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AUGUST 1974

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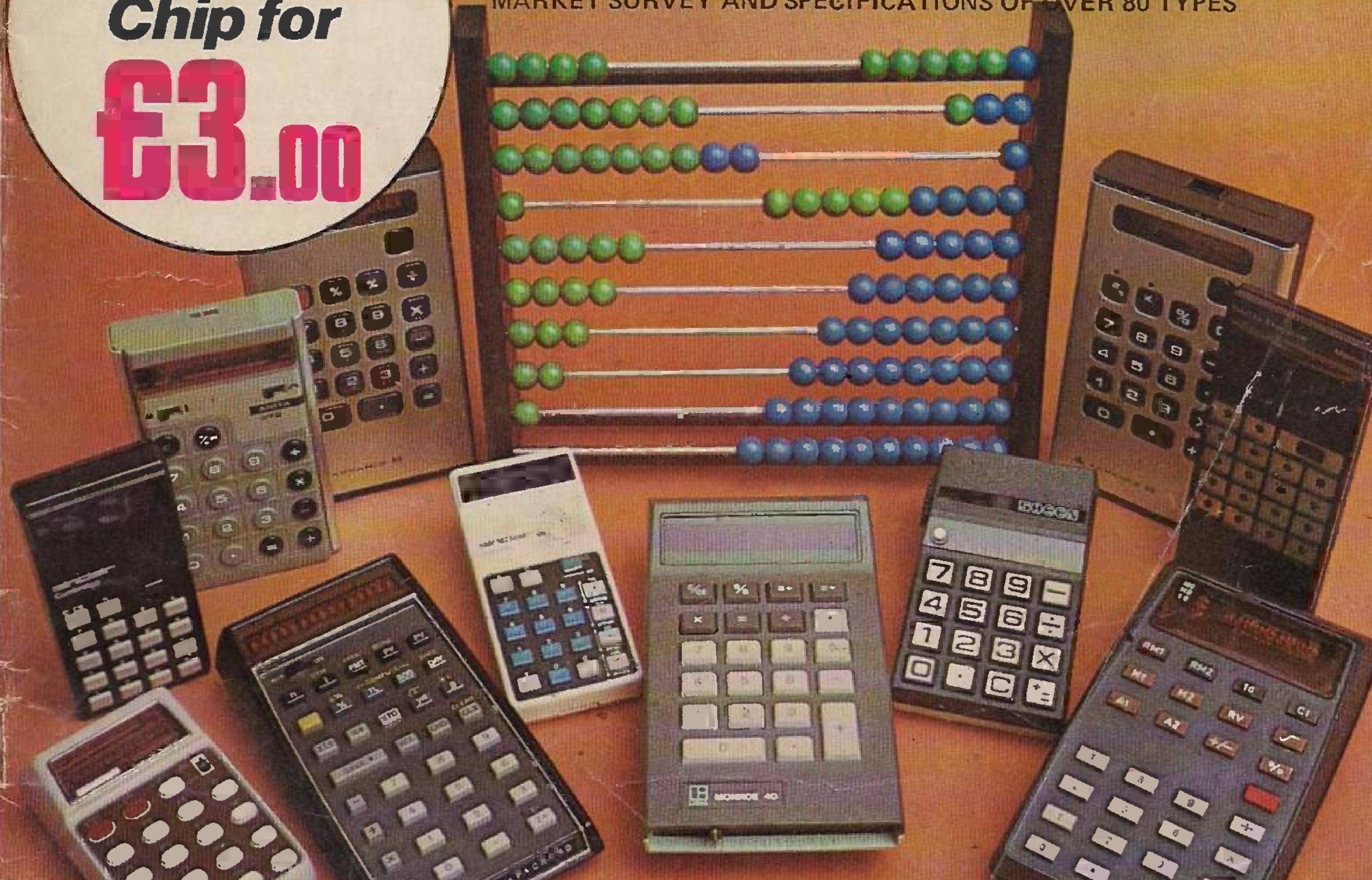

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THE MAGNETIC RIVER·DIGITAL CLOCK KITS

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CLOCK CHIPS

		Price	Pin count
MM5311	Basic clock chip, BCD outputs	£ 9.00	28
MM5314	As MM5311, no BCD outputs	£ 7.20	24
MM5309	As MM5311 plus reset to zero.	TBA	28
MM5316	4 dig alarm chip, Liq. Crys. drive.	£15.00	40
MM5375	6 dig alarm, Sperry drive.	TBA	24
MK5017AA	6 dig alarm, sleep and snooze.	£14.00	24
MK50250	6 digit alarm.	£ 7.60	28
CT7001	Alarm/date/sleep/snooze/etc.	£16.50	28
CT7002	As CT7001 but BCD outputs.	£16.50	28
TMS3952	Alarm/stopwatch.	£20.00	28
CT6002	CMOS, Liq.Crys. drive, for battery clock.	£22.65	40

DIGITAL WATCHES

The CT6002 chip is available built into a complete digital watch module complete with everything except case - no soldering to do, the module is actually running when you get it! CT6001/M £92.60.

MHI DIGITAL CLOCK KITS

Our MHI range of kits is intended to allow the building of virtually any type of digital clock. The range was announced in May with the MHI-5314/C kit and is now supplemented by four new additions.

MHI-5314/C is based on the MM5314 chip, it gives a basic digital clock suitable for driving any of the MHI display units. £8.40

MHI-5025 kit uses the Mostek MK50250 alarm chip, it gives a six digit display with an alarm tone circuit to drive a small speaker. The kit is suitable for any of the MHI display boards. £11.35

MHI-7001 kit uses the fantastic CAL-TEX CT7001 chip with time, date, alarm, sleep, snooze and many other features. We would advise the use of a six digit MHI readout for this kit. £19.00

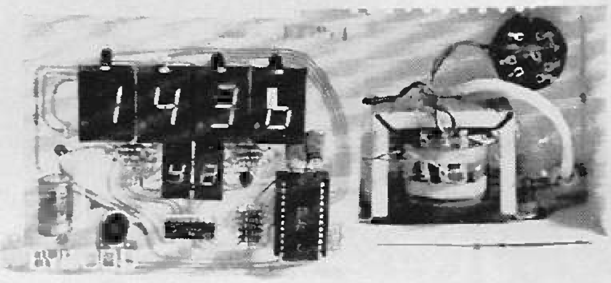
MHI-D707 display kit uses the DL707 0.3" LED display digits, available as a four digit or six digit kit.
MHi-D707/4 £7.60, MHI-D707/6 £11.40

MHI-D747 display kit uses the DL747 0.6" LED digits, these give a display which is readable at over 25 feet.
MHI-D747/4 £10.25 MHI-D747/6 £15.35

MHI-D3IN is specifically designed for advertising type displays, the digits are made up from discrete LED lamps and form digits about 3" high. These are readable at distances of well over 50 yards. Available as four or six digits with colons between each pair of digits.
MHI-D3IN/4 £24.00 MHI-D3IN/6 £36.00

The clock kits contain clock chip, CA3081 segment driver, PCB (4" x 2"). The MHI-5314/C kit does nor contain a socket for the clock chip (£1.00 extra) but all other kits have a socket as standard. The display kit contains the LEDs and a four or six digit PCB.

MHI is a modular approach to building digital equipment and all present and future kits are interchangeable wherever possible. The simplicity of the kits makes them ideal for small production runs of clocks or for teaching and training. For details of quantity prices please contact us at Hemel Hempstead (0442) 62757.



5314 - JUMBO EVALUATION KIT

Our most popular kit so far is our 5314 - JUMBO Evaluation Kit, due to the large orders that we have received from amateurs and from industrial users we are able to offer this kit at a new price of £22.80.

The MM5314 is a 24-pin LSI chip containing all the logic necessary for a 12/24 hour, 4/6 digit, 50/60Hz digital clock. The new 0.6" LED display from Litronix (the Jumbo) is readable from distances of over 25ft. We supply MM5314, socket, 4 Jumbo's, 2 DL707 0.3" digits, CA3081 driver and a 5" x 4" fibreglass PCB. You supply 16 resistors, 3 capacitors, 2 diodes, 6 transistors, transformer and switch.

KIT PRICE: £22.80

DISPLAY READOUTS

DL707	Common Anode 0.3" LED.	£ 1.70
DL704	Common Cathode DL707.	£ 1.70
DL747	Common Anode 0.6" LED.	£ 2.45
DG10A	Phosphor-diode 8.5mm.	£ 1.10
DG12H	Phosphor-diode 12.5mm (0.5").	£ 1.20
LC823440	Field effect Liq.Crys. four digits.	£16.00
3015F	Minitron filament, 9mm digit.	£ 1.25
3016F	Minitron type filament, 12mm digit.	£ 1.25
3017F	Minitron type filament, 16mm digit.	£ 2.00
SP752	Sperry high voltage, 0.5", 2 digits.	£ 4.00

CALCULATOR CHIPS

CT5002	Four function, 12 digits.	£ 5.00
CT5031	8 digit, Constant, 'timer' option.	£14.55
CT5032	12 dig, cons, mem, averager, etc.	£19.36
CT5037	8 dig, cons, mem, internal mpx.	£15.49

SOCKETS

We advise the use of sockets with the above chips. 24 or 28 pin £1.00, 40 pin £1.35.

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AUGUST 1974 Vol. 3 No.8.

main features

projects

product tests

news & information

Cover: The old and the new. A few of the 80+ handheld calculators featured in our special market survey starting on page 37.

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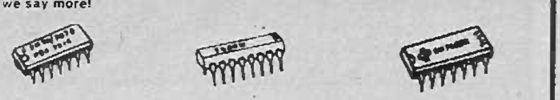

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SN7401N	0·20	0·18	0·16	SN7450N	0·20	0·18	0·16	SN74142N	2·88	2·88	2·52
SN7401AN	0·38	0·38	0·33	SN7451N	0·20	0·18	0·16	SN74145N	1·44	1·44	1·26
SN7402N	0·20	0·18	0·16	SN7453N	0·20	0·18	0·16	SN74147N	2·30	2·30	1·83
SN7403N	0·20	0·18	0·16	SN7454N	0·20	0·18	0·16	SN74148N	2·01	2·01	1·63
SN7403AN	0·38	0·38	0·33	SN7460N	0·20	0·18	0·16	SN74150N	2·30	2·30	2·01
SN7404N	0·24	0·21	0·18	SN7470N	0·33	0·30	0·27	SN74151N	1·15	1·15	1·00
SN7405N	0·20	0·18	0·16	SN7472N	0·38	0·38	0·34	SN74153N	1·09	1·09	0·95
SN7405AN	0·44	0·44	0·38	SN7473N	0·44	0·41	0·37	SN74154N	2·30	2·30	2·01
SN7406N	0·40	0·38	0·35	SN7474N	0·48	0·48	0·42	SN74155N	1·15	1·15	1·00
SN7407N	0·40	0·38	0·35	SN7475N	0·59	0·55	0·51	SN74156N	1·09	1·09	1·00
SN7408N	0·25	0·22	0·19	SN7476N	0·45	0·36	0·32	SN74157N	1·09	1·09	0·95
SN7409N	0·33	0·33	0·28	SN7480N	0·80	0·70	0·50	SN74159N	2·44	2·44	2·14
SN7409AN	0·44	0·44	0·38	SN7481N	1·25	1·10	0·95	SN74160N	1·58	1·58	1·38
SN7410N	0·20	0·18	0·16	SN7482N	0·87	0·80	0·72	SN74161N	1·58	1·58	1·38
SN7411N	0·25	0·23	0·21	SN7483N	1·20	1·10	1·00	SN74162N	1·58	1·58	1·38
SN7412N	0·28	0·28	0·25	SN7485N	1·87	1·87	1·63	SN74163N	1·58	1·58	1·38
SN7412AN	0·38	0·38	0·33	SN7486N	0·50	0·50	0·44	SN74164N	2·01	2·01	1·76
SN7413N	0·30	0·27	0·25	SN7489N	4·32	4·32	3·78	SN74165N	2·01	2·01	1·76
SN7414N	0·72	0·72	0·63	SN7490N	0·75	0·70	0·63	SN74166N	2·16	2·16	1·89
SN7416N	0·30	0·27	0·25	SN7491AN	1·10	1·00	0·90	SN74167N	4·10	4·10	3·59
SN7417N	0·30	0·27	0·25	SN7492N	0·75	0·70	0·63	SN74170N	2·88	2·88	2·52
SN7420N	0·20	0·18	0·16	SN7493N	0·75	0·70	0·63	SN74172N	5·76	5·76	5·04
SN7422N	0·28	0·28	0·25	SN7494N	0·85	0·80	0·75	SN74173N	1·66	1·66	1·45
SN7422AN	0·38	0·38	0·33	SN7495N	0·85	0·80	0·75	SN74174N	1·80	1·80	1·57
SN7423N	0·37	0·34	0·32	SN7496N	1·00	0·90	0·83	SN74175N	1·29	1·29	1·13
SN7425N	0·37	0·37	0·32	SN74100N	2·16	1·89	1·89	SN74176N	1·44	1·44	1·26
SN7427N	0·37	0·37	0·32	SN74104N	0·60	0·53	0·45	SN74177N	1·44	1·44	1·26
SN7428N	0·43	0·43	0·37	SN74105N	0·60	0·53	0·45	SN74180N	1·44	1·44	1·26
SN7430N	0·20	0·18	0·16	SN74107N	0·51	0·51	0·45	SN74181N	5·18	5·18	4·53
SN7432N	0·37	0·37	0·32	SN74110N	0·57	0·57	0·50	SN74182N	1·44	1·44	1·26
SN7433N	0·43	0·43	0·38	SN74111N	0·88	0·88	0·75	SN74184N	2·16	2·16	1·89
SN7433AN	0·57	0·57	0·50	SN74116N	2·16	2·16	1·89	SN74185AN	2·16	2·16	1·89
SN7437N	0·43	0·43	0·37	SN74118N	1·00	0·90	0·83	SN74188N	6·48	6·48	5·67
SN7438N	0·43	0·43	0·37	SN74119N	1·92	1·92	1·68	SN74190N	2·30	2·30	2·01
SN7438AN	0·57	0·57	0·50	SN74120N	1·05	1·05	0·92	SN74191N	2·30	2·30	2·01
SN7440N	0·20	0·18	0·16	SN74121N	0·57	0·57	0·50	SN74192N	2·30	2·30	2·01
SN7441AN	0·85	0·79	0·73	SN74122N	0·80	0·80	0·70	SN74193N	2·30	2·30	2·01
SN7442N	0·85	0·79	0·73	SN74123N	1·44	1·44	1·26	SN74194N	1·72	1·72	1·51
SN7443N	1·50	1·27	1·13	SN74125N	0·69	0·69	0·60	SN74195N	1·44	1·44	1·26
SN7444N	1·50	1·27	1·13	SN74126N	0·69	0·69	0·60	SN74196N	1·58	1·58	1·38
SN7445N	2·16	2·16	1·89	SN74132N	0·72	0·72	0·63	SN74197N	1·58	1·58	1·38
SN7446N	2·16	2·16	1·89	SN74136N	0·63	0·63	0·55	SN74198N	3·16	3·16	2·77
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B05/20	200v	23p
B05/40	400v	25p
B05/60	600v	27p

⅜H x ⅜L x 5/16" dia.

1 AMP P.I.V.

B1/05	50v	25p
B1/10	100v	25p
B1/20	200v	28p
B1/60	600v	30p

⅜H x ⅜L x 5/16" dia.

1 AMP P.I.V.

W005	50v	29p
W01	100v	30p
W02	200v	32p
W06	600v	35p

⅜ x ⅜" Tubular

2 AMPS P.I.V.

B2/05	50v	35p
B2/10	100v	40p
B2/20	200v	45p
B2/60	600v	50p
B2/100	1000v	55p

⅜H x ⅜L x 5/16" dia.

4 AMPS P.I.V.

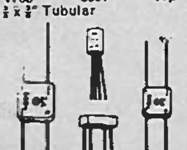
B4/100	100v	55p
B4/200	200v	59p
B4/400	400v	65p
B4/600	600v	75p
B4/800	800v	£1·00

⅜H x ⅜L x 5/16" dia.

6 AMPS P.I.V.

B6/05	50v	65p
B6/10	100v	70p
B6/20	200v	80p
B6/40	400v	90p
B6/6x0	600v	£1·00

⅜H x ⅜L x 5/16" dia.



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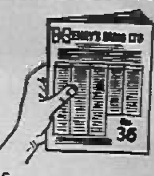

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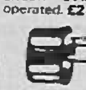

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ZFT4A/XTF2 Suitable for Dec. '73 Pract. Electronics — £3·50

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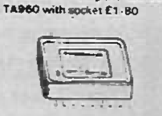

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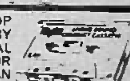

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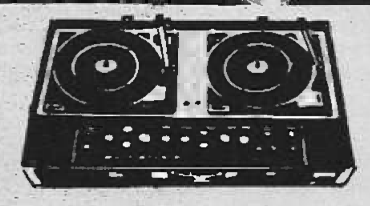

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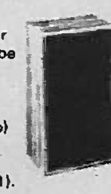

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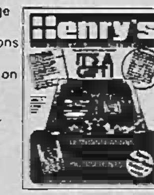

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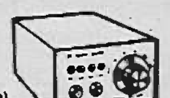

470C 6/7½/9 volt 300 MA (includes Multi-Adaptor for Tape Recorders, etc.)	£2·25 post 20p
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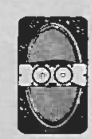
*Polished wood cabinet £4·80 post 35p.



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(carr. etc. 30p)

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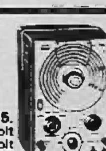
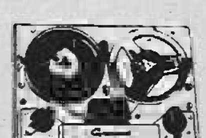


OTHER EQUIPMENT

SE 250B Pocket Signal Injector £2·25 carr. 15p. TE15 Grid Dip meter 440kHz–280mHz £16·50 carr. 30p. TE40 AC Millivoltmeter 1·2mHz £19·75 carr. 35p. TE65 28 Range valve voltmeter £22·50 carr. 40p. TE20D 120kHz–500mHz RF Generator £18·95 carr. 40p. TE22D 20Hz–200kHz Audio Generator £19·95 carr. 40p. SE350A Deluxe Signal Tracer £12·95 carr. 20p SE400 Volts/ohms/R-C sub./RF field/RF gen. £15·50 carr. 20p.

GARRARD BATTERY TAPE DECK

GARRARD 2 speed 9 volt tape decks. Fitted record/play and oscillator/Erase heads. Wind and rewind controls. Takes up to 4" spools. Brand new complete with head circuits. £9·50 carr. 30p.



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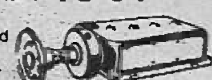
Brand new transistorised geared tuners for 625 Line Receiver 1F output. **£2·50** Post 20p



FIBRE OPTICS

0·01 Diam. Mono Filament £5·50 per 100 metre reel
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Amp AC = 10 ranges from 200μA to 5A
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Capacity = 6 ranges from 0 to 500pF and from 0 to 0.5μF and from 0 to 50.000pF
Frequency = 2 ranges from 0 to 500Hz and from 0 to 5000Hz
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Decibels = 10 ranges from −24 to +70dB

price £18·50

Accessories

Transistor tester	£11·00
Electronic voltmeter	£18·00
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Singles Log and Lin 5K, 10K, 22K, 50K, 100K, 250K, 500K, 1 Meg. 48p each.
Ganged Log and Lin 10K, 22K, 50K, 100K, 250K, 85p each. (Quantity discounts available.) Complete with knobs.

MARRIOT TAPE HEADS

4 TRACK MONO or 2 TRACK STEREO. '17' High Impedance £2·50. '18' Medium Impedance £3·50. '36' Medium Impedance £5·00. R730/E73 2 track mono Record/Erase low imp. 75p pair. Erase Heads for '17' and '18' and '36' £1·00. '63' 2 track mono, Hi imp. £1·75. '43' Erase Head for '63' 75p. (Post, etc., 15p any quantity.)

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news digest

HITACHI WIN THE TV FLAT-SCREEN RACE

The world's first working prototype of a flat-screen colour TV set that could be hung on the wall like a picture has been made by Hitachi.

This is the big breakthrough which all television makers have been pursuing. The Hitachi disclosure came in the same week that another Japanese manufacturer, Sony, began production in Britain of conventional colour sets.

Not only is this new TV flat, but the screen can be as big as you want it. There could even be whole TV walls, in schools for instance.

There is still a long way to go, however, before the prototype can be converted into a mass-production model.

British television makers have kept their own research into flat-screen sets very secret, but we are informed that all have been pursuing research into the flat-screen.

There appears, however, to be no co-ordinated research. Each company wants the profits that would flow from exclusive patents, just as AEG-Telefunken, of West Germany, has benefited from its PAL colour system patents.

FOUR-CHANNEL BROADCASTING STANDARD

It now seems virtually certain that the US Federal Communications Commission will eventually lay down a standard for discrete four-channel FM broadcasting.

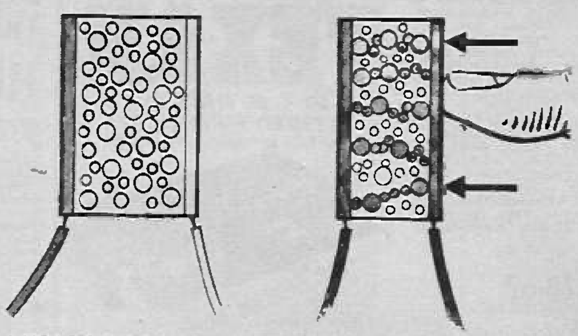
General Electric, Zenith, RCA, Nippon Columbia, and Lou Dorrin all have discrete systems under evaluation by the National Quadrasonic Evaluation Committee.

Matrixed quadrasonic recordings are now broadcast by a number of stations around the USA, but station managements are obviously reluctant to spend a great deal of money on equipment that may soon be technically obsolete.

Nevertheless CBS has over 250 FM stations currently transmitting SQ encoded material — and Sansui are making strenuous efforts to have their QS system adopted as a broadcasting industry standard.

Although the scene is still very confusing it looks as if four-channel broadcasting may well end up using one of the five competing discrete systems — and techniques will be devised for processing matrix material in such a way that it can be transmitted via the discrete broadcasting link.

NEW SWITCH MATERIAL IS A CONDUCTIVE ELASTOMER



LEFT: A cross sectional diagram of Spherax in its relaxed state with the shaded area showing the live feed. RIGHT: Spherax in its compressed state. When pressure is applied the metallic particles, represented by the spheres, form a chain creating a circuit through which current (the shaded area) flows.

LUCAS SPHERAX is a formulation of compounded metallo-organic materials which are capable of conducting an electric current. A number of formulations are available which provide a variety of mechanical and electrical characteristics and are suitable for many different applications as switches or inert conductors.

A new switch material called 'Spherax' has just been announced by the Lucas group.

'Spherax' looks like a piece of rubber. It is, in fact, a conductive elastomer. This material has the property of acting as a conductor when it is compressed, thus it is ideally suited for use in vehicle switchgear.

One of our biggest motor manufacturers plans to use it as a horn push in a forthcoming model. But many other applications for 'Spherax' are envisaged by the Lucas research team who have been experimenting with it for use in the automotive environment.

These include: touch switches, panel switches, courtesy light switches, brake light switches, direction indication switches, gear lever and steering column lock switches, oil pressure and temperature switches and electronic direction indication switches.

Vehicle manufacturers in several parts of the world who have been given a preview of the 'Spherax' qualities are showing great interest in various combinations of possible applications.

Conductive elastomers (metallic-silicone compounds) are materials whose electrical conductivities are increased as the materials are compressed. The millivolt drop per ampere flowing through the material is a function of the pressure.

Those designed for connector (as distinct from switching applications) are conductive whether stressed or unstressed.

Technical advantages foreseen for switches and connectors employing conductive elastomers include:

Reduction in heat generated, longer life, rheostatic nature of switch provides substantial arc suppression, increased resistance to adverse environmental conditions.

For cables, advantages include the capability of connecting virtually any type of electrical conductor, in any combination, without the use of rivets, terminals and suchlike, no loss in performance resulting from repeated disconnection and reconnection, good ageing stability in various environmental conditions, water-tight connections readily obtained.

In most metal-to-metal contact and connection systems only a small number of actual interfacial contacts are obtained. Consequently high current densities are produced at these points.

But, because of the elasticity of conductive elastomer materials, the contours of contacting surfaces adapt to each other, resulting in a greater number of interfacial conducting paths and less than half the millivolt drop and energy loss of conventional systems.

'Spherax' is being developed technically in conjunction with Essex International.

LASER GUNS

Solartron Ltd., who developed the Simfire system, are developing laser simulation equipment for almost all weapons used by the Army. This year the Army's order for 300 Simfire sets will be completed. This system is used with tanks to simulate realistic fire between opposing forces. When the gunner presses the firing switch the laser fires pulses at the enemy tank. When on-target, the system will simulate damage by cutting out the engine, radio, etc., of the hit tank.

Soon, laser simulation will help train riflemen, too. By firing at live targets with a modified rifle, laser beam pulses will trigger detectors attached to the enemy clothing. The advantages over previous methods are obvious, as this system gives clear indication of whether a marksman hit his target, and whether he has been hit himself.

JAPAN LOSES GRIP ON CALCULATOR MARKET

There have been dramatic changes in the world market for electronic calculators in the last two years. The American manufacturers have siezed the initiative from their Japanese rivals, while prices have dropped like a stone and the number of units sold soared to an estimated 15m worldwide in 1973.

A new report shows how the value of Japanese calculator production has actually declined, despite a huge increase in the number of units produced, while the Americans have forged ahead. The average price of calculators leaving Japan fell from about £115 in early 1971 to about £26 by late 1973. From 80% of the world calculator market in 1971, Japan's slice fell to 40% in 1973.

American companies realised that their LSI technology was being exploited by their Japanese competitors and decided to start using the circuits themselves, with great success. LSI technology allows all the computing circuitry needed in a calculator to be carried on a few tiny chips of silicon. This is what has made the pocket calculator boom possible, but producing the chips demands high-level technology and long production runs to be economic. The Americans are far ahead of the rest of the world in LSI.

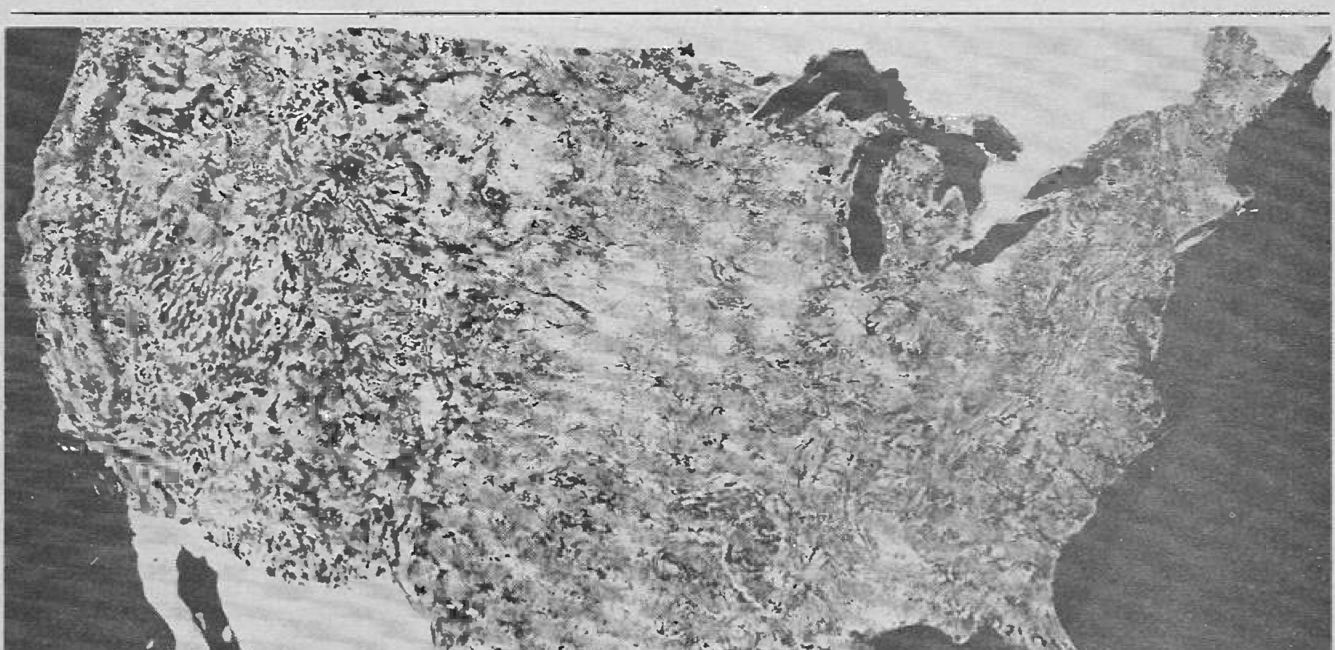
Big Japanese manufacturers (such as Sharp which made about 2 million calculators in 1973) are building up their own LSI capability in the struggle to stay ahead. The value of Japanese calculator manufacture fell from 132 billion Yen in 1970 (about £200m) to an estimated 111 billion Yen in 1973, even though the number produced soared from 1.4m to 10m.

In the USA Bowmar, by far the biggest specialist in the field, increased its total sales from $13m in 1971 to $64m in 1973, largely as a result of its entry into calculators. Other big US calculator manufacturers include Rockwell International, prime contractor in the moon-landing programme, Texas Instruments, the world's biggest manufacturer of integrated circuits, and Hewlett-Packard which is specialising very successfully in sophisticated financial and technical calculators.

The US manufacturers are moving rapidly into Britain. Rockwell, for example, last year took over Britain's largest calculator manufacturer, Sumlock Anita and Texas Instruments has set up a large plant to make calculators at Plymouth. As far as sales in Britain are concerned, Japan accounted for just over 25% of the £26m calculator imports in 1973, slightly ahead of the USA, with Italy, West Germany, Singapore, Canada and Hong Kong following behind in that order. Altogether an estimated 810,000 calculators were supplied in Britain last year.

The future is expected to see a continuing rapid increase in the number of calculators sold, but a much slower growth in the value of the market. The Japanese manufacturers are already showing signs of closing the technology gap in LSI, and also in producing calculator displays. The Americans now have such a strong lead in the market that they are unlikely to lose it - unless the Japanese can come up with a major technical innovation.

Continued overleaf



This extraordinary photograph shows the NASA Earth Resources Technology Satellite (ERTS) image of the entire United States from an altitude of 905 kilometres (562 miles). A large number of individual shots have been combined to form the first mosaic of America. Produced at a scale of 1:1 million, the map is composed of 595 cloud-free ERTS images produced by a red portion (Band 5) of the visible spectrum during the summer and autumn of 1972. The map will be used to assess the national water drainage network, land use and vegetation coverage as well as to inventory the nation's surface water. A second map is being constructed to give a synoptic picture of the US during winter time.

The strongest possibility of breaking this barrier is with the thermal printer.. At present calculators which print out their results take a relatively small share of the market, because of their high cost. Many commentators believe that if the £100 price barrier can be broken, a very large market would be opened up. In the thermal printer, heat-emitting components reproduce numerals as a pattern of fine dots on sensitised paper. The mechanism promises to be silent, fast, reliable, easy to manufacture and cheap. The drawback at present is that it needs expensive special papers. The first manufacturer to find a way round this problem will have a valuable lead in the printing calculator market.

PULSE CYCLE?

HRH The Duke of Edinburgh awarded this bicycle to Mr. George Robins, Managing Director of Design Animations Ltd. Mr Robins won the 1973 Duke of Edinburgh's Design Prize for elegant and efficient design of his picture framing system and designed his prize himself, in conjunction with Cambridge Consultants Ltd.

Pulse control makes his the only electric bicycle fitted with a throttle allowing smooth control of speed and acceleration, allowing manoeuvrability in traffic and on the open road. In addition the need for a gear change and clutch has been eliminated.

The throttle unit regulates power to the motor by the pulse width system - the battery supply is turned on and off repetitively at a high rate. Power to the motor is determined by the relative durations of the "on" and "off" periods of this switching. If more power is required, then the supply is switched on for longer in every cycle. With this control ranging from off to fully on, smooth regulation of the motor power is available.

An electronic "centrifugal clutch" protects the drive system against excessive loading.

The bicycle is powered by 12 nickel-cadmium 1.35 volt batteries which allow 40 miles of silent riding before recharging is necessary. A meter, very similar to a conventional fuel guage, indicates the condition of the batteries. Recharging can take place at any domestic mains socket using the integral battery charger. This feature effectively extends the range of travel since the bicycle is not dependent on its home base for recharging. The batteries can be recharged up to 2,000 times and a complete recharge takes only a few hours and costs less than 1p. Operating costs are expected to work out at approximately ½p./10 miles. The compact lines of the bicycle are complemented by the novel form of construction in steel and aluminium. Other features of the bicycle (length 47" and width 5") include cable operated drum brakes and a simple chain drive. Top speed is 30 mph.

LIE-DETECTION – 1974

A new form of lie detector is becoming widely used in the USA.

The device, known as the Dektor psychological stress analyser works by analysing the human voice – and can be used without the subject's knowledge.

Operating principle is that the muscles that vibrate the human vocal chords normally (not under stress) add a 8 Hz to 12 Hz component to the voice.

Under stress this component changes – and the change is detected by the Dektor instrument.

The manufacturers advise that the device merely indicates stress – not necessarily lies, but an alarming number of private companies are using the devices during employment interviews and even for regular employee checking.

As a demonstration of the instrument's capabilities, the manufacturers analysed the broadcast Watergate hearings and told the press just whom they thought were lying. To date they have been remarkably correct!

There is an increasingly strong reaction against the use of these devices, and US Senator Sam Ervin has now introduced a bill to ban their use by private industry.

ACC AFTER ONE YEAR

Now moving into its second year of existence the Amateur Computer Club has now formulised its activities into a constitution and has a membership of over 200. A full newsletter forms the nucleus of the club.

Activities are being arranged and will be announced in the newsletter. The newsletter has provided a forum for the airing of ideas and introducing basic principles to the beginner. New members and ideas are very welcome, membership is £1.00 per year (that includes the near monthly newsletter) and applications should be directed to *Mike Lord, 7 Dordells, Basildon, Essex.*

MONEY IDENTIFIER FOR BLIND PERSONS

The cliche "money talks" will soon acquire a new literal meaning for blind business persons thanks to a simple paper money identifier developed from NASA technology.

The device will enable a blind person to identify paper money by its sound "signature". Until now no reliable paper money identifier for the blind has been available.

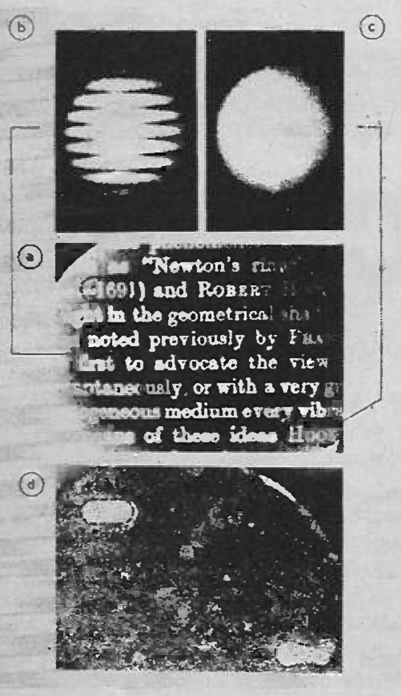
To determine its denomination, a bank note is passed under a light source on the small, inexpensive device. A phototransistor measures changes in the note's light patterns. These changes are converted into sound signals by an oscillator – producing sounds much like the "beeping" tones one hears when making a long-distance telephone call. Since the design of various denominations of paper money differs, each bank note gives off its own easily identified sounds.

Tests of an early version of the money identifier were successfully conducted by Arkansas Enterprises for the Blind in Little Rock. It was found that after about three hours of practice a subject could easily distinguish the sound patterns of different denominations of paper money.

The paper money identifier is being produced by the Marchak Engineering and Manufacturing Co., Austin, Tex. It is being marketed by Applied Rehabilitation Systems, 3902 Idlewild, Austin.

LASER PHOTOGRAPHY

Photographic processes have been used for a long time to investigate the deformation of material under stress, disadvantages were the poor depth of field, the limits of resolution of the camera lens and the laboratories microscopic evaluation of the negatives. When laser light is used, the laser beam produces speckles on the object. Then if a point on the measured object is displaced, the individual speckles around this point on the image are also displaced. This displacement can easily be determined by illumination with coherent light. The speckles appear well defined and sharp regardless of the sharpness of the image. The method developed in the Siemens test laboratories allows measurements to be carried out over the micrometer range showing deformations, vibrations, elongations, tiltings and deflection angles of laser beams at phase-modulating objects.



If the surface area is displaced as a result of mechanical stress, the doubly exposed image shows two identical speckle patterns displaced with respect to each other. The negative is scanned by a laser beam to determine the distance between the two patterns. The speckle pattern diffracts the laser light, which results in the production of parallel interference stripes, the distance between which is inversely proportional to the displacement of the two speckle patterns.

Another use of the laser in photography is for correlation measurements. Young's interference fringes can only occur in the case of double exposure, if identical speckle patterns which are displaced with respect to each other are recorded. The contrast in the interference fringes is a measure of the change in the microstructure on the surface of the material. The photographic plate of the paper shown above (a) was shifted by a few thousandths of a millimeter and some areas were erased between the two exposures. When the beam was directed upon the unerased areas, interference fringes were produced at some points (b). The erased areas are clearly visible since they do not produce interference stripes (c). These are particularly prominent in the coherent-light filtered image of the negative (d).

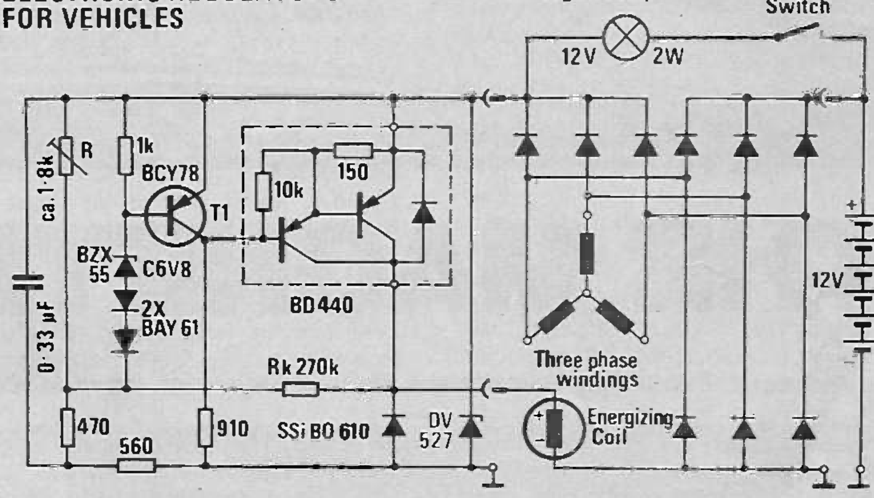
This process opens up new possibilities for the discovery of forgeries and the early detection of fatigue in materials.

BAEC AMATEUR ELECTRONICS EXHIBITION THIS JULY

If you are luck enough to get your ETI early, you might like to go down to Penarth for the ninth annual exhibition of the British Amateur Electronics Club. Cyril Bogod, the Chairman, promises us it will be the best yet: "This year we want to have all new electronic games and exhibits, with the possible exception of the BAEC Noughts and Crosses Computer, which has always been very popular".

The games will all be made by members of the BAEC and there will be a prize for the best exhibit. The exhibition will be run by club members and all proceeds will go to charity. *It will be held from Sat July 20th to July 27th at the Shelter on the Esplanade, Penarth, Glam.*

ELECTRONIC REGULATORS FOR VEHICLES



Most vehicles manufactured today are fitted with three phase alternators rather than dc generators but the method of control relies on electromechanical regulators, which are unreliable and inaccurate. In order to gain the full benefits of high regulation accuracy and long life from an alternator it is desirable to use a fully electronic control system. Siemens have developed a circuit for this which can be constructed from discrete components.

