too - a lot of response from readers on those!"

"Oh, that's interesting! Great!"

NEW COMPUTERS

"Have you any other new products coming up which we might be able to present as competition prizes?"

"Well, we've always got lots of developments. Of course I can't talk about them too far in advance, though there's a new computer early next year. But I can't talk about it at this stage."

One can understand Sir Clive's reluctance to discuss future plans too closely. On several occasions, the Japanese have stepped into his market, to his detriment. Pocket calculators were one product to which this happened, so too were digital watches. He appears philosophical about it, though, acknowledging that his initial marketing of innovative products is good, but less so when the market becomes cut-throat.

This was particularly exemplified perhaps when, in 1986, he sold the Sinclair computer business and the Sinclair trade name to Alan Sugar of Amstrad. Sir Clive had recognised that Alan Sugar's world wide marketing techniques were superior to his own.

On the innovative scene, though, Sir Clive is probably unsurpassable. What, then, of the more distant future?

"Do you have any other predictions as to where things might go in the next twenty five years?"

"Well, the things that interest me are obviously computers. The only thing about new products there that I feel very strongly about, is portable as opposed to personal computers.

"I do believe that as long as personal computers are tied to the desk, that greatly restricts their usefulness. Because, obviously, a computer is a very nice way to keep your address book, your data files, and everything, but if it's not with you then it fails in its

purpose. So I do think it's important to have a truly portable system.

"A lot of the technology that we've been developing at Sinclair Research has been with that in mind. So portable phones and computers are an important part of that, as are silicon wafers which can replace hard disks. So, yes, there's a lot of mileage in that. And I do see a time in the not far distant future where most people will have a portable computer with them all the time."

WAFER SCALE INTEGRATION

The silicon wafers to which Sir Clive refers are those using the wafer scale integration technique. In essence, wafer scale integration involves the repetition of identical chips across the whole of the silicon wafer. In normal manufacturing processes, these wafers are subdivided into their individual chips. Since the manufacturing process is unable to achieve 100% reliability of each chip, all chips have to be tested after separation, and defective ones discarded.

In wafer scale, the silicon disc is not broken down into chips, though the rejection likelihood remains. However, each chip is interconnected to its partners, and has additionally been designed so that it can test them. In the test procedure, a satisfactory chip is first found at the edge of the wafer. It then tests a partner. If it too is satisfactory, a permanent link is established. If it is unsatisfactory, that partner is ignored, and another partner tested. The procedure ripples through the wafer, chip after chip, until a spiral path encompassing as many chips as possible is established.

The technique has profound implications for increased miniaturisation of computers, and for easier implementation of parallel processing systems. It thus has great significance for the design of systems that could ultimately result in the achievement of artificial intelligence. In other words, in the emulation of the human brain's huge parallel processing power.

PARALLEL WEALTH

Sir Clive is greatly excited by the field of AI. He considers that the great achievement of the industrial revolution was to replace men's muscles with machinery, resulting in an increase in social wealth. The next great step forward to achieving universal wealth, he believes, is to replace men's minds with machinery, through the introduction of AI. He thus recognises the potential importance of wafer scale integration in this aim, and is at the forefront of research into it.

"The reason for starting the wafer scale program is that I believe the future lies with very highly parallel computer systems, as opposed to the single processing machines that we have today. Having reached that conclusion, I realised that the interconnection problems were such as to be very severe indeed, and that really the only way to solve that problem was to go for wafer scale integration.

"Wafer scale at that time didn't exist. Everybody had tried it, but everyone had failed. So we decided we had to solve that problem ourselves, if we were to have wafer scale integration available to us as a process.

"Hence, we bought the rights to the inventions of Ivor Catt, and we founded the company Anamartic, which we have a share in, along with some other people.

Ivor Catt is an inventor whose creative ideas on wafer scaling had, prior to meeting up with Sir Clive, been disregarded by the conventional scientific establishment. The collaboration between the two men provided the key to solving the integration problem.

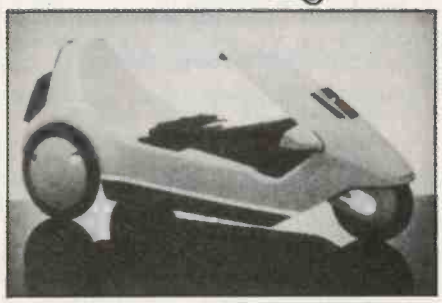
"It's such a technical problem that hundreds of millions have been spent by several companies without succeeding, so it's a huge problem, which we've solved - we're the only people who have solved it."

The first wafers that will be used in production are six inches in diameter. Initially, they will consist only of memory chips, though processor chips will eventually follow. Ultimately, computers having thousands of times more processing power than today will become possible, yet without an increase in physical size.

VEHICLE POWER

In addition to involvement with wafer scale and computers, Sir Clive has other, diverse, business interests in the future as well.

"Another field that of course interests me a lot is vehicles, because the transport problems we're going to be facing are very severe. As you know, I've been interested in electric vehicles for a very long time, and still am."



Whether or not the revival of interest in the C5 continues, Sir Clive has profound belief in the necessity for ecologically satisfactory vehicle power.

A reference, of course, to the ill-fated C5 launched in 1985. Or is it so ill-fated?

"The C5 is back in the news again", I remarked. "Following the recent train strike, someone acquired 600 C5s, and has already resold most of them. Does this surprise you?"

"No, not really. It's one of those things that happens."

"Do you see that C5 could, perhaps, really take off, rather belatedly?"

"Possibly, but C5 I never saw as, in itself, important. It seemed to me more a stepping stone. So whether C5 itself does or not I'm not too sure. What I do think is very important is that we develop what is, ecologically, more satisfactory vehicles, whether they're electrical, or whatever. We shouldn't continue to pump up carbon dioxide into the atmosphere."

"You're saying that we must move away from, say, petroleum as the energy source, and move more into batteries?"

Sir Clive has forthright views about the future for satellite tv. He is seen here launching his "squish" aerial for receiving Astra/Sky transmissions.

"Whether or not it's batteries is not essential, but it is essential, I think, that it's not carbon based fuel. There are many, many alternatives, but obviously, one would prefer to burn hydrogen."

Knowing some readers might jump to mistaken conclusions, I asked the inevitable question, "So you could fill up with water and extract the hydrogen from it?"

"No, you'd need as much energy to break it down as you'd get back from burning it, so it wouldn't help much!"

Although obviously concerned for conservation matters, Sir Clive didn't elucidate on what his energy source intentions are. Intriguing! I doubt that we have heard the last on Sir Clive's transport solutions.

SATELLITE TV

He was, however, very forthright in another area.

"You're very much into satellite tv at present. Do you see that the current battle between Astra and BSB will resolve itself in favour of one side or the other?"

"Well, I do see that Astra have got a very powerful lead, and it's my experience, and I'm sure yours, that where a lead occurs it's very hard for the second-comer to overcome it."

"Barry Fox came out very firmly in favour of Astra recently. His column in *What Satellite* magazine of August was reproduced as an advert for Sky in *The Times*, on July 21st."

"I didn't see that, but that's interesting. Barry Fox is a very, very reliable bloke. I entirely agree with him. I think that BSB have just got almost everything they could have, wrong."

INVENTIVENESS

"Many people very much admire the way in which you have promoted technology, and the way that you've really been a true inventor. What advice would you give to would-be inventors?"

"I think that the most important thing to realise is that a lot of people think that if they come up with a bright idea, they can just take it to some company and get it exploited. This is very difficult indeed; very seldom is that possible. Very often, what you have to do, really, is to do it yourself. Which isn't necessarily easy. Not all ideas are great, and so it's up to the individual.

"The trouble is that all our own ideas look good to ourselves. But who's to know? So the inventor has got to get the product to the marketplace, for the marketplace to judge. Almost certainly, no-one else will!"

"Then you need to be a salesman as well as an inventor?"

"There is no choice - except find another line of work!"

KIPLING NEVER FAILS

"Which brings me to the question of how one faces up to marketplace failure. You've had one or two ..."

"No! I've had greater or lesser successes!

"It's Kipling's thing - 'If you can meet with Triumph and Disaster and treat those two imposters just the same ...'

"The word 'failure' is a misnomer. I mean, anybody who is in the business of introducing innovative products and thinks that they're all going to succeed is very naive indeed. Most products of all sorts do not succeed. You try them and some win, and some don't. That's not failure, that's just - trying it!"

"Following 'lesser successes', is it that much harder to fight your way back in again? Do you find there is a reluctance of people to cooperate?"

"I've never found them anything but reluctant anyway, so I don't go out looking! They're always reluctant - so what the hell!"

"Sir Clive, many thanks for talking to me. It's really very kind of you."

"A pleasure! It's very nice of you and Practical Electronics!"

PE

NEW COMPONENT PACKS

New components, lots of new packs, and a better selection than ever in the old favourites. If you haven't yet sampled these delicious component assortments, you just don't know what you're missing! All the packs are **£1** (+VAT) each, but if you order five packs you can select an extra one FREE. Order ten packs and you can have three extra packs FREE. Go for it!

PASSIVE COMPONENTS

PACK 1 - 200 RESISTORS. Finest carbon film, with lots of E12 values and a few precision.
PACK 2 -100 CAPACITORS. Polystyrene, ceramics, metallised film. A fine selection!
PACK 3 -30 ELECTROLYTICS. Values to 470µF.
PACK 4 -15 LARGE ELECTROLYTICS. Values to 4,700µF.
PACK 5 - 10 TANTALUM CAPACITORS. Values from 0.1µF to 68µF!
PACK 6 - 20 HIGH VALUE POLYESTER CAPACITORS. Values to at least 3µ3.
PACK 7 - 15 DIL RESISTOR NETWORKS. Lots of values.
PACK 8 - 50 POWER RESISTORS. 1W and above.
PACK 9 - 30 SUB-MINIATURE CAPACITORS. Look like diodes!

OPTO ELECTRONICS & DISPLAYS

PACK 11 - 10 5mm LEDS: 4 red, 2 yellow, 2 orange, 2 green.
PACK 12 - 10 3mm LEDs: 4 red, 2 yellow, 2 orange, 2 green.
PACK 13 - 10 Rectangular LEDs. Mixed red and green.
PACK 14 - 10 Mixed LEDs. All shapes, sizes, colours.
PACK 15 - 2 DUAL 0.3" CA 7-seg displays (panel type).
PACK 16 - 1 DUAL 0.5" CC 7-seg display (panel type).
PACK 17 - 1 QUAD 0.3" CA 7-seg display (panel type).
PACK 18 - 2 INFRA-RED COMPONENTS. Emitter and receiver.
PACK 20 - 1 CALCULATOR DISPLAY, eight digits.
PACK 23 - 2 PHOTOTRANSISTORS. Respond to visible and IR light.

SEMICONDUCTORS

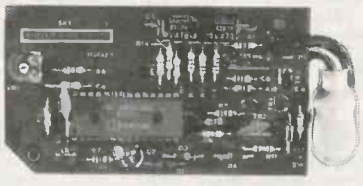
PACK 26 - 3 TAG136D MAINS TRIACS (400V, 4A).
PACK 27 - 30 IN4000-SERIES RECTIFIERS.
PACK 28 - 30 MIXED SEMICONDUCTORS. Diodes, transistors, ICs, triacs, all sorts.
PACK 29 - 20 ASSORTED ICs. CMOS, TTL, linear, memory, as available. Changes daily!
PACK 30 - 20 TRANSISTORS. High grade general purpose NPN.
PACK 31 - 12 BC212 TRANSISTORS. High grade general purpose PNP.
PACK 32 - 12 BC213 TRANSISTORS. High grade general purpose PNP.
PACK 33 - 3 DUAL OP-AMPS MC1458. With data.
PACK 35 - 20 RECTIFIERS. Studs, high current, glass bead, top hat, IN4000, etc.
PACK 36 - 50 DIODES 1N4148. The most popular type for projects!
PACK 39 - 10 SURFACE MOUNT AND LCC ICs. Special hi-tech pack!

MISCELLANEOUS

PACK 41 - 4 POWER MICROSWITCHES. Push to break.
PACK 42 - 8 SPST STANDARD MICROSWITCHES (V3).
PACK 43 - 5 SPST ROLLER-OPERATED MICROSWITCHES (V3).
PACK 44 - 1 MINI BIO-FEEDBACK KIT. With PCB, components and instructions.
PACK 45 - 1 MINI DREAM-MACHINE KIT. With PCB, components and instructions.
PACK 46 - 1 MINI BURGLAR ALARM KIT. With PCB, components and instructions.
PACK 47 - 6 AUDIO TRANSFORMERS.
PACK 48 - 200 CABLE CLIPS to attach alarm or doorbell wires to wall.
PACK 51 - 1 CRYSTAL OSCILLATOR MODULE, 19.6608MHz.
PACK 52 - 12 PP3 BATTERY CLIPS.
PACK 53 - 2 PIEZO TRANSDUCERS. Use as microphone or speaker.
PACK 60 - 100 MYSTERY PACK of at least 100 components. The most popular pack of all!

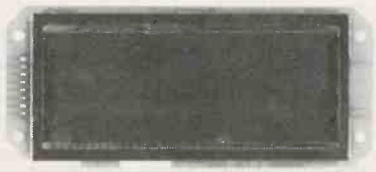
AUTUMN COLLECTION

Buzz like a butterfly, hoot like a bee; the computer you pay for, but the switches are free! Match this famous quotation with our equally famous sound effects computer, and you could be on your way to a fortnight's holiday in the Canary Islands. On the other hand, you're much more likely to be sitting in your front room. But you never can tell where people read their electronics mags, can you?



SOUND EFFECTS COMPUTER

Take a powerful PIC655A single chip computer, mask program it to produce the most outrageously realistic sound effects, add an audio amplifier to bring them up to loudspeaker level, and you have the Highgrade Sound Effects Computer. How about a motor rally, complete with gear changes? Or a ship hooting its mournful way through the fog? Or a fly so realistic it'll have you running for the swat! Sirens, helicopters, steam trains, aliens - you name it, it's in there. The computer is easily programmed with the thirteen switches supplied. In one mode you can even play it like a synthesizer! I have to admit, it's my favourite project of the moment.
With your computer we also give you: a battery connector, a loudspeaker, thirteen switches, and a wiring diagram and programming instructions. You add a PP3 battery, a length of connecting wire and ten minutes of your time to connect it all together.
SOUND EFFECTS COMPUTER KIT **£12.80!** (+VAT)



LCD DISPLAY MODULES

On one side of the PCB is an LCD which displays two lines of text and symbols. On the back there's a powerful surface-mount drive IC to take in data, store it, and drive the display. Interface is through an eight-way connector for the power supply and data signals. We supply full data on the IC, which should be enough for you to get it up and running!
LCD DISPLAY MODULE **£6.60** (+VAT) 10 DISPLAYS **£54!** (+VAT)

LED DISPLAYS

TYPE 1: DUAL 0.56" COMMON ANODE
Large, high brightness digits for displays that have to be visible at some distance. Each display has two digits, but the connections to each are entirely separate. They can be butted up to each other to make a display as long as you choose! And just look at the price.
10 0.56" DUAL CA DISPLAYS **£4.80!** (+VAT) 50 DISPLAYS FOR **£22!** (+VAT)

TYPE 2: 1⅛ DIGIT 0.5" COMMON CATHODE
Another two digit display, with the left-hand one lighting up as ±1. Once again, connections to the two digits are entirely separate.
PACK OF 10 1⅛ DIGIT 0.5" CC DISPLAYS **£3.80!** (+VAT) 50 DISPLAYS FOR **£17!** (+VAT)

BAR-GRAPH LED MODULE

Eleven rectangular green LEDs assembled as a bar graph display. The central LED is turned edge-on to indicate the 'normal' position, or for centre-zero or tuning indicator displays. All LED leads are individually available at the rear of the assembly.
BAR GRAPH MODULE **£1.40** (+VAT) 10 MODULES **£11.80!** (+VAT)

LEDs

Rectangular LEDs in a tasteful shade of green, or a violent primary red. Bring some colour into your life! The prices ARE genuine.
PACK OF 100 RED, GREEN OR MIXED (you choose) RECTANGULAR LEDs **£3!** (+VAT)
PACK OF 500 RED, GREEN OR MIXED LED's **£14!** (+VAT)

BUFFER AMP

Elantec EL2033 damn fast (100MHz) buffer amplifiers. Equivalent to National LH0033C. Current list price is **£28.50** each, I kid you not. With data.
EL2033 100MHz BUFFER AMP **£2.80!** (+VAT)

KEYBOARDS

Full size QWERTY keyboard units with separate numeric pad and function keys. Exactly 100 keys in all. Must be good value just for the switches!
COMPUTER KEYBOARD **£4.80!** (+VAT)

POWER METERS

Meter movement scaled 0-10 with red pointer against a green scale which can be back lit for glowing effect. Full scale approx. 1mA.
POWER METER **£1.80!** (+VAT) 5 METERS **£7.80** (+VAT)

MONSTER PARCELS

PARCEL 3 Lots and lots of ICs. Who knows what might turn up? Into the parcel go all the remainders from past lists, ICs we haven't got enough of to advertise separately, all the CMOS and TTL, and lots more. Some IC's will be common and familiar, some won't. Some have data and some don't. Some you'll recognise at once, others you'll have to do some detective work on. A fascinating mixture with lots of nice surprises for you if you know your ICs.
PARCEL 3A: 100 ICs for **£12!** (+VAT) PARCEL 3B: 500 ICs for **£49!** (+VAT)

PARCEL 4 Tants. So much nicer than common old electrolytics, I always think. An excellent range of values, now reaching as high as 68µF (all parcels) and up to 100µF if you're lucky!
PARCEL 4A: 100 TANTS FOR **£6.80!** (+VAT) PARCEL 4B: 500 TANTS FOR **£29!** (+VAT)

PARCEL 6 Transistors. A useful selection of general purpose types, with a few exotics to keep you on your toes. Lots of BC212s, BC548s, and other common types.
PARCEL 6A: 200 TRANSISTORS for **£7.80!** (+VAT)

PARCEL 7 LEDs! All kinds of shapes, sizes, styles and colours. How about making an LED garden? During the day, flowers. At night, a spectacular display of coloured LEDs!
PARCEL 7A: 100 LEDs for **£5.90!** (+VAT)
PARCEL 7B: 500 LEDs for **£24.90!** (+VAT)

UK Orders: Please add £1 postage and packing and 15% VAT to the total (including postage).
Europe and Eire: Please add £2.50 carriage and insurance. No VAT.
Outside Europe: Please add £4.80 carriage and insurance. No VAT.
Access Orders Please phone 0600 3715 for immediate attention to your order.

H2

HIGHGRADE COMPONENTS LTD UNIT 108, 8 Woburn Road, Eastville, Bristol BS5 6TT.

THE *ORIGINAL* SURPLUS WONDERLAND!

THIS MONTH'S SPECIAL!

Very high resolution, fully cased 14" green or amber screen monitor with non-glare screen and swivel/tilt base. The very latest technology at the very lowest price! Fully compatible and plug compatible with all IBM PCs and clones fitted with a high res Hercules or equivalent card! Enables superb graphics and resolution, all at a give away price. Has many extra features including aux +5 & 12v DC outputs to power at least 2 disk drives, If your PC power supply is getting hot! Supplied BRAND NEW and boxed. State whether amber or green screen required.

Amber .....£79 Green .....£69 (E)

COMPUTER SYSTEMS

TATUNG PC2000. Big brother of the famous Einstein. The TPC2000 Professional 3 piece system comprises: Quality high resolution Green 12" monitor. Sculptured 92 key keyboard and plinth unit containing Z80A CPU and all control circuits. PLUS 2 integral TEAC 5.25 80 track double sided disk drives. Generous other features include dual 8" IBM format disk drive support. Serial and parallel outputs, full expansion port, 64K ram and ready to run software. Supplied complete with CP/M, Wordstar and Basic. Brand new and covered by our famous 90 day guarantee and backup. Normal price of this unit is over £1400!

Our price .... only .....£299 (E)

PC-AT 286 CLONE Lowest ever priced 8 mhz PC-AT clone complete with a 20mhz hard drive, a 5.25" 360k floppy, 640k of RAM plus Hercules card compatability. The keyboard is NCR with 85 keys in an attractive beige, grey and cream finish to match the computer. The monitor is very high resolution 14" non-glare, with your choice of amber or green screen. A very nice package at a super price!

Our price .... only .....£799 (E)

SPECIAL PURCHASE
V22 1200 baud modems

We got a tremendous buy on further stocks of this popular **Master Systems 2/12** microprocessor controlled V22 full duplex 1200 baud modem - we can now bring them to you at ***half last advertised price!*** Fully **BT approved** unit, provides standard V22 high speed data comm, which at 120 cps, can save your phone bill and connect time by a staggering 75%! Ultra slim 45 mm high. Full featured with LED status indicators and remote error diagnostics. Sync or Async use; speech or data switching; built in 240v mains supply and 2 wire connection to BT. Units are in used but good condition. Fully tested prior despatch, with data and a full 90 day guarantee. What more can you ask for - and at this price!! **ONLY £69 (D)**

Write to us today and get your name on our mailing list for our FREE eight weekly bargain flyer *The Display News* **with thousands of unadvertised special offers.**

MONITORS

COLOUR MONITORS

Decca 16" 80 series budget range colour monitors. Features include PIL tube, housed in a beautiful teak style case and guaranteed 80 column resolution, features which are only normally seen on colour monitors costing 3 times our price! It is absolutely ready to connect to a host of computer or video outputs. Manufacturers fully tested surplus, sold in little or hardly used condition with 90 day full RTB guarantee. **Decca 80 COMPO** 75 ohm composite video input with integral audio amp & speaker. Ideal for use with video recorder or our Telebox ST, or any other audio visual use. **Any type only £99.00 (E)**

HI-DEFINITION COLOUR MONITORS

Brand new Centronic 14" monitor for IBM PC and compatibles at a lower than ever price! Completely CGA equivalent. Hi-res Mitsubushi 0.42 dot pitch giving 669 x 507 pixels. Big 28 Mhz bandwidth. A super monitor in attractive style moulded case.Full 90 day guarantee. **Only £149 (E)**

20",22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & sound inputs. Attractive teak style case. Perfect for Schools,Shops,Disco, Clubs. In EXCELLENT little used condition with full 90 day guarantee.

20"....£155 22"....£170 26"....£185 (F)

MONOCHROME MONITORS

Wang green screen 12" chassis monitor with composite video input. Adjustable for tilt. Requires 12 vdc. Brand new and boxed in perfect condition. **Only £39 each or 2 for £75 (F)**

Motorola M1000-100 5" black & white compact chassis measuring only 11.6H x 12W x 22D. Ideal for CCTV or computer applications. Accepts standard composite or individual H & V syncs. Needs 12vdc at only 0.8a. Some units may have minor screen blemishes. Fully tested with 30 day guarantee and full data. **£29.00(C)**

Fully cased as above in attractive moulded desk standing swivel. Dim 12 x 14.5 x 26cm. **£39.00(C)**

JVC 751 ultra compact chassis monitor for 12vdc 0.7a. Dim 11 x t4 x 18cm. Simple DIY data included to convert to composite video input .Full data. **BRAND NEW £65.00(B)**

20" Black & white monitors by Aztek, Cotron & National. All solid state, fully cased monitors ideal for all types of AV or CCTV applications. Standard composite video inputs with integral audio amp and speaker. Sold in good used condition - fully tested with 90 day guarantee. **£85.00(F)**

FLOPPY DISK DRIVES BARGAINS GALORE !

NEW 5¼ inch from £29.95!

Massive purchases of standard 5¼" drives enables us to present prime product at industry beating low prices! All units (unless stated) are removed from often brand new equipment and are fully tested,aligned and shipped to you with a 90 day guarantee and operate from +5 & +12vdc, are of standard size and accept the standard 34 way connector.

SHUGART SA405. BRAND NEW £29.95(B)
TANDON TM100-2A IBM compatible DS **£39.95(B)**
TANDON TM101-4 80 Track DS **£49.95(B)**
CANON,TEC etc.DS half height.State 40 or 80T **£75.00(B)**
TEAC FD-55-F.40-80 DS half height. **BRAND NEW £99.00(B)**

3½ INCH BRAND NEW AT £19.95!!

Never before seen price for a 3½" drive. Standard size believed to be by Canon. Brand new and packaged - mint condition! 40 track SS, run from +5 & +12vdc with standard power connector.....Only..... **£19.95 or 2 for £34.50(B)**

CHOOSE YOUR 8 INCH!

Shugart 800/801 SS refurbished & tested **£125.00(E)**
Shugart 851 double sided refurbished & tested **£195.00(E)**
Mitsubishi M2894-63 double sided switchable hard or soft sectors- BRAND NEW **£250.00(E)**

SPECIAL OFFERS!!

Dual 8" drives with 2 megabyte capacity housed in a smart case with built in power supply! **Only £499.00 (F)**
Ideal as exterior drives!

End of line purchase scoop! Brand new **NEC D2246** 8" 85 megabyte of hard disk storage! Full CPU control and industry standard SMD interface. Ultra hi speed transfer and access time leaves the good old ST506 interface standing. In mint condition and comes complete with manual. Only.....**£399(E)**

MAINS SUPPRESSORS & FILTERS

The "Filtan" from Crotan is a British made high current mains spike suppressor and RF filter in one, capable of handling up to 10 amps! The attractive case has an integral 13 amp socket for your equipment plug and a flying lead terminates in a quality plug (to BS 1363A standard) to go to the mains socket. There is an internal fuse plus one in the plug. Two LED indicators, one for power on and the other lights if the internal fuse falls. Dims:6" x 3" x 2". Brand new. Normal distributor's price is £65.00!

Our price only .....£15.95 each or 2 for £29.95 (B)

Belling-Lee type L2127 mains RFI filters rated at 250 volts 3 amps maximum. Comes complete with a built in mains cable (English coding), and a three pin miniature non-reversible socket and a mating plug, to go to the equipment. Ideal for those who are bugged by RF interference. Very compact. Dims 3-1/8" x 2.5" x 1.5".....**£3.95 each or 3 for £10 (A)**

COOLING FANS

Please specify 110 or 240 volts for AC fans.

3 inch	AC. 1½" thick	**£ 8.50(B)**
3½ inch	AC ETRI slimline.Only 1" thick.	**£ 9.95(B)**
4 inch	AC 110/240v 1½" thick.	**£10.95(B)**
4 inch	AC 1½" thick	**£ 9.95(B)**
10 inch	Round.3½ thick. Rotron 110v	**£10.95(B)**
62 mm	DC 1" thick. No.812 for 6/12v.814 24v.	**£15.95(A)**
92 mm	DC 12v. 19 mm thick.	**£10.95(A)**
4 inch	DC 12v. 12w 1½" thick	**£12.50(B)**
4 inch	DC 24v 8w. 1" thick.	**£14.50(B)**

RECHARGEABLE BATTERIES

LEAD ACID

Maintenance free sealed long life. Type A300.

12 volts	12 volts 3 amp/hours	**£13.95(A)**
6 volts	6 volts3 amp/hours	**£ 9.95(A)**
6-0-6 volts	Centre tapped 1.8 amp hours	**£ 5.95(A)**
12 volts	12 volts 24 amp hours. A200. RFE.	**£29.00(B)**

SPECIAL OFFER!

100 amp/hours at 6 volt! Brand new Chloride Powersafe 3VB11. Leakproof with additional snap-on security lid. Perfect for uninterruptable power supplies, portable power source, caravans etc. Normally costs £80! **£39 (E)**

NICKEL CADMIUM

Quality 12v 4ah cell pack. Originally made for the Technicolor video company. Contains 10 GE top quality D nicad cells in a smart robust case with a DC output connector. Ideal for portable equipment. Brandnew. **£19.95(B)**

Ex-equipment NICAD cells by GE. Removed from equipment and in good, used condition: **D** size 4ah **4 for £5(B)**
F size 7ah **6 for £8(B)**

SPECIAL INTEREST

Racal-Redac real time colour drafting PCB layout system. Includes furniture and huge monitor.Complete ready to go! **£3950**
DEC VAX11/750 inc. 2 Meg Ram DZ and full documentation, in brand new condition! **£3900**
Large Calcomp plotter £ 650
Tektronix RM529 Waveform Monitor **£ 300**
1.5kw 115v 60hz power source. **£ 950**
Wayne Kerr RA200 audio real time freq.res.analyser. **£3000**
VG Electronics 1033 Teletext Bridge **£3750**
Tektronics R140 NTSC TV test signal standard. **£ 875**
Versatek V80 Printer plotter **£1500**
DEC LS11/02 CPU board **£ 150**

SPECIAL EXPERIMENTERS PSU's

These 2 PSUs are built to BT's rigorous specs and give fully protected DC outputs ideal for the electronic hobbyist & experimenter. Type EPSU1 input is 240v AC; outputs are 5v @ 2a,±12v @ 1a, 24v @ 1a, 5v fully floating 50ma. EPSU2 input is 30-70vdc outputs are 5v @ 6a,12v @ 1a,-12v @ 0.5a & 5 others. Circuit diagram on request for EPSU1. No data with EPSU2 - hence the price! Both at parts alone price!

EPSU1.....**£16.95** (C) EPSU2.....**£9.95** (C)

BARGAIN PARTS & BOARDS PACKS

Its stock taking time once more so we have made up a lot of our famous bargain parcels again! These parcels represent the best value for money available and the greatest bargains of the century - a real thrill to open them up when you find that you have bought equipment and components (mostly brand new) for well under a third of our normal low price!!!

Mix of general electronic parts & equipment:
5kilos weight for.... **£8.95(B)** **20 kilos** weight for ....**£22.50(D)**

Boards Parcels for parts recovery:
Parcels contain almost any type of boards including ICs, memory, logic, passives and vast assortments of parts!
10 board parcel....£7.50(B) **20 board parcel....£13.95(C)**

POWER SUPPLIES

All PSUs 220-240vac input and are BRAND NEW unless stated. Many types ranging from 3v to 10kv always in stock.

Byte BD301 5vdc @ 1.6a. 12vdc @ 1.5a.Perfect for disk drives; with Molex sockets.Very attractvely cased.Illum. sw. **£19.50(B)**

Greendale 19AB0E 60 watts switch mode.+5v @ 6a,±12v @ 1a,±15v @ 1a. RFE and fully tested.11 x 20 x5.5cms. **£24.95(C)**

Conver AC130. 130 watt hi-grade VDE spec.Switch mode.+5v @ 15a,-5v @ 1a,±12v @ 6a.27 x 12.5 x 6.5cms **£49.95(C)**

Boshert 13090. Switch mode.Ideal for drives & system. +5v@ 6a, +12v @ 2.5a, -12v @ 0.5a, -5v @ 0.5a. **£29.95(B)**

IBM KEYBOARD DEAL

A replacement or backup keyboard, switchable for IBM PC, PC-XT or PC-AT. LED's for Caps,Scroll & Num Locks. Standard 85 keyboard layout. Made by NCR for the English & US markets. Absolutely standard. Brand new & boxed with manual and key template for user slogans on the function keys. Attractive beige,grey and cream finish, with the usual retractable legs underneath. A generous length of curly cord, terminating in the standard 5 pin DIN plug. A beautiful clean piece of manufacturers surplus. What a deal!

BRAND NEW AND BOXED ONLY..... £49 (B)

THE *AMAZING* TELEBOX!

Converts your colour monitor into a QUALITY COLOUR TV!!

TV SOUND & VIDEO TUNER!

Brand new high quality, fully cased, 7 channel UHF PAL TV tuner system. Unit simply connects to your TV aerial socket and colour video monitor turning same into a fabulous colour TV. Dont worry if your monitor does'nt have sound, the TELEBOX even has an integral audio amp for driving a speaker plus an auxillary output for Headphones or HI Fi system etc. Many other features: LED Status Indicator, Smart moulded case, Mains powered, Built to BS safety specs. Many other uses for TV sound or video etc. Supplied BRAND NEW with full 1 year guarantee.

Telebox ST for composite video input monitors.....**£29.95(B)**
Telebox STL as ST but with integral speaker.....**£34.95(B)**
Telebox RGB for analogue RGB monitors.....**£59.95(B)**

NOT suitable for IBM or Clone type colour monitors.

BRAND NEW PRINTERS

Epson MX-80 F/T One of the most popular printers around! Bi-directional printing with full logic seeking. 9 x 9 dot matrix for enlarged,bold,condensed etc. Standard parallel interface. Brand label removed from front. Handles tractor,fanfold and individual paper. OK with IBM PC and most others. A tremendous buy! **£129.00 (E)**

Hazeltine Esprint small desktop.100 cps with RS232 and standard parallel. Full pin addressable and 6 user selectable fonts. Up to 9.5" paper. Sheet & tractor feed. **£149.00(E)**

Centronics 150 series. Always known for their reliability in continuous use - real workhorses in any environment. Fast 150 cps with 4 fonts and choice of interfaces.

150-SN up to 9.5" paper.....**£155.00(E)**
150-SW up to 14.5" paper.....**£199.00(E)**

Specify whether serial or parallel required.

CALL FOR THE MANY OTHERS IN STOCK INCLUDING DAISY WHEELS.

Visit our Shop - Technical help always on hand plus many un-advertised specials. You can buy a colour television for as little as £29! Come and join the gang at 215 Whitehorse Lane!

LARGE QUANTITES OF OSCILLOSCOPES AND TEST GEAR ALWAYS AVAILABLE - CALL NOW!

DISPLAY
-Electronics-

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LONDON SHOP
100's of bargains!
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South Norwood,
London, SE25 6RB.

DISTEL © The Original
Free dial-up database!
1000's of items+Info On Line
300 bd 01-679-1888,
1200/75 bd 01-679-6183,
1200/1200 bd 01-679-8769

ALL ENQUIRIES
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Fax- 01-679-1927
Telex- 894502

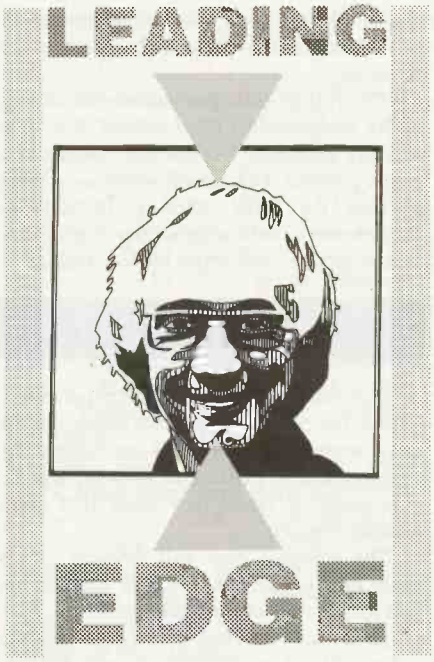
Access Visa

All prices for UK Mainland. UK customers ADD 15% VAT to total order amount. Minimum order £10. PO orders from Government,Universities,Schools & Local Authorities welcome-minimum account order £25. Carriage charges (A)=£1.50. (B)=£3.50. (C)=£6.50. (D)=£8.50. (E)=£12.50 (F)=£15. (G)=Call . All goods supplied subject to our standard Conditions of Sale and unless otherwise stated guaranteed for 90 days. All guarantees given on a return to base basis.We reserve the right to change prices & specifications without prior notice. Orders accepted subject to stock.Quotations willingly given for higher quantities than those stated.

THE NEXT TWENTY-FIVE YEARS

BY BARRY FOX.
Winner of the
UK Technology Press Award

All-digital audio and video face the commercial hurdles; computerised speech translation faces the development challenge.



Predictions are always dangerous. And there are good reasons why. The reasons can be as interesting as the predictions.

The fact that something has been patented tells only that someone has put up the idea, and their local patent office has been unable to find any previous proposal along similar lines. Hence the daftest ideas stand the best chance of winning a patent.

The patent laws are not there to stop armchair dreamers dreaming.

Japanese companies have now filed so many patents that the government has had to beg them to stop. Partly it's a buck-shot approach. Japanese researchers patent every conceivable idea. They reason that within the twenty year life of a patent there is a good chance that at least some of those ideas will be proven to work, and earn money.

Although the British Patent Office put a ban on perpetual motion machines in the pre-war years, the new European Patent Office in Munich takes a more liberal view. Who are we, they argue, to say something that cannot ever be made to work?

So looking at the patent files can be a misleading guide to the future!

Even when an invention has been made to work as a one-off prototype, it is still a long and expensive road to mass production. Remember bubble memories and how they were going to take over from ram – but never did?

OPTICAL ILLUSION

Electronics companies all round the world have for well over a decade now been able to make optical discs which can record, be erased and used again – but only small numbers of laboratory samples. One eraseable disc technology, called phase change (where spots on a metal coating are switched between amorphous and crystalline state, and the resultant optical effect read by laser light) are easier to make. In practice they can still only be made to work in the laboratory.

"Ask to see a working sample", said an engineer at Hewlett-Packard, "and they will show you one, working. But ask for a price on bulk purchase and they will tell you to wait for a little while. They've been telling us that for years".

The same goes for flat screen tvs. The large liquid crystal screen that you can hang on the wall has been "just around the corner" for years. Many of the major electronics companies now mass-produce small lcd colour screens, around three, four or five inches in size for portables. Several have produced one-off laboratory prototypes of screens around 14 inches in size. But the prototypes are valued at literally millions of dollars each. Mass production is still a long way off. Every fault is visible, and as the screen gets larger the chances of making a fault free display become smaller and smaller.

