

APRIL 1974

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ETI MUSIC SYNTHESIZER ■ LASER EXPERIMENTS**

HI-FI

... CONSTRUCTION ... COMMUNICATIONS ... DEVELOPMENTS

£4
 Valid until 30th April 74
 on clock kits only.

CHEAPER CLOCK KITS

We have a few "Timtronic" kits (ETI Sept. 73) left and when these have gone we cannot guarantee future availability of this kit. If you want one take advantage of our special £4 voucher. The voucher is valid for £4 off the pre-VAT price of any one of our clock

kits advertised below only and is valid until 30th April 1974. The coupon must accompany each order (C.W.O. only).

The special offer kit prices are thus: Timtronic £20; 5316-LC £28; 5314-Jumbo £22.80; all plus VAT and p.p.

INTEGRATED CIRCUITS

MM5311	6 digit clock chip with BCD and seven-segment outputs, interfaces with most display types.	£ 9.00
MM5314	As MM5311 but no BCD outputs.	£ 7.20
MM5316	Four digit alarm clock with alternate seconds display, Sleep and Snooze features. Interfaces directly to DG12 and TA8055 displays.	£15.00
MK5017AA	Six digit clock chip with alarm and Snooze, interfaces to DG12, DL34 and TIL360. As used in ETI Sept. 73 TIMTRONIC.	£14.00
CT7001	Six digit clock/alarm/calendar chip.	£18.00
ZN414	AM radio chip, as used in many articles.	£ 1.10
LM380	2½W Audio Amp in 14-pin pack,	£ 1.50
LM377	Two LM380s in one pack, 14-pin DIL.	£ 2.70
LM381A	Stereo pre-amp, very high spec, lower noise figures than LM381 (which are not available).	£ 4.47
LM. . .	Other National audio chips available to order we will have the 1800, 1805, etc when available.	
LM3900	4 Op-amps in 14-pin DIL	69p
555	General purpose Mono/Astable timer.	90p
LM322	High stability precision timer.	£ 2.50
CA3081	16-pin DIL containing 7 NPN Common-emitter transistors, for 7 seg LED drivers.	£ 1.47
CA3082	As CA3081 but common-collector connected.	£ 1.47
OTHERS	We have a few calculator ICs at special prices, please ring for details.	

SEVEN SEGMENT DISPLAYS

DG12	Phosphor-diode (Fluorescent) tubes digit 12.5mm.	£ 2.00
DL707	Light-pipe LED in 14-pin package, 0.3ins.	£ 2.00
DL747	Light-pipe LED in DIL package, Giant 0.6ins.	£ 2.62
DL34	Four 0.1in digits in 14-pin DIL pack, Common C.	£10.00
TIL360	Six 0.1in digits in 16-pin DIL pack, Common C.	£15.00
TA8055	Four 0.6in Liquid-crystal digits	£13.00

KITS AND PCBs

TIMTRONIC	Kit for ETI article, MK5017AA, four DG12s, IC socket, PCB and full instructions.	£24.00
5316-LC	MM5316, socket, TA8055, PCB and instructions.	£32.00
5314-Jumbo	MM5314, socket, 4 x DL747, 2 x DL707, CA3081, PCB and full instructions.	£26.80
CASES	Complete kit less case, etc. Perspex Timtronic case 2.50, Wood 5314 case £4.50.	£30.00
PCBs	Timtronic or 5316 or 5314 kits £2.50. PCB for six DL707 for Digitronic type project £1.00.	

LEDS, SOCKETS ETC.

TIL209	These and similar LED lamps, Red colour.	20p	Pin Headers. 14 and 16-pin units which may be used as DIY ICs or as a plug for DIL sockets.	40p
RED & GREEN	We still have a few pairs of LEDs which we are clearing at a special price. 1 red & 1 green.	50p	Flat cable. 16 way flat cable for use with pin headers, metre.	35p
24 & 28-pin LSI sockets, high quality gold contacts, etc.		£1.15	DILSWs	A range of miniature switches in a 16-pin DIL pack. 1 pole 8 way 75p, 2 pole 4 way 80p, 4 pole 2 way 85p, DILVARI four 1 pole 2 ways 90p.
40-pin LSI sockets, high quality gold contacts etc.		£1.35		
16-pin low insertion force sockets for IC testing, etc.		£2.00		

CLOCK DATA SHEETS -SAE. ADVICE - PHONE 0442-62757
 POST & PACKING - 10p. OVERSEAS (AIRMAIL) 50p. VAT - ALL PRICES EXCLUDE VAT.
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electronics today

INTERNATIONAL

APRIL 1974

Vol.3 No.4

main features

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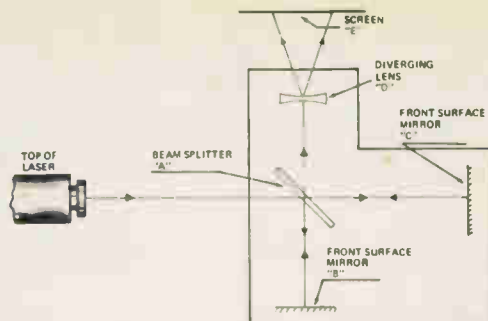
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Cover: The ETI International 4-Channel Amplifier not only looks good but has excellent performance. Complete article starts on page 16.



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SN7403N	0.20	0.18	0.18	SN7454N	0.20	0.18	0.18	SN74148N	2.01	2.01	1.63
SN7403AN	0.38	0.38	0.33	SN7460N	0.20	0.18	0.18	SN74150N	2.30	2.30	2.01
SN7404AN	0.24	0.21	0.18	SN7470N	0.33	0.38	0.27	SN74151N	1.15	1.15	1.00
SN7405N	0.20	0.18	0.18	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	2.02
SN7406N	0.28	0.28	0.25	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	0.38	0.32	SN74157N	1.09	1.09	0.95
SN7409N	0.33	0.33	0.28	SN7480N	0.00	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	0.18	SN7482N	0.87	0.80	0.72	SN74161N	1.58	1.58	1.38
SN7411N	0.25	0.23	0.21	SN7483N	1.47	1.47	1.33	SN74162N	1.58	1.58	1.38
SN7412N	0.37	0.37	0.32	SN7484N	1.47	1.47	1.33	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	1.78
SN7413N	0.30	0.27	0.25	SN7489N	4.32	4.32	3.78	SN74185N	2.01	2.01	1.78
SN7414N	0.72	0.72	0.63	SN7490N	0.75	0.70	0.63	SN74186N	2.18	2.18	1.89
SN7416N	0.30	0.27	0.25	SN7491AN	1.10	1.00	0.80	SN74167N	4.10	4.10	3.59
SN7417N	0.30	0.27	0.25	SN7492AN	0.75	0.70	0.63	SN74170N	2.88	2.88	2.52
SN7420N	0.20	0.18	0.18	SN7493N	0.75	0.70	0.63	SN74172N	5.78	5.78	5.04
SN7422N	0.37	0.37	0.32	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	1.28	1.28	1.13
SN7425N	0.37	0.37	0.32	SN74100N	2.18	1.88	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	0.18	SN74107N	0.57	0.57	0.50	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	0.66	0.66	0.57	SN74184N	2.18	2.18	1.89
SN7433AN	0.57	0.57	0.50	SN74116N	2.18	2.18	1.89	SN74185AN	2.18	2.18	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	1.88	SN74190N	2.30	2.30	2.01
SN7438AN	0.57	0.57	0.50	SN74120N	1.05	1.05	0.98	SN74191N	2.30	2.30	2.01
SN7440N	0.20	0.18	0.18	SN74121N	0.57	0.57	0.50	SN74192N	2.30	2.30	2.01
SN7441AN	0.85	0.78	0.73	SN74122N	0.80	0.80	0.70	SN74193N	2.30	2.30	2.01
SN7442N	0.85	0.78	0.73	SN74123N	1.44	1.44	1.26	SN74194N	1.72	1.72	1.51
SN7443N	1.50	1.27	1.13	SN74125N	0.89	0.89	0.80	SN74195N	1.44	1.44	1.26
SN7444AN	1.50	1.27	1.13	SN74126N	0.89	0.89	0.80	SN74196N	1.58	1.58	1.38
SN7445AN	2.16	2.16	1.89	SN74128N	0.89	0.89	0.80	SN74197N	1.58	1.58	1.38
SN7446N	2.16	2.16	1.89	SN74132N	0.72	0.72	0.63	SN74198N	3.16	3.16	2.77
SN7447AN	1.80	1.80	1.57	SN74136N	0.63	0.63	0.55	SN74199N	2.88	2.88	2.52

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			V405A 25p	2N3614 59p	
				2N3702 11p	

TRIACS

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Type	P.I.V. Each	15 AMP RANGE	SC50A 100v £1.45	SC50B 200v £1.85
SC35A	100v 80p	SC50C 400v £1.95	SC50E 500v £2.25	
SC35B	200v 85p	40A30 TRIAC	(Plastic) 85p	
SC35D	400v 90p	40669 TRIAC	(Plastic) 90p	
SC35E	500v £1.20	40486 TRIAC	(T05) 75p	
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SC40A	100v 90p	40430 TRIAC (T066) 85p		
SC40B	200v 95p	40669 TRIAC (Plastic) 90p		
SC40C	400v £1.20	40486 TRIAC (T05) 75p		
SC40E	500v £1.50			
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SC45A	100v £1.05	15 Amp T048		

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CRS 1110AF	100v	30p
CRS 120AF	200v	35p
CRS 140AF	400v	45p
CRS 180AF	600v	55p
THREE AMP (T048)		
CRS 3105AF	50v	40p
CRS 3110AF	100v	40p
CRS 3120AF	200v	45p
CRS 3140AF	400v	55p
CRS 3160AF	600v	65p
FIVE AMP		
CRS 51400	400v	60p
SEVEN AMP (T048)		
CRS 71100	100v	60p
CRS 71200	200v	67p
CRS 71400	400v	85p
CRS 71600	600v	95p
SIXTEEN AMP (T043)		
CRS 16100	100v	70p
CRS 16200	200v	75p
CRS 16400	400v	85p
CRS 16600	600v	£1.10

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65 Simple transistor tester	1.90
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125 Stereo control unit	3.80
130 Mono control unit	4.95
205 Power supply for 115	4.85
610 Power supply for 120	6.73
615 Power supply for 2 x 120	2.93
230 AM/FM aerial amplifier	8.00
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275 Mic. preamplifier	18.80
370 LF generator 10Hz-1mHz	14.60
575 Sq. wave generator 20Hz-20KHz	12.88
590	8.00
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235 Acoustic Alarm for livestock	7.80
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Prices correct at time of preparation. Subject to change without notice

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FREE—Teak cabinet with complete kit.

KIT PRICE £28.50

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Kit price **£21.00 (+ VAT)**

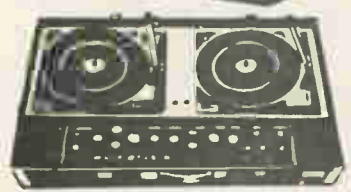
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| As above but with Slider Controls | £118.50 |
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| SDLI (rotary controls) | £49.60 |
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| DJ40L as 30L plus built in microphone | £47.50 |
| DIMAMATIC 1 kW adjustable speed auto dimmer | £25.00 |
| Carlabro reverbation unit | £25.00 |
| SCENE STROBE £19.00. ROAD STROBE | £44.00 |
| SUPER STROBE £45 | |
| Disco anti-feedback microphone | £11.95 |
| COH 150 watt liquid wheel projector | £22.50 |
| 150 watt QI liquid wheel projector | £50.00 |
| 150 watt QI cassette wheel projector | £50.00 |
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6" Liquid wheels £5.50
Mini spot bank fitted 3 lamp £12.95
Auto Trille from with fluorescent £17.00
Bubblemaster with 1 Gall Liquid £41.15
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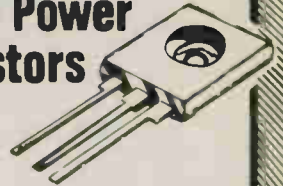
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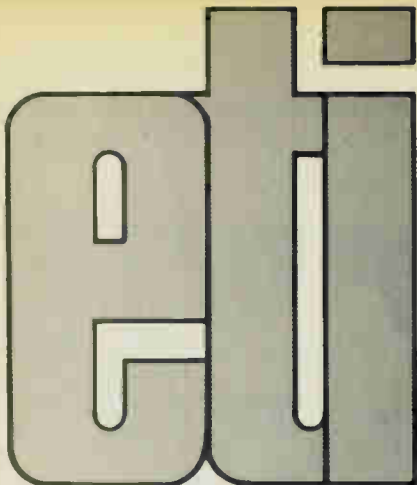
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CHANGES

REGULAR READERS of ETI will have noticed quite a number of changes to the magazine in the last few months and in this issue we have made two more changes which we hope are successful.

The Tech-Tips feature, until now, has varied in size and has been left out of some issues due to pressure on space. We know that this is a very popular item and in future we hope to devote two full pages to this, at the same time adding general tips and hints as well as circuits. The problem with any feature of this type is to obtain the necessary number of original or little known circuits and ideas that will have a wide enough appeal. In order to keep up the standard, we are inviting readers and companies to contribute to this feature and we shall, of course, pay for those items used.

The second change is the new Hi-Fi section. For some time we have considered various ways of presenting these reviews. We have opted for presenting more reviews but compressing the space devoted to each and to concentrate on the technical performance. We know that some readers are interested in Hi-Fi reviews and as any expansion in one section normally means a cutting back on another, we have not increased appreciably the space devoted to reviews.

Whenever a publication makes a change, it does so in the hope of gaining additional readers. The changes that we have made so far have worked and not only brought about a batch of congratulatory letters but have been reflected in a substantial increase in sales.

We welcome readers views on the contents, presentation and other aspects of ETI, especially with regard to the recent changes. —H.W.M.

electronics today international

news digest

AUTOMATIC BANKING

An automatic bank teller device has recently been announced by Chubb. Banks will use the device, known as an Integrated Teller, to make available to the public a variety of banking services, for example cash dispensing, payments and transfer of funds, not only when the banks are closed but also during normal banking hours.

The Teller forms part of a number of modular banking devices, to be known as the MD.6000 range, from which the banks will be able to build up their own tailor made systems.

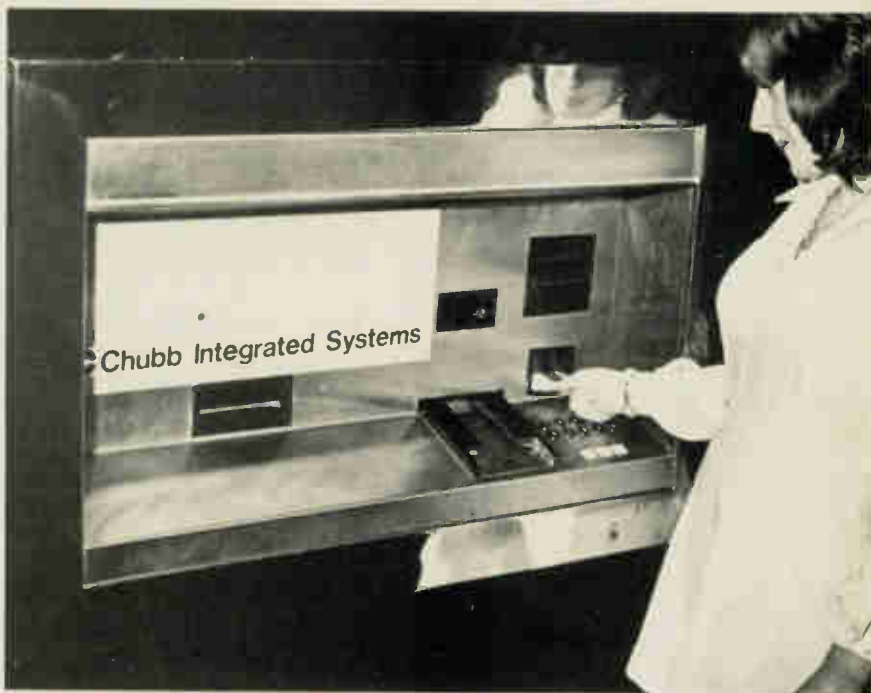
The new teller device is a significant development from cash dispensers, both of "card retained" and "card returned" types, of which around 1,000 are now installed around the world. The Teller is designed to operate either online to a bank's mainframe computer installation or as an offline installation.

The range of devices has been designed to provide 24 hour online operation of banking services. The Integrated Teller has been designed to revert automatically to off-line working in the event of failure of the mainframe computer or any connections to it. When normal working is resumed, the Teller will switch again to on-line working without interrupting service to the customer.

The Teller itself will provide a bank customer with four main groups of services. On inserting his card (which is returned to him) and keying in his personal number, the customer can choose to withdraw money, either in the forms of loose notes to a specified sum or as a specified number of packs each containing the same sum. He can also use the Teller to deposit money, either to be put into his own account or to pay his creditors by credit transfer. He could also, via the Teller, request the bank to transfer funds between his accounts.

A major point of the new system allows a user bank to have cash cards coded so that services can be specifically tailored to an individual customer's needs. Finally, the customer can leave miscellaneous requests with his bank, such as for a statement or a new cheque book.

The heart of the Integrated Teller is a Computer Automation Incorporated LSI 2 mini computer and mass data storage is provided by a DR1 diskette holding 300,000 characters of information. Besides a magnetic stripe reading device associated with a card slot, the unit has a numeric keyboard and a small VDU screen having 16 lines with up to 36 characters



in each line.

Besides the Integrated Teller, Chubb's range includes a regional concentrator through which Tellers can be linked to the mainframe computer. In addition there is the cash card preparation system. Also in the range is the two-way data module used for stripping and diskette when used offline.

One of the modules in the range is a branch control unit. A bank branch could install one of these units to link not only its Integrated Tellers but also any other different terminal equipment (present or future) to the bank's

mainframe computer.

The devices in the MD.6000 range are designed to be exceptionally vandal-proof. While user banks will install some Integrated Tellers both inside and on the outside walls of their own premises, it is anticipated that they will install Tellers in places possibly remote from their own premises, such as in a shopping centre or airports.

Chubb Integrated Systems Limited has commissioned Logica, one of Europe's leading Computer Consultancies, to work closely with them on the detailed design and development of the MD.6000 Range.

SOLAR BATTERY A COMMERCIAL PROPOSITION

After eight years of research, a British company has developed a solar battery 125mm square that provides an output of 300mA at 2V in full sunlight.

The firm, which has been working on thin-film solar cells for space applications, is adapting its know-how to other fields including remote marine lights, buoys and other navigational aids.

Among the various terrestrial applications, also envisaged for solar batteries are portable flashing beacons, portable power supplies, water pumping and irrigation control, and television and domestic lighting in developing countries.

The company is interested in receiving enquiries about licence to manufacture; it is still engaged in work on further improving the unit.

Interested principals should write directly to *International Research and Development Co. Ltd., Fossway, Newcastle-upon-Tyne, Northumberland, NE6 2YD.*

OPTO-ELECTRONICS LITERATURE

Optical encoders are the subject of a new range of literature from the Ferranti Rotating Components Group in Dalkeith, Scotland. In all, three separate publications are available: two wall charts and a reference handbook. The wall charts deal with the absolute and incremental types of optical encoder, giving easy-to-read details of mechanical specifications and electrical performance.

The third publication, entitled 'Optical Incremental Shaft Encoders' is a 57-page handbook providing a detailed breakdown of the complete range of Ferranti incremental devices.



LIGHTING THE WAY

Many local authorities are now using a street lighting control system in which a photoelectric cell measures the light level and varies the input to a thick film heating element controlling a temperature sensitive switch. The street lights are therefore automatically switched on at dusk and off at dawn, which means that light is provided only when it is needed and ensures that electricity is not wasted.

The Microelectronics Division of EMI Electronics, the makers, has developed its thick film technology to the point where miniature heating elements used in bi-metal switches of this type can be operated consistently

at power ratings of up to 60 watts per square inch of film area in ambient temperature up to 90°C.

A recent order placed brings the total sales of thick film heaters specifically for street lighting control systems to well over a million units.

EMI thick film heaters also provide the controlling element in the totally enclosed systems, supplied to local authorities by Royce Thompson Electric Limited, which are used to good effect along many British main roads. An example of this is the overhead catenary system along parts of the A4 near London - one of only two such systems at present in use in this country.

EMI, Hayes, Middlesex.

ISOPLANAR UPGRADES PERFORMANCE OF NEW CMOS FAMILY

Fairchild have introduced a line of complementary MOS logic circuits that use Isoplanar processing to achieve high density and performance.

The new products, designated the 34000 series, are available in the industry standard 4000 series functions and pinouts. They mark the first application of Isoplanar technology to non-LSI circuits, as well as to CMOS.

All Fairchild CMOS devices are designed with a unique fully buffered circuit configuration which results in the highest guaranteed noise immunity of any 4000 series CMOS family. Typical noise immunity is equal to 45 percent of the supply voltage (3V to 15V). CMOS circuits, which combine n-channel devices on the same circuit "chip", also offer extremely lower power operation. Fairchild's CMOS gates have a typical quiescent power dissipation of 10 nanowatts, compared to 10 milliwatts for standard TTL gate. This is a power savings factor of one million. All Fairchild CMOS circuits have a standardised output drive of 400 microamps. This allows the units to drive low power TTL elements and low power Schottky TTL logic directly.

First products in the 34000 family are six logic gates. Additional gates, standard MSI parts and proprietary circuits are scheduled for introduction during 1974.

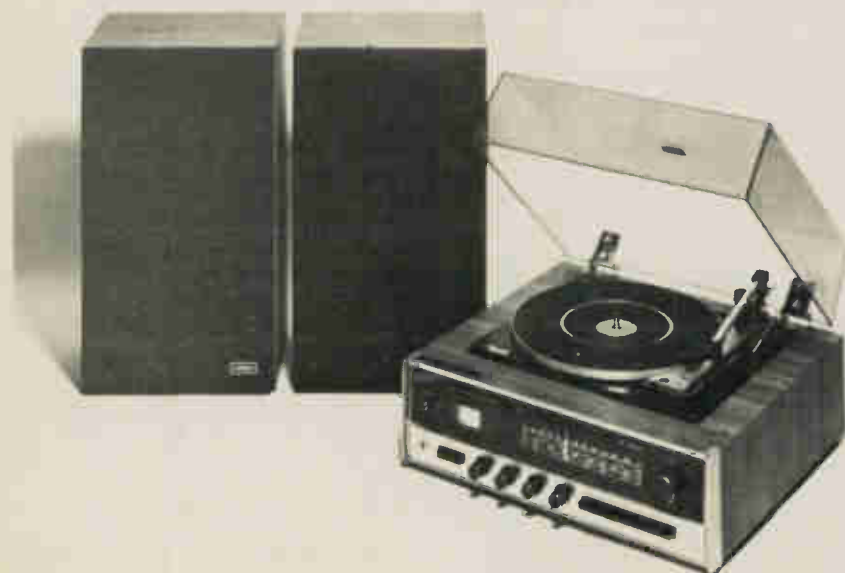
Fairchild Semiconductor Limited, Kingmaker House, Station Road, New Barnet, Herts.

STEREO UNITS

Three new medium price range stereo units have been announced recently by Hitachi. The units came onto the British market at the end of January.

The MC 3402, a record player AM/FM tuner stereo system, incorporating 5532 speakers retails at £198 and is aimed at the top end of the audio market. The power output is quoted as 32W peak music power. Another addition is the SP 2900, an 8-track cartridge stereo recorder with an AM/FM radio. Mains operated the SP 2900 retails at £159. It incorporates VU meters and 20W peak music power output.

The ST 3412 is the third new line being a stereo cassette recorder with AM/FM radio, with a distinctive white plastic design and curved styling has a recommended resale price of £109.