The regulator has to react to both the voltage output of the alternator and the battery voltage to control the energising control current. The characteristics of the generator automatically limit the maximum current. The built-in diodes prevent the possibility of current flowing in the wrong direction. In a 12V car system, the transistor regulator supplies a nominal battery charging voltage of 14.3V. During the change-over from battery charging to no-load operation the control transistor T1 becomes conductive if there is a higher voltage at the input divider than at the Zener diode BZX55. At the same time the Darlington output stage T2 blocks. Since the generator's energising coil lies in the collector input, the energisation decays within the time constant of the field. If, however, the generator's terminal voltage fails to reach the desired value as determined by the Zener diode, the generator is again energised, this time more highly because the switching condition of T1 and T2 is reversed.

The Zener diode DV526 protects both the regulator and the entire mobile power supply from excess voltages which could occur if the battery cable suddenly became disconnected or if the generator cables were incorrectly connected.

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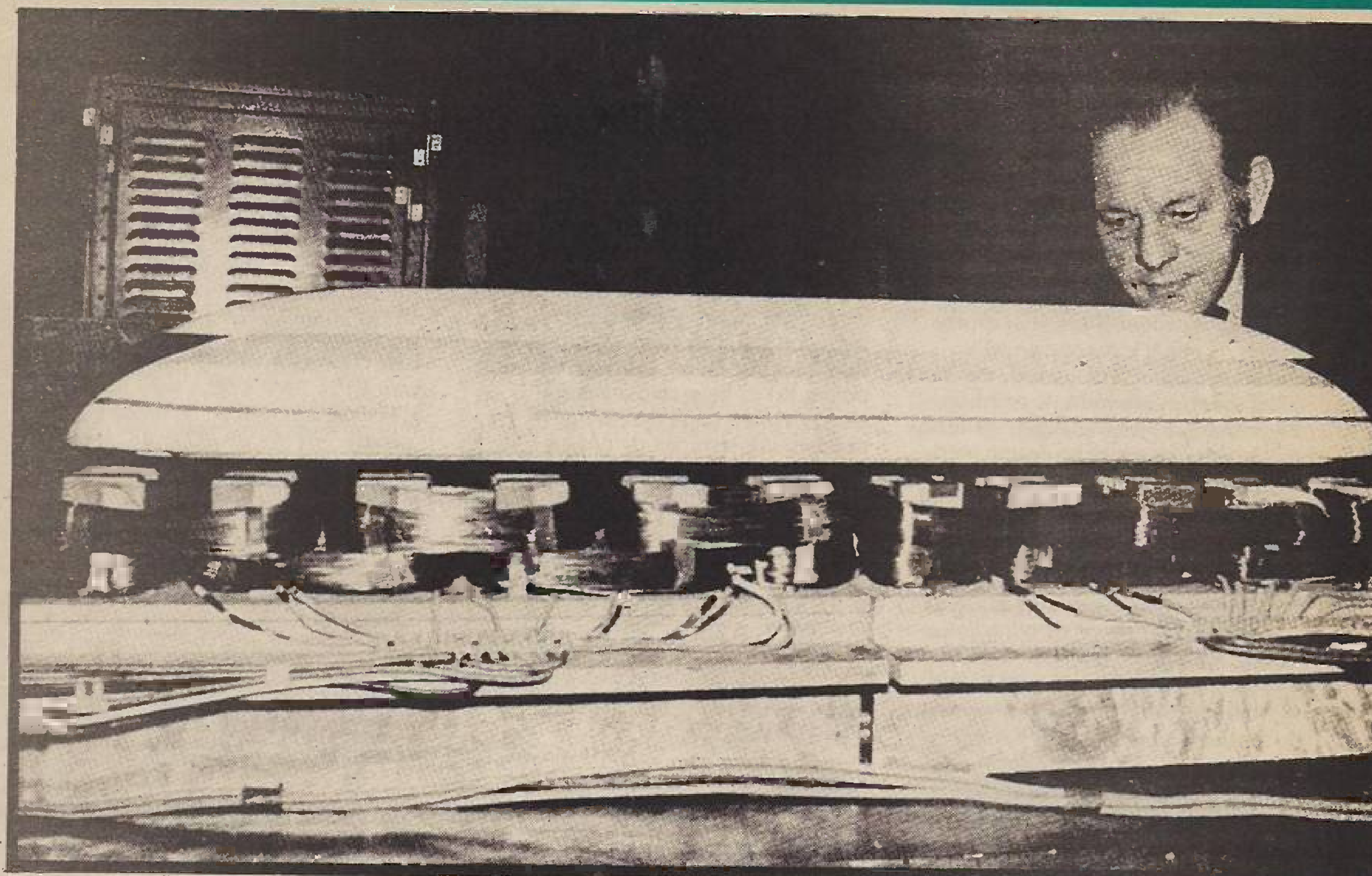


THE MAGNETIC RIVER

By Professor E.R. Laithwaite, Dept of Heavy Electrical Engineering. Imperial College of Science & Technology, London

Professor Laithwaite's article on linear motors (ETI Dec 1973) created a great deal of reader interest. Since then Professor Laithwaite's discovery and development of the 'electromagnetic river' effect has been applauded as the dramatic scientific breakthrough that it unquestionably is. Here Professor Laithwaite describes, in beautifully clear and simple terms, the sequence of events leading to his latest discovery.

SCIENCE is a process of unending discovery — a detective game in which the players, as it were, match their wits against their mental limitations.

But perhaps no attempt to define the process by analogy succeeds so well as that in which the whole is seen as a gigantic jig-saw puzzle, so large that the individual constructors are, in the main, too far apart to see each other! Thus it is a day of great joy when two science workers' efforts are seen to join up in the unique way that belongs to a jig-saw game, bringing satisfaction which perhaps only a true philosopher can know when he discovers a little more of what Sir William Bragg (President of the Royal Society, 1935-1940) described as 'The Nature of Things'.

It is even possible for one constructor to work for years on two different parts of the jig-saw and not realise how close are those two parts — how only one missing piece of the puzzle would join them together. And when that piece is finally found he feels, most of all, a sense of humility that it should have taken him so long to find it.

I hope the relevance of the foregoing remarks will be obvious when I describe how I worked for 20 years, often at great pressure, to make better and better linear motors. Spasmodically I also studied electromagnetic levitation, a highly specialised technology of little interest to most electrical engineers except as a manifestation of the 'magic' of a 4-dimensional phenomenon which we call 'electromagnetism' but will never fully understand. Our ancestors who first *designed* electric motors and generators (as opposed to copying the previous one with the odd alteration here and there') knew well the difficulties of descriptive presentation and invented analogies which would help a whole generation of young men to mass-produce those useful machines. Such analogies included the concepts of 'rotating magnetic fields', 'circle diagrams', 'phasors' and 'equivalent circuits'.

Besides helping the initiators' immediate descendants, these concepts were in fact so good as virtually to throw sand in the eyes of subsequent generations in that the latter, including myself, were taught the subject with a confidence which suggested (a) that it was all completely understood and (b) that all the research had already been done — in other words that all was known that *was* to be known about electrical machines.

Professor Eric Laithwaite with his most recent laboratory working-model of a high-speed vehicle on a scaled down 'magnetic river' track, photographed at Imperial College, London. The 'magnetic river' can float, guide and propel the vehicle.

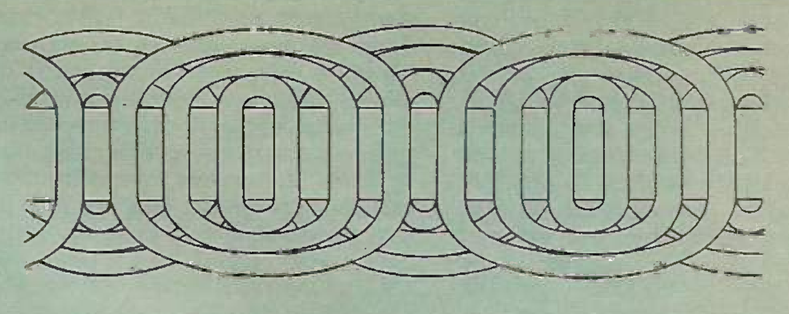


Fig. 1: A pole-face view of a linear motor primary showing conductors in slots in a laminated steel block.

The 'missing piece' of jig-saw puzzle which now links the subjects of linear motors and levitation was the study of shape — and the motivation to find it was undoubtedly high-speed transport. A linear motor primary is a highly sophisticated arrangement of coils in slots cut in laminated iron blocks, as shown at Fig. 1, the same basic structure as that which results from the imaginary process of splitting and unrolling a 'conventional' rotating electrical machine. Magnetic levitation, on the other hand, was relatively in its infancy, only a few systems beyond those in which a single coil or pair of coils supported a lump of metal ever having been tried.

The reasons for the lag in levitation research were two-fold. First, there was no great demand for it at the price that had to be paid to achieve it. Secondly, it was not a subject amenable to mathematical analysis as were the more complex but much more systematic systems of commercial motors and generators. As I see it now, the last statement can be more usefully expressed by saying that levitation is three-dimensional engineering whereas machine design has been, until recently, *one-dimensional*.

What I mean by this needs further explanation. In a rotating machine of the induction type, tradition has it that only machines in which the clearance between rotating and stationary parts (the 'airgap' as it is called in English, although the French word *entrefer* is much more meaningful) is small are any good. Be this true or false, it is the way they are manufactured — with the result that the magnetic flux crosses the airgap radially, either 'into' or 'out from' the rotor. Then linearise this machine so that the airgap is in, say, a horizontal plane and the flux in the gap is always vertical and it can be termed one-dimensional.

Suppose, however, we examine the double sided sandwich or sheet-rotor motor shown at Fig. 2, which was thought, in the early 1960s, to be the only possible 'starter' in the high-speed transport game because it simplified the form of track member (the secondary, corresponding to the rotor of a rotary machine) to that of a simple sheet of aluminium. Some of the flux may now bend into the horizontal plane, as shown at Fig. 3, an effect which conventionalists may regard at worst as sheer waste or, at best, as a means of limiting starting current, for they see it as 'secondary leakage flux' in terms of conventional rotary-motor engineering.

THE ACADEMIC IDEA

But suppose one is an experimentalist and an academic seeking knowledge for its own sake, who follows 'clues' out of curiosity alone. Then it is interesting to remove the top member from the machine shown at Fig. 3 and really 'let the flux bend' in the second dimension. The results of this exercise are quite amazing and instructive. Fig. 4 shows a series of them. Perhaps the first thing to be noticed is that the secondary sheet is levitated as at Fig. 5(a). Having 'seen' it one can 'explain' it simply as the result of horizontal flux lines acting on induced currents which are

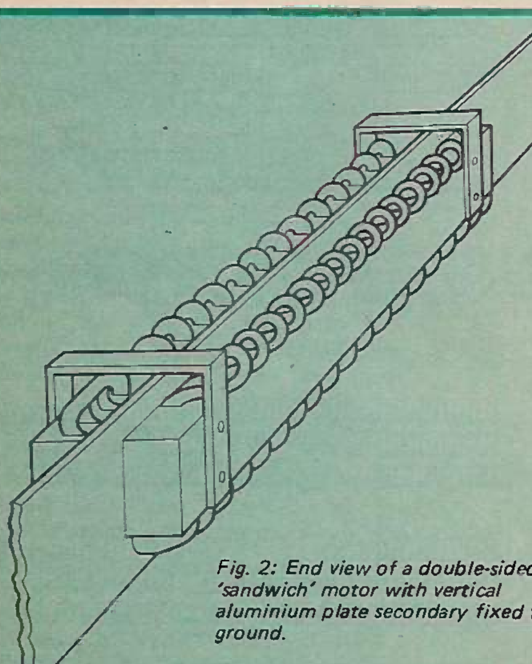


Fig. 2: End view of a double-sided 'sandwich' motor with vertical aluminium plate secondary fixed to the ground.

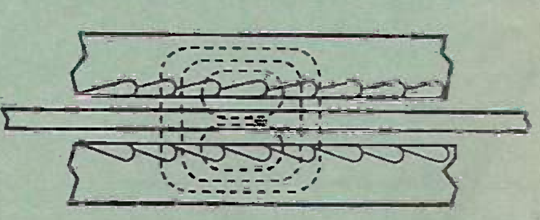


Fig. 3: Flux bending in a plane containing the direction of a motion.

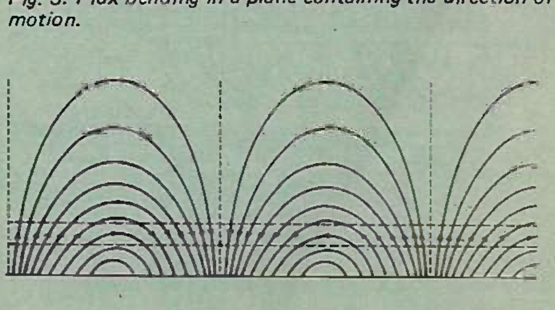


Fig. 4: Flux distribution over an open-sided linear primary.

perpendicular to the plane of the diagram, but this is a dangerous thought-path if pursued far, for those same secondary currents will be found to distort the flux enormously, until it is far from clear how the lift is generated. (Clearly, a good engineer must know how to use analogy and when to stop!) Let it suffice, at this stage, to say that the plate is lifted, but is laterally unstable.

If a conducting cylinder, which is free to rotate on its axis, is held above the open-sided motor with the secondary sheet removed (as seen at Fig. 5(b) it rotates in the direction shown, suggesting that the magnetic flux behaves like a river of water flowing beneath and just touching the cylinder. If, however, we place the clyinder right in the 'river' so that it rests on the river bed, as at Fig. 5(c), we might expect that because all forces on the cylinder are to the right, and the point of contact is at rest, the cylinder must roll to the right. It is inconceivable that such a cylinder would roll upstream in water.

But in the linear motor it does! So does a split washer which has no electric circuit. A wire paper-clip unwrapped and re-rolled around the pencil to form a helix will spin just

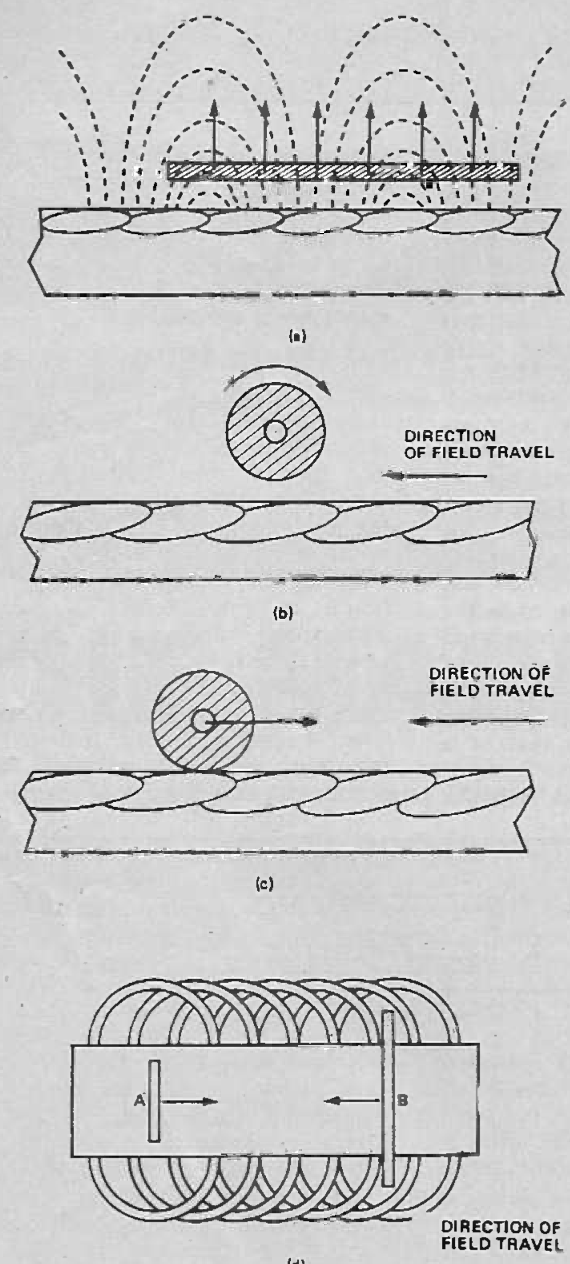


Fig. 5: Phenomena associated with the flux pattern from an open-sided motor:—
(a) A conducting sheet experiences a lifting force in addition to one of propulsion.
(b) A copper cylinder held and pivoted above the motor surface spins in the direction shown.
(c) A copper cylinder in contact with the surface of the motor rolls 'upstream' in the travelling field.
(d) Opposite rotation of a short steel rod (A) and a long steel rod (B) resting on the motor pole face.

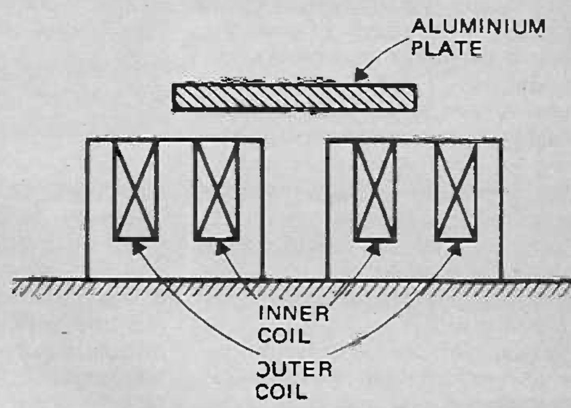


Fig. 6: Cross-section through a cylindrical levitator capable of supporting a conducting disc of the size shown.

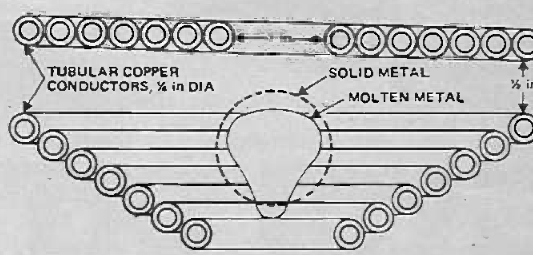


Fig. 7: Cross-section through a liquidmetal levitator using water-cooled tubes as primary windings.

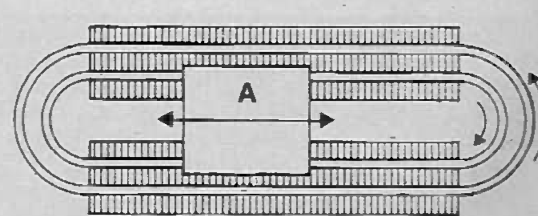


Fig. 8: Plan view of a concentric coil levitator with coils elongated to float rectangular sheets with neutral equilibrium in one horizontal axis.

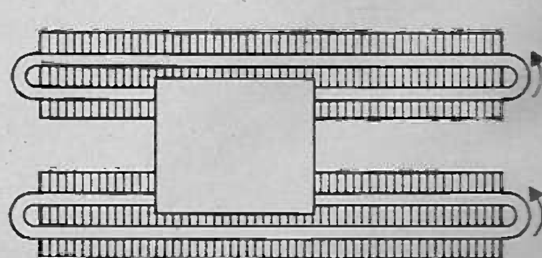


Fig. 9: Rearrangement of the coils shown in Fig. 8 produces the same basic system and the same result.

like the copper cylinder in Fig. 5(b). However, it is not the purpose of this article to 'explain' these phenomena; they were part of the evidence from experiments which led me into a three-dimensional line of thinking.

So far, we have bent the flux only in two-dimensional planes. My introduction to the third dimension came through the experiment shown at Fig. 5(d). A short steel rod rolls 'upstream' because steel is a conductor of electricity, just as is copper. But a long rod of the same diameter and material — a rod which is longer than the motor is wide — rolls very positively *downstream*! The explanation of this phenomenon took several months, until it was realised that in this instance the important flux was that which proceeded laterally and induced circumferential currents in the rod. The third dimension had made its presence felt at last.

Within a year of that explanation we were building 'transverse flux machines' (TFM) in which the whole of the working flux was conducted in lateral paths.

LEVITATION PUZZLES

Turning now to the other 'working edge' of the jig-saw puzzle — that is the levitation — the double-coil, circular plate levitator as shown in cross-section at Fig. 6, having completely cylindrical symmetry about a vertical axis, was known as far back as 1939. Levitation of liquid metals using high-frequency currents (in the order of 10-50 kHz) was also much discussed in the 1950s, a typical coil system being shown in cross-section at Fig. 7. Again the geometry was cylindrical, for man seems reluctant to abandon circles, even when an alternative is demanded! However, by 1960 the circular coil arrangement of Fig. 6 had been extended in one dimension to enable rectangular conducting sheets to be supported and (seen later to be of greater importance) to enable them to have one neutral axis along which they could be moved without any electromagnetic retardation.

Figure 8 shows a plane view of such a levitator in which the aluminium plate A is capable of unrestrained motion in the axis indicated by the arrows. It was further discovered that, unlike the circular plate devices in which the two primary coils required different numbers of ampere-turns (AT) from each other and a phase lag of approximately 30° on the inner coil current, the two coils of the system shown at Fig. 8 could each have the same AT and be connected in series with opposite sense as shown. It was then realised that for a very long primary system the ends of the coils were not detectable by the secondary sheet and therefore from a suspension stability point of view the system is unaltered if the two coils are replaced by two narrower coils arranged non-concentrically, as shown at Fig. 9. This allows different widths of plate to be levitated on different occasions without rewinding the coils.

In 1966 the principles of the air-cushion vehicle and the linear induction motor were combined by the launching of Tracked Hovercraft Ltd. (THL) — an ill-fated marriage of electromagnetism and aerodynamics so far as Britain was concerned, as events in 1973 were to demonstrate. Earlier than 1966, Monsieur Bertin had demonstrated in France the possibility of an all-aerodynamic system using air-cushion support and lateral guidance and airscrew propulsion (later to be replaced by rocket propulsion).

When between 1960 and 1970 the world awoke to the need for a reliable high-speed ground transport system, all but M. Bertin opted for linear motor propulsion, although with a variety of lift and guidance mechanisms of which an air-cushion system was only one possible option.

A method with the obvious advantage of requiring no power for lift was to use a permanent-magnet array on the vehicle repelling a track-mounted system of similar magnets. Much was claimed for the use of new magnetic materials in such a system and it was some time before the basic properties of permanent magnets were seen to make them commercially unacceptable. First, because an arrangement of permanent magnets can never be self-stabilising, some additional stabilising equipment would be required on both vehicle and track. Secondly, anyone who designs a repulsive magnetic system invites the use of very constricted magnetic circuits, where only low effective-flux densities can be achieved without enormous quantities of permanent magnet material. Thirdly, and perhaps worst of all, the system is not electromagnetic in that there is no current generated in track or vehicle, and is therefore not entitled to the benefit of the 'bigger-the-better' rule pertaining to electromagnetic systems, but rather the reverse. It is an irony of nature that small magnetic things work splendidly and only when you have spent your money on a big version do you find that you have wasted it!

SERIOUS PROPOSAL

A much more serious proposal, however, was to use electromagnets — whose strength could therefore exceed that of permanent magnets and yet be controlled — to attract rather than to repel, thereby employing good magnetic circuits instead of inherently poor ones.

The system is a simple piece of control technology. The track carries a pair of strips of steel, preferably on an 'under surface' (although vertical surfaces are possible, using the less-effective shearing forces rather than the attracting). The electromagnet system is fastened to the vehicle and positioned under the strips so as to attempt to lift the vehicle until the magnets make contact with the strips. Before final contact occurs, a detecting device — for example a light-beam and photoelectric cell — indicates that the magnets are within x millimetres of the strips and sends signals to an amplifier, whose output feeds the electromagnet, to control their position at a distance x from the strip. The same system can then be used for lateral guidance.

This removes two of the disadvantages of the permanent-magnet system. It is stable and has a good magnetic circuit, but cannot be scaled up indefinitely without penalty, the most probable aspect of which will be seen in the cost of track maintenance.

The maximum lifting force per unit area of poleface from a magnet is fixed

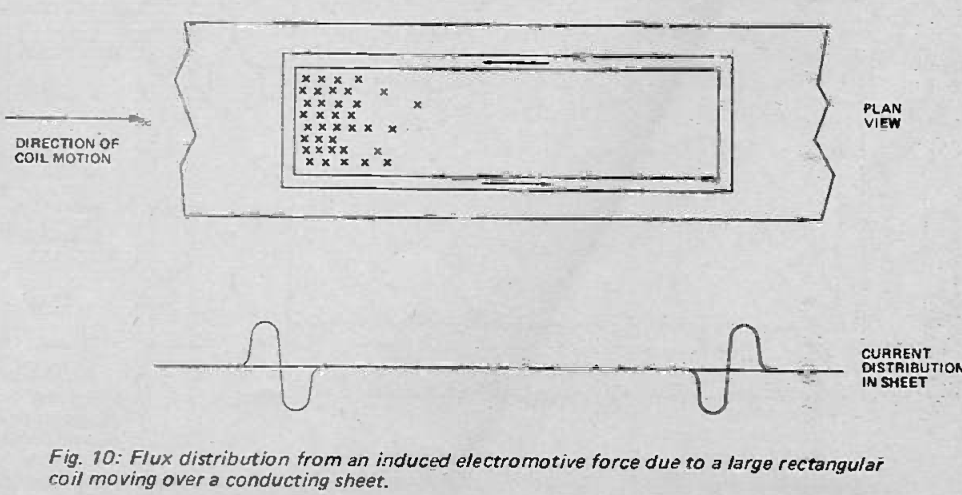


Fig. 10: Flux distribution from an induced electromotive force due to a large rectangular coil moving over a conducting sheet.

by peak flux density and therefore the total lift can only increase as the square of length. But vehicle weight tends to increase with the cube of linear dimension and therefore a vehicle scaled up by a factor of two requires eight times as much lifting force and therefore eight times the magnet pole area. Even if the mechanical clearance remains the same for the larger vehicle, the same magnetic length will be needed to produce the same flux density. The magnets will therefore be eight times as heavy but occupy twice the relative track area compared with the vehicle track coverage, in relation to the same ratio for the smaller vehicle. If, however, a greater mechanical clearance is required for the larger vehicle, magnet volume will increase more rapidly than vehicle volume, as the size increases, and this is a much more serious limitation than pole area.

Protagonists of the amplifier-fed electromagnetic suspension system, often known as 'mag-lev' (confusingly, for the same name is used for cryogenic levitation systems) claim that weight support can be obtained for such low power input as 1 watt/kg. No one can doubt this, for a crane-magnet lifting scrap-iron in a breaker's yard can lift 3 tons of metal for a total input of 80 watts (= 0.027 watts/kg). However, this figure has virtually no relation either to the size of amplifier needed or to the power it must handle. The amplifier is present in the system to correct disturbances in supported height or in lateral displacement (a second amplifier being required for the latter axis). If the steel grip in the track is inaccurate to the extent of 1 mm of height per metre of track, a 50-ton vehicle requires 11 watts/kg to correct such a disturbance when travelling at 450 km/h (a total of over 0.5/MW of 'handled' power). The lateral guidance and roll stability may suffer even greater disturbances if a gust of wind, acting on the whole vehicle-side area, is timed by ill fortune in unison with a lateral track inaccuracy. Track maintenance will present real problems in this respect.

The alternative 'mag-lev' system uses a large air-cored superconducting magnet which has the advantage of being capable of producing flux densities in the order of 7 tesla, which cannot be matched by any other type of electromagnet. When such a magnet is drapped over a conducting plate it induces currents in the latter which, being of opposite sense, repel the magnet that produced them; so lift is obtained by such an inductive system. The penalties are incurred, of course, in the costs of the cryogenic coil, of maintaining it at low temperature (a liquid helium supply), and of the aluminium track sheet. It can be argued of course that the latter is needed for linear motor propulsion anyway, but whether the same thickness will 'match' — that is suit — both requirements is a subject which so far has not advanced beyond speculation. A simple coil-and-sheet arrangement is not laterally stable and as with feedback amplifier systems must be repeated in a second axis, so that the track is not a sheet but a 'channel' of conductor

FLUX EFFECTS

Figure 10 shows the effect of the plate currents on the flux produced by a simple rectangular cryogenic coil at speed. Flux can redistribute itself over the surface of a direct-current electromagnet of any kind without changing the line-linkages and therefore without inducing electromotive forces. The resulting plate currents are therefore virtually confined to the back edge of the magnet and their effective 'pole-pitch' (to use induction-motor parlance) is relatively small. Small pole pitches mean low 'goodness factors', which is why the cryogenic lift system requires large thicknesses of sheet to compensate for lack of pole pitch dimension.

Flux-shifting can be avoided by the use of more elaborate coils, such as the concentric system shown at Fig. 11. But cryogenic technology has not yet reached this level of sophistication; when it does, it will enable secondary currents to be distributed in long pole pitches as shown — resulting in high 'goodness factors' and lots of lift with thin track sheets. However, there will then also be lots of drag! The system is now seen to be an induction motor in reverse, having a pole pitch and flux

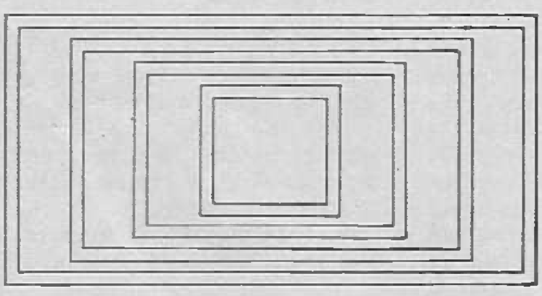


Fig. 11: A more elaborate air-cored coil intended to distribute flux and induced electromotive force more effectively.

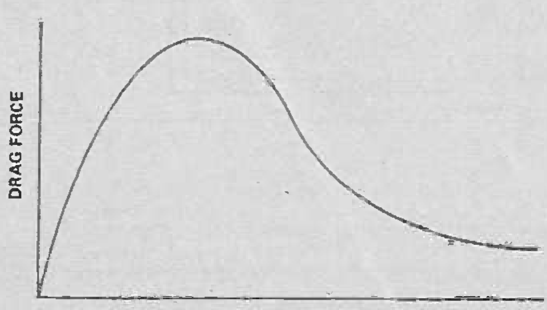


Fig. 12: Speed-drag curve of a superconducting levitating magnet.

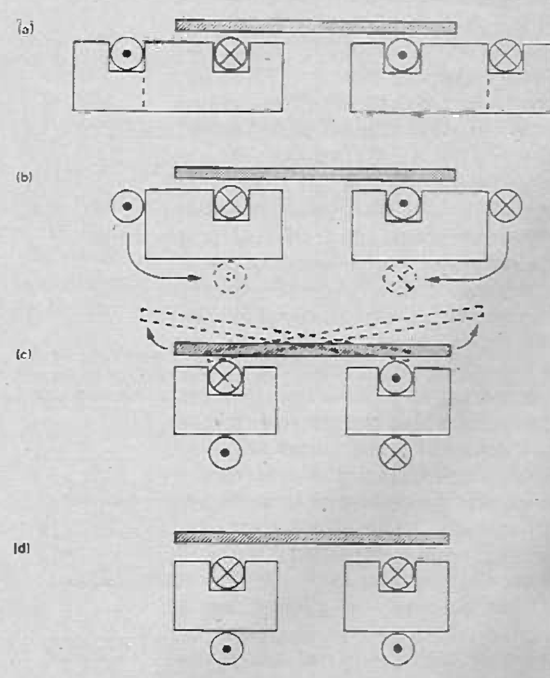


Fig. 13: Developing topology of the magnetic river:
(a) Cross-section through the levitator shown at Fig. 9.
(b) Removal of the outer teeth and associated core.
(c) Repositioning of the return sides of the coil makes the plate unstable.
(d) Reconnection of one coil restores stability.

density appropriate to a 400 km/h linear motor at rest, and its speed-drag characteristic is of the form shown at Fig. 12.

Now such a system is basically an inductive system, as is the one shown at Fig. 9. In 1972 an international exhibition ('Transpo 72') was held at Dulles, near Washington, United States of America, where THL proposed that it, along with organisations from other countries, should demonstrate a working model of a practical high-speed system. Knowing of the public's concern about noise and environmental pollution, we decided that the British exhibit should if possible be all-electromagnetic. It was realised however, that such systems were more difficult to make successfully as they were scaled down, so it was proposed to invert the linear motor propulsion system — putting the primary on the track — and to switch it on in short sections as required, allowing each section to cool for perhaps 90 percent of the running time. The levitation and guidance system already existed (Fig. 9) and it was clearly possible to put the linear motor primary between the two halves. But the width of the levitator overall was 425 cm on the 9 m run to which the exhibit was restricted, a vehicle longer than 90 cm would look ridiculous, and to scale down a practical design meant that the track width should be only 10 cm.

We doubted our ability to design a system of that size which could be run continuously, lamented the fact that no one would believe us if we ran it for only three seconds every 20 minutes or told spectators that 'all would come right when it was scaled up', and decided to attempt some new shapes which might be better.

'First of all", I agreed with my colleague Dr. J.F. Eastham, 'we know that electromagnetic levitation is all a matter of edges.' In a cross-section of the levitator of Fig. 9 (shown at Fig. 13(a)) it seemed unlikely that the edges of the outer 'tooth' could influence the plate edges (it being known that the best width of plate for lateral stability bisected the centre tooth almost exactly). Having — mentally — removed these teeth, the iron beneath the coil outer limbs could clearly go also, leaving us with the situation shown at Fig. 13(b). 'Now,' I argued, 'the primary flux links with both plate and coil (as shown), and a linkage is a linkage however it is effected, so it ought to be possible to return the lifting currents in the coil inner members beneath the steel,' as shown at Fig. 13(c). This would reduce our 425 cm wide machine to 20 cm.

Unfortunately, when we tried-out the system it was completely unstable laterally. Then Dr Eastham remembered an earlier occasion when someone accidentally connected the machine shown at Fig. 8 with one coil reversed — which seemed to have a little effect on the lift and stability. He therefore reconnected the system of Fig. 13(c) with one coil in reverse (as in (*a*)) and at once obtained stability. At this point a manufacturer (Linear Motors Ltd) was consulted and this firm pointed out the difficulties of manufacturing 9 m of such primary as a continuous piece and shipping it to Washington.

'Could it not,' asked a THL employee, 'be made in sections and coupled together on site?' I pointed out that there were hundreds of strands of wire in each coil and 100-pin plugs were out of the question. But within seconds Dr Eastham said, 'Not only could you make them in sections, but in very short sections each with its own winding, and you could feed the windings from successive phases of the supply', a concept which eliminated the need for a separate driving motor. So was the vital missing piece of the jig-saw fitted into the pattern.

The magnetic river had come to light!

NEW SEQUENCE

This single notion was to trigger off a whole new sequence of thinking. It led ultimately to a system using only a single row of transverse 'C-core' electromagnets, as shown at Fig. 14(a), and the 'Transpo 72' demonstration was assured of success at only 10 cm width. But much more was to follow.

In May 1972, the date of 'Transpo 72', we were convinced that our track was no more than a scientific toy — and a very expensive toy, for it cost over 220 watts/kg lifted. All but five per cent of the input was lost in heat in the secondary aluminium plate and the primary windings, making us realise what a poor system it was when regarded purely as a motor. But suppose we took one step back in the topological chain, to Fig. 14(b), and put 'standard' windings in what is effectively just a double row of 'teeth', as shown at Fig. 15. Now the currents induced in the plate are much better utilised than those in the crude

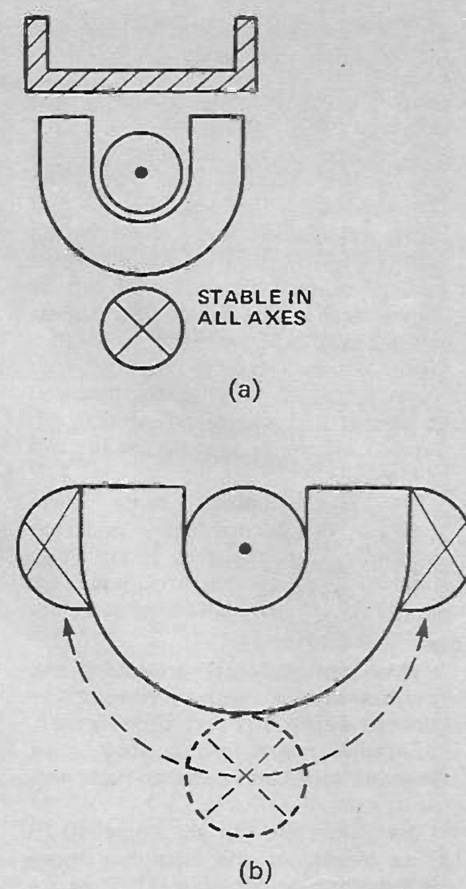


Fig. 14. Single 'C-core' magnetic river apparatus in cross-section:
(a) Return current beneath the core.
(b) Return currents led back up each side of poles.

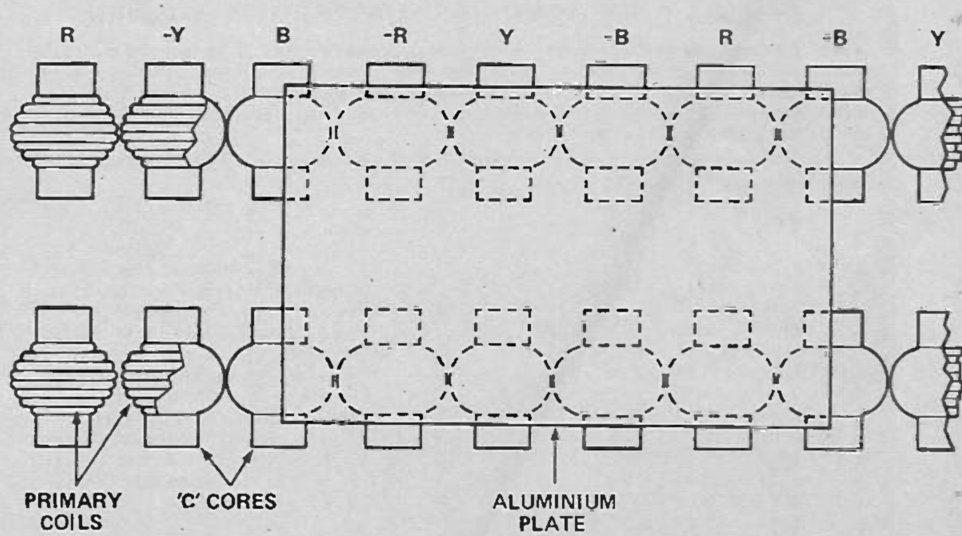


Fig. 15: The magnetic river seen (pole-face view) as simply a pair of parallel linear motors.

'Transpo 72' model — so well used, in fact, that the machine might operate at a 90 per cent efficiency (if it were made large enough). What then provided the lifting forces?

For a few days it appeared as if lift and drive could not be had simultaneously, for we already had both calculated and experimental results showing that lift force became zero at quite a high value of slip, as shown at Fig. 16. For higher speeds the lift was replaced by an attractive force which increased rapidly with increase in slip. So who was prepared to run at half speed and possibly 45 percent efficiency, just to get lift and guidance?

The final concept came quite suddenly. In a normal rotary induction motor, such as might be found in an ordinary washing machine, there are two sets of forces acting on the spinning rotor:

(1) tangential forces producing the rotation as the result of interaction between airgap flux and rotor current:

(2) radial forces arising from pure magnetic attraction between rotor and stator iron.

The forces in (2) are some 10-20 times bigger per unit area than those of induction described in (1). They are an embarrassment to the machine designer who finds that, if his rotor be only a fraction of a millimetre out of centre, the radial unbalance of these enormous forces bends the shaft. It has been the lament of engineers since Boucherot (1905) that they cannot use these magnetic forces in conjunction with continuous motion. But if *power* was associated with them *pro rata*, the washing machine motor could never exceed five per cent efficiency, and we know this not to be so. So long as there is no radial movement, there is no mechanical power output and no inherent requirement for power input.