And why bother? Although the military, and aerospace engineers, may want flat screen tv panels (and are ready to spend tax payers' money on whatever it costs) the general public will not pay much extra for a tv, simply because it is flat and thin.

Modern colour tv tubes take up remarkably little space and the tv set has to have some bulk, if it is to incorporate loudspeakers large enough to produce reasonable bass response. Factories have been producing cathode ray tubes for well over half a century and are geared to mass production at such low prices that it is now possible to buy a colour tv set for under £100. Tube factories are still investing in production lines. Why spend billions on the development of different technology that makes those lines obsolete?

So although we will see large colour lcds over the next quarter century, it could still take longer than the casual pundits predict.

DAT AND CD

Sometimes technology is invented, developed and tooled for mass production, but still never reaches the market. Here digital audio tape is the classical example. The Japanese were ready to launch dat three years ago, but the record industry suddenly woke up to the fact that their customers would be able to copy at least two cds onto a cassette the size of a credit card in digital code and thus without the loss of any quality.

So they have fought tooth and nail to block the sale of dat. It is only the threat of recordable compact disc, that has encouraged the record companies to look again at dat. Whereas dat provides the opportunity for the record companies to earn revenue, because they can release "longform" music programmes (like concerts and operas) without breaks on a single cassette, recordable cd offers absolutely nothing – except the facility to copy music that is already released on a pressed cd.

What particularly shocked the record companies, was the lateral thinking of the electronics industry on recordable disc. For years research laboratories had been striving to produce erasable discs at reasonable cost on the assumption that the public would think of disc as a direct equivalent to tape.

But then the penny dropped. Many people who buy audio and video tape, never erase it. They make one recording and keep it.

It is far easier to produce recordable discs, if they do not have to offer an erase facility. A write-once cd can be sold for a few pounds.

What's more, for the first time ever in the history of consumer electronics, there is no need for a new technology to wait for a standard. Different manufacturers who have worked on different recordable disc technologies can all sell their own proprietary systems provided they have one thing in common – the ability to play back on a conventional cd player.

There can be write-once discs and – at higher price – erasable discs. The recording can be made by changing the colour of a

dye, altering the characteristic of a metal or deforming polymer. It doesn't matter what they offer and how they work, provided the end result fools the laser in a cd player into thinking that it is reading the track of pits pressed into a conventional cd.

SOLID STATE RECORDING

Every spring, along with cuckoos and the promise of flat tvs that hang on the wall like a picture, comes the promise of solid state recording as an alternative to disc or tape.

It's an attractive idea. The recorder has no moving parts. Solid state recorders are already up and running. When you dial 123 on a BT phone, you hear the time from a solid state memory. The recording industry loads short snatches of sound into solid state memory for editing. The video industry uses solid state memory to store one or two picture frames, to synchronise video signals from different sources.

But it is a long way from limited bandwidth jigsaw phrase recording (as with BT's time clock) and the temporary storage of short snatches of full quality audio or video in professional equipment, to a microchip record which stores as much sound as a cd or dat cassette, with the same quality, the same robustness, the same bulk and – above all – the same price tag.

Even with data compression, which does not waste code on recording gaps or repetition in a sound or picture image, the capacity and cost still makes solid state memory a hopeless rival for disc or tape. Moving a medium is by far the most efficient means of storage.

Of course the balance of cost and convenience will change. Completely new storage techniques, using optical read-out of the molecular structure, will re-write the rules of mass storage. But will the electronics industry want to develop and launch radical new storage technology, which wipes out all its investments in disc and tape?

CYCLIC FACTORS

Here hides the key factor governing what comes over the next 25 years. We are not just talking about what is possible or even what can be mass produced at a price that makes it competitive with existing technology, thereby sacrificing decades of development work and billions of dollars of investment.

And we are not just talking about investment in technology. We are talking about investment in advertising and communication, to overcome that most powerful of all human charcteristics – inertia.

It is said that the entertainment industry works on a thirty year cycle. The cylinder, the 78rpm disc, the lp, stereo, radio, black and white television, PAL 625 lines colour tv – all last around 30 years before they are replaced.

The Philips analogue cassette is coming up for replacement. The compact disc, only recently launched, has another quarter of a century to run. Colour television is moving towards the stage when it is due for improvement, with wide screen, higher definition pictures and better colour coding.

DIGITAL VIDEO

The video recorder is still comparatively young, the camcorder, a mere infant. So the next twenty-five years will see mainly the development of existing technology and the emergence of brand new ideas that make nothing obsolete.

The compact disc will develop into a multi function carrier, a storage medium not just for sound, but computer programs, text, graphics, and moving video. The moving video will not be analogue, as with Philips' abortive attempt to re-launch the ill-fated Laservision video disc as cd Video. The future for cd video holds tv pictures recorded as digital code, with heavy compression and narrower track pitch (read by shorter wavelength lasers) to squeeze an hour of colour pictures and sound on a single sided five inch disc. Home tape recorders – or disc recorders – will store video as digital code, too.

The real advantage of a digital video system is not that material can be copied or "cloned" without quality loss. The bonus is that because the pictures as well as sound are recorded in digital code, one disc can be played back in any country of the world, regardless of local tv standards. So the old tv standard barriers will come tumbling down. Already we are seeing the first multi-standard video recorders, which use digital circuitry to record and play back in any country in any standard. This could soon be a routine feature.

FILM FIGHT

But here again, technology will not be the deciding factor. The film industry will fight tooth and nail to block the sale of multi-standard video recorders because it puts paid to the studios' cosy policy of releasing feature films in America long before they reach Europe. If digits break down the artificial trade wall created by the NTSC/PAL standards barrier, the video and film industries' releasing strategy has be to re-thought.

Japan and the USA will stick with the NTSC tv system; Europe will stick with PAL. They are too deeply entrenched to shift, especially if digital circuitry makes conversion easy.

But there will be a move in Europe towards the adoption of MAC, for satellite broadcasting. MAC provides the upgrade path to high definition and wide screen tv.

Although the Philips audio cassette will live on as a low cost convenience medium, for listening to music on the move, it is only a question of time before the electronics industry offers a digital recording system for the home. Will it be dat or recordable disc? My personal bet is that it will be dat, simply because the record companies will back dat in a trade-off against cd-r.

But twenty-five years is a long time and once a technology has been developed, there is no way to uninvent it. Perhaps we will see dat blossom over the next few years, and then a gradual introduction of cd-r. But the delay on dat may well turn out to have killed it. Only time, and the amount of money which the electronics industry decides to spend on revitalising yesterday's dreams will tell.

SPEECH TRANSLATION

Solid state recording will come into its own as a dictation medium, long before it competes with disc or tape as a carrier for entertainment. Psion has for several years now been secretly working on an Organiser, which can record speech in the same way that the current Organiser records text. From there it is a logical step - although not an easy or short step - to the direct translation of speech into text.

Japan as a nation is committed to developing an instant translation system which, by the beginning of the next century, will let a Japanese caller talk with a British caller, each hearing the other's conversation in their own language. Already there are computers that respond to speech. The logical step, but again not a short or easy step, is a word processor which produces letters from speech.

Don't underestimate the practical problems and the time it will take to solve them. Different people use different words, say them in different ways and mean different things. Massive intelligence is needed to interpret subtlety and cope with creative and inventive thought.

But the intelligent speech processor will come. And here there is an incentive for the electronics industry to hammer away at the problem. Developing circuitry which translates speech into text, converts speech of one language into speech of another language and reads text to generate speech creates a whole new area of opportunity. It makes nothing already on sale redundant - only some people.

There will always be room for real live human language translators, and secretaries, but only if they do a first class job and offer the initiative and intelligence which machines will have no hope of offering until well past our twenty-five year prediction period. Anyone who has suffered in the hands of incompetent secretaries or clumsy translators will be unlikely to shed too many tears at the prospect of their job being taken over by a bank of microchips.

PERSONAL COMMUNICATIONS

The other area in which we shall see major advances, is personal communications. In the whole history of telecommunications, every new development has been far more successful than anyone predicted.

Witness for instance the way that cellular telephones have sold so well that current estimates show the allocated frequencies likely to collapse under the strain by June 1991. Then there will have to be spill-over into the new pan-European GSM system which has a small band of unused frequencies and uses digital technology to cram at least two conversations in each channel. But as GSM becomes successful, if only because would-be subscribers to the existing cellular services are forced to become GSM subscribers, the pan-European frequencies will dry up too.

Far quicker than expected, the national cellular services will have to contract, handing over their frequencies for more efficient use by the pan-European technology. Far quicker than anyone predicted, these frequencies will run out too.

Long before the end of the century, the 900MHz band used for national and pan-European cellular radio will be full. The military holds acres of space in the band below 1GHz, on a "just in case" policy. It is reserved for use, just in case there is a war or a civil uprising. Telecoms engineers argue that the military should release these frequencies for business, because in time of war or civil uprising, the military could simply shut down the cellular base stations and blast everyone else off the air with high power transmissions. But its unlikely that this will ever happen – especially as civil unrest becomes more rather than less unlikely.

The only place then to look is up, at around 2GHz. No-one yet knows whether the equipment needed to exploit this band will be ready before the lower frequencies congest.

The Government's dream for the next decade and next century is a world in which everyone has their own personal telephone number and can thus be contacted on an individual basis, at any time, anywhere in Europe, perhaps eventually anywhere in the world.

Without doubt the technology will eventualy be there to make this happen. But the most important question, which no-one yet seems to have addressed, let alone answered, is this. Do you really want to be contactable by telephone anywhere at any time?

So once again, the question is not, can it happen, but will an infinitely variable set of circumstances conspire to let it happen? PE

POINTS ARISING

SOLAR HEATING CONTROLLER (Jun 89)

Some readers have reported difficulty in locating the sensors type LM335. These are available from STC Electronic Services, Edinburgh Way, Harlow, Essex, CM20 2DF, tel : 0279 626777. Their stock number for the LM335Z is 26452D. They do not stock the LM335H, but the Z version may be used instead. Both devices are also available from Viewcom Electronics, 77 Upton Road, London E13 9LT, Tel: 01-471 9338. Also note that C4 in the parts list should be 1000uF 35V.

VODALEK (Aug 89)

Fig.1 circuit diagram: bottom of VR2 goes to 0V, C10 +ve goes to TR1 gate, TR1 drain does to junction R10/R11, pin numbering of IC1c and IC1d should be transposed. The pcb is correct.

POLYWHATSIT! (May-Jun 87)

Fig.5 May 87 - leads 11 and 12 should go to either of the two outer transformer secondary connections.

Constructors should also note that on the pcb track foil layout for part two in June 87, the closeness of two pairs of tracks may result in a connection between them. Check that IC16 pin 9 is separated from the track connecting to IC16 pins 8 and 10, and that the track to IC18 pin 3 is separated from the track connecting IC18 pins 4 and 13. Photocopies of the tracks are available from the Editorial office on receipt of an SAE. As previously reported, there are minor errors on the circuit diagram in Fig.2 June 87 but the pcb component layouts and wiring diagrams are correct.

No. 1 LIST BAKERS DOZEN PACKS

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BD49	10	Neon valves, with series resistor, these make good night lights.
BD56	1	Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD59	2	Flat solenoids – you could make your multi-tester read AC amps with this.
BD67	1	Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD91	1	Mains operated motors with gearbox. Final speed 16 rpm, 2 watt rated.
BD103A	1	6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120	2	Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD128	10	Very fine drills for pcb boards etc. Normal cost about 80p each.
BD132	2	Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134	10	Motors for model aeroplanes, spin to start so needs no switch.
BD139	6	Microphone inserts – magnetic 400 ohm also act as speakers.
BD148	4	Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149	6	Safety cover for 13A sockets – prevent those inquisitive little fingers getting nasty shocks.
BD180	6	Neon Indicators in panel mounting holders with lens.
BD193	6	5 amp 3 pin flush mounting sockets make a low cost disco panel. Need cable clips
BD196	1	in flex simmerstat – keeps your soldering iron etc. always at the ready.
BD199	1	Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201	8	Keyboard switches – made for computers but have many other applications.
BD211	1	Electric clock, mains operated, put this in a box and you need never be late.
BD221	5	12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
BD242	2	6in ×4in speakers, 4 ohm made from Radiomobile so very good quality.
BD252	1	Panostat, controls output of boiling ring from simmer to boil.
BD259	50	Leads with push-onb ¼in tags – a must for hook-ups – mains connections etc.
BD263	2	Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
BD268	1	Mini 1 watt amp for record player. Will also change speed of record player motor.
BD283	3	Mild steel boxes approx 3in × 3in × 1in deep – standard electrical.
BD293	50	Mixed silicon diodes.
BD305	1	Tubular dynamic mic with optional table rest.
BD400	4	Books, useful for beginners, describes amplifiers, equipment and kit sets.
BD653	2	Miniature driver transformers. Ref. LT44. 20k to 1k centre tapped.
BD553a	2	3.5V relays each with 2 pairs changeover contacts.

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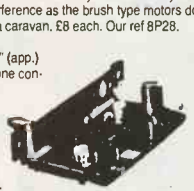

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In The Beginning

Fred Bennett, PE's founding editor, recalls how it all began, and pays tribute to those who helped to map-out PE's future highway

"...And what do you think of *Practical Wireless*?" the Editorial Director asked.

Just a slight pause before the interviewee replied. "Well, I must say the title seems rather old fashioned. I think it ought to be renamed *Practical Electronics*."

The ED looked at the Managing Editor. They exchanged glances but said nothing. It passed in a flash and the interviewee proceeded with no further reference to this audacious, if pertinent, suggestion from a would-be employee.

This interview took place in Tower House, The Strand, London, the head office of George Newnes, publishers.

The time, February 1962.

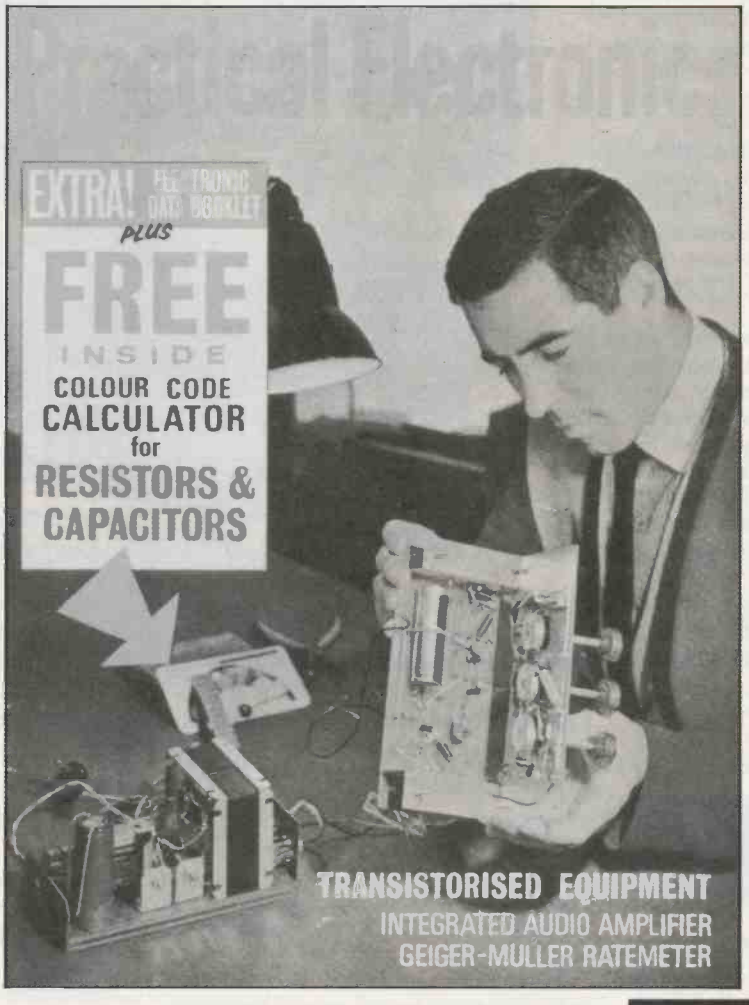
Was this the first occasion these words had been uttered? I like to think so, though it seems unlikely, as will be seen shortly.

ASSISTING PW

Some weeks later I took up my appointment as an editorial assistant on *Practical Wireless*. Within a few months I became aware that a new magazine was being mooted. I saw a dummy issue that had been prepared by members of the PW team sometime prior to my joining the company. I believe the Assistant Editor, Ray Street, was mainly responsible for this. It bore the title *Practical Electronics and Hi Fi*.

At that time PW was doing exceedingly well with sales peaking for a while around 120,000. The availability of cheap transistors had caused a proliferation of designs for small radios, ideally suitable for construction by amateurs. PW had benefitted greatly through its publication of such designs. What is more, suppliers of transistors and other components were clamouring for advertising space and many had to be disappointed every month. The management had read the signs and concluded that another journal ought to be launched covering a similar market. So far as I can judge, this must have occurred to them during the previous year - although it could conceivably have been as early as 1960 that the germ of the idea was first established within the Newnes organisation.

As I settled down in my new job it gradually dawned on me that I had been engaged specifically for this very operation, though, ostensibly, I was filling a vacancy on PW. Unfamiliar as I was then with the ways of the magazine publishing business, even I could see that there was hardly any need for an addition to the existing staff.



Cover Number One, November 1964. PE's intentions are prominently established: to inspire interest in electronics through building useful electronic equipment, the word "transistorised" highlighting the use of advanced current technology. The free gifts were an added incentive.

EARLY BACKGROUND

Here, perhaps, before proceeding further with these recollections I ought to give some details of my background. Previously, I had been employed in technical publications at EMI and two other electronic firms since demob in 1946, which followed six and a half years in the RAF as wireless operator and (later) w/op-mechanic.

Back to Tower House. Towards the end of that year my suspicions were confirmed when the Managing Editor, Bert Collins, (successor to F.J. Camm, the founder of the Practical Group of Magazines) informed me there was the prospect of an editorship and instructed me to set about the planning of a new title, to be called *Practical Electronics* (surprise, surprise!).

Naturally I was delighted to and eager to take up the challenge. This new work I fitted in with my sub-editing duties on PW and it spread over several months. I started from scratch and was not influenced by the earlier dummy. I set out my ideas for a broad-based magazine, to do full justice to the title. A new dummy was produced with the valuable and essential assistance of the Practical Group Art Department. This was passed around amongst various important people in Newnes.

LAUNCH APPROVAL

Time went by, while I waited anxiously. All I heard were occasional rumours - first that it was on, then that it was in the balance, or even killed off! I was kept in a state of high suspense for nigh on 12 months. Then one day at the end of 1963 Berts Collins called me into his office. He was all smiles, my dummy lay on the desk before him. "It's OK. They have approved it. We are going to launch next October."

A couple of months later the entire Practical group moved from Tower House to premises next door to the Theatre Royal, Drury Lane. Here separate offices were allocated to the new magazine and my severance from PW became absolute! I was on my own! Not quite so of course, but that was the feeling.

ROLL OF HONOUR

Now the exciting work started in earnest, with little more than six months to launch date. I want now to record all individuals directly involved with me from the onset. Dave Barrington moved over with me from PW and Jack Poutney of the general art department was assigned to PE as Art Editor. Joe Hadley came from industry to become our first technical illustrator. An Assistant Editor was recruited, Eddie Barnet, who did yeoman service in designing projects and, amongst other things, the colour code calculator which was given away in our first issue. Regrettably Eddie had to leave us before the launch, but he left his mark for he was featured on the front cover of our opening issue. His successor was Morris Colwell who joined just after the first issue had been put to bed. I was to have a long association with Morris, which ended when he was promoted to the editorship of PW some years later.

The commercial viability of a publication is very dependent upon the efforts of the advertisement people. Roy Smith (PW Ad Manager) and David Tilleard, his assistant, were very successful in getting retailers and other firms to take space in a new and unknown journal. Within a few months of PE's establishment on the market, David was confirmed in the position of Ad Manager.

That was a hectic period as we immersed ourselves in our task. It was a unique and exciting experience, taxing our energies and at times tempers, too. But it was all highly satisfying and rewarding, as I am sure my colleagues of those pioneering days at Catherine Street will agree.

Fred Bennett, immortalised on the front cover of PE Oct 70. The apparatus is not for fending off or detecting 'the bandits', but the Proton Magnetometer described in that issue. Legend has it that the photographer, intent on a wide-angle shot on a narrow Thames river bank, kept telling Fred, "move back further ..." so many times that Fred and equipment were almost tested for their sub-aqua abilities! The inset photo is of Fred now, actively enjoying retirement.

FREELY INTERPRETING

As Editor Presumptive, I was given a free hand in interpreting what electronics embraced and what subjects to include in our contents. I was told, furthermore, in this respect to disregard PW and include radio subjects if I so wished.

It is fair to say there was much forward looking and awareness of the potential of applied electronics amongst the Practical Group people at Newnes. For example the concept of the automated home was commonly discussed at the time I joined the Company in 1962. Light-operated curtains and remotely operated garage doors were favourite subjects that were constantly brought to my attention! There was also a Hi Fi lobby. Its chief protagonists were in the sales promotion department. I firmly resisted their pressure to include full length reviews of commercial equipments in our magazine.

My official appointment as Editor came only a couple of months prior to the launch. A bit of the stick and carrot might be detected here!

TALENTED STOCK

One of my anxieties at the beginning was whether we could collect enough material to fill the first issues - I need not have worried on that account. As the launch date drew near I had headaches deciding what to put in and what to exclude! Thereafter our stock of manuscripts increased steadily and we never at any time faced a shortage.

Soon after PE made its appearance, I realised we had begun to tap an apparently inexhaustible source of talent. It was as though electronics enthusiasts had been anticipating our appearance. Scores of individuals - amateurs and professionals - were swift to offer their projects. Oh how I often regretted that wasted 12 months while the powers-that-be leisurely made up their minds!

Despite the rival attraction of a general election (!) the launch went off well and about 115,000 copies of that first number were sold.

BANDIT SCREEN

The Company view was that PE would be complementary to PW and was not intended, nor supposed likely, to be a serious competitor to that long established magazine which had held a dominant position in the radio hobbyist field for 30 years or so. It was the Editorial Director who told me the new publication "was intended to provide a fighter screen for PW" against threats from rival publishing houses.

No "Bandits" appeared over our territory for some years and PE established itself alongside its older sister, though exploring its own particular bit of "airspace". Our circulation, after the heady opening months, settled down around the 95,000 mark.

For six or seven years we enjoyed a leading and unchallenged position. In 1971 we launched *Everyday Electronics* and about that time the first serious opposition came into view. "Bandits! Tally ho!" The battle for the hobbyist market had begun. But that's another story.

VETERANS

I am confining my reminiscences to the gestation period and those few early years of PE's life. As I conclude, I am conscious that among present day readers there must be many who have perused these pages right from issue number one. That thought gives me especial pleasure. I hope these veteran readers, in particular, find interest in my account of those early years.

As one of those veteran readers, Fred, I have been greatly interested by your reminiscences. There are many of us, as I know from readers' letters, who recall the early days with affection.

Fred continued to edit PE until the end of 1977 when Mike Kenward took over the chair. His early memories are recalled on page 23.

PE

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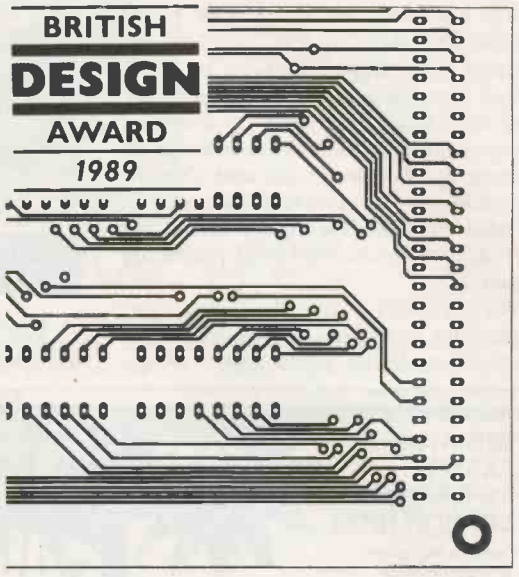

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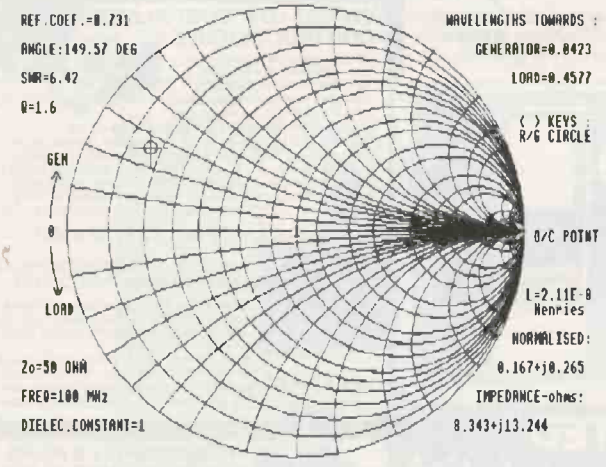

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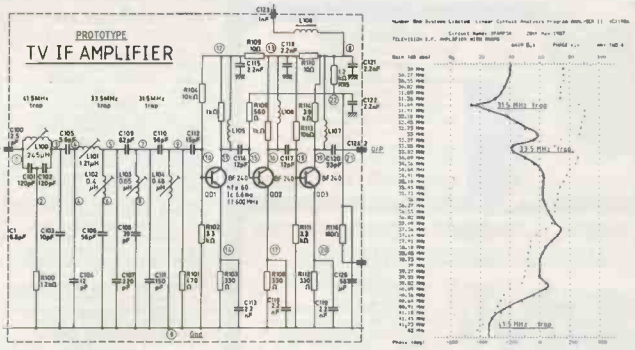

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THE MIDDLE YEARS

Mike Kenward, Editor of PE 1977 – 85, offers some personal thoughts on PE and the Meaning of Life in Publishing.

Way back in 1968 Fred Bennett offered me a job as a technical sub-editor on PE – a job that was to lead to a career in publishing which I had never even considered.

Right from the start the whole thing intrigued me for many reasons, not the least that I had no idea what a technical sub actually did. The interview was almost unbelievable; I was to see the Managing Editor (a breed long since extinct) and having waited 30 minutes in his outer office with a couple of very attractive females – one of whom later became my wife, but that's another story *(Angelo, our publisher says he wants to run a full length PE feature on that story! Ed)* – I glimpsed the great man himself practising golf putting on his carpet. Eventually I was let in to his rather grand office to be introduced to Fred Bennett the Editor, whereupon the Managing Editor promptly departed – well it was opening time!

PRINCELY OFFER

As I remember, my interview with Fred was fairly brief and when salary was mentioned it almost ended abruptly as I came close to falling off the chair – if I secured the job I would also get a 50% salary increase to the princely sum of £1600 pa! I managed to almost cover my joyous surprise and prayed for the next week or so that the appointment would be mine – fortunately it was and, thanks to Fred, I thus started a long and very happy association with PE and later with *Everyday Electronics*.

POOLED EFFORTS

My involvement as Editor of PE came when the Title was moved from London to Poole at the end of 1977. Fred Bennett did not wish to make the move and the Editorship was offered to me – a position I gladly accepted. The new job meant recruiting staff, setting up new offices and keeping the monthly publishing cycle going. Needless to say it was a busy time but, with the goodwill and excellent effort of the remaining staff, we managed it without too many problems. Incidentally, the first staff member I ever recruited turned out to be "unsuitable" and he left "by mutual agreement" a few months later – the experience taught me a lot and gave me a few grey hairs!

We managed somehow to get the first issue out only to find an advertiser threatening legal action over an omission, and a mistake on the front cover. *(I remember it well! Ed)* The first problem was sorted out over a business lunch and the advertiser and I later became good friends. The second problem appeared to go unnoticed by readers and the gibes from staff and the publisher died away after a year or two anyway. Not a wonderful start but certainly in the great tradition of publishing when there never seems to be a dull moment.

Through PE I have taught some of those that taught me at school. I have sold materials for training those that trained me in the Ministry of Defence and I have had contact with readers all around the world. One even offered his pet monkey in exchange for a subscription – on reflection I think we should have employed him (the monkey) to sort out the subscription computers at IPC.

FASCINATING

I have come into contact with many fascinating people – some at the forefront of technology and some knocking on the door of insanity (one or two might have already passed through). PE gave me many headaches, much pleasure and a fascinating and rewarding job for many years. When the Title was sold by IPC in 1986 I was made redundant but, once again, this led to a further enhancement of my career *(Mike, you're too modest! Ed)*.

Thanks PE and the best of luck for the next 25 years.

COMMAND CONTROL

Mike Kenward is, of course, presently Publisher and Editor of Everyday Electronics. The cover photo shows him when he was newly Fred's to command! By 1977 he was no longer remote, but full controller of PE's editorial policy.

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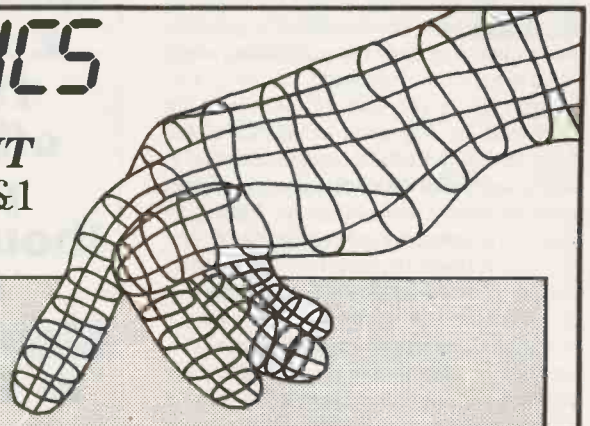

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230V AC BALLAST KIT for either 6in, 9in or 12in tubes £5.50 + 55p p&p (£6.96 inc VAT) For 13in tubes £6.00 + 75p p&p (£7.75 inc VAT)

400 WATT UV LAMP
Only £28.00 + £2.50 p&p (£35.08 inc VAT)

175 WATT SELF BALLASTED BLACK LIGHT MERCURY BULBS Available with BC or ES fitting. Price incl VAT & p&p £19.84.

12 VOLT BILGE PUMPS
Buy direct from the importers
500 GPH 15ft head 3 amp
£16.00 inc.
1750 GPH 15ft head 9 amp
£19.25 + £2.00 p&p (£25.00 inc VAT)

EPROM ERASURE KIT
Build your own EPROM ERASURE for a fraction of the price of a made-up unit. Kit of parts less case includes 12in 8 watt 2537 Angst Tube Ballast unit pair of bi-pin leads neon indicator on/off switch safety microswitch and circuit £14.00 + £2.00 p&p (£18.40 inc VAT).

SUPER HY-LIGHT STROBE KIT
Designed for Disco, Theatrical users etc.
Approx 16 joules. Adjustable speed £48.00 + £2.00 p&p (£57.50 inc. VAT)
Case and reflector £22.00 + £2.00 p&p (£27.60 inc VAT)
SAE for further details including Hy-Light and industrial Strobe Kits.

WIDE RANGE OF XENON FLASHTUBES
Write/Phone your enquires

WASHING MACHINE WATER PUMP
Brand new 240V AC fan cooled can be used for a variety of purposes. Inlets 1½ ins. Outlet 1 inch. Price including p&p and VAT — £10.95 or 2 for £20 including p&p and VAT.

SPECIAL OFFER AC CAPACITORS

1.5 MFD 440V £2.00	5 MFD 440V £4.00
2 MFD 440V £2.50	5.4 MFD 280V £2.00
4.1 MFD 440V £3.50	5 MFD 660V £3.00
	12 MFD 400 £4.00

p+p 50p per unit plus VAT to be added to total.

TORIN CENTRIFUGAL BLOWER
230V ac 2,800 RPM 0.9amp 130mm diameter impellor outlet 63 x 37mm overall size 195 x 160 x 150mm long. Price £17.50 + £2.50 p&p (£23 inc. VAT)

SHADED POLE GEAR MOTORS
In the following sizes:
9 RPM 12 RPM 80 RPM 160 RPM 110V AC or 240V AC with capacitors (supplied). Price incl VAT & p&p £12.65

GEARED MOTORS
71 RPM 20lb inch torque reversable 115V AC input including capacitor and transformer for 240V AC operation. Price incl VAT & p&p £23.00.

12 V DC COOLER EXTRACTOR FAN
New brushless motor 92mm sq. Price incl VAT & p&p £11.50.

SOLID STATE EHT UNIT
Input 230/240V AC, Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics. eg supplying neon or argon tubes etc. Price less case £8.50 + £1.00 p&p (£10.93 inc VAT) NMS

COOLING FANS-BRAND NEW!
200/400V AC American Boxer 'Peewee' 7-bladed high efficiency cooling unit 80mm sq zx 40mm deeps 40cm approx. Price incl VAT & p&p £10.35.

EX-EQUIPMENT FANS 120mm sq x 38mm deep in either 115V or 230V AC Tested and guaranteed. Price incl VAT & p&p £7.76.

Large selection of various speed greased motors from stock. Phone or write for details.

From stock at prices that defy competition
C/F Blowers Program Timers
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JET SETTING

New York was well behind now, the Statue of Liberty had dwindled to a mere memory. Below, there was sea, nothing but sea. His three companions were sleeping, conversation dried up. A film-making team of mixed backgrounds: the producer, with a past encompassing War-time espionage with SOE; the director-cameraman, part red-Indian, part white-Canadian, a man with a deep interest in philosophy, and in building amplifiers; the camera assistant, a Cockney and an excellent PR-man in any situation; and himself, sound recordist and film editor, thriving on the excitement and freedom of film making. The mission: a documentary in Dominica, southern West Indies.

Over five hours yet to fly. Under his seat, his airline bag, stuffed with tape spools, a taperecorder, and some magazines: Wireless World, Practical Wireless, Radio Constructor, *and a new one,* Practical Electronics, *first issue. What had that one got to pass away the flight?*

TIME TRAVELLING THROUGH TECHNOLOGY

A participant's perspective : John Becker takes a nostalgic trip through the past, reliving some of PE's history.

Little did I know that this new magazine would not only interest me for the remainder of the flight, but would have a profound effect on the course of my life over the next twenty five years. It was to inspire an addiction to electronics, cause me to leave film making, become an author, set up an electronics business and, most remarkable of all, to become its editor! PE, what an impact you've had ...

TIME CAPSULES

I've lately been browsing through old copies of PE, from issue Number One to present day. In my living room, 25 years of history lies in piles around the walls. Time encapsulated. Each PE issue part of life for many thousands of people; for its staff, many recorded by name on its pages, many not; for its authors, for whom each article represents many days, perhaps months, of work in bringing it to perfection; for the advertisers, livelihoods made, in some cases, fortunes; for the readers - who knows how many have found PE to be inspiration for their hobbies, and the stepping stone to careers in electronics?

Twenty five years, over three hundred issues, probably over 25000 pages. Too much to re-read in depth - I can only pick and choose at random.

It's fascinating to relive some of the past, to examine it through the eyes of those who were looking at their current technology and speculating on the future. How perceptive some ideas, how indicative of things to come. But how some things have changed, how some innovations unforeseen. Yet that's life in any age of advancing technology.

INITIATION

Issue Number One, November 1964, where it all began ...

In his first editorial, Fred Bennett said, "*In our pages the emphasis will be given to fully detailed designs for the modestly equipped constructor. The projects described will reflect the extremely diverse applications of electronics, labour saving devices for the home, aids for motorists, photographers and others with specialised interests, equipment for entertainment and instruments for more serious pursuits of a scientific nature. Also included will be informative articles on circuit design, components and building techniques. Special features will bring in word and picture some of the highlights from the electronic scene - from industry, research, medicine etc. Other articles dealing with the specialised fields of interest such as nucleonics, tape recording and amateur radio, etc, will appear at regular intervals.*"

Though there are more aspects to technology now than perhaps there were twenty five years ago, Fred's words sum up the concept which PE continues to follow.

FOREFRONT HI-TECH

Transistors represented the forefront of hi-tech for diy enthusiasts when PE began. They had been invented sixteen years earlier, but in 1964 valve circuits still featured heavily in many magazines. In PE's first issue, though, there was not a valve circuit in sight. Certainly there were many advertisers whose main income appeared to come from valve sales, but Fred had obviously made the decision that PE should immediately be recognised as a forward looking magazine by showing transistor projects. Perversely, though, I recall my slight consternation that there *weren't* any valve projects.

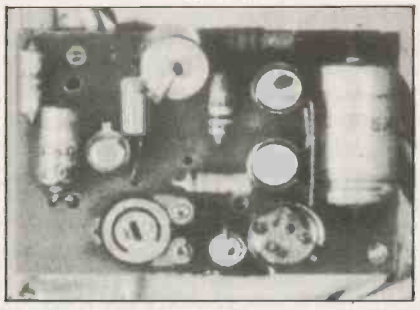
By today's standards, the transistors were rudimentary. Those in the first projects, and for many issues to come, were pnp germanium types. One reason I had not yet moved on from valves was because of rumours about transistors being vulnerable to heat damage and physical breakage of their glass envelopes. Grasping the convention of having negative as the top power rail was also taxing to an inexperienced mind!

However, npn and silicon transistors were not far away. The first ad I now spot for them is in PE Jan 66, with the first project in Feb 66, a vibrato unit project, by G.Wareham.