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BA5	4"	x	2 1/2"	41p
BA6	3"	x	2"	41p
BA7	7"	x	2 1/2"	86p
BA8	8"	x	3"	84p
BA9	6"	x	2"	54p

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UK300	4-channel Radio Control Transmitter	£8-58
UK310	Radio Control Receiver	£3-25
UK325	'GCX2' Channel splitting unit 1,000 & 2,000 Hz	£7-86
UK330	'GCX2' Channel splitting unit 1,500 & 2,500 Hz	£7-86
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1101 For model CCN240 1/2" 82p

1020 For model CCN240 1/2" 82p

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1022 For model G240 1/2" 82p

50 For model X35 3/4" 82p

51 For model X25 1/2" 82p

52 For model X25 3/4" 82p

ELEMENTS

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EG 240 £1-16 EX 25 £1-16

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Pack No.	Qty.	Description	Price
C1	250	Resistors mixed values approx. count by weight	0-55
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C3	50	Precision Resistors mixed values 1-2%	0-55
C4	75	1/2W Resistors mixed preferred values	0-55
C5	5	Pieces assorted Ferrite Rods	0-55
C6	2	Tuning Gangs, MW/LW VHF	0-55
C7	7	Pack Wire 50 metres assorted colours	0-55
C8	10	Reed Switches	0-55
C9	3	Micro switches	0-55
C10	15	Assorted Pots & Pre-Sets	0-55
C11	5	Jack Sockets 3 x 3.5m 2 x Standard Switch Type	0-55
C12	40	Paper Condensers preferred types mixed valued	0-55
C13	20	Electrolytics Trans. types	0-55
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0-55
C15	4	Mains Slide Switches, 2 Amp	0-55
C16	20	Assorted Tag Strips & Panels	0-55
C17	10	Assorted Control Knobs	0-55
C18	4	Rotary Wave Change Switches	0-55
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C20	4	Sheets Copper Laminate approx. 10" x 7"	0-55

PLUGS AND SOCKETS

Socket	Description	Price
PS 35	DIN 2 Pin (Speaker)	0-08
PS 36	DIN 3 Pin	0-10
PS 37	DIN 5 Pin 180°	0-10
PS 38	DIN 5 Pin 240°	0-10
PS 39	Jack 2.5mm Switched	0-09
PS 40	Jack 3.5mm Switched	0-10
PS 41	Jack 1/2" Switched	0-17
PS 42	Jack Stereo Switched	0-28
PS 43	Phono Single	0-06
PS 44	Phono Double	0-10
PS 45	Car Aerial	0-09
PS 46	Co-Axial Surface	0-09
PS 47	Co-Axial Flush	0-14

INLINE SOCKETS

Socket	Description	Price
PS 21	D.I.N. 2 Pin (Speaker)	0-13
PS 22	D.I.N. 3 Pin	0-17
PS 23	D.I.N. 5 Pin 180°	0-17
PS 24	D.I.N. 5 Pin 240°	0-17
PS 25	Jack 2.5mm Plastic	0-10
PS 26	Jack 3.5mm Plastic	0-12
PS 27	Jack 1/2" Plastic	0-24
PS 28	Jack 1/2" Screened	0-28
PS 29	Jack Stereo Plastic	0-22
PS 30	Jack Stereo Screened	0-32
PS 31	Phono Screened	0-14
PS 32	Car Aerial	0-15
PS 33	Co-Axial	0-17

PLUGS

Plug	Description	Price
PS 1	D.I.N. 2 Pin (Speaker)	0-11
PS 2	D.I.N. 3 Pin	0-12
PS 3	D.I.N. 4 Pin	0-15
PS 4	D.I.N. 5 Pin 180°	0-14
PS 5	D.I.N. 5 Pin 240°	0-15
PS 6	D.I.N. 6 Pin	0-15
PS 7	D.I.N. 7 Pin	0-18
PS 8	Jack 2.5mm Screened	0-10
PS 9	Jack 3.5mm Plastic	0-09
PS 10	Jack 3.5mm Screened	0-12
PS 11	Jack 1/2" Plastic	0-13
PS 12	Jack 1/2" Screened	0-18
PS 13	Jack Stereo Screened	0-29
PS 14	Phono	0-08
PS 15	Car Aerial	0-15
PS 16	Co-Axial	0-10

CABLES

Cable	Description	Price
CP 1	Single Lapped Screen	0-06
CP 2	Twin Common Screen	0-06
CP 3	Stereo Screened	0-08
CP 4	Four Core Common Screen	0-23
CP 5	Four Core Individually Screened	0-30
CP 6	Microphone Fully Braided Cable 10	0-07
CP 7	Three Core Mains Cable	0-07
CP 8	Twin Oval Mains Cable	0-06
CP 9	Speaker Cable	0-04
CP 10	Low Loss Co-Axial	0-10

CARBON POTENTIOMETERS

Potentiometer	Description	Price
VC 1	Single Leas Switch	0-14
VC 2	Single D.P. Switch	0-26
VC 3	Tandem Leas Switch	0-44
VC 4	1K Lin Leas Switch	0-14
VC 5	100K Log anti-Log	0-14

HORIZONTAL CARBON PRESETS

Resistor	Description	Price
100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M	0.1 watt 0-08 each	

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REPANCO TRANSFORMERS

Transformer	Primary	Secondary	Price	F & P
MT50/1	4V, 7V, 8V, 10V, 14V, 18V, 17V, 19V, 21V, 25V, 31V, 33V, 40V, 50V, and 25V-0-25V.	4V, 7V, 8V, 10V, 14V, 18V, 17V, 19V, 21V, 25V, 31V, 33V, 40V, 50V, and 25V-0-25V.	£1-93	30p
MT50/1			£2-42	35p
MT/502			£3-30	40p

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Holds 12. 10" x 3 1/2" x 5". Lock & Handle £1-30

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Holds 14. 13" x 5" x 6". Lock & Handle. £1-95
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COLOURS: Red, Black and Tan—Please state preference.

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ACOS GP91-18C	200mV at 1.2cms/sec £1-16	
ACOS GP93-1	280mV at 1cm/sec £1-65	
ACOS GP96-1	100mV at 1cm/sec £2-65	
TTC J-2005	Crystal/Hi Output 95p	
TTC J-20 10C	Crystal/Hi Output Compatible £1-10	
TTC J-200 CS	Stereo/Hi Output £1-60	
TTC J-2105	Ceramic/Med. Output £1-64	

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The E12 Range of Carbon Film Resistors. 1/2 watt available in PAKS of 50 pieces, assorted into the following groups:—
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R4 50 Mixed 100K ohms-1Meg. ohms 40p
THESE ARE UNEQUALLED PRICES—LESS THAN 1p EACH INCL. V.A.T.

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GUARANTEED. ALL FAMOUS MANUFACTURERS



1				25				100-				1				25				100-			
7400	0.18	0.17	0.16	7418	£1.10	£1.07	£1.05	74122	£1.50	£1.45	£1.40	74123	£3.00	£2.90	£2.80								
7401	0.18	0.17	0.16	7419	0.18	0.17	0.16	74124	0.85	0.82	0.79	74125	0.85	0.82	0.79								
7402	0.18	0.17	0.16	7420	0.18	0.17	0.16	74145	£1.65	£1.55	£1.45	74126	£1.50	£1.45	£1.40								
7403	0.18	0.17	0.16	7421	0.18	0.17	0.16	74150	£2.90	£2.80	£2.70	74127	£1.10	£1.05	£1.00								
7404	0.18	0.17	0.16	7422	0.18	0.17	0.16	74151	£1.30	£1.20	£1.10	74128	£1.10	£1.05	£1.00								
7405	0.18	0.17	0.16	7423	0.18	0.17	0.16	74152	£1.98	£1.90	£1.75	74129	£1.10	£1.05	£1.00								
7406	0.39	0.34	0.31	7424	0.41	0.39	0.35	74155	£1.50	£1.45	£1.35	74130	£1.10	£1.05	£1.00								
7407	0.39	0.34	0.31	7425	0.32	0.29	0.27	74156	£1.50	£1.45	£1.35	74131	£1.10	£1.05	£1.00								
7408	0.20	0.19	0.18	7426	0.40	0.39	0.35	74157	£2.00	£1.90	£1.80	74132	£2.10	£2.00	£1.90								
7409	0.20	0.19	0.18	7427	0.50	0.48	0.46	74160	£2.10	£2.00	£1.90	74133	£2.10	£2.00	£1.90								
7410	0.28	0.27	0.26	7428	0.74	0.71	0.64	74161	£2.10	£2.00	£1.90	74134	£2.10	£2.00	£1.90								
7411	0.39	0.34	0.31	7429	£1.30	£1.25	£1.21	74162	£4.40	£4.15	£3.85	74135	£4.40	£4.15	£3.85								
7412	0.32	0.31	0.30	7430	£1.20	£1.15	£1.05	74163	£2.20	£2.10	£2.00	74136	£2.20	£2.10	£2.00								
7413	0.48	0.44	0.42	7431	£3.50	£3.40	£3.30	74166	£3.20	£3.10	£3.00	74137	£2.50	£2.40	£2.30								
7414	0.48	0.44	0.42	7432	£0.95	£0.95	£0.94	74167	£1.75	£1.65	£1.55	74138	£1.75	£1.65	£1.55								
7415	0.48	0.44	0.42	7433	£1.20	£1.15	£1.05	74172	£1.85	£1.75	£1.65	74139	£1.75	£1.65	£1.55								
7416	0.48	0.44	0.42	7434	£1.10	£1.05	£1.05	74176	£1.85	£1.75	£1.65	74140	£1.50	£1.40	£1.30								
7417	0.17	0.16	0.16	7435	£3.50	£3.40	£3.30	74177	£1.85	£1.75	£1.65	74141	£1.50	£1.40	£1.30								
7418	0.55	0.53	0.50	7436	0.35	0.34	0.33	74178	£2.00	£1.90	£1.80	74142	£1.50	£1.40	£1.30								
7419	0.55	0.53	0.50	7437	£4.00	£3.75	£3.50	74179	£1.75	£1.65	£1.55	74143	£1.50	£1.40	£1.30								
7420	0.50	0.46	0.44	7438	£1.10	£1.05	£1.05	74180	£1.50	£1.40	£1.30	74144	£1.50	£1.40	£1.30								
7421	0.50	0.46	0.44	7439	0.74	0.71	0.64	74181	£1.50	£1.40	£1.30	74145	£1.50	£1.40	£1.30								
7422	0.55	0.53	0.50	7440	0.85	0.82	0.75	74182	£2.00	£1.90	£1.80	74146	£1.50	£1.40	£1.30								
7423	0.55	0.53	0.50	7441	0.85	0.82	0.75	74183	£3.20	£3.10	£3.00	74147	£1.50	£1.40	£1.30								
7424	0.50	0.46	0.44	7442	0.85	0.82	0.75	74184	£2.15	£2.10	£2.00	74148	£1.50	£1.40	£1.30								
7425	0.50	0.46	0.44	7443	£1.10	£1.05	£1.05	74185	£2.15	£2.10	£2.00	74149	£1.50	£1.40	£1.30								
7426	0.50	0.46	0.44	7444	£1.10	£1.05	£1.05	74186	£1.95	£1.90	£1.85	74150	£1.95	£1.90	£1.85								
7427	0.50	0.46	0.44	7445	£1.98	£1.95	£1.90	74187	£1.95	£1.90	£1.85	74151	£1.95	£1.90	£1.85								
7428	0.55	0.53	0.50	7446	£1.20	£1.15	£1.10	74188	£3.00	£2.75	£2.50	74152	£3.00	£2.75	£2.50								
7429	0.55	0.53	0.50	7447	£1.10	£1.05	£1.05	74189	£3.00	£2.75	£2.50	74153	£3.00	£2.75	£2.50								
7430	0.18	0.17	0.16	7448	0.74	0.71	0.64	74190	£3.00	£2.75	£2.50	74154	£3.00	£2.75	£2.50								
7431	0.50	0.46	0.44	7449	0.85	0.82	0.75	74191	£2.15	£2.10	£2.00	74155	£2.15	£2.10	£2.00								
7432	0.75	0.73	0.70	7450	0.85	0.82	0.75	74192	£2.15	£2.10	£2.00	74156	£2.15	£2.10	£2.00								
7433	0.70	0.68	0.65	7451	£1.50	£1.45	£1.40	74193	£2.15	£2.10	£2.00	74157	£2.15	£2.10	£2.00								
7434	0.70	0.68	0.65	7452	£1.07	£1.04	£1.00	74194	£2.15	£2.10	£2.00	74158	£2.15	£2.10	£2.00								
7435	0.18	0.17	0.16	7453	£1.07	£1.04	£1.00	74195	£2.00	£1.95	£1.90	74159	£2.00	£1.95	£1.90								
7436	0.74	0.71	0.64	7454	£1.07	£1.04	£1.00	74196	£1.95	£1.90	£1.85	74160	£1.95	£1.90	£1.85								
7437	0.74	0.71	0.64	7455	£1.07	£1.04	£1.00	74197	£1.95	£1.90	£1.85	74161	£1.95	£1.90	£1.85								
7438	£1.20	£1.15	£1.10	7456	£1.10	£1.05	£1.05	74198	£3.00	£2.75	£2.50	74162	£3.00	£2.75	£2.50								
7439	£1.20	£1.15	£1.10	7457	£1.10	£1.05	£1.05	74199	£3.00	£2.75	£2.50	74163	£3.00	£2.75	£2.50								
7440	£1.20	£1.15	£1.10	7458	£1.10	£1.05	£1.05	74200	£3.00	£2.75	£2.50	74164	£3.00	£2.75	£2.50								
7441	£1.20	£1.15	£1.10	7459	£1.10	£1.05	£1.05	74201	£3.00	£2.75	£2.50	74165	£3.00	£2.75	£2.50								
7442	£1.20	£1.15	£1.10	7460	£1.10	£1.05	£1.05	74202	£3.00	£2.75	£2.50	74166	£3.00	£2.75	£2.50								
7443	£1.20	£1.15	£1.10	7461	£1.10	£1.05	£1.05	74203	£3.00	£2.75	£2.50	74167	£3.00	£2.75	£2.50								
7444	£1.20	£1.15	£1.10	7462	£1.10	£1.05	£1.05	74204	£3.00	£2.75	£2.50	74168	£3.00	£2.75	£2.50								
7445	£1.98	£1.95	£1.90	7463	£1.10	£1.05	£1.05	74205	£3.00	£2.75	£2.50	74169	£3.00	£2.75	£2.50								
7446	£1.20	£1.15	£1.10	7464	£1.10	£1.05	£1.05	74206	£3.00	£2.75	£2.50	74170	£3.00	£2.75	£2.50								
7447	£1.20	£1.15	£1.10	7465	£1.10	£1.05	£1.05	74207	£3.00	£2.75	£2.50	74171	£3.00	£2.75	£2.50								

DEVICES MAY BE MIXED TO QUALIFY FOR QUANTITY PRICES (TTL 74 SERIES ONLY) DATA IS AVAILABLE FOR THE ABOVE SERIES OF I.C.'S IN BOOK FORM. PRICE 35P.

NOW WE GIVE YOU 50W PEAK (25W R.M.S.) PLUS THERMAL PROTECTION!

The NEW AL60 Hi-Fi Audio Amplifier

FOR ONLY £3.95

- Max Heat Sink temp 90°
- Thermal Feedback
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- 0.1% Distortion
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- Overall size 63mm x 105mm x 13mm



Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

FULLY BUILT - TESTED and GUARANTEED

STABILISED POWER

MODULE SPM80

£3.25



AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Main Transformer MT80, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 83mm x 105mm x 20mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p.

TRANSFORMER BMT80 £2.15 p. & p. 25p

INTEGRATED CIRCUIT PAKS

Manufacturers "Fall Outs" which include Functional and Part-Functional Units. These are classed as "out-of-spec" from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	-12 x 7400	0.55	UIC46	-5 x 7448	0.55	UIC90	-5 x 7490	0.55
UIC01	-12 x 7401	0.55	UIC48	-5 x 7448	0.55	UIC91	-5 x 7491	0.55
UIC02	-12 x 7402	0.55	UIC50	-12 x 7450	0.55	UIC92	-5 x 7492	0.55
UIC03	-12 x 7403	0.55	UIC51	-12 x 7451	0.55	UIC93	-5 x 7493	0.55
UIC04	-12 x 7404	0.55	UIC53	-12 x 7453	0.55	UIC94	-5 x 7494	0.55
UIC05	-12 x 7405	0.55	UIC54	-12 x 7454	0.55	UIC95	-5 x 7495	0.55
UIC06	-8 x 7406	0.55	UIC50	-12 x 7450	0.55	UIC96	-5 x 7496	0.55
UIC07	-8 x 7407	0.55	UIC70	-8 x 7470	0.55	UIC100	-5 x 74100	0.55
UIC10	-12 x 7410	0.55	UIC72	-8 x 7472	0.55	UIC121	-5 x 74121	0.55
UIC20	-12 x 7420	0.55	UIC73	-8 x 7473	0.55	UIC141	-5 x 74141	0.55
UIC30	-12 x 7430	0.55	UIC74	-8 x 7474	0.55	UIC151	-5 x 74151	0.55
UIC40	-12 x 7440	0.55	UIC78	-8 x 7478	0.55	UIC184	-5 x 74184	0.55
UIC41	-5 x 7441	0.55	UIC80	-5 x 7480	0.55	UIC193	-5 x 74193	0.55
UIC42	-5 x 7442	0.55	UIC82	-5 x 7482	0.55	UIC199	-5 x 74199	0.55
UIC43	-5 x 7443	0.55	UIC83	-5 x 7483	0.55			
UIC44	-5 x 7444	0.55	UIC86	-5 x 7486	0.55	UICX1	-25 Assorted 74's	1.55
UIC45	-5 x 7445	0.55						

Packs cannot be split, but 25 assorted pieces (our mix) is available as PAK UIO X1.

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO MONO switch, volume, balance and continuously variable bass and treble controls.

Frequency response 20Hz-20kHz ±1dB
Harmonic distortion better than 0.1%
Inputs: 1. Tape head, 1.25mV into 50KΩ
2. Radio, Tuner 35mV into 50KΩ
3. Magnetic P.U. 1.5mV into 50KΩ
All input voltages are for an output of 250mV.
Tape and P.U. inputs equalised to RIAA curve within ±1dB from 20Hz to 20kHz.

SPECIAL COMPLETE KIT MK50 COMPRISING 2 AL50's, 1 SPM80, 18MT80 & 1 PA100 ONLY £25.30 FREE p.&g



Linear I.C.'s—FULL SPEC.	DTL 930 SERIES LOGIC I.C.'s	DUAL IN-LINE SOCKETS.
72902 DIL 14 0.30 0.48 0.43	10900 0.15 0.14 0.13	14 & 16 Lead Sockets for use with DUAL IN-LINE I.C.'s. TWO Ranges PROFESSIONAL & NEW LOW COST
72910 DIL 14 0.35 0.33 0.30	10902 0.16 0.15 0.14	PROF. TYPE No. 1-24 25-99 100up.
72941 DIL 14 0.40 0.38 0.35	10903 0.16 0.15 0.14	TSO 14 pin type 33p 30p 27p
72944 DIL 14 0.45 0.43 0.40	10904 0.16 0.15 0.14	TSO 16 38p 35p 32p
72947 DIL 14 0.50 0.48 0.45	10905 0.16 0.15 0.14	TO 24 75p 70p 68p
72949 DIL 14 0.55 0.53 0.50	10906 0.16 0.15 0.14	LOW COST No.
81201 DIL 14 0.50 0.45 0.40	10907 0.15 0.14 0.13	BPS 8 pin type 13p 13p 11p
81204 DIL 14 0.50 0.45 0.40	10908 0.15 0.14 0.13	BPS 14 16p 14p 12p
81205 DIL 14 0.50 0.45 0.40	10909 0.15 0.14 0.13	BPS 16 17p 15p 13p
7AA283 DIL 14 0.40 0.38 0.35	81902 0.13 0.14 0.13	

MICROWAVE WEEDING

Microwave ovens have long been used for cooking and industrial heating. This same principle - of electromagnetic radiation - is now being used in an attempt to kill agricultural pests (i.e. insects, weeds, fungi) 'in situ'.

The method is attractive, to the agriculturist at least, in that no inorganic materials are left in the soil.

Power requirements are quite considerable, the energy source being a pair of 30kW klystron tubes powered by a diesel generator. The whole equipment package is mounted on a 16 ton vehicle, the wheels of which are spaced to travel along rows between plants.

Early experiments have shown that plant yield is as much as 60 per cent greater compared with hand weeding.

The technique currently being researched (by the Agricultural Research Service of the Dept. of Agriculture, Texas A & M University) consists of exposing the soil to radiation at a frequency of 2450MHz - the same frequency that is used in microwave ovens. If the radiation is absorbed by living tissue, the molecules are set into vibration and vital functions are disrupted.

SOYUZ 11 - WHAT REALLY HAPPENED

In June 1971, three Russian cosmonauts were found to be dead when their Soyuz spacecraft returned to earth.

USSR space authorities stated that the deaths were due to loss of cabin pressure on re-entry into the earth's atmosphere.

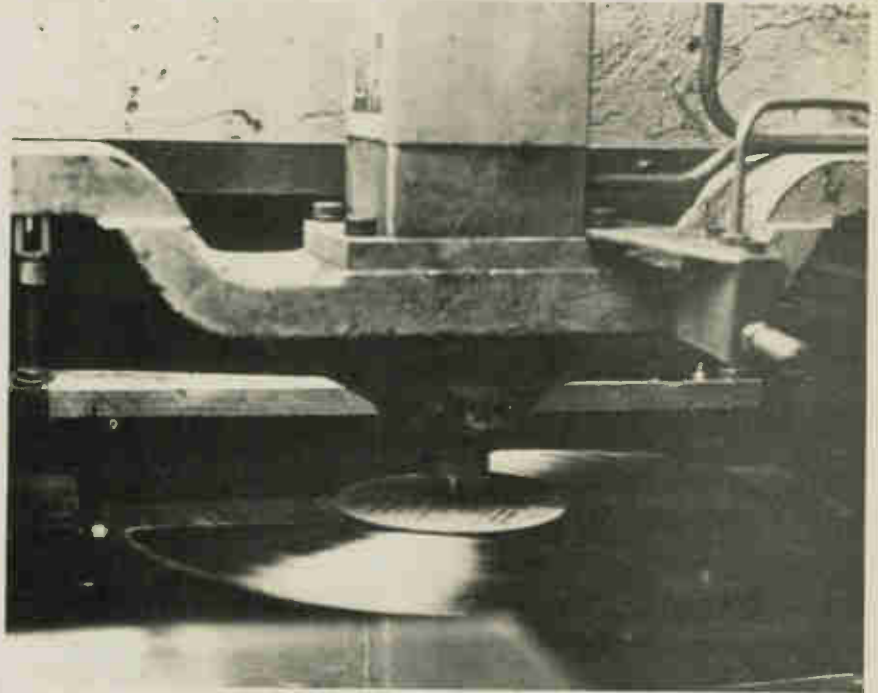
Academician Boris Petroc - in a Pravda article (July 4, 1971) hinted at mechanical failure, but USSR space authorities refused to give any further details.

Full details of the accident have now been revealed. Apparently the loss of cabin pressure was caused by excessively violent firing of the 12 explosive bolts used to join the re-entry capsule to the space vehicle. This accidentally loosened a safety valve cap which in turn triggered an exhaust valve. Cabin pressure was totally lost in 45 seconds.

Subsequent ground tests showed that 27 seconds were required to close the valve by hand, but this was a full 17 seconds longer than the crew could have remained conscious.

The explanation of the accident was provided at American insistence - during the second round of talks for the joint Soyuz-Apollo space mission held in Moscow on October 1 to October 17, 1973.

STATIC PROBLEM SOLVED



The growing demand for high quality, budget-priced records, coupled with constant progress and developments in modern audio equipment, has necessitated stringent specifications in record materials and surface qualities.

EMI Records, currently celebrating its 75th anniversary in the recording industry, has taken a major step to ensure top results at its record pressing plant.

These records are produced automatically on injection moulding machines, a hot plastic copy is taken from the highly-polished metal 'master disc' then is partially cooled, trimmed and ejected for packing into sleeves. Despite rigorous precautions, like full air conditioning of the production areas, a high static charge was generated as the pressings separated from the

metal master.

Because this charge could cause attraction of any minute dust particles from the edge trimming operation, it was therefore vital to remove the static from the process altogether.

The problem was solved when EMI incorporated a Model 210 12inch static eliminator bar from 3M United Kingdom Limited at a point where the vinyl pressings move forward to a rotary trimmer.

The Model 210 is a self-powered, compact device with no moving parts or wires that causes localised ionisation of the air, producing a conductive path to drain off any charges on an adjacent surface. By fitting the bar near the rotary trimmer, the static charge was instantly removed - as were any dust and dirt particles.

LOWER COST AND WIDER APPLICATION FOR LASER RECORDING SYSTEMS

The use of solid-state design could lower the cost of laser recording systems and eventually widen their range of application, according to an RCA engineer.

Gerald M. Claffie said that existing laser recording systems are typically bulky, mechanically elaborate and expensive. Mr. Claffie is an engineer at RCA's Advanced Technology Laboratories in Camden, New Jersey.

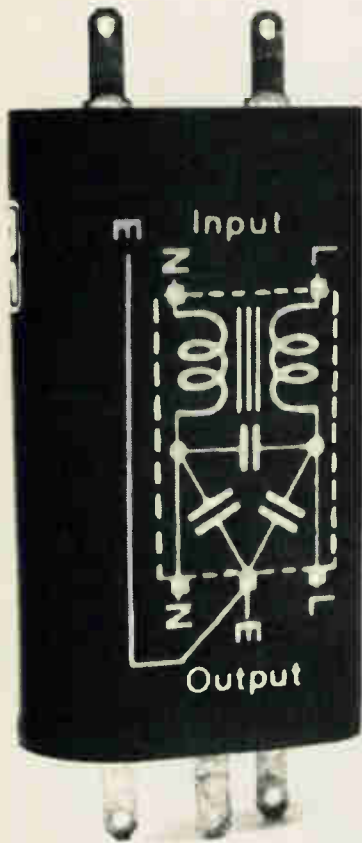
"Laser recording can be used for other than highly specialized applicat-

ions if the component cost is reduced and reliance on high-precision mechanical parts is minimized...and then reductions are feasible", Mr. Claffie said.

RCA has been researching the use of semiconductor devices and beam deflectors as replacements for the gas-laser external beam intensity modulators and rotating mirror assemblies currently used in laser recording systems.

"Laser diodes and acousto-optic beam deflectors... appear to be well suited for use in solid-state laser film recording systems of moderate complexity", Mr. Claffie said.

MAINS FILTER



One of the main problems with modern Hi-Fi equipment is their sensitivity to interference - especially mains borne pulses etc. The usual solution of wiring capacitors across the mains is rarely adequate. However R.S. Components have now added a 1A mains filter to their range which provides 40dB attenuation over the range 0.15-30MHz.

The unit which will retail around the £2.50 mark also has applications for business machines, teleprinters and digital circuitry.

POCKET-SIZED CALCULATOR

Hewlett-Packard have announced the introduction of the first pocket calculator to have full programming capability.

The new HP-65, similar in appearance and construction to the HP-35 and the HP-80 enables anyone to write and edit their own programs. They may also use precoded programs developed by Hewlett-Packard which solve many frequently encountered problems. The HP-65 is being launched on a world wide basis.

More than 250,000 Hewlett-Packard pocket-sized calculators are now in use throughout the world. The new HP-65 is a significantly more powerful version of its predecessors

and incorporates for the first time the capacity to prepare and edit programs and store them on tiny magnetic cards for reuse when needed.

"The HP-65 is a major advance in electronic calculator technology", said Mr. Robin Mansfield, calculator group manager at Slough, when introducing the new calculator at a news conference in London. "It expands Hewlett-Packard's line of programmable calculators from desktop units with full systems capability to the handheld HP-65 which offers new convenience in programming," he added.