Linearise the machine and the fact becomes that, for no lateral or vertical motion, no power loss is necessarily incurred. It is necessary only to be sufficiently ingenious to know how to build vertical and lateral forces into the design. Then there remains only the problem of how to convert attractive force into repulsive force at high speed.

In a conventional rotating machine the rotor is subject to a radial pull which is proportional to the square of the flux density and inversely proportional to the free space permeability.

This is expressed mathematically as follows:—

$$F_{rp} = \frac{B^2}{2\mu_0} \text{ per unit area.}$$

where F_{rp} = radial pull.
B = flux density.
μ_0 = free space permeability.

Few realize that this formula is incomplete because, as primary and secondary currents flow in opposing directions, the field coil and the rotor repel each other with a force proportional to the square of the current loading per unit length of airgap times the free-space permeability.

The formula for this repulsive force may be expressed as:—

$$F_r = \frac{\mu_0 J^2}{2}$$

where F_r = radial pull.
J = current loading per unit length of airgap
μ_0 = free space permeability.

Thus the full formula for attractive force between the rotor and stator is

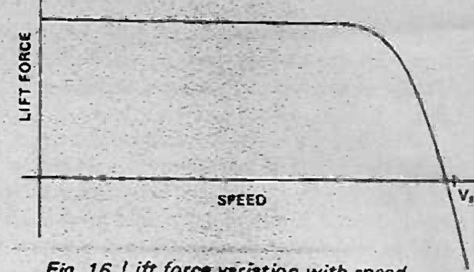


Fig. 16 Lift force variation with speed

the difference of the two forces. That is —

$$\frac{B^2}{2\mu_0} - \frac{\mu_0 J^2}{2}$$

In a commercial washing machine motor the repulsive force is only a few percent of the radial attractive force and hence is usually neglected.

But the basic rule of linear motors, where airgaps are much larger than in rotary motors, is to use wide slots and narrow teeth so that J is big and B is small. Since each term in equation (1) involves the square of the variable, little re-adjustment of B and J is necessary before the first term becomes but a fraction of the second and the equation may be written in terms of the repulsive force thus:

$$(\mu_0 J^2/2 - B^2/2\mu_0).$$

Thus by correct design, the linear motor may provide lift as well as propulsion without extra power input.

While the world's electrical machine designers argue about whether feedback amplifier magnets or cryogenic coils or aircushions are best for the suspension of high-speed vehicles, the sparkling jewel lies exposed for all to see. We can now design linear motors to give lift and guidance without additional equipment and for no additional power input.

So what are we waiting for — a miracle? ●

READER QUESTIONNAIRE SUBSCRIPTION WINNERS

A real thank you to all those readers who took the time and trouble to reply to our reader questionnaire - we received nearly 2,500 of them and each has been read as far as comments are concerned already. The first analysis has already been done and some useful pointers have become clear. The total analysis is however so complex that we are going to use a computer for the final results.

As promised, we have drawn at random 25 of the questionnaires and a year's subscription will be sent to the following readers:

J. Curran, London E.17.
R. Bleach, Bridgwater, Somerset.
S. Smith, Worcester.
T. R. Fowler, London N.20.
C. Head, Bristol.
K. M. Mansbridge, Horsham, Sussex.
R. Willoughby, Malton, Yorks.
T. Gourd, Pinner, Middlesex.
D. C. Luya, London E.4.
A. C. Kemp, Romford, Essex.
C. J. Dowse, Kenton, Suffolk.
A. C. Young, Glasgow.
V. C. Patel, London N.22.
J. Davey, London S.E.14.
K. H. Lum, Loughborough, Leics.
D. W. Bailey, London, N.13.
B. A. Corner, Deisenhofen, W. Germany.
W. Bratt, Croydon, Surrey.
R. J. Wylde, Fittleworth, Sussex.
P. Guest, Brownhills, Staffs.
D. A. Adams, Oxford.
C. J. Newberry, Billingshurst, Sussex.
A. P. Toller, Croft, Leics.
K. W. Hobbs, Dagenham, Essex.
C. Lucas, Manchester.

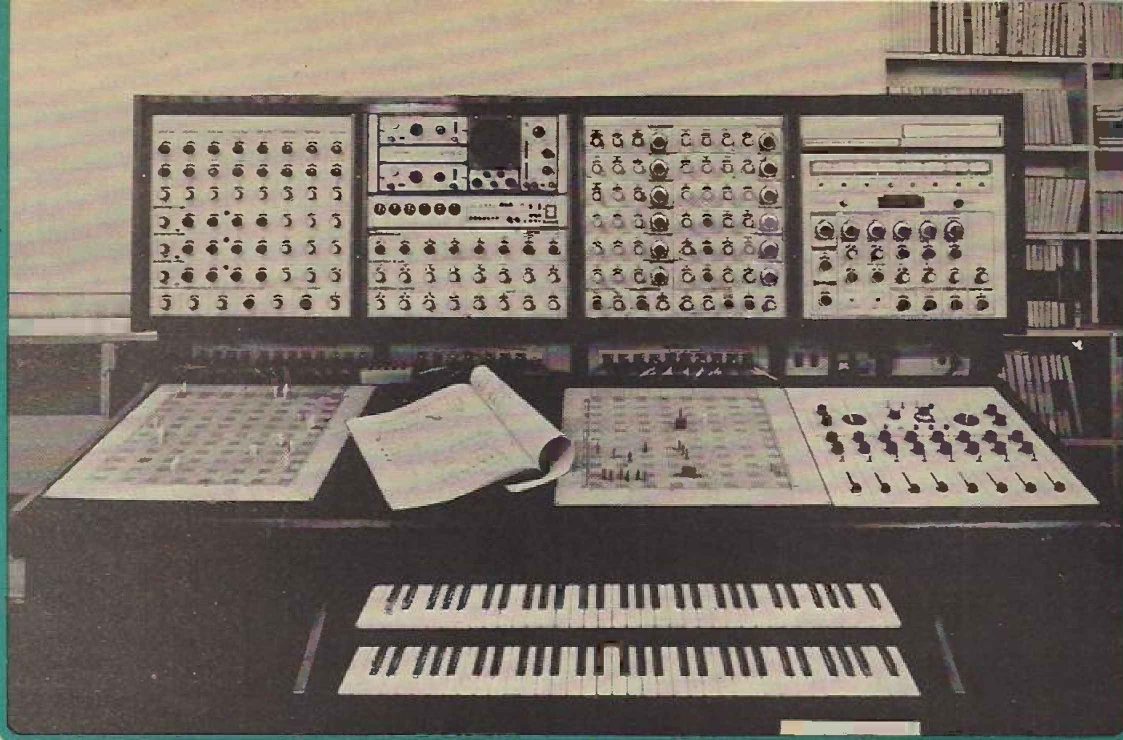
PRICE OF ETI

The selling price of ETI has remained the same since the magazine was launched in April 1972 but like all magazines we have been subjected to inflationary costs way beyond those generally ruling in the country. Paper in this time has increased in cost by 130%, our printing costs by about 40%.

We have been above to hold our cover price at 20p during the last six months only due to considerably increased sales and advertising. Our costs have risen so considerably that we have long since passed the point where absorption is possible and we regret that the cover price from the September issue will be 25p. We have gone into more detail than is usual above in giving specific figures for our rise in costs in the hope that readers will appreciate the necessity for this increase.

SUBSCRIPTIONS

Existing subsciptions will of course be unaffected. We also intend to keep the cost of postal subscriptions at £3.60 (U.K.), £4.00 (overseas) for the time being despite the higher postal charges.



RADIOPHONIC WORKSHOP

Electronic technology evolves its own art forms.

(TOP): Synthi 100 Electronic Music Synthesiser
(ABOVE): General view of one of the Workshop areas showing bank of tuned oscillators.

A CONVERTED skating rink in the heart of London's Maida Vale is the home of the highly specialized B.B.C. department, picturesquely known as the Radiophonic Workshop. Responsible for virtually all the incidental electronic music and effects for BBC radio and television, it is unique in that all of its output is commissioned. Furthermore, this output is the product of a small but dedicated staff of musicians/technicians — the Workshop is not generally open to outside composers nor for the production of electronic music as an end in itself.

The BBC has, however, issued two collections, selected from the Workshop's sizeable output, that offer a fascinating insight into the extent to which electronic technology has evolved its own art forms.

The two discs highlight different modes of working, with some common ground in the manner in which the final tracks have been realized i.e. by the synchronized playing of a number of separate musical tracks.

The individual tracks were physically separate in the case of the LP *"BBC Radiophonic Music" (REC 25M)* — each completed musical part was laced up on a separate Philips EL3566 console tape machine and the final mix conducted by replaying the synchronized tapes and recording the result on a further machine. The playing of machines 'wild' in theory should not work, but in practice, synchronization between tracks is maintained for periods greater than a minute.

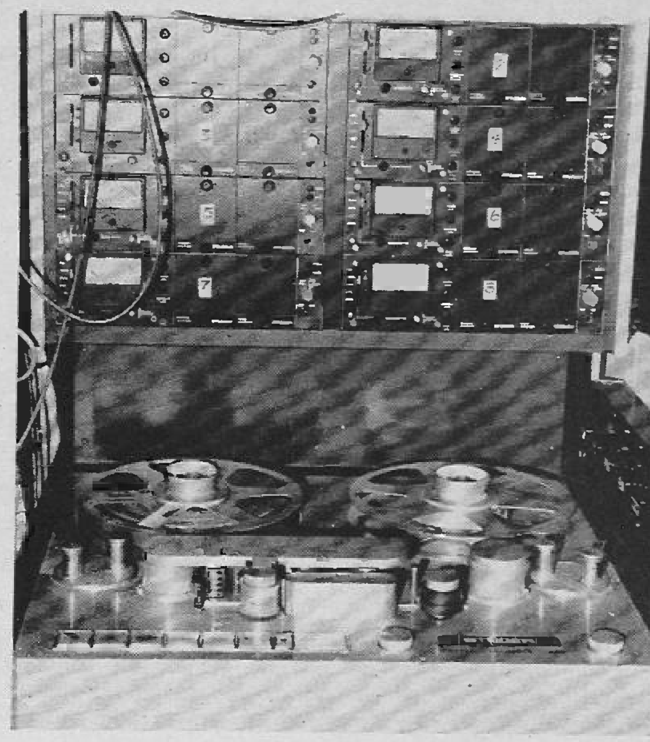
The tracks on the *"Fourth Dimension" LP (RED 93S)* were produced on rather more recognized studio principles with the aid of an eight-track Studer A60 recorder.

"Radiophonic Music", the earlier disc, was only pressed in mono, but notwithstanding, makes highly entertaining listening from the technical aspect alone.

At least three days concentrated effort go into a twenty *second* piece to produce a final result. After the composition on paper, styled to the wishes of the programme producer who has commissioned it, the worker will explore all possible sounds suitable for the piece. A dripping tap, two bricks knocked together, or a cork pulled out of a bottle, any of these may fit the bill.

The various sounds are recorded and after more careful listening and experimenting, a final selection is made.

Provisionally, three well-contrasting sounds may be selected; loops of tape with the selected sounds are played continuously on a special recorder with incremental speed change facility.



Studer A60 8 track tape recorder.

There are a number of switched steps between one standard tape speed and the next and, as reproduced pitch is relative to the reproducing tape speed, a scale of notes can be derived from a single sound. The scale is recorded on another machine, possibly using filters to change the character of the notes and different recording volumes to give the required dynamic range.

After this comes the exacting task of piecing together all the notes of one 'instrument' in the right order and taking care to space the notes by appropriate silent gaps to give correct tempo.

When the separate musical parts have been compiled, the final mix is carried out as already detailed.

At any stage in the process further tonal modification, reverberation, envelope shaping or a host of other techniques may be applied to give a 'different' sound.

The music? 'Different' is one, if inadequate, way to describe it. Using natural sounds (though pure electronic tones are used when considered desirable) in this fastidious manner, unique and quite beautiful results are achieved.

All the tunes sound 'fresh' and it is possible to identify each composers individual style. The majority of John Baker's work has a lively almost pointillistic arrangement of melody, counter melody and bass line, each complementing the other. He tends to utilise well-contrasting timbres, offsetting harsh percussive notes with more rounded notes with slow attacks.

My personal favourite is "Sea Sports" which features an ethereal watery reverberation, quite different

Variable speed Leevers Rich used to give a chromatic scale from a single note or sound.

from any effect I have heard before.

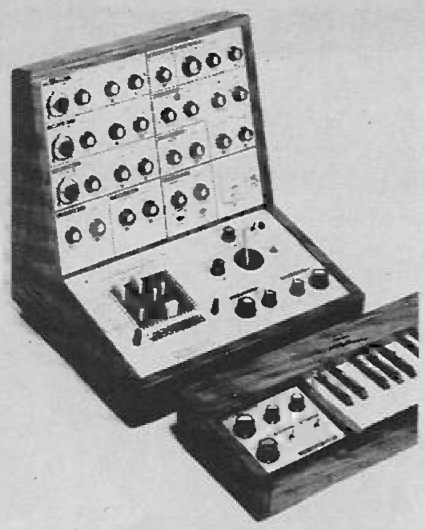
To find out more about the basic sounds he used, I contacted John Baker; the sound sources he said, included twanged rulers, bubbles escaping, plucked undamped piano strings, metal springs being released and corks popping from bottles.

The second composer on this record, Delia Derbyshire, incidentally now no longer with the Workshop, has a rather different approach, preferring to synthesize complex sounds from electronic tones.

I found her offerings on this disc highly evocative, especially her "Blue Veils and Golden Sands" — it was very noticeable how tonal qualities and contrasts have almost a greater role in her compositions than even the melody does, although her "Door to Door", with its collection of 'musical door-knockers' shows her versatility with its infectious foot-tapping lilt.

David Cain is the final composer on this disc. Originally qualifying in mathematics, he joined the BBC as a studio manager on the drama side. His works here span a wide spectrum of styles, ranging from Baker's effervescence to a "classical" Stockhausen-like approach. It is music for the radio production "War of the Worlds" was most thought-provoking.

The second record features Paddy Kingsland's synthesizer work at the Workshop. This stereo disc contains twelve tracks composed and produced by Kingsland for various radio and TV programmes.



VCS3 Electronic Music Synthesiser.

A different style is once again very evident — on most tracks he uses a basic backing of conventional instruments, drums and guitars with the melody, and one or more harmonies produced on voltage controlled electronic music synthesizers — these being the British EMS Synthi 100 and its diminutive, though nevertheless extremely versatile, brother, the VCS3.

The Synthi 100, in addition to numerous sine, square and sawtooth generators, noise sources, ring modulators, envelope amplifiers, filters and other signal modifying devices, contains a three parameter 256 event digital memory. Programmed by a conventional keyboard, the recorded information can be 'edited' as required and the sequence run at any speed in either direction.

I was rather sorry that Kingsland placed so much emphasis on acoustic instrumental backing in view of the capabilities of the apparatus at his disposal, but this no doubt must be partly attributed to the wishes of those who provide the Workshop with its commissions.

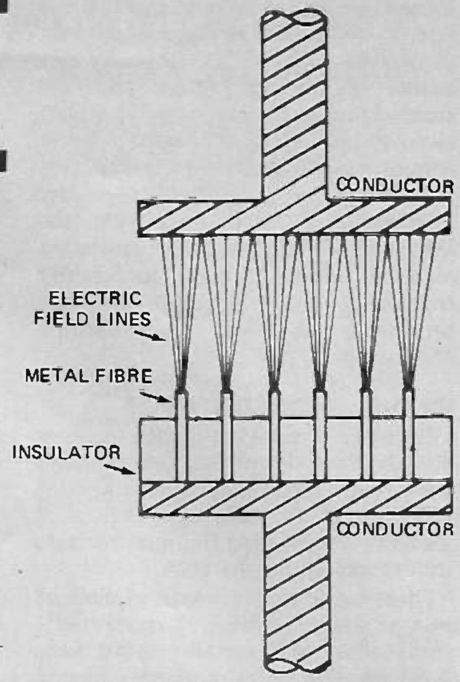
"Colour Radio" on the second side has some attractive quasi-vocalisations but, of this selection "Flashback" and the title track held my interest most.

In summary, Kingsland reveals himself to be a competent and adept composer and I hope he is given more rein to experiment with the Synthi. It would be an education to hear his work integrated with an 'edited-tape' backing, as featured on the examples on the earlier disc, instead of the 'straight' backings he has used here. ●

This article has been based on information supplied to us by Joe Shelton, Jerry W. Hagood and Ralph L. Norman of the US Army Missile Command, Redstone Arsenal, and A. T. Chapman of the Georgia Institute of Technology, Atlanta, Georgia, USA.

ELECTRONS FROM COLD EMITTERS

Will this new technique revive valve technology?



EFFECT EMISSION ELECTRONS ARE DRAWN FROM THE METAL FIBRES BY THE ELECTRIC FIELD FORCE

IN 1904, Alexander Fleming patented a device known as the Fleming electric valve. This valve contained two elements, a filament that, when heated, emitted electrons — and a plate called an anode.

Later in 1906, de Forest added a third element. This element, known as the grid, was an open weave screen placed between the filament and the anode. An electric charge placed on this grid controlled the flow of electrons in the space between the emitter and the anode.

Such valves formed the basis of all radio and 'electronic' equipment until the advent of the transistor in 1948.

Even now, despite the commercial acceptance of solid-state technology, valves are still used in many applications from home TV sets to high-power transmitters.

In fact a recent survey showed that the total value of valve sales has increased steadily despite semiconductor and IC technology.

Valves fill applications where combinations of bandwidth, high-frequency of operation and power capability cannot be met by present semiconductor techniques as economically, if at all.

Typical of such valves would be the klystron, the travelling wave tube and high power transmitter output valves.

HEATED FILAMENTS

Since valves obtain the electrons required for their operation from some material which gives off electrons when heated, this material is either formed directly *into* a filament or is indirectly heated *by* a filament.

At first glance, the heated emitter appears satisfactory as a source of electrons for the valve. However, in actual devices there are many problems associated with heated electron emitters. The emitter heaters operate at high temperatures and are very inefficient. Most of the input energy is given off as heat instead of emitted electrons. The results are somewhat comparable to that of the incandescent light bulb where the input energy is mostly converted into heat instead of the required light.

Since the incandescent light bulb is filled with an inert gas, excess filament heat is rapidly carried away by convection; however, in valves elaborate emitter and/or filament cooling techniques are sometimes necessary, especially in higher-power applications.

The excess heat requires space to be provided for its dissipation, both within the valve and the equipment in which the valve is used.

This is a very serious limitation and because of this many attempts have been made to obtain electron emission from a cold substance.

COLD EMISSION

So far the most promising approach involves the use of a few million ultrafine metallic fibres, projecting from a conducting plate which serves as the source of the electrons in the circuit, The electrons are emitted from the metal fibres when a voltage source is connected (as shown in Fig.1).

Experimentally, electrons have been emitted from single tungsten wires after appropriate pointing by chemical means. However, the area of the individual tip is very small, and consequently, the current per wire is also small (less than a microampere). Many millions of pins of fibres are required to provide the necessary electron current to make a useful device. Further, these fibres must be spaced so that a million or more are available per square centimetre of the emitting surface.

These minute fibres must be structurally stable under the stresses encountered in use, the high accelerative forces of a missile for instance, and under the electric field forces which are quite high. Electrically, each fibre must be conductive and continuous and a manufacturing process must be available to weld the fibres to the plate which is the source of the electrons. The final emitter must be designed such that all fibres project the same distance so as to subject each of them to the same electric field forces.

Ideally, one would like a material similar to that illustrated in Fig. 2. In this ideal material, in addition to the characteristics outlined above, each fibre is approximately the same distance from all its next nearest neighbours and each fibre is structurally supported by a high-resistance insulating material, perhaps a ceramic or glass of high strength.

The density of the fibres should be one million to a few million fibres per square centimetre surface area and the size of the individual fibres should be variable in a controllable manner. The overall matrix of fibres and the surrounding insulating material should be such as to enable its shaping by common manufacturing processes such as cutting, grinding, polishing, etc. Further, one could hope that the metallic fibres and the insulating material would differ sufficiently chemically to enable chemical processing as well as machine processing.

UNIQUE COMPOSITES

Recently materials with almost exactly these demanding requirements were developed under the technical direction of Dr. Chapman, School of Ceramic Engineering,Georgia Institute of Technology in the USA.

These materials are a unique class of composites, called oxide-metal composites, and contain many very small metallic fibres uniformly aligned in an insulating-ceramic matrix.

The composites are produced by radio-frequency induction-melting oxide-metal mixtures and using a technique called *unidirectional solidification.*

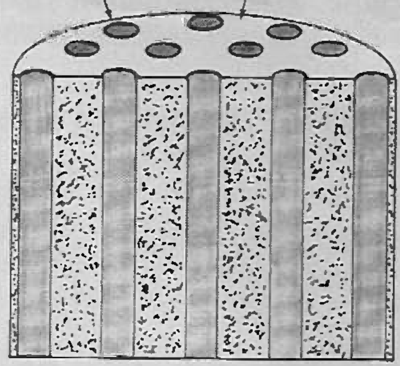
Early experimental results at Georgia and elsewhere indicate these new materials perform well. Currents of several 100 milliamperes per square centimetre have routinely been obtained Maximum currents of 0.5 amperes per square centimetre were drawn from this same emitter.

These results predict the appearance of a whole family of new valve devices. With the elimination of the emitter heater, circuitry and manufacturing complexity decrease. The total absence of the excess heat eliminates cooling equipment and allows device packaging in a smaller envelope.

This device has another characteristic not yet discussed which is extremely valuable in many electronic applications — it is truly "instant on". Several TV manufacturers advertise that their sets are "instant-on"; however, they achieve rapid activation of the set after it is turned on by keeping its valve emitter filaments activated to some 40 per cent normal power. This lower power level enables the emitters to produce electrons very rapidly after the set is turned on.

Since the new emitter operates at room temperature, it will give both picture and sound instantly. It will not require power during the time the set is not in use.

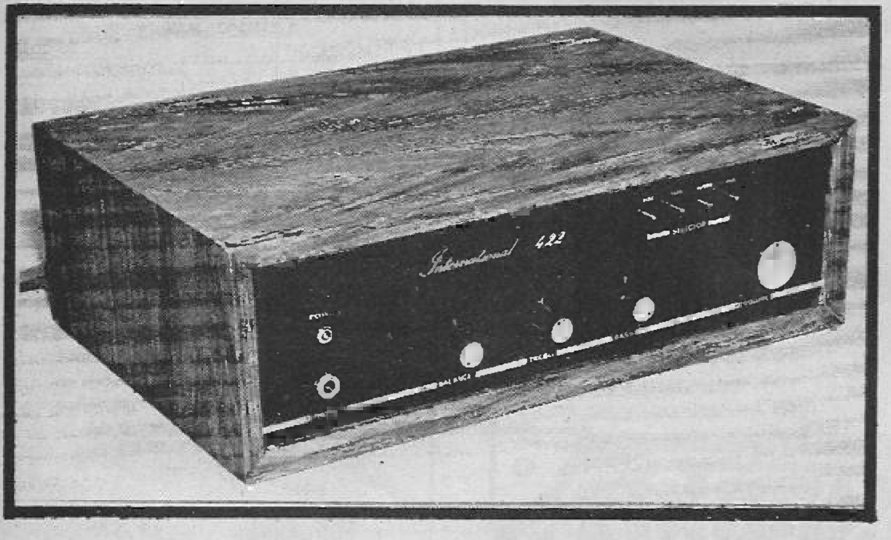
It is predicted that this new vacuum device will replace many present electronic valves, especially those utilized in high-power equipment, that its useful lifetime will be longer than the heated emitter valves and that it will result in an overall cost reduction for the consumer.



OXIDE-METAL COMPOSITE MATERIAL FOR FIELD EFFECT TRANSMISSION

The research efforts were sponsored by the US Defence Advanced Research Projects Agency. ●

INTERNATIONAL 422 STEREO AMPLIFIER



PROJECT 422

This exciting new amplifier produces a full 50W (rms) per channel!

SINCE publication of our 100 watt guitar amplifier, in February 1973, several thousand have been built and a surprisingly large quantity of these have been for home stereo use. People have used two of these together with a separate preamplifier for stereo, and would you believe it, we know of a few people using four in a quadraphonic system!

This is not as way out as it sounds for many present-day speakers sacrifice efficiency to gain quality. Many high quality speakers need at least 50 watts ('rms') to drive them satisfactorily.

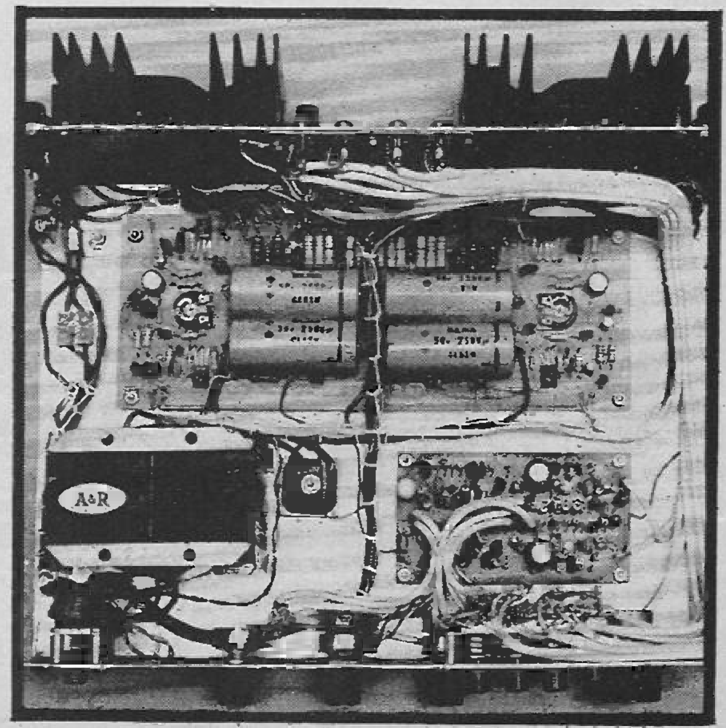
There is an obvious *need* for a high powered amplifier, and in response to many pleas, we have designed an inexpensive amplifier that will deliver a genuine 50 watts rms per channel, both channels driven, into 8 ohms.

Since most modern speakers are 8 ohms impedance, we have not designed the amplifier for 4 ohm operation. Such an amplifier would require a much larger transformer and would be considerably more expensive, so we have decided to

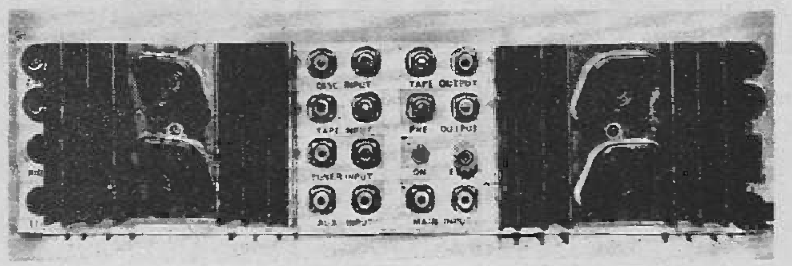
MEASURED PERFORMANCE OF PROTOTYPE UNIT

POWER OUTPUT			
Both channels driven $8\Omega + 8\Omega$ loads	50W rms		
FREQUENCY RESPONSE			
20Hz-20kHz	±0.5dB		
CHANNEL SEPARATION			
At rated output and 1kHz	45dB		
HUM AND NOISE			
With respect to rated output			
Tape, Tuner and Aux. inputs	−78dB		
Disc input (re 10mV)	−67dB		
INPUT SENSITIVITIES (for rated output)			
Tape, Tuner and Aux. inputs	210mV into 47k		
Disc at 1kHz	2.1mV into 47k		
Main amplifier	500mV into 10k		
TOTAL HARMONIC DISTORTION			
	100Hz	1kHz	6.3kHz
1W output	0.14%	0.11%	0.12%
5W output	0.17%	0.13%	0.15%
10W output	0.16%	0.11%	0.13%
50W output	0.27%	0.38%	0.60%
TONE CONTROLS			
Base	±13dB at 50Hz		
Treble	±13dB at 10kHz		
DAMPING FACTOR	>70		

Internal view of the completed amplifier.



INTERNATIONAL 422 STEREO AMPLIFIER



View of the rear panel of the amplifier.

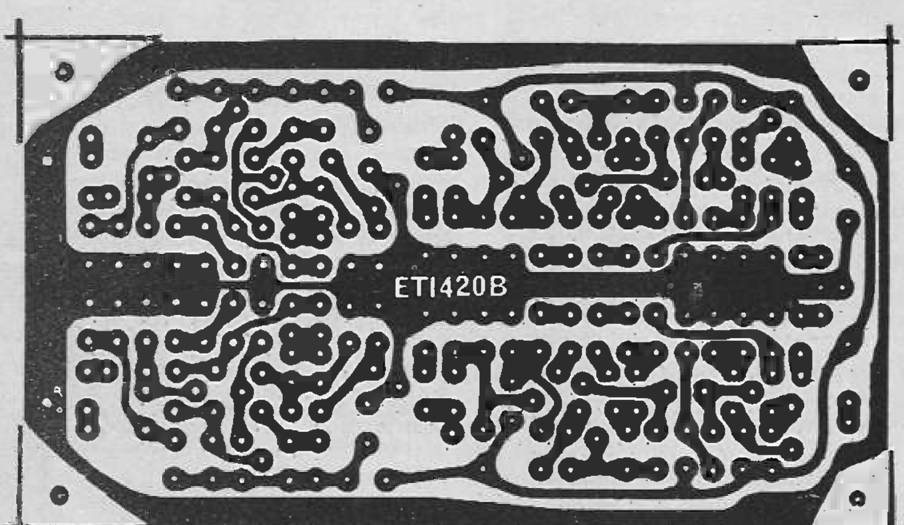
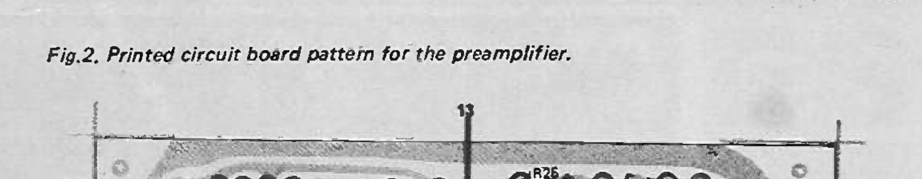


Fig.2. Printed circuit board pattern for the preamplifier.



NOTES–
PADS 1–12 ARE FOR THE TONE CONTROLS
WIRES 13 & 14 GO TO THE DECODER BOARD
PADS 19 & 20 ARE THE MAG. AMP. OUTPUT
PADS 21 & 22 ARE THE SHIELD OF 19 & 20
PADS 15 & 16 ARE ARE THE PREAMP. INPUTS
PADS 17 & 18 ARE THE SHIELD OF 15 & 15

Fig.3. Component overlay for the preamplifier.

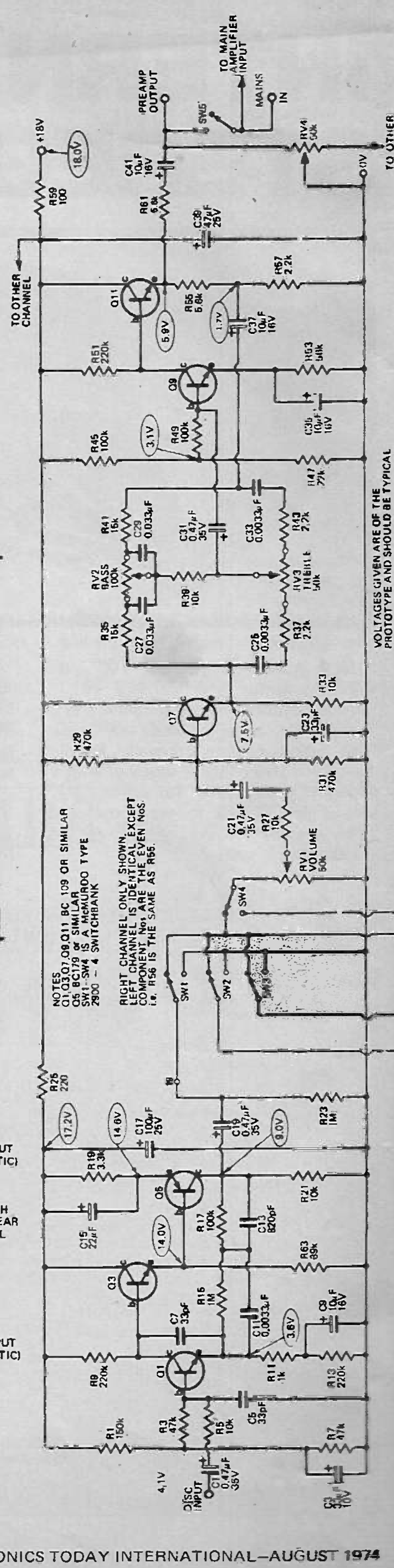


Fig.1. Circuit diagram of the preamplifier (one channel only shown).

satisfy the many, rather than the few.

As well as being designed to provide high power at low cost, the amplifier has been kept simple from the constructional point of view. It uses the preamplifier from our ETI420 four-channel amplifier with only a few minor changes. Tape-in, tape-out and main amp in/preamp-out facilities have been provided. Tape monitoring may be achieved by pressing, simultaneously, the tape button as well as that for the desired input.

A new main amplifier board is used. This carries the components for both main amplifiers (apart from those mounted on the heatsinks) and the power supply components. All components are mounted on a simple pan-type chassis which slides into the same wooden case as was used for the four channel amplifier.

CONSTRUCTION

The construction has been kept as simple as possible so that a person with only average electronics experience should have no problems in building the amplifier.

The printed circuit boards carry the majority of the components apart from hardware items such as switches, potentiometers and the transformer etc.

The boards should be assembled with reference to their component overlays making sure that all components are in the correct position and that they are orientated correctly.

It is preferable that pins be used to connect all external wiring to the main amplifier board, as this will considerably facilitate wiring up the board at a later stage.

The components should be assembled onto the heatsinks with the aid of Fig. 7 and Fig. 8. Note that a mica washer should be used on both sides of the heatsink for each of the 2N3055's so that the BD139-140 transistors may also be insulated from the heatsink.

The PN3643 transistor, Q13, should be glued into the heatsink in the position shown in Fig. 7 and the wires which connect to the flying leads of the transistors should also be secured to the heatsink with glue. The new quick-dry epoxies are ideal for this application.

The chassis hardware should be assembled in the following order:—

1. Fit all the phono sockets (tape in, tape out etc), the two-pin DIN sockets for the speaker outlets and the power outlet socket.

2, Fit the rear panel escutcheon using the fuse holders, the main-preamplifier connect toggle switch, the earth terminal and the 3-core flex and grommet, to secure it to the rear panel.

3. The heatsinks can now be fitted by passing the wiring through the rear panel holes (which should be fitted with grommets) and securing them using 12 mm long ¼" screws. The screws will screw directly into the

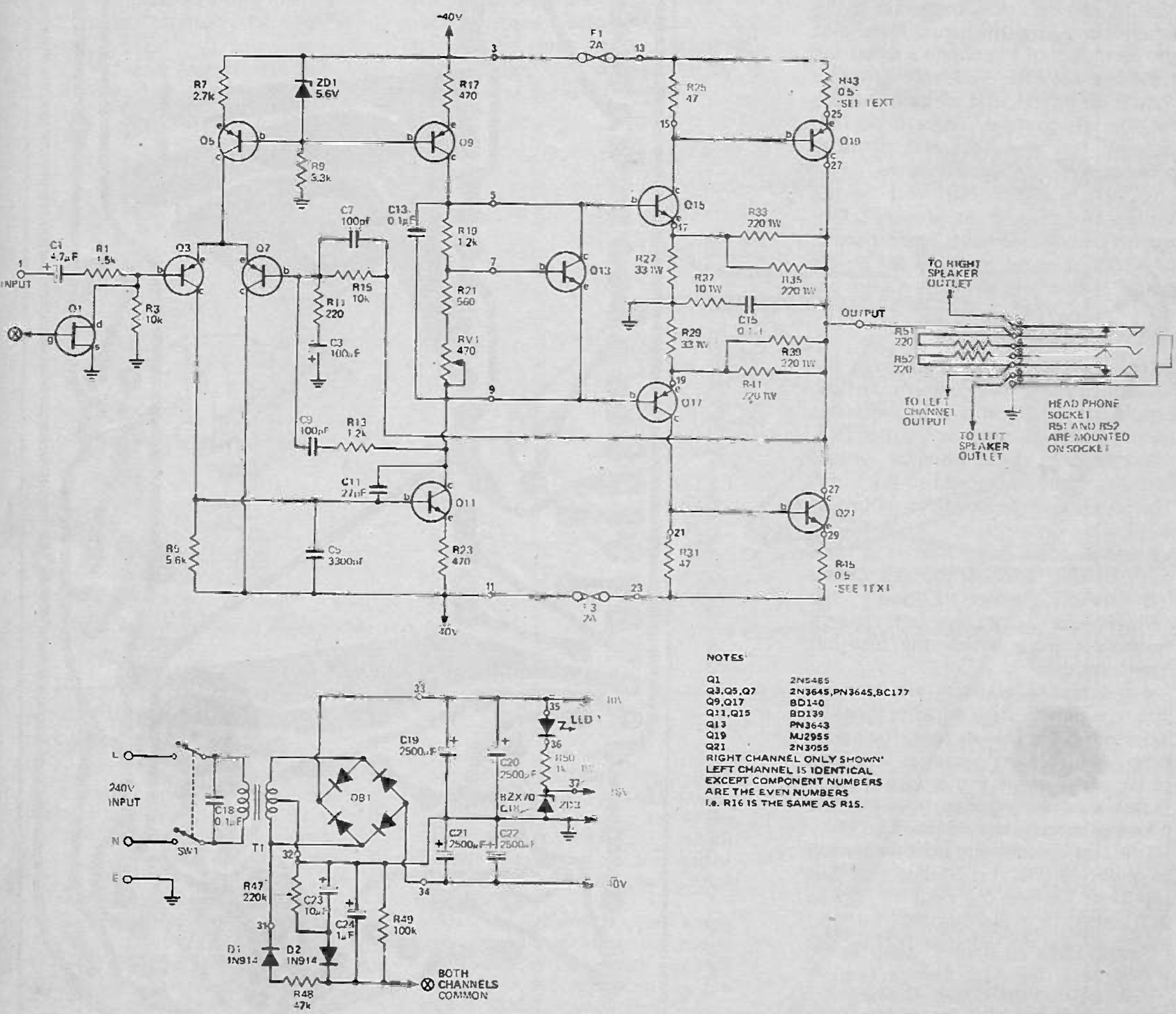


Fig. 4. Circuit diagram of the main amplifier (one channel only) and the power supply

INTERNATIONAL 422 STEREO AMPLIFIER

heatsink-fin spacing which is designed for such a mounting technique.

4. Fit a cable clamp to the 3-core power flex and terminate the cable into a two way terminal block and a separate earth screw.

5. The power switch and the selector switch should now be mounted using 12.7 mm spacers.

6. The front panel can now be mounted. It is secured by the potentiometers, LED and the phone socket.

7. Mount the preamplifier board after connecting coax. or hookup wire where applicable. The board should be supported on 6 mm spacers.

8. Mount the power amplifier board, also on 6 mm spacers, the power transformer and the bridge rectifier.

9. The interconnection wiring should now be carried out with the aid of the schematic wiring diagrams. Note that the earth lugs of the phono sockets for right channel PRE-OUT and MAIN-IN should be linked, and so should those for the left channel. There is no link between left and right and all other sockets have independent earths.

10. All exposed 240 volt wiring should be taped up to provide safety against personal contact. The capacitor C18 should be mounted on the power outlet socket and similarly taped up.