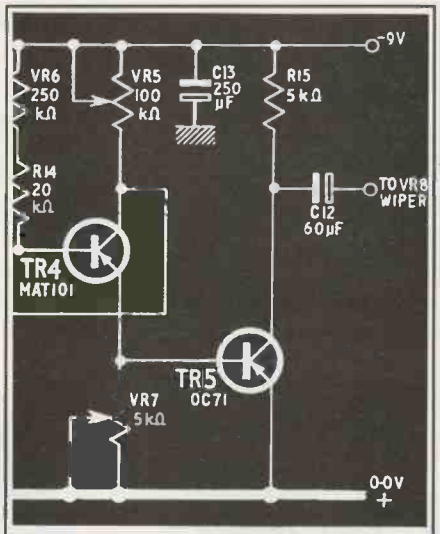
NO FEAR

PE showed me that I need not fear transistors, and that Fred was right in his editorial of Dec 66 when he said, "*Thanks to the transistor, gone largely is the need for a metal chassis and the tedious metal work this often entailed. A small battery replaces a bulky power pack and so demolishes a psychological barrier for some would-be constructors -apprehension of high voltage supplies. Yes, truly can we say that in the realm of electronics a new emphasis has been given to the word* practical."

Nonetheless, for many years, PE did not totally ignore valves in favour of transistors (or 'crystal triodes' as I saw them referred to somewhere in one issue). There were many projects for which transistors could not yet do the job. (There still are, for that matter.)



Above, the first circuit using an ic to be published in PE, Oct 67. The ic is the can device middle left. Things don't look too different from today's techniques, but opamp qualities had yet to be improved. So had the 'gramophone' style in which the circuit was used, as in the photo below.



Circuit for part of the Didjeridoo project in PE Nov 64. The transistors are pnp germanium types, npn and silicon devices were not yet readily available to readers. The 'inverted' power lines would have caused mental acrobatics for some! Using white lines on a black background was probably meant to imply equivalence to 'blue prints', so inspiring a feeling of 'belonging' to the engineering fraternity.

MICROELECTRONICS

PE had responded to the incoming technology of microelectronics by Aug 67. Mike Hughes' series of five articles covered the major aspects of current integrated circuit technology, including digital logic ics, and opamps. He concluded the Dec 67 article by saying, "*What the future holds is a little obscure, but certainly there are going to be even more changes in techniques and applications in this rapidly expanding field.*" How true!

Prices and availability of ics at that time made them luxuries for the amateur constructor, but Fred recognised the potential and published the first ic project in the Oct 67 issue. It was in a 'gramophone' (there's a long-gone term) amplifier and used a Mullard opamp type 263TAA. No, I don't recognise the number either!

MECHANICAL COMPUTING

One noteworthy digital point must surely be the *Simple Digital Computer*, by Messrs J.R.Reid, described in Jan 66. But no, not because it foreshadowed the computers we know now, rather, because it *did not*. It was a hardware-only project, using switches and torch bulbs to teach binary conversion to students. Not a valve or semiconductor in sight! This is no criticism of PE, the technology was simply not within viable reach of diy enthusiasts. The need for binary experience, though, is in itself significant.

S.T.Andrews helped to bridge the gap in his series starting June 66, on *Experiments in Logic Design*. The photo of the transistorised adder in July 66 plainly illustrates the complexities faced by home constructors.

ANALOGUE COMPUTERS

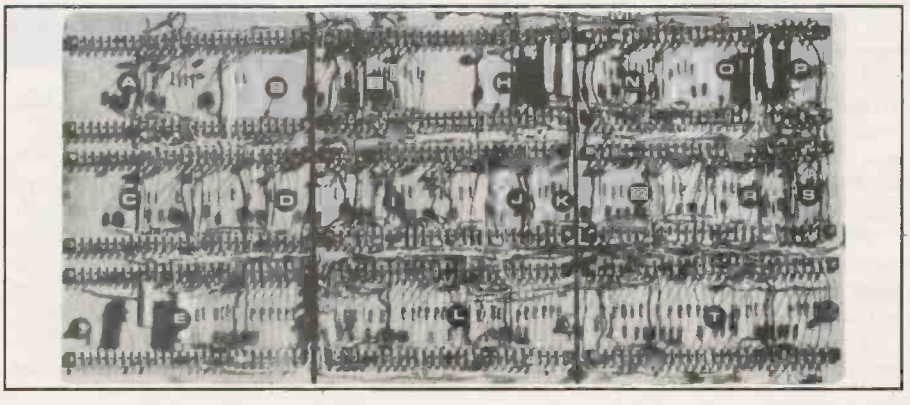
But, could there be doubt about digital futures? From Aug 66 a brief comment suggested that there was still debate about the merits of analogue versus digital computer technologies.

PE had published a simple analogue computer in Aug 65, "*... multiplication and division with reasonable accuracy ...*", and went on to another much more sophisticated one starting in Jan 68, running for ten issues. There's a picture of it on the next page.

CALCULATORS

A further reminder of how the course of technology was yet to change comes from the news item in issue one on a new slide rule. Of particular interest to electronics experimenters were "*the special scales*

The transistorised adder of Jul 66 plainly illustrates the complexities then faced by constructors when building digital circuits. The components are soldered to tag strips. Each of the three sections represents a single adder stage.



PEAC was a major project for PE, running for ten issues from Jan to Oct 68.

enabling ready calculation of most electronic problems ...". Alternatively, perhaps you could have used the electronic calculator in the news pages of Dec 64 which "*displays four rows of numbers and answers ... on a small crt.*" A pity PE didn't show a picture! Slide rules were still being advertised as calculators at least as late as 1970.

DIGI-CAL

In July 72, PE began a series of constructional articles on the *Digi-Cal*. It too was to become symbolic of the rate of change in electronic development.

At the time the calculator was commissioned, commercial digital desk calculators cost in the region of £250. PE's *Digi-Cal*, using readily available cheap ttl devices, would have cost much less than this to build. Between commissioning of the article and its publication, however, the cost of commercial units dropped to a third of the price. The single-chip calculator ic had arrived.

Accompanying *Digi-Cal* Part 4 in Oct 72, Fred's editorial highlights the dilemma that had faced him. "*Does one sit back neglecting contemporary and readily available devices, just waiting for the 'ultimate' one to turn up? For example, to have knowledge of impending changes in ic design that are likely to revolutionise the commercial calculator in the near future is one thing; it is quite a different thing, though, to predict with certainty if and when these new lsi chips will be made available to private individuals - and if so at what cost. Though (Digi-Cal is) 'priced out of the market' ...as an educational exercise... it offers the technically inquisitive far more than the mere assembly of any commercial kit can possibly provide.*"

PE continued to run the project through the full eleven parts. Quite right, too, Fred!

So far as I can see, the first pocket calculator kit to be advertised in PE was from SCS Components, in PE May 73. Though, of course, Sinclair had been the first to design one.

MEMORABLE

The entire history of electronics is riddled with problems, choices, intermediary techniques and alternative futures.

A news item of Nov 64 mentioned research in the USSR into optical memory storage recording "*electronic ray*" signals on a film of calcium chloride. "*The receptive capacity ... is very great ... over 10,000 signs per square centimetre of surface.*" The recording time was "*in the order of tens of milliseconds.*"

IBM, though, had other ideas, reported in Sept 66, "*A lightning fast laser device, which might lead to optical computer memories in place of the slower magnetic core storage systems currently in use ... allows a shaft of light to be positioned more than 100,000 times a second on up to 131,072 distinct points in an area smaller than a match head.*" Was this the beginnings of the technology that led to compact discs, and to laser printers?

At about the same time it would set you back £40,000 to buy a plotter! (Mind you, they're still not very cheap ...)

Slightly earlier, in the Jan 66 issue, there was a general feature on *A Modern Computer System*, which at that time still meant those using punched tapes for data input, though for bulk data storage a variety of magnetic coated surfaces were in common use, typically on tapes, discs, drums and cards.

I was somewhat surprised to discover that active research into computer aided design had been started as early as 1966, by Racal, and by 1969 had become a reality.

PE reviewed bubble memories in April 79, and it appears from December 85 that Mike Kenward still had hopes for them. But, is there a gap in my education? I've not noticed them mentioned since then.

The first pocket calculator kit to be advertised in PE. It was shown as a full page advert in May 73. Costing £39 plus vat.

TRAINED PREDICTIONS

A comment in PE May 65 also deserves quoting : "*Now that there is a large number of computers in operational use ... there is a growing demand for personnel to operate these massive electronic brains.*"

Some advertisers were not slow in catering for the new demand for skilled computer ops. Sim-Tech headed their electronics course ad in the same issue with the words "*The Thinking Machine*", going on to say, "*We are told that the electronic thinking machine may very well become a reality in twenty or thirty years' time. Ultimately, we will be able to leave most of the important business and government decisions to the impartial machine. This could result in some very interesting possibilities! Are you prepared ... ?*"

The Digi-Cal of July 72 became the victim of advancing technology. Between design and publication the first single-chip calculator ic had arrived. The project, though, offered valuable knowledge and experience of logic systems.

Twenty four years on, how near are we to the true *thinking machine*, and are we yet prepared? Thorny questions, both of them. Perhaps with risc architecture, transputers and so forth, we may be closer to the technology, but educationally prepared? No, not yet.

And thinking of careers, by Nov 66, radio service engineers could earn as much as £20 per week, according to one ad!

SEMICONDUCTING MUSIC

Music making was one area that significantly benefited from semiconductor technology. From the first issue, PE's intentions for this field were made clear - a transistorised Didjeridoo, accompanied of course by a photo of Rolf Harris! The author making history was A.J.Bassett.

Echo units were yet to be hi-technotised - the project by A.T.J.Carrington in Sept 65 used a taperecorder with displaced heads, and valve driven signal handling. Mechanical spring lines had been around for many years, but were only suitable for reverb; PE's first version came in Dec 67, thanks to A.J.Bassett again. If memory serves me correctly, M.A.Sawicki and A.Kowalewski designed the first delay chip circuit PE published, the *Guitar Multiprocessor* project of Dec 78, using the SAD1024.

Trend setting : the PE Sound Synthesiser of Feb 73-Mar 74 was the first diy synth to be published in Britain. The sun-burst flash at the bottom right highlights the Triffid single-ic radio, using the ZN414 chip, a device that is still widely available.

Perhaps the greatest music triumph was the *PE Sound Synthesiser* of Feb 73, designed by Doug Shaw. No other British magazine had yet published a diy synth, and over the series of 13 parts, untold numbers were built by ecstatic readers. Doug followed it up in 75 with the *PE Minisonic*, of which I know many thousands were built over the best part of ten years.

It is unlikely that those synths could have been designed had opamps, notably the 741, not been invented. Digital electronics then made organs and pianos a more practical diy proposition. Alan Boothman made full use of the digital top octave divider, AY-1-0212, when designing the *PE Joanna* piano of May 75. Prior to that, separate oscillators had to be used for each octave, (I wonder how well they stayed in tune?), a marvellous example of which is Alan Douglas's well presented eleven-part transistorised organ project of 1969/70.

Now, of course, the microprocessing techniques of commercial synths and the like have all-but knocked this area of diy involvement on the head.

RE-ROUTED

Paging on ... paging on ...

There it is ... the answering machine. And what a lot that machine has to answer for !

For months I worked on it. Furthermore, my brother, myself, and several of his electronics designer-colleagues would spend most evenings discussing electronics in a notable local tavern. "Transistors rule, ok - have another beer!" Resentment against film editing began to build up - I wanted to do electronics.

Knowing that PE invited reader's contributions, I wrote an article on the completed machine. Script and machine were tucked under arm, and deposited in front of Mike Kenward and Dave Barrington at PE's offices. After very friendly discussions with Fred Bennett, to my delight, the project was accepted, on condition it was slightly modified to become a door answering machine. (Hell hath no fury like GPO HQ scorned!) Thus the *Callercord* was born and published, in PE Jul 72.

Callercord, the July 72 project that was to re-route a reader's destiny!

KITTING OUT

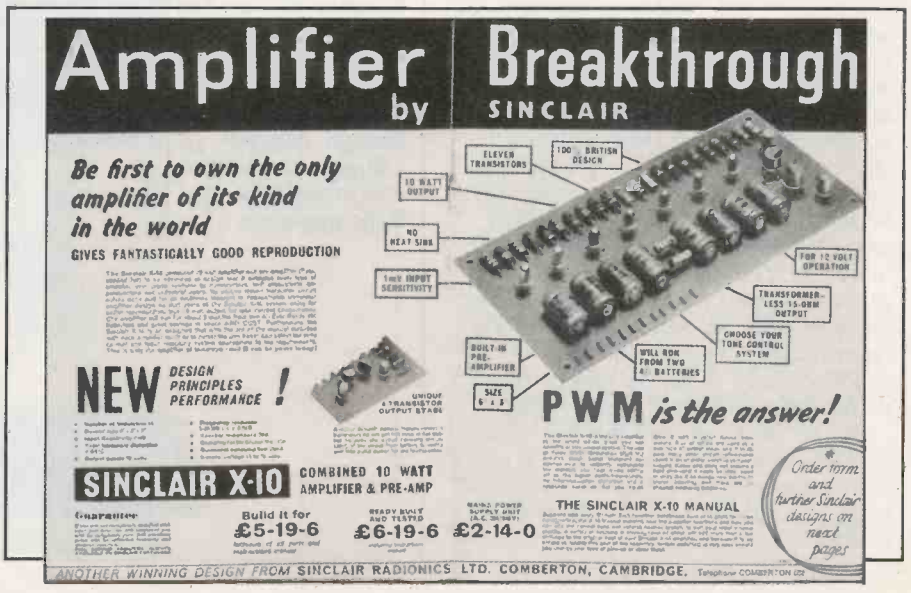
Between acceptance and publication, I decided to set up a separate business, to sell parts for the *Callercord* through PE. "Right then, if I'm selling kits for one PE project," thinks I, "what other PE projects can I sell them for?"

So began a kit source for PE projects. By 1974, so ended film making. See how PE can change your life?

CHANGING ODDS

In his editorial of June 69, Fred had answered readers' suggestions that advertisers should supply kits for PE projects. He understood their feelings but said, "*... it would not be a viable business*

An established source for commercially designed diy kits - Sinclair Radionics Ltd. The revolutionary X-10 amplifier kit was heavily promoted on a double-page spread in PE Nov 64, though knighthood for Sir Clive was still many years into the future.

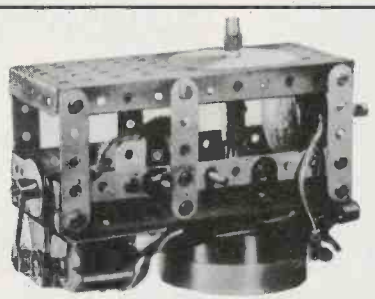


proposition (for retailers) to make up kits for every design published." It seems that other retailers of that era agreed with him. I see that a couple of companies had briefly tried PE kit sales in 1968 but, after only a few issues, they dropped out. Indeed one company was apparently the cause of readers' complaints, resulting in an editorial statement in July 69. There were of course companies selling kits for commercial products, Sinclair, Heathkit, Radionics, for example, but not specifically for PE projects.

BAND WAGONS

Then, after a couple of years, others also recognised that PE *did* have great potential for published project kit sales. Names like Davian, Eaton Audio, Clef Products, Powertran, Magenta, Electrokit, Astro, Bywood, E & A, Maplin, Lascar, Watford, and others, come to mind. A significant trend developed as well - advertisers using their design expertise to produce excellent quality projects specifically for PE. Magazine, advertiser and reader all benefited.

PE and its readers particularly benefited from the designs by Doug Shaw of Eaton Audio, as well as those from Alan Boothman of Clef. Doug's synthesisers mentioned above are good examples, so too is Alan's *Joanna*. The contributions of Powertran and later Cybernetic Applications, put PE in prime position on constructional robotics. Remember the robots *Genesis* of Nov 81 and *Neptune* of Sept 84? Therein lies another success story enhanced through projects published in PE, if brother Dick would allow me to tell it.



Keeping pace with advancing control automation, PE published the Genesis robot projects in Nov. 81. They were designed by Richard Becker, though that's Mike Kenward being the boffin on the cover! The mechanical principles and electronic control technology were a far cry from PE's first servo control project in Jan 66. (Right.)

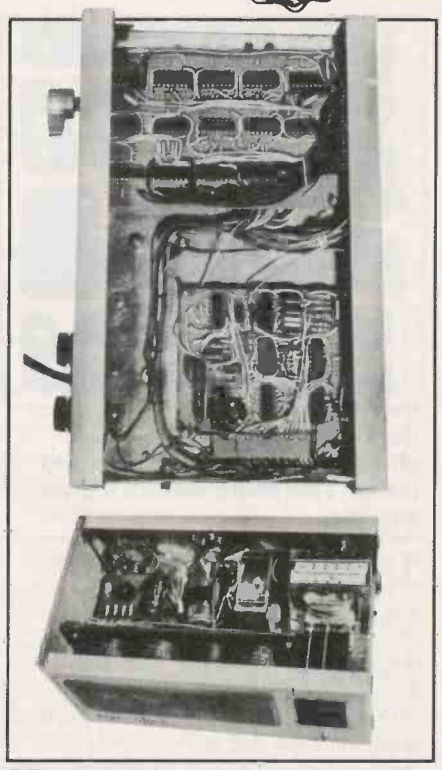
At this point I'd like to interject a tribute to David Tilleard, PE's Ad Manager during IPC days. With his genial charm and courtesy he did much to ensure that advertisers remained happy. He made, and continues to keep, many friends – myself included.

GROUND FLOOR SALES

Reading Fred Bennett's reminiscences, I was struck by his comment on the great number of advertisers who were around at the start. In the first issue, many prominent companies of the time featured their wares. Sadly, many of the names were to eventually fall by the wayside.

But, also I see in that first issue many names that are still part of today's scene in different ways, Henry's Radio, H.L.Smith, Eagle, Modern Book Co, Z & I Aero, Lasky's, Avo, Service Trading, and Sinclair. It's especially interesting to see the four pages of ads for Sinclair Radionics - long before Sir Clive was knighted. Oh, the nostalgia of seeing the X10 amp at 5-19-6d and the Micro-6 "*Smallest radio set in the world*" at 59/6d!

Sinclair were to remain stalwart supporters of PE for many years, and of course, we still maintain a very good relationship with Sir Clive through his newer activities.



PE's first digital clock, in Dec 70, used digitron tubes for the numerical displays. These were a type of valve with glowing digits. The circuit was designed around the standard 7400 series of ttl chips. With the current all those chips and tubes consumed, the unit was probably a good source of central heating as well!

Seeing prices in pounds, shillings and pence is nostalgia in itself, but to see some quoted in guineas is incredible! Do many of you know how many new pence make a guinea? Incidentally, PE's first competition had the caption "*REWARD TWO GUINEAS*" - Feb 65!

DIGITAL WATCHES

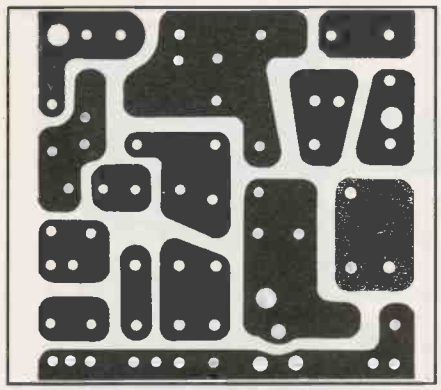
Angelo, our publisher, particularly recalls the Sinclair Black Watch kit, first advertised in PE Dec 75, and selling at £17.95. Although it was acknowledged as the first digital watch in the world, there was a special PE offer for a Sabchron digital led wristwatch kit, selling at £36.25, in an earlier issue, Oct 75.

PE's first electronic clock, of Mar 65, used digitrons, a type of valve with glowing (neon?) numerals. A clock was the subject for the first project PE published using digital ics, 20 of them, in Dec 70. It too used digitrons - lcds were not yet part of the amateur scene.

And now we can buy fully-integrated digital time pieces for less than a pound!

ASSEMBLY BOARDS

It's remarkable to be reminded that in 1964 Veroboard was not yet fully part of the diy constructional armoury. There is a



Even in issue one, PE showed pcb track layouts, though they bore striking resemblance to Meccano plates! This board was for a drive amplifier

news item photograph and reference to it which is worded - "*A typical example of how developments in industry are finally passed on to the amateur experimenter is the ease of Veroboard and Vero Plain Board*". But PE didn't show Vero layouts until issue two, and there is a constructional project in issue one that was to be built on laminated plastic boards which had neither copper tracking on them, nor holes drilled. That project was the cover feature. Occasionally, PE continued to show even tag board layouts.

PCBs, however, were in from the start, even though by today's standards their layout styles were unsophisticated, looking more like Meccano plates fixed to a flat surface, and were still known as printed wiring boards. An advert I saw in a later issue, Feb 66, showed that there was already a market for diy pcb making kits, and in Mar 66 PE ran two articles on making your own boards.

Do you remember, all you veterans, the other assembly aids that were to arrive? Breadboarding systems like S-Dec and Chequerboard, which I first spotted in Apr 68 and Aug 68 - the former is still around, but what happened to the latter? What about Cir-Kit, the stick-on pcb copper tracking system, a marvellous idea it seemed when it appeared in Nov 66 - why did it not survive? Nor do I recall the outcome for the suggestion in Nov 66 of making pcbs tracks using electrolysis techniques.

Paging through ... month after month ... ah, yes ...

From Nov 66, the first advert for Cir-kit, the pcb tracking system that should have revolutionised one-off diy pcb making.

MICROPROCESSORS

Microprocessors, first produced by Intel, were becoming well established as the control hearts in many automation systems by 1975. Speculation was rife on what functions they would soon be controlling, from domestic appliances to traffic control and telecommunications.

PE responded by publishing a detailed two-part series of articles on microprocessors, commencing in Oct 75. In his conclusion, V.E.Yates said, "*Likely applications home experimenters will have for microprocessors are electronic games, model railway control and television games.*"

Then in Feb 77 PE ran a short article on *Computer Hobbies in the US*. Across the Atlantic were hints of the revolution that was soon to dominate electronic applications. In December 1974 a small company, MITS, had introduced a computer in kit form, the Altair. Sales had boomed, and other companies joined the market. PE reported that the Personal Computing show of August 1976 in Atlantic City had drawn over 100 exhibitors. "*The show ...was an example of the remarkable boom in computer hobbies in the United States, which has grown so rapidly in the past two years that it has taken both the electronics industry and the retail trade completely by surprise.*"

"*Will the boom in computing as a hobby come to Britain?*", speculated the author, Roger Woolnough. "*It seems quite likely, though how soon is difficult to decide. Despite the fall in price of microprocessor chips, at the moment it would probably be necessary to pay out between £150 and £1000 to set up a usable system to start computing at home.*"

PE's response to the growing interest in home computers, the Champ microprocessor development system of Sept 77.

PE's constructional response was to publish the *Champ* microprocessor development system, in a ten-part series starting Sept 77. "*Champ is* not *a toy for you to merely sample the wonders of real computers. Champ is a real computer in its own class.*" It had 8K of program storage.

The transition to the computer-filled world we now know, was occurring.

'Computing is highly addictive!' was the warning accompanying PE's highly successful Compukit UK101 computer project of Aug 79.

TRANSITIONS

There were other transitions afoot, too.

In 1977 IPC decided to move PE down to Poole. Fred remained in London where he continued to edit EE. Mike Kenward accepted IPC's offer of PE editorship, and returned from Canada where, for a few months, he had been editing a similar periodical (albeit, a version of one of the 'Bandits', as Fred puts it!). His first edition as PE's editor was that of Jan 78.

I was interested to see that Mike's first published article was on boating electronics, in Aug 69. Yes, as I said in my own article on the subject in June 89, things have really changed on that scene too!

Mike was to steer PE not only through the rapids of increasing computerisation of so many everyday items and functions, but also through an era of increasing recession.

As editor, he took advantage of the introduction of lower cost microprocessors and the (comparatively!) user-friendly Microsoft Basic. In Aug 79, using the design expertise of A.A.Berk, he published the highly successful *Compukit UK101* computer, complete with the warning : "*Computing is highly addictive*" !

By then, that warning would have been well understood by thousands of hooked hackers. "*It must be the fastest growing*

hobby in this country, probably in the world", said Mike about computing in his editorial of July 79.

"With the increase in hobbyist computing ability, so came the demand for various computer add-ons and stand-alone devices. PE satisfied the demand with issue after issue of projects performing a variety of control and monitoring functions. To name but three, projects ranged from Sam Withey's *Expanding the Vic 20* series starting Oct 83, and the *BBC Speech Synth* by Anthony Foord of Mar 85, to the self contained *Car Computer* of Dec 84, designed by S.H.Cousins and P.D.Wilson. Additionally, every issue seems to have had its more-theoretical feature on associated computer technology.

Nothing to do with computing, but a further addiction, though shortlived, was brought about by the legalisation of cb radio in 1981. PE responded from the outset with the *PE Ranger* of Sept 81, designed by Michael Tooley and David Whitfield.

With the legalisation of cb radio, PE's immediate response was to publish the Ranger project in Sept 81.

Computing, though, was the dominant factor during Mike's editorship. But he had another increasingly powerful factor to cope with as well, the recession.

RECESSION

With the change of government in 79, "tough measures" were introduced resulting in a rise in unemployment and a reduction in hobbyist spending power. Advertisers and magazines suffered a loss of sales.

Sitting in Mike Kenward's office one day in 1984, I was shown the comparative sales graphs for all the competing magazines, The downward slopes were significant, and they were all declining equally.

In Dec 85, following PE's 21st Anniversary celebrations, Mike reviewed the situation in his look to the future. "*Some companies have not withstood the recession and disappeared, with very few newcomers to replace them. PE has weathered the storm well ... from a firm base with many new ideas we will again move forward with the next generation of hobbyists and engineers.*"

CHRISTMAS CHAT

Then, just before Christmas 1985, I phoned to offer him another article. "Wait a moment", he said above the office party noise, "don't say whether it's for PE or EE until I tell you the news. IPC are disposing of a lot of their titles, including PE and EE!"

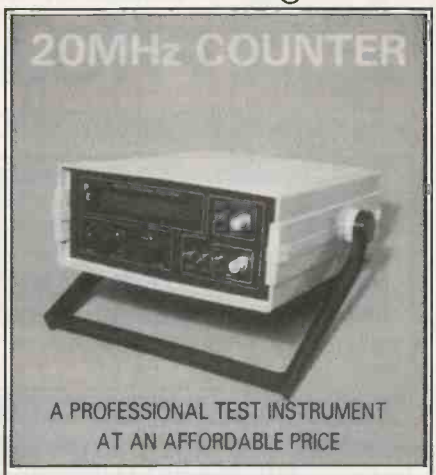
Silence and dismay at my end.

But - "I'm buying EE", said Mike, "and a publisher called Angelo Zgorelec is buying PE. It was he who founded *Personal Computer World* magazine."

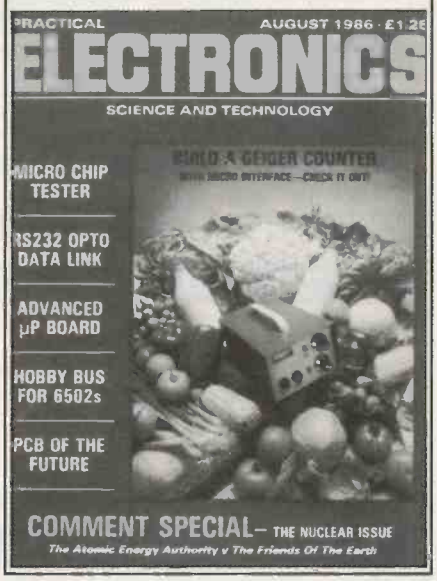
LONDON PRIDE

Angelo took over PE, taking it to London. He also took with him Richard Barron, Mike's previous assistant technical editor. Nick Hampshire, author and publisher of many computer books, then joined Angelo and Richard in an advisory capacity for a couple of months. Following Nick's departure, Richard took over as full editor. March 1986 was the cover date on the first PE copy to originate from Intra Press at Garway Road. With the April issue, a change readers would have noticed was the improved quality of the paper on which PE was printed, and the selective use of colour inside.

March 86, the first issue to be published by PE's new owners, Intra Press.



Though ownership had changed, there was no change to the tradition that PE had established for publishing projects of good quality and in response to readers' needs. Above, the 20MHz digital counter project of June 86, and below, the Geiger counter project of Aug 86, designed following Chernobyl. It was to be demonstrated three times on BBC TV.



Richard continued to edit PE for the rest of 1986. During his editorship he helped to reaffirm PE's position as "*The Science Magazine for Serious Electronics and Computer Enthusiasts*". With his previous experience on PE at Poole, he provided the continuity necessary to ensure that the ideals for which PE stands were maintained. He was additionally instrumental in assisting Intra Press in the establishment of two additional magazines, *Astronomy Now*, and *Office at Home*.

So the era didn't end, as I had feared it might that Christmas of 85. It simply changed its location and owner. And from that point, PE began to reverse the decline I'd seen on Mike's office graph. PE

John Becker takes up the story again on page 35, from the time he took over as editor.

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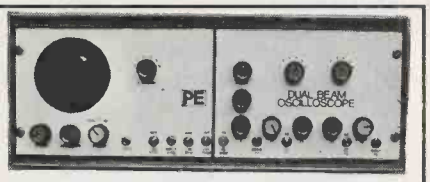

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TOASTING TRANSITIONS

Richard Barron, PE Editor 1986, dips into the Poole and drinks to the past, present and future - hic!

Let's raise a glass (or several) to PE: the occasion is the 25th birthday anniversary of one of the most interesting and authoritative journals for the serious electronics enthusiast; the toast must be to its next 25 years of successful and innovative publishing.

I have been asked to write a few words about my experience at PE but unfortunately, I'm not one for idle chatter and reminiscence whilst suffering from sobriety, an ailment which attacks all too frequently these days. However, one or two random access memories have just been addressed...

MOTLEY CREW CUT

Shortly after joining the PE team, in Poole, Dorset, I finally agreed to forgo my bachelor existence in favour of long nights by the fire and the CRT (I got married). Anyway, being the new boy, the team seized on the excuse to get me drunk. That night a motley crew of technical journalists hit the town: Dave Shortland, the wise owl; Mike Abbott, guru of the sixties; Brian Butler, the "I'm not technical", technical journalist; Dave Brunskill, the dynamite man (I daren't tell that story here!) (*I'll dare, if you whisper the details to me! Ed.*); Bill and Ben the artistic men, and Dave Barrington, the old Fleet Street hack of the thirties. (*Dave, are you going to stand for such assessment? Ed!*)

The idea was to get me to make a fool of myself in good old stag-night style. Unfortunately for the team, being well practised in the art of walking straight, the night ended with an apparently sober groom-to-be, explaining away the behaviour of eight drunken *Electronics and Wireless World* journalists.

CAPTAIN AND MATES

The events of that night set the scene for two extremely happy and satisfying years with PE captained by the highly respected Mike Kenward.

Under Mike's watchful eye, I successfully completed my apprenticeship and went on to be the assistant editor (technical). It was in this capacity that I had the dubious pleasure of deciding what projects and circuit ideas of unlimited genious should reach the polished pages of PE.

Many of the projects considered for publication were superbly designed, well written and of great value to the electronics hobbyist and home micro owner. Contributions from such companies as Magenta, Greenweld and Phonosonics, and from valued writers such as Owen Bishop, John Becker (current ed), Tom Ivall, Robert Penfold and award winning journalist Barry Fox made PE the best read and most respected journal in its field. Some contributions, however, left a lot to be desired.

Richard Barron, just prior to opening time, at the PC Show 1986. Rumour has it that later he could be clearly heard attracting attention by calling across the hall, "Orders Please!"

NOBEL LIGHT

One such contribution was an oscillator circuit which consisted of a couple of resistors, a capacitor and an led - no active components, yet it worked! Nobel Prize winning idea, I thought. After all, it seemed to contradict all known laws of physics. It was three hours of head-scratching and testing before I realised that the led was of the flashing variety!

INTRAPRESSIVE ENTREPRENEUR

All good things come to an end, though. Realising that it was unable to successfully publish PE for any longer, IPC finally sold the 21 year old title to Intra Press, headed by Angelo Zgorelec, innovative entrepreneur and founder of Personal Computer World. Angelo was full of enthusiasm for the journal and keen to employ the right staff to take it into the 1990s. Unfortunately for Angelo, I was part of the fixtures and fittings.

No seriously, we got on like a house on fire and were soon working well together. We set about the enormous task of redefining the editorial direction and coverage and the way we presented information. And, I would like to think that the magazine you are reading now has been shaped to some extent by me.

MANUAL DEPRESSION

I couldn't possibly talk about PE without acknowledging that it has faced serious problems in its long history, particularly getting through the hobby depression of the early eighties when there seemed to be a mass migration to the home micro. Hobbyists everywhere were putting away their soldering irons and getting out their programming manuals.

EMBARRASSING ED LINES

All credit must go to the people that have worked on PE in recent years and particularly to John Becker who currently edits the journal. John, who I have known for many years, is the first editor realistically qualified to lead PE (*Come now, Richard, I didn't bribe you that much! Ed.*) He is a real enthusiast and grassroots hobbyist, a natural writer and has had many years experience as a professional designer and businessman.

LEADING REVIVAL

Finally, I am pleased to say that it appears that the worst of the depression in the electronics enthusiast market is over with many of the leading suppliers such as Maplin, TK, Magenta, Phonosonics, Technomatic and others surviving to tell the story. Even more encouraging is the commitment being shown by newer companies who are prepared to fill the gaps created by some of the businesses which sadly went to the wall in the earlier part of this decade.

Once again: Happy Anniversary; Good Luck John, Angelo and all those involved with PE.

To the next 25 years of success (hiccup...)!

PE

Richard has two other addictions now – he's the Editor of both Image Processing and Digital Review magazines, which are part of the Reed Business Publishing organisation.

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Please mention this mag. when writing

It was over twenty two years since he'd discovered a new magazine that could break flight tedium and change lives. It had certainly changed his own.

He was surrounded by test equipment, staring morosely at a new circuit under test. As yet he was not sure if it was working properly. He wasn't even sure he cared. Toothache raged, swamping any attempt at logical thought.

The phone rang.

"John?", queried the voice, "It's Angelo, of Intra Press."

"Hullo, Angelo", he uttered above the scream of dental nerve ends.

"I'm looking for someone to edit PE. Are you interested?"

The toothache vanished.

"Indeed I could be", I replied, suddenly finding all my wits now in working order.

Next afternoon, saw me at PE, chatting with Angelo for the second time since he'd taken over. The first time was in the early months of 86 when I'd gone to discuss future projects with Richard Barron and Nick Hampshire.

Never one to be afraid of the deep end, John Becker finds liquid greetings offer the best salute to any celebration. Happy 25th Anniversary PE!

FUTURE FULFILMENT

ACROSS THE COUNTER

On Angelo's desk was a copy of PE Aug 86. It was opened at the Geiger counter project I'd designed for PE following Chernobyl. That broke the ice as a good opening conversation point. The project had been exceptionally well received, and continued to inspire interest. Within a few months it was to bring PE further glory by being shown on BBC TV.

Chatting about PE generally, it transpired that Alf Tonge had suggested I might be interested in editing PE. I'd known Alf for many years during the time he'd been with IPC prior to PE's move to Poole. He'd now joined Angelo as advertisement manager.

"Could you," asked Angelo, "take on editing PE as well as running your other activities?"

INSIDE JOB

Some opportunities come only once in a lifetime. PE had been the cause of me becoming seriously involved with electronics. I had great affection for the magazine, and knew its history and its aims. In fact I'd jokingly said to Mike a few times, "Got a job for me at Poole?" Of course I would be delighted to be involved with PE from the inside.

John Becker, Editor since 1987, finds a cure for toothache and keeps PE on tracks to the future.

"Let's give it a try for a few weeks", I replied at 4.30pm on Thursday January 8th 1987.

9.30am next morning, I was already replying to PE readers' letters that had arrived since Christmas.

Somehow, those "few weeks" have become nearly three years.

Somehow, I've found another area of electronics to which I've become addicted. PE, what is it you do to people?!

PRACTICAL PEOPLE

Well, I know what it is I try to make PE do to people. Through PE's pages I try to communicate enthusiasm, interest, knowledge and participation in the world's most exciting technology.

PE appeals to all age groups, backgrounds and abilities. I have tried to cater for all those tastes with the projects and features I've presented. Projects have ranged from the simplicity of Bill Kent's burglar alarm controller of Nov 87, to the advanced *PLD Programmer* designed by Chris Kelly and Steve Pattinson of Nov 88.

Features, too, have catered for a variety of tastes. For example, the Prof, alias Robert Penfold, examined Midi interfacing in Sept 87, he also discussed proximity detectors in Aug 88. Mike Sanders has discussed the technology of communications systems, from satellites to submarine cables, in two series, beginning Mar 88 and Oct 88 respectively. Tom Ivall examined the future for HDTV, and Barry Fox reported on current laser and optic fibre techniques. Fred Thorns took advanced technology servicing as his theme for Nov 88, describing how surface mounted devices (smds) should be handled. The future for home automation was summarised in Apr 89.

INFO STRUCTURE

The quest for knowledge among the inexperienced has had extensive coverage. PE has always played a tutorial role, and this has been reaffirmed through Tim Pike's GCSE series commencing Sept 87. Owen Bishop has continued the tradition, completing his *Digital Electronics* course last month. More advanced design information has been imparted by Andrew Armstrong in his in-depth series on semiconductors from Nov 87. The depths

Imaging advancing technologies, maintaining traditional standards ...

...PE reflects the past, present and future, and keeps your imagination gifted with interest.

of *Time and Measurement* are still being plumbed by Tony Smith.