Among the prerecorded programs available are programs to find L or C to resonate with a known L or C at some frequency; to compute the impedance of an arbitrarily long ladder network containing series or shunt R, L, and C, a transmission line impedance transformer, and S to Y parameter conversion and vice-versa; and to calculate six Fourier coefficients for any number of data points.

Medical users can get a total of 39 prerecorded programs from Hewlett-Packard. Included among these programs are IV Rate Calculations, Cardiac Output (Fick), Shunt Fraction, Cardiac Output (Gamma Variate), Male and Female Vital Capacity, Body

keystrokes. When a recorded program is no longer needed, the magnetic card can be erased on the same machine and reused to record another program. Accidental erasures can be prevented by clipping a corner of the magnetic card.

The user simply enters the program using the HP-65's keyboard. The program can be changed at any time. It is not necessary to rewrite the entire program when an error is made, as is the case with other small programmable calculators.

The program cards are easily entered into the calculator. One program containing up to 100 steps, or many programs totalling 100 steps, can be recorded on a single card.

The HP-65 allows the user to perform branches, logic comparisons and conditional skips in his programs as an aid to more efficient programming.

The keyboard has 51 calculating functions and data manipulation operations. Many of the keys can each perform four functions.

Included among the preprogrammed functions are the standard arithmetic operations, logarithms - both natural and common - square and square root, exponential, factorial, reciprocal and trigonometric functions. When used in a program, each of these built-in



Surface Area, (Dubois), Body Surface (Boyd), and O₂ Saturation and Content (Oxygen Dissociation).

With the HP-65, no previous programming experience is required. The calculator has five master keys (A-E) for storing and recalling programs written by the user. These programs can be called up at the touch of the appropriate key.

Editing is done with a few simple

functions occupies only one or two program steps.

The HP-65 can add and subtract in degrees, minutes and seconds format, allowing it to also perform calculations involving hours, minutes and seconds. It also will operate in any of three trigonometric modes - degrees, grads and radians - and will convert octal-based integer numbers to decimal-based integer numbers and back.

The HP-65 has nine addressable memory registers, resulting in far greater memory capacity than in any other pocket-sized calculator except the HP-45. This extended memory, plus the calculator's ability to perform 51 built-in functions, enable the user to solve complex multi-step problems with greater ease and in less time than possible with comparable desktop machines.

The nine memory locations permit register arithmetic. The user may specify which of the registers he wants to store a number in, recall it quickly, or combine it with other stored numbers.

Like other Hewlett-Packard pocket-sized calculators, the HP-65 has a four-register operational stack which stores intermediate answers and automatically brings them back when needed in calculation.

The LED display can be set to show results in either fixed or scientific notation. Up to 10 digits are displayed plus exponent and appropriate signs.

Rechargeable batteries operate the calculator for approximately three hours. It will also run on a.c. The HP-65 measures 15.25 cms by 8 cms by 3.5 cms.

COMPONENT PRICES

The relative stability of component prices of the last few years looks like ending with a bang. Worldwide shortages in almost every field together with the fall of sterling plus general inflationary trends all point to substantial increases during 1974. P.C. board raw materials increased by 20% in 1973 and expected to rise by even more in the near future.

Predictions of the average price rise vary enormously but we could find no one suggesting less than 15% and one estimate was as high as 50%.

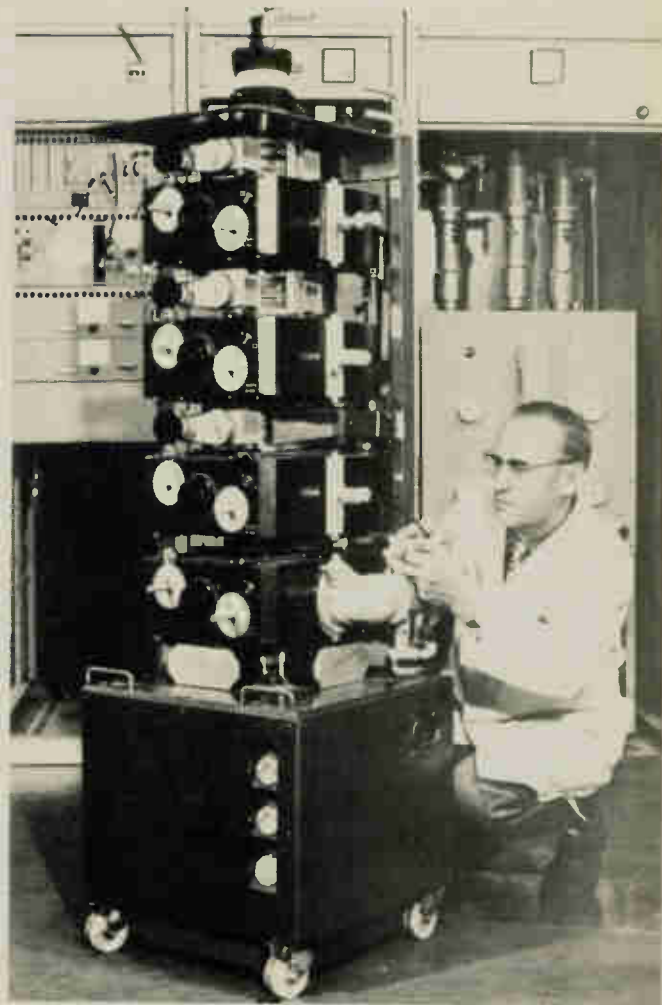
VOX BOX

Among new additions to the Amtron range of D-I-Y kits is a voice operated electronic switch known as the VOX-UK390. As well as acting as a transmit/receive switch, the unit, which has a 7 transistor circuit, provides about 60dB gain and acts as a preamplifier. The tripping time can be varied from one tenth of a second to two seconds.

There are both high and low impedance inputs with a 2000 ohm output impedance at 500mV. Power requirements are 12V at 150mA.

Amtron (UK) Limited, 4-7 Castle Street, Hastings, Sussex TN34 3DY.

A NEW UHF TV TRANSMITTER



At the end of last year the Deutsche Bundespost started operation of a new UHF TV transmitter in Regensburg in the Federal Republic of Germany. This transmitter is considered the first member of the so-called third generation. The system consists of two identical transmitters which by virtue of a suitable standby circuit allow continuity of operation in the face of abnormal conditions and which employ the same output tube both in the video and the sound sections. This type of transmitter has been jointly developed by Siemens and SEL to supersede the older transmitters now in use in Bands IV and V.

The use of a high-gain Klystron (Type YK 1151) in the video section and another in the sound section made it possible to apply the long sought-after '2 tube solution' to this 20kW TV transmitter as well. The use of the same type of tube in the power amplifiers results in a virtually identical video and sound output stage configuration, simple maintenance of a small replacement parts inventory in addition to true parallel feeding from common power supply. The new power klystron YK 1151 (Siemens and Valvo) is designed for an output

power in excess of 22kW and for the entire UHF range from 470 to 860MHz, thus covering the full range of Bands IV and V (channels 21 through 68). This air-cooled klystron with the resonator is mounted on a carriage which is moved into the video or the sound output stage of the transmitter as required. In addition to the common power supply for the video and sound output stages, a new solid-state prestage with sufficient output power for driving klystron YK 1151 directly has been devised. About 4W are required in the lower channels and 2.5W in the upper channels. New UHF transistors have enabled this power to be obtained while at the same time satisfying the Deutsche Bundespost specifications for signal quality with solid-state technology. With this new transmitting system it is also possible to emit a second frequency-modulated sound carrier (250kHz above the normal sound carrier). Both signals are combined in the IF position and jointly amplified in the klystron sound output stage. This second sound channel will become important when stereo broadcasts or multilingual programmes are to be televised.

PHOTOMULTIPLIER GUIDE

The Electron Tube Division of EMI has produced a photomultiplier tube replacement guide. It lists near and direct equivalents and contains an application index for about 150 tube types.

EMI photomultipliers are used mainly in two categories of radiation detection and measurement. One is direct measurement of electromagnetic radiation in the ultra violet, visible and infra red spectrum in the range ca. 170 nm to 1100 nm, such as is used in spectrometers, reflectometers, photometers etc. The other is measurement of nuclear radiation by using a scintillator material to convert nuclear energy into light which is detected by the photomultiplier tube. For instance, alpha, beta, gamma, X-ray and other charged and uncharged particles can be detected in this way.

Many tubes are equally suited to both techniques and the guide lists the main application groups, together with the tube types primarily associated with them. In addition to general purpose tubes for photometry and spectrophotometry EMI tube types cover special applications including infra red detection, photon counting, scintillation counting, fast pulse resolution and flying spot scanning. Tubes are also available for use in high temperature environments and where high vibration or shock will be encountered.

Copies of the replacement guide, which also contains a list of technical papers, are available free of charge from EMI Electronics Limited, Electron Tube Division, Blyth Road, Hayes, Middlesex.

COLOUR TV LICENCES EXCEED 5 MILLION

Although figures are not yet available from the Ministry of Posts and Telecommunications the 5 millionth colour TV licence was also certainly issued just before Christmas 1973.

Until recent credit clampdown sales and new rentals were running at around the 200,000 per month mark. UK colour TV production in 1973 is now known to have exceeded 2 million and to this must be added 700,000 imported sets. A recent estimate suggested that 1974 totals would be similar but that imports would fall to perhaps half the 1973 figures with a corresponding increase in home production. Recent political decisions and the economy cast doubt on these figures however.

The total number of all TV licences is now about 17.5 million of which over 30% are colour.

DOMESTIC EARLY-WARNING FIRE DETECTOR

A Products-Of-Combustion (POC) detector specially designed for protection of the home has been introduced by Helios. This new unit, the BRK Electronics Model 718S, is claimed to be the World's most advanced equipment of its type, and is the only domestic early-warning detector to be given full approval of the Underwriters Laboratory (USA).

It employs an extremely sensitive ionized-air type sensor, which responds to the imperceptibly small concentrations of atmospheric impurities that occur at the earliest stages of a fire starting - before either visible smoke or heat become apparent. Presence of these impurities triggers a circuit that activates a loud built-in electric horn, which continues to sound until switched off manually.



Completely self-contained and powered by an internal battery, the detector takes the form of a single compact unit measuring only 7" x 7" x 1", designed for easy fixing to ceiling or wall.

The only maintenance normally required is replacement of the internal battery - which should last for more than a year. It is an important feature of the unit that it fails safe when the battery approaches exhaustion; a warning signal is given by intermittent sounding of the alarm. This begins to occur at least ten days before the voltage falls below the minimum operating level.

For overall protection of property the Model 718S can also form the central unit of a complete warning system, provision being made in the unit for connection of remote alarms and external thermal sensors, all of which are available as accessories.

*Bowcom Electronics Limited,
13 City Road, Winchester, Hants.*

LOW COST GUNN OSCILLATORS FOR INTRUDER ALARMS

New X-Band Gunn-effect oscillators, types GDO 2-4, have been introduced by Plessey. They are solid state microwave sources designed specifically for intruder alarm applications in the frequency ranges 9.2 - 9.9GHz and 10.2 - 10.9GHz.



The oscillators are intended for fixed frequency operation and can be preset to any frequency in the above ranges. They have a frequency/temperature coefficient of -200kHz/°C maximum and a power/temperature coefficient of -0.02dB/°C maximum, over the temperature range -40°C to +70°C.

Plessey Optoelectronics and Microwave Unit, Wood Burcote Way, Towcester, Northants NN12 7JN.

PROGRAMMABLE LOGIC ARRAY

In the past, digital processors were designed with gates and flip-flops. Then along came read only memories (ROMS) which enabled the designer to programme logic in memory, thus simplifying system design. And now National Semiconductor has gone one step further with the Programmable Logic Array (PLA).

Called the DM7575/DM8575 and the DM7576/8576, the new bipolar monolithic integrated circuits are mask-programmable logic arrays intended to implement random logic. The PLA's have 14 data inputs and 8 outputs. Each output provides a sum of product terms where each product term can contain any combination of 14 variables or their complements. The total number of product terms which can be provided is 96. If the equivalent function were to be implemented in ROM, it would take a 128,000 bit memory.

Logically, the PLA looks like a bank of input receivers and two programmable logic matrices which transform the 14 inputs into 8 outputs. The first matrix forms the AND products and the second matrix OR's these products, forming the 8 products.

Each variable or its complement may appear in any product term, and every product may appear in any of the 8 output functions. Any product term which is repeated is counted only once, and since some functions are

Continued on page 68

INTERNATIONAL 420 4-CHANNEL AMPLIFIER

By BARRY WILKINSON



Simple, yet effective unit has SQ plus ambience decoding — and produces 15 watts per channel.

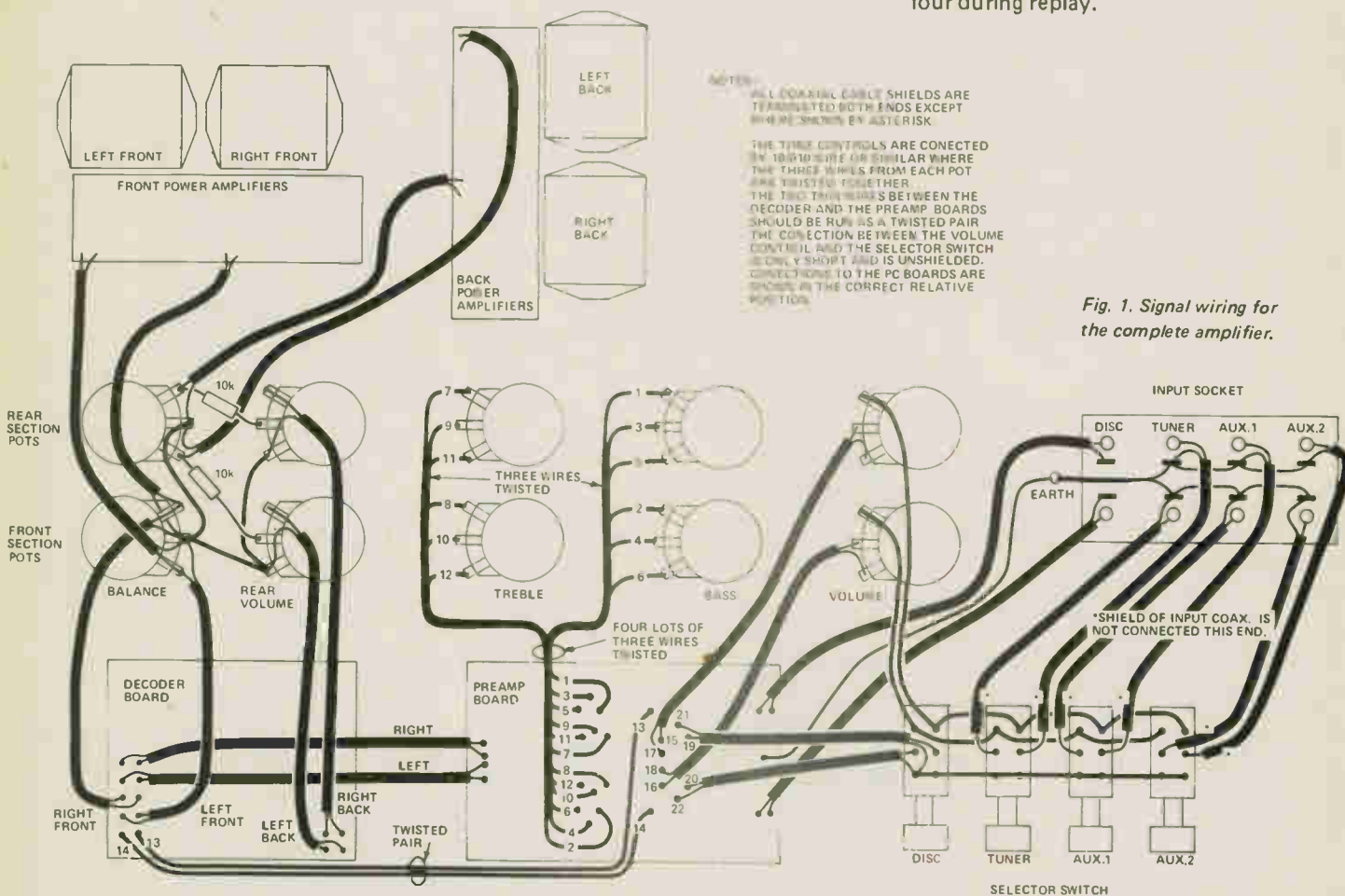
TWO basic, non-compatible methods are used to obtain four-channel sound from gramophone records.

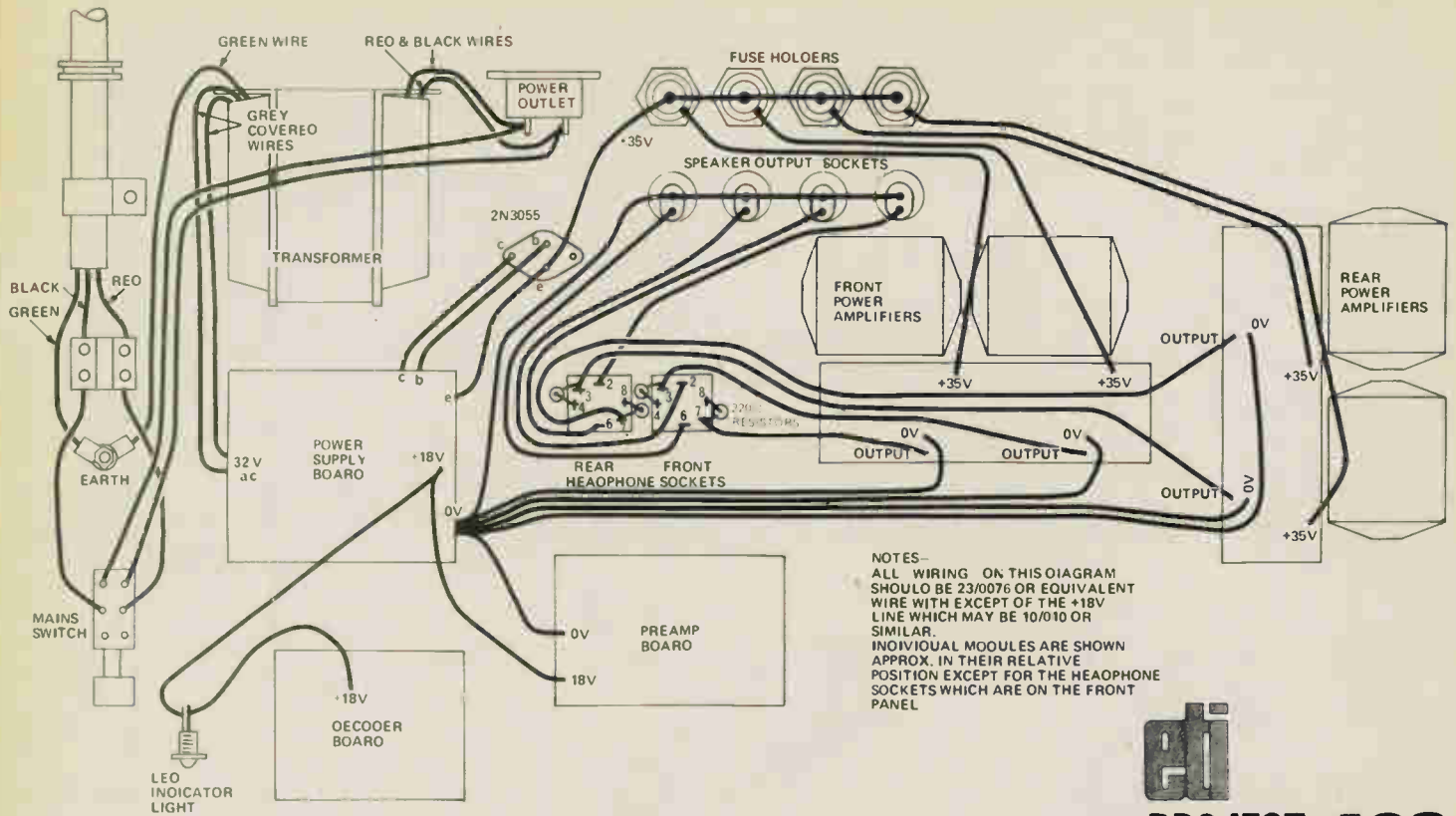
These are discrete, exemplified by JVC/RCA's CD-4 system; and the competing matrix systems, of which the Columbia SQ and the Sansui QS are best known.

Opinions differ as to which of the two main techniques has the most to offer.

Broadly, the discrete system has far better separation between channels — especially front-to-rear, but is more complex than the matrix systems. Furthermore a special cartridge and stylus is required.

All matrix systems are basically the same. Their only real differences lie in the proportions and phase relationships in which the original four channels of programme material are mixed down to two — and subsequently expanded out again to four during replay.





PROJECT 420

Channel separation of even very sophisticated matrix decoders is not as good as can be obtained from discrete units. Typically it is 10 dB left-to-right, and 3 dB or so front to rear — compared with the 20 dB — 40 dB and 20 dB respectively that is typically obtained from the CD-4 technique.

But against inferior channel separation, matrix systems are cheap, simple and relatively effective. So much so that over 100 makers of audio equipment worldwide now produce matrix four-channel systems, and of these, some 85 per cent use the so-called SQ coding/decoding technique.

The SQ system has also been chosen by the great majority of FM broadcasting stations. These stations transmit SQ matrixed programme material by conventional stereo broadcasting. The programmes are then decoded by the listeners' receiving equipment.

No special turntable, cartridge or stylus is required for use with SQ records.

Considering all the above, it is clear that the SQ system is by far the most commonly used today — hence our decision to use SQ decoding in the International 450 four-channel amplifier. We would however like to stress that this decision does not necessarily imply that we think that the SQ technique is the best

SPECIFICATION

OUTPUT POWER (at 1% distortion)

2 channels driven	15 W per channel
4 channels driven	12.5 per channel

DISTORTION	100 Hz	1 kHz	10 kHz
At 0.1 W output	0.15%	0.13%	0.25%
At 1 W output	0.14%	0.11%	0.18%
At 10 W output	0.14%	0.1%	0.15%

SENSITIVITY

Disc input	1.6 mW at 1 kHz
All other inputs	160 mV at 1 kHz

INPUT IMPEDANCE

All inputs	50 kohm
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SIGNAL TO NOISE RATIO (Stereo)

Disc re 10 mV input	70 dB
All other inputs	79 dB

DAMPING FACTOR

100 Hz	5
1 kHz	30
10 kHz	30

SQ DECODER PHASE SHIFT

100 Hz to 10 kHz within $\pm 10^\circ$

FREQUENCY RESPONSE

Tone controls flat	+ 0 dB at 10 Hz
	- 2 dB at 50 kHz
Treble control	- 10 dB at 10 kHz
	+ 11 dB at 10 kHz
Bass control	- 12 dB at 100 Hz
	+ 11 dB at 100 Hz

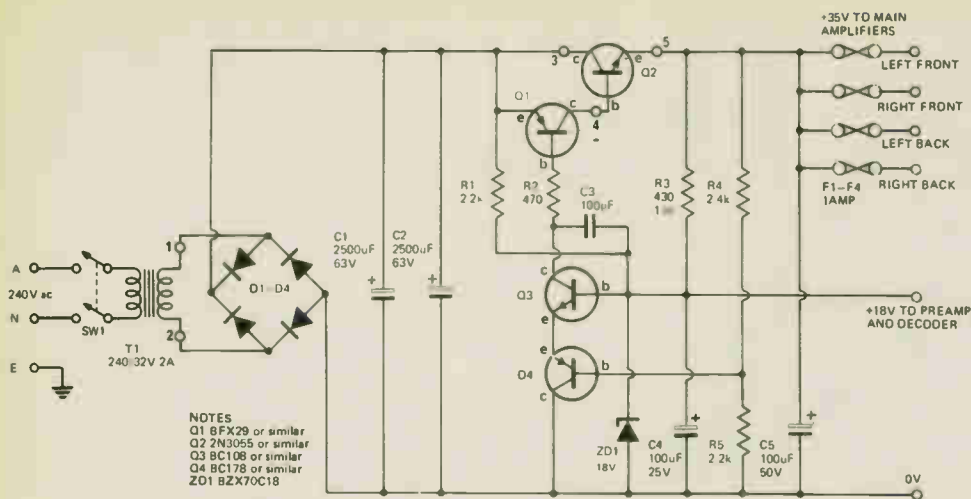


Fig. 3. Circuit diagram of the power supply.

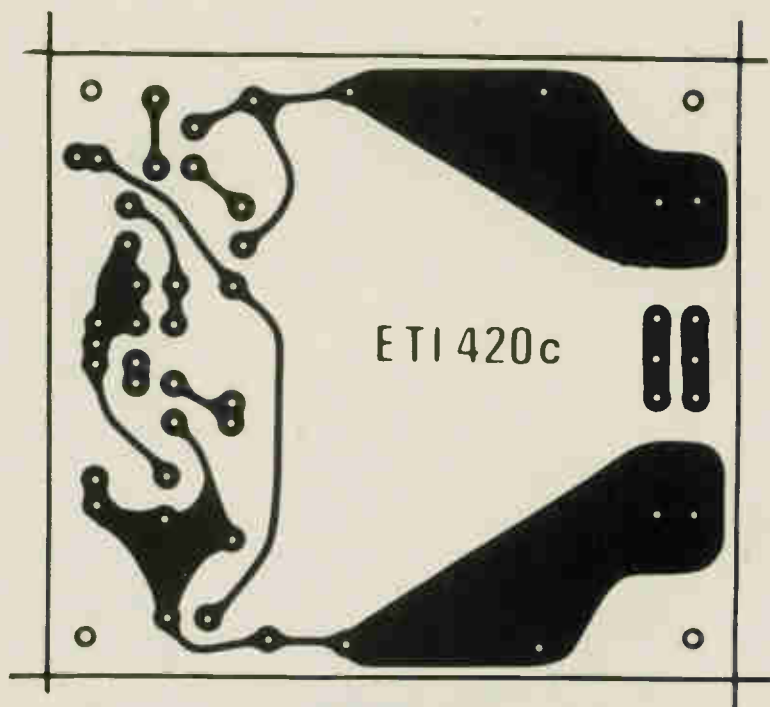


Fig. 4. Printed circuit board layout for the power supply.