SETTING UP

The only setting up required is the adjustment of bias current in the output stage. For this a milliammeter having a 100 mA range is required.

Rotate trim potentiometer wipers such that they are closest to the front. This adjusts bias current to its lowest value.

Remove both fuses from the right hand channel and the top fuse of the left hand channel. Connect the milliammeter across the left channel fuseholder from which the fuse has been removed.

If a variac is available wind the ac line supply up slowly whilst monitoring the bias current. If a variac is not available the amplifier will have to be switched on, if there is any gross fault the remaining fuse will blow but no other damage should result.

The bias current should be adjusted to about 25 mA. If it is adjustable, but too high, increase the value of R21 to 820 ohms. If it is adjustable but too low, decrease the value of R21 to 330 ohms.

If it is not adjustable *at all* check for errors in the layout or wiring. In a normal amplifier the range of bias

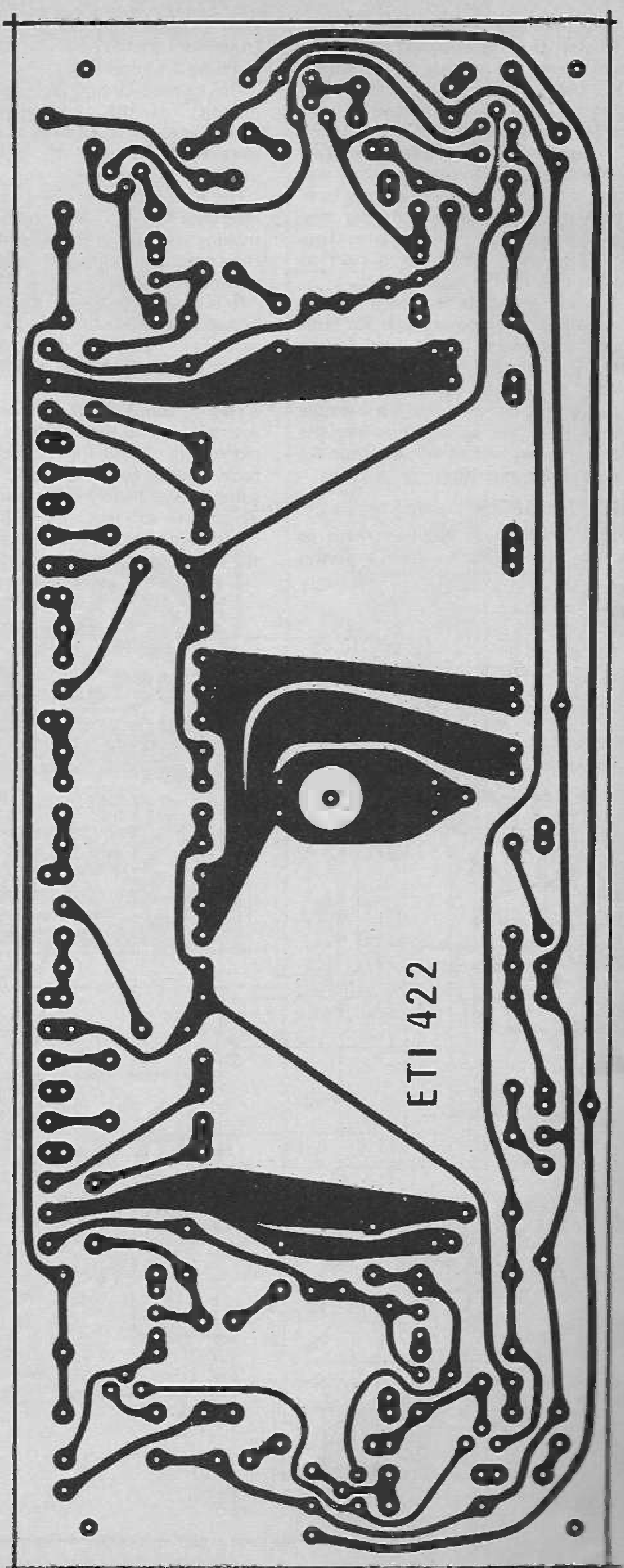


Fig. 5. Printed circuit board pattern for the main amplifier and power supply (full size).

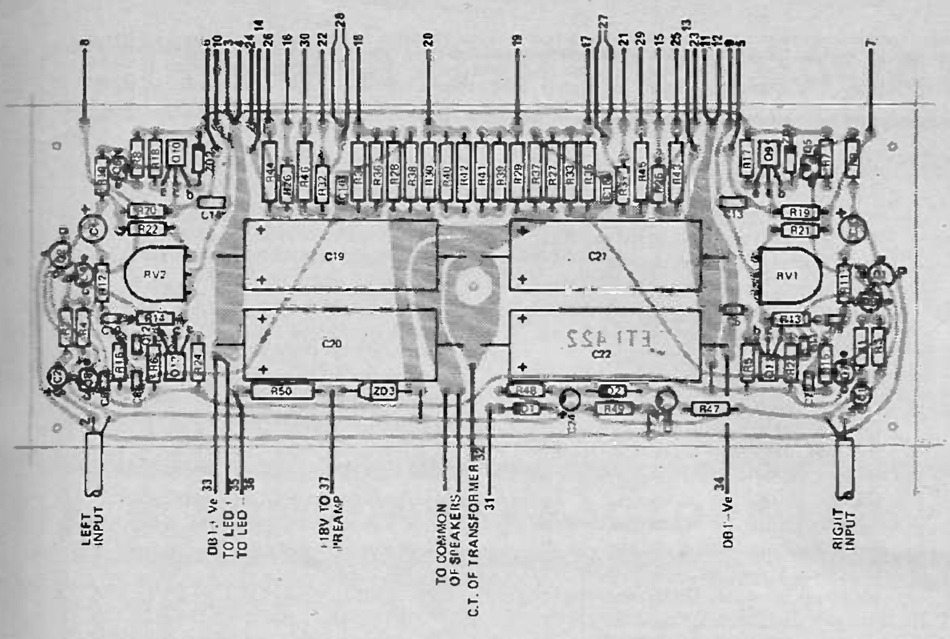


Fig. 6. Component overlay for the main amplifiers and power supply.

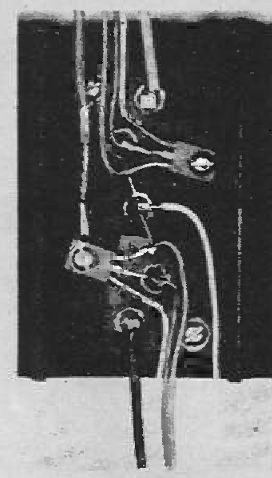


Fig. 7. Details of heatsink assembly. Note particularly the orientation of Q13.

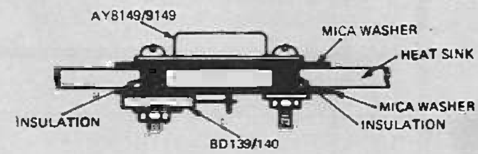


Fig. 8 Method of assembly of power and BD139-140 transistors to the heatsink.

adjustment offered by the trim potentiometer should be entirely adequate.

Switch off and replace the missing left channel fuse together with the lower right channel fuse. Using the milliammeter across the top right-channel fuse holder, adjust the right channel bias current to 20 to 25 mA as for the left channel.

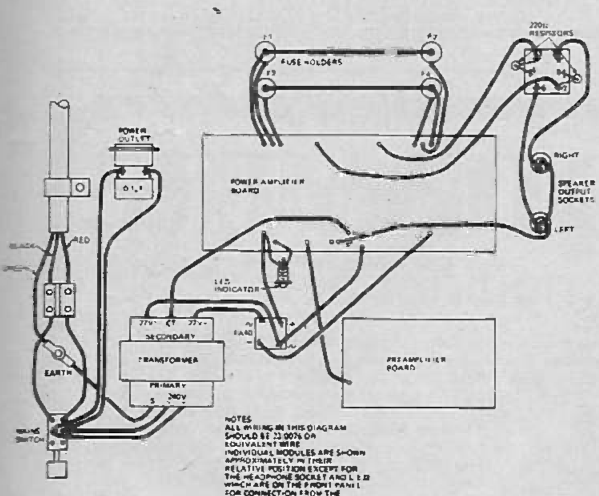


Fig. 9. Power wiring diagram of the complete amplifier.

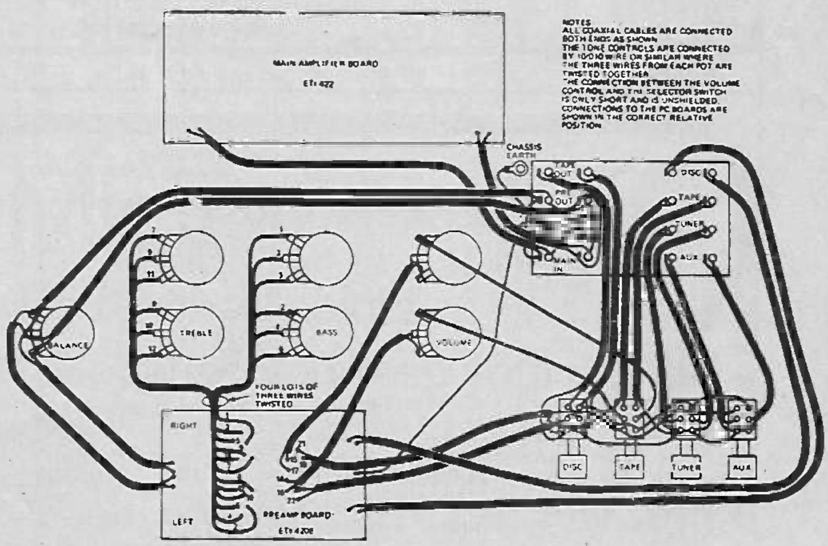


Fig. 10. Signal wiring diagram of the complete amplifier.

HOW IT WORKS – PREAMPLIFIER

The output level of a magnetic cartridge may be as low as 1 mV and this must be amplified and equalised before being applied to the tone controls.

Transistors Q1, 3 and 5 form this equalizing amplifier. The gain is controlled by R11, and the frequency response by R15, R17, C11 and C13. This complex network provides the correct RIAA equalization, the desired signal source and appropriate network being selected by SW1, 2 and 3 and 4. The signal is then passed to Q7 which buffers the output of the volume control and drives the tone control network.

Transistor Q9 and Q11 form a high gain amplifier in which the gain is determined by the relative positions of the bass and treble controls. The gain at 1 kHz is approximately 2.

HOW IT WORKS – MAIN AMPLIFIER

The input signal is fed via C1 and R1 to the base of Q3 which, with Q7, forms a differential pair. Transistor Q5 is a constant current source where the current is [5.6V (ZD1) – 0.6 (Q5)]/2700 (R7) – that is about 2 mA. This current is shared by Q3 and Q7. Transistor Q9 is also a constant current source supplying about 10 mA which, if no input signal exists, flows through Q13 and Q11. The differential pair controls Q11 and thus the voltage at its collector.

INTERNATIONAL 422 STEREO AMPLIFIER

HOW IT WORKS

MAIN AMPLIFIER (Cont'd)

The resistors R19 and R21, together with potentiometer RV1, control the voltage across Q13 and maintain it at about 1.9 volts. But as Q13 is mounted on the heatsink, this voltage will vary with heatsink temperature. Assuming that the voltage at points 5 and 9 is equally spaced about zero volts (ie ± 0.95 volts), the current will be set at about 12 mA through Q15 and Q17. The voltage drop across the 47 ohm resistors (R25 and R31) will be enough to bias the output transistors, Q19 and Q20, on slightly to give about 10 mA quiescent current. This quiescent current is adjustable by means of potentiometer RV1.

Local feedback is applied to the output stage by the network R33, R35, R39 and R41, giving the output stage a voltage gain of about four. The overall feedback resistor, R15, gives the required gain control.

Protection to the amplifier, against shorted output leads, is provided by fuses in the positive and negative supply rails to both amplifiers.

Temperature stability is obtained by mounting Q13 on the heatsink. Q13 will thus automatically adjust the bias voltage. Frequency stability is ensured by C9/R13, C5, C11 and C7.

Although the power amplifier itself does not produce a thump in the loudspeaker, when switched on, the preamplifier does. This is because the preamplifier uses a single power rail and has to stabilize. To reduce this thump to an acceptable level, Q1 is used to short the input for about 2 seconds on switch-on and immediately after switch-off.

The power supply is a conventional full-wave bridge with centre tap, providing + 40 volts and − 40 volts. Diode D1 is used to rectify a second negative supply which is used to control the FETs. Due to the resistance in series with the diode, the charge of C24 is slow. In addition, during the charge period, C23 is also being charged increasing the delay. On switch off, however, C23 cannot assist the voltage on C24 and the off-timing is much shorter than the on-timing.

The power supply for the preamplifier is derived by an 18 volt zener which is fed from the +40 volt rail via an LED power-on indicator and R50.

PARTS LIST — Preamplifier

R59	Resistor	100	¼ or ½W	5%
R25,26	"	220 "	"	"
R11,12	"	1k "	"	"
R37,38,43	"	2.2k"	"	"
R44,57,58	"	2.2k"	"	"
R19,20	"	3.3k	¼ or ½W	5%
R55,56,61,62	"	5.6k "	"	"
R5,6,21,22	"	10k "	"	"
R27,28,33,34	"	10k "	"	"
R39,40	"	10k "	"	"
R35,36,41,42	"	15k "	"	"
R47,48	"	22k "	"	"
R63,64	"	39k "	"	"
R3,4,7,8	"	47k "	"	"
R53,54	"	56k "	"	"
R17,18,45	"	100k "	"	"
R46,49,50	"	100k "	"	"
R1,2	"	150k "	"	"
R9,10,13	"	220k "	"	"
R14,51,52	"	220k "	"	"
R29,30,31,32	"	470k "	"	"
R15,16,23,24	"	1M "	"	"

RV1	Potentiometer	50k log dual r'tary
RV2	"	100k lin dual r'tary
RV3	"	50k lin dual r'tary
RV4	"	50k lin rotary

C5,6,7	Capacitor	33pF ceramic
C8,23,24	"	33pF ceramic
C13,14	"	820pF ceramic
C11,12,25	"	0.0033µF polyester
C26,33,34	"	0.0033µF polyester
C27,28,29,30	"	0.033µF polyester
C1,2,19,20	"	0.47µF 35V tag tantalum
C21,22,31,32	"	0.47µF 35V tag tantalum
C9,10,35,36	"	10µF 16V electrolytic *
C37,38,41,42	"	10µF tag tantalum

C15,16	Capacitor	22µF 16V	elect'ytic*
C3,4	"	33µF 10V	"
C39	"	47µF 25V	"
C17,18	"	100µF 25V	"

* PC mounting or tag tantalum

Q1,2,3,4,7	Transistor	BC109, BC549*
Q8,9,10,11,12	"	" "
C5,6	"	BC179,BC559

* can be BC108,548 except for Q1,Q2

SW1-4 Switch assembly

PC board ETI 420 B

PARTS LIST — Main Amplifiers and Power Supply

R43,44,45,46	Resistor	0.5ohm	
R37,38	"	10 "	1W 5%
R27,28,29,30	"	33 "	1W 5%
R25,26,31,32	"	47 "	½W "
R11,12,51,52	"	220 "	½W "
R33,34,35,36	"	220 "	1W "
R39,40,41,42	"	220 "	1W "
R17,18,23,24	"	470 "	½W "
R21,22	"	560 "	½W "
R50	"	1k "	1W "
R13,14,19,20	"	1.2k "	½W "

R1,2	Resistor	1.5k	½W	5%
R7,8	"	2.7k	"	"
R9,10	"	3.3k	"	"
R5,6	"	5.6k	"	"
R3,4,15,16	"	10k	"	"
R48	"	47k	"	"
R49	"	100k	"	"
R47	"	220k	"	"

RV1,2 Potentiometer 470 ohm Trim type

C11,12	Capacitor	27pF ceramic
C7,8,9,10	"	100pF "
C5,6	"	0.0033µF polyester
C13,14,15,16	"	0.1µF "
C18	"	0.1µF 250V ac

C24	Capacitor	1µF 35V	electrolytic *
C1,2	"	4.7µF 10V	"
C23	"	10µF 25V	"
C3,4	"	100µF 10V	"
C19,20,21,22	Capacitor	2500µF 50V	electrolytic

* should be PC mounting type

Q1,2	Transistor	2N5485
Q3,4,5,6,7,8	"	2N 3645, BC177
Q9,10.17.18	"	BD 140
Q11,12,15,16	"	BD 139
Q13,14	"	PN 3643
Q19,20	"	AY 9149, MJ2955
Q21,22	"	AY 8149, 2N 3055

D1,2 diode IN 914,
ZD1 zener diode BZX70C18 **
** 20V or 16V will do if 18V unobtainable

DB1 diode bridge 100V, 2A

T1 Transformer 56V CT 1.5A

PC Board ETI 422
F1-F4 miniature 2 AMP Fuse and holders
SW1 Mains on/off
4 covers for TO3 transistors
4 insulation kits for TO3 transistors
4 extra mica washers for TO3

PARTS LIST — General

Chassis
Front panel
Rear panel
Wooden box
12.7 mm spacers 4 req.
6.4 mm spacers 9 req.
3 small knobs
1 large knob
1 stereo phone jack
1 LED indicator
2 heatsinks
Miniature DPDT toggle switch
Earth binding post
3 core flex and cable clamp
3 rubber grummets
6 ¼" Whit ½" long screws
17 1/8" Whit 3/8" long c/s screws
4 1/8" whit 3/8" long c/s screws
17 1/8" whit 3/4" long r/h screws
coax cable
23/0076 cable
10/0076 cable

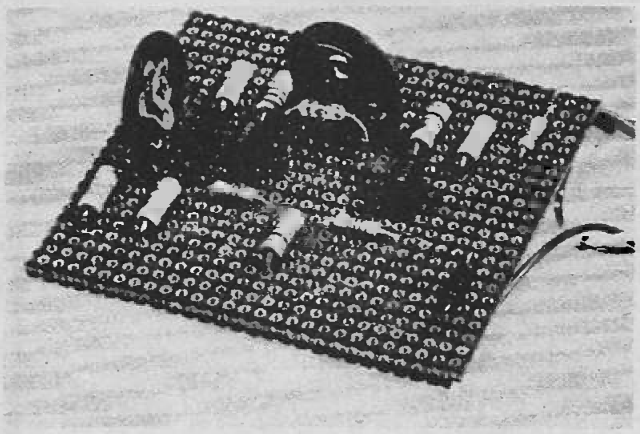
Details of case, metalwork and front/rear panels will be published in ETI next month.

eti

PROJECT 226

TEMPERATURE METER

Solid-state meter displays temperatures — even from distant points



The completed temperature meter. Note that the sensing diode is shown mounted on the board. This would normally be located remotely with a pair of leads running back to the board.

AN ELECTRONIC temperature meter is an extremely useful instrument, and, is far more versatile than the mercury, or alcohol-in-glass types. For example, the temperature sensing element does not have to be located with the meter and thus, a remote sensor could be used to monitor swimming pool temperature on a meter readout located within the house. Additionally, several sensors may be used, e.g. monitoring temperatures of pool water, outside air and air inside the house. This is simply achieved by running separate sensor leads back to the meter and using a switch to select the appropriate sensor.

Many devices are capable of being used as temperature sensors. Examples of these are the thermistor, the thermocouple and the semiconductor diode junction.

The voltage across a forward biased diode junction, whether it is part of a transistor (e.g. base emitter) or a discrete diode, has a negative temperature coefficient. This means that with an increase in temperature the voltage across the diode drops. This effect is normally detrimental to stable operation of other circuitry but may be used, as in this circuit, to measure temperature.

CALIBRATION

The meter is calibrated by adjusting the meter at two known temperatures. The temperatures of melting ice and boiling water should be used as reference points.

With the diode sensor and the thermometer immersed in melting ice, adjust RV1 to read 0°. Then insert the sensor into boiling water and adjust RV2 for 100°. A kettle is ideal for the boiling water adjustment or some vessel that restricts the steam to some extent. **Do not** use an electric jug **having an exposed heater** element.

A known ambient temperature can be used as the low reference if desired by first adjusting RV1 such that the meter reads 0° with the sensor at ambient temperature. Then with the sensor in hot or boiling water adjust RV2 such that the meter reads the *difference* between the two temperatures. With the sensor back at ambient (allow time to cool) readjust RV1 to read the actual ambient temperature.

Recheck the meter at both set points for which ever method of calibration is used. ●

SPECIFICATION

Temperature Range	0-100°C
Sensor	silicon diode
Scaling	reasonably linear over 0-100°C

HOW IT WORKS

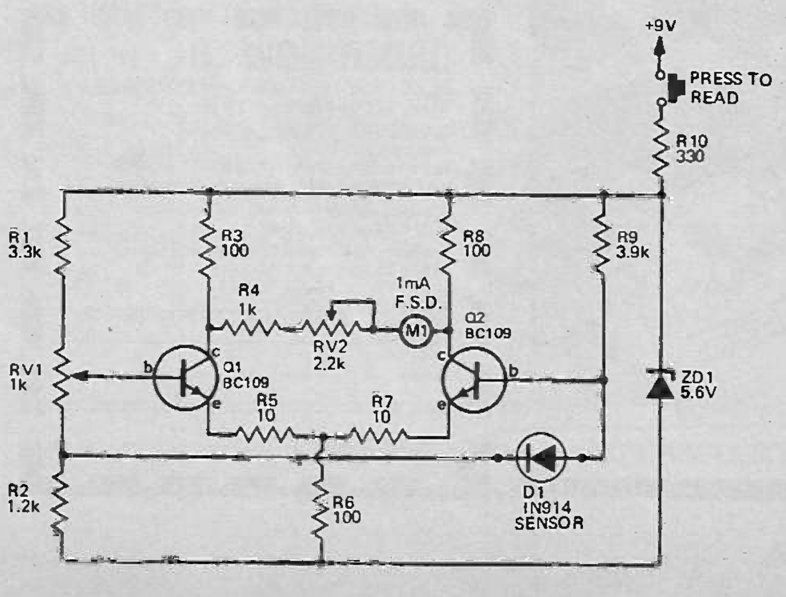
The negative temperature coefficient of a diode is of the order of 2 mV/°C, and in our circuit, this voltage is measured by a differential amplifier Q_1 and Q_2.

The diode has an offset voltage of 0.55 mV which is compensated for by RV1. A differential amplifier is used so that variations in transistors due to temperature do not affect the calibration.

As there is no instrument warm-up time, it is suggested that a push-to-read button be used to switch on power in order to extend battery life. Battery drain is about 10 mA when the meter is operational hence, if *continuous* readout is required, a small power supply should be used.

PARTS LIST

R5,7	Resistor 10 ohms		5% ½W
R3,6,8	"	100 ohms	" "
R10	"	330 ohms	" "
R4	"	1k	" "
R2	"	1.2 k	" "
R1	"	3.3 k	" "
R9	"	3.9 k	" "
RV1	Potentiometer 1k trim		
RV2	"	2.2 k	Potentiometer "
Q1,2	Transistor BC109 or similar		
D1	Diode 1N914		
ZD1	Zenerdiode BZY88C5V6		
M1	1ma meter scaled preferably 0-100		
PB1	push to-make pushbutton		
Small piece of matrix board			
9V	battery		



What to look for in September's ETI

2 GREAT ETI READER OFFERS

7-SEGMENT 0·33" LED DISPLAYS

Full spec, new, numerical displays with a decimal point. These LEDs can be used with this month's CT5001 chip (circuits will be given). These devices are so cheap that they can be used for hitherto uneconomical functions: switch indicators for instance. Price includes VAT and postage.

5 FOR £3.30

DIGITAL CLOCK KIT

A superb digital clock kit which has only just been introduced and which is now being sold for £32.62. The finished product looks excellent as it is housed in an award-winning designed case. For ETI readers only, the price for a limited period will be:

£27.50

IGNITION TIMING LIGHT PROJECT

Several years ago you were able to set your ignition timing simply by listening to the engine. Today's improved petrols make this impossible. By using our ignition timing light described in next month's ETI, you will be able to set the ignition accurately and easily, ensuring the best performance and petrol consumption.

OTHER FEATURES INCLUDE:
PRODUCT TESTS, ETI MUSIC SYNTHESISER

BYTING THE SCENE

Computers today can be fed with a lot more than punched paper cards, tape etc. and can accept visual scenes as long as these are converted to digital form. How this is done, and what fields it opens up, are discussed in next month's ETI.

PLUS

ALL AT SEA

In a recent issue we had a feature dealing with electronics on the surface of the sea. This covered navigation etc. A companion article in September's ETI will cover the use of electronics underneath the surface of the sea.

SEPTEMBER ISSUE — ON SALE AUGUST 16th

The features mentioned here are, at the time of this issue going to press, in an advanced state of preparation. However, circumstances, including highly topical developments, may affect the final contents.

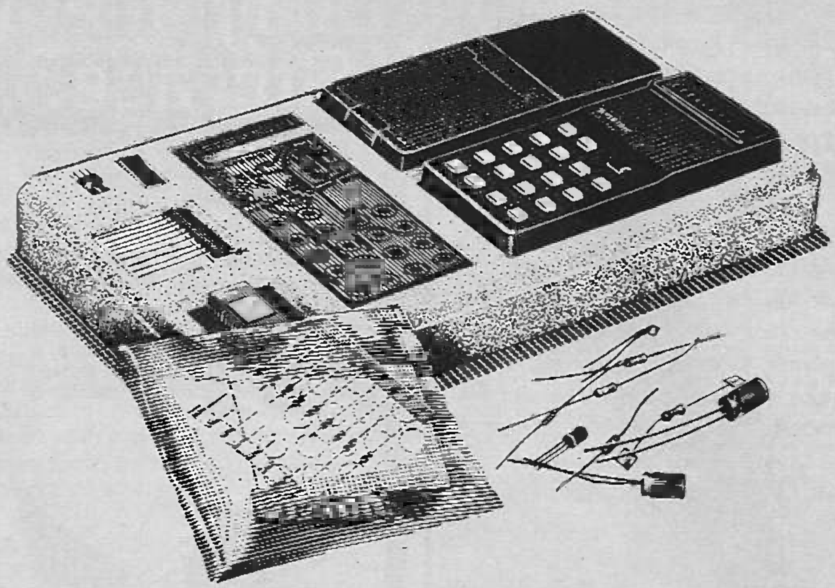
electronics today INTERNATIONAL

A complete kit!

The kit comes to you packaged in a heavy-duty polystyrene container. It contains all you need to assemble your Sinclair Cambridge. Assembly time is about 3 hours.

Contents:

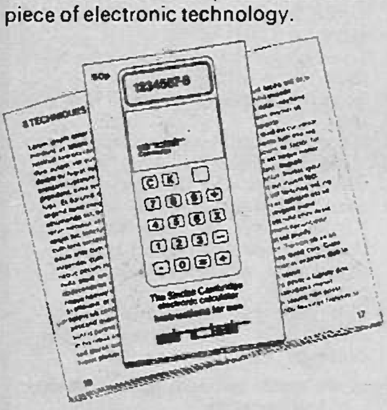
1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



This valuable book – free!

If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

But if you want to get even more out of it, you can go one step further and learn how to unlock the full potential of this piece of electronic technology.



How? It's all explained in this unique booklet, written by a leading calculator design consultant. In its fact-packed 32 pages it explains, step by step, how you can use the Sinclair Cambridge to carry out complex calculations.

Why only Sinclair can make you this offer

The reason's simple: only Sinclair – Europe's largest electronic calculator manufacturer – have the necessary combination of skills and scale.

Sinclair Radionics are the makers of the Executive – the smallest electronic calculator in the world. In spite of being one of the more expensive of the small calculators, it was a runaway best-seller. The experience gained on the Executive has enabled us to design and produce the Cambridge at this remarkably low price.

But that in itself wouldn't be enough. Sinclair also have a very long experience of producing and marketing electronic kits. You may have used one, and you've almost certainly heard of them – the Sinclair Project 80 stereo modules.

It seemed only logical to combine the knowledge of do-it-yourself kits with the knowledge of small calculator technology.
And *you* benefit!

Take advantage of this money-back, no-risks offer today

The Sinclair Cambridge is fully guaranteed. Return your kit within 10 days, and we'll refund your money without question. All parts are tested and checked before despatch – and we guarantee a correctly-assembled calculator for one year.

Simply fill in the preferential order form below and slip it in the post today.

Price in kit form: £13·59 + £1·36 VAT. (Total: £14·95)
Price fully built: £19·95 + £2·00 VAT. (Total: £21·95)

To: Sinclair Radionics Ltd, London Road, St Ives, Huntingdonshire, PE17 4HJ

Please send me

☐ a Sinclair Cambridge Calculator kit at £13·59 + £1·36 VAT (Total: £14·95)

☐ a Sinclair Cambridge calculator ready built at £19·95 + £2·00 VAT (Total: £21·95)

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

*Please debit my *Barclaycard/Access account. Account number __________

*Delete as required.

Name __________

Address __________

ETI/8/74. PLEASE PRINT

sinclair

Sinclair Radionics Ltd, London Road,
St Ives, Huntingdonshire
Reg. no: 699483 England
VAT Reg. no: 213 8170 88

CT5001 CALCULATOR CHIP

ETI Reader Offer

LIMITED TO THE FIRST 500 ORDERS

The CT5001 offered here is a full spec Cal-Tex calculator chip with a 12-digit capacity. We are not doing this as a normal constructional feature and the circuits shown here are intended only as a guide. Those purchasing the I.C. will be sent a spec sheet which gives lead configurations etc. as well as additional information.

The chip can be used with LEDs and Minitrons; circuits are given for both. The displays must have a right-handed decimal point.

Suggested displays are: i) Hewlett-Packard HP5082/7731 0.3" red LEDs; ii) Minitrons 3015F; iii) Opcoa SLA 11R, 0.33" green LEDs; iv) Litronix DL707R LEDs.

There are only 500 of these chips available and orders will be dealt with in strict rotation. It is emphasised that this chip is offered mainly for those wishing to experiment with a calculator chip, rather than for those wishing to build a practical calculator.

NOTES

1. The signal from the chip keeps the digits off for most of the time. If power is applied to the digits and not the chip, all displays will go on and will dissipate about sixteen times the normal power. It is advisable to apply power initially to the I.C. and then to make temporary connection to the digit power supply to ensure all is well before a permanent connection is made.

2. Counter. a) Connect the ± pin to VDD. b) Electronically key the '1' key. The I.C. will count and display the number of ones keyed. The number is displayed whenever the '1' key is up. The maximum pulse rate is about 50Hz. To reset press the Clear key. The ± pin can be left connected to VDD whilst resetting. See Fig.8.

3. Timer/Counter. Using the I.C. as the counter described above, it can, with the addition of some TTL circuits, be made into a frequency counter. The frequency to be measured must be divided by a

Continued overleaf

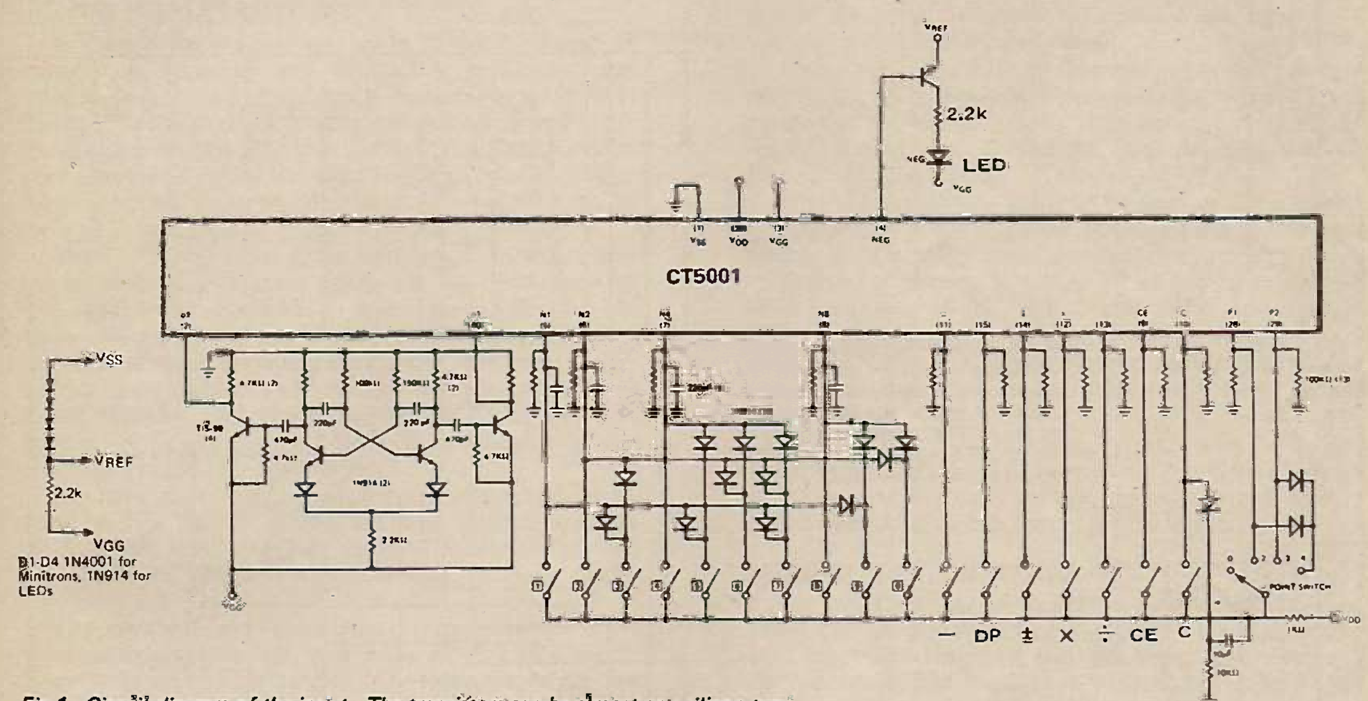


Fig.1. Circuit diagram of the input. The transistors can be almost any silicon type such as 2N3708, 2N706. All diodes are 1N914 or similar. Capacitors can be any type except ceramic.

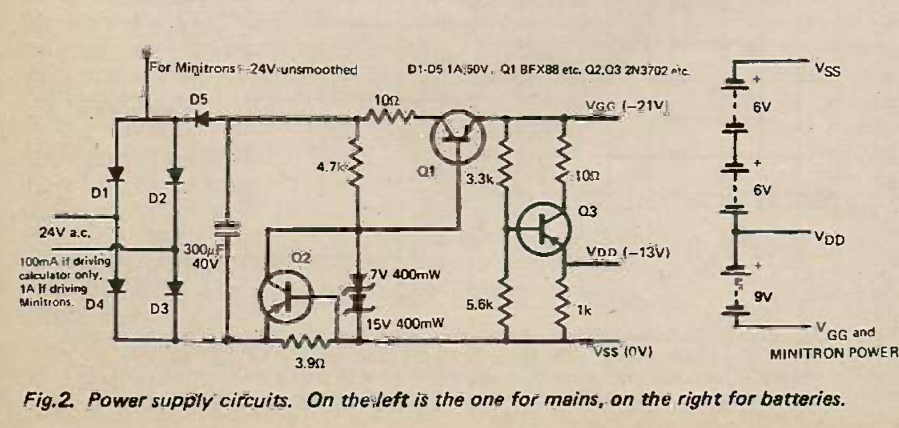


Fig.2. Power supply circuits. On the left is the one for mains, on the right for batteries.

– – – – – CUT – – – – –

To: ETI/SINTEL CT5001 OFFER, 53 Aston Street, Oxford OX4 1EW.

Please find enclosed my cheque/P.O. for £3.00 for my CT5001 (cheques etc. to be made out to Sintel). I also enclose a self-addressed, stamped envelope for the return of my money should the offer be over subscribed.

Name..

Address..

....

....

Offer closes August 31st, 1974

This offer is limited strictly to one I.C. per coupon. Readers may order more than one device but a separate coupon must be enclosed for each.

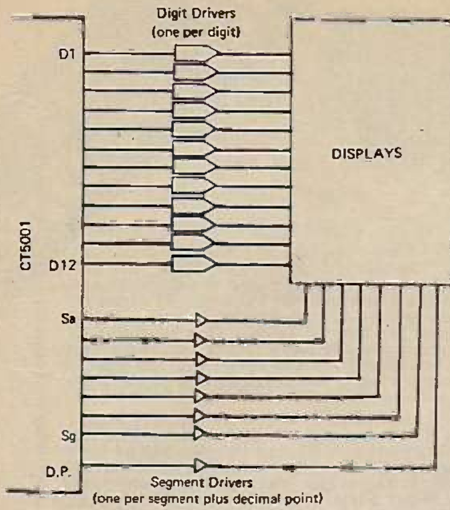


Fig.3. Basic arrangement for the display.

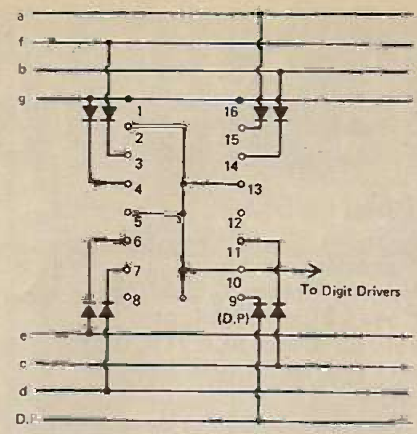


Fig.5. Connections for Minitrons. All diodes are 1N914 or similar. Connections to LEDs are the same but the diodes are not required.

Continued from previous page

convenient number, using the TTL, so that the output is less than 50Hz, and this output must be gated into the chip for a known period.

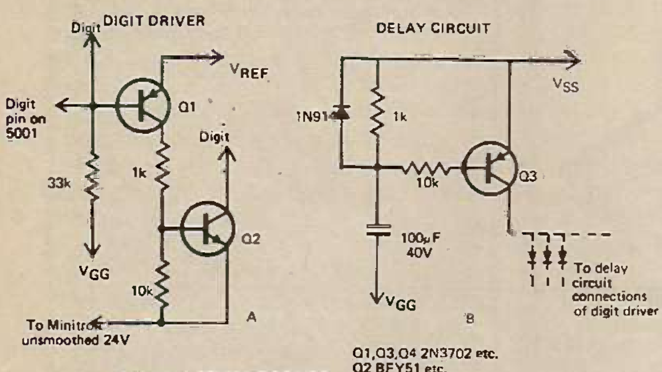
4. Stopwatch. Instead of electronically keying '1' as in note 2, any other number (up to 9) may be used. The maximum rate is less than 50Hz for larger numbers.

However, if '2's' are keyed in, the 50Hz rate is still usable. Thus if a 50Hz signal derived from the mains or a stable oscillator is used to key '2's' in, the I.C. will indicate time elapsed in one hundredths of a second, accurate to one fiftieth of a second.

5. Accurate Long Delay Generator. If, say, 1Hz pulses are obtained to activate three monostables so that each pulse causes electronic keying of the '1' key (or some other digit) and then the minus key, the calculator will automatically count down from a number initially loaded into it. When the total in the I.C. gets to minus 1, there will be an output from the negative pin to activate some device.

6. Counting Faster than 50Hz. If numbers larger than '1' are keyed into the I.C., a counting rate over 50Hz can be achieved. Some TTL counter, gates, etc. can be arranged to key '9' into the total at about 25Hz as pulses of about 250Hz arrive. When the end of count time is reached, the TTL can be arranged to key the figure from a buffer counter into the 5001. In this way it is possible to achieve count rates of up to about 250Hz.

7. Keyboards. We have successfully used: a) Surplus microswitches, b) Eagle SW5 push-buttons, c) Surplus reed relays with a magnetic pen, d) A keyboard. The cheapest method is probably using the surplus reeds.