Computer related technology is frequently to the fore. Constructional projects included those such as the *Polywhatsit* of May 87, Michael Sweet's *HF Scope Store* of Mar 89, and Kevin Browne's *Home Security Controller* in Sept 89. Likewise, computer hardware theory has been covered in many ways, by Robert Penfold, Owen Bishop and Chris Kelly, among others.

TESTED DEMAND

Test gear has always featured heavily in PE, and will continue to do so. We've lately had projects for an oscilloscope, frequency counter, signal generator, function generator, and several power supplies.

In response to the demand for simple quicky projects, we've introduced the *Easi-build* series. Another new series is Andy Armstrong's answers to some of your interesting technical problems.

And, to entertain you, we've had numerous competitions with high value, worthwhile prizes.

One factor I also try to communicate to you is that *we care about you*. This is reflected in the styles of writing which I have tried to encourage in our authors. Writing in the first person, talking to you, not at you. Introducing colloquialisms into the text, occasional humorous comments, adopting an informal approach, use of first names instead of initials, and so on.

SILVER LININGS

The recession is receding, more people in many parts of Britain are again employed, money in their pockets. Computers, though still a dominant hobby factor, are not the only outlet people seek for their intellectual and manual abilities. Electronics is again increasingly becoming a major source of leisuretime fulfilment. To use Mike's analogy of Dec 85, the storm is over, the ripples subsiding. The marketplace for retailers is again expanding, the stalls vacated by those who didn't withstand the storm are being filled by new companies. The present, and the future is brighter than at the time of our twenty first anniversary. There is indeed, a silver lining in this our silver anniversary year.

FUTURE HISTORY

Over the twenty five years of PE's history, and before that, I have gained much knowledge and had enormous pleasure and satisfaction from electronics. If PE can help you to discover the same, even pursuading some of you to make electronics your career, we shall continue to fulfil our role during the next twenty five years.

Which brings me round to speculation about the future. But for that, read my editorial on page 9.

PE

IN PERSPECTIVE

In looking back over 25 years it has, perhaps, been assumed that all advances in technology were immediately welcomed. Not so, it seems.

For example, there was a letter in PE Feb 65 in which the reader said, "May I question why you advocate the use of printed circuits on some projects. There is no one among my friends in this hobby who likes them ... I cannot think that the amateur is keen on messing around ... for the purpose of producing 'one off' circuits."

One of Fred Bennett's early editorials, Dec 67, also reflected reluctance among some readers to accept change. He said, "Looking back to before the transistor era, the beginner received his initiation into electronics through valve theory and practice. When the transistor first appeared on the scene it received a somewhat cool welcome. It seemed to some an intruder bent on bringing undue complications into a nicely ordered field."

Fred also said, though, "Today's beginner in electronics has a decided advantage over the beginner of, say, five to ten years ago. ... From a practical point of view, the newcomer to the hobby is destined to be 80 per cent or more a transistor man."

A generation has passed in 25 years, but today's generation should not regard the fears and outlooks of 25 years ago as naive or quaint. The techniques of that time represented the leading edge of technology, a technology without which our current abilities could not have been achieved. Even today there are innovations which are only slowly being accepted. Any age will regard its abilities as advanced, and perhaps regard some products with caution, but the hi-tech of one age can become the lo-tech of the next. Our abilities and fears in 1989 may well seem primitive to those looking back in another 25 years. And, as another thought, they may well also marvel that we did not foresee some innovations which to them will have become commonplace.

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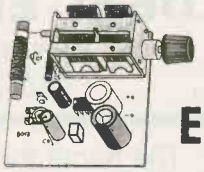

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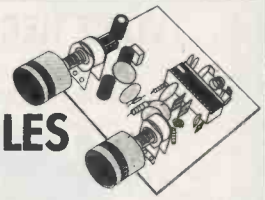
ELECTRONIC KITS & MODULES



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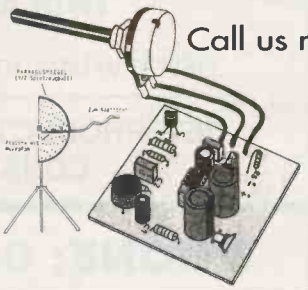

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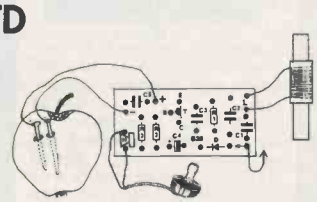

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4 S	8	21.72	2.75
5	10	27.46	3.19
6	12	31.32	3.41
8	16	44.04	4.12
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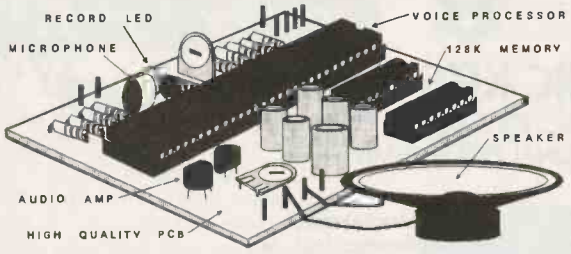

This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses – seatbelt or lights reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places, in fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys – why not convert your daughter's £8 doll to an £80 talking doll!!

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XK129 ..... £22.50

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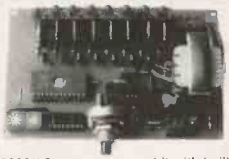

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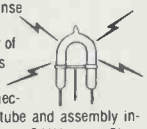

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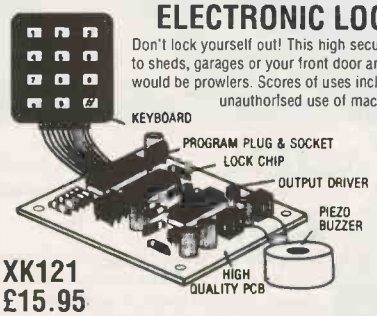

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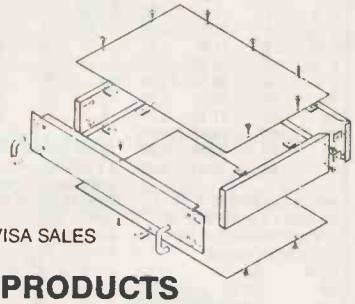

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PE COMPETITION RESULTS

FOLIO FORMULATION!

THREE ATARI FOLIO POCKET PCS WERE THE PRIZES TO BE WON IN PE'S JULY 89 COMPETITION THE WELL-FORMULATED WINNERS WERE :

M.N.Harron of Lisburn, Co Antrim; Peter Jowett of Cleckheaton, West Yorks; Irfan Chaudhry of Hainault, Essex.

12 month's subscription to PE was awarded to the three runners-up : P. Statham of Colwyn Bay, Clwyd; C. Simpson of Aberdeen; N. Hunter of Dawlish, Devon.

Four formulae and three subject headings were quoted and you were asked to allocate to each subject the formula you thought was most appropriate. These are the answers you should have had :

Power : $E = W/I$. Voltage, Current and Resistance : $E = IR$. Life, the Universe and Everything : $E = MC^2$

The fourth formula was $E = 2\Pi R^2$, this of course relates to circular area.

Well done all of you, nearly everyone got the answers right. As a devoted SF fan, I was interested to note that a lot of you have followed the Hitch-Hikers Guide to the Galaxy, correctly(?!) pointing out that the answer to Life, the Universe and Everything is "42" ! (I wonder if that might cheer up Marvin?)

SHARPENING LIFE-STYLES!

THE NEW SHARP IQ-7000 ORGANISER WAS THE PRIZE AVAILABLE TO THREE OF YOU IN OUR AUGUST 89 COMPETITION. THE SHARPLY-ORGANISED THREE WINNERS WERE :

A.J. Williams of Minster, Isle of Sheppey, Kent; A. Mathews of Cowes, Isle of Wight; James W. Porter of Coventry.

12 month's subscription to PE was awarded to the three runners-up : Ian Cargill of Leatherhead, Surrey; Heeley Culton of Cotham, Bristol; Peter Blackmore of Rainhill, Merseyside.

For this competition your Ed had put his unaided IQ to erroneous use spotting relationships between PE author's names and a list of quoted phrases. You were asked to match them. Practically everyone succeeded! For the tiny minority who didn't, these are the answers I was looking for :Wimbledon Tennis : Becker (John), Woodworking Tools : Sanders (Mike), Cheese Processing : Ivall (Tom), Southern Counties : Kent (Harvey), Scottish Kings : Stuart (Mark),Bleak Countryside : Moore (Patrick), Hunted Animals : Fox (Barry).

(Though some spellings don't quite match, the words sound the same!)

SURVEY REWARDS!

The Readers' Survey we ran in the May 89 issue produced some interesting and informative results. To all who returned their questionnaires on time have been sent vouchers offering £ 2 off annual subscription to PE. £200 worth of cash rewards have also been sent to those who most closely estimated the total number of questionnaires returned. The rewards were :£100 to Paul Gammons of Rotherham, S. Yorks, £50 to G.T. Edwards of Weymouth, Dorset £25 to R. Flitcroft of Disley, Cheshire, £ 5 to Michael Gordon of Belfast, £ 5 to J.F. Barton of St Leonards on Sea, Sussex, £ 5 to R.T. Lovelock of Exeter, Devon, £ 5 to D. Banning of Douglas, Isle of Man, £5 to N. Dobson of Carrville, Durham.

Many thanks to each and every one of you who sent in the completed questionnaires, and for all the information offered. (My two typing fingers are still quite numb from entering all the data into the computer!)

The three friends, Tom, Peter and Keith, who founded a multimillion pound business because of interest inspired by a PE metal detector. Peter, in the middle, holds one of the original detectors. On the left, Tom proudly displays one of the latest products manufactured by Detectronic, a portable flow measurement instrument.

FROM PE TO PROSPERITY

A LETTER FROM ANTHONY H. SMITH, BSc.

Building a PE Project a Reader Went in Search of Fortune – and Found it!

Dear John: Knowing your interest in readers' PE-related reminiscences, I'd like to tell you about a series of events which, like PE, has evolved over the last quarter of a century.

It concerns an engineer, Keith Smith, who started taking copies of a new electronics magazine - *Practical Electronics* - during the sixties. His young son also used to leaf through the pages, marvelling at the weird and wonderful devices, although he little understood what they were all about!

PE METAL DETECTOR

In 1968, give or take a year or so, Keith decided to have a go at a PE metal detector project. He built it on Veroboard, and used an old steel brush handle and some garden hose as the framework for the device.

At the time, he was working for an electronics firm designing security systems, and one of his colleagues, Peter Smith (no relation), had also built a metal detector. Over the following months their interest grew, the designs became more sophisticated, and they began building and selling metal detectors in their spare time. The models sold for about £15, and went like hot cakes!

BISHOP'S RING

Then, a curious thing happened. While out walking in his native countryside, the Bishop of Bangor had the misfortune to lose his priceless Bishop's ring. A group of school children were brought in to search for the ring, but when their efforts failed, the Bishop asked a local army base if they could help. Unfortunately, after scouring the fields with their sophisticated military metal detectors, even the army had to admit defeat.

At this point, following the intervention of a national newspaper, Keith's colleague travelled down to Bangor, and - using one of the £15 metal detectors - searched for a minute or so, and found the ring!

WAR GAMES!

The success was astounding, and the newspaper headlines went something along the lines of "Amateurs beat army at their own game".

The Bishop was delighted! The owner of the electronic security firm, however, was not. He had important contracts with the military, and because the army had lost face due to the spare-time activities of one of his employees, he was somewhat irked. So irked was he that he delivered an ultimatum ... "Either this metal detecting lark stops, or you leave my firm and start up your own detector company ..."

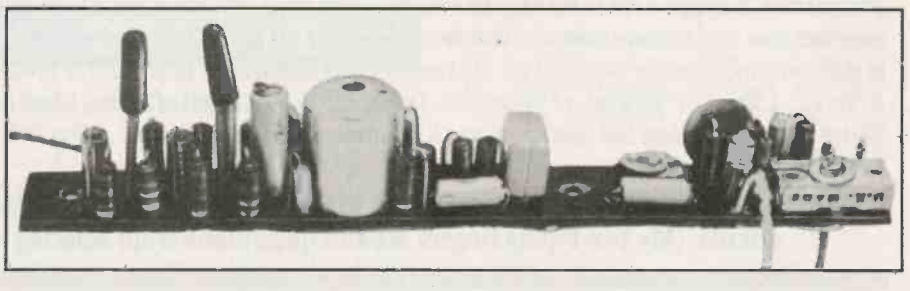
This is exactly what Keith Smith and his colleague decided to do - but where was the capital to come from?

CROSSING FATE

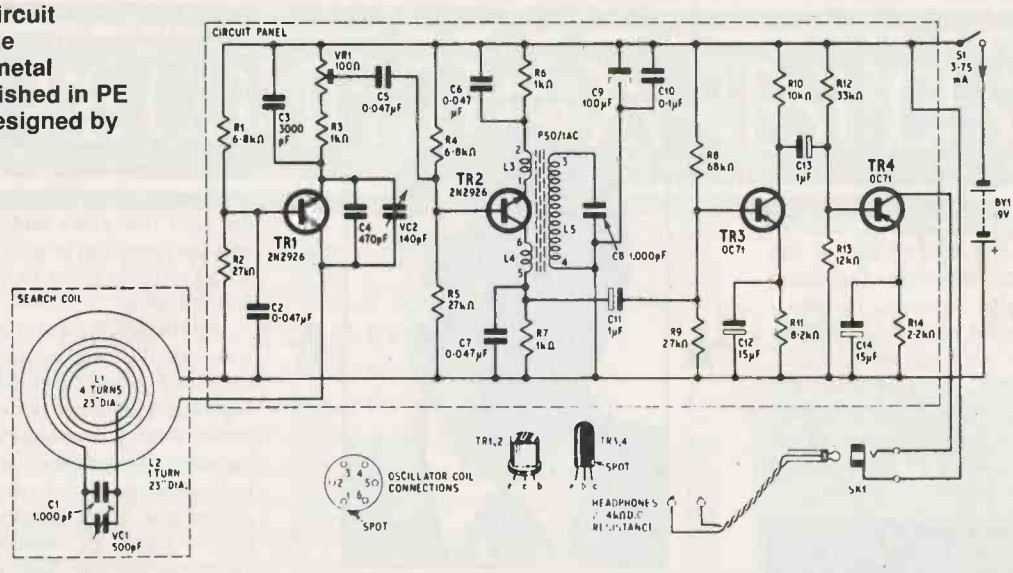
At this point, Fate (as it often does) took a hand. Following the success story of the Bishop's ring, they were asked by a wealthy family to look for another ring, an important family heirloom which had been lost in their gardens. Keith contacted another friend, Tom Woods, who had become interested in the detectors, and enjoyed searching with them at any opportunity.

While making arrangements to travel down to the family's estate, there was a knock at the door. It was the football pools collector, asking Tom for his coupon.

The component board for the PE 1969 metal detector.



The original circuit diagram for the inspirational metal detector, published in PE Jan 69, and designed by D. Bollen.



Normally Tom used the same numbers when doing the pools, but in his haste to get back to the search arrangements, he simply jotted down the crosses in a random fashion.

A few days later, while searching for the family's ring, Tom joked to the group, "Wouldn't it be great if I could win the pools, then we could do this kind of thing all the time!". Soon, the ring was found, the group returned home happy, and Tom's remarks were forgotten.

RECORD WINNINGS

However, the following Monday, Tom received a knock at the door. Incredibly, it was a representative from Littlewoods Pools who informed Tom that he'd won a lot of money. This turned out to be an understatement - the sum turned out to be a staggering £287,000, and Tom went into the *Guinness Book of Records* as the winner of the largest ever summertime pools handout!

The record-breaking prize provided the capital necessary to turn dreams into reality, and in the summer of 1971, the three colleagues formed Detectronic Ltd - what else could you call a company making metal detectors? *(I shall no doubt be flooded with replies to this question from other companies making metal detectors, including some of our advertisers! Ed.)*

NATURAL EXPANSION

For over eighteen months, the firm had great success making and selling detectors, but gradually, interests diversified and they moved into the field of marine electronics, making speed logs and ultrasonic echo sounders. *(Nice to know, Tony, of Keith's and your interest in the "Boating Revolution" articles in PE June-Aug 89. Ed.)* From here, it was a natural step to progress into fluid measurement and detection systems, and - using techniques based on the Doppler principle - the firm has been amongst the world leaders in their field for many years.

Throughout their existence, the firm has been based in Blackburn, Lancashire, and in 1988 the organisation moved into a brand new, purpose built factory. The workforce has steadily increased over the years, and now Detectronic Ltd employ over forty people, and has an average annual turnover in excess of two million pounds!

BOOK OF REVELATIONS

You may have guessed by now that Keith Smith is, of course, my father, and the little boy who used to leaf through the early editions of PE is now a graduate electronics engineer, and also writes the occasional article for PE - yours truly!

I can't help wondering, though, would things have been different if that metal detector project hadn't appeared in PE?

From little acorns ....

Looking up the files, and checking back with Tony Smith, the inspirational metal detector was the one designed by D. Bollen and published in PE Jan 69.

I know of several people who directly owe their choice of career to the interest in electronics inspired by PE. Your Editor is one such. Undoubtedly, there are many others. How about some of you telling me your story?

Tony Smith is, of course, the author of the periodic series of articles relating to Time and Frequency Measurement, one of which is in this issue. We shall shortly be publishing his Universal Counter Timer constructional project. Ed

PE

Tom, Keith and Peter with the PE metal detector in front of Detectronic's new purpose-built factory.

STATE SIDE

2014? WHEW!

Wayne Green believes that cars, comms and education will call the future hi-tech tune, but will it be Uncle Sam's song?

When you consider that only one magazine in nine manages to survive its first five years and about one in a hundred lasts 20 years, a 25th anniversary is a remarkable success story. It's even more amazing how much electronics has changed in this time.

As the editor and publisher of *73 Amateur Radio* magazine, which I started in 1960, I was right in the middle of the electronics and communications revolution which was just really beginning in 1964 - so I can tell you about it; at least from the American side. It's been one heck of a 25 years, but you haven't seen anything yet. Technology is progressing faster and faster, making predictions for five years ahead almost as difficult now as 25 years used to be.

PIVOTAL EVENTS

1964, oddly enough, was a pivotal year in America. It was the year a little-known event triggered our decline in consumer electronics - a weakness which Japan exploited mercilessly a few years later. Who could have guessed that it could lead to the destruction of the American consumer electronics industry and result in the emergence of Japan as the world's number one financial and industrial nation?

In the early 60s America was on top. We were busy developing the transistor, getting started with integrated circuits to help make our Apollo moon excursions practical, developing video tape, converting to colour tv.

So what happened? 1964 was before cb radio. It was before ham radio repeaters, which helped cellular radio develop. And the cellular radio we have today is just a hint of what I see coming for us in the future. A big hint.

Amateur radio was going strong in 1964, providing nearly 25,000 youngsters a year for the electronics industry as technicians, engineers and scientists. These electronics-crazy young hams were our primary new technology inventor and pioneer resource.

DISINCENTIVE LICENCE

Alas, in 1963 the American Relay League (ARRL), our national ham organization, pulled an all-time bummer. Frustrated over their static membership situation, they decided to do something "controversial." In late 1963 the ARRL petitioned the FCC to force virtually all hams to upgrade their licenses in order to continue using voice on the major ham bands. They called it "Incentive Licensing."

A few hams said, "Hey, that's a great idea - now we can get rid of all those turkeys who cheated to get their licenses and we'll have less interference." It turned out to be very few. The majority reaction was one of horror. Tens of thousands of hams sold their equipment in panic in 1964 and this, in turn, virtually stopped the sale of new equipment. Ham sales dropped 85% in one year, putting 85% of the ham stores and manufacturers out of business. Losing 85% of my ham store single copy sales and most advertisers in one year almost killed my *73* magazine.

OFF THE AIR

Soon gone were the famous old names such as Hallicrafters, Hammarlund, National, EF Johnson, Barker & Williamson, Central Electronics, Sideband Engineers, Technical Materiel, Thordarson, Stancor, Harvey Wells, Gonset, Multi-Elmac, Millen, Lakeshore Industries, Webster, World Radio, Eldico, Allied Radio, Lafayette Radio, United Transformer, Mosely and hundreds of smaller firms. It was a disaster!

Worse, school radio clubs by the thousands closed, wiping out the infrastructure which had been bringing us new hams. We had a net ham loss over the next few years and that dropped our engineer supply to a trickle. Today the ARRL figures show us having only 2.4% young hams.

At the same time that amateur radio was self-destructing in America, Japan instituted a no-code ham license. The Japanese kids went bonkers over amateur radio. Today there are radio clubs in virtually every school in Japan and these kids, buying parts to build experimental equipment, keep hundreds of electronic parts stores in business in Tokyo's Akihabar section. This is something like the old Radio Row on Cortlandt Street in New York before 1964 - only much more so.

REPETITIVE GROWTH

An interest in repeaters and cb (which had become a fad) helped US amateur radio grow again in the early 70s. Amateur radio repeaters, automatic relay stations atop mountains and tv towers which extended the range of mobile and hand (HTs) transceivers, went from a couple hundred in 1970 to over 12,000 today, covering virtually the entire country.

But now the ham newcomers, refugees from the intensely jammed cb channels, were mostly older people, so there was little resultant increase in youngsters wanting to become engineers. Indeed, today we're graduating far fewer engineers than we did in 1964, even though electronics has grown enormously. And 70% of our engineering graduate students are foreigners who will be returning to their own countries. The future for technology in America looks bleak.

BITS AND PCS

Now, let's see how technology has changed. By 1970 tubes were mostly a memory and ics were taking over. The need for an all-purpose programmable control ic for running washing machines and other electrical equipment resulted in the Intel 4004, a four-bit digital processor. When even more power was needed, they put two on a chip, bringing us the 8008, the first 8-bit processor.

Experimenters said *hmmm, look what we have here*, and turned the 8008 into the

first microcomputer and started selling kits. Intel added even more circuits to the chip, resulting in their 8080, which was announced in January 1975. Sales that year were $5 million and the microcomputer revolution was started. Computer sales proceeded to grow by 235% a year for the next eight years!

FIRST 73 BYTES

MITS advertised their new computer in *73* and the reader response was so incredible, I felt there was a need for a magazine devoted to this brand new technology. By July 1975 I was the proud publisher of the first microcomputer magazine, *Byte*.

In 1976 I visited Steve Jobs and Wozniak to check out their Apple computer prototype. I encouraged them to bring it to a computer show in Atlantic City. Jobs was there, right opposite the booth where I announced the start of *Microcomputing* magazine. Both were successful, with Apple six years later capturing 40% of the microcomputer market.

Microcomputing magazine spun off *8—Micro*, the first computer-specific magazine (Radio Shack TRS-80), then *InCider* (Apple), *Run* (Commodore) and a few others. Soon there were hundreds of small computer magazines and the micro revolution was in full swing.

Today there are few American business or schools without computers. The microcomputer has replaced the old work station in larger companies and computers are moving from local to international networking systems.

COMPACT FUTURE

So much for the past, now let's see what the future looks like. There's no way to predict technology break throughs, so let's see what developments our current technology probably has in store for us.

Digital audio, which was introduced about eight years ago, allowed the compact disc (cd) to pretty well trounce lps. Yes, of course I publish a cd magazine. But this development is leading us into digital video, which will bring high definition tv (hdtv) and computers together.

Through time-multiplexing and data compacting, we'll overcome many frequency shortage problems. Packet radio, as developed by amateurs, will make it possible to type messages on your pocket communicators and have them delivered anywhere in the world in seconds for pennies and, if you want, translated automatically into any other language. Of course, our communicators will have built in answering and message storing. Since this can all be implemented using currently available technology, and since there are firms (such as AT&T) working on these projects, I'm not giving my crystal ball much of a workout.

We're seeing impressive strides in data compacting, a technology which allows more information to be sent over fewer frequencies. We see bigger and better data storage systems - larger memory chips, digital audio tape, optical storage. The cd will eventually be replaced by a small card with the music (information) optically encoded. A small electronic scanner will read the data, eliminating our current ridiculously complex compact disc player mechanism which revolves the cd at a different speed for every revolution.

Our wireless pocket communicators will be personal message centres, telephones and even a credit card substitute. They'll pick up fm radio and tv too. Why not? They might even have small video cameras built in. But, since all previous attempts at getting people to use video phones have failed, perhaps we can use the camera to send full colour still pictures - as we do with amateur radio slow-scan. That way, if we want to show someone something over the phone, we can.

Oh yes, facsimile and copies are coming together and they'll be hooked into our communications/computer network too. We're already seeing the power and speed of mainframe computers heading toward laptop size. It isn't even going to take 25 years for laptops to outperform today's supercomputers.

TYRANTS AND TUTORS

All the above looks like it should be in place within 25 years...If. The big "if" is politics. With the communist countries disintegrating, the world could be in for some terrible disasters. People who have power won't give it up without a fight no matter what it does to their country. The Tiananmen Square massacre, I believe, is just a hint of what's ahead for most communist countries.

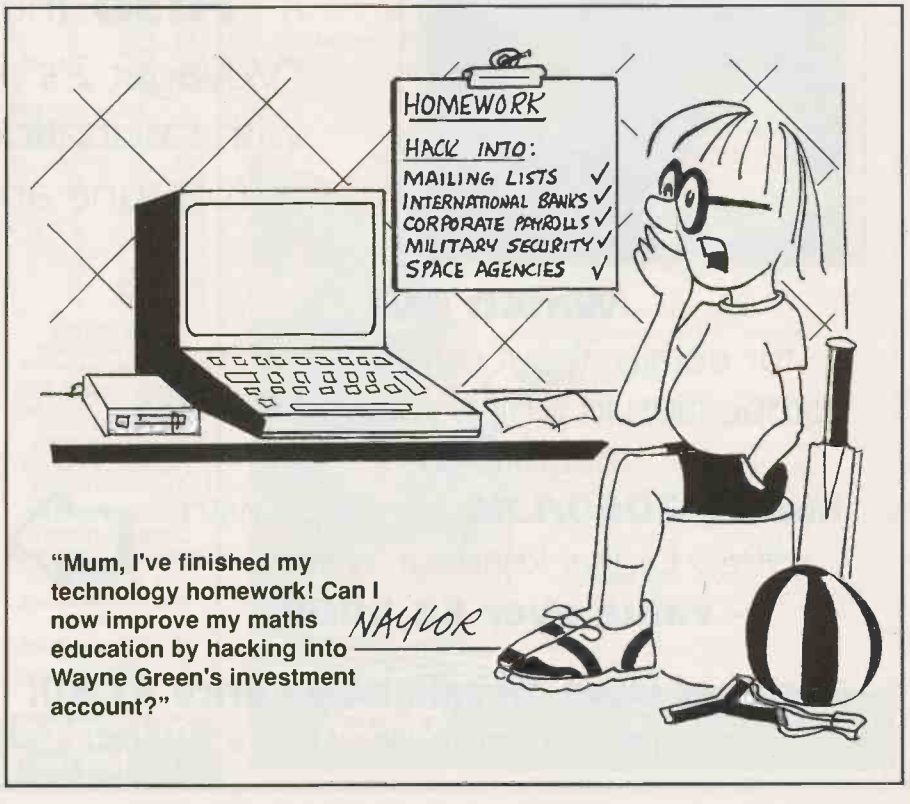
I'm hoping that low cost, high quality education can break the control tyrants have over so many third world countries. We'll see.

Will technology make it so the wealthier countries get even richer? Probably, but we may see some efforts at improving education coming out of the American educational disaster. I favour a move to educational video tapes which can be watched at home as a substitute for much of the current educational system. We'll still need schools, but mainly for making available the equipment and special teachers needed to teach skills.

Memorization and the forum style of teaching have been pretty well discredited as wasteful and ineffective. Today schools are starting to experiment with peer and tutor teaching methods. I favour video tapes with world-class exciting teachers - backed up by a monthly magazine devoted to each subject and peer group discussions in school.

In 25 years I would hope it would be possible to go from birth to a doctorate via video tapes, with skills such as driving, flying, public speaking, getting along with people, skating, skiing and so on taught in schools.

As parents are more able to work at home and commute electronically, the need for schools as baby-sitters will diminish. I already have some of my employees working at least half their time at home. They are integrated into my publishing computer system by telephone wires.



GREEN TRANSPORT

The need for cleaner air will force car companies to develop better electric cars. I see cars with electric motors on all four wheels. But, instead of a huge battery there will just be a medium-sized one, powered by a small constant-speed gas or natural-gas powered generator. This will enable us to build much less expensive cars and to greatly reduce pollution. This is not just a dream, by the way. Though I described just such a car about 15 years ago in an editorial, one of the largest car makers in the world is secretly working on just such a car right now.

Trolley cars used to use motors on their wheels, even using them as generators to put power back into the system when braking.

So that's what I see for 25 years from now in cars, communications and education. Practical breakthrough in fusion or superconductivity could change things enormously. It looks as if high speed trains may come to America and that would help reduce our dependence on air transportation. In 25 years? Maybe.

AEROBATICS

Commercial air transportation is only 51 years old. Since my father was an aviation pioneer, I lucked into being on the first commercial flight from Philadelphia to New York in 1928. I remember getting up in assembly and telling everyone in school about it.

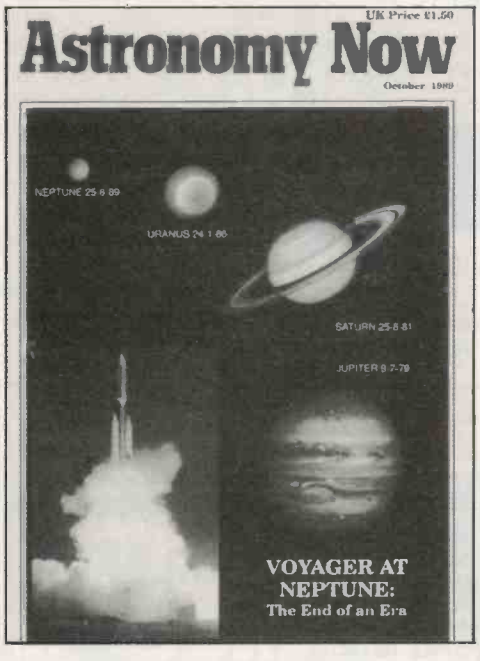
What's ahead in airplanes? Not much different, I expect. The Concorde has never attracted many passengers. Sure, it's fun to get there faster, but this fun requires a nonchalance about money which few of us can comfortably muster. I sure don't use it when I'm paying. Yes, I would travel more if it were faster and cheaper. Heck, I've passed up free trips to Australia just because it takes so long to get there.

If you get interested in developing technologies you'll find, as I have, many opportunities to profit from them. Entrepreneurs will have a great time. Unfortunately, it doesn't look as if many will be American. PE

Dr. Wayne Green lives in New Hampshire, USA, where he runs a successful publishing company. His hobbies include scuba diving and skiing. He is also passionately interested in the future of education.

Astronomy Now

Britain's leading astronomical magazine



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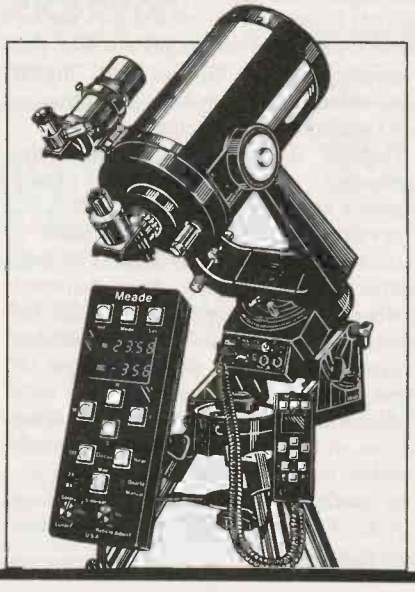

October issue on sale now - price £1.50!

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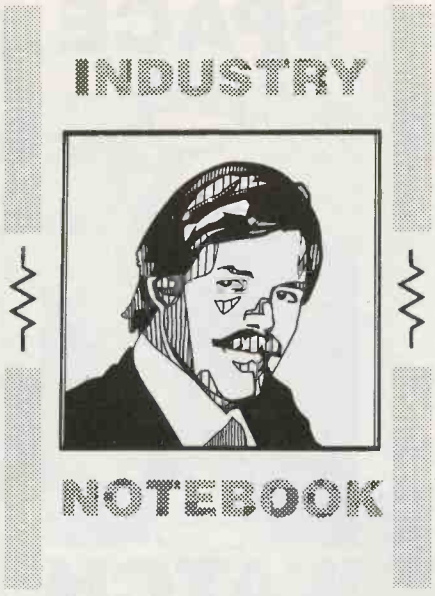
25 YEARS OF I.T.

Tom Ivall Assesses 25 Years of Information Technology, But Wonders if Green Issues Will Affect IT's Future.



The year PE was launched, British Telecom (then the GPO) started its Datel data communications service. For the first time computers could be linked together, and to remote terminals, through the public telephone system. It was the beginning of computer networking. In the same year BT also put into service its first, trial pulse code modulation systems, between exchanges up to about 15 miles apart. Thus digital transmission of speech and other analogue signals came into general use.

COMMUNICATIONS

1964 was also the year when researchers concluded that dielectric waveguides - solid materials rather than hollow pipes could be used for optical communications. Only two years later Charles Kao of STC published his now famous paper showing the feasibility of optical fibres for telecommunications. The laser had already been invented (in 1960) and this was soon followed by the semiconductor diode laser. So a practical means of converting electrical signals into optical form for the fibre was already available.

In this same year the first geostationary satellite, Syncom III, was put into orbit to function as a radio relay station in space. Only 12 months later an improved version called Early Bird went into regular service. It was the start of satellite communications and broadcasting.

COMPUTERS

Readers of the first PE issues would almost certainly be aware that digital computers had become an important application of electronics technology. But by 1964 only about 600 machines had been installed in the UK and these were all large, mainframe types. One of the most powerful, the Ferranti Atlas, was just coming into use at Cambridge University to run a program providing a mathematical model of the UK economy. Thus a more accurate technique for economic forecasting became possible.

But 25 years ago nobody could have realised that small, cheap personal computers for industry, commerce and the home would become generally available. Machines built from transistors and magnetic cores were certainly on the market, but the integrated circuit was still in its infancy - mainly in the form of small-scale logic devices - and the first microprocessor was not to appear for another seven years.

Nevertheless the benefits that computers could offer were well understood. In 1961 - 63 there had been an economic recession in the Western world. By 1964 we were just beginning to come out of it, but the great fear then was that economic growth would be restricted by a shortage of manpower. Productivity was seen largely as depending on the number of workers available to produce. But the more perceptive industrialists knew that labour productivity could be increased by automation - which was already going strongly electronic - and a few of them understood that on-line computers were central to the information processing in automatic control systems.

Thus the early 1960s saw the beginning of computer process control in industry. Some of the process control techniques used analogue computers in multi-loop systems, but in the end the digital computer became dominant because of its greater operational flexibility made possible by software programming. By 1964, for example, ICI was operating a complete soda-ash production plant under the control of a single digital computer. Using a time-sharing technique, it took over all the functions of the previous host of separate three-term controllers.

RECOGNITION

All these technical developments, and many others world-wide, had brought home to our rulers the growing importance of electronics technology and manufacturing to the country as a whole. This activity was no longer to be dismissed as a kind of ad hoc gadgetry somewhere on the fringes of the main business of industry. It was in 1964, in fact, that we saw the electronics industry officially recognised as a component of the British economy. The new National Economic Development Council set up an electronics 'Little Neddy', while Lord Mountbatten and other influential people decided that electronics research should be co-ordinated throughout the UK by a National Electronics Research Council.

Also in 1964 the UK's first Chair of Control Engineering was established at the University College of North Wales. The IEE launched its highly successful *Electronics Letters* journal for quick publication of R&D results and in the same year introduced Instrumentation and Control as a qualifying exam subject.

Over the intervening years these events had been made to look insignificant by the increasing dominance of Japan, the USA and now Germany on the world electronics stage. The UK is fast becoming a 'screwdriver economy', merely assembling devices originated and produced elsewhere, and consequently now has a large external trade deficit in electronics goods. However, the country as a whole - industry, commerce and the people - has not been slow to exploit the products of electronics, wherever manufactured. Information technology has resulted in new, efficient methods of working and different lifestyles for many individuals.

MICROCHIP YUPPIES

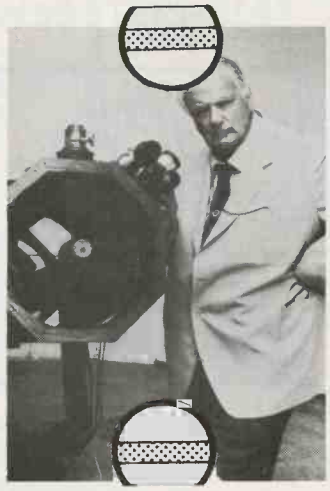
The novelist and academic Malcolm Bradbury, commenting recently on the 'yuppie' generation (specifically those who graduated in 1973), said "These Eighties kids ... were children of the information revolution: the microchip."

Personally I find the technological determinism implicit in this statement a bit too flip and simplistic. I think it more likely that the people concerned have been moulded by more pervasive economic, political and social pressures and have simply adopted whatever modern technology was around to help them pursue their perceived goals. In buying the technology they have encouraged its further development and production. This in turn has reflected back on general patterns of life and work. So it is really an interactive process, between people and things.