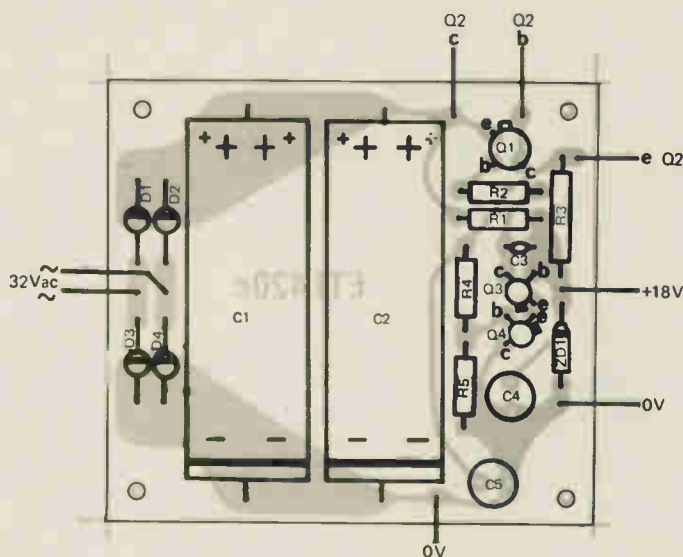


Fig. 5. Component overlay for the power supply.

technically — merely that it is the most successful commercially, and the only one for which programme material is really freely available.

Unlike a number of other four-channel amplifier projects published recently, the International 450 has been designed specifically for home construction. The unit is simple yet rugged — above all it is relatively easy to construct.

Heart of the unit is of course the SQ decoder. Here we have used Motorola's very latest SQ decoder integrated circuit type MC 1312P. This chip is produced under a licencing arrangement from the holders of the world patents, CBS. Price of the chip includes a licence fee which is paid by the seller to CBS. (For those interested in the techniques of SQ decoders we will shortly be publishing full constructional details of an SQ decoder using discrete components. Our experience is that performance of this latter decoder is better than the IC version, but not by any really substantial amount. It is of course far more complex).

Apart from the inbuilt SQ decoder, our new four-channel amplifier incorporates 'ambience' circuitry. This enables 'synthesized' four-channel reproduction to be obtained from normal stereo records.

HOW IT WORKS — POWER SUPPLY

Transformer T1 reduces the 240 Vac mains to 32 Vac which is then rectified by D1 — D4 and smoothed by capacitors C1 and C2. This provides a no-load voltage of about 48 V dc.

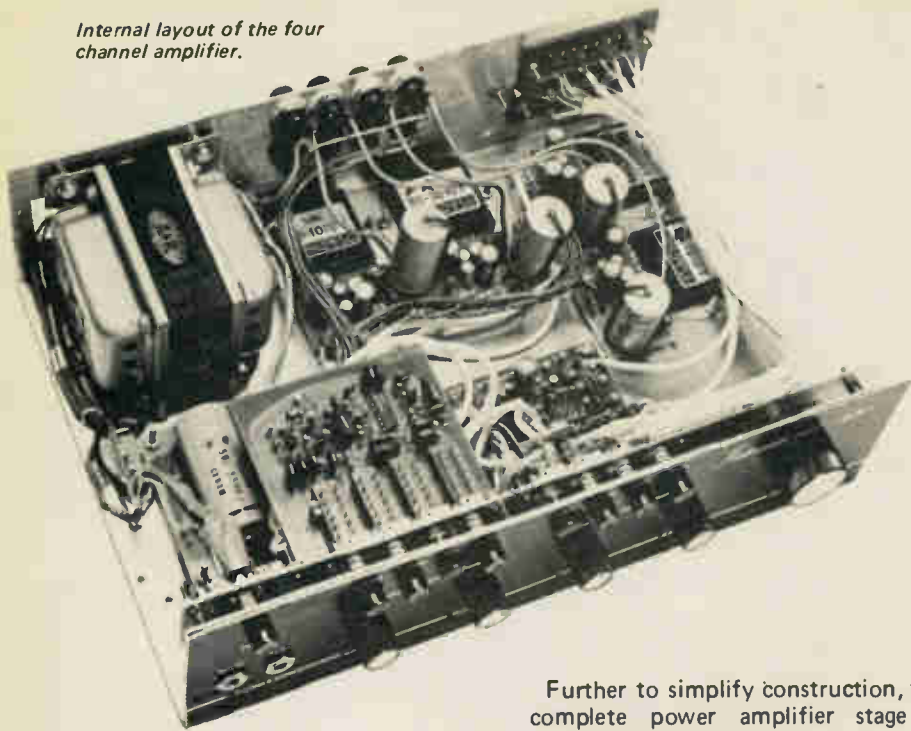
Since this is in excess of the maximum allowable for the power module, a series regulator is used to provide a maximum of 35 V regardless of load. Transistor Q2 is the series regulator transistor, and as it dissipates a fair amount of heat it is mounted on the rear panel (but insulated from it) and has a plastic cover fitted to prevent damage to the transistor by accidental shorts.

Zener diode ZD1 (18 V) provides the reference voltage for the regulator. Transistors Q3 and Q4 compare the zener voltage with the output voltage (divided by R4/R5) and hence provide a control voltage to Q1 which in turn controls Q2. The final output voltage is thus:

$$V_o = (V_z - 1.2) \times \frac{R4 + R5}{R5}$$

Fuses are incorporated in the

Internal layout of the four channel amplifier.



Further to simplify construction, the complete power amplifier stage is based on four hybrid amplifier modules. These modules are again, simple, cheap and effective.

CONSTRUCTION

The individual printed circuit boards should be assembled in accordance with the respective overlays. Care should be taken with regards to the polarities of all polarized components such as integrated circuits, diodes, capacitors and transistors etc.

Before soldering the power modules to the power amplifier boards, fit the boards and modules to the chassis and check alignment of the board and module since it is essential that the completed assembly aligns with the mounting holes later.

The mode selector switch is mounted directly onto the decoder printed circuit board. Press the switch fully home into the printed circuit board and solder all the pins to the board.

ASSEMBLY AND INTERCONNECTION (Refer to Figs. 1 and 2)

1. Fit the grommet and the clamp.
2. Fit the power transformer to the rear panel using ¼ inch (6 mm) spacers (to allow room for the wires to come out). Orientate the transformer so that the red and black mains input leads are on the right-hand side.
3. Mount potentiometers and power switch to the support bracket, Fig. 19, and mount the bracket on the chassis on ½ inch (13 mm) spacers, retained by countersunk screws. Cut the potentiometer shafts to the correct length for the knobs being used.
4. Mount the external power socket, speaker outlets, fuses, input sockets and the power transistor to the rear panel. The power transistor must be mounted with insulating hardware. An insulating cover should be fitted to the transistor to prevent accidental shorts.
5. Fit a two-way terminal block, in the position shown in Fig. 2, in front and to the left of the power transformer. A screw should be fitted to the chassis just in front of the terminal block to which should be clamped the mains earth and the transformer earth. No other leads should be attached to this point.
6. The red and black wires from the power transformer should be terminated into the power outlet socket (one wire to each terminal) and two more wires should be taken from the power outlet socket to the mains power switch. Two further wires are then taken from the power switch to the mains terminal block as shown in Fig. 2.

Note that all wiring in the above section should be insulated for 240 Vac. All exposed 240 V connections, i.e. the power switch and output socket, should be well wrapped with insulating tape as a precaution against electrical shock whilst servicing the unit.

output of the main amplifier modules to protect them from damage due to accidentally shorted speaker leads, and in addition, protect the regulator from overload.

As current limit is not provided for the regulator itself, care should be taken not to cause any shorts on the regulator side of the track, such shorts could damage the regulator.

The 18-volt zener also provides a regulated supply for the power amplifier and decoder boards. The 18-volt supply to the decoder board goes via a series LED indicator which also provides a power-on indication.

Most of the power amplifier circuitry is contained within the Sanken 51-1010 amplifier modules and there is little point in describing the operation of these modules. The gain of the power amplifier is determined by the value of R1. The higher the value, the higher the gain. With 2.2 k the sensitivity is 650 mV R.F. for 10 W and with 4.7 k the sensitivity is 250 mV R.F. for 10W. The higher gain is used in the four channel amplifiers to obtain a greater control range for the main volume potentiometers.

PARTS LIST POWER SUPPLY

R1	Resistor	2.2k	½W	5%
R2	"	470	"	"
R3	"	430	1W	"
R4	"	2.4k	½W	"
R5	"	2.2k	"	"
C1,2	Capacitor	2500µF	63V	electrolytic
C3	"	100pF		ceramic
C4	"	100µF	25V	electrolytic PC mounting
C5	"	100µF	50V	electrolytic PC mounting
Q1	Transistor	BFX29		or similar
Q2	"	2N3055		or similar
Q3	"	BC108		" "
Q4	"	BC178		" "
D1-D4	Diode	50V	2A	
ZD1	Zener diode	BZX70C18		
T1	Transformer	240V/32V	@ 2A	
SW1	Switch (Isostat)	—see page 25		
PC Board ET1 420				
F1-F4 1 Amp Fuse and panel mounting holders				
Cover for 2N3055 transistor				
Insulator kit for 2N3055				

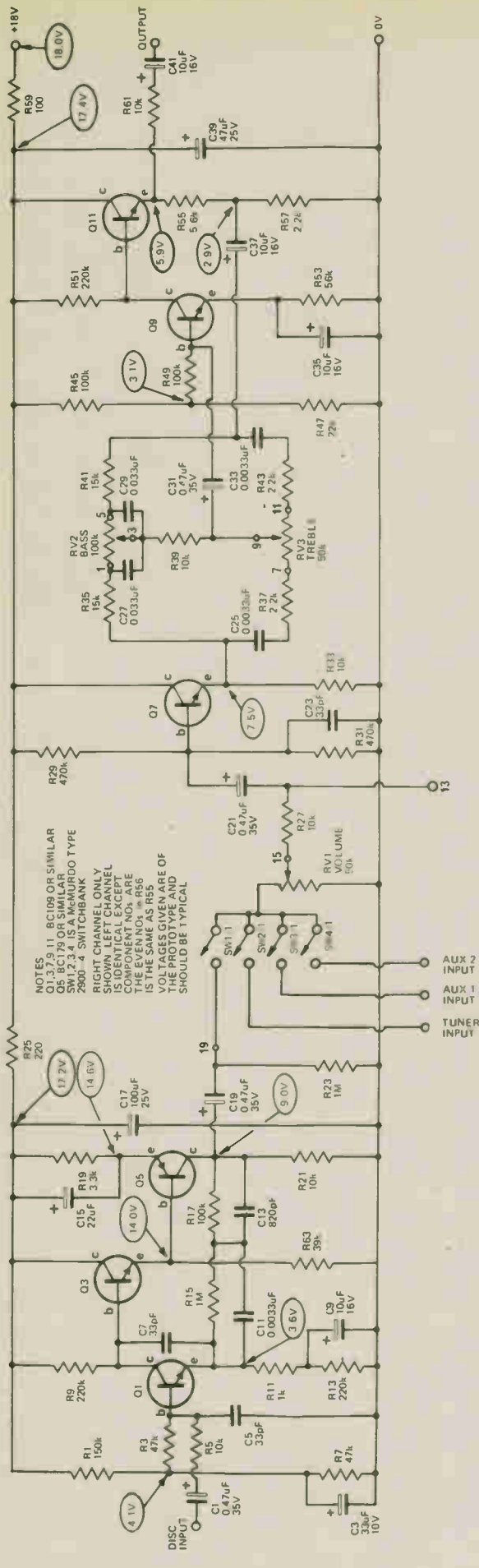


Fig. 6. Circuit diagram of the preamplifier.

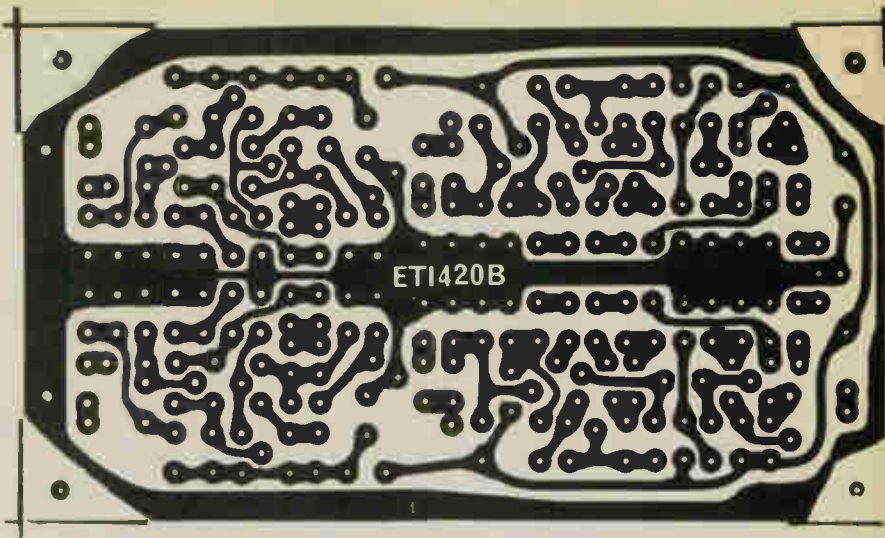


Fig. 7. Printed circuit board for the preamplifier (full size).

PARTS LISTS			
PREAMPLIFIER			
R1,2	Resistor	150k	1/4 or 1/2 W 5%
R3,4,7,8	"	47k	"
R5,6,21,22,27,26,33,34,39,40,61,62	"	10k	"
R9,10,13,14,51,52	Resistor	220k	"
R11,12	"	1k	"
R15,16,23,24	"	1M	"
R17,18,45,46,49,50	"	100k	"
R19,20	"	3.3k	"
R25,28	"	220Ω	"
R29,30,31,32	"	470k	"
R35,36,41,42	"	15k	"
R37,38,43,44,57,58	"	2.2k	"
R47,48	"	22k	"
R53,54	"	5.6k	"
R55,56	"	5.6k	"
R59	"	100Ω	"
R63,64	"	39k	"
C1,2,19,20,21,22,31,32	Capacitor	0.47μF 25V tag tantalum	
C3,4	"	33μF 10V electrolytic or tag tantalum *	
C5,6,7,8,23,24	"	33pF ceramic	
C9,10,35,36	"	10μF 16V electrolytic or tag tantalum *	
C11,12,25,26,33,34	"	0.0033μF polyester	
C13,14	"	820pF ceramic	
C15,16	"	22μF 16V electrolytic or tag tantalum *	
C17,18	"	100μF 25V electrolytic	
C27,28,29,30	"	0.033μF polyester	
C37,38,41,42	"	10μF 16V tag tantalum	
C39	"	47μF 25V electrolytic	
* PC Mounting capacitor			
RV1	Potentiometer	50k log dual rotary	
RV2	"	100k lin dual rotary	
RV3	"	50k lin dual rotary	
Q1,2,3,4,7,8,9,10,11,12	Transistor	BC109, BC549 or similar	
Q5,6	"	BC179, BC559 or similar	
SW1-4	Switch assembly (Isostat)	—see page 25	
PC board ET1 420 B			

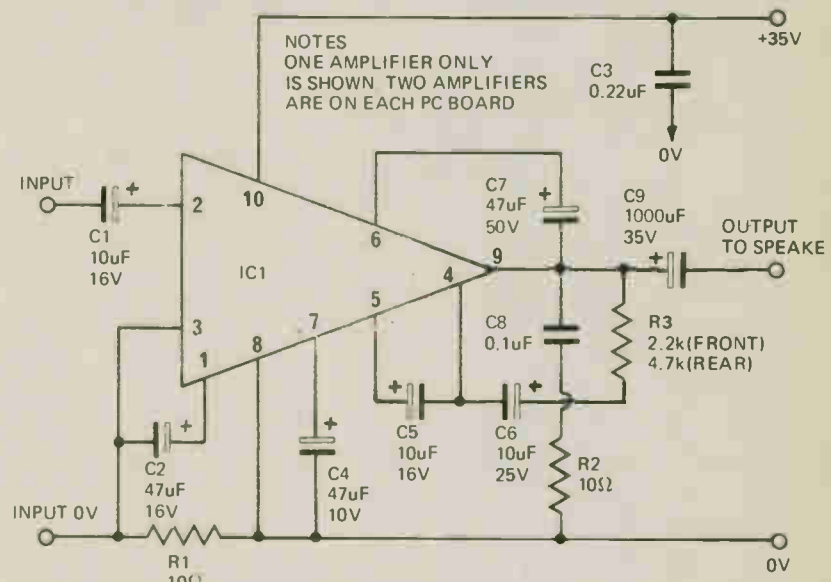


Fig. 9. Circuit diagram of one power amplifier module (two per assembly).

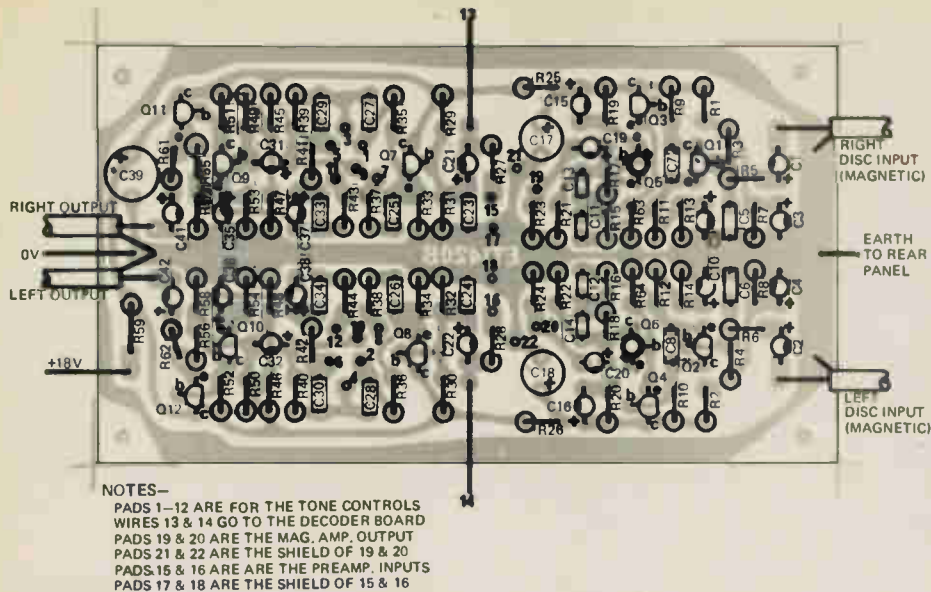


Fig. 8. Component overlay for the preamplifier.

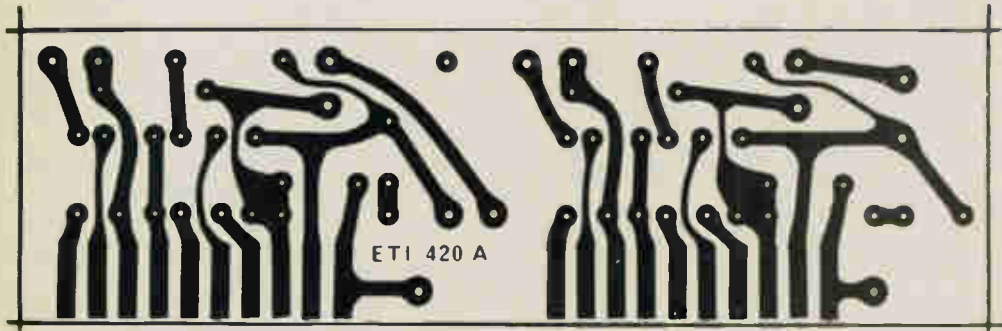


Fig. 10. Printed circuit board for the twin power amplifier assembly.

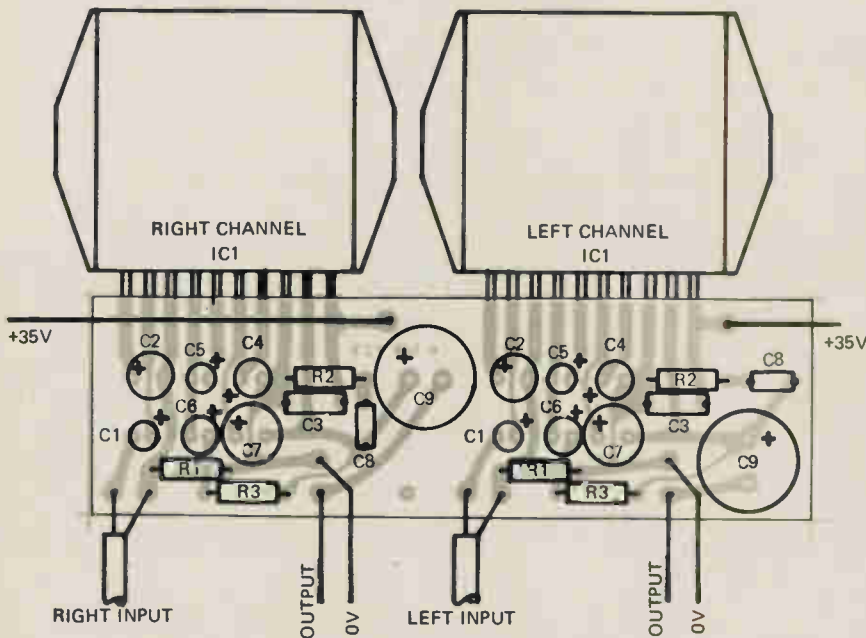


Fig. 11. Component overlay for the twin power amplifier assembly.

HOW IT WORKS — PREAMPLIFIER

The output level of a magnetic cartridge may be as low as 1 mV and this must be amplified and equalized 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, 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 1 kHz gain is being approximately 2.

When monophonic mode is selected the outputs are combined after the volume control.

7. On the power amplifier boards, connect leads for +35 V, 0 V and the speaker output. Allow plenty of length for these wires so that they may be loomed up later. The wire gauge used for these leads should preferably be 23/0076. At this time also connect the input screened cables to these boards making sure that the screen is also connected to the board at this end.

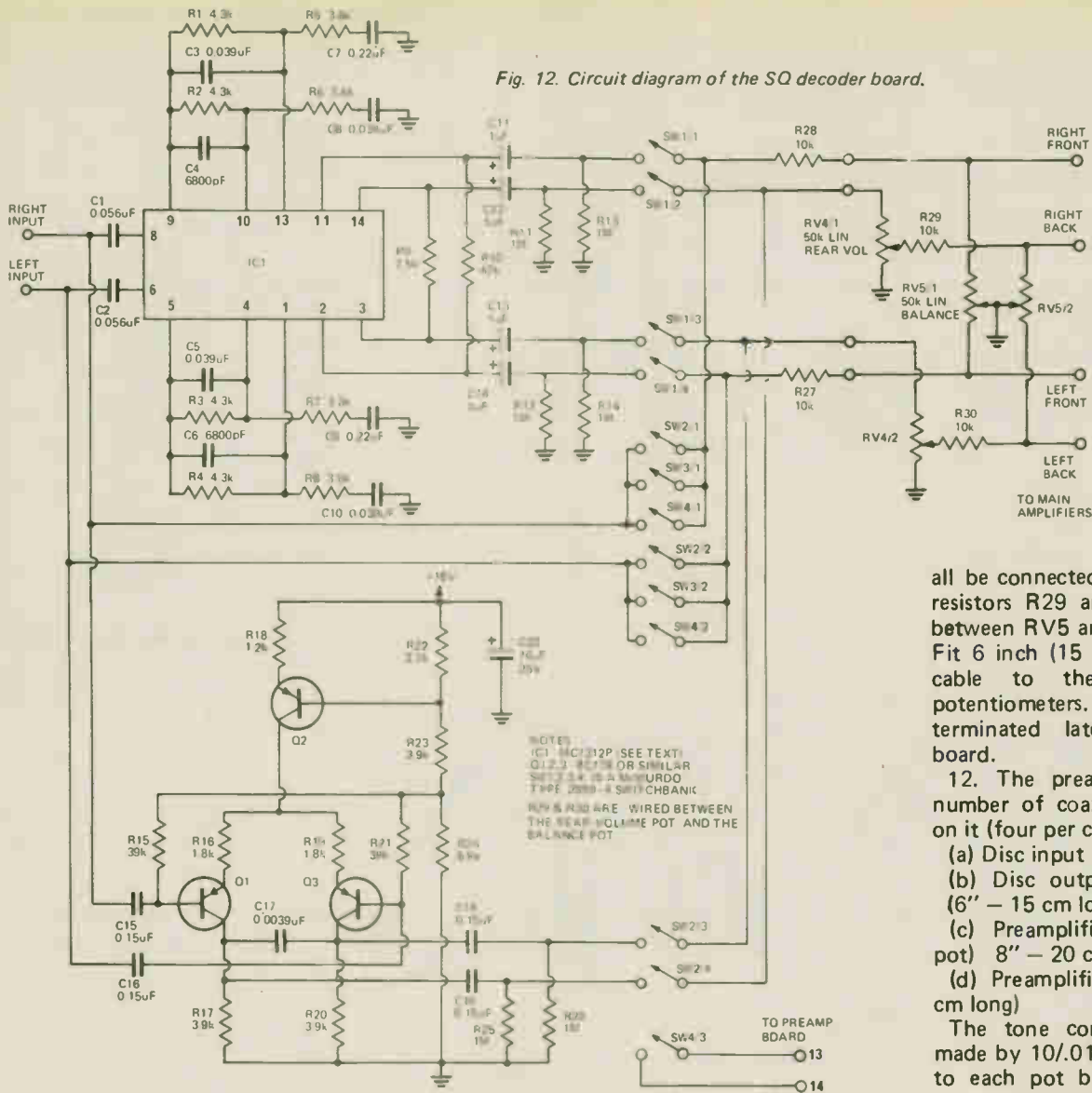
8. Mount the two power amplifier boards into the chassis. The modules are bolted directly to the chassis and the boards are supported by 1/4" (6 mm) spacers.