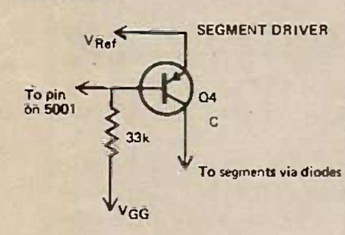


Fig.4. Digit driver, segment driver and delay circuit for use with Minitrons. These are connected from the chip to the arrangement in Fig.5. The delay circuit is to switch on the digits after the 5001 to protect the Minitrons.

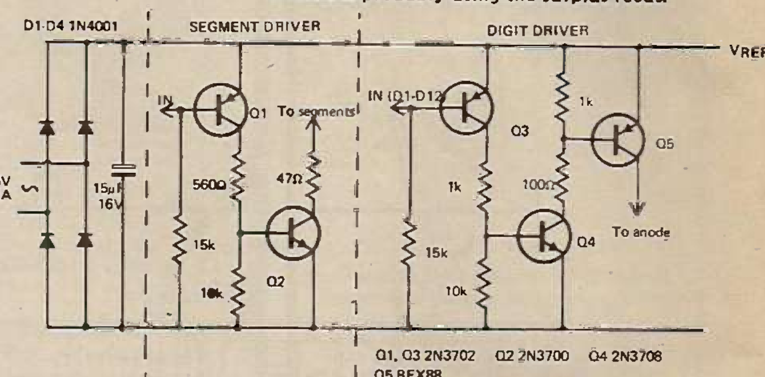


Fig.7. Segment and digit driver circuits for 0.33" LED displays.

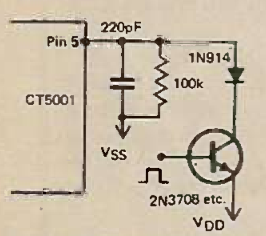


Fig.8. Electronic '1' key, see notes.

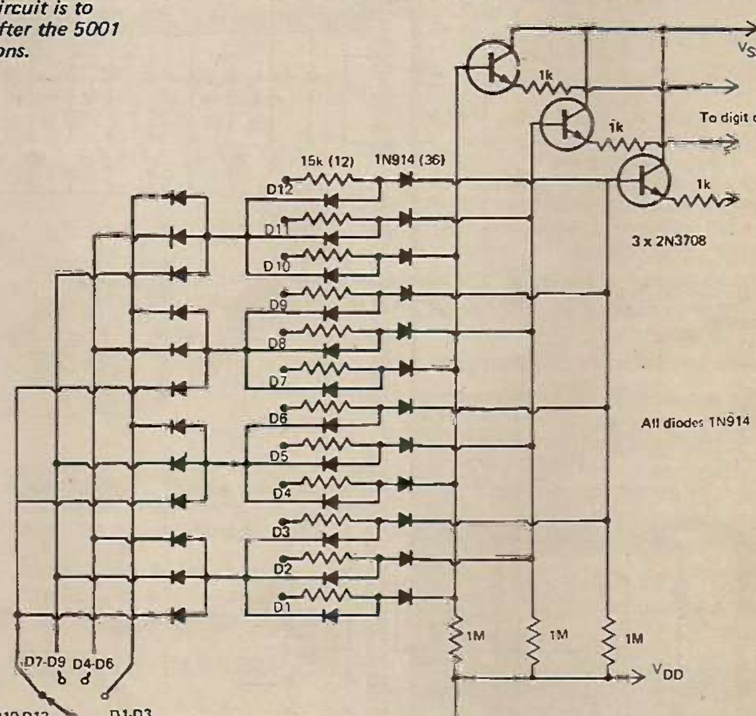


Fig.6. Digit switching circuit. If wired up as shown, the display is similar to that of the Sharp calculator: only three digits are used and the 12 digit number is viewed three at a time. Variations are 4 at a time or 6 at a time. This applies to both LEDs and Minitrons.

NEXT MONTH'S READER OFFER:
FIVE 0.33" LED NUMERIC DISPLAYS FOR £3.30!

These LED's are ideal for use with this month's offer but different segment and driver circuits are needed. These will be given next month.

ETI CALCULATOR DIRECTORY

TWO YEARS AGO there were small electronic calculators about, but you had to think in terms of at least £70 and the choice was very limited. Today there are masses to choose from with several costing less than £20.

In Britain we are just beginning to see mass sales of calculators, In Japan and the U.S.A. this point was reached some time ago and it is this situation, rather than the local one, that has pulled the prices down. It is difficult to predict if prices will fall as dramatically as they have done in the last eight months. Sooner or later there is bound to be an £8 calculator but it may not be for a very long time.

The variety of types is daunting, even to those who try to keep up with these things. In the preparation of this feature we managed to track down considerably more calculators than those shown but they have not been included for a variety of reasons. The main reason for not being included is that current models are shortly to be replaced and stocks were now selling out. A number of calculators are not widely available and have not been included for that reason.

We have been very loose in our interpretation of 'hand-held'. Relatively few are true pocket size and many of the small ones are designed primarily for desk top operation. We have not dealt with the larger machines, print-out types or non-portables.

Although this feature has been planned for some time, the final information has been gathered very recently to make it as up-to-date as possible. However there are continual changes and readers will be well advised to check prices before buying; current trends mean that these will normally be lower.

We have included recommended retail prices only. Some calculators are available at considerable discounts while others are only sold at the recommended price. We have included VAT in all prices. Avoid being impressed by high percentage discounts - these are often on *last year's* recommended prices. It is only what you pay that matters.

ANALYSE YOUR REQUIREMENTS

Before you even look at prices, work out what you want out of your calculator. This sounds obvious but we know of several people who have calculators wholly unsuited to their purposes. It can be surprisingly difficult to predict your needs unless you have had experience of using a calculator.

At ETI we have a company calculator which is used for the editorial, accounts and advertising. Before we had it we never felt the need except on rare occasions - but once you *have* the facility, your working methods alter: you no longer rely on crude estimates for highly complex calculations as the true answer is so easy to derive. It is also very quick to double-check figures and you get in the habit of doing this.

If you are doing a lot of financial calculations such as percentage discounts and VAT, a constant facility and percentage key are very useful although on even the simpler calculators you quickly get used to doing without these if you have to.

If your calculator is going to be used in one place for several hours a day a mains power supply, or at least rechargeable batteries, have obvious advantages.

A number of people are put off an otherwise satisfactory calculator by entry methods which are unusual. With some calculators for 3 – 2 = 1 the numbers are entered 3 + 2 – = 1. This appears awkward at first but one rapidly becomes used to it and it is not a serious drawback.

Calculators with a memory have obvious advantages but they are considerably dearer and if the occasions on which it is required are few and far between this facility may be wasted (you can always jot the number down!).

SCIENTIFIC CALCULATORS

There are a number of scientific calculators available. These can rapidly solve extremely complex problems if used properly. However, they are a different breed and are less useful for basic four function arithmetic than cheap ones. In their own field however they cannot be compared to the simple types.

GUARANTEES AND SERVICING

Theoretically, calculators should not go wrong once they have left the factory but in our experience a high proportion do go wrong in the first month. This is not meant as an indictment of the manufacturers but as advice to purchase your calculator from a reputable source.

The consumer protection laws mean you are well protected legally *whatever* the guarantee says but it is obviously better to deal with a company who offer far more than your legal rights: the British manufacturers generally are outstandingly good in this respect.

'FEEL'

A variety of keyboard switches are used, most are excellent but some have a very unpleasant feel and are not positive. We have not listed these as 'feel' is very subjective. For this reason, if you are considering a calculator make sure you try it out first.

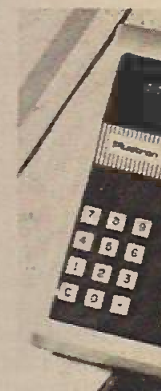
Casio Root 8.

Sinclair Executive Memory.

ETI CALCULATO

Key to table: A tick denotes the facility is available. Under Power Supply B=Battery, R=Rechargeable batteries, M=Mains P.S.U. Under notes F=Full flow arithmetic function (conventional entry). Under distributor,

Decimo Double Six.



Plustro

Sperry-Remington 663.

Minutem

The Canon Palmtronic LE-83.

MAKE	MODEL	PRICE INC.VAT	APPROX. SIZE IN MM.	POWER SUPPLY	MAINS PSU PRICE INC. VAT	CASE INCLUDED	SPECIAL FUNCTION KEYS	MEMORY	CLEAR ENTRY KEY	CONSTANT ÷ ×	CONSTANT − +	DIGITS DISPLAYED	DECIMAL POINT FLOATING	DECIMAL POINT FIXED	DECIMAL POINT MONEY INPUT	NOTES	DISTRIBUTOR
Minuteman	6	10.95	102x51x19	B								6		2			6
Sinclair	Cambridge kit	14.95	114x51x19	B					✓	✓	✓	8	✓			F	11
Prinztronic	4	15.95		B					✓	✓		8	✓				7
Prinztronic	C15	15.95		B/M	3.95							6		2			7
Prinztronic	Mini	19.95	121x54x16	B		✓	%		✓	✓		8	✓			F	7
Sinclair	Cambridge	21.94	114x51x19	B					✓	✓	✓	8	✓			F	11
Prinz	LE.808	22.95	105x60x20	B/M	3.95				✓	✓		8	✓				7
Advance	Executive Mini	23.10	140x80x22	B/R/M	7.59	✓			✓	✓		8	✓	2			5
Minuteman	3R	23.60	107x75x25	B/R/M	Inc				✓	✓		8	✓				6
Plustronics	Plustron 108	24.60	165x83x7	B/M					✓	✓	✓	8	✓			F	2
Chinon	1200	24.95		B/M	3.95				✓	✓		8	✓	✓			7
Prinztronic	M	24.95		B/M	3.95			✓	✓	✓		8	✓				7
Prinztronic	C30	24.95	171x83x25	B/M	3.95	✓	%		✓	✓		9	✓				7
Advance	80	27.50	140x80x20	B/R/M	7.59	✓	%			✓		8	✓	2			5
Hanimex	BC80	27.50	155x77x23	B						✓		8	✓				9
Sheen	004	27.90	114x64x22	B		✓				✓	✓	8	✓			F	19
Minuteman	3SR	27.95	105x78x28	R				✓	✓	✓		8	✓				6
Prinztronic	1001M	27.95		B/M	3.95			✓	✓	✓		8	✓				7
Casio	Mini	29.15	147x72x30	B/M	4.95					✓	✓	6 (12)		2			23
Chinon	1800M	29.95		B/M	3.95			✓	✓	✓		8	✓				7
Minuteman	3MRT	31.95	103x75x25	R/M	Inc			✓		✓		8	✓				6
Canon	LE-83	32.45	154x73x24	B/M	4.13					✓		8	✓			F	22
Hanimex	BC807%	32.50	138x80x31	B/M			%		✓	✓		8	✓	2or4			9
Anita	810	32.93	120x70x24	B/R/M		✓	%		✓	✓		8	✓	2	✓		10
Anita	102	32.93	146x76x19	B						✓		8	✓	0-7		F	10
Adler	80c	32.94	102x73x20	B			%			✓		8	✓				8
Kovac	LE-808	33.15	105x60x20	B/M					✓	✓	✓	8	✓			F	2
Bowmar	MX20	33.30	152x70x19	B/M					✓	✓		8	✓			F	4
Bowmar	MX51	33.30	140x76x29	B/M		✓	%			✓	✓	8	✓				4
Sperry Remington	663	34.00	146x76x44	B/M		✓						6	✓				17

Sheen 004.

Sinclair C

Colex 811A.

Decimo Slimline.

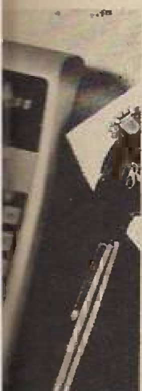
Sinclair Scientific.

Gemini 1.

[CALCULATO]R DIRECTORY

[T]he numbers refer to the listings on [p]age 41 which tell you where to [ob]tain further information. A number [o]f companies are currently changing [th]eir ranges and details are therefore [n]ot given.

Adler models: 80S, 80C, 81S, 88T.



[...]08.

[...]MC.

[...]bridge.

MAKE	MODEL	PRICE INC.VAT	APPROX. SIZE IN MM.	POWER SUPPLY	MAINS PSU PRICE INC. VAT	CASE INCLUDED	SPECIAL FUNCTION KEYS	MEMORY	CLEAR ENTRY KEY	CONSTANT ÷ ×	CONSTANT − +	DIGITS DISPLAYED	DECIMAL POINT: FLOATING	DECIMAL POINT: FIXED	DECIMAL POINT: MONEY INPUT	NOTES	DISTRIBUTOR
Hanimex	BC820	35.75	160x90x33	B/M			%			✓		8	✓				9
Emihus	Gemini 1	36.75	121x70x29	B/R/M		✓	%		✓			8	✓	2/4			20
Adler	EC60	36.85	158x100x42	B/M								6 (12)	✓				8
Hanimex	BCM817	37.50	138x129x81	B/M				✓	✓	✓		8	✓				9
Decimo	Double Six	38.44	135x85x25	B		✓			✓	✓	✓	6 (12)	✓				21
Colex	CO12X	38.50	127x76x25	B/(R)/M	5.50	✓			✓			6 (12)	✓				18
Minuteman	2SR	39.95	152x76x38	R	Inc		√, x^2, $\frac{1}{x}$, %	✓	✓			8	✓	✓			6
Kovac	LE-802P	41.16	135x68x28	B/R/M			%		✓	✓		8	✓				2
Adler	80S	41.25	120x73x20	B			√		✓	✓		8	✓				8
Geller	Citizen 120R	41.80	133x83x25	R/M					✓	✓		6 (12)	✓				25
Sinclair	Executive	42.90	140x67x10	B					✓	✓	✓	8	✓				11
Plustronic	LE-806D	43.74	135x68x28	B/R/M					✓	✓	✓	8	✓				2
Hanimex	BCM821	44.00	145x100x29	B/M				✓		✓		8	✓				9
Bowmar	MX55	47.49	140x76x29	B/R/M		✓	%		✓	✓	✓		✓			F	4
Royal	Digital 5T	48.40	150x89x36	B/R/M	Inc	✓	%		✓	✓	✓	8	✓			F	3
Minuteman	MC	48.95	102x76x25	R/M	Inc	✓	metric %	✓	✓			8	✓				6
Decimo	Slimline	49.22	160x67x14	B			%	✓		✓		8	✓				21
Anita	811	49.44	120x70x24	B/R/M		✓	%	✓	✓	✓		8	✓	2		F	10
Elektron	Mk I	49.50	146x89x38	B/R/M	Inc	✓	%			✓		8	✓	4	✓		23
Hanimex	BCM 850	49.50	157x116x39	B/M				✓		✓		8	✓			F	9
Kingspoint	Micro Universal	49.95	152x86x35	B/R/M		✓			✓	✓		8	✓	2/4/6			13
Adler	81S	50.60	120x73x20	B			√ %	✓	✓	✓		8	✓				8
Colex	811A	51.70	140x92x28	B/M	5.50	✓	%	✓	✓	✓		8	✓			F	18
Sinclair	Executive Memory	53.90	140x57x10	B				✓	✓	✓	✓	8	✓				11
Monroe	30	53.90	152x86x51	B/R/M		✓	%		✓	✓		8	✓		✓	.2" Planer Display	14
Sinclair	Scientific	53.90	114x51x19	B			Scientific					5+2					11
Decimo	Verax 874	53.90	130x79x25	B			%					8	✓				21
Casio	Memory 8	54.45	144x116x32	B/M	Inc			✓	✓	✓		8	✓			F	23
Royal	Digital 5M	54.94	150x89x36	B/R/M	Inc	✓	%	✓	✓			8	✓			F	3
Casio	Root 8	57.78	178x86x38	B/M	Inc		√			✓		8	✓				23

Kingspoint Micro Universal.

Bowmar MX55.

Hanimex BCM817.

Anita 810.

Royal Digital 5M.

Electron Mk 1.

Hanimex BC80.

ETI CALCULATOR DIRECTORY

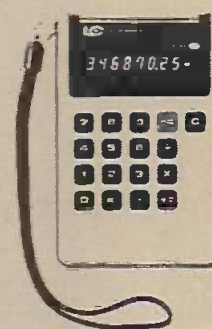
Hewlett-Packard HP45 Scientific Calculator.

Plustronic SM 838.

Key to table: A tick denotes the facility is available. Under Power Supply B=Battery, R=Rechargeable batteries, M=Mains P.S.U. Under notes F=Full flow arithmetic function (conventional entry). Under distributor, the numbers refer to the listings on page 41 which tell you where to obtain further information. A number of companies are currently changing their ranges and details are therefore not given.

MAKE	MODEL	PRICE INC.VAT	APPROX. SIZE IN MM.	POWER SUPPLY	MAINS PSU PRICE INC. VAT	CASE INCLUDED	SPECIAL FUNCTION KEYS	MEMORY	CLEAR ENTRY KEY	CONSTANT ÷ ×	CONSTANT − +	DIGITS DISPLAYED	DECIMAL POINT FLOATING	FIXED	MONEY INPUT	NOTES	DISTRIBUTOR
Prinztronic	SC2001M	59.00		B/M	3.95		Scientific	✓	✓	✓		8	✓				7
Kingspoint	Micro Executive	59.95	152x86x35	B/R/M	Inc	✓	%		✓	✓		8	✓	2/4/6			13
Bowmar	MX80	60.00	140x76x29	R/M		✓	%		✓	✓	✓	10	✓				4
Sharp	805	64.90	120x76x19	B		✓			✓	✓		8				Liquid crystal display	15
Toshiba	BC 0808B	64.90	149x97x34	B/M	7.70	✓			✓	✓		8	✓				1
Bowmar	MX75	64.99	140x76x29	R/M			%	✓	✓	✓	✓	8	✓			F	4
Advance	82R	68.75	157x83x39	B/M	Inc		% ✓	2	✓	✓	✓	8 (16)	✓	0-6		F	5
Gregory	M801	64.94	145x90x36	B/R/M				✓	✓	✓		8	✓			F	2
Kingspoint	Micro Memory	69.95	152x86x35	B/R/M	Inc	✓	%	✓				8	✓	2/4	✓		13
Canon	LE-81M	71.50	138x78x38	B/R/M			% ✓	✓	✓	✓		8	✓			F	22
Canon	LE-100	71.50	138x78x38	B/R/M					✓	✓		10	✓			F	22
Plustronic	SM838M	72.95	150x90x25	R/M				✓	✓	✓		8	✓				2
Casio	fx-10	76.45	150x95x33	B/M	Inc		Scientific		✓	✓	✓	8	✓				23
Sanyo	ICC810	76.45	152x92x23	R/M	Inc				✓	✓		8	✓				24
Monroe	40	81.40	152x86x48	B/R/M		✓	%			✓		10	✓	0-6	✓	2" Planar display	14
Anita	201	82.50	157x86x35	B/R/M		✓	%	✓	✓	✓		8	✓	2	✓	F	10
Hitachi	181B	86.90	180x100x42	R/M	Inc	✓			✓			8	✓	0/2/4			16
Hitachi	221B	97.90	169x113x38	R/M	Inc	✓	%	✓	✓	✓		8 (12)		0-7			16
Adler	88T	97.90	120x73x20	B			Scientific	✓	✓	✓		8	✓				8
CBM	SR36	99.95	152x76x38	B/M	Inc		Scientific	✓	✓			10+2					6
Colex	ESR	107.80	154x96x33	B/R/M	5.50		Scientific	✓	✓	✓		8	✓			F	18
Toshiba	BC 0811B	108.90	175x104x42	B/R/M	Inc		%	✓		✓		8	✓	2/4			1
Anita	202SR	119.90	152x83x38	B/R/M			Scientific	✓				8					10
Bowmar	MX100	120.89	140x76x29	R/M		✓	Scientific	✓	✓	✓		8				F	4
Hewlett-Packard	HP35	126.50	147x81x33	R/M			Scientific	3				+2	special				12
Advance	88	126.50	140x80x22	R/M	Inc		✓ %	2	✓	✓	✓	8 (16)	✓	0-6		F	5
Kovac	SR-801	134.38	158x90x25	R/M			Scientific	✓	✓	✓		8	✓			F	2
Sharp	PC1801	163.90	152x89x38	B/R/M		✓	Scientific	✓	✓	✓	✓	8	✓				15
Hewlett-Packard	HP45	194.70	147x81x33	R/M			Scientific & Metric	9	✓			8+2	special				12
Hewlett-Packard	HP80	224.00	148x81x35	R/M	Inc		Financial	7	special			10+2	special				12
Hewlett-Packard	HP65	489.00	163x80x35	R/M	Inc	✓	Programmable & 51 functions	9	✓	special ✓	✓	10+2	special				12

CBM SR36, Scientific Calculator.



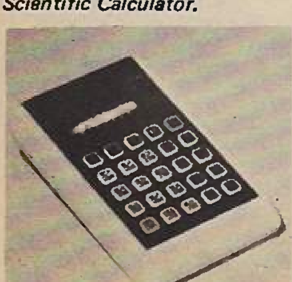
Sharp 805.

Canon Palmtronic LE-100.

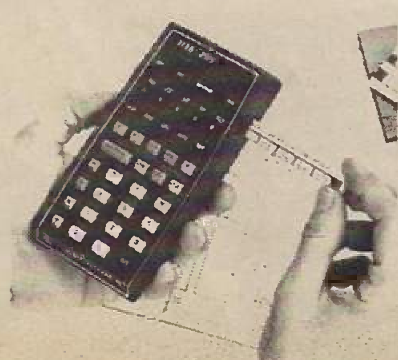
Sanyo ICC810.

Bowmar MX100 Scientific Calculator.

Sharp PC1801 Scientific Calculator.



Colex ESR Scientific Calculator.



Hewlett-Packard HP65 Programmable Calculator.

Toshiba 0811 and 0808.

Kingspoint Micro Memory.

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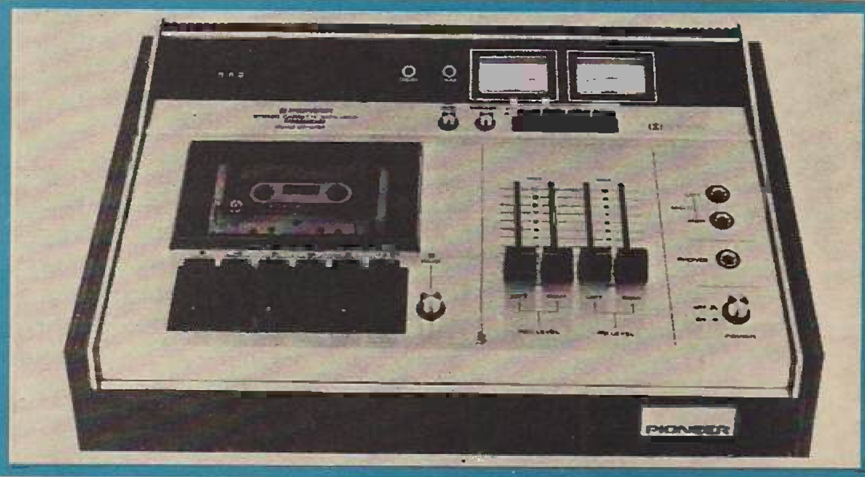
PIONEER CT5151 CASSETTE RECORDER

TWO TRENDS are clearly emerging in cassette recorder development.

The first of these is for designers to produce big and expensive machines that — sometimes successfully — emulate the performance of their reel-to-reel counterparts.

The second trend is towards smaller decks — at a much lower price — which nevertheless offer the features that the great majority of people want in a cassette machine.

Pioneer's CT-5151 reviewed here is in this second category. It is in many respects very similar to the CT-4141, reviewed by Electronics Today International in April 1973 but has a number of changes that have significantly improved performance.



MEASURED PERFORMANCE OF PIONEER CT-5151 CASSETTE RECORDER

Record to Replay Frequency Response:	0 VU	60Hz to 8kHz	±3dB	
(with BASF CrO_2 cassette)	-10 VU	50Hz to 13kHz	±3dB	
	-20 VU	50Hz to 15kHz	±3dB	
(with BASF LH-C90 cassette)	0 VU	40Hz to 4.5kHz	±3dB	
	-10 VU	50Hz to 10kHz	±3dB	
	-20 VU	50Hz to 13kHz	±3dB	
Total Harmonic Distortion: (at 1kHz)		100Hz	1kHz	6.3k
	0 VU	2.2%	0.9%	0.6%
	-10 VU	0.45%	0.4%	0.1%
Intermodulation Distortion: (at 1kHz and 960Hz)	0 VU	.085%		
	-10 VU	.08%		
Signal-to-Noise Ratio at 0 VU re 1kHz: (using CrO_2)		Linear	dB(A) weighted	
	with Dolby	-47dB	-57dB(A)	
	without Dolby	-46dB	-51dB(A)	
Erase Ratio: (1kHz signal recorded at 0 VU)	-69dB			
Cross Talk at 0 VU:	1kHz	40dB		
Wow and Flutter:	start of cassette	.08% weighted		
	middle of cassette	.055% weighted		
Line Input Sensitivity for:	0 VU	40mV		
Line Output Sensitivity for:	0 VU	0.45V		
Microphone Input Sensitivity for 0 VU		0.5mV		
Price:	£158.83 plus VAT.			

MECHANICAL CONSTRUCTION

The deck is divided into three main areas. At the back there is a sloping raised fascia of black plastic. This has a satin brushed aluminium inset — fortunately finger mark resistant. This inset panel contains, from left to right, a three digit tape counter plus reset, a tape run bezel in the form of a circular rotating light, yellow during play, and illuminated with red during record, and two small bezels which respectively indicate Dolby selection and tape over-recording. To the right of these bezels are two fairly small V-U meters.

Immediately below the V-U meters are a row of push buttons of which the one on the extreme left is a skip button. This operates electronically, disconnecting the regulated motor drive to increase play speed. The skip button is only effective in the play mode and allows the tape to run at twice the normal speed with the playback head engaged. This facility makes it possible to find a passage in the middle of a tape without the inconvenience of having to stop and revert between play and fast rewind to find the exact point on the tape that you are looking for. The facility could also be quite handy for dictation purposes.

Next to the skip control is a memory on-off switch which, on rewind, returns the tape to the 999 position indicated by the three digit counter. To the right of the memory switch are four black push buttons for Dolby noise reduction on-off, separate bias and equaliser selectors for normal or chromium dioxide tape, and at the extreme end a limiter on-off switch whose function it is to prevent overmodulation of the recorded signal.

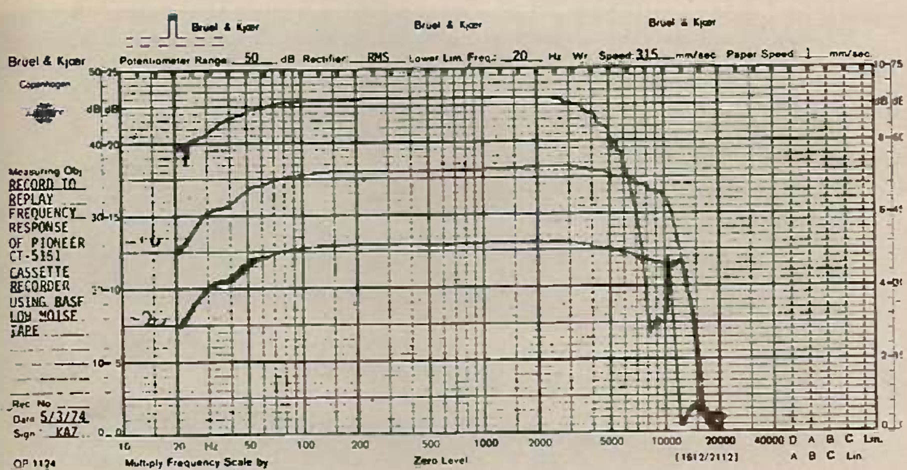
The largest section of the recorder deck lies in front of these controls, and consists of two sections. To the left, is a large cassette well with clear plastic cover. This is one of the best that we have encountered, in that it facilitates instantaneous and positive identification of the cassette.

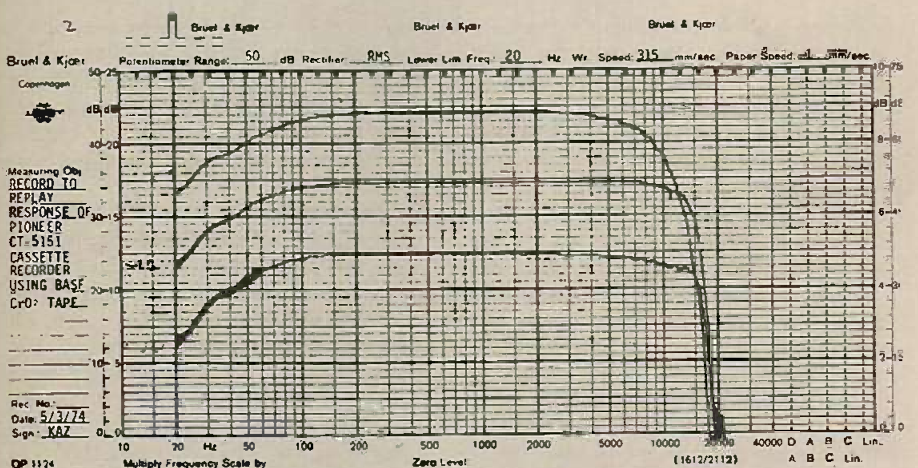
The pause button, unlike most others, is not a lever switch but a polished aluminium button. This facilitates identification and, in keeping with the latest trends, offers

SUMMARY: The CT-5151 is a most worthy successor to the CT-4141. It has performance comparable with a number of much more expensive machines.

It is a remarkable indication of the almost breathtaking speed of cassette recorder development, that this moderately priced machine has an overall performance that equals most *good* reel-to-reel machines.

And that is a statement we could not have made of *any* cassette machines until a few months ago.





The drop out shown on the top graph (OVU) was due to a characteristic of the test tape used — not the recorder.

two levels of operation — pause at the intermediate level, and a lock-pause mode when fully depressed.

Slider controls are provided for record level and playback level.

Two standard tip and ring sockets are provided for high impedance microphones, together with a socket for eight-ohm headphones.

Phono-type coaxial type sockets are provided for line input and line output, and one DIN socket for record playback.

The case of the unit is a composite of veneered wood and plastic.

USING THE MACHINE

Operation of this unit is simple and straightforward. The designers have overcome many of the pitfalls of previous cassette decks through the use of a number of simple design features. The first of these is that the drive system uses a dc motor. This overcomes the need for interchangeable pulleys to cater for 50Hz or 60Hz line frequency operation. The second is an improvement in heads and their configuration in order to extend the frequency response beyond that of the previous CT-4141 deck. Now, the performance is so good, that, with normal gamma ferric oxide cassettes, performance is equal to that previously achieved with chromium dioxide tapes. With chromium dioxide tapes performance is almost comparable with reel to reel machines.

We tried a number of cassettes of various brands in the machine and found that, provided the controls are set as recommended in the excellent 16 page handbook, the frequency response is more than acceptable for most discerning users.

Unlike the CT-4141 where we found it necessary to optimise the performance for various tapes, the CT 5151's frequency response was quite good enough (on most brands of tape) not to require this form of optimisation.

In keeping with the CT-4141, Pioneer have again provided a limiter switch with a relatively sharp transfer characteristic which clips the signal quite effectively, at +2.5 dB. When this limiter circuit is not used the peak overload light comes on, at +3 dB, to indicate overmodulation. The use of the limiter, as well as reducing overmodulation, significantly reduces second and third order harmonic distortion — the most unpleasant feature of overmodulation (or excessive recording levels).

It is interesting to note that the overall shape of the frequency response curve obtained with the CT-5151 is very similar in the low frequency region to that provided by the CT-4141 previously tested, but the mid-frequency linearity and high frequency response particularly with the gamma ferric oxide tapes, are substantially improved.

The performance achieved with chromium dioxide is remarkably flat, and a credit to the machine. This improvement is a result of the record bias, as well as the record equalisation, now being switchable for chromium dioxide and gamma ferric oxide tapes. The previous lack of this facility was our main criticism of the CT-4141. Its rectification is the single most important improvement in the CT-5151.

Wow and flutter was found to be 0.08% (weighted) at the beginning of the cassette and 0.055% in the middle. This performance is exemplary.

In most other respects the performance of the new machine is very similar to that of the CT-4141 — our measured results are tabulated in the performance chart. ●

eti product test

KARDON 330A TUNER AMPLIFIER

THE VERY FIRST IMPRESSION that the Harman/Kardon 330A made when it was unpacked for testing was that the designer has succeeded in giving it looks which balanced nicely between the quietly subdued and 'Star Trek' modern. As the table of performance figures shows, the manufacturers have not omitted to give it performance to match its good looks. Too often in reviewing so called Hi-Fi equipment one meets situations where good looks are used to cover up rather poor performance and it was a pleasure to find a piece of gear where this ruse had not been used.

The output power of the H/K 330A at 22W per channel is just about the minimum that can be used to drive the modern low efficiency speakers to obtain a satisfying sound in medium to large rooms. In this respect, the 330A is the 'baby' of the Harman/Kardon range but nevertheless it seems to share with its larger kin a pedigree that shows itself in a good clean sound and ease of use.

In common with many recent designs, the Harman/Kardon 330A is equipped with a filter that is automatically adjusted with the volume control to compensate for the varying sensitivity of the human ear to bass notes reproduced at different levels; as the volume control is reduced a degree of bass boost is introduced. Like many people who spend a great deal of their time listening to Hi-Fi I have some reservations about this system which, though it sounds good in theory, the practical results seem, to my ears at least, to leave something to be desired. Fortunately the "Contour" control (as it is known) can be switched out of circuit.

Another and much more useful facility with which the H/K 330A is equipped is two sets of loudspeaker terminals, separately switched to the output of the amplifier by a couple of front panel switches. This enables two separate stereo setups to be powered from the same main amplifier and could be used to provide correct stereo coverage in both a lounge and 'say' an adjacent dining room.

The third and final unusual facility that this amplifier can boast of is a couple of links on the back between

the preamplifier stages and the main power amplifier which can be used to insert a quadraphonic decoder of the matrix type (and you have the other two channels worth of amplifier and loudspeakers.)

All these features add up to a very flexible unit which seems to be designed to meet almost any situation.

The bandwidth of the amplifier section was very wide and it was not possible to measure the bandwidth to the point where the rated distortion could just be maintained at halfpower (the half-power bandwidth) because the frequency range of the notch filter on the THD distortion analyser was not wide enough. At the bass end, the frequency range was extended down to 7Hz at only 1dB down on the output at 1kHz which accounts for the very good damping factor and the consequent good control of a loudspeakers bass resonance.

One area in which this amplifier did not acquit itself well was in the way in which it handled a high frequency square wave when working into a capacitive load designed to simulate an electrostatic loudspeaker; the addition of 2µF in parallel with the 8Ω load caused a loss of stability in the amplifier and the resultant output was a most impressive set of oscillations (shown in the photographs). In defence of the amplifier it must be said that the input squarewave had a rise-time of better than 200nS but, even allowing for this in an amplifier of this quality one does not expect to find a deficiency of this type, especially as the manufacturer's "blurb" uses the phrase *"unconditionally stable with all loads"*.

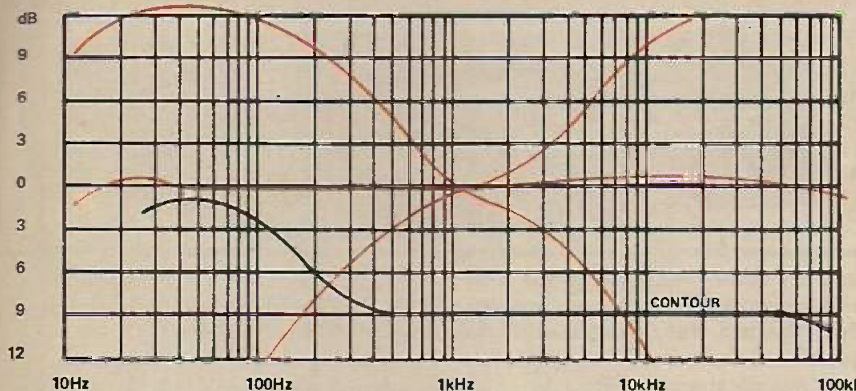
The accuracy with which the amplifier equalised an RIAA signal fed into the amplifier was as accurate as any I have met and in fact to obtain a really accurate deviation curve, resort has to be made to a preemphasis network that had very recently been calibrated to 0.1dB standard. Using this standard the network in the amplifier equalisation circuit was found to be within 1dB from 20Hz right up to 100kHz which is remarkably good.

Distortion and sensitivity of the inputs were all within the manufacturers specification though it must be said that trying to squeeze even another 0.5W beyond 22W (both channels driven) or 22.5W (with a single channel driven) resulted in distortion figures that were worse than those obtained at rated output by a large margin and in one case with an overload of only 1W distortion of 1% was measured.

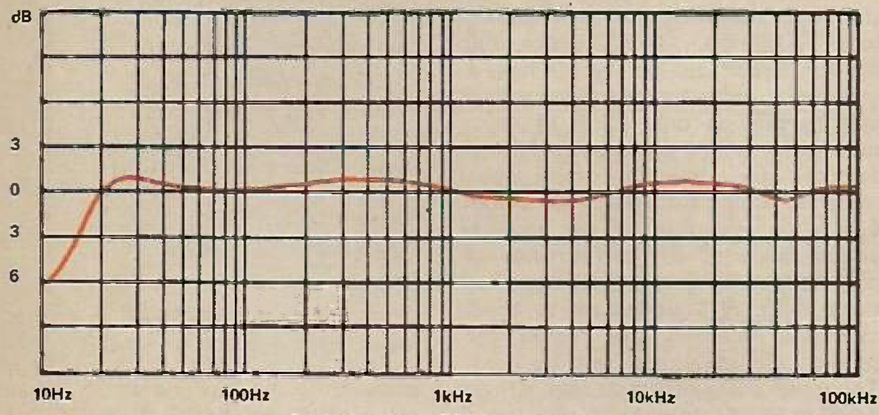
The distortion measured at rated output was mostly low order harmonics with second and third order harmonics making up most of that.

The signal-to-noise ratio quoted by the manufacturers was not met on the test sample but the figures that were obtained still do the H/K 330A credit

SUMMARY:
A good middle-of-the-road tuner amplifier having few vices and a number of virtues.



Frequency response with controls flat and at maximum settings. The response of the 'contour' control is shown in black.



Deviation from RIAA response.

MEASURED PERFORMANCE OF HARMAN KARDON 330A

AMPLIFIER SECTION

Power Output
22W into 8 ohms, both channels driven
18W into 4 ohms, both channels driven
15W into 16 ohms, both channels driven
Frequency Response (±1dB)
7Hz—100kHz
Channel Separation at 1kHz: 60dB
Hum and Noise with respect to Rated Output
Pickup: —56dB
Others: —75dB
Input Sensitivities for Rated Output
Mag. P.U. 3mV
Ceramic P.U. 160mV
Aux. 160mV

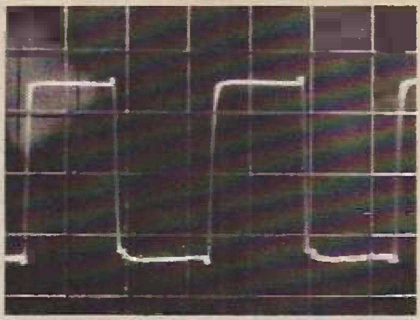
Total Harmonic Distortion	40Hz	1kHz	10kHz
Rated Output	0.5%	0.15%	0.2%
½ Rated Output	0.11%	0.08%	0.12%
1Watt	0.2%	0.08%	0.12%

Tone Controls: See Graph
Damping Factor for 8 ohms: 80 at 40Hz
Deviation from RIAA Response: ±1dB

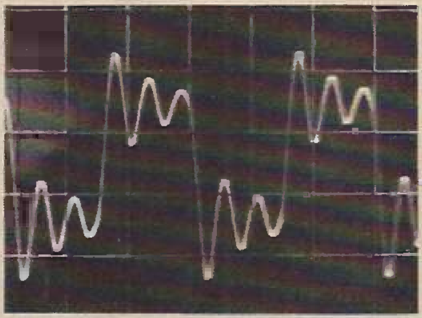
TUNER SECTION

Sensitivity:	3.2μV	Harmonic Distortion:	0.5%
Signal/Noise Ratio:	58dB	Channel Separation:	36dB
AM Rejection:	60dB	Capture Ratio:	3dB
Pilot Tone Rejection:	58dB	Image Rejection:	53dB

RECOMMENDED RETAIL PRICE (inc. VAT): £137.50.