GREEN EFFECT

If the current Green movement in society proves to be more than a passing fad, there could could be a reaction against materialism, consumerism, profit, efficiency, Great Britain Plc and the instrumental approach to life. It will be interesting to see if any effects on electronics technology are reflected in the next 25 years of PE. PE

SPACE WATCH



BY DR PATRICK MOORE CBE

'Space', yes; but why a 'race' when we should work together? Plus a retrospective view of the 1980s.

The Australian Telescope is now in full operation. This is not a single instrument - it is a network of antennae, eight in all; six are near Narrabri in New South Wales, and the other two are the famous Parkes 'dish' and a new antenna near Coonabarabran. They make up a huge interferometer - much the largest ever constructed - and we may hope for many new discoveries in the near future. I will say more about it in an article later this year.

By now Voyager 2 has passed by Neptune, and started on its never-ending journey out of the Solar System. Obviously I am having to write this article before the pass, but I will report the results as soon as I can; I will be at the space mission headquarters in Pasadena, California, throughout the encounter.

At the end of October, Commander Henry Hatfield comes to the end of his two-year Presidency of the British Astronomical Association. He took over the Presidency at perhaps the most difficult moment in the whole history of the Association, and has worked wonders! He is succeeded by Colin A. Ronan, the well-known astronomical historian. The coming session is the BAA's centenary; the Association held its first meeting in October 1890. It has an observational record second to none, and among its Past Presidents are several Astronomers Royal.

MEN ON MARS?

In 1963 President John F. Kennedy of the United States gave a commitment to putting a man on the Moon before 1970. As we all know, this was achieved. Now, in 1989, President Bush has committed the United States to putting a man on Mars in the foreseeable future.

Unlike President Kennedy, Mr. Bush has not attempted to give a date - clearly he cannot - but at least the intent is there. What is slightly worrying is his emphasis upon putting America back into the lead so far as space is concerned. It seems, however, that the whole concept of a 'space race' is a hindrance to real progress. In some ways the Americans are far ahead of anyone else, but the same applies also to the Russians - their space-station techniques are unrivalled - and we must not forget that British technology has also played a very major part.

Obviously, a Martian voyage is far more difficult than a there-and-back trip to the Moon, as Colonel Yuri Romanenko emphasised when I talked to him recently; associated "minor" problems, such as air and water supply, become anything but minor when considering a journey which takes months instead of days, and which cannot be aborted in the way that Apollo 13 was. If we are to reach Mars, it must surely

THE SKY THIS MONTH

Mercury, the innermost planet, is on view this month. It is a morning object, and will be visible for the first three weeks of October, also it is close to the celestial equator, so that there should be little difficulty in seeing it with the naked eye shortly before sunrise. Greatest elongation (18 degrees from the Sun) occurs on the 10th of the month, when the magnitude is -0.5 that is to say, brighter than any star visible from Britain apart from Sirius, though since Mercury is seen against a bright background it never appears really prominent.

Venus is an evening object. As always, it is brighter than anything else in the sky apart from the Sun and the Moon, but unfortunately it is well south of the equator, and this means that it sets not very long after the Sun. On October 17 Venus passes less than two degrees north of Antares, the red star in the Scorpion. Greatest elongation is reached on 8 November, so that throughout October Venus is gibbous, i.e. more than half-phase but less than full.

Mars is to all intents and purposes out of view, but Jupiter is a brilliant morning object in Gemini. It does not come to opposition until the end of December, but already it can be seen for much of the night. Saturn, well south of the equator, is visible in the early evening; the ring system is still wide open.

The Moon is at first quarter on October 8, full on the 14th, last quarter on the 21st and new on the 29th. There are no solar or lunar eclipses this month.

The main meteor shower is that of the Orionids, associated with Halley's Comet. Maximum is reached on October 22, so that the Moon will not be really obtrusive; the meteors tend to be swift, with long trains, and the ZHR or Zenithal Hourly Rate is around 25. There may also be some Taurids; the shower begins around October 20, though the ZHR is seldom more than 8. The Taurids are associated with Encke's Comet, which has a period of only 3.3 years - the shortest known.

When I last compiled these notes we were still searching for the periodical comet Brorsen-Metcalf, which has a period of 72 years and is thus of the same type as Halley's Comet, though much fainter. It was originally found in 1847, and seen again in 1919, when it attained magnitude 4.5 and developed a tail almost 2 degrees long. It had been expected back early this year, but failed to put in an appearance. When it was eventually recovered, it was considerably away from its predicted position. The original predicted position for October 1 was RA 10h 59m.8, dec +11°45', the corrected position now predicted is RA 11h 20.6m, dec +2°15! This is quite a difference, so that there has presumably been some non-gravitational effect - perhaps due to activity in the comet itself. When I observed it in late July, using my 15-inch reflector, the estimated magnitude was 7.5, and there were three faint tails. During October the comet should be above magnitude 8, and only slightly south of the celestial equator.

The Square of Pegasus is still prominent in the evening sky. It is interesting to look at its four stars in turn, preferably with binoculars; three of them are pure white, but the fourth, Scheat (Beta Pegasi) in the upper right of the Square is clearly orange, indicating a lower surface temperature. Well below Pegasus you can still make out Fomalhaut in the Southern Fish, one of the stars found to be associated with cool material which just may be planet-forming. The Great Bear (Ursa Major) is low in the north, with the W of Cassiopeia almost overhead. The Summer Triangle is sinking in the west; in the east, the Pleiades come into view soon after dark, heralding the approach of winter, and by the early hours we can also see Orion, which will dominate the scene right through until next spring. This is a good time to sweep along the Milky Way, from Orion and Auriga in the east through Cassiopeia and down to Cygnus and Aquila in the west. It is strange to reflect that the stars in the Milky Way are not genuinely close together, and that the lovely, shining band is nothing more than a line of sight effect as we look along the main plane of our flattened Galaxy!

be as an international project rather than a national one. The proposed Juno programme, when a British astronaut will make a flight in a Soviet space-craft, is certainly a step in the right direction.

When will Mars be reached? Making forecasts is always a dangerous business. If pressed, I would say that a reasonable date would be around 2020, but I may well be wrong by 20 years either way!

With nostalgia in mind for this celebratory issue of PE, we asked Patrick to summarise the significant Spacewatch events over the last decade:

SPACE IN THE 80s

Looking back at the 1980s, it seems to me that we have a mixture of consolidation, triumph and tragedy. We have seen the Voyager passes of the outer planets, and the remarkable encounters with Halley's Comet: the Russians have built a major space-station; but we have also had the Challenger tragedy which has put the American programmes back for years.

When the decade opened, Voyagers 1 and 2 were on their way to Saturn. Both probes by-passed the Ringed Planet, sending back magnificent pictures, and subsequently Voyager 2 went on to an encounter with Uranus in 1986. Meanwhile, the Russians were concentrating on the inner planets, and in 1982 their Veneras 13 and 14 landed on Venus, providing improved pictures and data. At the same time two cosmonauts, A. Berezevoy and V. Lebedev, spent two months in the space station Salyut 7 - a record at that time.

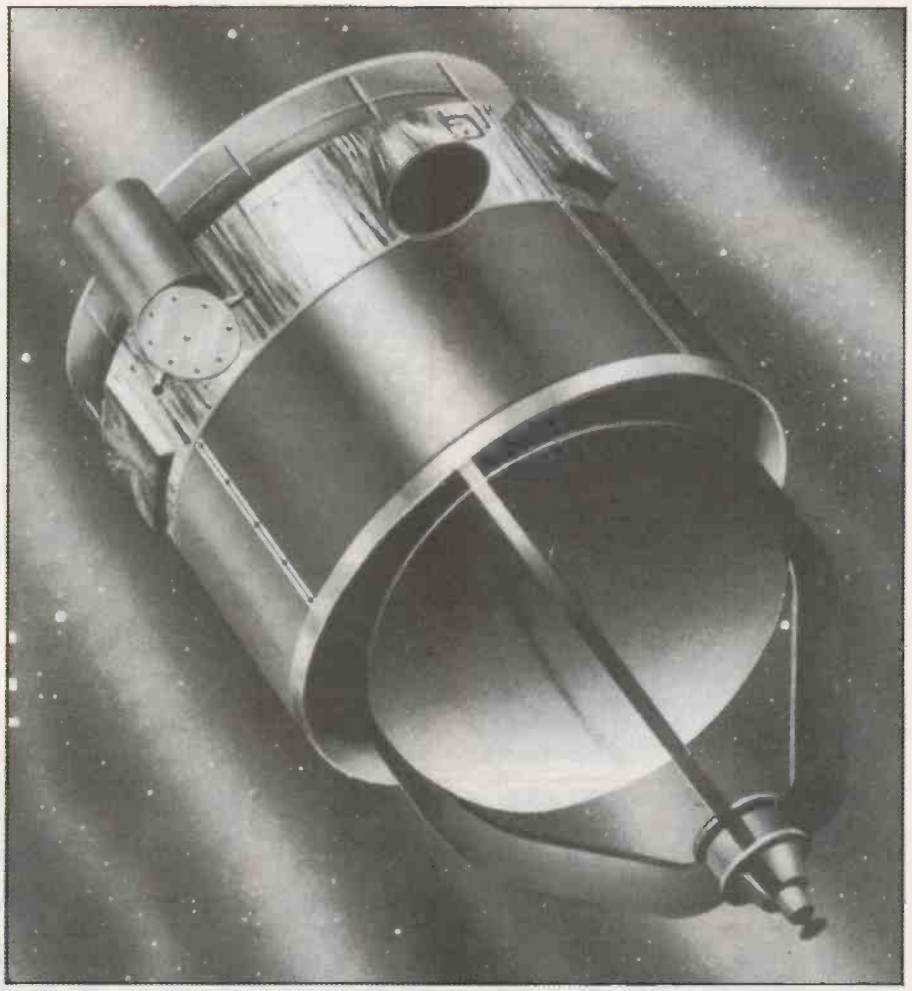
1983 provided a triumph of a totally different nature. IRAS, the Infra-Red Astronomical Satellite, operated for most of the year, and revolutionized our knowledge of the infrared sky: it also gave evidence of cool, possibly planet forming material around various stars, notably Vega, Fomalhaut, and the southern Beta Pictoris, which may well have a planetary family. Incidentally, the IUE or International Ultra-Violet Explorer satellite, dating from the 1970s, was still working well; and as I write these words, in September 1989, it still is - and has provided more research papers than other satellite in history!

1986 began with the fly-by of Uranus by Voyager 2. Up to that time our knowledge of the strange, green planet had been somewhat meagre, but Voyager performed faultlessly, and was then put on its way to its final target - Neptune.

HALLEY'S COMET

But before long, Uranus was forgotten in the popular mind, by Halley's Comet, which was paying us its first visit since 1910.

As a spectacle, Halley`s Comet was not impressive - it and the Earth were in the wrong places at the wrong time - but it was the most important scientific return in history. Five probes encountered it: two Japanese, two Russian, and one European. The European probe, Giotto, actually penetrated the comet`s head, and sent back our first reliable information about a cometary nucleus. Surprisingly, Halley was dark, not bright, and highly active. In this mission America played no major role; their own Halley probe had been cancelled because it would cost too much - a lapse which the United States will certainly regret until the comet comes back once more in the year 2061!



Paul Doherty's impression of the Giotto probe which encountered Halley's Comet. The illustration was used on the front cover of PE December 1985.

A year later, the Russian cosmonaut, Yuri Romanenko, completed 326 days on board the space-station Mir. But the American space programme had been struck by tragedy. Only a few days after the Halley armada had by-passed the comet, the Challenger Shuttle exploded, killing its crew and putting U.S. space research back for at least a decade. Quite apart from the human tragedy (which was the most important factor of all, needless to say), very important probes were delayed or cancelled, including the Galileo mission to Jupiter and the Ulysses probe vehicle. Magellan, bound for Venus, was delayed until the spring of 1989, and Galileo, due for launch in October of that year, cannot now reach its target until 1995. Another casualty was the Hubble Space Telescope, for which astronomers all over the world have been waiting for many months. With luck, it may be in orbit by next summer, but we can only hope.

The Russian bad luck with Mars continued. In 1988 they launched two space-craft, with the main intention of making a close survey of Phobos, the larger of the two Martian satellites; one of the probes was lost by human error (the wrong command was sent out) while the other simply went out of contact. Yet Voyager 2 more than made up for this loss. In August 1989 it by-passed Neptune, sending back amazing pictures both of Neptune itself and its strange, nitrogen-ice covered satellite Triton, which has been described as 'the most mysterious thing we have ever seen'.

LOOKING AHEAD

Now, as the 1980s draw to their close, we must look ahead. Nations as well as the USA and the USSR have joined in the space programme, and we must hope that international collaboration will become really positive in the next decade. Plans for further probes have been drawn up, and even if not all can be successful (the loss of the Hipparcos astrometric satellite in 1989 was a disaster) there is plenty of scope. Before the year 2000 we may hope for major space-stations, further unmanned probes, and even a base on the Moon; but we must not forget that the foundations of these plans, drawn up originally in the 1960s and the 1970s, were consolidated in the 1980s. PE

Last month the basic system was described and we ended with a description of the decoded UART.

STEPPER MOTOR CONTROL

One of the very frequent operations in control is switching. This might be done by pulsing a logical toggle circuit with one of the uart decoded lines and a second line to set the toggle in its correct state at the beginning of the programmed sequence. Alternatively it may be achieved using an s-r latch as shown in Fig. 6 which represents a scheme for controlling a stepper motor.

On receipt of the character that makes line A go low, the state of the motor directional control goes high and remains high even when line A is returned to high. Reversing of the motor direction is achieved subsequently by applying a low signal to line B. Stepping the motor in the chosen direction is achieved by applying changes of state (down/up) on line C.

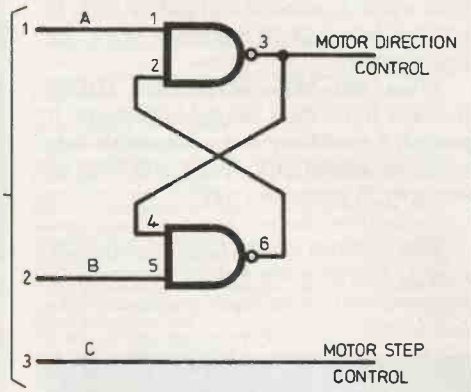
Such a control of a stepper motor provides an excellent example to demonstrate the simplicity of the required programming. Suppose that the uart decoded control lines 1, 2, 3 are chosen to operate the stepper motor as in Fig. 6. In the preamble to any program, it is convenient to establish "Defined Procedures" to streamline any sequence that the motor has to perform. As an example, the variable "f" might be defined to set the motor in the forward direction as follows:

```
300 DEFine PROCedure f
310 PRINT #5, CHR$(1) ; CHR$(0)
320 END DEFine
```

Similar procedures may be defined for Reversing and Stepping (r,s) the latter including a short pause to lengthen the pulse given to the motor. The overall program preamble might read:

```
120 BAUD 9600
130 OPEN #5, ser 2
300 DEFine PROcedure f
310 PRINT #5, CHR$(1) ; CHR$(0)
320 END DEFine
330 DEFine PROCedure r
340 PRINT #5, CHR$(2) ; CHR$(0)
350 END DEFine
360 DEFine PROCedure s
370 PRINT #5, CHR$(3) :
PAUSE 2 : PRINT #5, CHR$(0)
380 END DEFine
```

Fig. 6 The S/R-latch comprises two elements of a quadruple 2-input positive NAND chip (7400) and is set by line 1 and re-set by line 2. Line 3 operates the motor step.



With these procedures established by running the above program, the motor can be controlled by typing f, or r, or s on the keyboard. These procedures may also be incorporated into a program for a motor movement sequence. The following example causes the stepper motor to oscillate between two positions separated by 48 steps, ie, one revolution for a 7.5° per step motor.

```
400 f
410 FOR n=1 TO 48
420 s
430 END FOR n
440 r
450 FOR n=1 TO 48
460 s
470 END FOR n
480 GO TO 400
```

TELESCOPE CONTROL INTERFACE

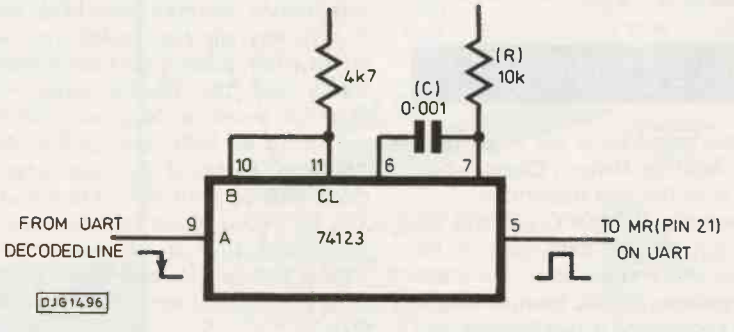
PART TWO
BY DAVID CLARKE

Concluding Circuits and Software for a Multi-Purpose Parallel-Serial Interface.

IRREGULAR TIMING

The executions of a program, particularly when loops are involved, do not necessarily take exactly the same time on each run. This is because the computer might be multitasking and makes checks on its "housekeeping" occasionally. Small amounts of time may be lost during the operation of the programmed tasks and this may vary on different runs. In most cases it is unimportant. For stellar photometry, photon counts need to be assembled over exact integration times. The most simple

Fig. 7 A monostable (74123) is used to provide a master reset to the UART from the computer. Similar circuits may be used to provide controlled pulse lengths for outside use via any of the UART decoded lines, according to the RC values of the monostable.



arrangement would be to operate an s-r latch, similar to the system described for the stepper motor control, by two of the uart decoded lines, one defined to Open (o) and the second defined to Close (c) the counter. A basic integration could then be performed by a simple program such as:

```
500 o
510 PAUSE 800
520 c
```

with the integration time being set by the numerical value of the PAUSE statement. However, by counting pulses from a standard oscillator in place of photon counts, experience shows that the integration times vary slightly from one run to another.

In the developed system for the stellar photometer, this problem was overcome by using an external oscillator to provide the time-base. The defined procedure "o" is used to operate an s-r latch which in turn opens a gate to let the external clock pulses through. The first pulse from the clock, which is then passed, opens the photon counter. After the required number of clock pulses have been counted either externally or by the computer, the defined procedure "c" may then be transmitted to operate the s-r latch so that on the next clock pulse the integration is completed and the computer informed. The short program below provides an example of achieving an exact integration of one second using an external clock running at 10Hz.

```
500 o
510 FOR n -=1 TO 10
520 z$=INKEY$ (#5, -1)
530 END FOR n
540 c
550 z$=INKEY$ (#5, -1)
```

The INKEY statement within the program has been defined so that the computer waits until a character is received from the uart. The string character z$ is a dummy variable to accept any character despatched by the uart. Its "value" is not used and only serves to act as a trigger to allow the program to procede. The detail of how the character is transmitted and how its timing is arranged so as to be accepted by the computer is described later.

MASTER RESET

As depicted, the Master Reset (MR) has been permanently set low. If it is required to have it operable, a push button switch may be incorporated so that the input may be made temporarily high and then returned to low.

It may also be worked by computer control, but it cannot be connected directly to one of the uart decoded lines. With the MR high, this being the normal state of a decoded line, the whole of the uart becomes inactive, making communication impossible. Inverting the signal from a decode does not help; when the MR goes high the uart is inhibited and no further signals can be received to return the MR to low.

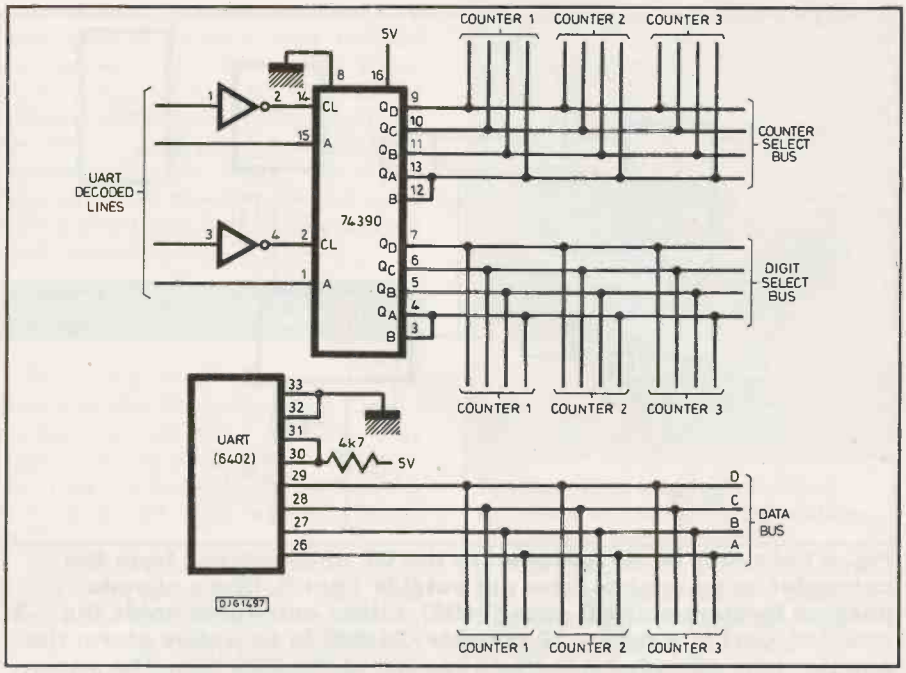


Fig. 8 For UART decoded lines operate the counter select and digit select buses via a dual ÷ ten counter (74390). The inputs to the clears are inverted by two elements within a hex inverter chip (7404). Each counter has a preset magnitude comparator chip (7485) which on recognising its pattern on the counter select bus allows its data to be connected to the data bus. The data select bus controls the outputs of multiplexers in the counters so that each digit may be selected in turn and placed on the data bus which is terminated at the lower order inputs of the UART, the higher ones being preset as explained in the text.

A simple way to overcome the problem is to connect the output of a monostable (74123) which is triggered on the rising edge of a chosen uart decoded line. A suggested arrangement is depicted in Fig. 7. Indeed, this kind of design may be applied to any of the decoded lines to produce pulses of desired length, both positive and negative going, for subsequent use.

Data Addressing

In the photometer system, the generated pulses produced by stellar photons are accumulated in various counter units. At the end of each integration, the counts are transferred to latches with their outputs in turn connected to multiplexer chips. When a BCD code is placed on the multiplexer address bus, the code corresponding to the position of a particular digit, the value of that digit, again in BCD code, is placed on the data bus. This bus is terminated on the lower order binary input buffers of the uart as described earlier. On receipt of the Defined Procedure Despatch (d), the value of the digit is transferred to the computer as an 8 bit ascii code.

The digit address bus corresponds to the BCD output lines of a divide-by-ten counter (7490 or half of a 74390) whose reset and advance count inputs are controlled by two of the uart decoded lines. A working circuit is depicted in Fig. 8. Suppose Defined Procedures have been established within the program to Reset the Digit count (rd) and Advance the Digit (ad). An eight digit accumulated photon count might be transferred to the computer, using a routine such as:

```
600 a$=""
610 rd
620 FOR n = 1 TO 8
630 d
640 b$=INKEY$ (#5, -1)
650 a$=a$&b$
660 ad
670 END FOR n
680 PRINT a$
```

The first statement sets the string variable a$ as "null". After resetting the digit address bus to zero, the eight digits are interrogated and despatched to the computer, each being coerced into a$. Finally the sequence of digits is displayed as a single number on the screen. Within a more elaborate program, the value would then be stored and used later in the data reduction calculation. Again the arrangement for the operation of the despatch of characters to the computer (lines 630, 640) is described under "Transmission Control" below.

If the collection of data occurs several times in a longer program, it is more efficient to write the above routine as a Defined Procedure so that a statement such as *type* would undertake the reading in of a data line. An interesting outcome of the workings of the data bus is that if all the BCD lines are high or are left floating because of some failure, the code corresponds to CHR$(63) and the returned digit is "?".

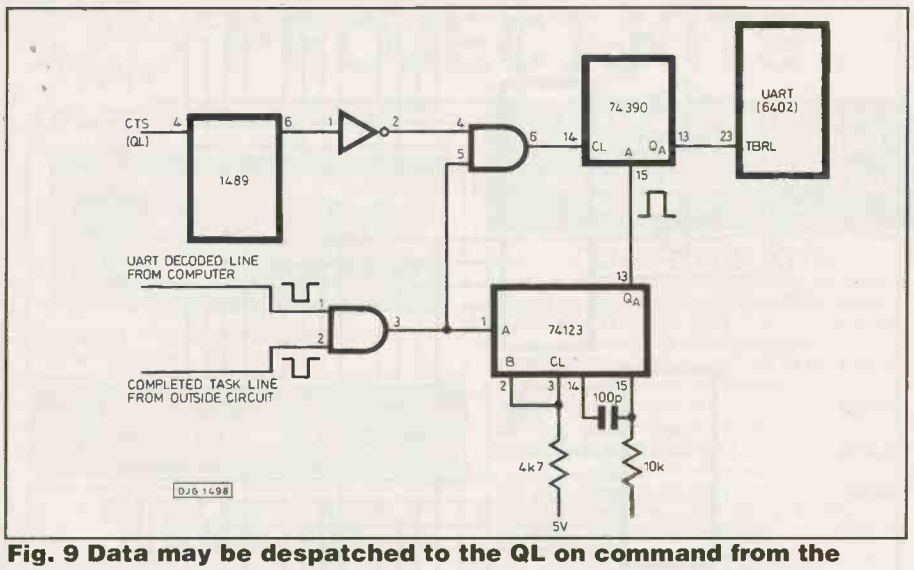


Fig. 9 Data may be despatched to the QL on command from the computer or by control from the outside circuit, these signals passing through an AND gate (7408). Either command holds the ÷ 2 counter (part of a dual ÷ 10 counter -74390) in an active state; the counter may already be active because of the CTS line. The same command pulse generates a delayed pulse to advance the counter, giving a high level at the TBRL pin of the UART. The level can only be returned to low with the UART despatching its loaded character when the command pulse has passed and ultimately when the CTS of the computer is high.

In a more complex system involving several separate counters, another similar address bus is required to select which counter is made active to allow its multiplexers to be attached to the data bus. In the stellar photometer the selection is achieved by including a preset magnitude comparator chip (7485) in each of the counter units with its inputs connected to the counter address bus as depicted in Fig. 8. As before, Defined Procedures can be established within the program to set the counter address bus to zero and to advance it in sequence.

Control Transmissions

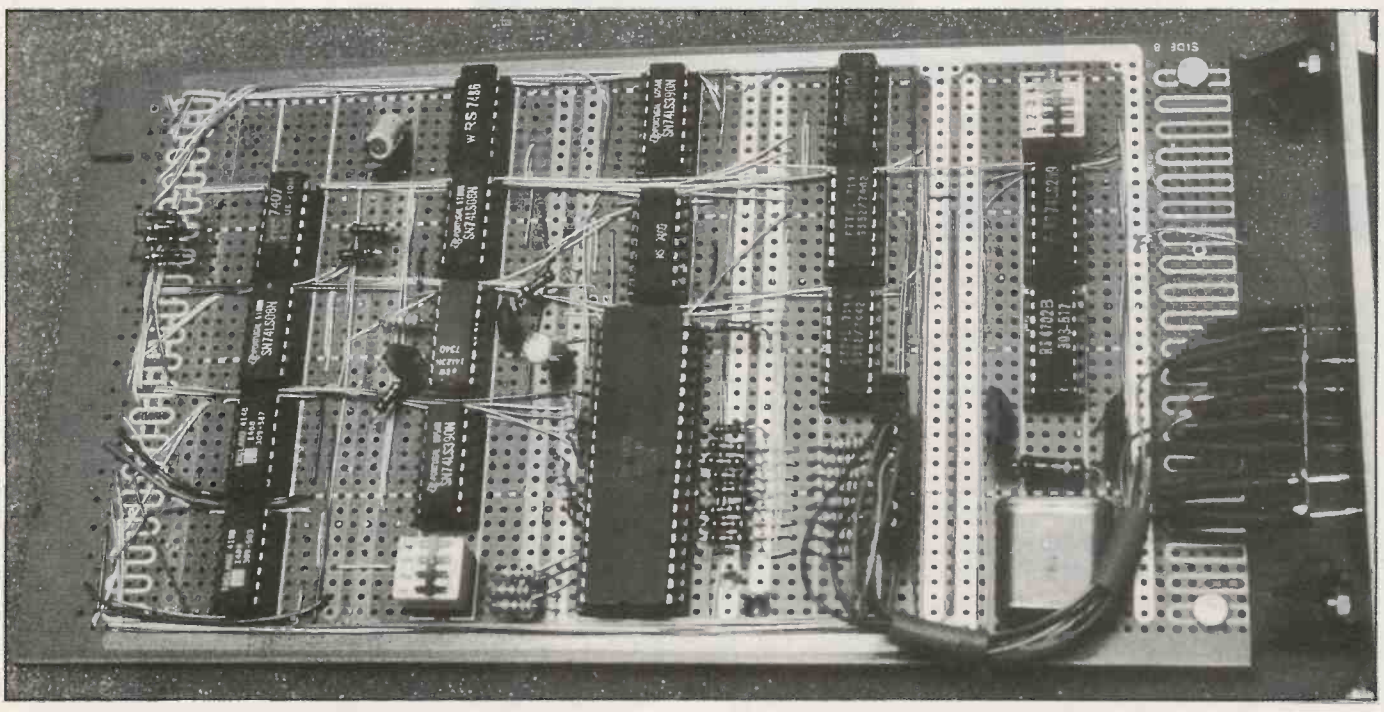
Information for transmission from the outside circuit is of two kinds. It may be in the form of a signal indicating that a task has been completed or it may be digits of data that have been requested by the computer, say by a Defined Procedure such as Despatch (d) or *type*.

In either case the character may only be received correctly if the computer is in a state of readiness as indicated by its CTS signal. There are many ways of achieving this but a solution is given in Fig. 9. The design is based on unused elements within chips already available in the stellar photometer. There are many other alternatives using other kinds of ttl circuitry.

The eight bits describing the character to be despatched are loaded and transmitted by instruction to the transmitter buffer register load input (TBRL – pin 23). A high to low change on the TBRL causes the serialised character to be transmitted.

The computer is ready to receive a character via its serial port when the CTS line is high. This line is sensed at the receiver chip (1489) and is inverted. In the design here it is re-inverted by an element within an hex inverter (7404). The despatch of the signal to the uart is obtained by using a divide-by-two (part of a 74390) which is advanced by a computer return signal from the circuitry or by a Despatch signal direct from the computer. Either of these signals releases the clear on the counter if it is not

Photo 4. The designed serial to parallel interface board which allows control of the photometer, or other equipment. The left hand column provides selectable baud rates; the second column decodes the eight parallel output bits of a despatched character to 18 switchable lines, each character being read by the eight leds on the front panel. The third column holds the 40-pin UART chip. At the top right the receive/transmit chips allow connection to the serial port of the microcomputer. All other ics controlling the master reset, the switching of stepper motors, the operation of the photon counter address bus, digit address bus and data bus are dispersed on the board.



already clear by the CTS. The same down – going edge of the release is made to trigger a monostable and the return falling edge of the produced positive pulse is used to advance the counter so making its output go high; by design of the monostable pulse length, the counter is advanced before the clear line is returned to a high state.

When the command to send pulse disappears, the counter will normally be cleared and the uart activated to send the character which it is holding. However, by connecting the CTS via the AND gate shown in Fig. 9, the clear can only be activated when both the send pulse has passed and the CTS is high. Ultimately, therefore, it is the CTS that is in control of the counter's clearing and the despatch of the send signal to the uart.

INPUT BUFFER CLEARING

At switch on or before any program has been run and taken control of the states of the circuitry, several characters may have been inadvertently transmitted to the computer and may be lurking in the serial port buffer. A call to read the port would produce these buffered characters first before reading in the ones that have been asked from the attached circuitry. Before running any program it is desirable to *clean* the input buffer and this can be done using software in the form of a Defined Procedure routine as follows:

```
260 DEFine PROCedure clean
261 REPeat loop
262 z$=INKEY$ (#5)
263 IF z$=" " THEN EXIT loop :
    END IF
264 END REPeat loop
265 END DEFine
```

ie, the routine of interrogating the buffer is repeated until a "null" is returned. The *clean* instruction can then be used at any time either via the keyboard or within a program.

FURTHER READING

Polarized Light and Optical Measurement – D. Clarke and J. F. Grainger – Pergamon Press (1971).
Astronomy: Principles and Practice (now in 3rd edition).
Astronomy: Structure of the Universe (now in 2nd edition) – A. E. Roy and D. Clarke – Adam Hilger.
The astronomy texts have been standard choices for courses given within Universities and Polytechnics.

Dr David Clarke is a lecturer at the Department of Physics and Astronomy of Glasgow University.

Detailed information on the assembly of the interface board is not offered for this feature, which is more suited to advanced constructors. The wiring of the board and selection of components should be carried out in conjunction with photo 4, the circuit diagrams and the descriptive text. **PE**

ETHEREAL

Perhaps one of the less well known historical technocrats is Albert Gallatin Whitney of Chicago. He believed that he could also extract "electricity from the interplanetary ether". His idea was to send a cable many miles up into the atmosphere, either by shooting it up there, or raising it on an airship. Presumably knowing something that Newton had overlooked, he was convinced that gravity could then be overcome without energy loss. He maintained that the ether had properties which would draw the top end of the cable ever further upwards. The cable would, as Franklin had discovered, conduct electricity down to the ground for collection or distribution.

Amazingly, even though his ideas were never tried, (unless the Indian rope trick is an attempt at validation), he was granted a patent on them in 1903! Ed.

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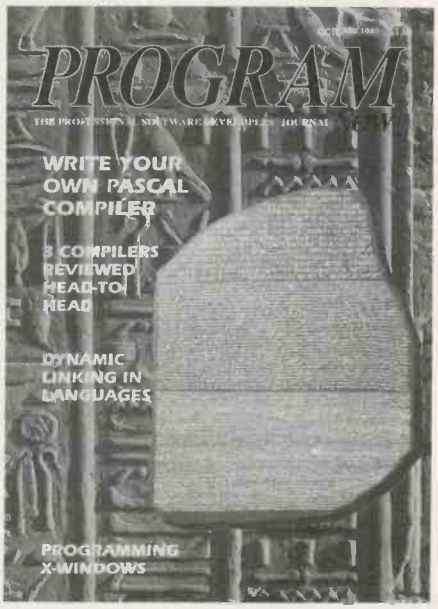

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HF RADIO

PART FOUR
BY MIKE SANDERS

The Amplifier Alphabet May Be Short, But It Characterises Efficiency.

Ending last month with a look at filters, we now logically move on to tuned amplifiers.

TUNED AMPLIFIERS

There are instances when the linearity of class A is not required and the better efficiency as well as simplicity of class C can be used. For instance in continuous wave transmission (Morse) the listener is only interested in detecting breaks in the transmission and not the fidelity of the amplitude variation.

Fig. 43 shows a tuned amplifier using a fet. In a valve circuit the valve acts as a current source but the class C operation of a transistor is a bit more complex. Class C amplifiers are driven hard into saturation during a part of the rf cycle.

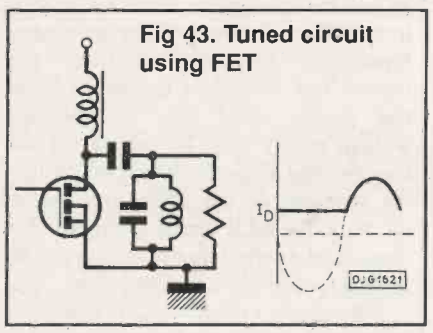


Fig 43. Tuned circuit using FET

This results in an rf voltage source whose amplitude depends largely on the drain voltage and not sensitive to variations in the driving voltage. This means that amplitude modulated waves can be produced by variations in the drain supply voltage.

Fig. 44 shows a bipolar transistor in class C operation together with the waveforms. The transistor class C is a mixed mode operation unlike pure class C in valves. The mixed mode results from difficulty in providing bias and drive for pure class C.

Frequency multipliers are widely used in cw, am and fm transmitters. Frequency multipliers are designed mainly for intermediate power stages but are sometimes found in transmitter output stages. Fig. 45 shows one layout for a multiplier using a varactor diode.

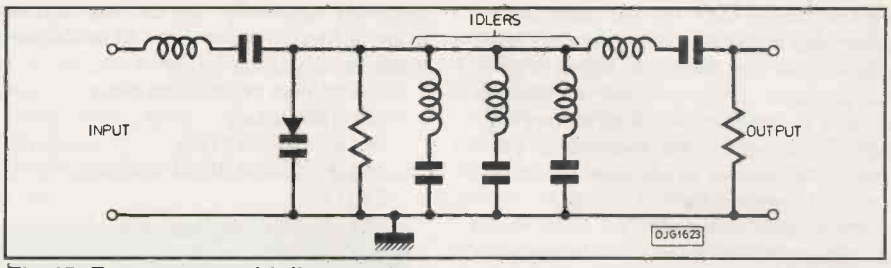


Fig 45. Frequency multiplier

A varactor diode is a voltage capacitor with a non-linear characteristic. In theory it should not dissipate energy in converting from one frequency to another but in practice it is only 70% to 80% efficient.

To keep Fig. 45 simple, the networks to match the multiplier are not included, but they are connected through series tuned circuits to keep the current and voltage at both input and output sinusoidal.

The circuits at the input and output may be of low or high impedance and if mismatched, only a small portion of the signal is transferred. The situation is improved by employing idlers which are series tuned LC circuits with resonant frequencies which are harmonics of the output. The values of L and C are determined by experiment.