9. The power supply may now be installed. Wires may be soldered directly to the printed circuit board, or, to pins inserted in the appropriate places on the board. The power transistor (mounted on the rear of chassis) should be connected to the power supply board using 23/0076 wire. Connect all the 0V lines to the board at this time, plus the single +35 V line which goes directly to the fuse holders on the rear panel. If it is decided to solder wires direct to the underside of the board, make sure the leads are left long enough to gain access to the bottom of the board later.

10. The speaker sockets, phone jacks and +35 V supply lines to the power amplifier (from the fuses) may now all be connected using 23/0076 wire.

11. Terminate the power amplifier input cables onto the balance control (RV5). The wipers (centre contact) of these potentiometers are at 0 V and hence the shields of the cables should

Fig. 12. Circuit diagram of the SQ decoder board.



all be connected to these points. Two resistors R29 and R30, are mounted between RV5 and RV4 (rear volume). Fit 6 inch (15 cm) lengths of coaxial cable to the inputs of these potentiometers. The other ends will be terminated later, on the decoder board.

12. The preamplifier board has a number of coaxial cables terminated on it (four per channel) these are:-

- (a) Disc input (12" - 30 cm long)
- (b) Disc output to selector switch (6" - 15 cm long)
- (c) Preamplifier input (to volume pot) 8" - 20 cm
- (d) Preamplifier output (10" - 25 cm long)

The tone control connections are made by 10/010 wire, the three wires to each pot being twisted together.

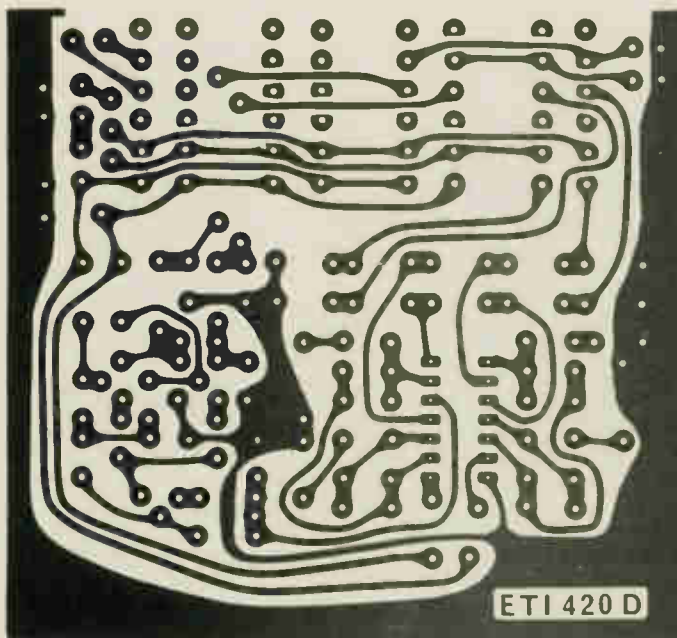


Fig. 13. Printed circuit board for the SQ decoder.

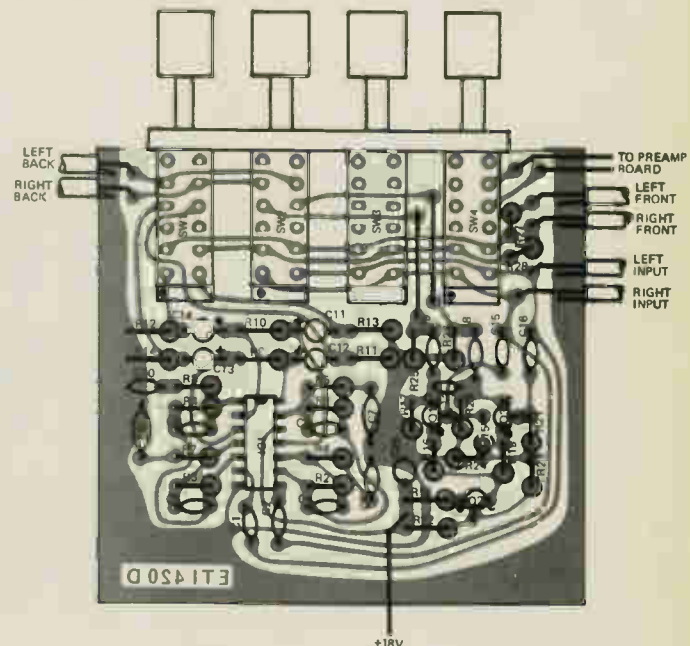


Fig. 14. Component overlay for the SQ decoder.

INTERNATIONAL 450 4-CHANNEL AMPLIFIER

PARTS LIST AMPLIFIER			
R1,2	Resistor	10 Ω	1/2W 5%
R3, (front amps)	"	2.2k	" "
R3 (rear amps)	"	4.7k	" "
C1,5	Capacitor	10 μ F 16V	electrolytic*
C2	"	47 μ F 16V	" "
C3	"	0.22 μ F	polyester
C4	"	47 μ F 10V	electrolytic*
C6	"	10 μ F 25V	" "
C7	"	47 μ F 50V	" "
C8	"	0.1 μ F	polyester
C9	"	1000 μ F 35V	electrolytic*

*all electrolytic should be PC mounting type.
IC1 Amplifier Module Sanken S1-1010Y
PC Board ETI 420A (pc board holds two amplifiers)

See page 25 for special offer on Sanken Modules

PARTS LIST DECODER			
R1,2,3,4	Resistor	4.3k	1/4 or 1/2W 5%
R5,6,7,8	"	3.6k	" "
R9	"	7.5k	" "
R10	"	47k	" "
R11,12,13,14,25,26	"	1M	" "
R15,21	"	39k	" "
R16,19	"	1.8k	" "
R17,20,23	"	3.9k	" "
R18	"	1.2k	" "
R22	"	2.7k	" "
R24	"	6.8k	" "
R27,28,29,30	"	10k	" "
RV4	Potentiometer	50k	Lin Dual Rotary
RV5	"	50k	Lin Dual Rotary
C1,2	Capacitor	0.056 μ F	polyester
C3,5,8,10	"	0.039 μ F	" "
C4,6	"	0.0068 μ F	" "
C7,9	"	0.22 μ F	" "
C11,12,13,14	"	1 μ F 25V	electrolytic or tag tantalum
C15,16,18,19	"	0.15 μ F	polyester
C17	"	0.0039 μ F	" "
C20	"	10 μ F 25V	electrolytic or tag tantalum
IC1	Integrated circuit	MC 1312P	(see page 25)
Q1,2,3	Transistor	BC178, BC558	or similar (Isostat)—see page 25
SW1,2,3,4	Switch bank		
PC Board	ETI420D		

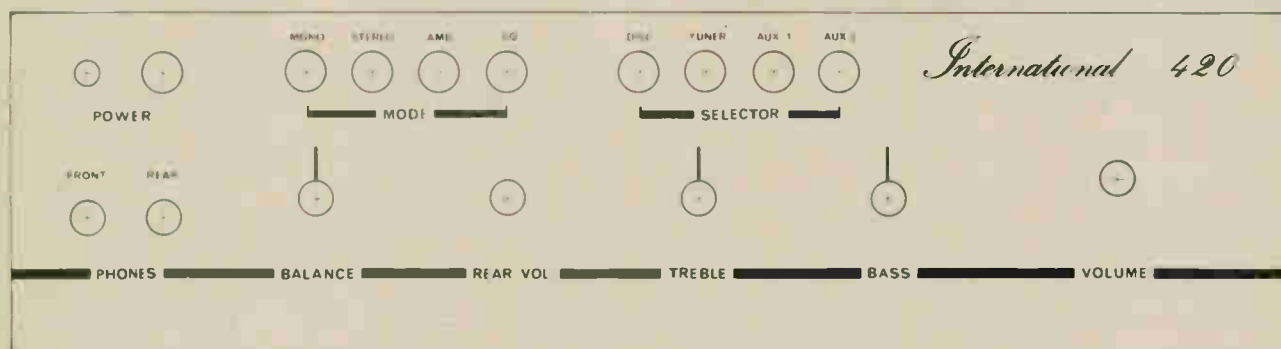


Fig. 15. Artwork for front panel escutcheon of the ETI 420 four channel amplifier.

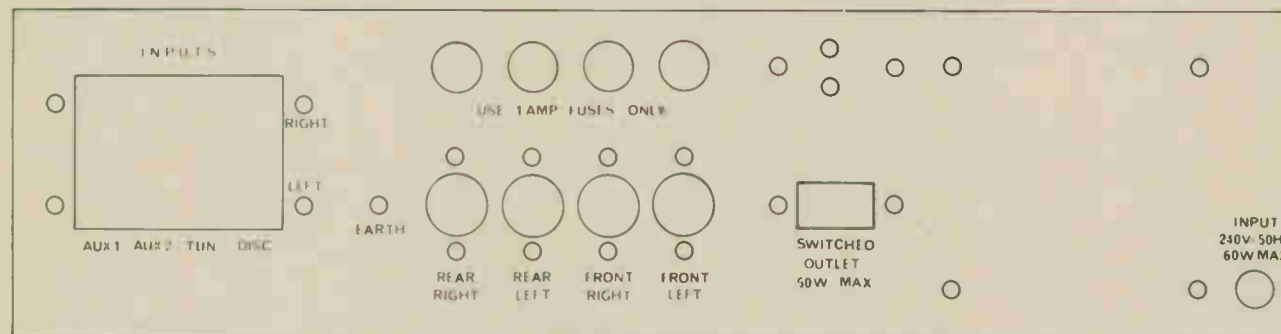


Fig. 16. Artwork for the rear panel.

HOW IT WORKS — DECODER

To properly decode SQ records it is necessary to phase shift the input signals and then selectively mix the phase shifted and original signals to synthesize the four outputs required. The Motorola IC, MC1312P, with the aid of a few external components, provides the four outputs very simply.

With conventional stereo records a mode of synthesizing four channel, known as 'Ambience Mode', has been used. This is quite effective and very simple. Normally in this method the two rear speakers are connected in

series, but in anti-phase, across the live outputs of the front speakers. In our case it is difficult to interface this system directly without complex switching. As we must use the rear-channel power amplifiers, we perform the same function by using a differential amplifier Q1, Q2 and Q3, the output of which is simply the difference of the two input signals with two outputs in antiphase. Switches SW1, 2, 3 and 4 select the appropriate output.

Allow about 6 inches (15 cm) for each lead. A further twisted pair is fitted between the preamplifier and decoder boards for 'mono' mode selection. Allow about 8 inches (20 cm) of wire, and an earth lead is connected to the rear panel earth lug.

Note that on the input phono sockets all commons are tied to the rear panel earth lug with the exception of those for the disc input which are individually connected to the preamplifier board.

The preamplifier power rails can now be connected and the preamplifier board bolted into position using 1/4

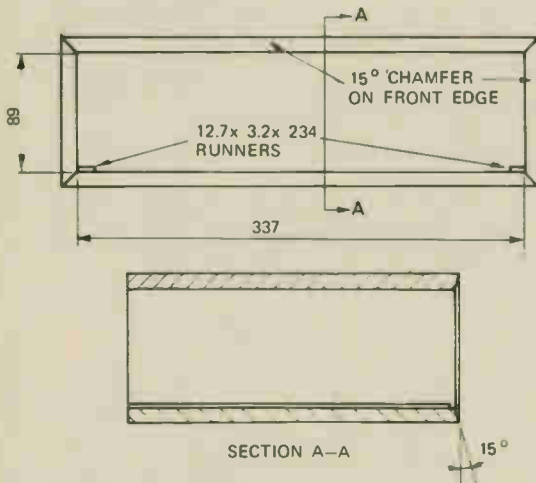
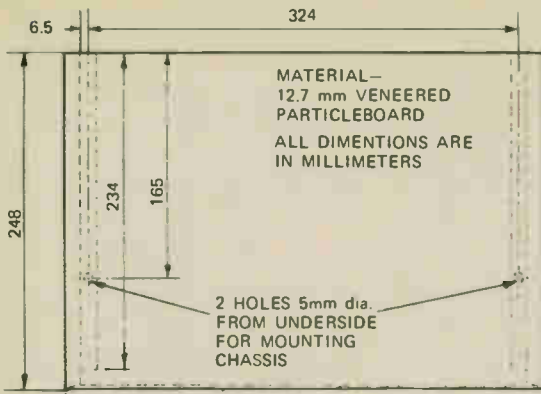


Fig. 17. Constructional details of the cabinet.

Fig. 18. Drilling details for front panel escutcheon.

PARTS LIST

CHASSIS AND MISCELLANEOUS

- 14 spacer 1/4" long
- 5 spacer 1/2" long
- LED indicator TIL209 or R.S. Components LED3 (Red)
- 4 small knobs
- 1 large knob
- 2 stereo phone jack
- 4 220Ω 1/2W resistor phone jack
- metal chassis to Fig. 20
- metal bracket to Fig. 19
- front panel to Fig. 18
- wood box to Fig. 17
- 4 two-pin DIN sockets
- 2 4 way phono sockets
- earth terminal for rear panel
- Bulgin power outlet
- Mains cord, grommet and clamp
- 2 way terminal block
- nuts bolts and washers
- 23/0076 wire
- 10/010 wire
- screened cable

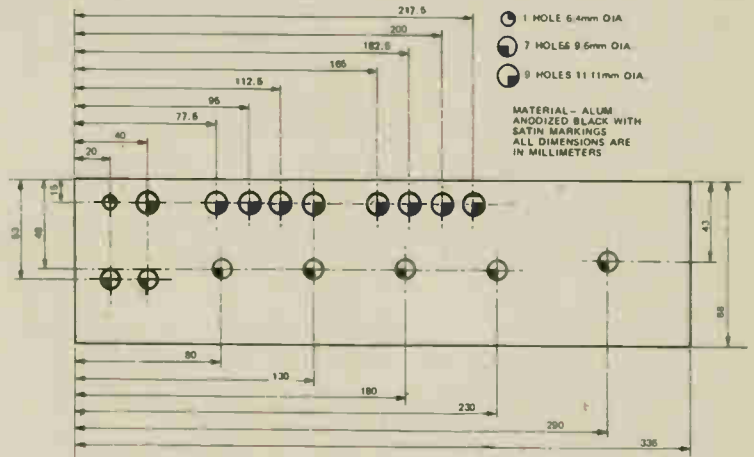
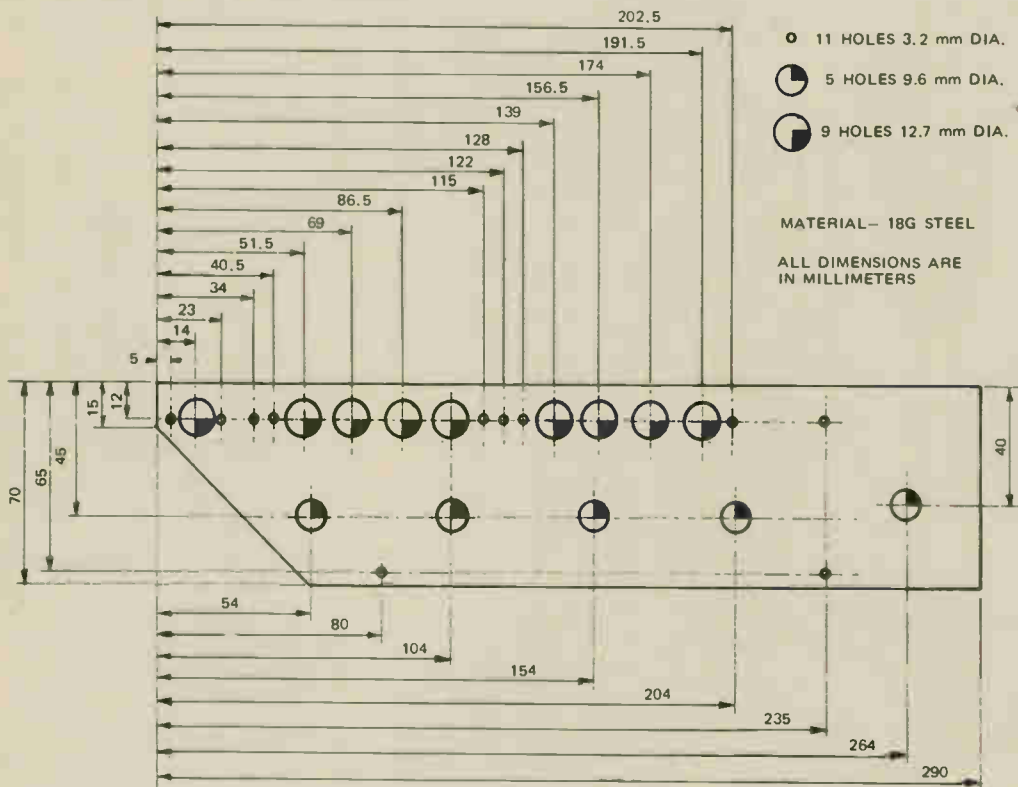


Fig. 19. Switch support bracket drilling details.



inch (6 mm) spacers. Check that these spacers do not short any of the copper tracks on the board, if so, use a small insulated washer between the spacer and the board.

13. Wire up the tone controls in accordance with Fig.1. Again using Fig.1 as a guide, wire the selector switch, volume control and all input wiring.

14. The +18 V power rail may now be connected to the decoder via the front panel LED power indicator. Make sure that the supply is connected to the long lead of the LED and the thick lead is connected to the decoder board. This ensures correct polarity of the diode, which could be damaged under reversed supply conditions.

There is no direct earth connection to the decoder board, earthing is provided by the shields of the preamplifier output coaxial cables. Additionally, the earths to RV4 and RV5 are made via the shields on the coaxial cables from the decoder board. The decoder board may now be bolted onto the support bracket. ●

SPECIAL OFFER – SANKEN MODULES

The Sanken S1-1010Y amplifier modules are available from Photain Controls Ltd, Randalls Road, Leatherhead, Surrey. The price is £4.00 each plus VAT.

Photain have agreed however to a special price for ETI readers who order four units at the same time of £15.84 inclusive of VAT and postage.

DECODER CHIP AND PUSH-BUTTON SWITCHES

The three Isostat push-button switches for this project are being specially made and are only available from Trampus Electronics, P.O. Box 29, Bracknell, Berks. At the time of going to press there is a waiting period of a few weeks on these. Other push-button switches may be used but this will necessitate modification of the p.c. board ETI420d (Fig. 13).

Trampus are also stocking the MC1312P decoder for readers, the price, which includes the royalty payment to CBS, postage and VAT is £2.75.

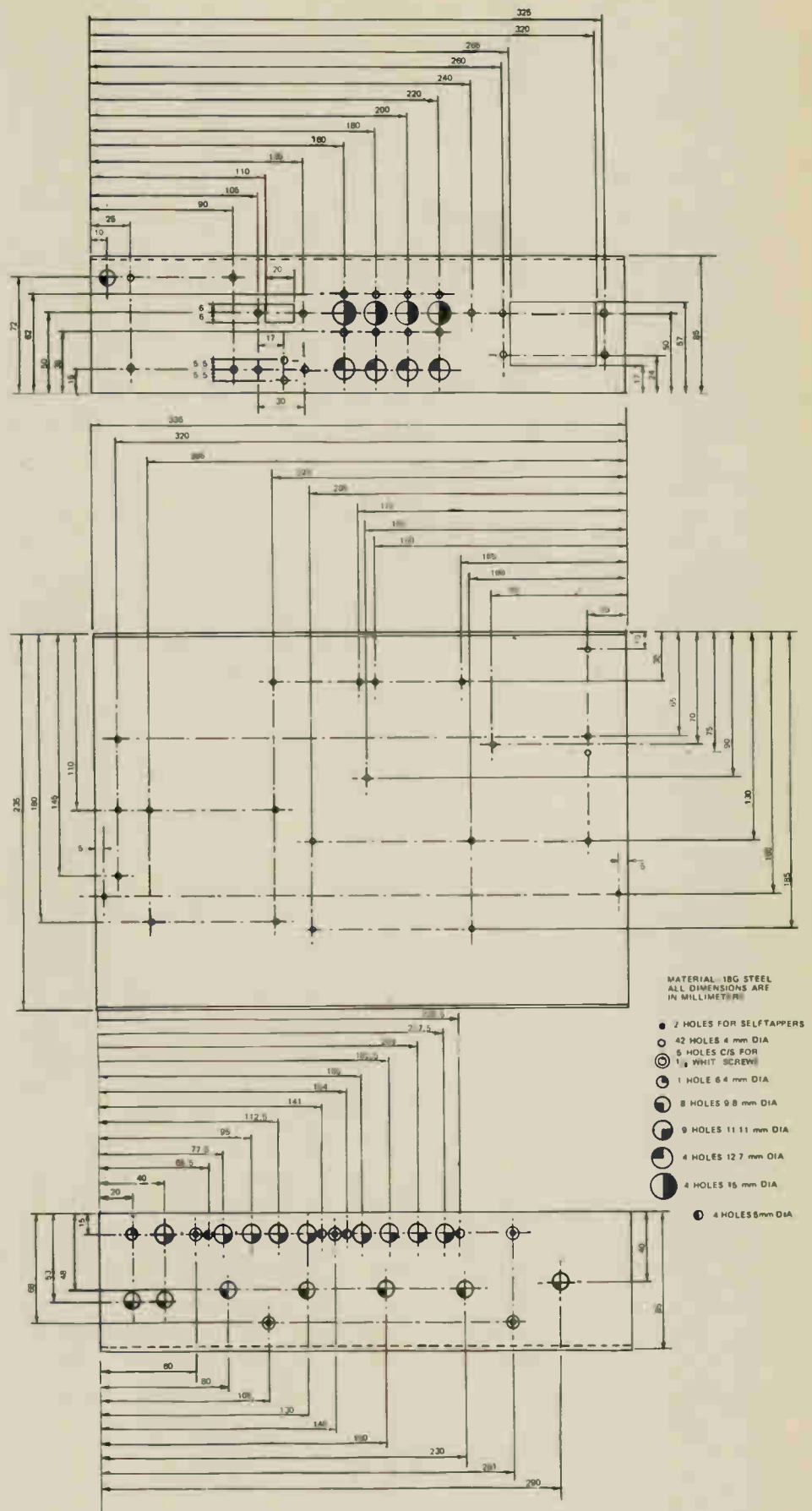


Fig.20. Details of chassis metal work and drilling.

eti

kit review:

LIGHT SHOW UNITS

DEVICES for visual excitation or relaxation fall into two basic types - stroboscopes and sound-to-light converters.

A stroboscope uses a high value capacitor to store energy which is released when required by applying a trigger pulse to a neon discharge tube. The trigger pulse ionizes the gas in the area of the contact and effectively creates a short circuit through the tube between the other two electrodes. A charged capacitor across the tube will discharge rapidly, causing an intense flash of short duration. The tube can be triggered again as soon as the capacitor has been recharged.

A successful strobe requires two distinct electronic units - a capacitor charging circuit and a trigger unit. For optimum results the trigger circuit should have a variable time constant (in order that the flash rate can be varied).

HY-LYGH T STROBE

The Hy-Lyght Strobe from the *Service Trading Company* uses a high quality mains transformer to produce 500V for the charging circuit. After rectification this is passed, at approximately 650V to a $8\mu\text{F}$ paper capacitor. A $1\text{M}\Omega$ resistor across the capacitor ensures that it does not retain its charge once the unit is switched off.

The trigger and timing circuit is quite conventional. The time period is determined by varying an RC network feeding the emitter of a unijunction transistor. When the turn-on voltage is reached the transistor conducts and applies a positive going pulse to the gate of a thyristor. This causes a pulse from the trigger coil that fires the strobe tube.

The kit consists of a neatly annotated PCB, bag of components, mains transformer, storage capacitor and

flash tube all carefully packed in a stout cardboard case. An optional extra is a ventilated metal case, finished in black leather-grain effect, ready drilled for all the necessary components. In view of the potential danger from a strobe (see below) this case is a worthwhile extra investment.

The instructions contain some general information about the use of a strobe for studying the performance of moving parts and for visual effects. A prominent warning is given regarding the high voltages present in the unit and the undesirable effect that a strobe can have on epileptics. These warnings *must* be heeded, hence the recommendation for a case. It is also a good idea to attach a warning to the finished unit.

Although the building instructions are of the narrative, rather than the step by step type favoured by the writer, they are reasonably easy to follow. The main instruction is to fit and solder all components to the PCB according to its printed layout. As already stated, this is clearly marked and easily done.

Two porcelain resistors are mounted clear of the PCB (they get quite hot) on the board mounting bolts. Connections between the board and other components require only eleven lengths of wire and are illustrated clearly in the instructions (in addition to the PCB instructions). The tube has to be carefully mounted in a plastic holder fitted to the 7" reflector supplied.

The completed unit, which took under 2 hours to assemble, looks very professional and works extremely well. The firing circuit is via a link which can be replaced by remote triggering, the instructions include suggested circuits for slave unit triggering, audio triggering and so on. Details are also given for calibration of the unit when used as a means of "freezing" rotating

Most discotheques now enhance their atmosphere by linking light displays to their sound output. Undoubtedly the patrons of such establishments are more receptive when two, rather than one, of their senses are stimulated. With the availability of low cost, high power, switching devices, the home constructor can also take advantage of audio-visual stimuli for home entertainment.