Square-wave response: 10kHz into 8 ohms.



Severe ringing at 10kHz into 8 ohms plus 2 μF to simulate an electrostatic speaker.

as does the stereo separation of the amplifier at 60dB (with one channel running at rated output and the other undriven).

In the tuner section of this equipment, virtually all the performance figures show that this is a receiver of quality; the listening tests confirm this. Stations were received at good strength and what might be termed entertainment quality from a wide sweep around including some over 150 miles away in France. As can be expected in what is essentially an American unit, the input for the FM aerial is of the 300Ω balanced variety and no provision is made for the use of the co-axial type of cable common in this country.

In conclusion, this is a fine unit but wanting in one or two small details and at £137·50 not bad value for money. It must be said however that it does tend to fall between the two schools of cheapness and quality, being neither very cheap and yet not quite having that last word in performance. A good middle of the road tuner-amplifier having few vices and a number of assets.

eti product test

SINCLAIR 4000 TUNER

THE IMPRESSION CREATED by the Sinclair 4000 Tuner is of a well constructed unit. The case is made of extruded aluminium sections spot-welded together. At first sight this seems to be rather an expensive way to build the case for what is a very reasonably priced FM tuner but it did provide good shielding for the circuitry and no doubt contributed to the good immunity from interference at IF frequencies.

The tuning scale is unusual in that instead of having a pointer, a moving band of colour is used, similar to some car speedometers. The tuning scale is visually attractive but with the engraving of the scale every 200kHz, the result was rather difficult to read.

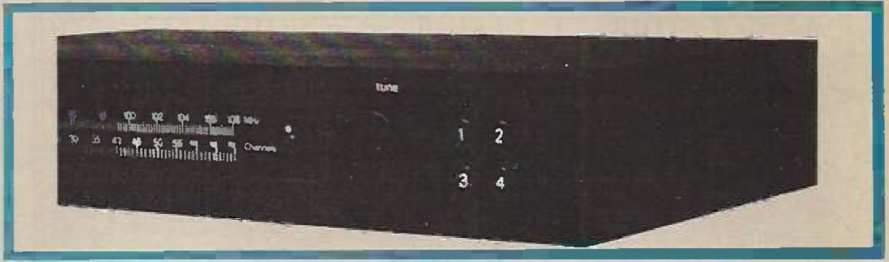
AFC., Squelch, Mono/Stereo manual over-ride facilities are all catered for by a group of push buttons on the front panel. An unusual facility provided is one to work with remote tuning unit, made possible by the use of a varicap tuning unit. Connection is via a DIN socket at the rear of the tuner. No remote tuning head is provided though the construction of one should present no problems as the only requirement is for a 1MΩ linear pot connected by a 3-core cable. Suppression of noise and spikes picked up in the cable is provided by a small capacitor permanently wired to the back of the tuner.

Aerial inputs are provided for both 75 ohm coax connectors and for 240 ohm twin feeders. The mis-match when using 300 ohm feeder will be insignificant.

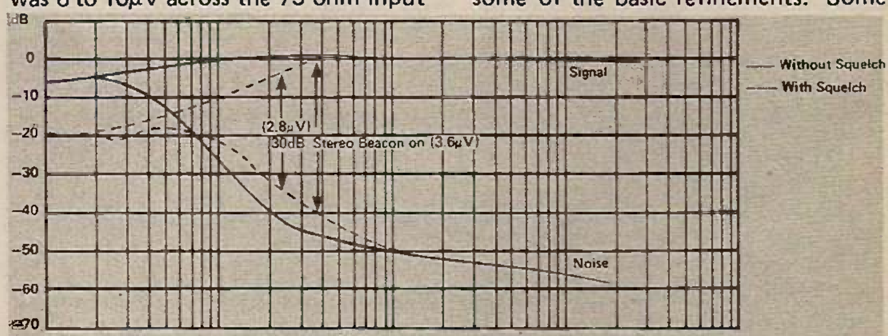
The output is also via a standard DIN connector, though no connector lead is provided and one must be either purchased separately or made up.

As can be seen from the test results, virtually all the manufacturers specified parameters were met and some were exceeded by a fair margin. While testing the tuner for the "useable sensitivity" parameter (IHF) and plotting the sensitivity against output signal graph, several anomolies were encountered.

With the squelch circuit switch out of operation, a fairly normal looking output audio and noise versa RF signal input graph was obtained but one which suggested that the manufacturers were being extremely conservative with the sensitivity. However, when the test was repeated with the squelch circuit switched *in*, the dotted curve was obtained.



Moreover this curve confirms the sensitivity that the makers claim for the 30dB signal-to-noise ratio condition. Also from these graphs, the squelch circuit can be seen to have a progressive rather than a sudden action and to provide only 12dB of noise muting (at 0.2μV signal potential difference). Over the range of RF input signal strengths from 10μV to below 1μV, the operation of the squelch circuit degraded the performance of the tuner with respect to signal-to-noise ratio by anything up to 15dB suggesting that in this region the squelch circuit should not be used. The onset point of the squelch circuit was 8 to 10μV across the 75 ohm input which tied up with the 10μV quoted by the manufacturers.



The IHF "useable sensitivity" shown in the test result table was measured with the squelch circuit in operation at 2.8μV confirms the manufacturers quoted performance specification. Without squelch, 30dB signal-to-noise ratio was reached at an input signal of only 1.2μV which is remarkably good when the cost of this tuner is considered.

In general the unit is well made and pleasant to use but one which lacked some of the basic refinements. Some means of ascertaining the correct tuning point (such as a tuning signal strength meter,) would have overcome one defect. The AFC pulled weak stations slightly off the tuning point for minimum distortion and tuning by ear was rather difficult without the use of AFC.

However the Sincalir System 4000 Tuner represents fair value for money though a pound or two more for a tuning meter would make it excellent value. ●

MEASURED PERFORMANCE OF SINCLAIR 4000 TUNER

Sensitivity:	2.8μV across 75Ω at 400Hz, 75kHz deviation; squelch on.
Signal-to-Noise Ratio:	65dB weighed to CCIR curve A.
AM Rejection:	45dB
Pilot Tone Rejection:	36dB
Harmonic Distortion:	0.15% at 25kHz, deviation 1kHz.
Channel Separation:	36dB at 400Hz (34dB at 1kHz)
Capture Ratio:	2.0dB
Image Rejection:	60dB
Output:	150mV
Price:	£43.95 including VAT.

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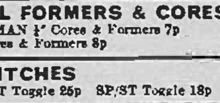

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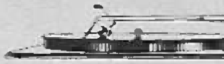

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DIGITAL CLOCK

THE ARRIVAL on the domestic market of the MOS/LSI chip has brought the electronic clock well within the reach and ability of the home constructor. No longer is it necessary to employ two dozen or more digital chips to achieve the counting circuitry; seven segment LED or fluourescent display further ease the problem by eliminating the need for 125V drives to Nixie tubes (or similar discharge displays).

The range of on chip facilities available is increasing with every new chip on the market. Basically, however, the facilities include 50/60Hz input (all current chips use the mains frequency as their basic counting input), 12 or 24 hour display option (usually with leading zero suppression for 12 hour mode), fast and slow time advance controls for initial display setting and time hold to await an accurate time indication (such as the Greenwich Time Signal).

Other options found include alarm circuitry used to trigger a buzzer or switch on an external radio, 6 digit counting, snooze alarm (i.e. turn off alarm buzzer for a further 10 minutes sleep) and mains failure indication.

A word of warning - all of the chips used are delicate and some can be damaged by finger-borne static electricity. The pins should never be touched and a PCB socket is advisable even if the kit does not include one. If a socket is not used an ultra-miniature iron bit should be used with very thin solder. Finally make sure the soldering iron used is well earthed.

BYWOOD

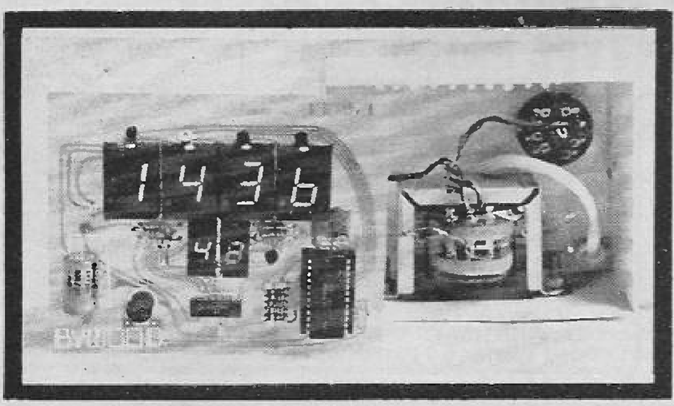
Readers of ETI are familiar with the name of Bywood who specialise in the supply of clock chips and associated circuitry.

The unit supplied for review, the 5314 Jumbo is an evaluation kit designed to provide detailed knowledge about the working of the chip and displays.

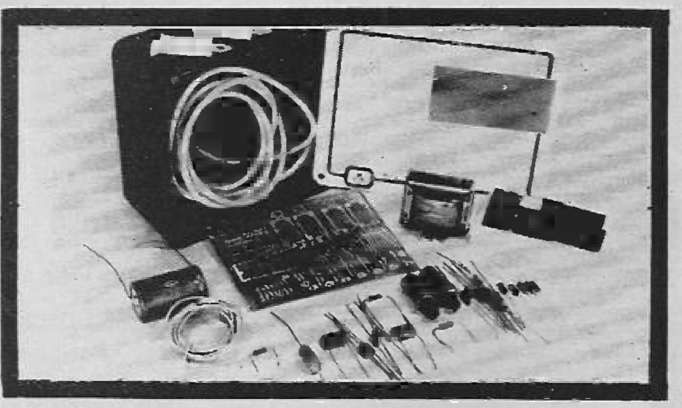
The kit includes the MM5314 clock chip and second IC (RCA CA 3081) acting as a display driver for the seven segment displays. Also included are four 0.6" LED displays (DL747) for hours and minutes and two 0.3" LED displays (DL707) for seconds indication.

A nicely produced and neatly annotated printed circuit board completes the Bywood contribution. The user is required to furnish 16 resistors, a couple of diodes, 3 capacitors and 6 LED switching transistors. BC213, 2N4403, or any similar transistor that happens to be available can be used. The kit supplied with manufacturers background information and a 4 page constructional guide. Clear details are given for component assembly with particular attention paid to ensuring that the displays are aligned and level on the PCB. A list of modifications (such as 12/24 hour select, display inhibit) is provided as expected with an evaluation kit and a fault tracing table is included.

Not only does the Bywood kit provide a ready means of evaluating clock circuitry, but is also forms the basis for a usable clock. Constructors requiring a case ready cut out for the displays etc. are asked to telephone Bywood to enquire as to current availability.



The Bywood 5314 Jumbo Evaluation Kit.



PEA's Kit O.

PEA

The "Kit O" electronic clock from PEA (Postlewaite Electronic Associates) provides a 4 digit time display only although on chip alarm logic is available. Push buttons are provided for hours and minutes advance and instructions are given as to the addition of a time hold switch.

The display is made up with 7-segment filament indicators which give a clear white easily read illumination and have a continuous usage life of twenty eight years. The instructions suggest trying a filter over the displays and for close reading a green or red shading certainly gives a display more pleasing to the eye.

The finished unit is mounted in a black ABS case (5" x 4" x 2") with a white screened perspex front which contains a PEA logo and a clear section behind which displays are fitted. When the reviewer's unit has completed, some transistor cases were visible through this clear section and some wiring could be discerned behind the white perspex. This was overcome by using some black non-conducting paint.

Once the see-through is cleared, the PEA Kit O is a neat and compact unit that has been admired by all who have seen it in use.

Assembly is straightforward if a little fiddly because of the small nature of the PCB and some components. The two page instruction sheet is brief but clear and includes a wiring diagram and circuit diagram. The first job is to fix the miniature transformer, mains lead, two switches and three PCB stand-off pillars to the base of the case.

Attaching the components to the PCB requires a miniature iron, thin solder (supplied with the kit) and a good eye since despite its small size

KITS

Continuing his series of electronic kit reviews, Jeff Maynard looks at some Digital Clocks.

(about 3½" x 2½") it holds the IC, four 7-segment displays, 11 transistors, 34 diodes and 29 passive components!

Fortunately the component side of the board is clearly screen printed with component locations and orientation where applicable. The roller tinned PCB tracking takes solder well but care is needed to ensure that no tracks are bridged. The IC is soldered directly to the board and as well as requiring the usual care in handling, necessitates an earthed iron.

Coming complete with mains cable, grommets, interconnecting wire and solder this kit is a very interesting one evening project.

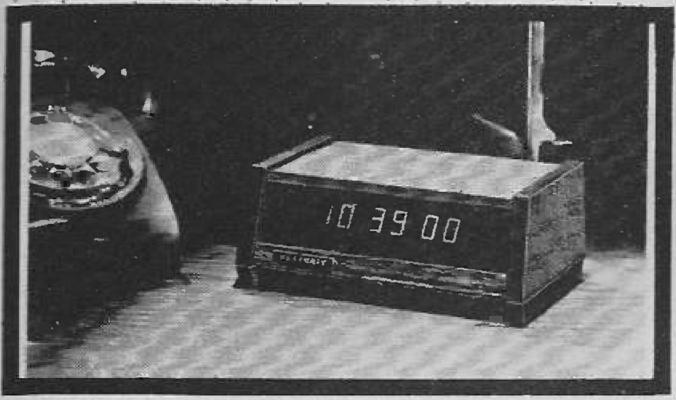
TRAMPUS

The "Real Time Digital Readout Clock" from Trampus Electronics is something of an electronic jigsaw in terms of instruction deciphering, electronic construction and mechanical assembly.

The kit is supplied with a white plastic case but this is not drilled or cut for any fittings. It is not too difficult to drill for the time-set switches and mains cable but producing a neat rectangular cut out for the LED display is not easy. The LEDs present the first of the wiring problems since the user has to produce his own veroboard layout and then decide how to connect it with the PCB. The board itself is double sided but does not have through-hole plating. This means that components have to be soldered on both sides of the board which in turn means they require standing off from the board surface. The soldering of the IC on both sides is so delicate that the instructions recommend the use of a socket for the IC and yet a socket is not included.

The instructions for construction of this clock are a mixture of information gleaned from manufacturers literature (and meant only as background material) and Trampus notes. Before constructing this kit the user would be well advised to read all the instructions carefully, delete the irrelevant comments and collate the non-contiguous references to specific points.

All kit suppliers are presently suffering from difficulties with component supply and many of the kits reviewed in this series arrive with amendment sheets. Trampus however have chosen to amend the multilith master used to print the instruction sheet and the reviewers copy had too many alterations and amendments. Trampus would be well advised to review the layout and content of their kit and its instructions.



The Heathkit Electronic Clock Kit.

DIGITAL CLOCK KITS

5314 Jumbo Kit	Bywood Electronics, 181 Ebberns Road, Hemel Hempstead, Herts. Price £25.08.
Kit O	P.E.A. Limited, 35 High Street, Welwyn, Herts. Price £25.30.
Real Time Digital Readout Clock	Trampus Electronics, P.O. Box 29, Bracknell, Berks. Price £22.00.
GC 1005	Heath (Gloucester) Limited, Bristol Road, Gloucester, GL2 6EE. Price £31.90.

ALL PRICES INCLUDE VAT.

HEATHKIT

Clear, concise and foolproof instructions coupled with easy to read diagrams are maintained in the 30 page construction manual supplied with the Heathkit Electronic Clock Kit. The kit is conventional in that it utilizes a MOS/LSI chip to provide all the necessary counting and memory circuitry. Discrete components are used for the power supply and readout display drive circuitry. (21 transistors in total). The clock is housed in a black plastic case with (optional) wood grain effect covering; as usual it looks more than good when finished.

The constructor has the option of 12 or 24 hour display when wiring up although the built in alarm is once a day only in either mode. The alarm display (push button operated) contains an AM/PM indicator. The 6 digit display is easily read even in bright sunlight and at sharp angles.

With the alarm button depressed the display is advanced using the time-set buttons and the set time remembered on-chip logic. When the actual time matches the alarm time an in built bleeper is activated - pressing the snooze alarm at this stage gives a further 7 minutes before the alarm is reactivated. Following a power supply failure the display reads all eights to avoid erroneous time readings.

The finished unit presents a good looking, functional, state-of-the-art clock. The only problem remaining for the would be constructor is actually putting it all together. Those who know Heathkit will realise that this does not really present any difficulty even for the first time builder.

A separate instruction is given for every component of the clock including individual display tube pin holders. Each instruction refers to a diagram of the circuit board currently being worked on to indicate component position. The orientation of semiconductors is shown both in the instruction manual diagram and on the circuit board itself.

All interconnecting wire required is included in the kit (together with a pack of solder) and the instructions include details of the exact length to which various pieces should be cut (helped by a scale along the bottom of each page!). Cutting exact lengths prior to installation certainly makes life easier and total construction time is about 3½ hours.

ELECTRONICS -it's easy! PART 7

Capacitance and inductance — the basic concepts

SO FAR we have concentrated on circuits which are composed of pure resistance only.

The relationship between current, voltage and resistance in such circuits follows Ohm's Law E = IR.

Ohm's Law is a linear relationship, that is, if we graph current against voltage for a particular value of resistance we obtain a straight line.

In practical circuits however we find that, when the current is varying with time, Ohm's Law does not adequately explain all the things that happen. This is because resistance is not the only basic property that an electronic circuit has, and the response of a circuit to a varying signal may be far from linear.

All electronic circuits have two further basic properties (other than resistance) which are evident only whilst current and voltage are changing. These two properties are known as INDUCTANCE and CAPACITANCE. They are of extreme importance in electronics.

Both of these phenomena enable energy to be stored in a circuit. An inductance stores energy in a magnetic field. Capacitance stores energy in an electrostatic field.

In this part of the course we will study the nature of capacitance and inductance, how components having given quantities of these properties are constructed, and additionally how all three basic components behave when subjected to transient signals.

THE TRANSIENT

The word transient describes comparatively short-lived conditions that may exist in a circuit when some form of electrical disturbance is applied — a sudden voltage change for instance.

The transient behaviour of the resistors, capacitors and inductors is fundamental to numerous electronic techniques — as we shall see.

Basically the way a transient signal is modified by a component depends on the energy storage capability of that component. Previously we have seen how a switch may be used to turn a source of power on and off causing a current to flow in the load — e.g. a bell or lamp. If however we were to examine how the current in the circuit changes with time for the bell and lamp, we would find that the current does not, in fact, change from zero to maximum instantly, but changes in the manner shown in Fig. 2a and 2b (respectively). The initial part of these

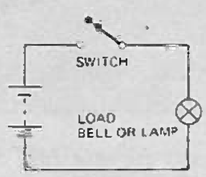
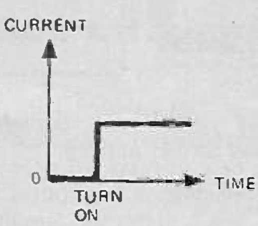


Fig. 1.



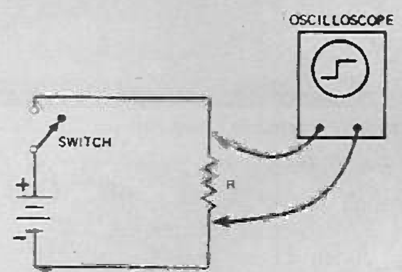


Fig. 3.

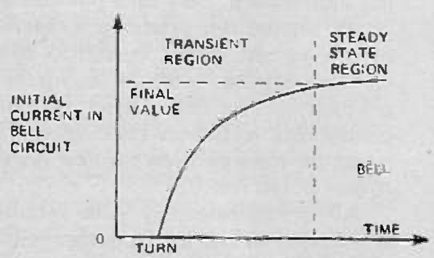


Fig. 2a.

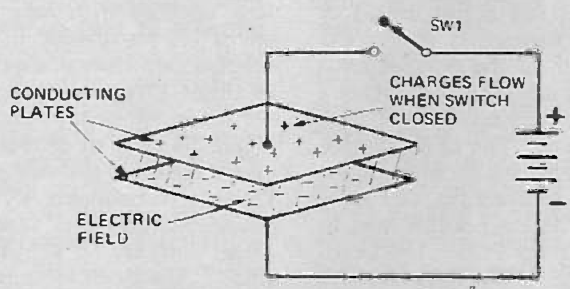


Fig. 4.

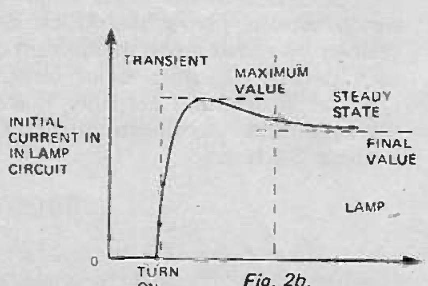


Fig. 2b.

Fig. 1. Basic circuit for switching bell or lamp etc.
Fig. 2a. Typical switch-on characteristic for a bell.
Fig. 2b. Switch-on characteristic for a lamp.
Fig. 3. A step in voltage applied to a resistor will produce a step voltage across. That is the shape is not changed in any way.
Fig. 4. The basic capacitor consists of conductive plates separated by an insulating space or material.

two curves is the transient region. Once the signal has *stabilized* to a constant value it is said to be in the steady state condition.

In the case of the bell the current rise is slowed by the electromagnetic effect of the coil (used to attract the metal armature). The coil of the bell is in fact – an inductor, and energy is stored in the electromagnetic field set up by current flow in the coil.

Current in the lamp, when first switched on, varies for a different reason. In this case the current immediately rises to a maximum value that is determined by the cold resistance of the filament. But as the lamp filament heats up, its resistance increases, causing the current to decrease to a steady-state value which is less than the initial value. Again it is the storage of energy – in heat form in this instance, that produces the initial transient response.

RESISTORS AND TRANSIENTS

We know that pure resistors cannot store electrical energy – they can only dissipate it in the form of heat. Consequently, a properly designed resistor, for use in electronic circuits, will not modify the time behaviour of an electronic signal. A square-wave applied via a switch, as mentioned above, will still remain a square wave.

This is illustrated in Fig. 3 which shows the waveform developed across a pure resistor in response to a step-change input. Such a test is called a step-response test.

Any kind of waveform when applied to a resistor (sinewave, sawtooth, pulse etc) will be handled without change of shape in the time dimension.

However although waveshape will not be affected, the amplitude will be, the output value will depend upon the voltage drops occurring in the resistive circuit and is easily calculated using Ohm's Law.

In ordinary electronic circuitry practical resistors behave like pure resistors and hence we need not worry about transient conditions.

But, as the operating frequency of a circuit is raised, to around 50 MHz or beyond, the resistor may have inductance and capacitance as well as its designed resistance value. For such work, special component design techniques must be used to minimize these undesirable (in this case) side-effects.

CAPACITANCE

Every electronic circuit will have current carrying conductors or components running next to other conductors or components. Where adjacent parts of the circuit are operating at different potentials, there will be an electric field between the two parts. This is a basic physical principle.

It takes energy to set up a field and it has been found that the amount of energy stored in an electric field for a given voltage difference is proportional to the area of the adjacent surfaces, and inversely proportional to the distance between them. That is, the capacity to store energy is inherent in the physical arrangement – the larger the conducting surfaces and the smaller the distance between them – the higher the energy storage capacity. Little wonder then that this characteristic of a circuit is known as CAPACITANCE.

In practical circuits the inherent capacitance between components and leads is very small and, unless the circuit is operating at very high frequencies, of little importance. However capacitance is useful, and we can put it to work by building components which have definite known values of capacitance.

The basic construction of such a component is illustrated in Fig. 4. There we can see that a capacitor may be constructed from electrically conductive plates separated by an insulating material. The electrical insulator, known as the DIELECTRIC may be air, oil, insulating paper, plastic film, ceramic layers or special fluids, depending on the properties required.

Assuming the capacitor in Fig. 4. has no initial charge, the voltage source causes charges to flow, the moment the supply switch is closed, creating a charge imbalance between the two plates (negative charges on one side and positive on the other). The charge imbalance will create an electric field in the dielectric between the plates and a voltage across the plates which opposes the source. Thus charges

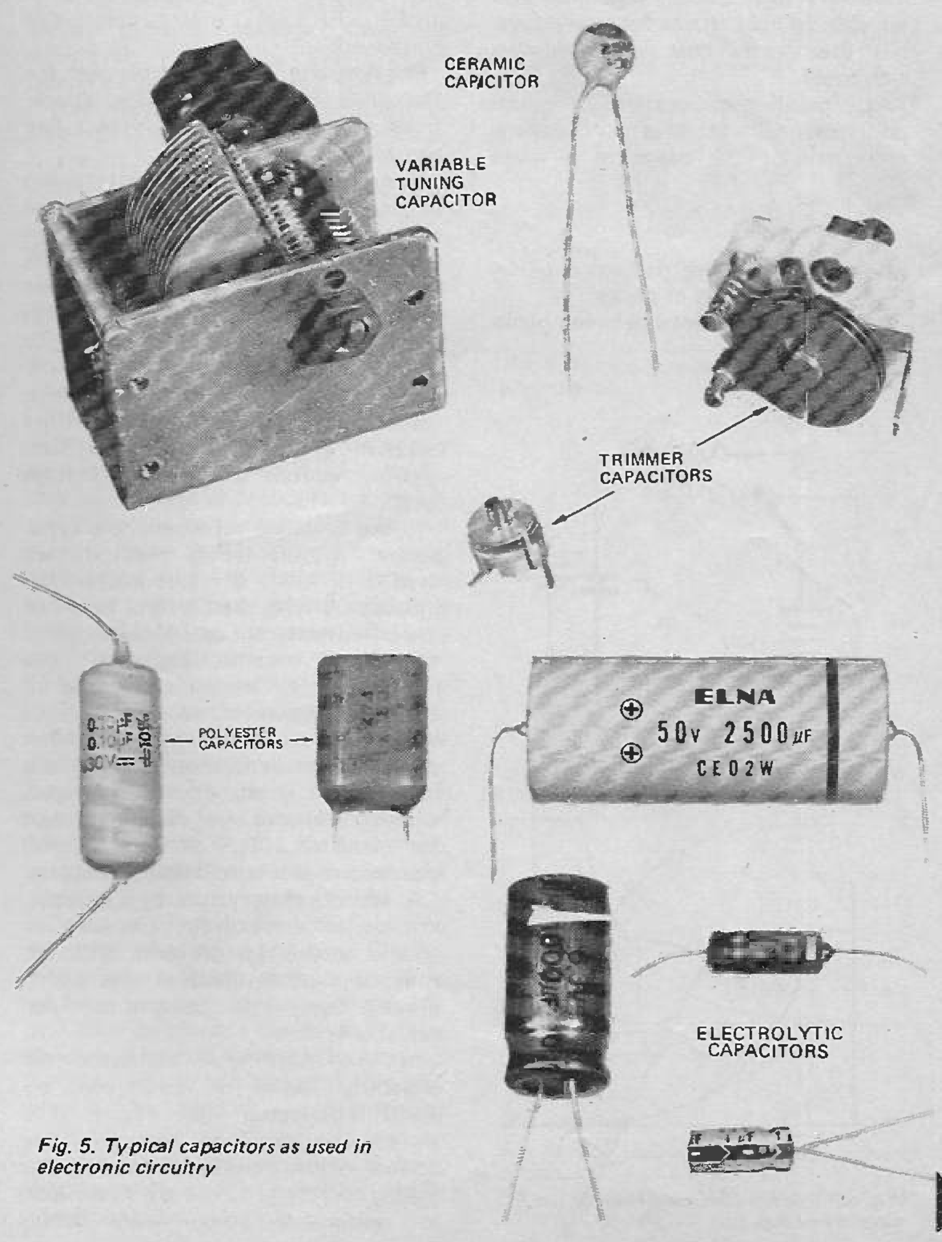


Fig. 5. Typical capacitors as used in electronic circuitry

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continue to flow until the voltage across the capacitor and that from the source are equa'

If the supply switch is opened, the charge remains, together with a voltage across the capacitor that depends on the quantity of charge stored. In this condition the capacitor is said to be charged.

Any resistance connected across the plates will provide a path for the charges to flow towards neutrality. Practical dielectric materials and mounting insulators are unable to provide an infinite insulation resistance and hence all capacitors have a finite value of resistance. The charge storage time, therefore, depends upon this resistance which is known as the LEAKAGE RESISTANCE. Quality capacitors have very high leakage resistance and are able to hold charge for many days, but their extra cost is not always warranted.

As mentioned earlier, physical principles tell us that the storage capability of the capacitor is given by:–

$$C = k\frac{A}{d}$$

where k equals dielectric constant
A equals area of plates
d equals distance between plates

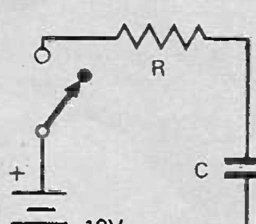


Fig. 6a. Circuit of an RC network.

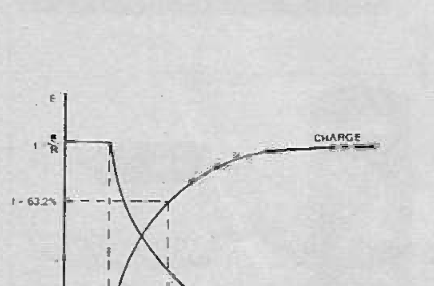


Fig. 6b. The transient behaviour of the RC network of Fig. 6a.

The dielectric constant ('k' in the equation above) is a number dependant upon the material used.

For example air is the standard dielectric having a constant of 1. Barium titanate has a dielectric constant of 1143, therefore a capacitor with barium titanate as a dielectric would have 1143 times the capacitance of an air dielectric capacitor with the same plate spacing.

The unit of capacitance is the FARAD and is the value of capacitance by which an applied voltage change of one volt per second produces a current flow of one ampere.

In practice the FARAD is a far larger value than is normally encountered. Instead the smaller sub-units microfarad ($\mu F = 10^{-6}$ F), nanofarad (nF = 10^{-9} F) and picofarad (pF = 10^{-12} F) are most commonly employed.

Physical size limitations prevent the flat plate capacitor, described above, from providing any more than a few picofarads of capacitance.

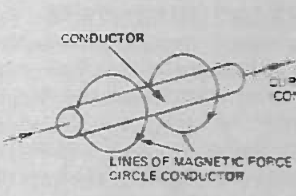
In order to make components having larger values of capacitance, different construction methods must be employed which utilize as much plate area as possible, have the smallest possible gap and use high dielectric-constant materials as insulation. However, small gaps imply low insulation resistance and large values are only obtained at the expense of increased physical size, and/or, reduced safe working voltage levels.

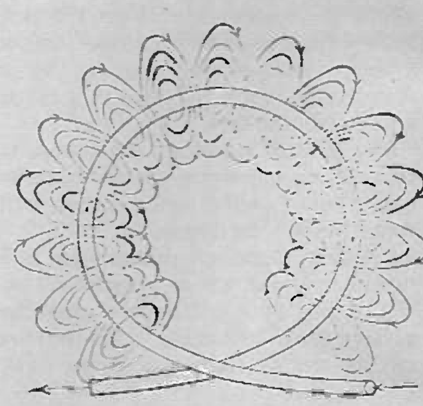
In the so called solid-dielectric types several manufacturing methods are used – rolls of aluminium foil interleaved with plastic film, layers of deposited materials etc. Knowledge of the actual construction is of little importance to an understanding of electronics however, so we will leave these aspects to the designer. What does concern us is that by using this method of construction, reasonable working voltages are obtainable, but for values of 100μF or more physical size becomes a considerable problem.

A second major class of capacitor, known as electrolytic, provides an answer to the size problem, although they have other disadvantages which prevent them from being a universal replacement.

In the electrolytic capacitor the dielectric layer is produced by electrolytic action (by means of a chemical solution or paste) on the surface of the aluminium foil. By this means very large values are obtainable in reasonable sizes. They suffer however from the fact that they are polarized (meaning that one connection lead must always remain positive with respect to the other). Electrolytic capacitors can be recognized, usually, by the leads being marked with polarity. If the polarity is reversed the capacitor will be damaged – it may even explode!

Electrolytic capacitors must not be used for ac signals unless the signal is biased with a dc level so that polarity of the capacitor is never reversed. (This is not as great a disadvantage as it may seem). Further, the insulation resistance of electrolytics is usually relatively low. However, not withstanding the above disadvantages,





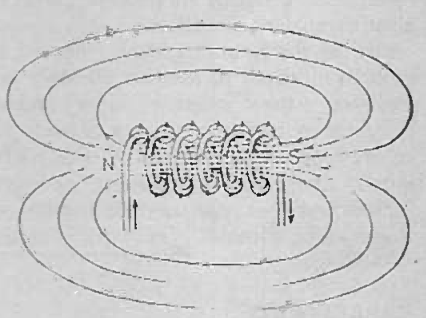


Fig. 7a. The basic inductor is merely a wire with current flowing through it.
Fig. 7b. The magnetic field about a single loop of wire carrying a current.
Fig. 7c. The magnetic field about a loosely wound coil of wire carrying a current.

electrolytics are used extensively because of their large capacitance per given volume of component.

An assortment of capacitors is shown in Fig. 5 and more illustrations may be seen in the trade catalogues mentioned in the previous article in this series.

As with resistors, capacitors are made in a wide range of values and may be fixed or variable types. In the variable types, those that have a wide capacitance range and have a shaft suitable for mounting a knob are known as *tuning* capacitors; those having a screw driver adjustment are known as *trimming* capacitors.

Fixed capacitors are sometimes colour coded and this code is given in Fig. 5. Usually however the value is marked on the capacitor together with its tolerance and working voltage e.g., 100 μF ± 10%, 50 V working.

CAPACITORS AND TRANSIENTS

We previously explained that charges will continue to flow into a capacitor until the voltage across the capacitor equals that of the source.

The important thing to realize about this is that charge flow constitutes a current flow *even though there is no direct electrical path*! Further, current flows only whilst the capacitor is charging or discharging. A little thought will show that if a changing voltage is applied to the capacitor a corresponding change in charge current will occur. Thus if dc is applied, the capacitor, after an initial charge period, will block any further dc current, but *an ac signal will pass through the capacitor*. The great usefulness of a capacitor is therefore in separating various sections of a circuit, as far as dc signals are concerned, but coupling them for ac signals.

The amplitude-time relationship for the charging (and discharging) of capacitors obeys an exponential law (stated simply, an exponential change is one which doubles, or halves, for each unit interval of time) and the shape of the charging function is always the same, (see Fig. 6), the only variation being in the scales used. The actual time taken for a capacitor to become fully charged (or discharged) depends on the size of the capacitor (i.e. amount of energy to be stored or released) and upon the amount of series resistance in the charging circuit. Fig. 6a shows a basic charging circuit.

As the charging curve obeys a well defined mathematical law we are able to characterize all charging and discharging operations by what is called the TIME CONSTANT (symbol T or τ).

The TIME CONSTANT is by definition the time taken to charge to 63.2% of the final value, or discharge to 36.8% of the final value. These values are chosen because the time constant is then simply equal to the product of the resistance and capacitance values. That is:–

$$T = CR$$

where T = time in seconds
C = capacitance in Farads
R = resistance in Ohms

For example a 1 μF capacitor, charged though a 1 kohm resistor, will reach 63.2% of its final voltage in one millisecond. Note that the actual value of the applied voltage does not alter the relative amount of charge stored in a given time.

A handy rule to remember is that the capacitor is virtually fully charged (an exponential charge never reaches the final value – it merely halves the charge remaining each additional time unit) after a time of 3T.

Similarly when a resistor is placed in parallel with a capacitor that is already charged it will discharge to 36.8% of the final value in accordance with the T = CR rule. As all capacitors have some internal leakage resistance effectively in parallel, they will all become discharged eventually.

The concept of time constant is important when capacitors are used as a means of storing voltages or for smoothing variations on a dc voltage, but more about this later.

INDUCTANCE

Previously, we have briefly mentioned that, when a current flows through a conductor, there is always an associated magnetic field around it, as shown in Fig. 7a.

We can show that the field exists by observing the movements of the needle of a compass when held near it. Again, this is a physical principle for which we have no real explanation – we merely know that it is *there* and have learnt how to make use of it. Thus, as with a capacitor, energy is stored in a field. This time, however, it is a *magnetic* field, not an electrostatic field as with capacitance.

The magnetic field around a simple loop of wire is shown in Fig. 7b. The field is represented by lines of circular form around the wire carrying the current. These lines are called lines of magnetic flux and constitute the magnetic field. The closer the lines are together – the stronger the field.

One way of reinforcing the field is to wind the wire into a coil, as in Fig. 7c. The effect is to concentrate the lines of force through the centre of the coil and thus produce a denser field. The field may be still further concentrated by winding the coil around a soft iron core and by winding several layers of wire. By such means we can produce powerful electromagnets which have many uses (such as in the relay used in an earlier experiment).

If we try to vary the current through the coil we find that the change is resisted, ie, the coil tries to maintain the current at a constant level. This is because the coil generates a voltage, called the back emf, which always opposes the supply voltage change. This effect is known as INDUCTANCE (symbol L) and is only evident when the current tries to change.

The unit of inductance is the HENRY and is defined as that value of

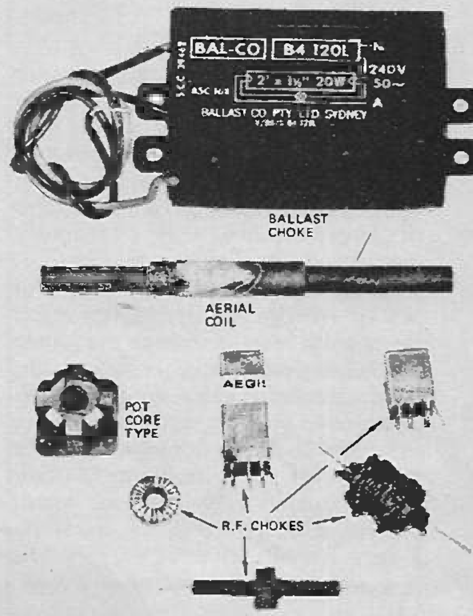
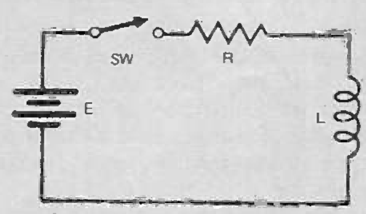


Fig. 8. Typical inductors as used in electronics.



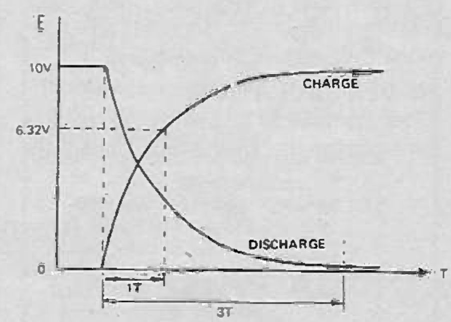


Fig. 9a. The basic resistor and series inductor circuit.
Fig. 9b. The transient characteristics of the series LR circuit.

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inductance which will produce an emf of 1 volt across it when the current is changing at 1 ampere per second.

$$\text{Thus } e = L\frac{di}{dt}$$

where e = instantaneous voltage across coil
L = inductance in Henries
$\frac{di}{dt}$ = rate of change of current in amperes/second

A single piece of conductor has only a minute amount of associated inductance. It is so small that it may be neglected in circuits operating at low frequencies. However, as with capacitance, inductance is useful, and components may be specially constructed having values of inductance from a few microhenries to tens of Henries, with millihenry and microhenry values being the most commonly used.