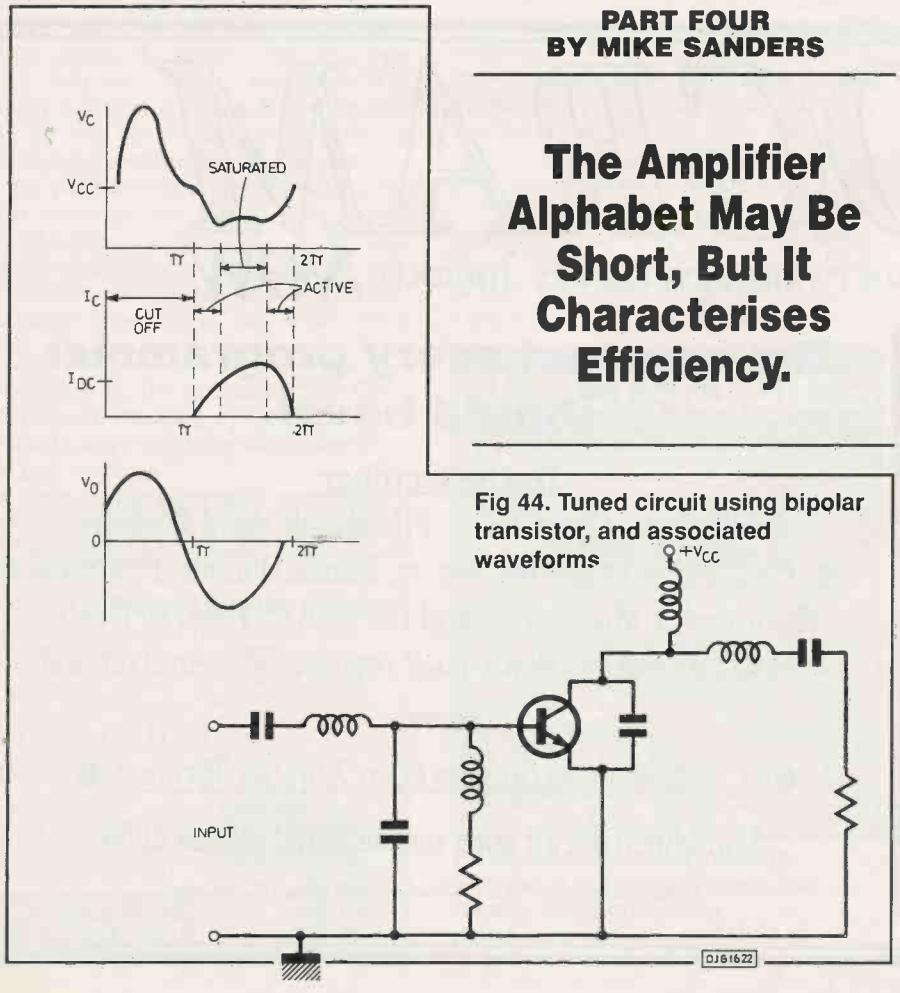


Fig 44. Tuned circuit using bipolar transistor, and associated waveforms

HIGH EFFICIENCY AMPLIFIERS

Class	Version	Number of devices	Efficiency %
A	Single ended	1	50
B	push-pull	2	78
C	partial cycle	1	90
D	voltage or current switch	2	100
E	switch mode	1	100
F	harmonic resonator	1	84-88
G	complementary two supplies	4	84
H	class B current source	4	100
S	switch mode	2	100

Fig. 46 Amplifier efficiencies

Amplifiers achieving higher efficiency than class A, B, C are class D, E, F, G, H, S. Fig. 46 shows the efficiency of ideal

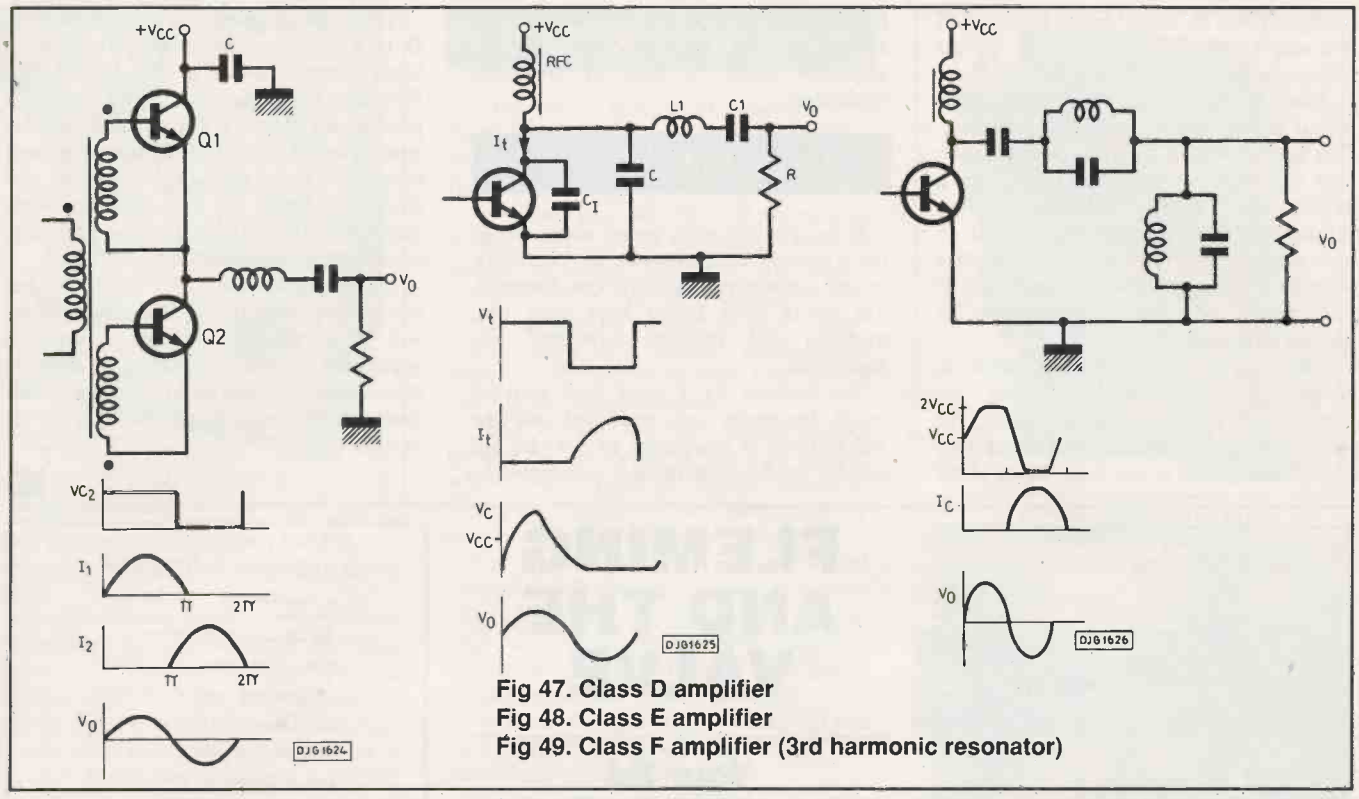


Fig 47. Class D amplifier
Fig 48. Class E amplifier
Fig 49. Class F amplifier (3rd harmonic resonator)

devices, the configuration commonly employed and number of transistors used. The demarcation between these modes is not sharp as we have seen and neither are the definitions universal. Designers sometimes call class D, class S.

The greater efficiency of these devices is obtained by reducing the average collector current and voltage and hence the power dissipation. In the switch mode amplifiers D, E and S, the active device is used as a switch rather than a current source. Since an ideal switch has no voltage drop across it and takes no current, it does not dissipate any power.

Other methods are used for high efficiency power amplifiers in class F, G and H. Such techniques include multiple supplies to reduce the current-voltage product and the use of harmonic resonators. In practice, devices have a finite switching time, saturation voltages and resistance and stray reactances, all of which reduce the efficiency.

Fig. 47 shows a class D amplifier in complementary mode. The output of the transformer drives Q1 and Q2 in antiphase and C is large enough to bypass ac to earth and therefore maintain a constant voltage on the collector of Q1.

The rectangular waveform in Fig. 47 shows that Q1 and Q2 are acting as a two pole switch. Class D amplifiers are used in low power hf transmitters and in am transmitters.

Fig. 48 shows a class E amplifier using a single active device. The switching transistors drive the passive network comprising C_1 L_1 C_2 R. The internal capacitance C_j of the transistor is supplemented by C_1 and since it has been included in the design, the efficiency is improved by reducing the power lost within the transistor. In Fig. 48, the waveforms V_t and I_t are the voltage and current into the transistor switch.

Fig. 49 shows one of the oldest methods of improving amplifier efficiency. In class F operation the load resonates at one or more harmonics of the carrier frequency as well as at the carrier frequency. This is called the biharmonic, polyharmonic or multiresonator method. In the waveforms of Fig. 49, the collector voltage waveform is flattened by the third harmonic.

Fig. 50 shows a circuit and waveform for a class S amplifier. As can be seen from the waveforms, the circuit can be used as an amplifier or as an amplitude modulator. In either case the transistors and diodes act as a two position switch. The output rectangular waveform is then applied to a low pass filter which passes only the slow varying average of the waveform through to the load.

Amplifiers using class S, G and H have been used in stereo amplifiers. Class S was invented in 1932 but became popular only since the 1970s with the advent of integrated circuits. Just like class S, classes G and H can be used in amplifiers as well as in amplitude modulators.

Class G is easier to implement when more than one supply voltage is available, like batteries in series. For instance, whereas class B complementary operation requires two transistors, complementary class G uses four transistors. Two of these operate from the full supply voltage and the other two from half the supply voltage.

Both pairs operate as current sources with the second pair operating when the output signal is lower than half the supply voltage. This makes it twice as efficient as with the first pair operating off the full supply

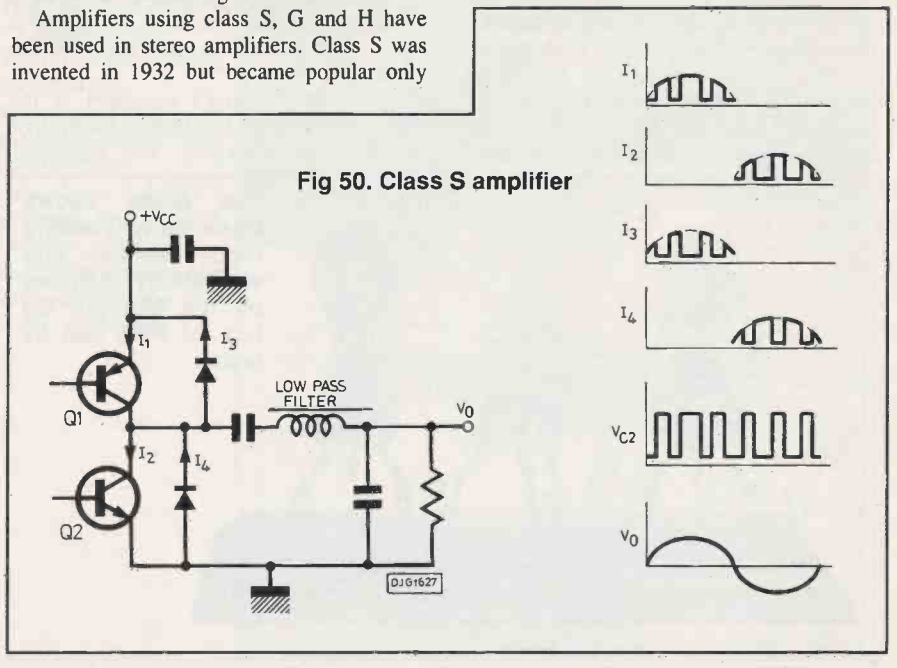


Fig 50. Class S amplifier

voltage. When the output signal exceeds half the supply voltage, the second pair are cut off and the first pair switched on.

Class H operates on the instantaneous signal and is similar to envelope tracking. The basic operation is class B current source and the collector voltage is varied by a regulator or an efficient switching amplifier so that it is just above the output signal. In this way the collector losses are kept to a minimum and any spurious noise that is generated by the regulator is removed by the current source amplifier.

The high efficiency amplifiers relied on various principles such as using the transistor as a perfect switch, following the desired waveform more closely or supplying just enough power to the stage. Some of the foregoing principles had more than one application, for instance some of the amplifiers could be used as amplitude modulators.

SUMMARY

In the last three parts, various stages that go into a receiver and transmitter, like oscillators, mixers, modulators, amplifiers, were discussed. The use of phase locked loops using sine, triangular and sawtooth waveforms was highlighted.

The necessity for a mixer stage to reject image frequencies was mentioned and the various forms of modulation: cw, am (dsb and ssb), fm, and the digital methods were explored.

The amplifier types class A, B, C, D, E, F, G, H, S were discussed starting with class A linear operation and on to class B push pull. If linearity can be sacrificed then Class C is a good source of power. The problems of cross over distortion with class B push pull as well distortion from operating close to the frequency limit of the transistor were mentioned. Heatsinks and power transistors construction were explored.

In the next part on receivers and transmitters some of the foregoing sections will be expanded to illustrate a particular application. For instance, although demodulation as been covered here, it will be dealt with in greater detail under am and fm as these arise.

PE

FLEMING AND THE VALVE

Your Ed commemorates another anniversary, and throws open a challenge to readers!

It's interesting to note that in this, PE's 25th anniversary year, another anniversary is with us, that of the thermionic valve. It is 85 years old this year.

The "Fleming Oscillation Valve" was discovered by Sir Ambrose Fleming in November 1904. At the time, Fleming was Scientific Adviser to The Marconi Company, and was closely associated with Marconi himself. He had played a leading part in the design of the powerful transmitting equipment used by Marconi in his first successful wireless transmission across the Atlantic in 1901.

In his search for better methods of detecting electromagnetic waves, Fleming did further research into earlier experiments involving the passage of electric currents through rarified gases. This led to his first valve, a diode. The immediate effect of the diode was to improve the sensitivity of the early wireless telegraphy receiving apparatus which had previously been dependent upon crystal detectors.

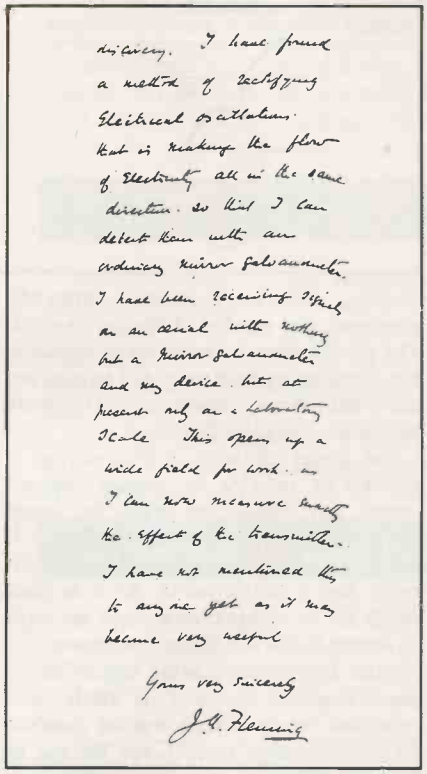
Three years after Fleming's invention, an American, Lee de Forest, patented a valve with a third electrode - the triode valve, but known at the time as the "Audion".

Although Fleming's invention of the thermionic valve is heralded as the birth of the electronics industry, with hindsight, one can't help but wonder whether the invention really was a necessary step to reaching the semiconductor-controlled world we know today. Could it, perhaps, have been that had the properties of crystals been further examined instead of electron flow through vacuums and rarified gases, semiconductors might have become more sophisticated at a much earlier time?

I don't wish to knock national heroes, but could Fleming and his thermionic valve have been responsible for *delaying* technology's advance? Readers, whether you are thunderstruck by my heresy, or agree with me, let me know your thoughts!

Fleming died on 18th April 1945, in his 96th year.

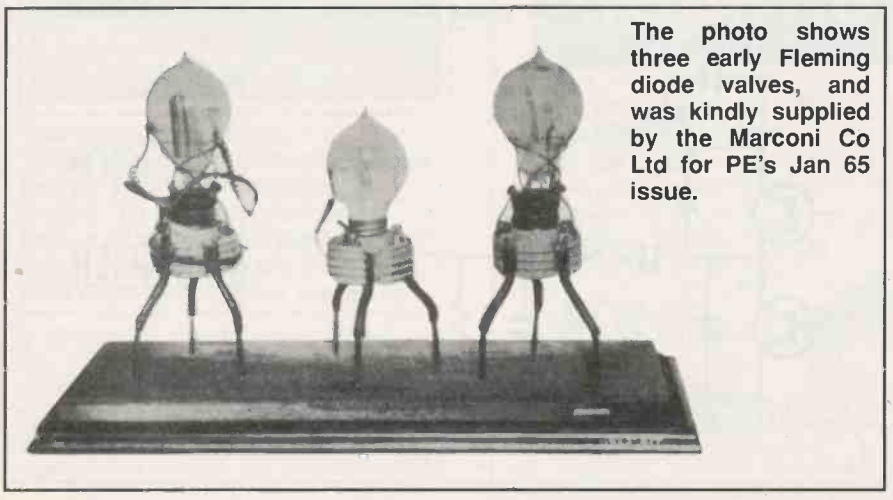
PE



discovery. I have found
a method of rectifying
Electrical oscillations.
that is making the flow
of Electricity all in the same
direction. so that I can
detect them with an
ordinary mirror galvanometer.
I had been receiving Signals
on an aerial with nothing
but a mirror galvanometer
and my device but at
present only on a Laboratory
Scale This opens up a
wide field for work. as
I can now measure exactly
the effect of the transmitter.
I have not mentioned this
to any one yet as it may
become very useful

Yours very sincerely
J.A. Fleming

A reproduction of the end of a letter from Fleming to Marconi informing him of the discovery which "may become very useful'.



The photo shows three early Fleming diode valves, and was kindly supplied by the Marconi Co Ltd for PE's Jan 65 issue.

UCT MEASUREMENTS

BY ANTHONY H. SMITH BSc

Universal attention to range settings, impedance and quantisation will give you time to count your blessings.

"Hey, look at this, it's the new counter-timer I was telling you about ..... isn't it a beauty?!"

"Yes, it looks great. What are you using it for?"

"Well, at the moment I'm using it to measure the time interval between the voltage and current waveforms feeding this ac motor. See, it's reading 65.236357 milliseconds; I can use this to calculate the phase angle."

"Hold on, that can't be right ....."

"Why not?"

"The time interval can't possibly be longer than the period of the mains supply, which is about twenty milliseconds."

"Oh yes, I see what you mean."

"I think I can see your problem: you've connected one of the counter inputs directly across the supply."

"But that doesn't matter; this counter has protection up to 300 volts rms."

"Maybe so, but that won't stop the input amplifier saturating: you should increase the attenuation."

"Why?"

"See, increasing it to x100 will bring the signal within the counter's dynamic range."

"Oh, er .... yes .... of course."

"That's more like it; it's reading about fifteen milliseconds now."

"Great. So now I can work out the phase angle."

"Not yet."

"What's wrong now?"

"You've got channel A set at a positive trigger level, and channel B set at a negative level."

"So what?"

"To find the phase angle you must trigger at the same point on each waveform; zero-crossings are best."

"OK, I'll set them both to trigger at zero. There, 11.635230 milliseconds; that must be spot on."

"No it isn't."

"But it must be! This counter's brand new, and it cost £499!"

"Don't worry, there's nothing wrong with the counter. It's just that you've got channel B triggering on the negative slope instead of the positive."

"Ah, so if I switch to the positive slope, the same as channel A, I get the right reading ..... 1.537260 milliseconds. At last! It's easy when you know how, isn't it?!"

FAITHFUL READING

Indeed it is! And yet I am continually amazed by the number of people who are only too eager to accept their instrument's readings as being 100% accurate. The reasons for this loyal (but misguided) faith seem to fall into three groups.

Firstly, test instruments are often elevated to a status far superior to all other equipment: it seems as though the fact that they are intended for test and calibration purposes automatically endows them with incredible powers of infallibility. Strangely, this exalted position is often directly proportional to the number of knobs and buttons and flashing indicators on the front panel. And of course, if the instrument was very expensive, well ... it must be right, mustn't it?!

Secondly, ignorance inevitably increases the chance of mistakes. Very often, we are simply not aware of the limitations inherent in a particular instrument.

Lastly, the crime of laziness (of which I am particularly guilty) is a common factor in sloppy measurements. How easy it is just to scribble down the readings and then bash on to the next test: "That'll do, it's close enough – I want to finish this before five o'clock."

In one respect, digital instruments lessen the chance of error since they remove the ambiguity associated with reading an analogue scale. However, they can also lull us into a false sense of security: simply being able to interpret the digital display with absolute precision does not mean that the measurement itself is completely accurate.

For most pieces of test gear, sources of measurement error can be grouped into two basic categories: errors due to misapplication; and errors inherent in the instrument itself. We will now consider each of these categories in relation to the uct (universal counter timer).

MISAPPLICATION ERRORS

The term 'misapplication' covers a multitude of sins. It applies, for example, when we use an instrument which is inappropriate for a particular measurement, or when we use the right instrument set to the wrong range. It also applies when we try to use an instrument in an unsuitable environment (for example, using a sensitive moving-coil meter in the presence of a strong magnetic field).

However, a particularly deceptive error of 'misapplication' arises as soon as we connect the uct to the circuit under test. When the connection is made, the probe and the uct input effectively become a *part* of the circuit, and thus introduce a degree of distortion to the signal being measured. Whether or not this distortion is significant depends upon the combined

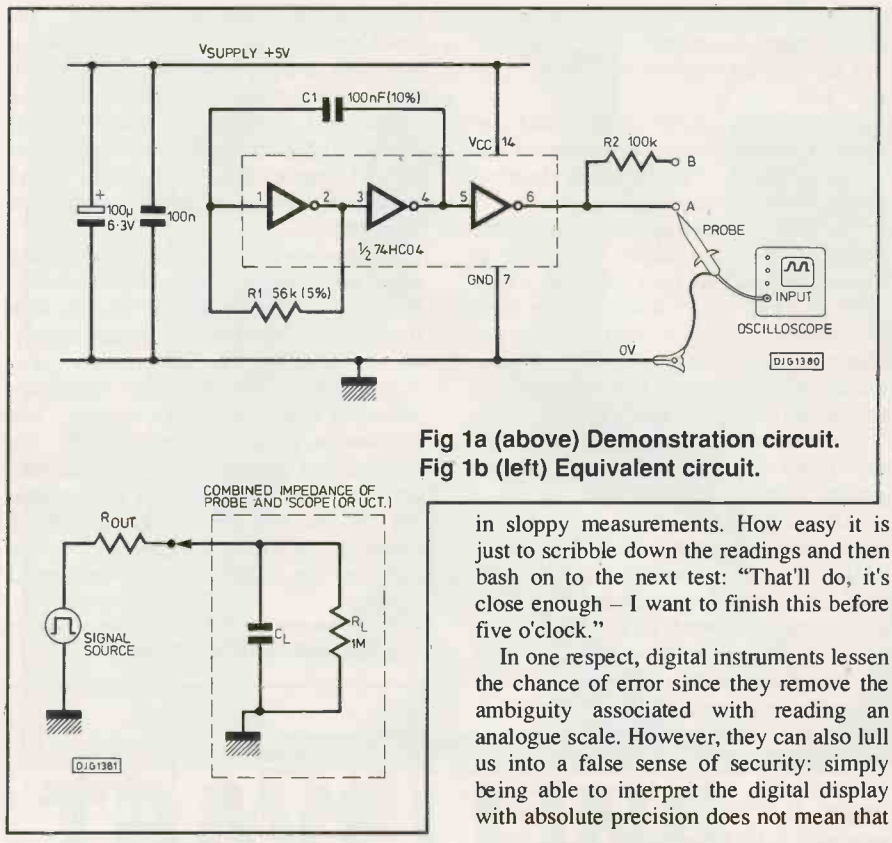


Fig 1a (above) Demonstration circuit.
Fig 1b (left) Equivalent circuit.

impedance of the probe and uct, on the output impedance of the circuit test node, and on the nature of the waveform being analysed.

Fig. 1a shows a useful circuit which can be used to demonstrate the nature of the signal distortion. Fig. 1b is an electrical model of the circuit.

The 74HC04 inverters form an astable multivibrator. The output frequency is given approximately by: $f = 0.7/(R_1 \times C_1)$. (The standard cmos 4049 can be used instead of the 74HC04, but note – the pin numbers are different). The output resistance of the multivibrator is represented in Fig. 1b by R_{OUT}.

The combined impedance of the scope and probe can be modelled by R_L in parallel with C_L. R_L is the input resistance of the scope (the probe resistance is negligible) and almost invariably equals 1MΩ. C_L is the capacitance of the probe plus that of the scope input, and may range from 30pF to around 100pF. Exactly the same RC circuit can be used to represent the impedance of the probe and uct, since the values of capacitance and resistance for the uct are almost always the same as the typical values for an oscilloscope. Consequently, the signal distortion displayed on the scope for the following examples is the same as that which would appear at the uct input.

Using the values of C_1 and R_1 shown in Fig. 1a, and with the probe connected to point A, the scope should display a rectangular waveform like that in Fig. 2, with a frequency of about 100Hz. Note how the pulse amplitude equals the supply voltage, 5 volts.

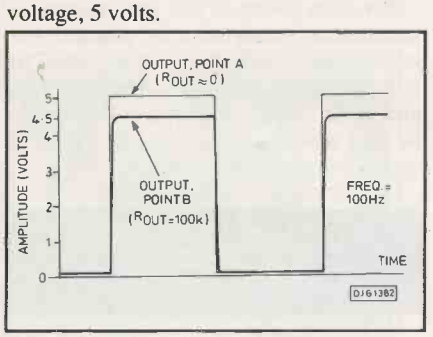


Fig 2. Multivibrator outputs.

Now connect the probe to point B. The presence of R_2 effectively increases the output resistance (R_{OUT}) of the multivibrator to 100kΩ. Referring to Fig. 1b, we see that the potential divider formed by R_{OUT} and R_L *attenuates* the pulse amplitude as shown in the second waveform of Fig. 2. The pulse voltage is given by:

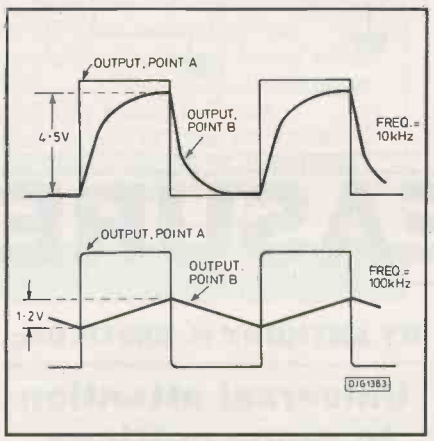
$$V_{PULSE} = \frac{R_L}{R_{OUT} + R_L} \times V_{SUPPLY} = \frac{1M}{100k + 1M} \times 5V \approx 4.5 \text{ volts.}$$

With the probe at point A, there is no attenuation since R_{OUT} is simply the output resistance of the inverter, which is negligible.

Obviously, the larger the value of R_{OUT}, the greater becomes the attenuation, and the corresponding reduction in pulse amplitude can result in mistriggering of the uct input, or even no triggering at all. Such problems are mainly encountered when measuring small signals derived from a source with a large output resistance, such as electret and crystal type microphones.

The presence of C_L also has a loading effect on the signal source. For sinusoids, the problem is most severe at high frequencies where the low reactance of C_L causes considerable attenuation. For rectangular signals, however, significant distortion can occur even at low frequencies. Look again at the multivibrator output at point B: you may notice a slight rounding of the pulse edges. We can see this effect more clearly by replacing C_1 with a 1nF capacitor which increases the pulse frequency to around 10kHz.

Fig 3. Pulse distortion due to CL.



The signal at point B now appears as shown in Fig. 3. The large value of R_{OUT} reduces the amount of current available to charge and discharge C_L: consequently, the voltage rises and falls exponentially with a time constant equal to $R_{OUT} \times C_L$. Although this pulse distortion is unlikely to affect a measurement of the frequency or period of the signal, a measurement of pulse rise time (or fall time) will obviously be in error, since the pulse rise time at point B is much longer than the *true* pulse rise time at point A. The larger the value of R_{OUT} and/or C_L, the larger becomes the time constant and the greater becomes the measurement error. (This type of distortion can also introduce a considerable error to time interval measurements made on different waveforms, *unless* they are derived from sources having the same output resistance.)

As a matter of interest, replace R_1 with a 4k7 resistor to increase the frequency to about 100kHz, and look again at the signal at point B. The pulse train has been integrated by C_L, and is now triangular in appearance (Fig. 3): imagine trying to make a pulse width or rise time measurement on this signal!

At point A, the signal is still fairly rectangular – obviously, the errors introduced by C_L can be minimised by making measurements at nodes with low output resistance. However, even here there is some rounding of the pulse edges, showing that it is never possible to eliminate totally the effects of capacitive loading.

Nevertheless, we *can* minimise these effects. A common solution is to use a x10 attenuating probe which introduces a 9M resistance in series with the 1M scope (or uct) input, thereby increasing the overall input resistance to 10M, and drastically reducing the resistive loading problems.

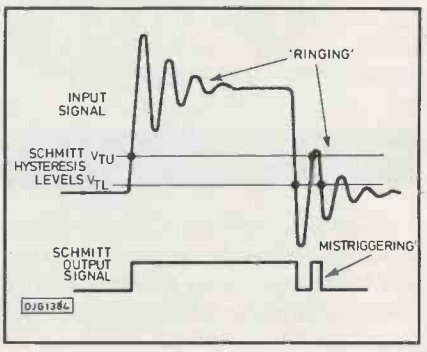
However, the major benefit of such a probe is the drastic reduction in capacitive loading: the attenuation network comprises a compensation capacitor (rather like the compensated uct attenuators described in part two of this series in July 88) such that the effective capacitance is almost ten times less than when using an ordinary probe. Remember, however, that attenuating probes attenuate the signal itself, thereby reducing the effective sensitivity of the uct.

HIGH FREQUENCIES

At high frequencies, the 1M input resistance of the counter is swamped by the low reactance of the shunt capacitance: for example, at 10MHz, the reactance of a 30pF input capacitance is just 530 ohms. Consequently, many ucts feature a 50Ω input specifically intended for high frequency measurements on low impedance circuits. For signals above 20MHz or so, the 50Ω input is particularly important for the correct termination of 50Ω coaxial cables and 50Ω video systems in order to prevent standing waves and signal reflections from introducing serious measurement error.

When measuring signals with very fast rise times, we cannot overlook the effects of inductance introduced by the probe ground lead (roughly 1nH per millimetre). This inductance and the probe capacitance form a resonant circuit whose damped oscillations appear as 'ringing' on the signal. If this is severe, the uct input could mistrigger – see Fig. 4.

Fig 4. Errors due to 'ringing' pulse



MINIMISING ERROR

When using a counter-timer on its own, it is often difficult to minimise the problems caused by probing since we cannot actually *see* the effects on the signal.

"But hold on ...", I hear you say, "why not simply observe the effects on a scope?" Well, this is fine for some measurements, but often the presence of the uct probe *plus* the scope probe simply doubles all the loading problems – Catch 22!

In cases like this, ucts which provide signal monitor outputs really come into their own. As we saw in part two, these outputs allow us to monitor the input signal as it appears at the uct's amplifier output, *without* increasing the loading problems. We can also see how ac coupling, filtering and attenuation affect the waveshape. Unfortunately, signal outputs only seem to be available on the more sophisticated models, such as the Tektronix DC5009.

When we need to make measurements on complex signals, or on signals distorted by noise, we come to rely on the counter's input conditioning circuits. The nature and operation of these circuits were discussed in part two; without them, it can often be impossible to make dependable, accurate measurements.

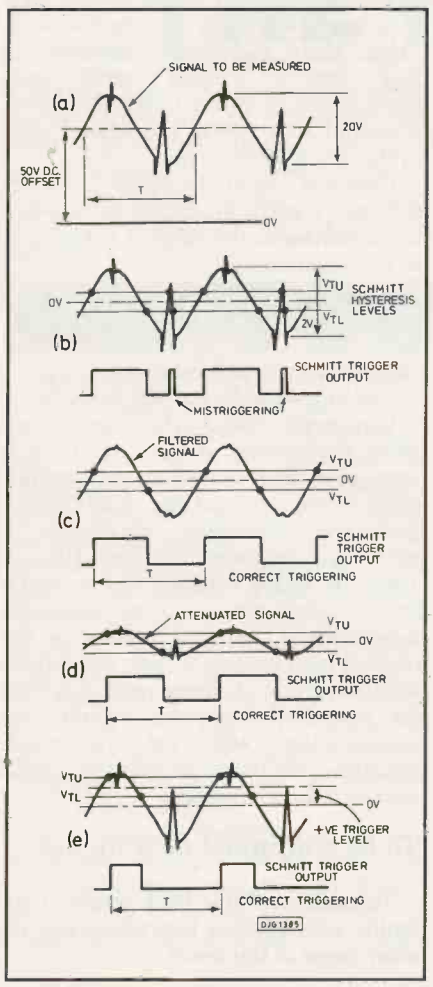
Remember, however, that incorrect use of these facilities can itself be a prime source of misapplication error. Later, we will summarise some of the dos and don'ts regarding the input controls. For the moment, however, a brief example will illustrate their versatility.

Assume we wish to measure the period, T, of the sinusoidal signal in Fig. 5a, using a counter with a dynamic range of, say, ±3 volts.

Because the signal is riding on a large dc level, we must set the counter's ac/dc coupling switch to ac, which removes the dc offset.

The signal is now symmetrical about zero volts, but is still too large to be counted. However, by switching the counter's attenuator to x10, we can effectively reduce the signal amplitude to 2 volts peak-peak, which is now within the counter's dynamic range.

Fig 5. UCT's input circuits can eliminate errors.



NOISE REMOVAL

Unfortunately, the superimposed noise spikes cause the counter to mistrigger (Fig. 5b), such that the displayed reading is incorrect (and beware – mistriggering can be difficult to detect unless the uct is fitted with 'trigger monitor' outputs).

How, then, can we remove the errors caused by the noise?

One solution, available on many counters, is to switch in a low pass filter which removes the high frequency noise components, leaving a 'clean' sinusoid as shown in Fig. 5c.

Note, however, that this approach is only suitable when the frequency of the signal to be measured is lower than the 'break' frequency ('corner' or 3dB frequency) of the filter: if not, the signal itself might be filtered out, leaving us with nothing!

If this is the case, we can ignore the filter, and instead increase the signal attenuation until only the sinusoid itself is large enough to cross the Schmitt threshold levels – see Fig. 5d.

Unfortunately, a factor of ten increase in the attenuation (in this case from x10 to x100) is often too severe, such that the signal is too small to cross the thresholds, resulting in no triggering at all. A solution is to combine decade attenuation with continuously variable attenuation, allowing us to adjust the signal amplitude for optimum triggering.

But what if the counter doesn't feature a potentiometer-type attenuator? Fortunately, all is not lost: by adjusting the trigger level, we can shift the hysteresis band relative to the signal so that the counter triggers only on the required waveform, avoiding the noise spikes – Fig. 5e.

Clearly, we can avoid a variety of 'mistriggering' errors by careful use of the counter's versatile input circuits. Indeed, as we saw in part two, it is often the sophistication of the conditioning circuitry which dictates the overall measurement accuracy.

ERRORS SUMMARY

* Avoid making measurements on nodes having a large output resistance.
* For precise measurements, avoid connecting more than one probe to a node.
* If an ordinary probe causes unacceptable loading, try a x10 attenuating probe and adjust the uct (or scope) input controls accordingly.
* When measuring high frequency signals, or fast pulses, keep all leads short, particularly the probe ground lead.
* Don't let the input signal exceed the counter's dynamic range – use the input attenuators if necessary.
* Exploit the counter's input circuits to achieve optimum measurement conditions.
* Make full use of any feedback provided by the counter, such as signal outputs, trigger outputs, trigger level indicators, etc.
* Remember that incorrect use of input controls can introduce considerable error.

INHERENT ERRORS

The accuracy of the uct itself is determined by random errors and systematic errors – Fig. 6.

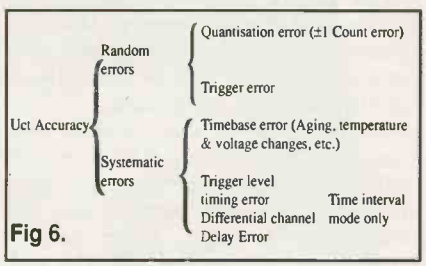


Fig 6.

Systematic errors can be reduced or even eliminated by careful calibration. However, as the name suggests, random error cannot be calibrated out; nevertheless, special techniques *can* minimise random errors. Incidentally, random errors effectively determine the useful *resolution* of a measurement: the larger the random errors, the poorer the resolution.

Unfortunately, we cannot simply state that a particular counter is 'X' per cent accurate since the accuracy specifications vary for the different types of measurement made.