In the first of a series, Jeff Maynard reviews some kits available in the light show area.

parts (the unijunction timing circuit is zener stabilised to provide repeatability).

A circuit diagram, PCB layout and servicing hints are included in the instruction booklet. It is hardly surprising that a number of firms buy this kit to market as their own as part of complete "disco" set-ups. The Hy-Lyght is considered an excellent buy for laboratory or effect usage.

GERMAN KIT

A. E. Marshall are the UK agents for the Kellner range of kits which originate in Germany. These are pre-packed in bubble containers complete with German instructions. A separate instruction sheet with a literal translation accompanies each kit.

Kellner ST800 is a strobe kit with a fixed flash rate determined by an RC network on the small PCB that houses the entire unit (including strobe tube).

This kit contains only a handful of components and has no case to assemble so can be built in half an hour or so. The tube will only fire reliably if the trigger element is correctly posit-



The Kellner L0350 kit.

HY-LYGHST STROBE: £16.75 (£12.00 without case)

Service Trading Company, 57 Bridgman Road,
London W45BB.

ST800 STROBE: £7.11

A. E. Marshall, 42 Cricklewood Broadway, London
NW2 3HD.

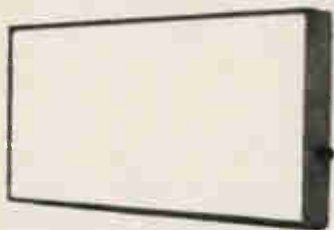
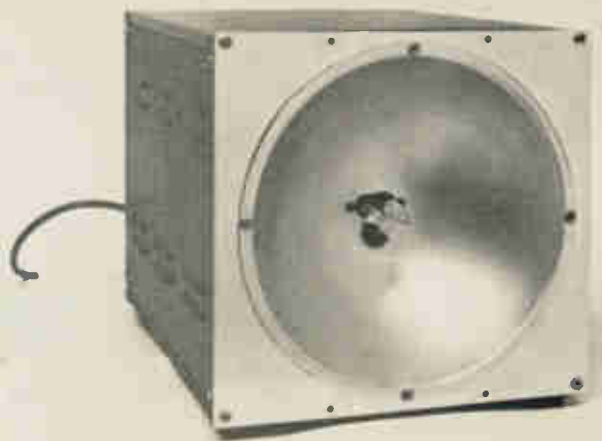
NOVA LIGHT DISPLAY: £19.50

Cosmic Electronics, 12 Grange Road, Romford, Essex
RM3 7DU.

L0350 LIGHT CONTROL 3 CHANNEL: £13.50

A. E. Marshall, 42 Cricklewood Broadway, London
NW2 3HD.

Post and packing and VAT should be added to all prices
except the Nova which is complete.



On the left is shown the Nova Light Display from Cosmic. The Hy-Lyghst Strobe from Service Trading Company is shown above.

ioned on the tube. Adjusting this is a trifle awkward, particularly as the whole unit is live to mains and has a high energy capacitor at either end.

This kit could provide the basis for a home built strobe at low cost but should not be used unless incorporated in a metal case. Heed should be taken of the warning accompanying the unit to discharge the capacitor with an insulated screwdriver before making adjustments.

SOUND TO LIGHT

An alternative form of audio-visual stimulation more suited to the home environment is the sound-to-light convertor. This contains a form of filter unit to split the feed from an amplifier into a number of channels - each frequency band being used to trigger a different coloured light.

Usually three filters (for three channels) are used each consisting of a simple RC network - accurate band passing is not necessary in this type of unit. The output of each filter is amplified and applied to the gate of the triac through which the appropriate lamp is illuminated.

NOVA LIGHT DISPLAY

The Nova Light display from *Cosmic Electronics* adopts a slightly different approach to the actual lights than other types.

The finished unit comprises a teak box approximately 24" x 12" x 2½" with a white diffusing screen on the

front. Behind the screen are six 1W lamps (two each of the primary colours, red, blue and green) the power supply and the PCB.

The sound pick-up is via a crystal microphone mounted within the case - this has the advantage that no direct connection is required to an amplifier and of course the unit will respond to voices or a television.

Construction is quite simple, the first job being to secure silver foil, mains transformer and lamp holders to the inside back of the unit. The PCB has a very high component packing density and consequently has a number of very fine close tracks on the solder side.

The PCB is not printed with component numbers and construction instructions consist basically of a detailed drawing and component list (which includes resistor colour coding).

The instructions are quite explicit on the procedure to be followed, once the PCB has been completed, even to listing the lengths of wire to be attached to various board take off points to connect with the lamps and power supply.

Setting up and initial adjustment require only the turning of one preset pot for each colour channel. This stage is rather amusing since the noise of setting up (or cursing as the case may be) is picked up by the microphone - the origin of "blue" language being apparent for the first time!

Once complete the unit can be hung on a wall or placed in any convenient location, a knob on the side provides an overall sensitivity control. Whereas the unit does not illuminate the whole room, the effect is most interesting and indeed very relaxing in a dimly lit room.

Construction of the kit, following

the lucid manual provided, took under three hours. The package supplied includes everything required (including mains lead) except glue and solder.

A sound-to-light convertor for room or hall lighting (i.e. 500W per channel) can be readily made up from the Kellner kit, again available from *A. E. Marshall*. As with the strobe kit described above this provides only the components, PCB and a translation of the instructions.

The PCB is laid out for up to 6 channels mono or stereo although the kit provides for only 3 channels. Construction is readily achieved by following the component layout on the board assisted by a schematic circuit diagram in the instructions. Additional information is provided on component values for adding extra channels. The board can be assembled in under an hour; however the purchaser is required to provide a case and power supply (the latter being available from the importers).

Supply requirement is 12V so a transformer can be obtained for under £1. The PCB is laid out for four individual diodes but a bridge rectifier can be accommodated if one is to hand. The gain of individual channels is adjusted by means of preset pots and these should be set just below the "flicker" threshold with zero level input to the unit. Overall sensitivity can be provided with one additional pot.

That part of the PCB containing the lamp drive triacs is live to mains so it is important that it be mounted in an earthed metal case. Two pin bayonet sockets can be bolted to the rear of the case of the lamps. It would of course be possible to build in the unit into a larger home-made version of the Nova described above. ●

USING THE TBA800

By J. Brian Dance; M.Sc.

IF ONE REQUIRED an audio power amplifier a few years ago, one would have made or bought one using discrete components. Nowadays it is much simpler for a manufacturer or a home constructor to obtain a suitable integrated circuit which can drive a loudspeaker directly at moderate power levels.

Each type of I.C. power amplifier has its own particular characteristics. This article discusses the use of the SGS-Ates type TBA800 audio amplifier. The device can provide an output power of up to 5 W into a 16 ohm speaker when it is being operated from a 24 V supply. The device contains some 16 transistors, 7 diodes and 10 resistors; it includes a Class B output stage, but there is negligible cross-over distortion.

ENCAPSULATION

The TBA800 is encapsulated in a plastic case with pins in the quad-in-line configuration shown in Fig. 1. Quad-in-line devices have alternate pins bent so that their lower ends are a different distance from the centres of the device. In the TBA800 two of the centre pins on each side of the device have been omitted to make way for metal cooling tabs. Even if no additional heat sink is connected to the device, these tabs enable an output of 2.5 W to be obtained.

The TBA800 has 12 pins, but there are no internal connections to pins 2 and 11. The connections are shown in Fig. 1.

POWER SUPPLY

The absolute maximum permissible power supply voltage to the TBA800 is 30 V. However, one should always allow an adequate safety margin to prevent damage to the device; it is therefore wise to regard the upper limit as 24 V if an unregulated supply is used and about 26 V in the case of a stabilised supply.

The minimum recommended power supply voltage is 5 V, but the power output is then only 0.2 W into a 16 ohm speaker or 0.4 W into an 8 ohm speaker (see Fig. 2.)

A typical TBA800 device consumes 9 mA when no signal is being fed to the

input and a 24 V supply is used, but no device should pass more than 20 mA under these conditions. The supply current is, of course, far higher than this when the device is providing a high output power. The device can provide an output current of up to 1.5 A.

CIRCUITS

A circuit for the TBA800 which requires a minimum number of external components is shown in Fig. 3. The mean output voltage at pin 12 of the device is about half of the positive supply potential and therefore a capacitor, C4, must be employed in

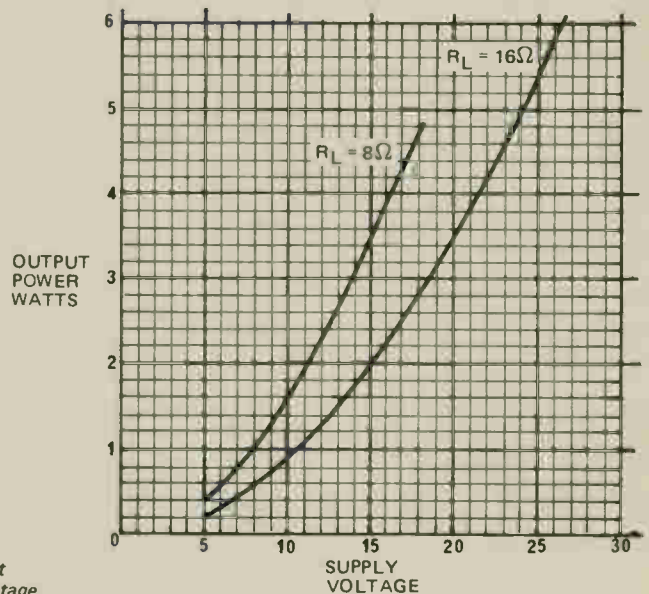


Fig. 2. Maximum output power against supply voltage.

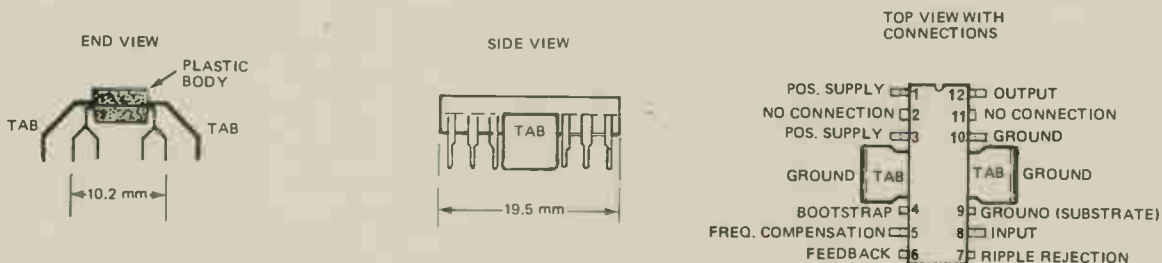


Fig. 1. The encapsulation, dimensions and pin connections of the TBA800.

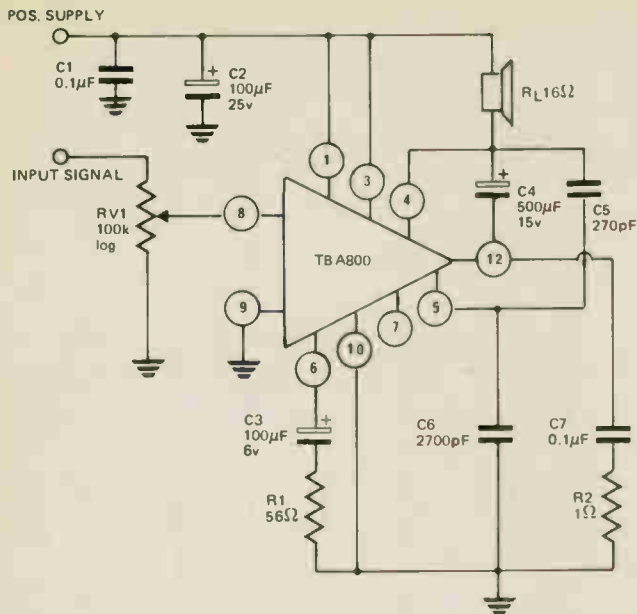


Fig. 3. Circuit for the TBA800 using the minimum number of additional components.

series with the speaker to prevent a steady current from flowing through the latter. If the value of this capacitor is reduced, the bass response will be reduced.

The bootstrap connection to pin 4 of the device is obtained from the junction of C4 and the loudspeaker. The high frequency response of the circuits is affected by the value of C5. When the value of this capacitor is 270 pF, the response is level to ± 3 dB from about 40 Hz to 20 kHz. If, however, C5 is increased to 470 pF, the upper 3 dB point is about 10 kHz.

Feedback is taken from the output via a 7 k ohm internal resistor to a point which is connected to pin 6. The feedback voltage is developed across R1; if the value of this resistor is increased, the gain will fall owing to the increased amount of feedback. However, the value of R1 also affects the frequency response.

The input is shown as being fed directly to the volume control, RV1. If, however, the input does not have a mean potential equal to the earth potential, a capacitor of about 0.22 μ F should be placed in series with the input. The input impedance of the TBA800 is typically 5 megohms (minimum value 1 megohm for any TBA800); however, a resistor not exceeding about 100 k ohm must always be present between pin 8 and the negative line.

C1 should be soldered close to pin 1. It provides good decoupling of the power supply lines at high frequencies, whilst C2 provides good low frequency decoupling. Capacitor C7 and R2 help to prevent instability.

EARTHEO LOAD

In the circuit of Fig. 4 one side of the loudspeaker is connected to earth, but there is no bootstrap connection to pin 4; this results in an appreciable loss of possible output voltage swing. This circuit is therefore suitable for use only at the higher power supply voltages where the loss of output voltage swing is not so important.

Pin 3 is not connected to the positive supply line in this circuit. This effectively inserts two internal diodes into the circuit so that a symmetrical output waveform can be obtained in the absence of the bootstrap connection.

A capacitor C8 may be connected between pin 7 and ground to prevent hum from the power supply line being present at an appreciable amplitude at the output of the device. The value of C8 may be 10 μ F to 100 μ F, 25 V.

BOOTSTRAP CIRCUIT

In the circuit of Fig. 5, the capacitor C9 provides a bootstrap between the output of the device and pin 4. This enables a performance similar to that of the circuit in Fig. 3 to be obtained when one side of the loudspeaker is earthed.

If the supply voltage is low (up to 14 V), a 150 ohm resistor, R3, should be connected between pin 4 and the positive supply line. C8 performs the same hum rejecting function as C8 of Fig. 4.

PERFORMANCE

The distortion rises rapidly with power output at high power levels. When a 24 V supply is employed with a 16 ohm load, the distortion

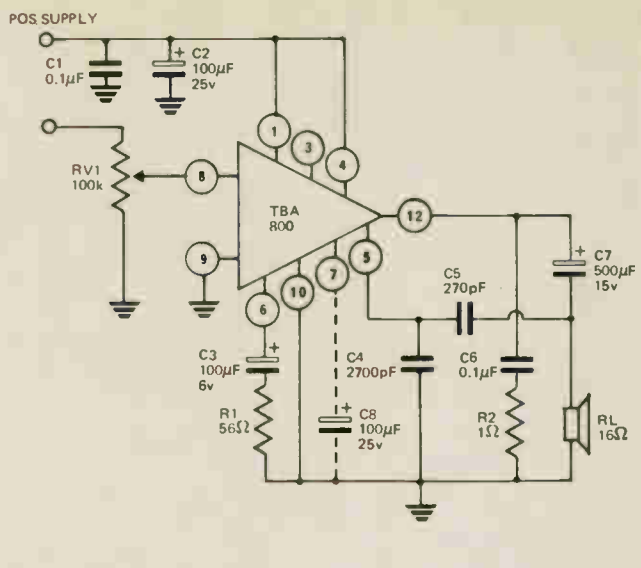


Fig. 4. A different circuit using an earthed load.

introduced by the Fig. 5 circuit at 1 kHz is about 0.5 per cent at output levels up to 3 W. At 4 W it rises to about 24 per cent and at 5 W to 10 per cent.

The efficiency (output power/power delivered by the supply) is typically 70 per cent at the 4 W level and 50 per cent at 2 W.

The voltage gain of the circuit in Fig. 5 ranges from 90 to 180 (39 to 45 dB). Without any feedback it is 10,000 or 80 dB.

APPLICATIONS

The circuits described are very suitable for use in radio receivers. If a 9 V battery is used to supply power to the device, the output power will be rather limited. In radio receivers operated from the mains, however, it will generally be convenient to use a 24 V power line to obtain more output power. The writer has tried the circuit of Fig. 3 in a simple battery powered receiver using the Ferranti ZN414 integrated circuit; reasonable volume was obtainable for a portable receiver.

The type of circuits shown in Figs. 3 and 5 are also suitable for use as simple record player amplifiers, but the input circuit may require slight modification to produce the optimum response. Two of the circuits may be used in a stereo record player.

PRECAUTIONS

Great care should be taken to ensure that the output (pin 12) is not accidentally shorted either to ground or to the positive supply line, since this is likely to cause a large current to flow and the device to be destroyed.

USING THE TBA800

The TBA800 will normally be destroyed if the power supply voltage is accidentally applied with a reversed polarity. When one is experimenting with circuits using this device, it is worthwhile including a diode in the power supply lead to prevent any appreciable reverse current from flowing. The diode may be removed when the experiments have been completed if there is no longer any likelihood of the power supply being accidentally reversed.

The device can also be damaged by an excessive temperature rise.

MOUNTING

The TBA800 may be soldered directly into a printed circuit board as shown in Fig. 6. The metal tabs are soldered to a suitable area of copper on the board: the copper must be earthed.

An alternative method of connecting a heat sink is shown in Fig. 7. In this case the tabs and the external heat sink are together soldered into a common hole in the board and are earthed. This leaves the remainder of the board available for constructing the circuit, but the heat sink does project above the board.

As with all high gain amplifiers, great care must be taken to ensure that the input and output are kept well separated or unwanted feedback may lead to oscillation.

It is, of course, possible to clamp metal heat sinks onto each of the tabs of the device. If desired, the device may be fitted into a 16 pin quad-in-line socket, but better heat transfer can be obtained by soldering directly to the pins of the device. It is also possible to bend the pins of the device so that they fit into a dual-in-line socket or to use a piece of socket strip made by RS Components Ltd. (Radiospares).

The external cooling tabs of the device enable it to dissipate up to 1.75 W without any additional heat sink at ambient temperatures up to 25°C. The device can be operated in this mode from a supply of about 13 V with an 8 ohm load or about 17 V with a 16 ohm load; in either case a maximum output of about 2.5 W is obtainable.

At the time of writing the list price of the TBA800 is £1.35, though this should be checked before ordering. The device is available from Henry's Radio or from Electronic Component Supplies (Windsor) Ltd., Thames Avenue, Windsor, Berks.

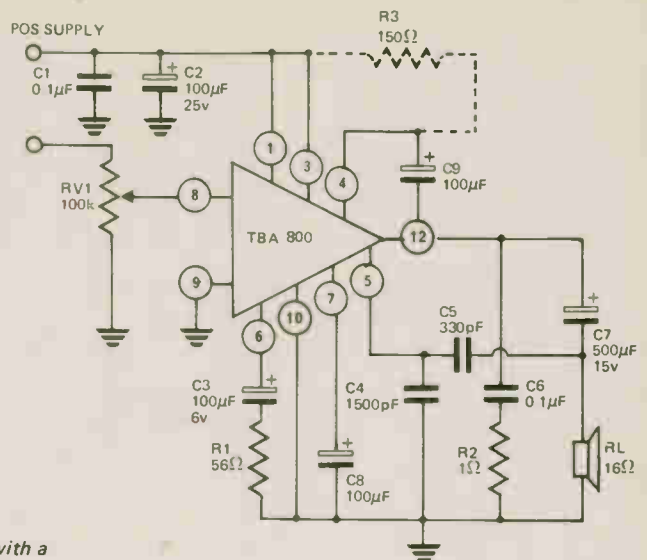


Fig. 5. The TBA800 with a bootstrap circuit.

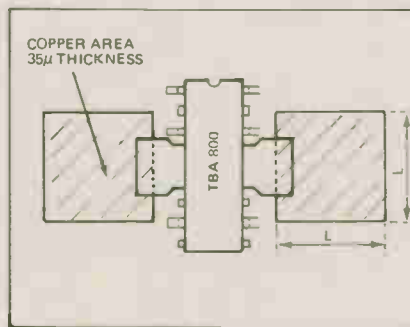


Fig. 6. The large tabs on the TBA800 may be connected in certain circumstances to an area of p.c.b. foil which acts as the heatsink.

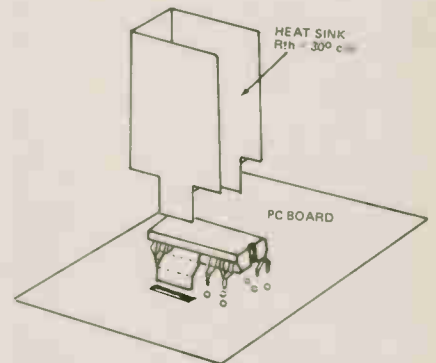


Fig. 7. An alternative form of heatsink.

SIMILAR DEVICES

The SGS-Ates TBA810S and TBA810AS are somewhat similar devices, but they can drive a 4 ohm speaker at a level of 7 W when a 16 V supply is used. They are more suitable for car radio receivers than the TBA800, since they can provide 4.5 W

into a 4 ohm speaker when a 12 V supply is used.

The TCA940 is not yet available, but it can provide 10 W into a 4 ohm load when fed from an 18 V supply. SGS-Ates are also planning the production of a 20 W amplifier.

LASER EXPERIMENTS

March issue, page 39

The component values on Fig. 7. reproduced very poorly in all copies. This is shown on the right.

INTERNATIONAL MUSIC SYNTHESISER - PART TWO

In the February issue on page 29, Fig. 8., two of the numbered take-off points are labeled incorrectly. In the centre left points 42 and 37 should be reversed.

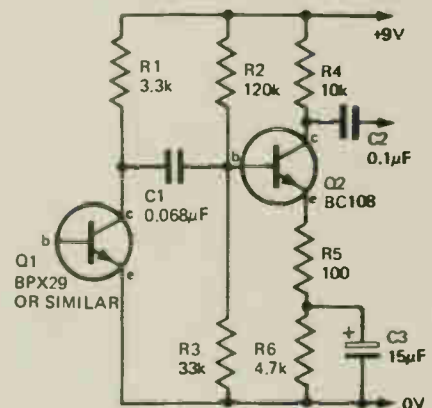
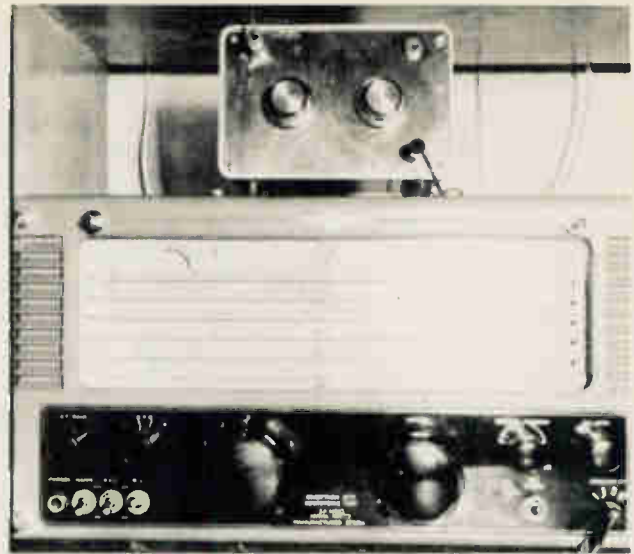


Fig. 7. A suitable detector circuit for optical communications experiments.

PEAK UP YOUR S.W. SIGNALS WITH OUR AERIAL MATCHER



FOR GENERAL RECEPTION purposes over the 1.7 MHz to 30 MHz range, an end-connected wire antenna is popular. This may be anything from a few feet of insulated wire indoors, to a long, high outdoor aerial. Such aerials can, and do, provide good long-distance reception, but the matter of matching the aerial impedance to the receiver is often totally disregarded. There is a maximum transfer of energy from the aerial to the receiver only when the end impedance of the aerial approximately matches the input impedance of the receiver aerial circuit.

Many specialised short wave receivers have an aerial input impedance of about 75 ohms. With other receivers, the input impedance may be unknown, and in any case it is likely to alter with changes in operating frequency.

The end impedance of the aerial, in its turn, depends on the length of the aerial system in terms of wavelength. If the aerial is a half wavelength long, or a multiple of half wavelengths, its end impedance is high — it may easily exceed 1000 ohms. On the other hand, if the aerial is a quarter wavelength long, or an *odd* multiple of quarter waves, its end impedance is low. In fact it will probably be under 50 ohms at some frequencies.

The length of a half-wave, in feet, is found with sufficient accuracy from $\text{length} = 468/\text{MHz}$. As much specialised short wave listening takes place on the Amateur Bands, and these are spaced nicely through the spectrum* it is convenient to use them as examples.

Adopting a centre-frequency for the (* 160 metre band, or 1.8 – 2.0 MHz; 80 m or 3.5 – 3.8 MHz; 40 m or 7.0 – 7.1 MHz; 20m or 14.0 – 14.35 MHz; 15 m or 21.0 – 21.45 MHz; and 10 m or 28.0 – 29.7 MHz.)

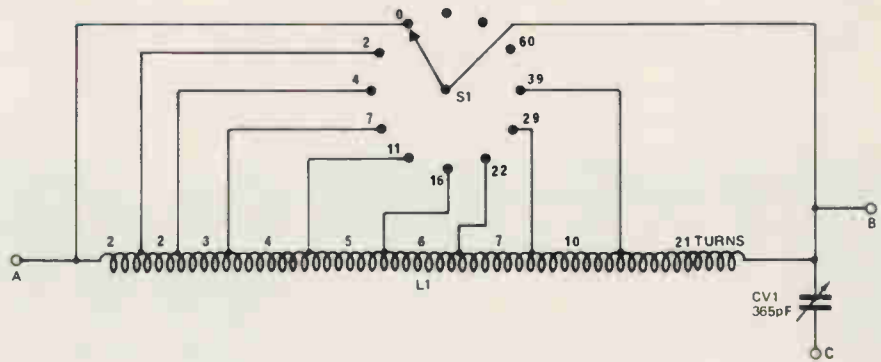


Fig. 1. The circuit of the aerial matcher.