The inductance value depends upon the number of turns, and (if used) the iron core. It does not depend on the resistance of the wire. Unfortunately large inductance values, of small physical size, can only be made by using thousands of turns of very fine wire, and hence, the resistance is high.

Thus an inductor which is required to carry a large dc current will be bulky and heavy.

Practical inductors, therefore, come in many shapes and sizes and may range from a single piece of wire to a million-turn coil, or a many kilogram-weight unit as used in radio transmitters. Fig. 8. shows a range of units commonly encountered in low power electronics. Variable inductors are also required in some circuits and these may be produced by arranging for, a variable air gap in the iron circuit or, a small slug of ferrite (a type of ferromagnetic material) which can be screwed in or out of the coil, or by using a sliding contact to 'tap off' various parts of the coil.

INDUCTORS AND TRANSIENTS

As said earlier, an inductor will resist any attempt to change the steady-state field conditions. In other words energy being put into, or taken out of, the field experiences a retarding force. This means that the inductor is quite happy to pass a dc current but will oppose any changes in that current. Hence an inductor is useful where it is desired to pass a dc current but block any ac component. This is the reverse of the effect of a capacitor which passes ac and blocks dc.

In a similar fashion to the capacitor, we find that the inductor has a characteristic time constant, in response to a step function input, and the current versus time curve also follows an exponential law.

The time constant for an inductor-resistor circuit is given by:—

$$T = \frac{L}{R}$$

where T = time in seconds
L = inductance in Henries
R = resistance in Ohms

The circuit of an LR network is given in Fig. 9a together with the current versus time behaviour when the switch is first closed. At the instant the switch is closed the value of current is zero but the rate of change of current is very high. Thus the current increases rapidly at first, and then more slowly as it approaches the Ohm's Law value ($\frac{E}{R}$). When the current reaches a steady state value the inductive effect disappears.

Thus we see that in any circuit containing inductance or capacitance *Ohm's Law only applies during direct current (that is steady state) conditions.* Next month we will show you how the effects of inductance and capacitance on an ac signal may be calculated. We will also examine a special kind of inductor known as a transformer. ●

ELECTRONICS -in practice

Continuing the signal transmission project

THE PREVIOUS ARTICLE in this series described how to build a low-frequency mechanical form of signal generator that could be used to examine waveforms and signal transmission.

We now expand this project so that it may be used as the sending end of, firstly, an amplitude modulated (AM) and secondly a frequency modulated (FM) telemetry link. (A telemetry link is one that carries information).

AM DEMODULATION

The generator is connected to the transmission line over which signals are to be sent. The line can be of any practical length providing the resistance of the cable is kept low. Bell wire or twin lighting flex is ideal.

Using the AM control, the received signal will be as shown in Fig. 10. This signal must be processed (demodulated) to regain the original signal — which in this case was the angle of the AM potentiometer input shaft.

Demodulating an AM signal is very easy. All we need to do is just average out the pulses using a smoothing circuit in which the values of the resistor and capacitor have a time-constant chosen to smooth out the 1 Hz carrier frequency but not the lower signal frequencies. The circuit shown in Fig. 10 does just that.

The needle of a multimeter, connected as shown, will rise and fall in sympathy with rotation of the AM potentiometer shaft. If the AM control is left set you should find that a frequency change — induced with the FM control potentiometer — will not alter the output level, showing that the AM link is not affected by changes in frequency.

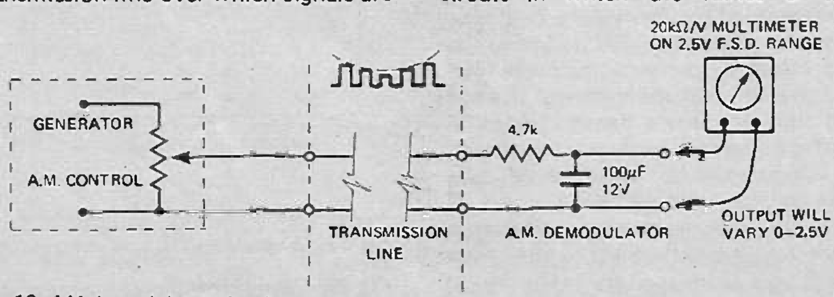


Fig. 10. AM demodulator circuit.

FM DEMODULATION

This is not as easy to achieve. The requirement is that the demodulating circuit provides energy to the output meter that is proportional to the *frequency* of the signal received, not to its *amplitude* — as was the case with AM.

It is accomplished here using several stages each having a specific purpose — see Fig. 11.

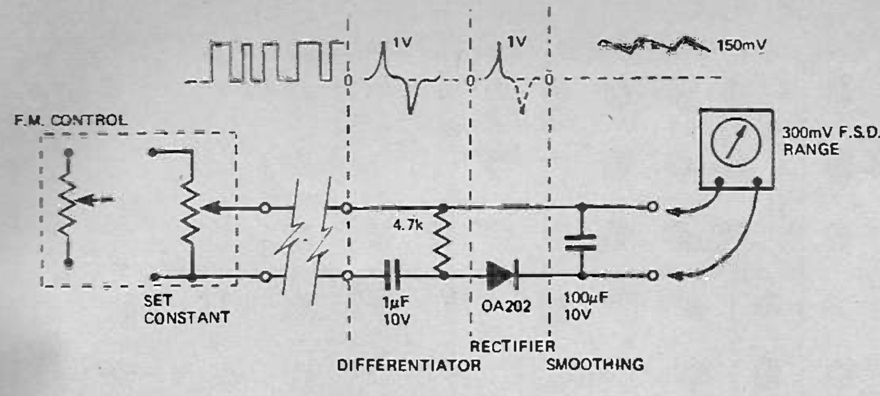


Fig. 11. FM demodulator circuit.

The first stage accepts the square waves as received and produces a pulse of constant width and height (and, therefore, constant energy) at each *transition* of the square wave.

The circuit used is called a *differentiating* circuit for it produces the *differential* of the input signal. This means that *changes* in the signal produce an output signal — but steady-state levels do not. In our circuit, the capacitor is used to let charge through when the signal is varying but not when it is steady.

The choice of time-constant decides the size of the pulses produced.

The second stage has the task of removing the negative-going pulses from the preceding differentiator which produces both positive *and* negative pulses and, unless one or the other is removed, the negative and positive going pulses will effectively cancel out — resulting in zero output.

The pulse-removing stage consists of a half-wave rectifier that lets through positive pulses only.

A more efficient circuit would be a full-wave rectifier as it would let both polarities through, giving twice the energy.

The original signal has now been converted to a train of constant size pulses that occur at a rate depending on the positions of the FM control input shaft. All that remains now is to average these pulses with our, now familiar, capacitor-resistor smoothing circuit.

This circuit is not particularly efficient and only fractional volts are produced at the output. It does, however, incorporate the basic concepts used in many circuits without needing the addition of amplifiers.

The waveforms at each position are given in Fig. 11. If you have an oscilloscope available you will be able to observe them.

This circuit will send shaft *position* information using FM techniques and the output signal is not affected for reasonable variation in AM control.

AC COUPLING

We know that capacitors will pass ac signals, but not steady dc levels. This is easily demonstrated by adding two (electrolytic) capacitors in series with one line as shown in Fig. 12. Provided the values are around those shown, the AM and FM links will work just the same. It is quite satisfactory to increase the size as this improves the coupling but a reduction in size will attenuate the signal.

MULTIPLEXING

So far we have not actually sent more than one signal along the wire at a time. If several generators were available, each operating at a different frequency, it would be quite possible to build a multi-channel link.

A simpler way to demonstrate this instead is to use a dc circuit through the wires as shown in Fig. 13. Operation of the light does not affect the AM or the FM link also working over the same two wires. ●

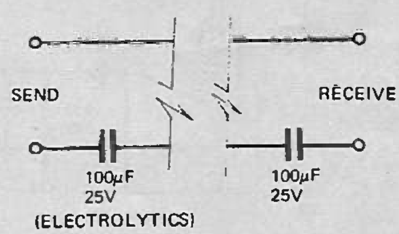


Fig. 12. The addition of capacitors does not stop the transmission of ac signals along the line.

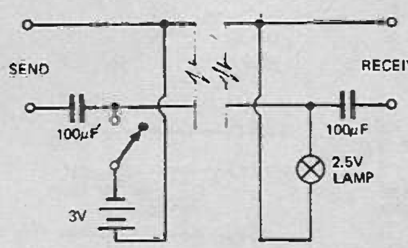
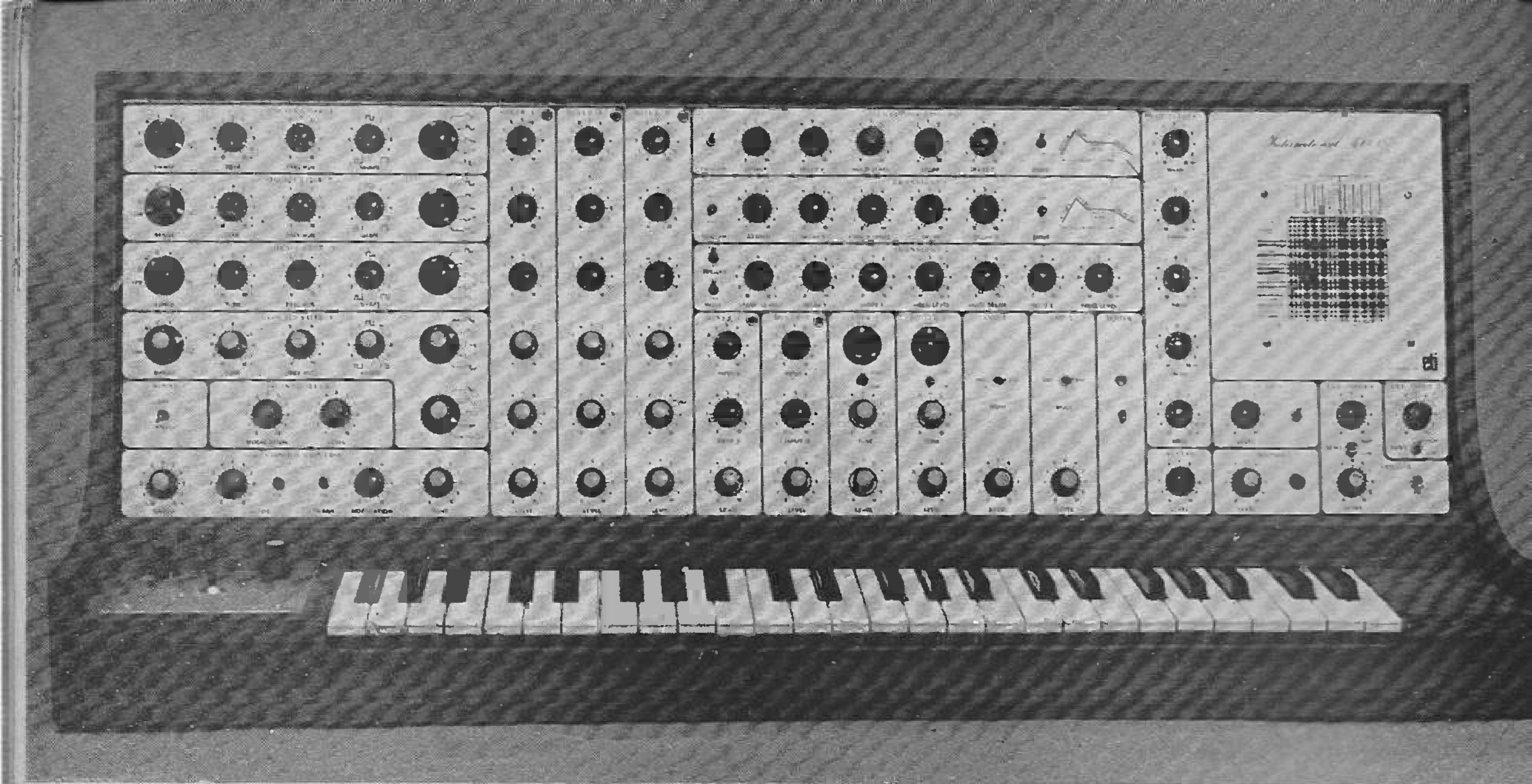


Fig. 13. A dc lamp circuit will operate on the line at the same time as a modulated signal channel thus demonstrating multiplexing.



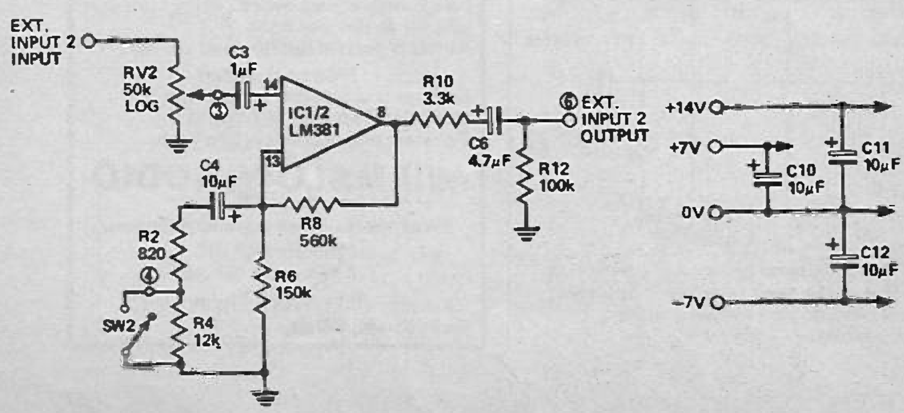
The completed International 4600 synthesizer.

INTERNATIONAL MUSIC SYNTHESIZER

ETI 3600/4600

External input module, keyboard details – and a keyboard controller modification.

Fig. 1. Circuit diagram of external input module.



HOW IT WORKS – External Inputs

The two preamplifiers for the external inputs are provided by a low-noise dual integrated circuit type LM381. A 50 k potentiometer at the input allows attenuation of the input and sets the input impedance.

The LM381 IC differs from the normal operational amplifier we have been using in that it uses a single power supply of +14 volts and, in that the output has to be biased to mid-voltage (7 to 8 V) by an external network – in our case R5 and R7. Gain of the amplifier is set by R7/(R1 + R3) and, since R3 may be switched in or out, two gain ranges are available. These are 56 dB and 32 dB (voltage gains of 630 and 40). These, of course, are fully variable by means of the input potentiometer.

The frequency response of the amplifiers is 20 Hz to 50 kHz +0 –3 dB.

Input 1 is provided with a trigger facility. If the peak negative output falls below the voltage selected by RV3, the output of IC2 (acting as a comparator) will go to +6 volts and remain there whilst the RV3 voltage is exceeded. At all other times the output of IC2 will be at –6 volts.

During the positive excursion of IC2, C8 charges rapidly to +6 volts and when IC2 goes negative again C8 discharges slowly via R17 to –7 volts. Another comparator, IC3, will have its output at –6 volts if the voltage on C8 is above 0 volts, and at +6 volts if the voltage on C8 is below '0' volts.

The envelope from a conventional instrument will usually have an initial attack period, a sustain period and then a decay. With this type of envelope the trigger will start high, go low whenever the envelope is greater than the preset level and then go high again. It will not respond to individual cycles due to the slow discharge of C8 by R17. The release time is about 20 milliseconds.

SPECIFICATION
EXTERNAL INPUT MODULE

Input levels	2 mV–5 V rms
Input Impedance	50 k
Frequency response 20 Hz–50 kHz	+0 –3 dB
Maximum gain high sensitivity	56 dB
low sensitivity	34 dB
Trigger level	adjustable 0 to +5V
Trigger release time	approx 20 mS

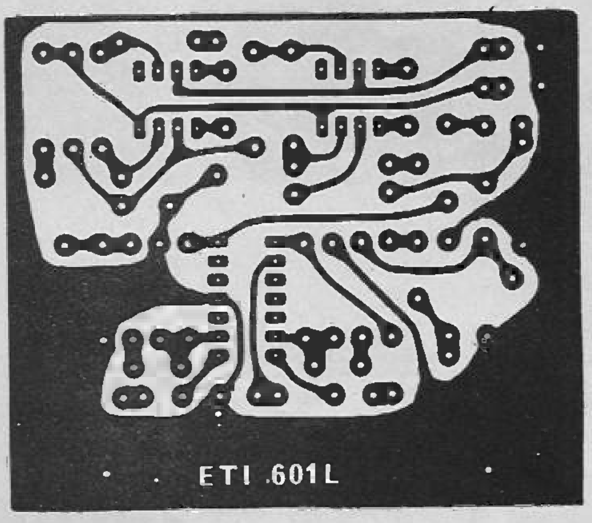


Fig. 2. Printed circuit pattern for the external input module.

THIS month we provide details of the external input amplifier and of a modification to the keyboard controller.

Using the external input circuitry, other electronic instruments (such as an electric guitar) may be fed into the synthesizer modules in order to obtain new and different sounds. One of the two inputs has circuitry which generates trigger pulses from the external instrument's signal, thus allowing the transient generators to be triggered.

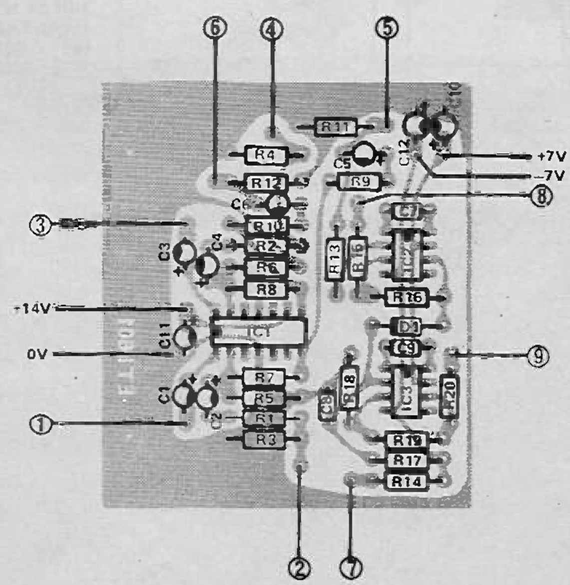


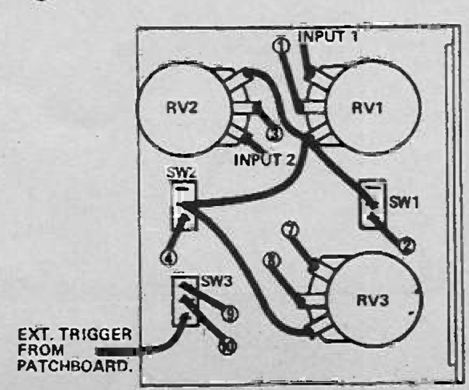
Fig. 3. Component overlay – external input module.

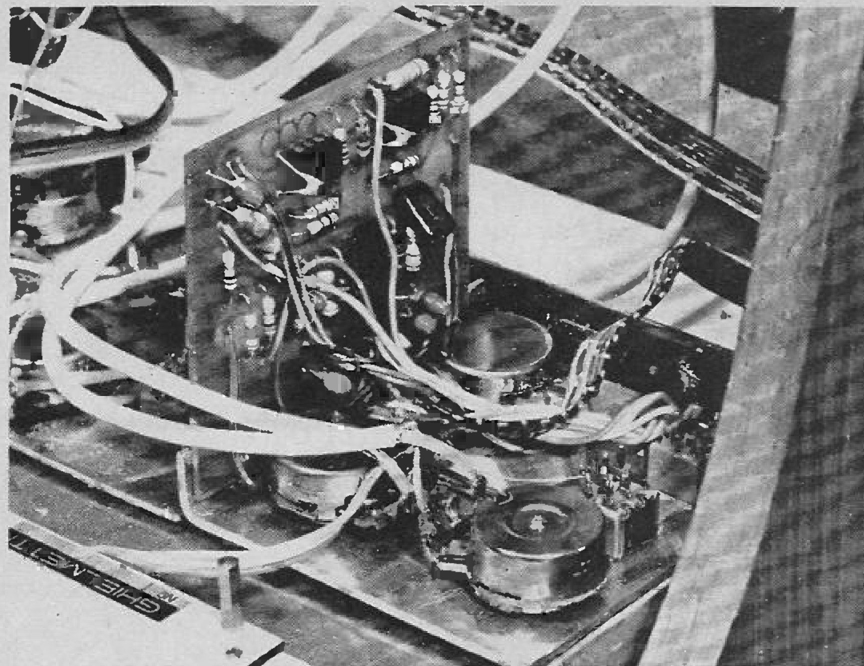
CONSTRUCTION

As with all other modules, a small aluminium bracket is used to support the printed circuit board, potentiometers and switches. The components should be mounted onto the printed circuit board in accordance with the component overlay Fig. 3, taking care with the orientation of polarized components.

The switches and potentiometers should then be wired as shown in Fig. 4. The input sockets are best mounted on a panel at the rear of the synthesizer.

Fig. 4. Wiring to potentiometers and switches – external input module. ▶





The external input module mounted in position.

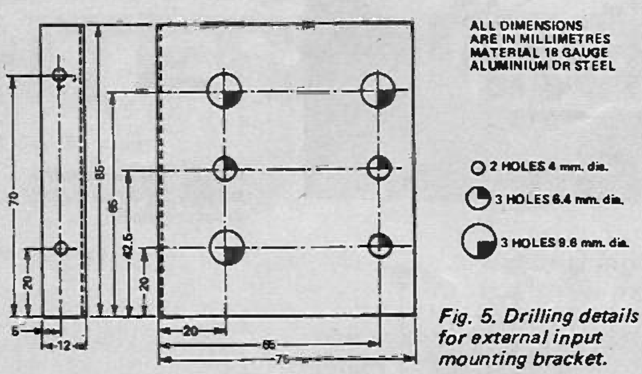
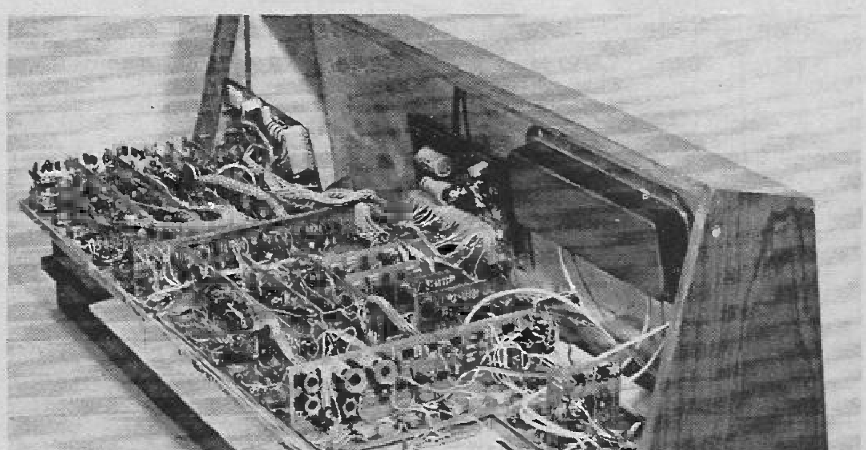


Fig. 5. Drilling details for external input mounting bracket.



The synthesizer front panel was hinged to allow ease of service.

KEYBOARD

Any 48 note keyboard may be used. We used an F to F organ keyboard but C to C keyboards may be used, if desired, simply by appropriately tuning the oscillators.

The keyboard which will be supplied by Maplin is a 48-note F to E with flat-fronted hard-wearing plastic keys. The keyboard is ready-sprung and touch adjustable with brass-bushed pivots for long life and minimum side-slop. The whole keyboard is hinged along its length allowing it to be lifted at the front for access to the contacts.

Contact blocks may be used, but these are quite expensive and since only one make contact is required per key, a simple but effective contact can be made using gold-clad phosphor-bronze wire.

Cut a 6" x 4" piece of 0.1" matrix SRBP into five 0.8" x 6" pieces and mount each one on the keyboard by means of four ½" No 4 self-tapping screws. These can be screwed into the holes provided in the keyboard chassis and the SRBP is held off the chassis using 4mm long spacers. The screw holes in the SRBP should be made with an 1/8" drill bit.

PRINTED CIRCUIT BOARD PATTERNS

We had hoped to publish in this issue full-sized patterns of the p.c. boards for this project. Due to the space this would take up and the limitations imposed by having copy printed on the back, we have changed these plans.

The layouts are being printed separately and a complete set will be sent on receipt of a large self-addressed stamped envelope (or an IRC for overseas readers): Requests for these should be sent to: Synthesiser P.C. Boards, Electronics Today International, 36, Ebury Street, London SW1W 0LW.

Please do not enclose any correspondence with your letter, just an s.a.e.

PARTS LIST — External Inputs ETI601L

R1,2	Resistor	820	¼ W	5%
R9,10,20	"	3.3k	"	"
R14,15,18	"	10k	"	"
R3,4	"	12k	"	"
R11,12,13	"	100k	"	"
R5,6	"	150k	"	"
R7,8	"	560k	"	"
R17	"	680k	"	"
R16,19	"	1M	"	"

RV1,2 Potentiometer 50k log rotary
RV3 " 10k lin rotary

C7,9 Capacitor 10pF ceramic
C8 " 0.1µF polyester
C1,3 " 1µF 16V electrolytic*
C5,6 " 4.7µF 16V "
C2,4,10,11,12 Capacitor 10µF 16V electrolytic*
* PC mounting or tag tantalum

IC1 Integrated circuit LM381
IC2,3 " " LM301A

D1 Diode IN914

SW1,2,3 Toggle switch SPDT

PC board ETI 601L

Metal bracket to Fig. 5.

Patchboard Data Precision Type 673-11-024-01
Patch pins Data Precision Type 673-31-100-04
(Maplin Supplies).

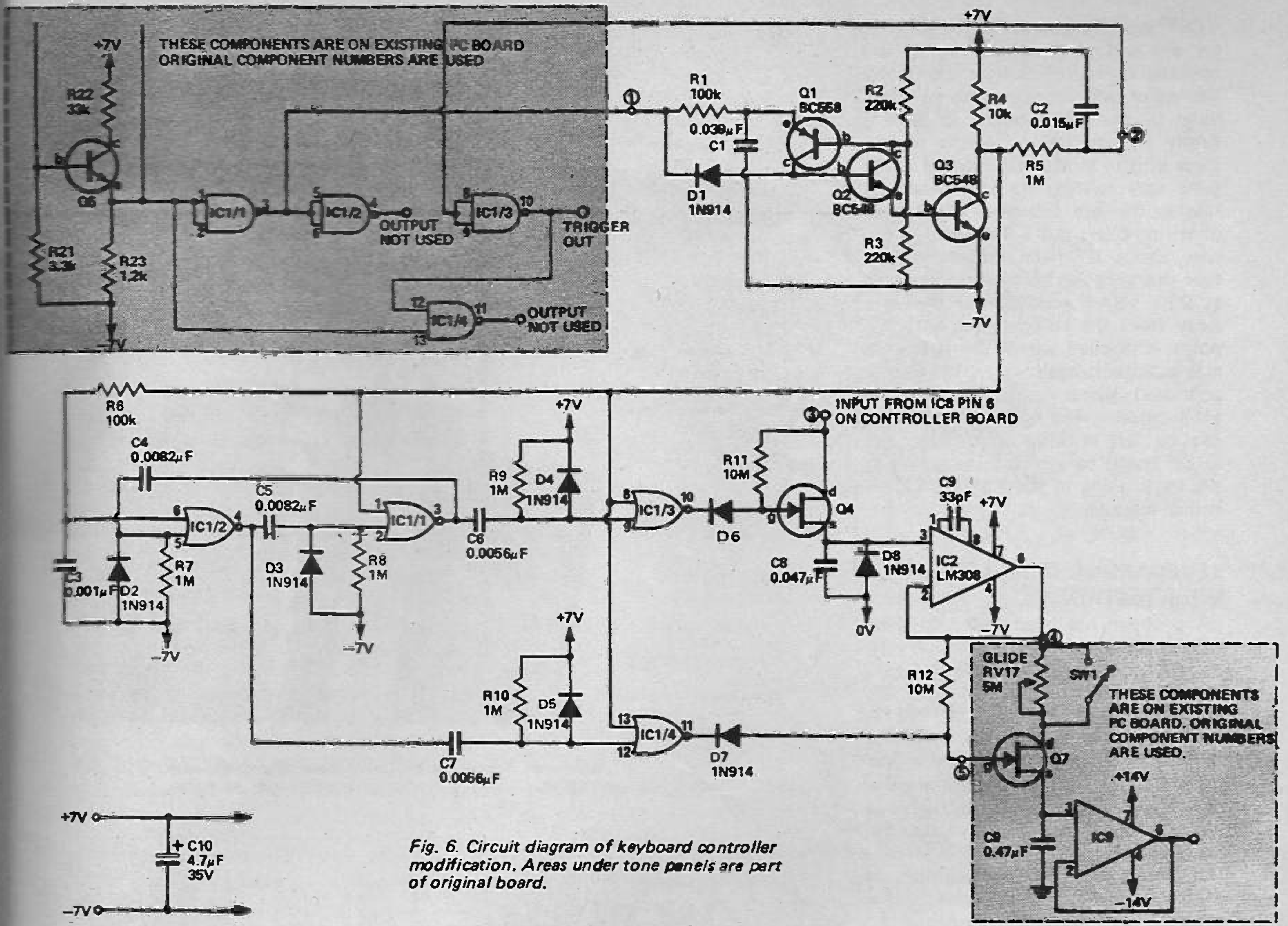


Fig. 6. Circuit diagram of keyboard controller modification. Areas under tone panels are part of original board.

HOW IT WORKS – Keyboard controller mod.

Transistors Q1, 2 and 3 form a 5 millisecond time delay for the trigger control signal. When a key is pressed the output of IC1/1 (on existing board) goes to +7 volts. When this occurs, C1 charges via R1, until, at about 0.6V, (set by R2 and R3) transistor Q1 starts to conduct turning on Q2 which by feedback turns on Q1 even harder. The result is that C1 is discharged by Q1 and Q2 to about –6 volts and Q1 and Q2 are held on due to the current through R1.

As Q3 is also turned on, the output voltage falls to –7 volts when the 5 millisecond period has elapsed. Now, when the key is released, the output of IC1/1 goes to –7 volts and, due to D1, transistors Q1, 2 and 3 all turn off. The output transition of Q3 is further delayed by R5 and C2 and then passed back to the CMOS gate IC1/3 where it is squared up and becomes the trigger signal.

The total time lag introduced between pressing the key and the production of the trigger signal is about 20 milliseconds, and the trigger signal continues for about 15 milliseconds after release.

We now have two sample and hold circuits. Transistor Q4 and IC2 form a temporary store which is capable of holding the required analogue voltage for a 10 millisecond period. When a key is pressed the following procedure takes place:–

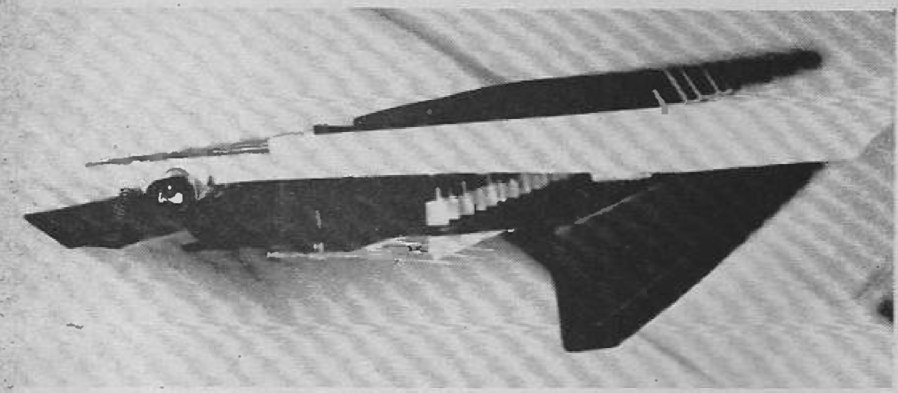
1. The desired note is selected and appears at the output of IC8 (ETI601e).
2. After 5 milliseconds this voltage is transferred to the temporary store.
3. After a further 5 milliseconds this hold is disconnected and a second hold circuit initiated thus transferring the voltage into the main memory.
4. After a total of 20 milliseconds, the trigger signal appears and activates the transient generators etc.
5. The two sample-and-holds are operated alternately at about 100 times a second. There is a slight gap between them so that it is impossible for them to both be on together.
6. When the key is released both sample and hold circuits are broken.

The result of all this manipulation is that the information going into the second and main memory, is always at least 5 milliseconds old and hence cannot be affected by the propogation delay.

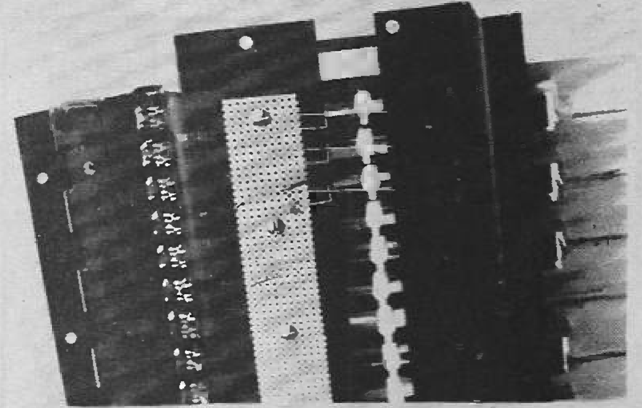
Gates IC1/1 and IC1/2 form a multivibrator which is switched on and off by the output of Q3. The network R6, C3 ensures that the multivibrator always starts in the same sequence. The outputs from IC1/2 and IC1/2 are coupled respectively to IC1/3 and IC1/4 by capacitors C6 and C4. Those gates (IC1/3, IC1/4) form a monostable which produces a pulse having a 4 millisecond period and, since these pulses occur every 5 milliseconds, they have a 1 millisecond period between them. The output of Q3 controls these gates directly (via IC1/3 pin 8 and IC1/4 pin 13) thus over-riding the monostable input. The outputs of IC1/3 and IC1/4 control FETs Q4 and Q7 (ETI 601e).

This sampling technique increases the delay of the glide potentiometer and if this effect is found to be undesirable the value of the glide potentiometer may be reduced to about 2 megohm.

Cut two 2" pieces of gold clad wire, lay one end of one piece on the unoperated nylon key plunger and thread the other end through two or three holes in the SRBP board to hold it firmly in position. Fix the second piece of wire to the SRBP board in the same way so that its other end just reaches the key plunger. With a pair of wiring pliers put a 90° bend in the wire about ¼" from the plunger so that this wire lies across the first wire at 90°. Now gently bend the wire away from the straight wire until the point is reached where the first wire makes with it again when the key is depressed about two-thirds of its total travel. The ends of the wires can be left sticking up through the SRBP board to facilitate soldering to the leads going to the Keyboard Controller module.



Side view of the keyboard showing how the gold-wire contacts are fitted.



Underneath view of the keyboard showing how the wire fits to the SRBP.

KEYBOARD CONTROLLER MODIFICATION

A problem has been found to exist with the sample-and-hold circuitry of the keyboard controller. The problem, which was not apparent on our prototype is that, when a key is released and another quickly pressed, the voltage generating circuitry moves from the previous setting before the sample-and-hold has released. This is due to propagation delays in the detection circuitry.

The solution to the problem is unfortunately a little complex, and a separate PC board is required to contain the new components.

Note that, on the circuit of the keyboard controller modification, the parts in the shaded areas already exist on the main controller board.

CONSTRUCTION

Assemble components to the PC board in accordance with the overlay Fig. 8, again taking care with polarization of components. It is recommended that a socket be used for the CMOS ICs.

PARTS LIST — Keyboard Controller Modification

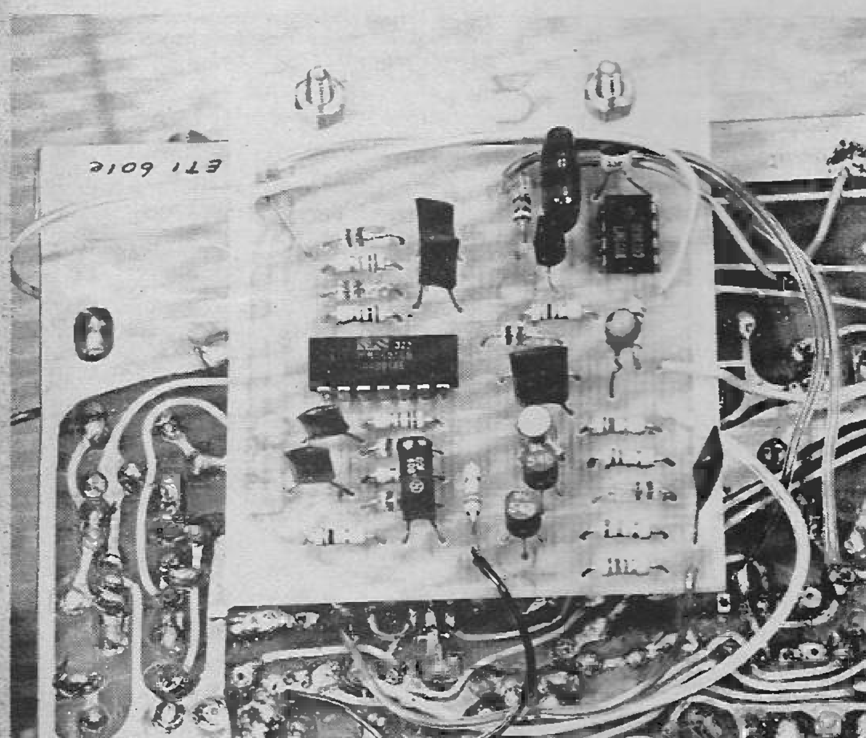
R4	Resistor	10k	¼W	5%
R1,6	"	100k	"	"
R2,3	"	220k	"	"
R5,7,8	"	1M	"	"
R9,10	"	1M	"	"
R11,12	"	10M	"	"
C9	Capacitor	33pF ceramic		
C3	"	0.001μF Polyester		
C6,7	"	0.0056μF	"	
C4,5	"	0.0082μF	"	
C2	"	0.015μF	"	
C1	"	0.039μF	"	
C8	"	0.047μF	"	
C10	"	4.7μF 35V electrolytic		
IC1	Integrated circuit	4001 CMOS		
IC2	"	LM308		
Q1	Transistor	BC558,BC178 or similar		
Q2,3	"	BC548,BC108 " "		
Q4	"	2N5459 *		

* from controller board

D1-D8 Diode IN914

PC board ETI 601M.

2 by 13mm spacers, 2 nuts, 2 by 20mm screws.



The keyboard controller modification board is mounted at the rear of the main board as shown.

We mounted the board on the back of the controller via two 13 mm spacers as shown in the photograph. Only one additional hole has to be drilled.

The interconnections and modifications necessary are as follows:—

1. Remove Q8 (can be used as new Q4), R48, C1, R26, D2 and the link numbered 40 which goes from IC8 pin 6 to RV17.

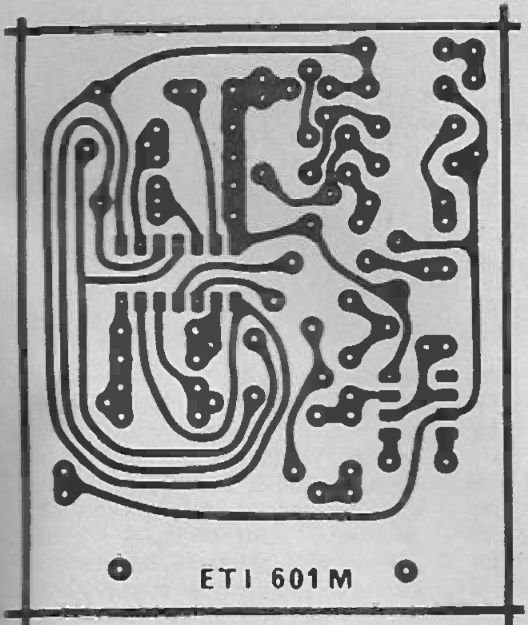


Fig. 7. Printed circuit pattern for keyboard-controller modification.