FREQUENCY ERRORS

Frequency error = ±1 count
± time base error

Frequency measurement error is a combination of quantisation error (±1

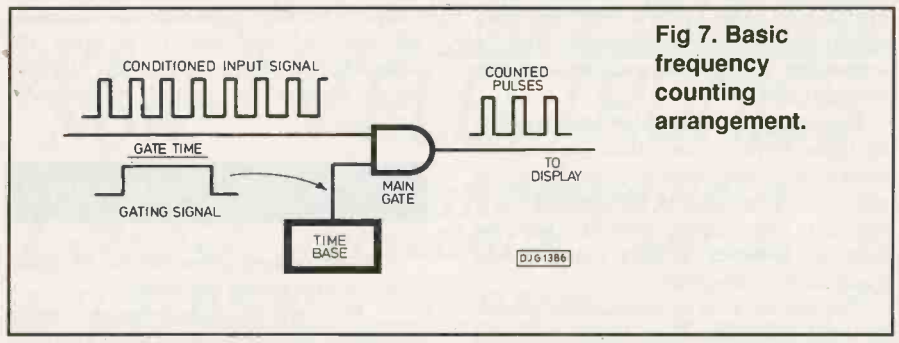


Fig 7. Basic frequency counting arrangement.

count error), and time base error. How does each source of error arise?

We saw in part one of this series (June 88) that frequency is measured by counting the number of input cycles which occur during a precise 'gate time' (usually one second); this is summarised in Fig. 7.

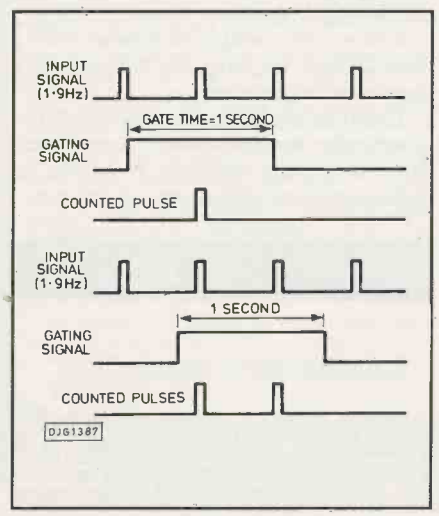
Unfortunately, because there is no coherence between the gating signal and the input signal, the counted pulses can be one too many or one too few, hence the 'plus or minus one count' error.

The example in Fig. 8 should make this clear. The input pulse train has a frequency of 1.9Hz; however, depending on the phase relationship between the gating signal and the input signal, either one or two pulses are counted, giving a reading of either 1Hz or 2Hz.

The 2Hz reading is in error by only +0.1Hz; the 1Hz reading, however, is out by -0.9Hz. For other examples, the limiting value of the error is 1Hz, and because the error can go 'either way', we specify it as ±1Hz or ±1lsd (least significant digit), or ±1 count.

We can look at this another way. Consider a constant input frequency of 2.5Hz: once again, because the input signal and gating signal are not necessarily in phase, either two or three pulses will be counted. The lack of phase coherence makes the reading fluctuate between 2Hz and 3Hz, even though the input frequency is constant.

Fig 8. Quantisation error.



Thus, the reading changes by either +1Hz or -1Hz, and we say there is an 'uncertainty', in the reading of ±1Hz (ie, ±1 count).

Since the gating signal is derived from the time base, any inaccuracy in the time base osciallator will inevitably affect the frequency measurement. In part three (Feb 89), we saw how the accuracy of a crystal oscillator can be degraded by various influences, particularly aging, and changes in temperature and supply voltage. For example, consider a crystal osciallator with the following specifications:

Nominal Frequency: 10MHz.
Aging Rate: 4×10^{-7} Hz/month
Temperature Dependence: 6×10^{-6} Hz from 0 to 50°C.
Supply Voltage Dependence: 2×10^{-7} Hz for ±1% variation.

The oscillator hasn't been calibrated for six months and is to be used over the entire temperature range. The maximum anticipated supply drift is ±2%. The total, worst-case inaccuracy is the sum of all the individual errors:

Aging		
Contribution:	$6 \times (4 \times 10^{-7})$	$= 2.4 \times 10^{-6}$
Temperature		
Contribution:		$= 6 \times 10^{-6}$
Voltage Drift		
Contribution:	$2 \times (2 \times 10^{-7})$	$= 4 \times 10^{-7}$
	Total Error	$= 8.8 \times 10^{-6}$

The worst-case deviation in the oscillator frequency is thus:

$8.8 \times 10^{-6} \times 10\text{MHz} - 8.8 \times 10^{-6} \times 10^{7} = 88\text{Hz}$.

We are now in a position to calculate the maximum error introduced into a frequency measurement by the combination of quantisation error and time base error.

EXAMPLE 1:

Input frequency, $f_{IN} = 2\text{MHz} = 2 \times 10^{6}$ Hz.
Quantisation Error Component = ±1Hz. (Gate Time = 1 second).
Time base Error Component $= \pm 8.8 \times 10^{-6} \times f_{IN} = \pm 8.8 \times 10^{-6} \times 2 \times 10^{6} = \pm 17.6$Hz.

Hence, the total, worst-case error = ±18.6Hz. In other words, our measurement of the 2MHz signal could be either 'high' or 'low' by 18.6Hz. Notice, here, how the time base constitutes by far the largest part of the error.

EXAMPLE 2:

Input Frequency $f_{IN} = 20$Hz.
Quantisation Error Component = ±1Hz. (Gate Time = 1 second).
Time Base Error Component $= \pm 8.8 \times 10^{-6} \times f_{IN} = \pm 8.8 \times 10^{-6} \times 20 = \pm 1.76 \times 10^{-4}$Hz.

Thus, the worst-case error = ±1.000176Hz. Obviously, in this example, practically all the error is due to quantisation error.

Before leaving these examples, there are one or two points we should consider. Firstly, both examples used a 1 second gate time. We could, however, have specified a 10 second gate time, in which case ten times as many input cycles would be counted for the same input frequency. (For example, 20 ±1 cycles are counted when measuring 20Hz with a 1 second gate time, whereas 200 ±1 cycles are counted when the gate is held open for 10 seconds.)

A ten second gate time means the lsd is now equivalent to 0.1Hz, and so we achieve a tenfold increase in resolution (resolution is the smallest change the counter can recognise; for a 1 second gate time, the resolution is 1Hz). More significant, however, is that the ±1 count error now corresponds to only ±0.1Hz, ie, we see a tenfold *decrease* in the relative size of the quantisation error.

Consider, again, Example 2 above; the most significant error was that due to quantisation, the relative magnitude of this error being:

$\pm 1/f_{IN} = \pm 1/20 = \pm 0.05$, or ±5%

However, had we used a ten second gate time, the quantisation error component would have been:

$\pm 0.1/f_{IN} = \pm 0.1/20 = \pm 0.005$, or ±0.5%

Obviously, then, when measuring small frequencies, it pays us to use a long gate time since the quantisation error is reduced and the resolution is increased. However, there is a problem: who wants to wait 100, or 1000, or 10000 seconds just to make an accurate, low-frequency measurement? Not me! So how can we make a high accuracy, high resolution, low-frequency measurement *quickly*? As we shall see next month, the answer lies with the 'reciprocal' counter – the name should give you a clue as to how it works.

To be continued next month.

The author of this UCT article, Tony Smith, tells another interesting tale on other pages of this issue!

SAGELY CD

Dear Editor,

The following paragraphs comprise an open letter to the Recording Industry concerning the quality of compact discs, which I hope you would care to publish in PE.

In the seventies, giant leaps in hifi system technology took place from the basic music centre type system. This included metal tapes, Dolby, moving coil cartridges, quartz locked dc motor turntables, synthesis tuning receivers, mosfet based amplifiers, ferro-fluid tweeters and a myriad of various poly based loudspeaker cones. In the midst of all this we also suffered an appalling standard of pressing quality on most records, albums in particular. We saw the recording industry get their knuckles severely rapped resulting in a considerable improvement in record pressing quality and surface noise in an attempt to save the record industry's profits amidst the evermore popular cassette tape medium.

Are we now to repeat such a fiasco in the eighties and nineties with compact disc? There again has been an absolute mega-leap forward for sound reproduction with cd players costing from as little as £50 to £2500, the average being £200, and sporting advanced features such as multi oversampling, bit multiplication, digital pulse axis control, plus all the user oriented remote control functions, and programmable track play. We are promised 100dB or more of signal to noise ratio, -95dB harmonic distortion, zero crosstalk, zero wow and flutter, zero hum, and superb frequency response.

Why then is it that after paying all this money for the latest digital cd player do we find that not one cd in the charts even nearly approaches the performance of even a standard player? I have found that the typical signal to noise on many chart cds is a little over 60dB (about the same as a good record). In addition, some have low levels of 50Hz hum, again typically 60dB, something that should have been banished from all recordings years ago. The best cd I could find (Paul McCartney, *Flowers in the Dirt*) clocks in a mere 75dB signal to noise ratio, some 25dB short of the promised magic 100dB.

The current state of cd recording quality makes complete nonsense of the latest state of the art technology fitted to current cd players. CDs are also not particularly cheap and I believe the public are being totally misled by the promised improved quality when the quality of recordings is so poor. So come on, the recording industry, put some of those huge profits made back into refurbishing your record equipment to a standard that at least matches today's hifi systems.

Les Sage, Sage Audio Electronics, Construction House, Whitley Street,Bingley, West Yorks, BD16 4JH.

And while they're about it, I wish they would drop the apparently heavy emphasis placed upon re-releasing very ancient recordings of 'classical' works, digitally reprocessed as cds. I am tired of so frequently hearing these reprocessed works transmitted on BBC Radio Three as examples of 'new' cd releases. It is hard to believe that it is coincidence I happen to switch on just at the 'wrong' moments.

Let's have new cd releases that are new in every sense of the word, having been recorded using today's recording techniques and with today's performers. There is no special interest for me in listening to interpretations of artists and conductors who were great half a century ago, but recordings of whom were made using equipment incapable of capturing the full ambience and frequency response. There is no way that reprocessing can put in quality that was never there in the first place. For Heaven's sake, it's the music itself *I want to experience, not the intellectual analysis of the techniques of bygone interpreters, and I want to listen to the music without being conscious of its recorded shortcomings. The interpretations of today's performers are surely equally as valid as those long dead. Or is the validity of interpretation entirely dependent upon the expense of acquiring it?* **Ed**

If you have any comments, criticisms or suggestions, write and let us know. We are interested in what you think and say.

TV SOUND AID

Dear Mr Becker

I feel very sympathetic towards your correspondent Dr R. Parfitt of Croydon, (*Letters*, PE Aug 89). I am also an ageing geriatric and have been deaf for nearly forty years. Now I can only hear with a hearing aid, and have used aids of increasing power for most of that time.

I have had two tv sound amplifiers: an Adaphone, marketed by Multitone Electric, 12-20 Underwood Street, London N1, and a Superpower Television Aid, marketed by R.W.Dixon & Co, Crowborough, Sussex.

In each case, the aid is connected to the tv set by an isolating transformer. This can be switched so that the deaf person can hear and adjust the volume for himself and no sound is radiated from the set at the same time. Others, therefore, will not be irritated by the sound (although they may be by the picture).

R.G.Ticehurst, Pickering, N.Yorks.

PRIZE PROJECT

Dear Mr Becker

It is not often that I win anything (particularly by guesswork) so it was a very pleasant surprise to return from holiday to find your cheque for £50, representing my prize for the survey questionnaire. Thank you very much indeed; thank you too for the £2 subscription voucher also received, and now used!

In passing, may I say how delighted I was to see your design for the Frequency Counter and Generator in the Sept 89 issue - very elegant and a useful addition to your Double-trace Oscilloscope on the test bench.

My prize money will go towards such projects, to my very great satisfaction.

Geoffrey T. Edwards, Weymouth. Dorset

How Nice! Ed

LIFE AND THE UNIVERSE

Dear Ed.

The trouble with us Senior Citizens is that we have long since been passed-by by Modern Technology. But I like your magazine because I can discipline myself to read it all and can then say 'I try to keep abreast'.

My interest is in making radios, from direct conversion to superhets, lw/mw/sw, et al. Life has its problems though; I needed a coil for a double conversion receiver, but they are no longer available. So I had to make one. There is a *'Coil Design'* book (1960!) which suggests 'oscillator coils for superhets are too difficult to design where tuning is ganged'. Undaunted, I made one - it looks a mess and my soldering is not much better, but it worked first time! We all have our successes!

But success has not yet come with the radio telescope I have been trying to make for many years. Pointing directly at the Sun I cannot produce a tremble on the VTM. How about PE producing a Mini Jodrell Bank? As far as I understand it, all you need is an aerial, aerial amp, receiver and a few bits to convert the signal so that the chart recorder can produce its pattern allowing you to predict aurorae or when the propagation will be good or bad. (When I think propagation is bad it usually turns out to be because the battery has run down!)

Peter McBeath, Kirkhill, Northumberland

Ah, yes! Whatever one's age, a single success makes up for a hundred disappointments!

Periodically, I chat with my colleagues on Astronomy Now about making radio telescopes. Many people have made their own and I'm sure one day my interest in things Universal will encourage me to make one and share it with PE readers. **Ed.**

DOG JAM

Dear Ed.

My wife and I are retired and living in a situation where we are troubled by a noisy dog whose owner incites it to bark. Is there a circuit that can be used to scare dogs away?

A.C. Dawson, Chichester

Dear Ed.

The use of personal stereos by people on trains and buses has become a very annoying form of aural pollution. Could PE produce a circuit that will jam the offending units?

N.H. Quick. Havant, Hants

We aired these two subjects at various times last year in the Letters columns. In a nut shell, jamming is contrary to the Law and we have no intention of publishing any circuits of this type. Animal Protection societies oppose the use of electronic devices which 'scare' animals. However, electronic 'deterrents' are acceptable in some circumstances - we have, for example, just published a mole deterrent, PE Sept 89. Perhaps a humane reader can come up with a kind dog deterrent? **Ed.**

CALL ON MAPLIN

Just plug into the mains and you can have immediate intercom contact with the new Maplin fm wireless 2-channel intercom. It is a very high quality intercom which transmits and receives via the mains wiring. No interwiring is required, simply plug each unit into a 240Vac mains outlet socket.

The intercom, which is ideal for home or office, can operate on either of two channels which are selected by a switch. The intercoms are sold as pairs, and additional units can be added to the system. The attractive modern-sized light-beige units can be desktop or wall-mounted, and can be locked on for baby sitting, or sick room monitoring.

The channel carrier frequencies are 110kHz and 140kHz, and the overall size is 165mm wide, 115mm deep and 45mm high. Maplin's order code is YT16S (FMIntercom 2 Chnl), and the price is £24.95 including vat.

Maplin also have a new good quality, low cost 2-station intercom which comes complete with 20m of cable, ready to be plugged in at each destination. The units incorporate buzzers operating in both directions and the high gain audio circuit ensures excellent sensitivity and voice clarity. By leaving the main unit switched on, the intercom can be used for baby-sitting.

The LB72P (Intercom 2-Station) costs just £9.95 including vat.

For further information contact any of Maplin's nationwide shops, or their head office, PO Box 3, Rayleigh, Essex SS6 8LR. Tel: 0702 554161.

MOTO-TOOL

First manufactured in the USA in 1932, the versatile Dremel Moto-Tool is back on the British market having undergone a major face-lift and re-engineering.

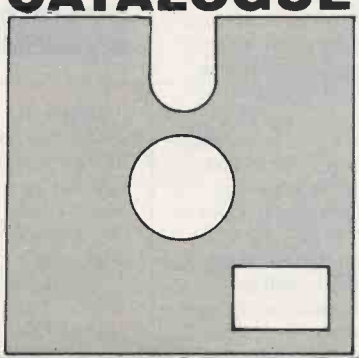
Weighing in at just 630gms and measuring less than 22cm by 6cm diameter, the input power of the latest Moto-Tool has been increased from 85 to 125 watts. A choice between constant and variable speed models provides operating speeds up to 30,000 rpm from a standard 240V power supply. The Dremel Freewheeler, a cordless version of the Moto-Tool is also available.

Attachments include a bench drill press, a flexible shaft, a router, and a special kit for sharpening chain saws! There are also over 160 specially designed bits for drilling, grinding, deburring, cutting, slotting, polishing, engraving, sanding, carving, or shaping all metals, woods, plastics, ceramics, glass, fibreglass, precious and non-precious stones.

Other tools manufactured by Dremel include a 6-inch table saw, a disc/belt sander, a suspension drill, two fretsaws, a miniature woodworking lathe, and a vibro engraver.

For further details contact: Microflame Limited, Vinces Road, Diss, Norfolk. Tel: 0379 644813.

CATALOGUE



Continuing our alphabetical browse through advertisers' literature

Biotrack have a most unusual line of business - they are specialists in animal radio monitoring, and have sent a short-form list of products. The company is run by zoologists who need **inexpensive, reliable radio-tracking and telemetry equipment** for their own research. Among their range they have several tiny transmitters and tags, and several Yagi receiving antennas. Biotrack are also very **happy to discuss your precise requirements** and produce other equipment where appropriate. Their prices look very reasonable. **Biotrack**, Stoborough Croft, Wareham, Dorset, BH20 5AJ. Tel : 092 952992.

Detectronic is the company which began as a result of a *PE* project, as described by Tony Smith elsewhere in this issue. Detectronic's catalogue includes a variety of **industrial ultrasonic measurement products.** Among them are several flow and velocity meters, fluid level switches, and a rain logger with electronic memory data storage. **Detectronic Ltd**, Systems House, Edge Nook Road, Shadsworth Industrial Park, Blackburn, BB1 2QB. Tel : 0254 54583.

Display Electronics have announced the expansion of their mail order and shop divisions, and the introduction of a **series of 'sales flyer' mail outs**. The one they've sent us consists of eight pages with a variety of products, including a time delay relay, cooling fans, acoustic couplers, disk drives and much more. **Also of interest are their 'bundles'** - assortments of various types of the same basic component, eg, ics, small semis, passives, and relays. **Display Electronics**, 32 Biggin Way, Upper Norwood, London SE19 3XF. Tel : 01-679 4414.

Greenbank have sent 30 or so pages of information which will be of **great interest to those wishing to build their own computer**. Reading through their introductory letter it's heart warming to learn that Messers Parkins who run the company share part of my own philosophy – they strongly believe in doing something for the sheer satisfaction of doing it, even though one could go out and buy a similar product ready made. **Their Interak computer satisfies** the needs of those with a similar outlook and, moreover, by building one you learn, in their words, **"a practical skill that will put you head and shoulders above those whose only computer skill is that of knowing how to handle an Access card at Dixon's"**. Oh yes, I like the sound of this company! (I like Access and Dixon's as well, but I especially like those who believe in diy as much as I do.) Come on, you enterprising readers, really find out about computers by building your own – get hold of a copy of the **Interak information from Greenbank Electronics**, 460 New Chester Road, Rock Ferry, Birkenhead, Merseyside, L42 2AE. 051-645 3391.

Hills Components' catalogue is very definitely one which you should add to your bookshelf. **If it's hardware you're after, you should browse** through over 70 pages of **their well presented information**, covering subjects such as adapters, audio leads, cases, connectors, soldering irons, meters, microphones, switches, and much more in between and beyond. **Hills Components Ltd,** Units 5-6, Melinite Industrial Estate, Brixton, Road, Watford, Herts, WD2 5SL. Tel : 0923 52000

FORUM CERT

The Forum Personal Phone, the second generation digital cordless telephone (CT2) designed by Shaye Communications, has been awarded full British Approvals Board for Telecommunications 'green dot' certification.

"We are delighted to announce that Shaye Communications is the first manufacturer to achieve full BABT approval for a CT2 handset," commented Bob Apollo, Shaye's director of sales and marketing. "Such certification represents a very important step in ensuring the success of CT2 technology and commercial-scale telepoint networks in the UK."

The Forum Personal Phone is being supplied to the Phonepoint and Mercury Callpoint telepoint networks and was the prize in PE's May 89 competition.

Shaye Communications is based at Capital House, 48-52 Andover Road, Winchester, Hants SO23 7BH. Tel: 0962 55925.

DEAF VIDEO PHONES

A unique system of moving cartoon pictures on miniature television screens, which could allow deaf people to communicate over the ordinary telephone network using sign language, has been unveiled by British Telecom.

This experimental equipment, developed by scientists at the company's research laboratories in collaboration with the University of Essex, has been tested by the Suffolk Deaf Association.

It has allowed Pearl Kerridge, the social worker attached to the Association's headquarters in Ipswich, to have frequent "conversations" with two of the members at their home.

Commenting on the project, Dr Tom Rowbotham, Director of Network Technology at BT's Research Labs said: "Once again British Telecom is making telecommunications history. We believe that this development enabling deaf people to sign to each other over the phone network is the first of its kind anywhere in the world."

The equipment used in the trial is based on the experimental videophone developed at BT's labs. This is a desk-top unit combining a miniature video camera and 6cm square tv screen. The videophone can give each person in a phone conversation a moving, colour, head-and-shoulders picture of the other. To make the equipment operate over an ordinary phone link, the Research labs applied the results of work on picture compression carried out by the University of Essex.

The image coding algorithms developed by Professor Don Pearson at Essex reduce the picture content to a level enabling its information to be sent over British Telecom's analogue network at 14,400 bits a second.

The resulting picture is a moving black and white outline, or cartoon. It depicts the main facial characteristics sufficiently for the individual to be clearly recognised, and it also enables the hand movements of sign language to be reliably identified.

Dr Rowbotham added: "Our development opens up the prospect of breaking down the telephone barrier, enabling the deaf to converse by phone using the alternative medium of sign language. But a commercial product is still many years away. A lot more research and development has still to be undertaken."

Enquiries about this research should be made to British Telecom's Corporate News Room on 01-356 5366.

EVENTS DIARY

If you are organising any event to do with electronics, big or small, drop us a line, we shall be glad to include it here

Please note : Some events listed here may be trade or restricted category only. Also, we cannot guarantee information accuracy, so check details with the organisers before setting out.

Oct 11. Phone Point - the modern generation of mobile phones. IEEIE lecture by British Telecom, The Tollgate Moat House Motel, Gravesend. 01-836 3357.

Oct 12. Satellite Television. IEEIE lecture by IBA, The Polygon Hotel, Southampton. 01-836 3357.

Oct 16-20. Systems, Computers and Communications. 11th International Trade Fair and Congress. Munich Trade Fair Centre. 01-948 5166.

Oct 17-19. ED 89. Electronic Displays exhibition and conference. Wembley Exhibition Centre. 01-868 4466.

Oct 24-26. Sensors and Systems - International Transducer Exhibition and Conference. Wembley Exhibition centre. 0822 614671.

Nov 7-11. Productronica. 8th International Trade Fair for Electronics production. Munich Trade Fair Centre. 01-948 5166.

Nov 14-16. Total Solutions. Incorporating Drives, Motors, Controls, Interface, Data Acquisition, Telemetry UK, Coil Winding. NEC Birmingham. 0799 26699.

1990

Mar 7-8. Laboratory 90. G-Mex Centre, Manchester. 0799 26699.

Mar 28-29. Laboratory, Science & Technology Show. Kelsey Kerridge Sports Hall, Cambridge. 0799 26699.

Apr 9-11. Cable and satellite exhibition and conference. Olympia, London. 01-486 1951.

Apr 4-5. Drives, Motors, Controls. New Century Hall, Manchester. 0799 26699.

NEWS

OPTICAL LAKE LINK

A million pound circle of optical fibre cable is bringing the latest in telecommunications technology to one of Britain's most scenic regions – the Lake District in Cumbria.

The first part of the British Telecom link from Kendal through Stavely to Windermere has just been completed. Work is now going on to carry the cable from Windermere to Ambleside and then it will go on to include Hawkshead, Grasmere and Coniston.

The optical fibre will provide high quality digital links to serve the new digital exchanges in the region. In some places this most modern type of cabling will replace old style cable that is more than fifty years old. And to serve environmental interests in such a beautiful region, cables wherever possible go underground.

Pictured here, British Telecom engineers laying and checking the cable between Windermere and Ambleside.

BT TV OPTICALS

British Telecom's blueprint for the communications network of the 21st century – optical fibre "pipelines" carrying stereo television, high fidelity stereo radio, telephone calls, information technology and other interactive services – becomes reality from next year.

About 500 business and residential customers at Bishops Stortford, Hertfordshire, are to take part in a trial to demonstrate technical feasibility of systems developed at British Telecom's research laboratories.

During its two year run, the trial, which will cost about £5 million, will provide British Telecom and industry with valuable data for planning the commercial communications systems of the future.

Bishops Stortford was chosen for the trial because it provides the appropriate mix of residential and small business customers in a number of compact estates with different kinds of houses. It has good road, rail, and air links, and is conveniently located both to London, and to British Telecom's research laboratories at Martlesham Heath, near Ipswich.

Areas being considered for the trial include two industrial estates and six residential areas.

British Telecom plans to set up a temporary "show house" to demonstrate to both residents and visitors the range of services to be made available and the technical capabilities of the networks.

The Department of Trade and Industry has agreed in principle to give a special licence for the trial to go ahead, as British Telecom is prevented by existing regulations from carrying the tv services involved over its main network.

Commenting on the trial, Dr Alan Rudge, British Telecom Group Technology and Development Director, said: "This trial is essential, not only for British Telecom, but to ensure that the UK retains a share of the future optical fibre communication market which is expected to grow significantly from the mid-1990s onwards."

TUBULAR VALVES

It's very rare now to hear news of valves, but Richardson Electronics tell us they have introduced a new line of audio amplifier tubes for the music market, audiophiles and hi-fi equipment manufacturers.

Providing excellent sound quality, the new National Gold tubes are specially tested and hand selected using AF spectrum analysers. Each tube is then matched for output and selected for linearity and very low microphonics. The tubes are available as singles, matched pairs or quad sets.

A distributor programme has been implemented for those wishing to stock these high quality tubes.

A leading international manufacturer and distributor of electron tubes and power semiconductors, with 17 sales offices worldwide, Richardson Electronics maintains the most extensive inventory in the industry and ships over 90 per cent of customer's orders the same day the are received.

For further information, please contact: David Ensor, Richardson Electronics (Europe) Ltd, The White House, 18 Church Road, Leatherhead, Surrey KT22 8BB. Tel: 0372 379414.

MOON BUGGY

Battelle has designed a concept for a robotic vehicle the National Aeronautics and Space Administration could build to help erect a radio astronomy observatory on the moon early in the next century.

Unlike the "dune buggy" US astronauts drove on the moon in the early 1970s, the six-wheeled lunar construction vehicle designed by Battelle could operate with no humans present.

"Our vehicle would deploy itself, and radio signals from earth would tell it how fast, how far, and in what direction it should go," says Corinne Buoni, Battelle's project manager. "However, it also would have computer controls on board allowing it to take some actions, such as avoiding obstacles, on its own."

NASA plans to use the vehicle to set up and maintain 600 very low-frequency antennae for a radio observatory to be located in a crater on the far side of the moon. The antennae would be installed using two arms mounted near the front of the vehicle. A cart-like payload bay would carry the antennae and any other necessary equipment.

Battelle conceived the vehicle to operate for seven to 10 years in the harsh, lunar environment.

Such a lunar vehicle could travel over a range of 5,000 kilometres (3,100 miles). While travelling over known terrain during the day, it could run at speeds of three kilometres per hour.

"That's fairly quick for a robotic vehicle in space," says Buoni.

The lunar vehicle would be powered using four radioisotope thermoelectric generators, with secondary lithium batteries for peak loading. It would use an inertial navigation system with laser triangulation calibration.

The vehicle is designed to weigh 3,100 pounds and would measure 14 feet long, six and a half feet wide, and six and a half feet high. For transportation to the moon, it would collapse to a volume of 310 cubic feet.

Initial plans call for the vehicle to be deployed shortly after the year 2000.

Battelle is an international technology organisation that serves industry and government by developing, commercialising, and managing technology. With a wide range of scientific and technical capabilities, Battelle puts technology to work for clients in 35 countries.

For further information contact: Renate Siebrasse, Battelle Institute Ltd, 15 Hanover Square, London W1R 9AJ.

RADIO BYGONES

Since we are celebrating PE's past and present, it's nice to hear of someone else looking back over vintage years. Geoff Arnold, editor of *Practical Wireless*, our erstwhile sister magazine, has introduced a new bi-monthly magazine for vintage radio enthusiasts. The first issue of *Radio Bygones* was published on August 22nd.

Geoff has told me that *Radio Bygones* will cover domestic radio and tv, amateur radio, commercial systems both fixed and mobile, and military, aviation and marine communications. It will cover them right back to the days of Hertz, Maxwell and Marconi, and onwards to what had become the state of the art just a few years ago.

It will feature articles on restoration and repair, history, reminiscences and "just plain nostalgia". It will also include features on museums and private collections, with colour pictures of some of their most interesting exhibits.

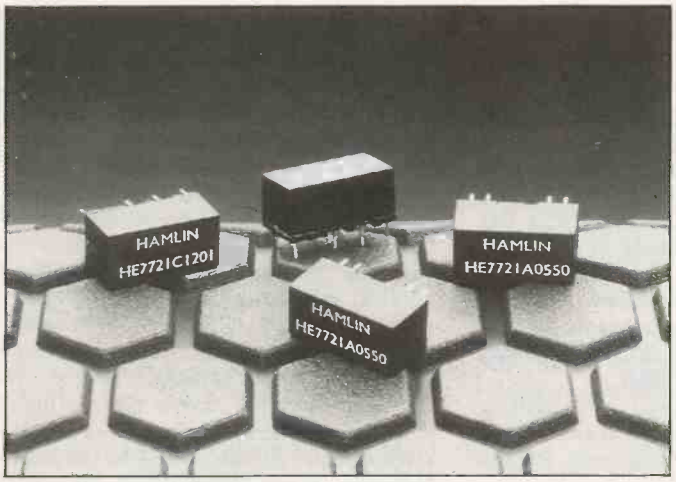
Geoff Arnold, who is also the publisher as well as the editor of *RB*, first became interested in radio during the 1939-45 war. He has been editing *PW* for the past twelve years.

The cover price of *Radio Bygones* is £2.20, or £12.00 for a year's subscription covering six issues. You can find out more about the magazine from **G.C.Arnold Partners**, 8a Corfe View road, Corfe Mullen, Wimborne, Dorset, BH21 3LZ, tel : 0202 658474.

We send our good wishes, Geoff, for the success of this interesting new publication.

The photo below is from *RB* and shows a selection of early home constructed equipment.

NEWS



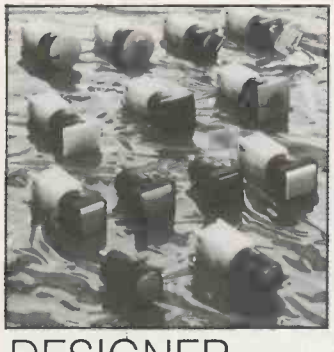
RELAYING SENSITIVELY

How available from Hamlin Electronics is the 7700 Series of sensitive reed relays, and with a choice of either dual-in-line or electro-mechanical (type 47) footprints.

Sensitivity of the 7700 Series relay is 40% higher than that of a standard dil relay – an essential feature where power saving is of paramount importance. The electro-mechanical footprint option enables the relay to become a drop-in replacement for that type of relay, and provides the advantages offered by reed relays of longer life, speed of operation, and greater sensitivity.

The relays are offered with a choice of either dry or mercury-wetted contacts, and are available with contact forms of 1A, 2A, 1C and 2C. Standard coil voltages are 5, 12, and 24V dc. A diode option is also available.

For further details, contact: Garth Willson, Hamlin Electronics, Diss, Norfolk, IP22 3AY. Tel: 0379 644411.



DESIGNER SWITCHES

Hlectrical and electronic component manufacturers A.F. Bulgin have further expanded their product base with the introduction of a range of illuminated and non-illuminated switches. Sealed against dust and water they fit an industry 16.2mm diameter hole. The range includes key switches and rotary versions.

Outstanding features of this designer range include three knob styles in two sizes, knob or key operated, semi-rotaries to match and circular push-to-lock/twist-to-release versions available to meet a wide range of requirements. Complementary led or filament signal lamps complete this excellent product range. Colours are red, orange, yellow, green, white, blue and black.

For further information contact: A.F. Bulgin & Co plc, Bypass Road, Barking, Essex IG11 0AZ. Tel: 01-594-5588.

GLOBAL POCKET PHONES

Global personal communicators, pocket phones that will work anywhere in the world, will soon be as common as pens and wallets in shirt pockets and purses. So predicts Olof Lundberg, Director General of the world mobile satellite organisation Inmarsat.

This prediction was one of many contained in Lundberg's closing address, "Futures Possible" at the Inmarsat 10th Anniversary Conference on Mobile Satellite Communications in London recently.

Much of the technology and systems required to support personal communicators was already in place, or existing, Lundberg said. "By the mid-1900's we can expect to buy cellular handsets weighing less than eight ounces."

At the same time the new telepoint services, the second generation cordless telephone system due to start up in the United Kingdom this year, will create a wider taste for mobile communications.

"The integration of cellular, cordless and telepoint will bring together three of the four major pieces necessary to usher in true global personal communications. It will do nicely for the chap who is always in range of these networks."

The fourth piece is satellite communications. "It is the integration of the terrestrial cellular, telepoint and mobile radio technologies with those of mobile satellites that snaps into place the final piece to complete the personal communicator jigsaw puzzle," he said.

Inmarsat operates a system which includes eight geostationary satellites and provides mobile telephone, telex, facsimile and data to more than 9,000 ships and land transportable stations. We reported on some aspects of Inmarsat in the Boating Revolution article of Aug. '89.

Contact: INMARSAT, 40 Melton Street, London NW1 2EQ. Tel: 01-387 9089.

CHIP COUNT

Highlighting details of some recently released chips.

SUPER-BLOCK OPAMPS LM604, LM611, LM613 AND LM614

National Semiconductor has introduced a new generation of highly integrated analog functions which are now available as low-cost, monolithic ics. We are pleased to highlight them as this month's *Chipcount* theme since they are bound to interest many PE readers.

The new family of standard analog products offers increased levels of integration, reliability and performance. Designated Super-Blocks, each device efficiently integrates associated analog functions onto a single chip.

Four Super-Blocks presently make up the new family. The latest is the LM613, a device that features dual opamps, dual comparators and an adjustable reference on a single chip.

The dual opamps are single supply and deliver improved slew rates, wider power bandwidths, reduced crossover distortion and lower supply current than their standard building bock counterparts. The dual comparators provide low input currents of 1000 microamps for large differential input voltages and swings of ± 36V. The on-chip voltage reference has an accuracy to ± 0,4%.

The LM611 and LM614 Super-Blocks are an alternative to the industry standard LM324 low-power quad opamp and the LM385 adjustable micropower voltage reference. The LM611 delivers more opamp and tighter initial tolerances (0.4% for the references) while the temperature coefficient is 22ppm/°C.

Both devices use low operating currents, of 300µA and 250µA per opamp respectively. They feature wide supply voltage range of 3V to 36V, as well as a reference voltage adjustment from 1.2V to 6.3V. As a result, next-generation level monitoring circuitry and portable test instruments using the LM611 and LM614 Super-Blocks will have a distinct advantage over their building block predecessors.

Finally, the LM604 mux-amp with bi-state output can multiplex four differential input channels to a single opamp. Its bi-state output can drive up to a 600 ohm load.

For true 8:1 multiplexing, two or more of the LM604 Super-Blocks may be used in parallel when the output is disabled. A wide voltage range lets this device serve in either 5V digital systems or ± 15V high performance analog circuits. Programmable gain blocks and filters and general test/measurement circuits are suitable applications for the Super-Block.

Super-Blocks simplify the designer's task by reducing board space and power requirements. In addition, the devices provide users with an affordable upgrade from standard building block designs. Says National Semiconductors' product marketing manager Colin Greene, "*Super-Blocks provide customers with the best possible price/performance for their next generation of analog designs.*"

All four Super-Blocks are available in plastic dual in-line packages.

For more information on these interesting new opamps, contact National Semiconductor (UK) Ltd, The Maple, Kembrey Park, Swindon, Wilts, SN2 6UT. Tel : 0793 614141.

Free Reader Adverts

Searching for that elusive component?
Surplus equipment to sell?
Read the rules and fill in the form below to have your free ad published in PE BAZAAR.

Wang 2236-D computer terminal wanted, or any terminal capable of 8-bit odd parity operation. J.R. Dean, 26 Halycon Way, Burton on Trent, Staffs DE14 2JR.

IBMPC double expansion card 68010 MMU 50 TTL socket for memory originally for running Unix £40. Kingston 01 546 1827.

Connecting wire, 555ics, 741s, sockets all new. By post Mr D. Martin, 6 Downland Garden, Epsom, Surrey KT18 5SJ.

Portable CP/M computer 5/4" drives, works into TV £50 9" green monitor all perfect P. Sykes, 19 Dunstable Street, Ampthill, Bedford MK45 2NJ.

Bench power supply unit. Weir Majoreg type 441 0-60V, -1A metered O/P will accept £30 Mr Williamson 01 391 0915 evenings.

200-step Stepper Motors 12/24 ex-equipment £6 each inc P&P J. Spence, 1 Gerard Avenue, Morley, Leeds LS27 9LZ.

Hameg HM203-5 20MHz dual trace scope with component tester and probes £100 tel: Livingston 416963 Tony Linas, 98 Kirkfield, East Livingston.

Surplus components: 1000 electrolytic capacitors, + 1000 assorted components. Brand new at only £20 P&P £3 Mr A. Khan 349 St Helens Road, Bolton, BL3 3QD.

Phazer for electric guitar with foot switch and effect depth cotrol. Good sound £17.50 by post Mr D. Martin, 6 Downland Garden, Epsom, Surrey KT18 5SU.