20 metre band of about 14.2 MHz, the length is $468/14.2$, or near enough to 33 ft for this to be used. Suppose 33 ft of wire forms the aerial and down-lead, the near end being taken to the receiver. The end impedance is high at the frequency which corresponds to a half-wave — about 14.2 MHz in the 20 m band. At twice this frequency, or about 28.4 MHz in the 10 m band, 33 ft is *two* half-waves so the end impedance is also high. But at half the frequency, or about 7.1 MHz, the aerial is one-quarter of a

wavelength long, and its end impedance is low. In fact, if the aerial impedance were measured through the range 30 MHz to 1.7 MHz, it would be found to make excursions from one extreme to the other, reaching a low figure as the frequency falls and the wire grows short in terms of a half wavelength.

Similar effects arise with any length of aerial. To compensate for them, an aerial matching device such as that described here may be placed between the aerial and receiver.

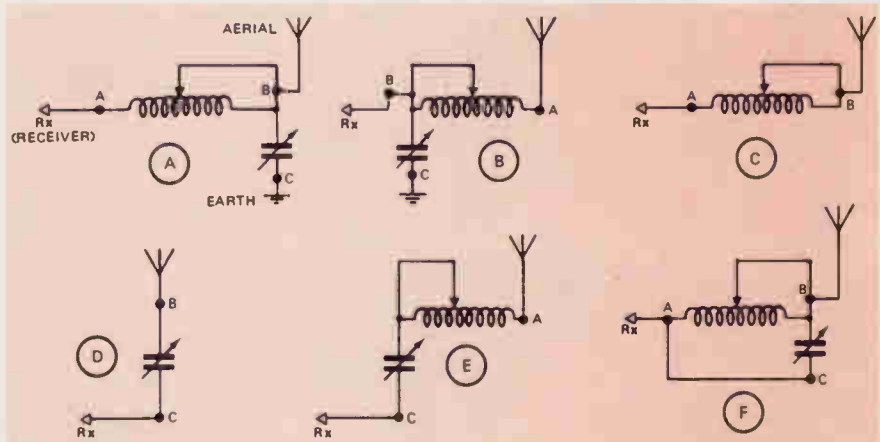


Fig. 2. The various permutations that can be obtained from the circuit in Fig. 1.

MATCHER CIRCUIT

This is shown in Fig. 1 and employs the tapped inductance L1 and variable capacitor CV1. The switch S1 has 10 positions. At '0' all of L1 is shorted out. At '2' two turns are in circuit. At '4' two plus two turns, or four turns, are in use. This continues for the remaining switch positions, so that 0, 2, 4, 7, 11, 16, 22, 29, 39 and 60 turns may be selected.

To cover the widest possible range of conditions, the matcher can be employed in any of the ways shown in Fig. 2. So many circuits may make it seem that operation is complicated. However this is not so, as it is only necessary to use any one which allows the switch and capacitor to be adjusted for best results. As a guide, the following will be helpful:

- A. CV1 is at the aerial side. This method is likely generally to be useful. Rotate the switch S1 from '0', meanwhile swinging CV1 from minimum to maximum to peak up signals. Use S1 and CV1 settings which

watch this while making adjustments. If there is no indicator, but an automatic volume control switch, put the AVC off so that changes in volume are more easily heard. If the AVC cannot be switched off and there is no tuning indicator, adjust the matcher with a weak signal. The benefit it can give is not necessary with strong signals, which will in any case operate the AVC system and mask the change in signal strength at the receiver aerial terminal.

INDUCTOR

This uses 24 swg enamelled wire, wound on a paxolin tube $1\frac{1}{2}$ in in diameter and $3\frac{1}{2}$ in long. Anchor the wire about $\frac{1}{4}$ in from one end, Fig. 3, and wind on two turns. Scrape the wire, twist a small loop, and wind a further two turns. Make a further loop, and wind three turns. Continue in this way until the coil is finished as in Fig. 3. A small space is left between each section. Anchor the end as when starting.

A little adhesive, such as Bostik 1, may be applied at the ends and tappings, to prevent turns moving, but

the whole winding must not be treated in this way.

ASSEMBLY

The panel is approximately 6 in x 4 in and is drilled or punched for three insulated sockets, S1, CV1. The latter requires a $\frac{1}{2}$ in hole, and is fixed by three 4BA countersunk screws. These *must* be short to avoid damaging the capacitor.

The coil is placed directly behind the switch, and leads are cut from 20 swg tinned copper or similar wire, and soldered from the tappings to the switch tags as shown. No other support for the coil is necessary.

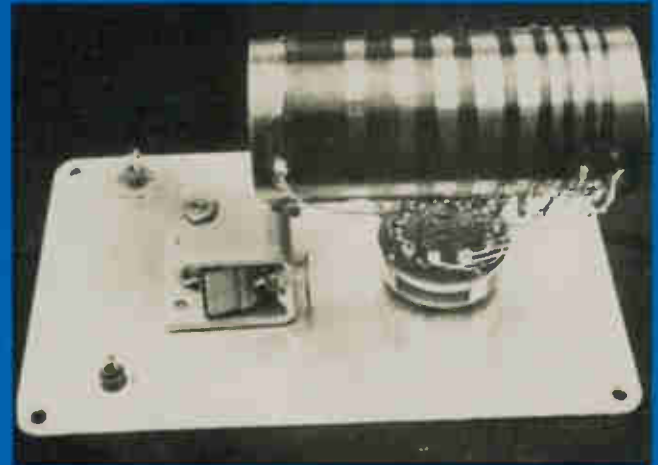
Audio gain potentiometer knobs numbered from 0-10 were fitted to S1 and CV1. '0' corresponds to '0' in Fig. 1, and the numbers 1 to 9 for the other positions, two positions of the 12-way switch being unused. As CV1 rotates only 180 degrees, numbers beyond 7 here can be blocked out.

USE OF MATCHER

Leads are equipped with plugs to



The completed unit.



An internal view of the completed unit.

- prove best.
- B. Aerial and receiver plugs are reversed. Try this if A proves unsatisfactory. Adjust as for A.
- C. A simplified inductive loading, broad-banded.
- D. Series capacitor only. Not likely to be needed often, but useful with some receivers.
- E. CV1 and L1 in series. This will allow many unknown aerial impedances to be matched.
- F. Parallel tuning by joining socket A and C. This can prove useful with very short aerials on low frequencies, allowing the whole system to be tuned to resonance.

If the receiver has a tuning indicator,

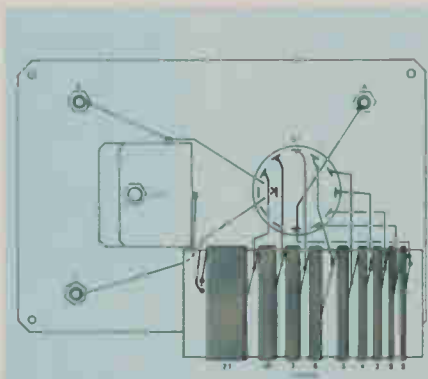


Fig. 3. The wiring of the unit. The case used for the prototype is the 'EIF', available from West Hyde Developments Ltd, Ryefield Crescent, Northwood, Middlesex.

place in the panel sockets. The case listed is completely insulated. It will be seen that when circuits such as D, E and F are used, the variable capacitor frame, and thus the metal panel, are not earthed. This appears to be of little importance, and there was felt to be no point in substituting an insulated panel, or insulating CV1 from the metal panel. With A and B, the panel is earthed.

Tuning adjustments are relatively flat with a longish aerial, but peak more sharply with a short aerial. Any circuit in Fig. 2 which gives best results can be used.

The matcher is not intended for use with universal AC/DC mains receivers where the chassis and other circuits are connected directly to the mains. ●

FREE COMPETITION

WIN A HEWLETT-PACKARD HP-970A HANDHELD DIGITAL MULTIMETER



Every once in a while an item of electronics equipment is introduced which everyone wants. The HP970A comes into this category; it measures a.c. and d.c. volts (up to 500V) and ohms ($1k\Omega$ to $10M\Omega$) quick and accurately selecting automatically from five ranges. A $3\frac{1}{2}$ digit LED display features fully automatic decimal placement and polarity indication.

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The probe tip and display are both located at the top of the HP970A whose size is roughly that of a thick pen. After setting the wristband-type function selector (A.C., D.C. or $k\Omega$) and clipping on the common lead, a user simply touches the test point with the probe and the solid state LED display automatically indicates the correct reading - in volts or kilohms. The minus sign turns on if the voltage is negative. The decimal point positions itself automatically.

Nickel-cadmium rechargeable batteries and a battery charger are standard. Battery life permits more than 2000 measurements using a 'press-to-read' switch or $2\frac{1}{2}$ hours continuous operation.

Input resistance on the volts range is $10M\Omega$ while input capacitance on a.c. is less than 30pF.

Normally the HP970A retails for over £150. but if you enter the competition on this page you stand a chance to win one.

RULES

All entries must be on the form cut from Electronics Today International. There is no entry fee and readers may submit as many entries as they wish as long as each is on a form cut from the magazine. Any entry not on the correct form will be deemed invalid.

The prize will be awarded to the first correct entry drawn after the closing date. The 'judges' decision will be final. No correspondence can be entered into concerning the contest. The winner will be notified by post.

Entries should be addressed to: HP-970A Competition, Electronics Today International, 36 Ebury Street, London SW1W 0LW.

Closing date for the competition is April 30th, 1974.

HOW TO ENTER THE COMPETITION

All you have to do is to work out the answers to the questions set out on the entry form on the right; they are not trick questions. The answers can be worked out using Ohm's and Kirchhoff's Laws with some straightforward mathematics. One of the questions demonstrates how misleading readings can be obtained using a low sensitivity meter.

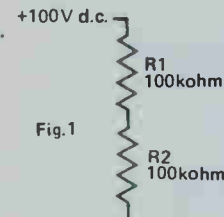
The prize of a Hewlett-Packard HP970A handheld digital multimeter will be awarded to the first correct entry drawn after the closing date.

Cut ENTRY FORM

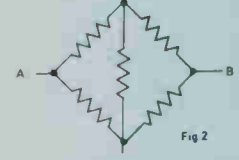
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SOLVE THE FOLLOWING PROBLEMS, all answers to three decimal places

1.  If R1 and R2 are 10% tolerance components, what is the highest and lowest voltage you would find across R2 assuming it is measured with a 'perfect' meter (i.e. one which has no effect on the conditions)
Max: _____ Min: _____

2. As a follow on from question 1, what would be the maximum and minimum readings would you expect if you used a 1000 ohms per volt multimeter, on a 100V range, if the meter accuracy is $\pm 3\%$?
Max: _____ Min: _____

3.  In this matrix, all the resistors are exactly 10 ohms. What is the resistance i) between A and B? _____
ii) between A and C _____
(If you don't know where to start, refer to Kirchhoff's Laws).

Please find my entry for your Competition. I have read the rules of the contest and agree to abide by the judges' decision.

SIGNED DATE

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A separate coupon must accompany each entry and entries must not be accompanied by any other correspondence.
Closing date is April 30th, 1974.

What to look for in May's ETI

eti reader offer **6W=50p**

Next month we have another bargain for ETI readers: a 6W r.m.s. audio amplifier IC made by Texas and designed for use with 8-15 ohm speakers. Distortion at all levels is less than 1%! The price, including VAT, is only 50p to ETI readers who must also send a stamped, self addressed envelope. The offer is limited to the first 5000 orders. Please note that orders can only be accepted using the coupon in the May issue.

LOCAL RADIO

Local Radio in Britain started only just over five years ago yet today there are about 25 stations operated by the BBC and the IBA.

The next issue carries a major, specially commissioned article which investigates the history, operation and success of these stations that have now gained a substantial audience.

The technical aspects are obviously given considerable coverage, but the report, which has been written by Keith Pitt, does not confine itself to this field.

PLUS: FOUR PRODUCT TESTS

One of the items that we have tested is a tuner amplifier costing less than £50 which is not only good but is perhaps the best value that we have ever come across.

COMPLETE INDEX TO ETI

ETI has been published for just over two years and to help those readers who wish to refer to their back issues, we are printing a complete index of all features carried to date.

PLUS:
POWER CONTROL WITH THE SL440
NICKEL-CADMIUM BATTERY CHARGER
ETI MUSIC SYNTHESIZER
and all the usual features

LASERS AT WORK

Once described as 'the ideal solution to yet unfound problems', the laser now finds innumerable applications throughout science today. Initially their cost was very high but the price has fallen so considerably (as shown by last month's DIY project for a home built laser) that the 'unfound problem' quip no longer applies.

Today, small, portable lasers are used for building and survey work of all kinds, even for such everyday tasks as floor-leveling. Next month's feature deals with measurement, while a later one will deal with power and communications and a whole host of other uses.

ON SALE APRIL 19th - 20p

ETI TAKES A PRIDE IN BEING REALLY UP TO DATE, SO WE OURSELVES DO NOT ALWAYS KNOW WHAT WILL BE IN THE NEXT ISSUE SO THE FEATURES MENTIONED ON THIS PAGE ARE ONLY SOME OF THOSE THAT WILL BE INCLUDED

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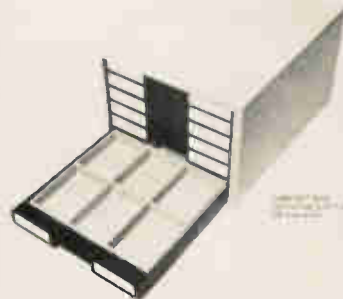
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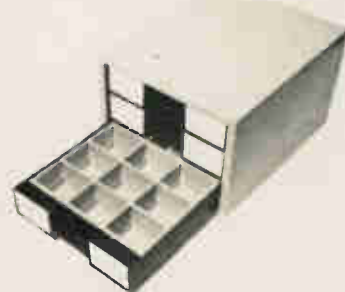


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PHILIPS RH521 AMPLIFIER

The Philips RH521 amplifier is of very modern design; perhaps its most striking feature is the frontal appearance which, surprisingly, is more typical of the best American design — rather than European.

MECHANICAL CONSTRUCTION

The main frame and chassis of the amplifier are constructed from steel, aluminium, and plastic mouldings. These have been cleverly designed to provide not only high strength but a system for supporting the wiring harnesses within the main body of the amplifier.

The top cover of the unit is fabricated from veneered plywood suitably slotted to provide ventilation whilst at the rear Philips have designed some fancy but nonetheless effective heat sinks to provide good thermal ventilation for the large BD182 type silicon transistors.

The inside of the amplifier is divided into four main sections. A large well shielded power transformer, with internal fuse connected to its main frame is on the right-hand side; the main preamplifier section of the printed circuit, with an array of printed circuit mounted switches (directly connected to the front mounted lever switches) is in the centre. Adjacent to this at the left hand end of the amplifier is a large and well constructed power supply complete with all silicon diodes for the rectifiers and large electrolytic capacitors. Behind this is the power output stage complete with main heat sinks and minor heat sinks for the driver transistors, together with internal fuses mounted in spring clips.

Most of these unit inter-connections are terminated in printed-circuit-board-mounted miniature Philips plugs and sockets.

Five DIN input-sockets are provided at the rear of the amplifier. These cater for crystal or auxiliary input, tuner, tape recorder, monitor output and magnetic pick-up. Surprisingly there are no phono type coaxial sockets. The connections for speakers are provided for also by four DIN sockets.

A screwdriver operated switch at the extreme left hand end of the amplifier provides for 110, 127, 220, and 240



volts mains input at either 50 or 60 Hz line frequency.

PERFORMANCE

In operation, the amplifier conforms exceedingly well with the manufacturer's specification. All of the main parameters, including power output (which in this case is 30 watts into four ohms both channels driven, and 16 watts into eight ohms) are achieved with a slightly lower harmonic distortion than indicated by the handbook.

The measured frequency response was within $\pm\frac{1}{2}$ dB from 35 Hz to 20 kHz at rated output (with both channels driven) into four ohms. Good though that was, even better results were observed at lower output levels.

In a system correctly wired as it should be, with shielded inputs to both channels, the manufacturer's claim of 45 dB separation should be easily achieved.

Input sensitivities are as they should be. In particular the two millivolts sensitivity for magnetic input is more than adequate for the majority of modern high quality cartridges.

The distortion characteristics of this amplifier are particularly good although the onset of high level distortion is particularly rapid once the threshold of clipping is reached. The true distortion level at one tenth and one half of the maximum output power lies between 0.01%

and 0.1%. The circuitry utilised for the final output stage is particularly effective in providing very low levels of distortion.

The incorporation of a presence control (ie control of mid-frequencies) is a relatively new feature. It is of especial value when one is using a speaker system whose performance is non-linear in the critical mid-frequency region and for enhancing response in rooms that are excessively absorptive in the critical mid-frequency regions. This problem is one that has plagued European-style homes for years because the combination of thick drapes and large stuffed furniture provides a substantial drop in effective reverberation time in the region between 1 and 10 kHz.

The loudness control is unusual in that there are three switch-selectable contours. Apart from this, the level of loudness compensation is set in two stages by the volume control setting. For example, on loudness contour position 1, the compensation is +4 dB at 50 Hz at a volume of -25 dB, increasing to +8 dB at 50 Hz at a volume of -43 dB, (maximum volume regarded as 0 dB). These two stages of loudness compensation are shown in the specification table accompanying this article.

We tried the amplifier out with a range of programme content using both Philips' and our own standard monitor speakers and could in no way fault its performance.

SUMMARY:

The Philips RH521 amplifier is extremely good. Its performance is of the highest level and it is in our opinion one of the finest amplifiers that Philips have ever produced. Whilst its maximum output power is only 30W per channel, provided one does not use speakers of unduly low efficiency, it has the ability to rattle the windows.



MEASURED PERFORMANCE OF PHILIPS RH521 AMPLIFIER

Power Output

16W into 8Ω load, both channels driven
30W into 4Ω load, both channels driven

Frequency Response (±½ dB)

Rated output 35 – 20 000 Hz
1 watt 25 – 20 000 Hz
10 watt 30 – 20 000 Hz

Channel Separation at Rated Output
100 Hz = -30 dB
1 kHz = -31 dB

Hum and Noise with Respect to Rated Power
87 dB unweighted
97 dBA weighted

Input Sensitivities for Rated Output

Input	mV	Impedance
Auxiliary	56	750 kΩ
Tuner	63	100 kΩ
Phono	2	50 kΩ
Tape Recorder	160	100 kΩ
Monitor	160	100 kΩ
Microphone	1	2 kΩ

Total Harmonic Distortion (at rated output both channels driven)

100 Hz 1 kHz 6.3 kHz
0.1% 0.1% 0.1%

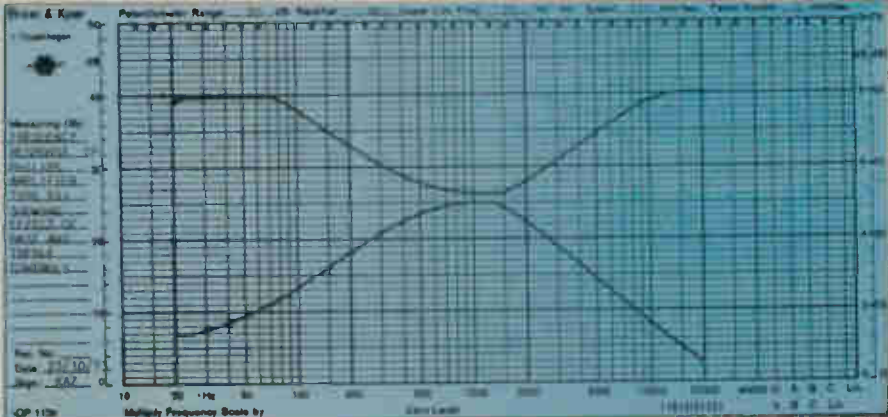
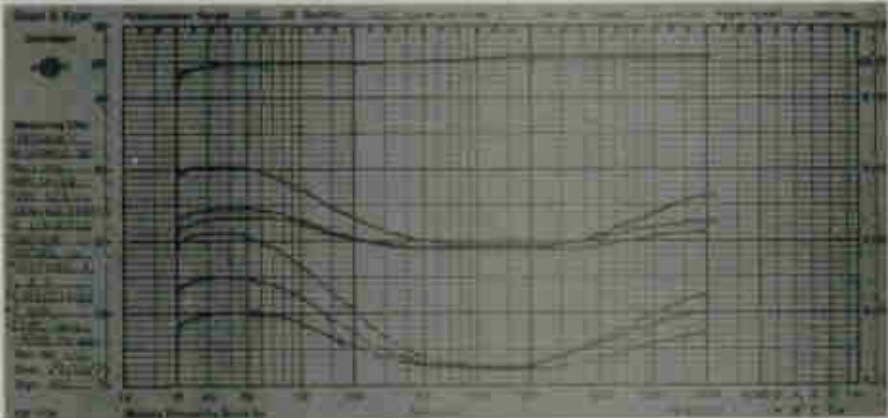
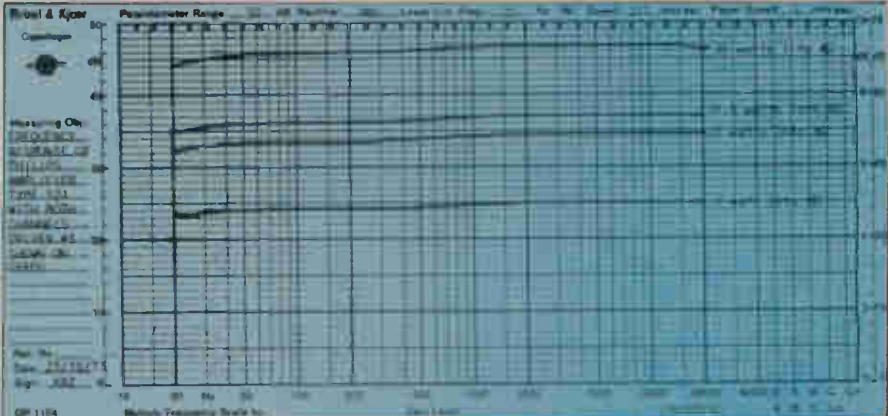
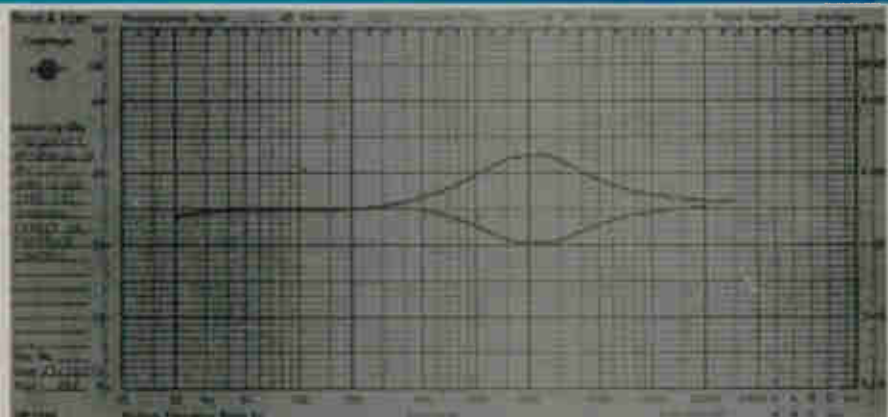
Intermodulation Distortion 1%

Tone Controls

Bass 14 dB boost at 50 Hz
16 dB cut at 50 Hz
Treble 13 dB boost at 10 kHz
17 dB cut at 10 kHz

Loudness Control

(at -25 dB/-43 dB re 0 dB max. volume setting)
Position 1. + 4/8dB at 50Hz and 2/4dB at 10kHz
Position 2. + 6/13dB at 50Hz and 3/7dB at 10kHz
Position 3. + 11/18dB at 50Hz and 5/8dB at 10kHz
Presence Control +7 to -5dB at 2kHz
Dimensions 470 x 117 x 280mm
Price £132.00 inc. VAT.



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SONY ELECTRET MICROPHONE ECM22P

FOR many, EXPO '70 in Japan, provided the first demonstration of Sony Electret Microphones. These were used extensively for the functions in the main arena, and in particular, as pick up microphones mounted directly on to the horns of the brass instruments in the orchestra.

This new generation of microphones makes use of the 'electret' principle. While the electret principle is not new, it is only in recent years that it has become sufficiently developed to become a commercial proposition.

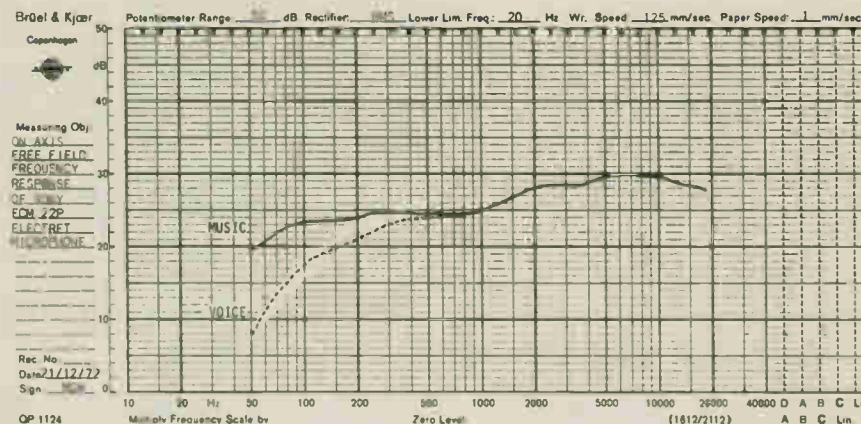
Electret microphones are a development of capacitor microphones. Capacitor microphones use the sound vibrations to move a thin metallic diaphragm which forms one plate of a parallel plate capacitor. The other plate is fixed to the body of the microphone. This capacitance is inversely related to the distance between the plates so, as the plates move closer together, the capacitance increases.