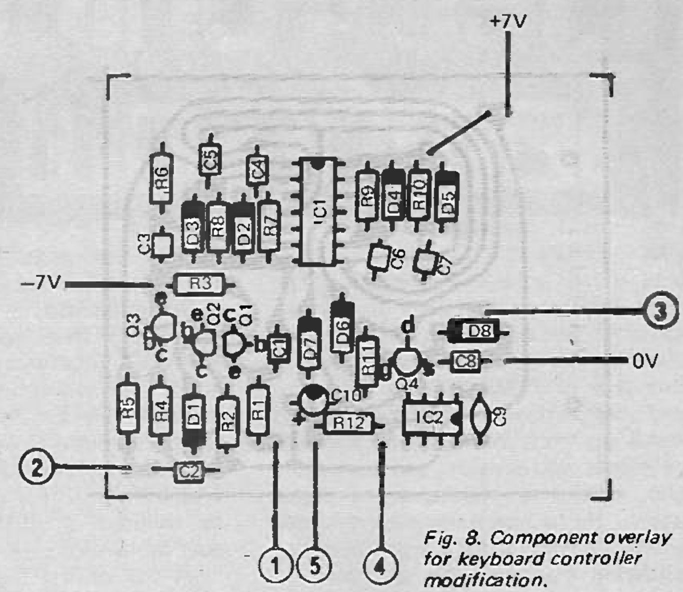


Fig. 8. Component overlay for keyboard controller modification.

2. Connect the +7V, 0V and −7V to the new board from convenient points on the old board. We used pin 14 (+7V) and pin 7 (−7v) of IC1 and a point on the outer copper track for 0V.

3. Link point 1 to pin 3 on IC1/1 (ETI601e).

4. Link point 2 to pin 8/9 on IC1/1 (ETI 601e).

5. Link point 3 to point 40 IC8 (ETI601e).

6. Link point 4 to point 40 on RV17 (ETI601e).

7. Link point 5 to the track joining Q7 and Q8 (ETI601e). ●

Electronics Tomorrow

by John Miller-Kirkpatrick

ONCE UPON A TIME, in a far away land, lived a large Peeceebee. The large Peeceebee was *very* happy because he was one of very few Peeceebees of his particular type because this type of Peeceebee was *very* large and *very* expensive to make. He was made up from lots and lots and lots of diodes and resistors and capacitors and absolutely thousands of transistors. He had been made by men and women slaving at their work over hot soldering irons in little stuffy workrooms in big factories in those far away lands.

The Peeceebee was going to visit one of his neighbours, another large and expensive type of Peeceebee who was unhappy becuase he had just heard that a new factory was building a cheaper and smaller Peeceebee that did more tricks than he could.

"Hello Calculator Peeceebee," said the first, *"what's the news?"*. *"Well, Digital Clock Peeceebee"*, said the second, *"somebody has invented integrated circuits and made it much easier to build us Calculator Peeceebees. The new types are smaller and lighter and need less power to drive them, in fact it is rumoured that they are being built so small that it only takes two men to move them around. At least the new types can live on in the knowledge that if somebody has put all of our components into only a few hundred ICs, nobody can put ICs into ICs."*

A few months later Calculator Peeceebee was uncerimoniously taken away and dismantled for scrap. If he had been around only a few years more he would have found out how wrong he was! Digital Clock Peeceebee was luckier than most of his fellows, he is still working somewhere but most of his friends were replaced by the new TTL clock Peeceebees.

The new TTL Peeceebees boasted about their lower power consumption of only an amp or two and how they could drive different displays - 'Nixies', then Minitrons and even LEDs.

Then, one day the rumours started again. Somewhere in Texas, where they do everything bigger, they did something smaller - the LSI chips were out, and out in force. The TTL Calculator Peeceebees were the first to feel the crunch because the new LSI Calculator Peeceebees needed only a few milliamps to drive them. The calculators were so small and light that a man could carry them with one hand, and worse yet they could be made battery operated, but worser and worser and much worser still was the rumour that they would be so cheap that within a few years there would be millions of little calculators all over the world!

A lot of the big TTL Calculator Peeceebees did not worry, *"I've got a memory"*, said one, *"I can do percentages"*, said another and another shouted, *"I've got both of those and sines and cosines, and I've got a square-root feature tucked away somewhere. They'll never beat that!"*. The new little LSI Peeceebees said nothing but just smiled as they made their way to St. Ives.

The Digital Clock Peeceebees were worried even if the Calculator Peeceebees weren't. You see, they had already realised that whatever happened to Calculator Peeceebees would eventually happen to them. They sat and waited with horror to the day of the Digital Clock LSI.

Moral: All that glistens hasn't happened yet.

And now, if you are sitting comfortably, we will leave the lands of the 24 and 28-pin LSI horrors and introduce you to the latest developments in the story. The problem is that LSI chips are expensive to put into 24 and 28 or even 40-pin packages, TTL is much cheaper because of its much smaller physical size. I am not suggesting (or am I?) that calculator and clock ICs would sell for 50p by September if only they were in 14 or 16-pin packages, but the first small package units are already available or have just been announced.

National Semiconductors recently produced a calculator chip called the MM5736 in a 18-pin plastic package. It has an on-board oscillator, an automatic constant and a multiplexed display driver and keyboard input system. It has 6 digit pins, 7 segment pins, 3 keyboard input pins and two supply pins. It is already used in several calculators (look for one with no decimal points) including NS's own machine. The interface to LEDs is simply a 75492 digit driver and seven resistors, add a battery, a keyboard and case and you have a very cheap calculator. Unfortunately NS have not yet made the MM5736 chip available in small quantities at a very cheap price, if fact you could probably buy their calculator cheaper than the chip alone. One day soon they might bring the price down to the £5 or so that it should cost.

Any calculator chip manufacturer making a new improved cheap chip expects to sell millions of them quite quickly (there are millions around if you 'Hunts' for them!). On the other hand, until last year most clock chip manufacturers count themselves lucky to sell more than a few thousand of their chips, thus calculator chip prices are lower than their simpler cousins, the clock chips. Two manufacturers are now out for the cheap digital clock market (known in the trade as the kitchen wall clock market).

The first is General Instrument Microelectronics with their AY-5-1224 a P-channel MOS IC for driving Sperry ('Beckman') displays or small LED displays. The spec is basically 12/24 hour, 50/60Hz, four digit clock with no extras, all in a 16-pin package. The second chip looks a bit more interesting as it has reset to zero and a 2MHz internal oscillator (or external quartz crystal) for ultra accuracy. It is designed to be built into car clocks where no mains frequency is available. Its two extra pins (18-pin package) make it potentially more accurate and more useful than the G1 counterpart. Well done NS (again) with the MM5378 and 5379 (for Sperry) - you appear to be heading in the right direction.

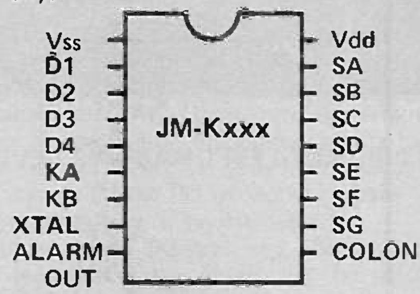
I once wrote an article on a design for a digital clock chip, three magazine editors rejected it saying that it was too complicated. Two months later CAL-TEX produced the CT7001 almost exactly to the spec that I had envisaged. So, how about a spec for a cheap clock chip using only 18 pins - we might well be lucky and find it available by November. If we first start with our 18 pins and take off the digit (4) and segment (7) drives and

INPUT	DIGIT TIME			
	1	2	3	4
KA	12/24 hour SELECT	SET HOURS	SET MINS	SET ALARM
KB	RESET	SHIFT	COLON SPEED	ALARM ENABLE

the two power supply pins we are left with 5 pins. One of these has to be a timing input pin and another could be a colon drive output pin; if we save one pin for later, we have two option input pins. These pins accept inputs from the four digit drives and are demultiplexed internally to give us eight switched options. These are now subjected to further internal logic to give us even more options, e.g. we have to have one for Set Hours and another for Set Mins, if both are pressed it will now Set tens of minutes. Similarly, if the reset is pressed it will reset the seconds digits and hold them at zero for accurate time setting, if it is pressed with either Set Hours or Set Mins it will reset the whole clock to zeros (or 12 midnight).

As can be seen from the option table above we have also included an alarm set input and an alarm enable input. The latter could be omitted if it were permissable for the alarm to sound every 24 hours, but in most cases an alarm is not required on Sundays. We have also included a Shift input which will shift the display register to show minutes and seconds in place of hours and minutes. Depending on the way we count down from our quartz crystal input it might be possible to display seconds, tenths and hundreds instead of minutes and seconds - well, what d'you know - a stopwatch! If we are working from a quartz input we can use the colon drive to give us 1Hz or (say) 1kHz, the choice being made on the colon speed option switch. At 1Hz the colon would flash but at 1kHz it would appear to be on all the time, the colon drive could of course be used to drive equipment other than a colon.

We have a pin left on our 18 pin package and this must be used for an alarm output. The alarm output is a 2-4kHz signal modulated at 1Hz and can be driven through a single transistor to a small speaker. If a stable switched output is required in place of the tone output a simple retriggerable monostable could be added externally.



Possible Pin configuration for our new chip.

Just a few more points - direct drive to common cathode LEDs, etc, 5mA power consumption, voltage range 3-30V, and a similar chip with BCD outputs.

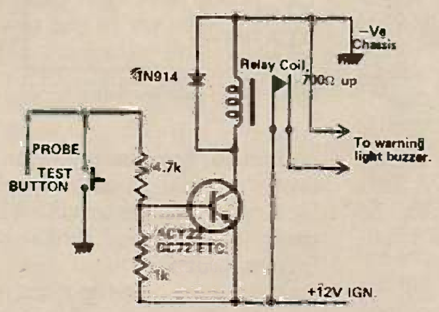
Well, there it is chip manufacturers - no design charge call the chip the JM-Kxxx.

REFERENCES

1. National Semiconductor (UK) Ltd, The Precinct, Broxbourne, Herts.
2. General Instruments, 57-61 Mortimer Street, London W1N 7TD.

Tech-Tips

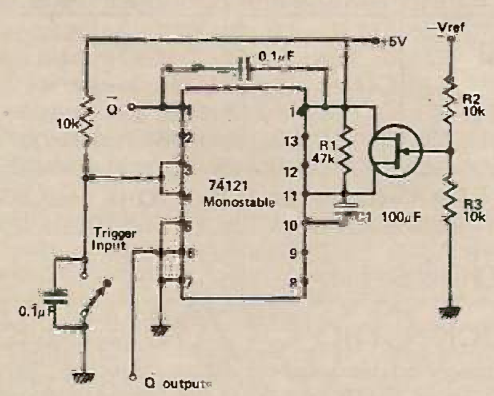
COOLANT LEVEL WARNING DEVICE



A simple circuit is shown for indicating a drop in radiator coolant level. A variety of transistors and relays can be used and the probe can be made quite easily. The coolant and anti-freeze resistance to earth is about 100Ω and with the level below the probe, infinity.

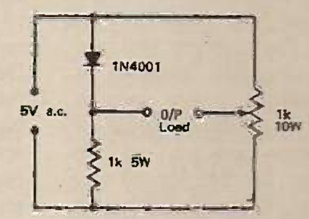
On the mechanical side the hole in the top tank of the radiator was cut with a pair of sharp pointed dividers.

VOLTAGE CONTROLLED MONOSTABLE



This circuit was used to switch a motor on for a variable period as part of a position control system. Using the components shown a range of 20mS to 2 seconds may be obtained, when V_{ref}, is varied between 0 and –5V. The maximum period is governed by the value of R1 (=0.7R1C1). The minimum by the drain-source resistance of the FET with no gate voltage applied. The FET acts as a voltage controlled resistor in the charging circuit of a 74121 monostable. The FET used was an N-channel 2N3819. If a P-channel device is used, R2 must be taken to + V_{ref}.

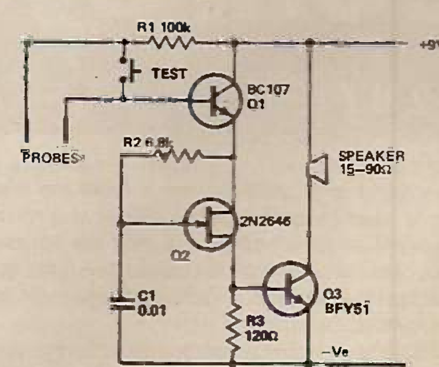
ARTIFICIAL FULL-WAVE RECTIFIER



This simple circuit can be used as a full-wave rectifier.

If you put a load at the output and adjust the potentiometer, you will see on the oscilloscope the two half cycles have equal amplitudes and they are touching each other, so its a full-wave rectifier with one diode only. This is only suitable for low currents.

WATER LEVEL ALARM



The disadvantage with battery operated alarm circuits is the quiescent current that they draw. The circuit shown above draws so little current that the shelf-life of the battery is the limiting factor - the only current drawn is the leakage of the transistors.

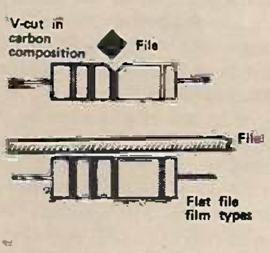
The circuit is shown in the form of a water level alarm but by using different forms of probe can act as a rain alarm or shorting alarm; anything from zero to about 1MΩ between the probes will trigger it.

Q1 acts as a switch which applies current to the unijunction relaxation oscillator Q2. Alarm signal frequency is controlled by values and ratios of C1/R2. Pulses switch Q3 on and off, applying a signal to the speaker.

Almost any NPN silicon transistors can be used for Q1 and Q3 and almost any unijunction for Q2.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to the Editor, Electronics Today International 36 Ebury Street, London SW1W 0LW.

ODD RESISTOR VALUES



If you are faced with finding an odd value resistor, e.g. for multimeter repairs or making shunts for meters, a simple trick is to take a resistor lower in value than that needed and file it until the required value is reached. The resistor should be connected to an accurate multimeter, preferably a digital type, when being filed. Carbon composition or film-types may be used.

The power rating of resistors may be reduced slightly by the filing. When finished, a coating of modeling paint or epoxy resin should be given over the area that has been filed, to prevent moisture changing the resistor value.

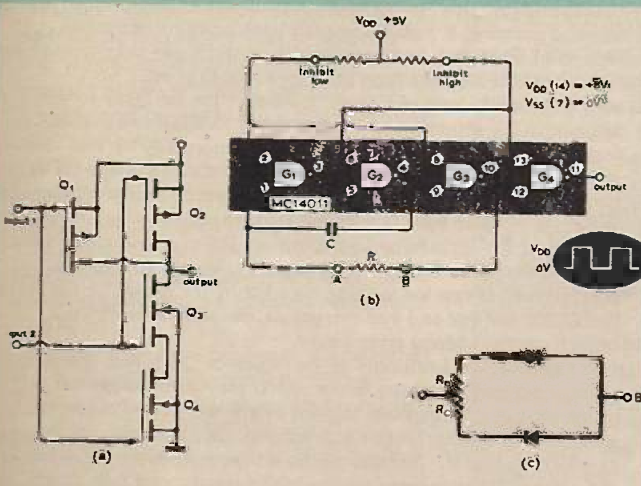


Fig. 1a. The basic circuit of the CMOS NAND gate on which the Astable is based. Fig. 1b. The ultra low frequency astable. Fig. 1c. Insert this network at points AB in place of R to obtain variable mark/space ratio up to 5000 : 1.

5000 SECOND ASTABLE

An astable multivibrator with RC network values as high as 200 MΩ and 25μF may be constructed using CMOS logic gates. A simple modification makes it possible to vary the mark-space ratio between wide limits. Mark-space ratios higher than 5000:1 can be achieved.

Such high values of RC frequency determining components are made possible by the almost infinite input impedance of the basic CMOS gate. This high impedance places negligible loading on the RC network, a factor that normally limits the lowest frequency attainable.

As the time constant of 200 MΩ and 25μF is 5000 seconds, it can be seen that the circuit can be used to provide long time delays or an ultra low frequency pulse generator.

The gates in the astable multivibrator, shown in Fig. 1b are used as simple inverters with the second inputs being employed to provide an inhibit function. Normally these inputs, pins 2, 6, 8 and 13, are connected to the positive supply line through two resistors and are at logical 1.

Three gates form the astable G_1, G_2 and G_3, and the fourth gate, G_4, performs the function of output buffer.

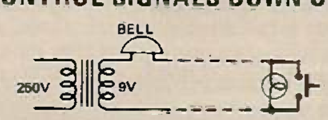
Gate G_1 monitors the potential at the junction of the timing capacitor (c) and resistor (R). When this potential is below the threshold of G_1, gate 2 connects one end of C to ground and G_3 connects one end of R to V_{DD}.

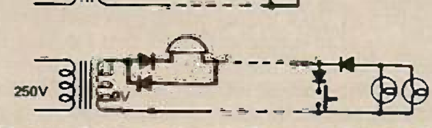
The capacitor charges through R until the potential at the input of G_1 exceeds the gate's threshold. When this occurs, the output of gate 1 falls to 0, G_2 rises to 1 and G_3 falls to 0. The gates have now connected the resistor to ground and the capacitor to V_{DD}. The capacitor discharges through the resistor until G_1 again switches off. The circuit therefore oscillates at a frequency determined by C and R with a mark-space ratio close to unity.

If the circuit shown in Fig. 1c is connected between A and B in place of R, the two diodes isolate the capacitor charge and discharge paths. Variable resistors in the two paths, or the potentiometer shown, allow the mark-space ratio to be varied over a very wide range.

Grounding the inhibit inputs stops the astable from oscillating and puts the output at either 1 or 0 depending upon which inhibit input is used.

TWO CONTROL SIGNALS DOWN ONE WIRE





Many houses have a door-bell push lit up by a small bulb as in Fig. 1. A second bulb was required to light up the house number - but the two bulbs together used so much current that the bell trembler was continually buzzing. Running a separate feed from the transformer to the front door was inconvenient.

The solution was to use four small cheap diodes as in Fig. 2.

Almost any wire ended diode will work - (0.5A, 50V if in doubt). This idea has many other extensions - wherever it is required to send two control signals or two power supplies down a single pair of wires.

DX MONITOR

Compiled by Alan Thompson

BACK IN THE 30s AND 40s, no self-respecting DXer considered his aerial system was complete unless he had a formidable array of knife-switches which allowed him to ground his aerial(s) in a thunderstorm! The switches were usually mounted just outside the point at which the aerial feeders entered the house and were solid constructions of porcelain and brass which very effectively connected the aerial(s) to the receiver(s) in the normal position but which provided a low-impedance connection to earth when the 'knife' was pulled over into the safety position. Recent searches of radio catalogues and radio shops have failed to produce anything of this kind (although they are certainly freely available in the United States!) apart from some rather flimsy constructions of plastic and steel which lasted just a few months in the ever-changing weather conditions of this part of the world. Should anyone know where the heavy-grade switches may still be obtained, details will be much appreciated as this is a safety factor well worth having, especially in these days of transistorised gear which can be affected by charges (and lightning discharges) much more easily than was the case with the older valve gear.

What prompted the preceding paragraph was the fact that this article is being written to the accompaniment of crashes and bangs from an approaching thunderstorm marking the end of a few days of warm, summer weather and the onset of the monsoon season! Whilst knife-switches may be the easiest way of grounding aerials, it is quite easy to construct a simple device which will have the same effect. All that is needed is a piece of insulated material (such as 'Paxolin') on which are mounted sockets which will take all the aerial plugs which terminate the feeders from the aerials themselves. Those sockets are connected direct to earth and as a storm approaches all that is required is to plug the aerials into suitable sockets thereby taking them straight to earth and making the likelihood of damage to expensive gear much less. The entire "device" takes only an hour or so to construct but can save several hundred pounds should there be a lightning strike in the vicinity.

The 8th Annual Conference of the European DX Council was held in Canterbury over the weekend of 31 May - 3 June and was the first occasion on which EDXC had gathered in the British Isles for this yearly get-together of people representing all sides of the DX-industry - the radio stations, the DXer, the journalists and those who write and present DX programmes. For the second time in its history, the office of Secretary-General of the Council passed to a British DXer with Ian Foster assuming the key position from the autumn of 1974 in succession to Wolfgang Scheunemann of West Germany. As the first British holder of the office, a few years back, I wished Ian a very successful year of office within a very few minutes of his being appointed to the post: a wish I should like to record, publicly, because it involves a great deal of work for the incumbent in coordinating the work of many DX Clubs, specialised committees, publicity for the Council in the Press and on the air, the editing and publication of the Council's own "Newsletter" and a host of other activities which because they are not newsworthy never get mentioned in print. Good luck, Ian, and may you have a very rewarding year looking after the affairs of a Council which represents some 15,000 or more DXers scattered all over Europe!

Since Canterbury has a history which goes back some 2,000 years, our Editor seemed to consider it fitting that I should attend the Conference by means of the ETI bicycle (or did he say tricycle?)! Eschewing his offer to lend me the official ETI bicycle-clips, I reached the Conference in time for the, by now, obligatory "informal get-together" which starts off these affairs and was soon plunged into a whirl of reunions with old friends in the DXing world - DXers, DX journalists and DX broadcasters were all there amongst a total gathering of over 50 which included representatives of Radio Canada International, Radio Nederland, Adventist World Radio, Radio Norway, Deutschlandfunk and quite a team from B.B.C. World Services' "World Radio Club". In a thousand or so words, one can only pick at the events of a solid weekend of discussions of all aspects of the hobby and for a coherent account reference must be made to the official EDXC "Newsletter". Details and subscription rates for this may be obtained from the Secretary-General, D-6 Frankfurt 90, Alexanderstrasse 122, West Germany.

For me - as the writer of a magazine feature on DXing, and the writer and presenter of a radio DX programme - one of the more interesting debates in the formal proceedings of the Council was one concerned with the improvement of relations between the DXer and the radio stations to which he listens. It was, to me, not unexpected to hear the broadcasters expressing the view that the DXer was, to them, rather a nuisance and that it was the SWL whose attention they really sought! I think, though, that this almost amounted to treason to many DXers. The purpose of international broadcasting is to "sell" your country or philosophy to your listeners and a report from a DXer who is mainly interested in having heard your station - possibly at very poor strength and readability - is of much less interest and importance than a report from an SWL which, although much less technical in content, gives his views on the programme material. Dxers often tend to forget that the majority of international broadcasters have their own monitoring arrangements either through the facilities of an official monitoring station, or by use of a monitoring panel, which will give them all the information they require about the technical aspects of the received signal. What they do need is to know what the average listener thinks of the material they are broadcasting for his interest or entertainment. I think it was Jim Vastenhoud, of Radio-Nederland, who remarked that one of the most useful reports that a radio station can get is the one which tells it that it is no longer audible on a particular frequency where it is normally well heard, especially if that report is sufficiently detailed and informative to give the reason as "interference from X", or whatever the cause may be.

Much of the value of Conferences of this kind is the interchange of views which takes place after the formal sessions are over: interchanges, which in my experience, get started after a few drinks have loosened a lot of reticent tongues and which then continue long into the night. One subject which cropped up was the extent to which one ought to include DX "tips" in features like this, or in radio DX-programmes. It is, of course, quite easy to fill up half a page with a lot of information about what one may hear as an article is being written; in fact, it is tempting to do so. The problem is that it doesn't follow that any or all of those stations will be audible by the time the magazine appears on the bookstalls and this is especially the case in the summer months when there is a considerable variation in DX conditions over a few weeks around the middle of the year. The "presenters" were, I think, unanimous that including "tips" in features like this was nothing more than inspired guessing, if you did not fall back on quoting readers' reports of what they had heard which would mean they were about two months old by the time they appeared in print.

We were pretty well of a single mind that the best way to get up-to-date DX information was to join a DX Club and that DX features in the Press, and on radio, should normally confine themselves to dealing with the more general aspects of DXing. Of course, there is much more immediacy about DX radio programmes and some of them have facilities available to them which mean that they can really include up-to-the-minute DX news - a good example perhaps, would be B.B.C. World Service's "World-Radio Club" programme. If you are looking for a list of DX Clubs, by the way, the EDXC has one and you can get details of how to obtain a copy from the address given above.

As I said earlier, I can only pick at a few of the topics which had a hearing over a very busy weekend! It may seem somewhat pompous but meetings like this are events which everyone interested in DXing, from whatever angle, should attend if they can possibly manage it. It is one of the rare opportunities afforded to the average DXer to meet the people who write and talk about DXing, and to share his views with them and to hear their side of the DX scene. Now that this opportunity has passed, it is likely to be some years before EDXC meets again in Great Britain: next year's meeting will be in Denmark, a popular venue for such Conferences owing to the easy access afforded to DXers from so many West European countries. However, there are other chances for such meetings, even if they are on a smaller scale. Most DX Clubs have some sort of annual gathering and a visit to one of them is an experience which few, with any interest in the hobby, will look back on with anything but pleasure in the years ahead. I'm already looking forward to the 1975 EDXC meeting and I hope to see you there.

 Continued from page 9.

NEW QUAD SYSTEM

Nippon Columbia's newUD-4 (that's right UD-4!) quad system was recently demonstrated to a small invited audience at New York's Hilton hotel.

The UD-4 system, developed jointly by Nippon Columbia and Dr Duane Cooper of the University of Illinois incorporates both matrix and discrete quad formats in a single unit.

Nippon Columbia President, Takami Shobochi claims that the system is completely universal – for not only can it handle both discrete and matrix recordings without the need for switching – but it is completely compatible in both stereo and mono modes as well.

Currently UD-4 is an engineering concept and the main purpose of the demonstrations was to convince both equipment and record manufacturers of UD-4's potential value and to solicit licencing agreements. There must have been some takers because Takayasu Yoshida, manager of Nippon Columbia's record division has since stated that the UD-4 system would be on sale in Japan and Europe by the end of 1974.

US NAVY DROP SANGUINE PROJECT

Work has been suspended on the US Navy's controversial Project Sanguine – a system intended for communication with submerged missile-launching nuclear submarines.

Project Sanguine was intended to operate at extremely low frequency and would have consisted of a massive antenna buried beneath the surface and powered by a multi-million watt transmitter.

Although the system has been bitterly attacked by environmentalists – who feared the effect of massive electromagnetic radiation on plant and animal life – the reason for the system's demise has been simply financial.

Industry sources however suggest that the Project Sanguine may only be postponed not totally dropped, for as they point out, ultra low frequency transmission is the only known way of communicating with submerged vessels.

DATA BOOKS

Motorola have introduced two new data books, each costing £1.26 and available from Motorola distributors. The *Linear Integrated Circuits Data Book* is the third edition with 800 pages and 300 circuits. The second is *McMOS Integrated Circuits Data Book* covering 68 of Motorola's 80 CMOS devices.

ULTRASONIC CANCER SCREENING

Scientists at the Institute of Cancer Research, working with doctors of the Royal Marsden Hospital's Department of Nuclear Medicine at Sutton, Surrey, have achieved a dramatic improvement in the definition obtainable from ultrasound 'scan pictures' used in the early diagnosis and treatment monitoring of certain types of cancer. Definition is as much as ten times better than previously possible. Growths as small as 2 millimetres across can be readily detected. At this stage of a tumour's development modern drug treatment is more likely to be effective. Most success has been in the detection of liver tumours previously very difficult to diagnose early.

After several years of intensive work, the teams of scientists and doctors have achieved this breakthrough by developing a number of automatic and manual scanning heads. For the first time these display the fine tissue structure, which is of particular importance in cancer diagnosis. The system's novelty is in recognising not only echo localisation, but also echo amplitude and size. In the Polaroid print - or cathode ray tube display - produced the two are linked to show a cross-sectional image of the internal structures of an organ. This is displayed in varying shades of grey, rather than the more conventional black-and-white ultrasound picture. Because of this, the technique has become known as 'grey scale echography'.

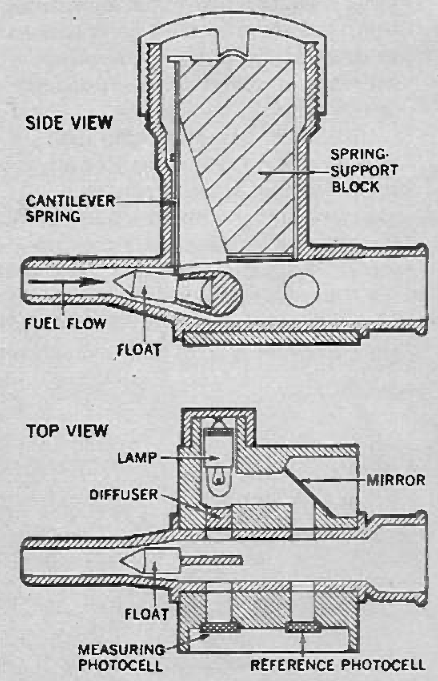
Information can also be fed on-line to a minicomputer for storage or analysis and displayed on a colour TV monitor. One liver scan produces about 1½ million computer words. If we could characterise a particular area as having so much attenuation and so much scatter we should be able to say what the tissue is, or what type of tumour is in it. We have already made modest steps in the direction of computer diagnosis and tissue identification. But there is still a great deal to be done before positive computer diagnosis of cancer using ultrasound can be put into clinical use.

In clinical use ultrasound has already demonstrated marked advantages in certain areas of cancer diagnosis and treatment management. Isotope studies frequently pick up something that looks like a tumour of the liver. Using the new equipment it is now possible to ascertain immediately whether it is, in fact, a malignant growth or a harmless cyst. Similarly, radiology procedures do not work in the case of severe jaundice. But with an ultrasound picture it is possible to tell precisely what the jaundice is due to in a few minutes. The test is also proving most effective in detecting bladder tumours and 'secondary' infiltration through the bladder wall. At the present time about 15 patients are being screened daily by the ultrasound equipment, which is being used as a complementary check to routine X-ray and isotope scanning investigations.

Perhaps the greatest advantage that ultrasound offers over either X-rays or isotope scanning is the fact that there is no radiation hazard even from repeated use. This means that regular screening of patients could be carried out without risk. In addition to being highly accurate the new method is fast: liver scans can be made in seconds compared with 15 to 20 minutes using other methods. It is possible not only to pick up local lesions but, by examination of the ultrasound picture alone, give a good indication of the cause. In the past the only way this could be done with certainty was to perform an autopsy.

Liver, gall-bladder, kidneys and lymph nodes can be covered in one sitting, rather than the five or six procedures previously necessary.

INSTANTANEOUS MPG METER



One of the most difficult quantities to measure accurately is instantaneous vehicle fuel consumption.

Now an ingenious technique has been developed by a British engineering company (Aviatric Ltd, Box 7, Romsey, Hants). Their recently announced three-part unit consists of a meter calibrated in mpg, a flowmeter inserted in the fuel line, and a pulse generator driven by the speedometer cable.

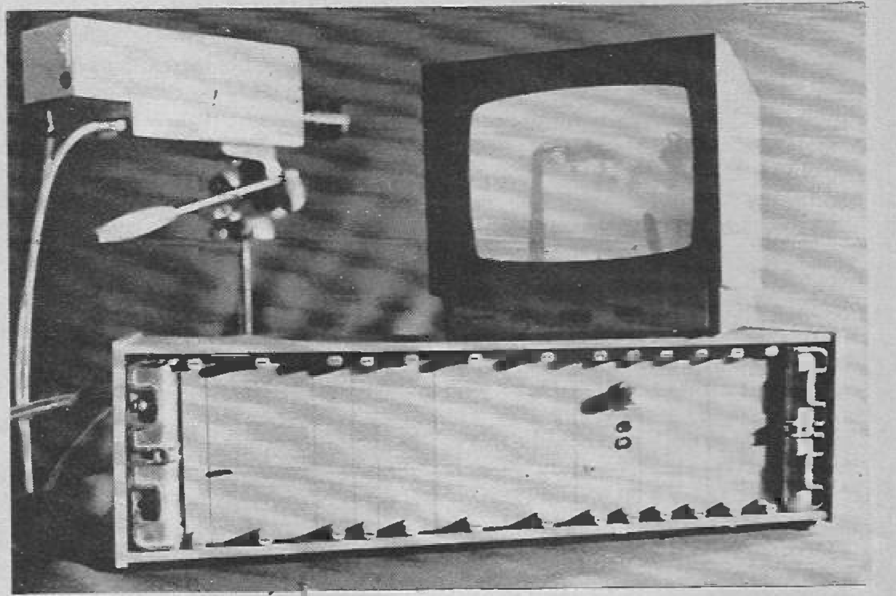
A cone-shaped float suspended in the fuel line is deflected by an amount proportional to fuel flow. The amount of deflection is monitored by a light source and photocell.

To compensate for colour variations in the fuel, changes in light output etc, a second photocell is used in a compensation circuit.

The data from the fuel flow transduce is integrated with data from the speedometer-cable driven distance-transducer to produce an output proportional to fuel miles-per gallon.

MONITORING BY IMAGE STORAGE AND EVALUATION

Numerous industrial processes need to be permanently monitored, so that undesirable harmful emissions, for example smoke from chimneys or polluted water from discharge pipes, etc., may be effectively limited or prevented. A suitable device for this function is the Telemat A developed by Siemens, an electronic module which can be added to closed circuit television cameras. In this module the image recorded by a compact camera is digitally stored and



constantly compared with the image which is transmitted live. If sudden changes occur in a stationary television image a visual or audible alarm is given immediately.

In the image storage section of the device the image of the object being monitored (this image can also be taken at night with very weak lighting) is broken down into 3200 dots and digitally stored in a manner corresponding to 64 x 50 words each of 4 bits, each in 16 shades of grey. If there is even a slight discrepancy at any point between the content of the stored image and the live image, the difference signal automatically causes an alarm to be given which may be audible or visual as required. In addition, the points in the image which have changed are marked by short bright dashes. Three adjustable parameters operating sensitivity, transient disturbance suppression and sustained disturbance suppression - allow for the particular function.

So that variations over a long period of time (slow changes in lighting) do not have an effect the stored image can be refreshed in a cycle which can be preselected between 2s and 20s. The storage process takes approximately 1s. The operating sensitivity is such that a level alteration of 30% on a coherent surface, corresponding to 0.1% of the television image, will cause an alarm to be given.

If required certain areas on the picture can be suppressed. Using a cross-bar matrix the television image can be divided into 256 (16 x 16) areas which can be combined in any way desired and excluded from the evaluation. For checking purposes, these sections appear darker on the screen.

WATTS RMS IN USA

The US Federal Trade Commission is expected to announce soon that the national standard rating of amplifier power output will be 'watts rms'.

The rule provides for standard test conditions for manufacturers' measure of power output. All advertising, print or broadcast, making power output claims, on such items as radios, phonographs, tape equipment and component audio amplifiers, will have to use a standard of continuous power output capability (RMS).

This will replace a variety of types of measurements such as Instantaneous Peak Power (IPP) and other manufacturer rating claims the FTC feels are misleading. Agency research shows consumers can be deceived by the diverse claims. Customers will, for example, buy a stereo set advertised as having 100-watt amplification, in preference to a 50-watt set, when the latter might be as good or far better.

The rules for all radio and TV and print media advertising are expected to become effective in October.

Any advertising that makes claims as to output must also disclose total harmonic distortion, load impedance, and rated power band or the continuous average power output in watts per channel. The standard test conditions set up in the rules must be met when any claims are made in the advertising.

Advertising may refer to other operating characteristics or specifications not required in the FTC rule, such as "music power" or peak power, provided certain conditions are met. When any extra disclosures of this type are made, they must be less prominent than the standard test rating.

LIQUID LEVEL DETECTOR

A thumb-sized electronic sensor that hangs on the side of a coffee cup to alert blind people against painful or embarrassing overspills has been developed at General Electric Company (USA).

Battery operated and weighing 1½oz., the liquid level detector buzzes when the liquid level rises within a half-inch of the cup's lip. It was devised by Dr. Richard W. Roberts while sitting next to a blind traveller during a cross-country airplane flight.

GE (USA) does *not* plan at this time to manufacture or market the device, since the detector is outside of the Company's usual product line but the company is offering a non-exclusive, royalty-free licence to any responsible outside firm, with proven manufacturing and marketing capabilities, that would agree to use its best efforts in commercializing the sensor.

Looking somewhat like a lapel microphone, the two-inch-long liquid level detector was assembled from off-the-shelf components, including a miniature speaker and two rechargeable nickel-cadmium batteries.

The sensor is hung over the lip of the cup by two sensitive L-shaped "feelers," which also serve as electrodes for detecting the level of the liquid. When the cup is nearly full, the liquid completes contact between the two "feelers," and the buzzer is activated.

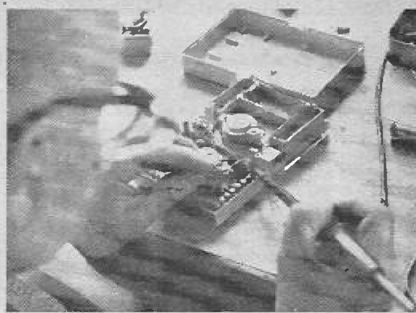
The inventors say that, with scaled-down components, the device could be made about the size of a fountain pen cap, and probably would sell "for less than £2." It also could be made to vibrate as well as buzz, for people who are both deaf and blind.

SEA AS AN ENERGY SOURCE

United Engineers and Constructors, Inc., a Raytheon subsidiary, will evaluate the sea as an electric power source, under a contract with Solar Power, Inc., (York, Pa.)

United Engineers plan to use temperature differences between the ocean's warm surfaces and colder depths – some times as great as 40°F. These differences provide conditions needed to boil and condense thermal fluids such as propane, which, in a pressurized vapour state, could run a vapour turbine generator. Though capital costs are high, fuel costs are about zero; in addition, there is no air pollution or solid waste, and thermal pollution is very low, say the company.

CHINAGLIA SERVICES



The Italian Chinaglia company who have recently launched in the U.K. in a big way have now appointed Coates-Clarke Limited of London W.7. as official service agents in the U.K.

This appointment will give Chinaglia as many services as any comparable U.K. company.

NEW DISC VIDEO PLAYER

France's Thomson – CSF are expected to release details of a video record playing system within the next few months.

It is believed that the system will use a soft translucent plastic disc and a laser readout device, Bandwidth of the encoded signal is said to be 4.5MHz. The disc rotates at 1500 rpm and carries some 40 minutes programme material.

Thomson–CSF are currently campaigning for agreement on standards for single video disc players, such as those from Philips and Telefunken/Decca.

But preliminary information indicates that the new Thomson–CSF system would not be compatible with the Philips video player, although it could perhaps be made to cater for the Telefunken/Decca Teldec system which uses a pressure sensitive readout.

MOTOROLA EXPAND IN UK

Motorola are usually associated with in-car entertainment or semiconductors but in the USA they are best known for radio-telephones and associated equipment. With growth in this field forecast here, Motorola will soon open a research and manufacturing plant at Warrington.

One of the first products is likely to be the Pageboy, a pocket pager currently being used by the Post Office in the Reading area for trials.

The pager, shown in the photograph, may soon be available to the general public. To reach someone with a Pageboy the caller will simply dial a number and within a few seconds the pager will 'bleep!

Motorola's Pageboy is small and light and can be worn anywhere even clipped to a coat lapel.

The Dyna TAC portable telephone. The short UHF aerial extends from the ear-piece.

At a recent demonstration Motorola installed a 250W transmitter in central London and successfully paged several people over a wide area of the city.

A recent company development is Dyna TAC (Dynamic Total Area Coverage). These are completely portable telephones, patched into the existing system allowing the user to make and receive calls almost anywhere. The system will require 380 channels, each of 25kHz around the 900MHz part of the spectrum.

The first Dyna TAC system is hoped to be in operation in New York in about a year.

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