Audio Signal Generator Advance HIE (Unused) Original Packing Leads Manual Sine/SQ £100 tel: 0293 882552 RD Hollebon, 33 Leighlands Pound Hill, Crawley RH10 3DN.

Maplin's Z80 module as new PSU and many more kits and components for sale write to: Mr R. Vahid, 275 Seely Road, Tooting, London SW17 9RB.

Battery charger 24 volt 2.5A built in Ammster meter, German made. Good quality £20 Mr C.P. Williamson, 01 391 0915 evening.

HMV Tape recorder 7"reels 2-speed 5-valve 240V.A.C. spkr. 7"x4" mike costs £65 50-10 KC/S O.P 35 ohms v.g. condition. Sensible offers + tapes Mr E.G. Middleton, 30 Zodiac Court, 165 London Road, Croydon CRO 2RJ Tel: 01 686 2031.

CMOS static rams, 8Kx8 bit, Hitachi 6264LP £3.80 each tel: Jim, 0252 626693. J Fricker, 11 Velmead Road, Fleet, Hants GU13 9JY.

Data sheets wanted for the NEC7220, NEC7201, 2964B 8276 and 1468RTC. Chip's cost must be low Mr R.M. Joseph, 108 Terrace Road, Plaistow, London E13 OPD tel: 472 8880.

Component bags strong 5" x 7" clear also ideal for screws etc. 100 £4.50 50 £2.50 by post from Mr D. Martin, 6 Downland Garden, Epsom, Surrey KT5SJ.

If you worked in the early transistor industry I would like to hear about your experiences. Andrew Wylie, 2E Welbeck Mansions, Inglewood Road, London NW6 1QX.

For sale 12 Intel D875IH microprocessors £30 each £300 the lot. tel: 0442 212037

100 small transformers, diecast and other boxes hobby clearance sae list 09277 65486 evenings S. Wozmak, The Jays, Bell Lane, Bedmond, Watford, Herts WDS OQT.

CB circuits book £5 military equipment circuits 4 volume set £30 video genie EG3003 perfect, £80, M.T. Small, 14 Meare Estate, Wouburn Green, Bourne End, Bucks HP10 ODX.

4164-15 £1.25 4156 £3.50 4116 80p lots more to clear. Phone for list 0621 89512 Nic Spiers, 20 Eaton Way, Gt. Totham, Maldon, Essex CM98EE.

Info reqd on tape recorder connections for 5 pin din socket Boots Th Auto focus slide projector. L. Hickingbotham, 95 Oakenshaw Road, Redditch B98 7PR.

For sale Phillips receivers model 170A (1947-8) and model V5A (1935). Good working condition. Offers. L.A. Wilkinson, 2 Craigside, Lower Contour Road, Kingswear, Devon TQ6 OAL.

Car amplifiers has anyone got any high power car amp circuits! Please send details kits/diagrams: Richard, 6 Rydal Avenue, Nuneaton, Warwickshire CU11 6HX tel: 0203 373166.

Practical Electronics 1978 to 1989. Some in binders. Offers Richard Stott, 37 Cocksmead Croft, Kings Heath, Birmingham tel: 021 443 3259.

Wide carriage star LV-1615 printer ser/par inputs. Unused recent spare (Epson fixed.) Good bargain £190.00 o.n.o R.Smith 0925 764833.

Telequipment scope manuals for sale D54/R. DM-64. S-51 S51 E/B S54 A/AR. D1010. D31/R. D-52. D.61. £8.50 each M. Small, 10 Sibleys Rise, South Heath, Great Missenden, Bucks HP16 9QQ.

Crotech 3036 Oscilloscope 20MHz with probe and manuals unnused £100 tel: 01 451 3093. Jack Anderson, 22 Landau, Chatsworth Road, NW2 4BW.

Wanted any info on Cossor 339 A scope or manual loan or purchase. A.C. Hemes, 3 Hanover Place, Bromsgrove, Worcs B61 7DT tel: 0527 36845.

Ferrograph RTST and ATU1 test set, perfect. What offers? Tel:01 546 3071 evenings. G. Sharp, 13 Buckingham Road, Kingston, Surrey KT1 3BH.

Wanted: any software for the Apricot PC-X1 twin disc portable preferably w.p. spreadsheet. G.W. basic copies acceptable Mike McKay, 58 Queens Gardens, Wednesbury, W. Midlands WS10 7PF tel: 021502 3511.

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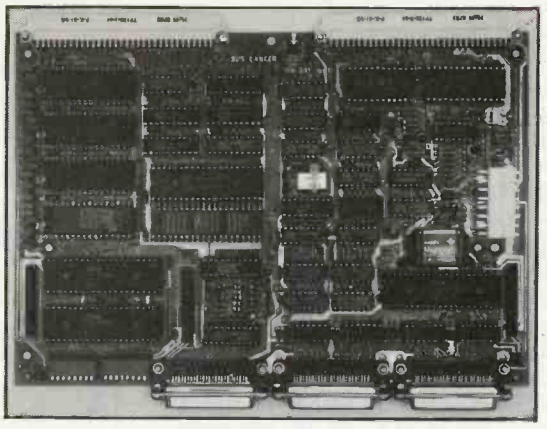

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EXTENDED TIMING

Andrew Armstrong answers a question about timer circuits.

This month's question is about timer circuits. The writer of the letter wishes to switch on and off some inaccessible battery-operated equipment on (approximately) a five-minutes-on each half hour cycle. "I've got a circuit working on the bench," he says, "but it uses a 556 dual timer ic. Someone told me recently that the reliability of the half hour timer period was questionable, because the timer uses an electrolytic capacitor. Is this really a problem, or is it so much flannel? If it is a problem, can you tell me a better way to do it?"

A very good question, and I wish more people asked such sensible questions. You imply that once the timer is installed, it will be difficult to carry out modifications or repairs. This being the case, it is very important to use a reliable design.

INTOLERANT TIMING

The problem with using electrolytic capacitors in timing circuits is that they are far from the ideal of a perfect capacitor. First of all, the tolerance on an electrolytic capacitor is greater than that on almost any non-electrolytic type. This would rule out electrolytic capacitors in a production run timer circuit, because no two units of the production line would be likely to work the same. However, for a one-off home-made circuit, one would avoid the problem by simply choosing the resistor to give the required time period. I imagine that this is what the reader did to make the circuit work. A more serious problem related to this is that electrolytic capacitors have a significant temperature coefficient, though this is not often quoted.

The problem which renders electrolytic capacitors unsuitable for long time delay circuits, at least those which employ a single time-constant, is that the leakage currents are likely to be not too much smaller than the charging current. As far as it goes, this would not appear to be an insuperable problem, one would simply use a higher charging current to account for the leakage. However, the leakage current can change, with temperature and over the life of the capacitor, so that the time period you obtain on a hot day on your laboratory bench is unlikely to be the same as the one you may obtain on a cold day two months later.

CMOS COUNTERS

Logic tells us that we need an RC time constant using non-electrolytic capacitors. Unfortunately, non-electrolytic capacitors of a high enough value are not made. It is no good just raising the resistor value to give the required time constant using a low-value capacitor, because, at high enough values of resistance to give a timer period of half an hour, using a practical value of polyester capacitor, board leakage current is likely to cause a problem. Even if the components are strung up in mid-air, there could still be leakage over the component bodies, or even just through the air.

The way to generate a reliable half hour time period is to use a shorter RC time constant many times. In other words, use an oscillator and a counter. If extreme accuracy were required, then one could use a crystal oscillator, but clearly in your application that kind of split second accuracy is not necessary.

The obvious way to tackle this is to use the circuit shown in Fig.1. The oscillator in this circuit runs at approximately nine Hertz (9.25Hz). It clocks the counter stages of the 4060 to produce varying frequency outputs. One of these, Q13, ($F_{osc}/2^{14}$) has a period of approximately half an hour. This triggers a cmos 555 timer circuit designed for a time constant of five minutes.

For some applications there is a better way, but that must wait for next month.

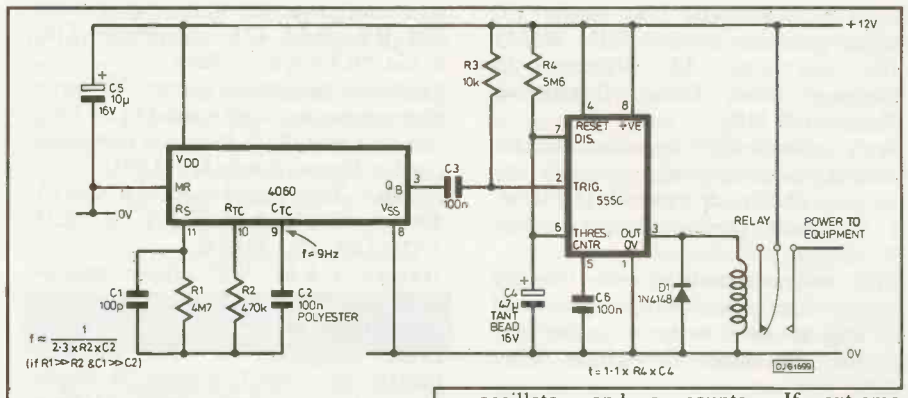
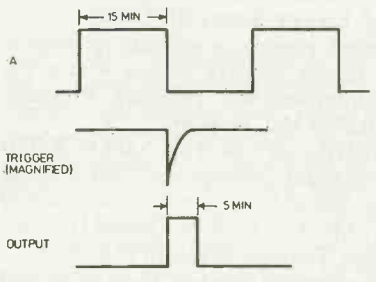


Fig 1. Suggested extended timing ratio circuit and typical waveforms.



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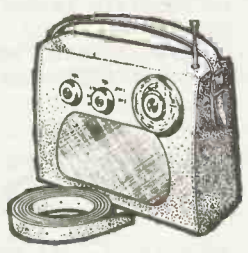

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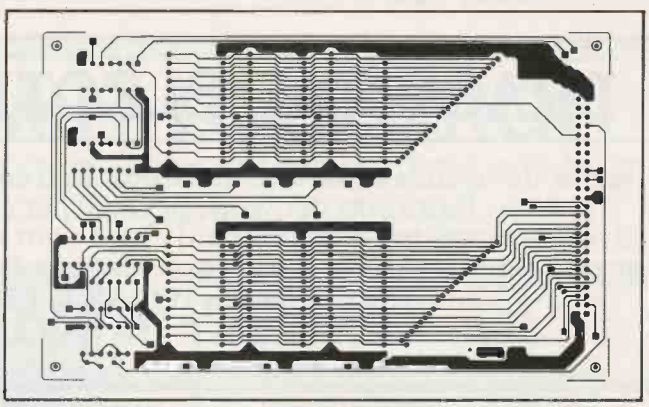

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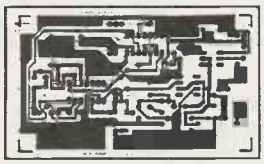

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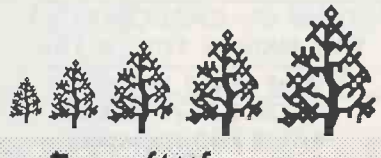

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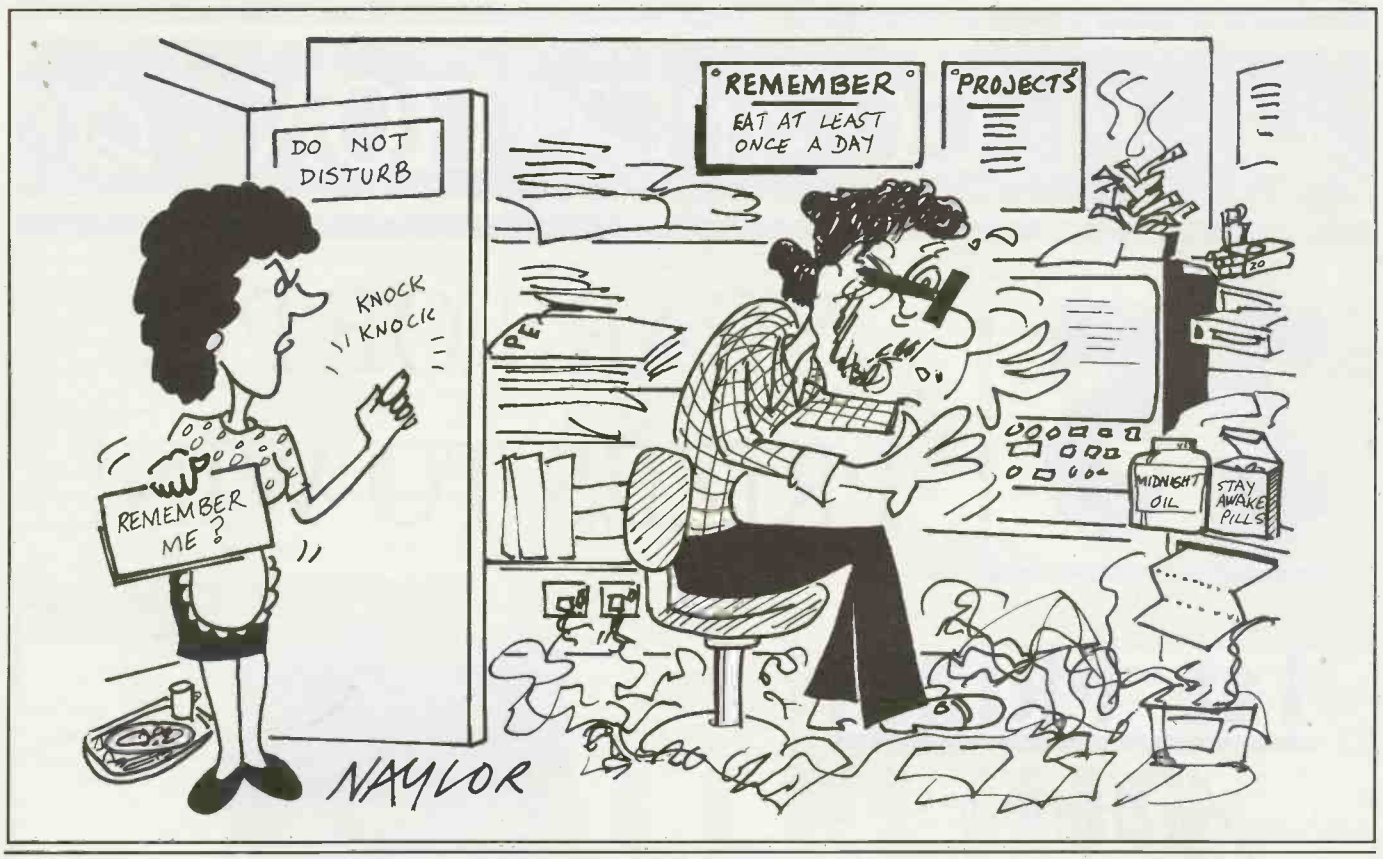

THE MICRO-GENIUS!

Jenny Welsh offers the uninitiated a cautionary description of a Home Computer.

Do you have a Home Computer? No, not a micro-chip one, but a micro-chap one! Well, if not, I'll give you an insight to what you're missing ...

It, the Home Computer micro-chap, works at an office computer all day, comes home and practically runs to its own computer room, sits down and plugs in. Thirty minutes travel home without a vdu screen to look at is too much for the poor creature!

ENTER NOT!

Unless communicated to, do not dare enter the workroom-bedsit. It's strewn with screwed-up programs, remains of last week's meals, and wires! Tread on a wire, and the whole system does down ... Sorry! I mean, the one-eyed monster goes dead, and weeks of work dissolve right in front of transfixed eyes.

PANGS OF GENIUS

Loving meals must be strategically given, thus enabling the Genius(?) to grab a mouthful, hours later, when the hunger pains take control - temporarily. I find a tray with food and water left outside its door is best; at least if you wait long enough you might get a glimpse of what was once your lover.

WHAT A FAG!

Besides the pig-sty on the floor, the one thing you get to hate more, and eventually becomes an obsession, is the pile of fag-ends! You know there's an ashtray under there - somewhere. But who knows if it's seen the light of day since it was bought?

You might think the Home Computer boff is intelligent and intellectual. But you've maybe never visited friends with it, and been stuck there for countless hours while, except for the odd suggestion of coffee, all you hear is "PC this" and "MS-Dos that", and further hours of wading through programs with bugs and viruses; and not forgetting trying to get *computers* to talk to one-another! This is beyond me! What's wrong with the *boffs* talking to each other without having to type it into the computer in the first place?

You finally escape the moronic drivel of these socially dead intellectual creatures at 3am. But no, wait - you forgot the journey home ...

ESCAPING EINSTEIN

By this time you think you could write a program that would beat Einstein himself, but unfortunately the ESC button has you lost. At least you can have a peaceful night away from the darn thing - except for the times you turn over to catch a glimpse of it/him dashing out of the room shouting "Eureka!"

MACRO MICRO SIGN

Let me warn you of the tell-tale signs -

The Characteristics of a Home Computer :

Hunched back - due to muscle fatigue;
Glasses - from vdu blindness;
Hair - hasn't seen a comb for weeks;
Foaming round the mouth - due to frenzied hours of debugging;
Beard - for obvious reasons;
Build - practically anorexic;
Finger tapping, eg, on table - automatic reflex of keying-in hand.

If you ever get anything but a "hello" from your Home Computer - he hasn't been installed properly! But what would we do without them? Probably remember the art of speech ...

(My wife says she recognises this description of what a Home Computer is like. Can't think why; I wonder if she's seeing someone I don't know about... **Ed)** PE

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Competition Entry Form and details on next page! ⇨ ⇨ ⇨

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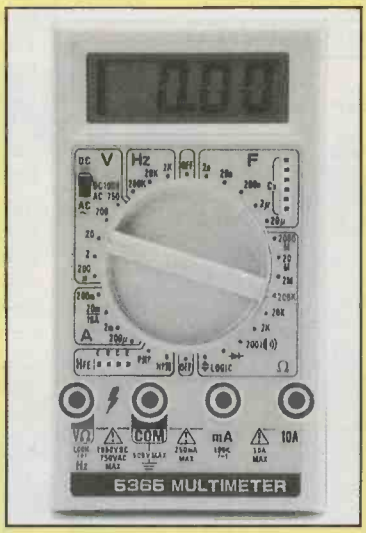

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You may send a photocopy of the entry form providing you also attach the original entry coupon clipped from the corner of this page (not a photocopy of it). The Editor's decision is final!

PE BIRTHDAY ENTRY FORM

Circle the correct answer to the following questions :

1. What exclamation is the historical Archimedes supposed to have made? (as a translation from the Greek!)

All that glitters is not gold!
Eureka - I've found it!
Save water - bath with a friend!
Oh no - not another drought!
Water, without which - nothing!

2. Who was the "Lovely Meter Maid" in the Beatles' song?
Lolita Margarita Rita Annita Pitta Cirkita

3. Which tree might you associate with the Archimedes computer?
Apple Apricot Elm Oak Sycamore Tangerine

4. PE is 25 years old, which of the following is the hex code for 25?
XXV 00011001 TF 19

5. At today's prices, what's the minimum monetary value of winning 25 years subs to PE? Enter your answer here:

6. What is the common link in the following? Enter your answer here:

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PE Competition November 89

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7451	0.35
7453	0.38
7454	0.38
7460	0.55
7470	0.50
7472	0.45
7473	0.45
7474	0.50
7475	0.60
7476	0.45
7480	0.65
7481	1.80
7483A	1.05
7484A	1.25
7485	1.10
7486	0.42
7489	2.10
7490A	0.55
7491	0.70
7492A	0.70
7493A	0.55
7494	1.10
7495A	0.60
7496	0.80
7497	2.90
74100	1.90
74107	0.50
74109	0.75
74110	0.75
74111	0.55
74116	1.70
74118	1.10
74119	1.70
74120	1.00
74121	0.55
74122	0.70
74123	0.80
74125	0.65
74126	0.55
74128	0.55
74132	0.75
74136	0.70
74141	0.90
74142	2.50
74143	2.70
74144	2.70
74145	1.10
74147	1.70
74148	1.40
74150	1.75
74151A	0.70
74153	0.80
74154	1.40
74155	0.80
74156	0.90
74157	0.80
74159	2.25
74160	1.10
74161	0.80
74162	1.10
74163	1.10
74164	1.20
74165	1.10
74166	1.40
74167	4.00
74170	2.00
74172	4.20
74173	1.40
74174	1.10
74175	1.05
74176	1.00
74178	1.50
74179	1.50
74180	1.00
74181	3.40
74182	1.40
74184	1.80
74185A	1.80
74190	1.30
74191	1.30
74192	1.10
74193	1.15
74194	1.10
74195	0.80
74196	1.30
74197	1.10
74198	2.20
74199	2.20
74221	1.10
74251	1.00
74259	1.50
74265	0.80
74273	2.00
74276	1.40
74278	1.70
74279	0.90
74283	1.05
74285	3.20
74290	0.90
74293	0.90
74298	1.80
74351	2.00
74365A	0.80
74366A	0.80
74367A	0.80
74368A	0.70
74376	1.60
74390	1.10
74393	1.20
74490	1.10
74393	1.20
74490	1.40

74LS SERIES

74LS00	0.24
74LS01	0.24
74LS02	0.24
74LS03	0.24
74LS04	0.24
74LS05	0.24
74LS08	0.24
74LS09	0.24
74LS10	0.24
74LS11	0.24
74LS12	0.24
74LS13	0.34
74LS14	0.50
74LS15	0.24
74LS20	0.24
74LS21	0.24
74LS22	0.24
74LS24	0.50
74LS26	0.24
74LS27	0.24
74LS28	0.24
74LS30	0.24
74LS32	0.24
74LS33	0.24
74LS37	0.24
74LS38	0.24
74LS40	0.24
74LS42	0.50
74LS47	0.80
74LS48	0.90
74LS51	0.24
74LS54	0.24
74LS55	0.24
74LS73A	0.30
74LS74A	0.35
74LS75	0.45
74LS76A	0.36
74LS78	0.42
74LS83A	0.70
74LS85	0.75
74LS86	0.35
74LS90	0.48
74LS91	0.90
74LS92	0.35
74LS93	0.54
74LS95B	0.75
74LS96	0.90
74LS107	0.40
74LS109	0.40
74LS112	0.45
74LS113	0.45
74LS114	0.45
74LS122	0.70
74LS123	0.80
74LS124	1.40
74LS125	0.50
74LS126	0.50
74LS132	0.65
74LS133	0.50
74LS136	0.45
74LS138	0.55
74LS139	0.55
74LS145	0.95
74LS147	1.75
74LS148	1.40
74LS151	0.65
74LS152	2.00
74LS153	0.65
74LS154	1.60
74LS155	0.65
74LS156	0.65
74LS157	0.50
74LS158	0.65
74LS160A	0.75
74LS161A	0.75
74LS162A	0.75
74LS163A	0.75
74LS164	0.75
74LS165A	1.30
74LS166A	1.50
74LS168	1.30
74LS169	1.00
74LS170	1.40
74LS173A	1.00
74LS174	0.75
74LS175	0.75
74LS181	2.00
74LS183	1.90
74LS190	0.75
74LS191	0.75
74LS192	0.80
74LS193	0.80
74LS194A	0.75
74LS195A	0.75
74LS196	0.80
74LS197	0.80
74LS221	0.90
74LS240	0.90
74LS241	0.90
74LS242	0.90
74LS243	0.90
74LS244	0.70
74LS245	0.90
74LS247	1.10
74LS248	1.10
74LS249	1.10
74LS251	0.75
74LS253	0.75
74LS256	0.90
74LS257A	0.75
74LS258A	0.70
74LS259	1.20
74LS260	0.75
74LS261	1.20
74LS266	0.60
74LS273	1.25
74LS279	0.70
74LS280	1.90
74LS283	0.80
74LS290	0.80
74LS292	14.00
74LS293	0.80
74LS295	1.40
74LS297	14.00
74LS298	1.00
74LS299	2.20
74LS231	3.70
74LS323	3.00
74LS324	3.20
74LS348	2.00
74LS352	1.20
74LS353	1.20
74LS356	2.10
74LS363	1.80
74LS364	1.80
74LS365	0.50
74LS366	0.50
74LS367	0.52
74LS368	0.50
74LS373	0.70
74LS374	0.70
74LS375	0.75
74LS377	1.30
74LS378	0.95
74LS379	1.30
74LS381	4.50
74LS390	0.60
74LS393	1.00
74LS395A	1.00
74LS399	1.40
74LS445	1.80
74LS465	1.20
74LS467	1.80
74LS540	1.00
74LS541	1.00
74LS608	7.00
74LS610	25.00
74LS612	25.00
74LS624	3.50
74LS626	2.25
74LS628	2.25
74LS629	1.25
74LS640	2.00
74LS640-1	3.00
74LS641	1.50
74LS642	2.50
74LS642-1	3.00
74LS643	2.50
74LS643-1	3.00
74LS644	3.50
74LS645	2.00
74LS645-1	4.00
74LS668	0.90
74LS669	0.90
74LS670	1.70
74LS682	2.50
74LS684	3.50
74LS687	3.50
74LS688	3.50
74C922	6.00
74C923	6.50
74C925	6.50
74C926	6.50

4000 SERIES

4000	0.20
4001	0.24
4002	0.25
4006	0.70
4007	0.25
4008	0.60
4009	0.45
4010	0.60
4011	0.24
4012	0.25
4013	0.36
4014	0.60
4015	0.70
4016	0.36
4017	0.55
4018	0.60
4019	0.60
4020	0.80
4021	0.60
4022	0.70
4023	0.30
4024	0.48
4025	0.24
4026	0.90
4027	0.40
4028	0.60
4029	0.75
4030	0.35
4031	1.25
4032	1.00
4033	1.25
4034	2.50
4035	0.70
4036	2.50
4037	1.10
4038	1.00
4039	2.50
4040	0.60
4041	0.55
4042	0.50
4043	0.60
4044	0.60
4045	1.00
4046	0.60
4047	0.60
4048	0.55
4049	0.36
4050	0.35
4051	0.65
4052	0.60
4053	0.60
4054	0.80
4055	0.80
4056	0.85
4059	4.00
4060	0.70
4063	0.85
4066	0.40
4068	0.25
4069	0.24
4070	0.24
4071	0.24
4072	0.24
4073	0.24
4075	0.24
4076	0.65
4077	0.25
4078	0.25
4081	0.24
4082	0.25
4085	0.60
4086	0.75
4089	1.20
4093	0.35
4094	0.90
4095	0.90
4096	0.90
4097	2.70
4098	0.75
4099	0.90
4501	0.36
4502	0.55
4503	0.36
4504	0.95
4505	3.60
4506	0.90
4507/4030	0.35
4508	1.20
4510	0.55
4511	0.55
4512	0.55
4513	1.50
4514	1.10
4515	1.10
4516	0.55
4517	2.20
4518	0.48
4519	0.32
4520	0.60
4521	1.15
4522	0.80
4526	0.70
4527	0.80
4528	0.65
4529	1.00
4531	0.75
4532	0.66
4534	
4536	2.50
4538	0.75
4539	0.75
4541	0.90
4543	0.70
4551	1.00
4553	2.40
4555	0.36
4556	0.50
4557	2.40
4560	1.40
4566	1.40
4568	2.40
4569	1.70
4572	0.45
4583	0.90
4584	0.48
4585	0.60
4724	1.50
14411	7.50
14412	7.50
14416	3.00
14419	2.60
14490	4.20
14495	4.50
14500	6.50
14599	2.00
22100	3.50
22101	7.00
22102	7.00
40014	0.48
40085	1.20
40097	0.36
40098	0.40
40100	1.50
40101	1.25
40102	1.50
40103	2.00
40104	1.20
40105	1.50
40106	0.48
40107	0.55
40108	3.20
40109	1.20
40110	2.25
40114	2.25
40147	2.80
40163	1.00
40173	1.20
40174	1.00
40175	1.00
40192	1.00
40193	1.00
40194	1.00
40244	1.50
40245	1.50
40257	1.80
40373	1.80
40374	1.80
80C95	0.75
80C97	0.75
80C98	0.75

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[illegible]

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10231	350p

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ADC0808	11.90
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AY3-8912	5.00
CA3019A	1.00
CA3028A	1.10
CA3046	0.70
CA3059	3.20
CA3060	3.50
CA3080E	0.70
CA3086	0.60
CA3089E	2.50
CA3090AQ	3.75
CA3130E	0.90
CA3130T	1.30
CA3140E	0.45
CA3140T	1.00
CA3146	2.25
CA3160E	1.50
CA3161E	2.00
CA3162E	6.00
CA3189E	2.70
CA3240E	1.50
CA3280G	3.00
D7002	6.00
DAC1408-8	3.00
DAC0800	3.00
DAC0808	3.00
DG308	3.00
HA1366	1.90
ICL7106	6.75
ICL7611	0.95
ICL7650	4.00
ICL7660	2.50
ICL8038	4.00
ICM7555	0.90
ICM7556	1.40
LC7120	3.00
LC7130	3.00
LC7431	3.50
LC7137	3.50
LF347	1.20
LF351	0.60
LF353	0.90
LF355	0.90
LF356N	1.10
LF357	1.00
LM10CLH	4.50
LM301A	0.30
LM307	0.45
LM308CN	0.75
LM310	2.25
LM311	0.60
LM318	1.50
LM319	1.80
LM324	0.45
LM3342	1.15
LM335Z	1.30
LM336	1.60
LM339	0.40
LM348	0.60
LM349CH	3.60
LM358P	0.50
LM377	3.00
LM380N-8	1.50
LM380N	1.50
LM381N	3.00
LM382	2.00
LM383	3.25
LM384	2.20
LM386N 1	1.00
LM387	2.70
LM391	1.80
LM392N	1.10
LM393	0.85
LM394CH	4.00
LM709	0.35
LM710	0.48
LM711	1.00
LM723	0.60
LM725CN	4.00
LM733	0.65
LM741	0.22
LM747	0.70
LM748	0.30
LM1011	4.80
LM1014	1.50
LM1801	3.00
LM1830	2.50
LM1871	3.00
LM1872	3.00
LM1886	6.00
LM1889	4.50
LM2917	3.00
LM3302	0.90
LM3900	0.80
LM3909	1.00
LM3911	1.80
LM3914	3.50
LM3915	3.40
LM3916	3.40
LM13600	1.50
M51513L	2.30
M51516L	4.50
MB3712	2.00
MC1310	1.50
MC1413	0.75
MC1458	0.45
MC1495L	3.00
MC1496	0.70
MC3340	2.00
MC3401	0.70
MC3403	0.65
MF10CN	4.00
MK50240	9.00
ML920	5.00
ML922	4.00
MM66221A	3.00
NE531	1.20
NE555	0.22
NE556	0.60
NE564	4.00
NE565	1.20
NE566	1.50
NE567	1.25
NE570	4.00
NE571	3.00
NE592	0.90
NE5532P	1.50
NE5533P	1.60
NE5534P	1.20
NE5534AP	1.50
OP-07EP	3.50
PLL02A	5.00
RC4136	0.55
RC4151	2.00
RC4195	1.50
RC4558	0.55
S50240	9.00
SAA1900	16.00
SFF96364	8.00
SL490	3.00
SN76033N	3.00
SN76489	4.00
SN76495	4.00
SN76660	1.20
SPO256AL2	7.00
TA7120	1.20
TA130	1.40
TA7204	1.50
TA7205	0.90
TA7222	1.50
TA7310	1.50
TBA231	1.20
TBA800	0.80
TBA810	0.90
TBA820	0.80
TBA820M	0.75
TBA920	2.00
TBA950	2.25
TC9109	5.00
TCA940	1.75
TDA1010	2.25
TDA1022	4.50
TDA1024	1.10
TDA1170S	3.00
TDA2002	3.25
TDA2003	1.90
TDA2004	2.40
TDA2006	3.20
TDA2020	3.20
TDA2030	2.50
TDA3810	7.50
TDA7000	3.50
TEA1002	7.00
TL061CP	0.40
TL062	0.60
TL064	0.90
TL071	0.40
TL072	0.70
TL074	1.10
TL081	0.35
TL082	0.55
TL083	0.75
TL084	1.00
TL094	2.00
UA759	3.20
UA2240	1.50
UCN5801A	6.00
ULN2003A	0.75
ULN2004A	0.75
ULN2068	2.90
ULN2802	1.90
ULN2803	1.80
ULN2804	1.90
UPC575	2.75
UPC592H	2.00
UPC1156H	3.00
UPC1185H	5.00
XR210	4.00
XR2206	4.00
XR2207	3.75
XR2211	5.75
XR2216	6.75
XR2240	1.20
ZN404	1.00
ZN414	0.80
ZN419P	1.75
ZN423E	1.30
ZN424E	1.30
ZN425E8	3.50
ZN426E8	3.00
ZN427E8	6.00
ZN428E8	4.50
ZN429E8	2.25
ZN447E	9.00
ZN448	7.50
ZN449E	3.00
ZN450E	7.50
ZN459CP	3.00
ZN1034E	2.00
ZN1040	6.60
ZNA134H	23.00
ZNA234E	9.50

CPU's

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65C02-2MHz	12.00
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6800	2.50
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6803-2	12.00
6809	6.50
6809E	10.00

CPU's

68B09	10.00
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8035	3.50
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80C39	7.00
8080A	7.50
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80C85A	9.00
8086	22.00
8087-5	£70
8087-8	£96
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8088	17.50
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Z80B	5.50
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3245	4.50
6520	3.00
6522	3.50
6522A	5.50
6532	4.80
6551A	5.50
6821	1.80
68B21	3.00
6829	12.50
6840	3.75
68B40	6.00
6850	1.80
68B50	3.00
6852	2.50
6854	6.50
68B54	8.00
6875	5.00
8154	8.50
8155	3.80
8156	3.80
8205	2.25
8212	2.20
8216	1.60
8224	P.O.A.
8226	4.25
8228	5.50
8243	2.60
8250	12.00
8251A	3.25
8253C-5	3.50
8255AC-5	3.20
8256	18.00
8257C-5	4.00
8259C-5	4.00
8275	29.00
8279C-5	4.80
8282	3.00
8283	4.00
8284	4.60
8287	3.80
8288D	6.50
8755A	
0 1 2/9	16.00
TMS4500	14.00
TMS9901	5.00
TMS9902	5.00
TMS9911	18.00
TMS9914	14.00
Z80P1O	2.50
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Z80DMA	7.00
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2114	1.50
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4116-15	2.00
4116-20	1.50
4164-15 (TI)	3.00
4164-15	1.50
4416-15	3.00
4532-20	2.50
41256-15	3.00
5101/5501	4.00
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5516	4.00
5517	4.00
50256-15	4.00
6116LP-3	3.00
6264LP-15	2.60
6810	2.00
74S189	1.80
74S201	3.50
74S289	2.25
93415	6.00
93425	6.00

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18SA030	2.00
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74S288	1.80
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32.768 kHz	1.00
1.00 MHz	2.70
1.8432 MHz	2.25
2.00 MHz	2.25
2.45760 MHz (S)	2.00
2.5 MHz	2.50
3.12 MHz	1.75
3.276 MHz	1.50
3.5795 MHz	1.00
4.00 MHz	1.40
4.194 MHz	1.50
4.43 MHz	1.00
4.608 MHz	2.50
4.9152 MHz	2.00
5.000 MHz	1.50
5.068	1.75
6.00 MHz	1.40
6.144 MHz	1.40
7.00 MHz	1.50
7.168 MHz	1.75
8.00 MHz	1.50
8.867 MHz	1.75
10.00 MHz	1.75
10.50 MHz	2.50
10.70 MHz	1.50
11.00 MHz	3.00
12.00 MHz	1.50
14.00 MHz	1.75
14.318 MHz	1.60
14.756MHz	2.50
15.00 MHz	2.00
16.00 MHz	2.00
17.734 MHz	1.50
18.00 MHz	1.70
18.432 MHz	1.50
19.969 MHz	1.50
20.000 MHz	1.75
24.000 MHz	1.50
48.00 MHz	1.75
116 MHz	2.50
PXO1000	12.00

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FD1793	20.00
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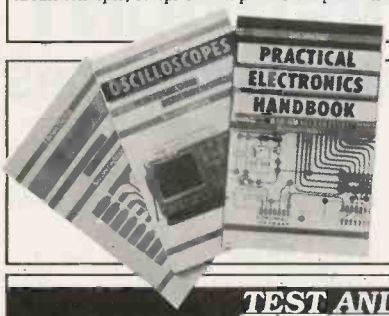

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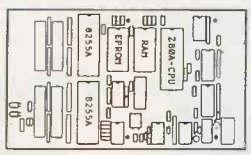

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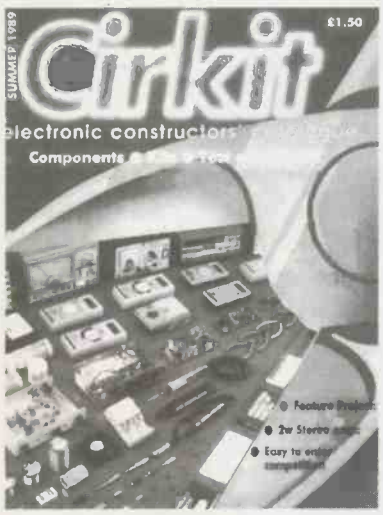
OCTOBER 1989



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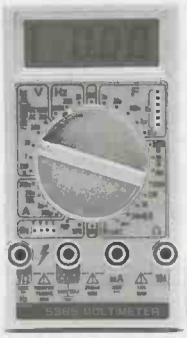

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ac volts: 200mV-750V
dc current: 200uA-10A
ac current: 200mA-10A
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