There are two ways commonly used to convert this change in capacitance into an electrical signal. The first uses the microphone as the tuning capacitor in an oscillator circuit. The second method uses a constant charge placed upon the capacitor (microphone). The voltage across a capacitor is inversely proportional to capacitance and therefore proportional to the displacement of the diaphragm. This is the system used in most precision microphones.

With this latter technique, a difficulty arises in providing the charge upon the microphone. This is usually achieved by a very stable dc power supply, delivering about 200 volts, connected to the microphone elements through a very high value resistor (200 megohms or greater).

The electret concept is to place a permanent charge on a dielectric material and this has an equivalent effect to a voltage of between 50 and 200 volts on the plates of a normal capacitor. Using this technique, the electronic circuitry associated with the microphone is vastly simplified.

The method that Sony used to form electrets is to place a piece of plastic, which has been coated with a metal



film between the plates of a capacitor. The capacitor is charged up to a high voltage, and the plastic film is then heated and allowed to cool. This causes the plastic to retain a permanent polarisation — except for the effects of leakage from one face to the other. With modern electret technology this leakage can be controlled to give a half life of between 100 years and 1000 years.

With normal capacitor microphones the stiffness of the diaphragm is controlled by an air cushion between the diaphragm and the back plate. This controls the many modes which would otherwise be set up in the diaphragm thus degrading the smooth performance for which a capacitor microphone is renowned. The spacing between the diaphragm and the back plate together with the geometry of the back plate is critical and expensive to achieve. Sony abandoned this technique and used a radical but ingenious departure in design. The back plate in their electret microphone is roughened aluminium, the plastic film is then stretched over this, giving random contact between the film and the high points of the aluminium backing plate. This provides the same effect as the air space in the conventional microphone, and is not only simple to make but provides maximum capacitance (because of the lowest possible spacing between the metal film on the diaphragm and the backing plate). The only trade-off is in the maximum sound level which the microphone can handle. This is typically 10 dB lower than a comparable conventional capacitor

microphone.

The electronics associated with the microphone are contained in a single integrated circuit. The circuit is basically an impedance converter transforming the very high output impedance of the microphone capsule down to a more useful impedance for driving the matching transformer. The sensitivity of the Sony ECM 22P microphone is comparable with most dynamic microphones, allowing interchangeability.

The microphone tested was supplied in an attractive and compact black plastic case. Supplied with the microphone and fitted into compartments in the case, was a 20ft. long microphone cable with Cannon connector, a wind-screen, a microphone holder, a stand adapter and an instruction manual. In addition, a plastic cover incorporating silica gel crystals was provided to cover the microphone when not in use (to minimize the retention of moisture).

In appearance the microphone is very plain. It is basically a straight tube with the top 1½" perforated to accommodate the capsule.

The unit unscrews at the centre to allow battery replacement and selection of output impedance. Above the central joint is a switch which provides response shaping, in addition to turning the microphone off when not in use.

The microphone cable supplied provides a balanced line to ground and extension cables up to 200 feet long may be used without affecting the performance. The wind-screen is

SUMMARY:

In all, this microphone provides an exciting yet economical alternative to conventional capacitor and dynamic microphones, in the semi-professional field.

MEASURED PERFORMANCE OF SONY ELECTRET MICROPHONE TYPE ECM22P

Frequency Response

Music Mode 50Hz to 20kHz ± 5 dB
Voice Mode 6dB/Octave
(filter) Corner Point 200Hz.

Sensitivity -54.6 dB re 1V/Pascal
into 600 Ω LOAD

Output Impedance 250 Ω or 600 Ω
balanced

Front to Back Ratio at 1kHz
28dB.

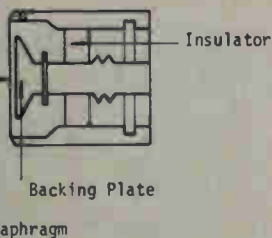


Fig. 1. Construction of typical conventional capacitor microphone.

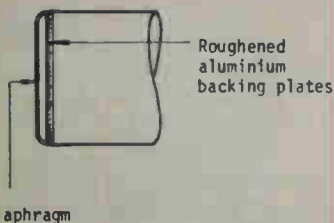


Fig. 2. Construction of Sony electret microphone.

recommended to be used at all times, as it acts not only as a 'pop' screen for vocal work, but also protects the capsule from shock, moisture and dust. The fifteen-page instruction manual is quite comprehensive and gives brief details of the electret principle as well as listing a complete specification, wiring details and instructions on the features and accessories provided. A separate section on the installation of the battery is included.

As supplied for testing, this microphone, and others seen elsewhere, have all been fitted with the incorrect battery — a 4.5V battery instead of the suggested 9V battery.

Provision is also made for phantom powering as well as the internal battery power and, in view of the high quality microphone mixers available with this supply, it is a worthwhile feature. The microphone itself is fitted with a three-way switch mounted mid-way along the tube and enables the user to select:— OFF, MUSIC or VOICE. The "Music" position provides a linear response, whilst the "Voice" position incorporates attenuation of the bass, to assist in areas where low-frequency ambients are encountered. This switch is

extremely valuable and enables the vocalist to switch from the "Off" position to the "vocal" position without the necessity to look carefully to see the switch is in the right position — good ergonomic design.

Naturally, users have found it necessary carefully to evaluate their requirements and select the most appropriate model from the range. For pure pop group use, the cheaper ECM 21 is extensively used whereas the ECM 22P has found applications in the semi-professional field of cabaret artists and has been recently used to videotape large concerts for TV specials.

From the practical point of view, the performance of the ECM 22P is excellent except when used at levels greater than 120dB. At these levels the cardioid pattern is not sufficiently narrow thus resulting in pick-up of the background noise, rather than the desired signal. For every day use, the microphone requires care in its handling (as do all precision microphones) as ruggedness is not one of its major assets. A recent pop festival found that the maximum lifetime of this microphone, when used for 14 hours a day was only around 1 — 1½ days. ●

DYNACO A-25 SPEAKER

THE Dynaco A 25 is an interesting loudspeaker — firstly because it is different from its competitors in a number of technical features, and secondly because it is lower in price than most other speakers imported from the USA.

Dynaco claim that this is an "aperiodic" system i.e. that its frequency response and acoustic impedance is flatter than the normal system. They also claim that the "Q" of the system is reduced by resistively loading the port. This approach was used extensively by Goodmans in the 1950's with their small volume enclosures, and their Acoustical Resistance Units which could be fitted in lieu of a tuned port on enclosures which used large speakers. The results that they achieved were satisfactory and comparable with the results that Dynaco have achieved.

The external appearance of the Dynaco A 25 speakers is plain and unpretentious. The enclosure is oiled walnut with a flecked beige grill cloth. The grill cloth is flush mounted in the timber enclosure with a two centimetre wide timber edging surrounding it. The speaker compliment consists of a 25 centimetre diameter (10") woofer and a 3.8 centimetre (1½") domed tweeter, with a capacitive crossover at approximately 1500Hz. The enclosure has a large single elongated rectangular port at the bottom of the face of the enclosure. This is damped by low density fibreglass protected by plastic mesh, rather than being tuned by a port in the conventional manner.

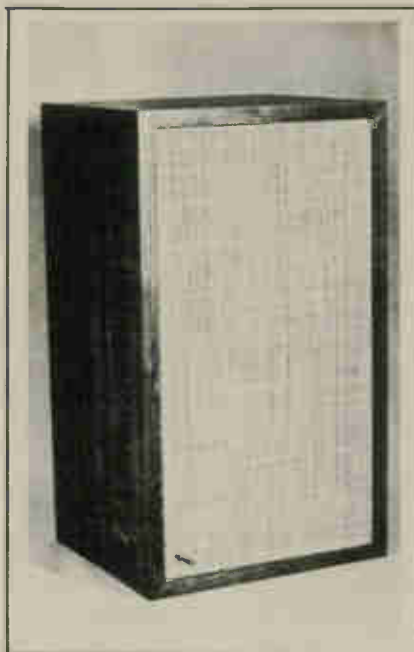
When the frequency response is measured right on axis the tweeter shows a marked improvement in its high frequency response. This was particularly noticeable with piccolos and violins which generate significant harmonic content in the 10-15kHz region.

With speech and singing, the performance of the Dynaco A 25 is exceptionally good and equal to any other speaker system that we have ever heard. This is primarily the result of first class linearity between 80Hz and 1kHz.

The 25 centimetre diameter low

MEASURED PERFORMANCE OF DYNACO A-25 SPEAKER SERIAL NO. 19-242036

Frequency Response			
50Hz to 18kHz ± 7dB			
Total Harmonic Distortion			
	100Hz	1kHz	6.3kHz
1 Watt Input	0.6%	0.4%	0.5%
5 Watts Input	0.8%	0.8%	1.5%
10 Watts Input	1.5%		
Electro-Acoustic Efficiency at 1kHz			0.4%
Cross-over Frequency			1700Hz
Woofer Resonance			
in free air			19Hz
in enclosure			62Hz
Measured Impedance			
100Hz			9 ohms
1kHz			18 ohms
6kHz			10 ohms
Enclosure Volume			
24 x 10 ³ cubic cm.			
Dimensions			
Height			50 cm
Width			29 cm
Depth			25 cm
Weight			8.5k kilograms



The Dynaco A-25 Speaker has a recommended resale price of £46.20 including VAT.

frequency driver is a conventional low efficiency speaker with a flexible roll surround and a 3.8 centimetre (1½") diameter copper voice coil. The unit has been efficiently designed to cope with normal transient signals and it is stated by the manufacturers that each speaker is tested and adjusted to cope with a 5Hz square wave so as to



SUMMARY:

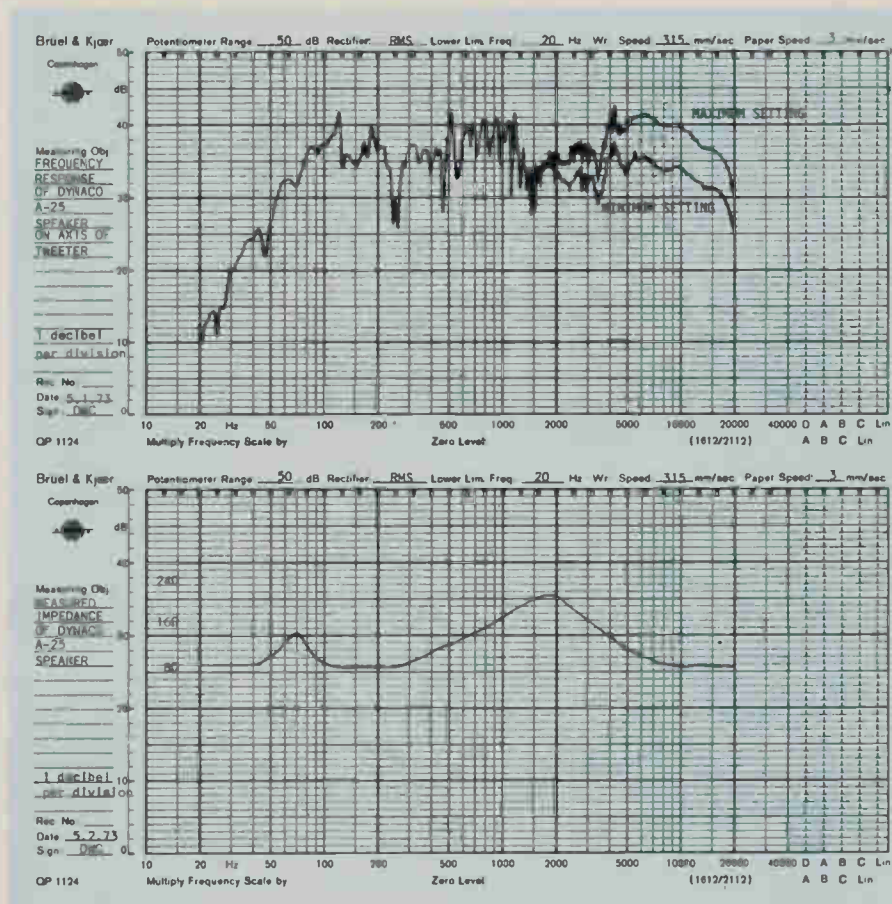
The clarity of programme content produced by the Dynaco A-25 speakers is equal to the best we have heard, but this is offset in part by poor off-axis high frequency response.

The design is interesting, and should create a lot of interest amongst hi-fi enthusiasts seeking a good speaker at a reasonable price.



provide the minimum distortion in the back emf voltage across the voice coil. The woofer is well designed and is very similar to many European units that we have tested.

The domed tweeter is not quite of such a high standard. It offers reasonable performance, but because of its size (3.8 cm), and its



configuration, there is some non-linearity in frequency response and excessive directionality at the top end of the spectrum. This tweeter is used to cover the spectrum from 1.5kHz to 15kHz.

We tried some of the latest records produced specifically for evaluating speakers and found that, apart from high level organ pieces and drum beats on which the A-25's woofer cone could be readily induced to break up, the overall performance was good. On classical guitar and flamenco pieces the performance was exemplary and every bit as good as speakers way out of their class.

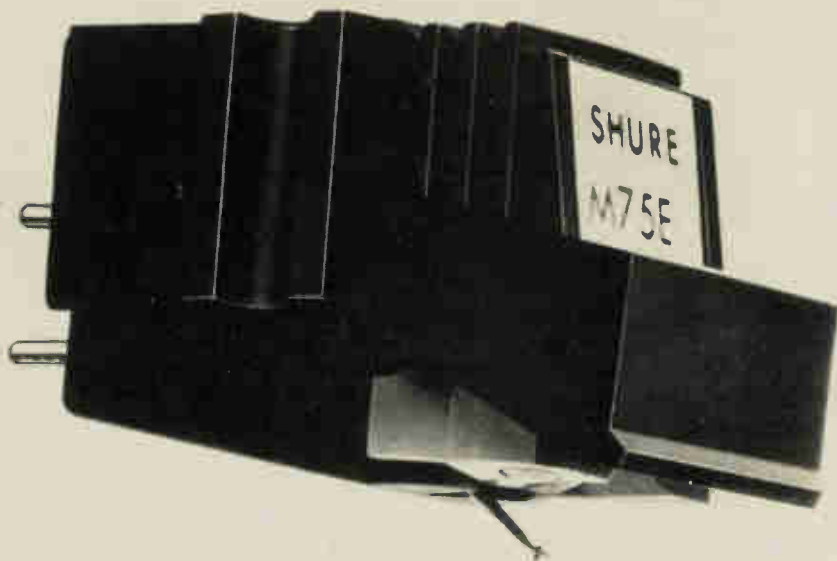
The transient response of the A-25 below 1500Hz is excellent (accounting for the exemplary reproduction of the guitar, which does not have much high frequency content). Above 1500Hz the transient response is comparable with other speakers in the same price category.

MEASURED PERFORMANCE

The measured performance of the A-25 was quite good, the frequency response being ± 7 dB from 50Hz to 18kHz. Distortion, at a realistic listening level of 5 watts, was very good — being below 1.5%. More detailed measurements between 1000Hz and 3000Hz showed a threefold increase in harmonic distortion compared with the rest of the spectrum.

This was also noticeable in the subjective assessment when very loud orchestral passages were played. The electro-acoustic efficiency of these speakers was lower than for a normal vented enclosure, for usually they have an efficiency in excess of 0.6% to 0.8% at 1000Hz.

The enclosure is not a truly aperiodic design, it has a measurable resonance at 62Hz due to the physical characteristics of the enclosure and its resistive vent.



SHURE have an excellent and long standing reputation for building top quality pickup cartridges, tone arms and microphones.

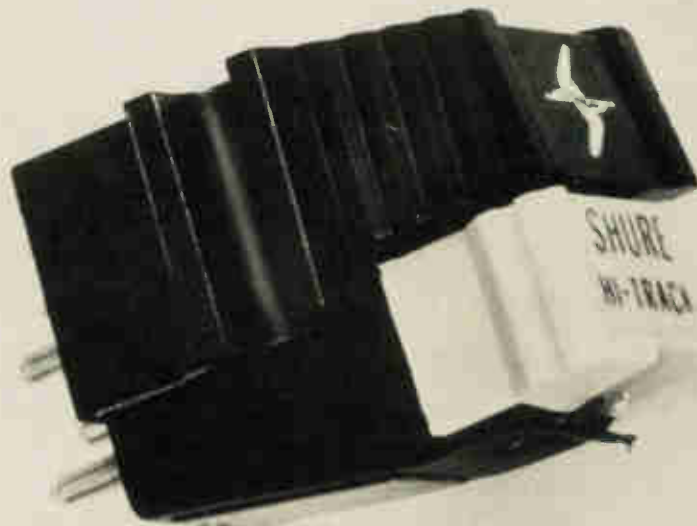
The company's top cartridge, the V15 Mk III was reviewed in the October 1973 issue and we considered that it was quite probably the world's best.

Apart from the V15 Mk III the company have produced a wide range of medium priced cartridges. First of these was the M44 series and whilst this series has been surpassed by many

others in the Shure range, very many M44 cartridges are providing good service today.

Among the company's medium priced cartridges are the M75ED and the M91ED. The specifications of these are identical and according to Shure Electronics Ltd who distribute only the M75ED the only differences are minor body changes. The tests were conducted on the M91ED but the results obviously hold good for both.

Most Shure cartridges already offer



a genuine 20Hz to 20kHz frequency response to within two or three decibels together with channel separation better than 20 dB over most of the audio frequency range. There are few areas for improvement excepting the related ones of effective stylus mass, tracking weight and trackability.

TRACKABILITY

It is a combination of the effective mass and tracking weight that governs the upper limit of the groove modulation which a stylus will follow. When the effective stylus mass multiplied by the acceleration level of the record groove becomes comparable with the tracking weight, tracking errors become apparent and distortion of the electrical output and the record groove results.

Theoretically, it is simple to measure the effective stylus mass using a force transducer and an accelerometer to measure the applied force and the resultant motion. This is a very common technique used for measuring this parameter. In practice however such a measurement becomes very difficult indeed for the forces and masses related to a record stylus are minute compared with the forces and masses related to the transducers.

The situation is like trying to measure the voltage across a charged 100 pF capacitor with a standard voltmeter — in that the energy required to obtain a meter reading is many times greater than the energy that one is attempting to measure.

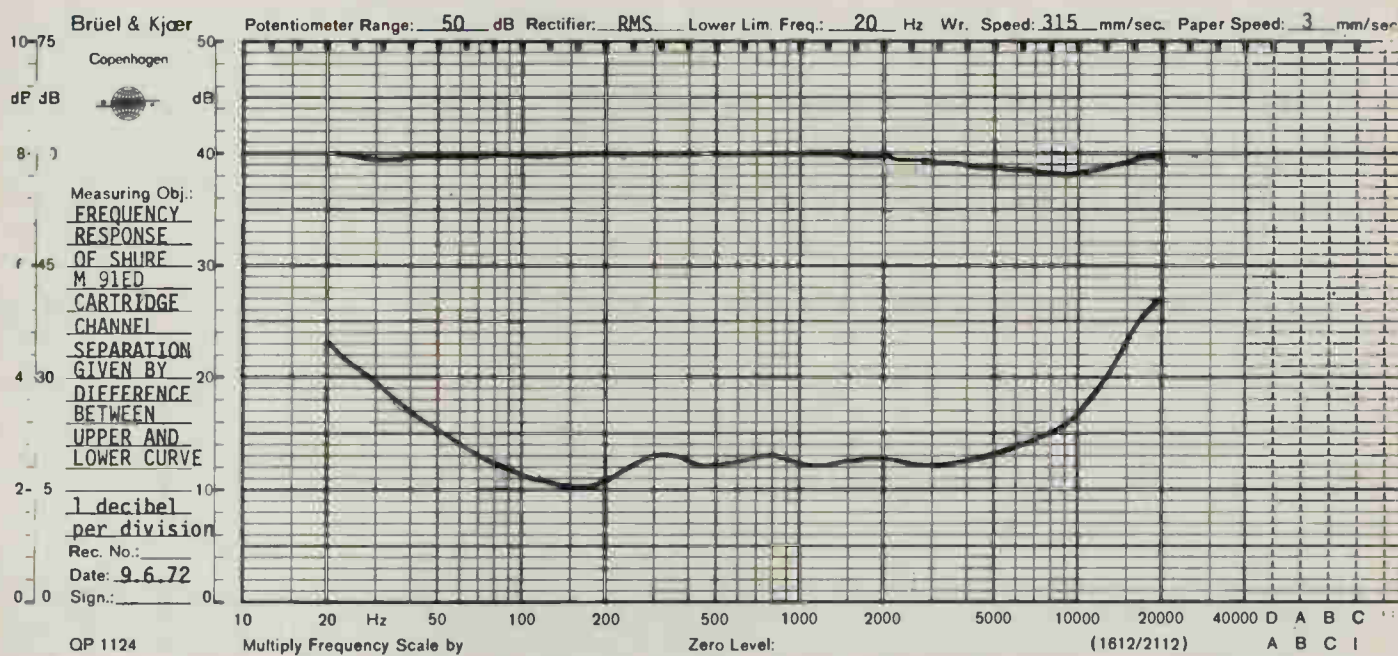
But whilst in the case of the capacitor voltage measurement, electrometer voltmeters are available which impose practically zero loading, there is no equivalent instrumentation available that may be used to measure the effective mass of a stylus.

Another and at first sight more practical approach, is to measure the effect of the stylus mass, by using a test record with a range of frequencies

M75ED

SUMMARY:

The Shure M75ED and M91ED are cartridges well worth the consideration of those who are looking for a cartridge for under £20. They exceed the manufacturer's specifications and outperform other cartridges which we have tested in the same price range.



MEASURED PERFORMANCE OF SHURE M75ED AND M91ED CARTRIDGES

Frequency Response
20Hz to 20kHz \pm 1dB

Channel Separation at 1kHz
27dB

Channel Difference at 1kHz
Less than $\frac{1}{2}$ dB

Output Sensitivity
(at 1kHz — re 5cm/sec)
4.6mV

Cartridge Impedance
47k Ω

Cartridge Weight
5.8 grams

Recommended Resale Price
(M75ED) £17.49

recorded at various velocities, and then to measure the resultant distortion. But there are problems related to this too. The most serious is that there are no commercially available test records with trackability grooves of really accurately known velocities. Even if there were, they would be practically unusable after a few playings for as soon as a stylus loses 'tracking' its resultant movement in the record groove causes considerable damage.

This forces a reviewer of pick-up cartridges to using commercially available records which, by their nature, only allow the crudest of measurements to be performed on one of the most important parameters on pick-up cartridges. This is a fact that is glossed over by most equipment reviewers — even ourselves on occasions. The problem is even more serious in the case of a review such as this, where the main claim to improved performance is in trackability.

Because of the problem involved in measuring trackability to fine degrees of accuracy we decided that the best way to appraise the new Shure

cartridge was to listen to a number of recorded passages known to be 'difficult'.

The range of recording covered bass drums, pianos, Moog synthesizers, female vocalists (where the 'sibilance' is so difficult to reproduce without distortion), and many more.

In all cases the performance was excellent, and no mistracking could be detected. Irrespective of the material that we tried, the cartridge appeared to perform faultlessly.

The measured performance of the cartridge was equally as good. Using our latest automated Brüel and Kjaer measuring equipment we found the frequency response to be within +0 and -2 dB from 20Hz to 20kHz. The channel separation was also very good being better than -25 dB between 50Hz and 8kHz.

Of the trackability tests that we conducted, the most pleasing result was the ability of the cartridge to faithfully track modulation levels in excess of 10 cm per second (at frequencies above 15kHz) at one gram tracking weight. ●

CONSTRUCTION Transient Generator 1

Assemble components to the printed circuit board, as shown with the component overlay (Fig. 2), paying particular attention to the orientation of integrated circuits, transistors, diodes and electrolytic capacitors. We recommend that sockets be used for the CMOS ICs at least. These CMOS ICs should also be the last components to be fitted to the board.

The mechanical assembly is similar to that for the oscillators (previously described). All rotary potentiometers and switches are mounted on a bracket as shown in Fig.6. The bracket, in turn, is mounted onto the component side of the printed circuit board. The wiring between the potentiometer and the switches is as shown in Fig.8.

VOLTAGE CONTROLLED AMPLIFIER

This is a very simple module and should not cause any difficulty. The component overlay is given in Fig. 4. and the potentiometer and switch wiring diagram in Fig.9. The MC1496 may be either a dual-in-line package or TO5. If the TO5 version is used it may be connected as shown in Fig. 3. The tag on the TO5 version is adjacent to pin 10 and this pin goes to what would otherwise be DIL pin 14 on the printed circuit board. Pin position 7, 9, 11 and 13 on the printed circuit board are not used with the TO5 IC.

ENVELOPE CONTROL

The envelope control is constructed by assembling a transient 1 module and a voltage controlled amplifier (VCA) to the same bracket. The VCA module is modified by omitting the rectifier IC1 (see 'How it Works' and overlay Fig.5) and the control input is taken from the transient 1 board output.

CALIBRATION Transient Generator 1

The only section of this circuit that needs calibration is the exponential generator. The procedure is as follows:-

With the module switched to the linear mode check that normal output is obtained. Now with the trigger input disconnected, and the output voltage at 0V, adjust RV5 such that the output of IC3 is also 0V. Set *attack time* to minimum and *delay* and *hold level* to maximum. If the module is now triggered the output voltage will go to +5V and stay there for about 10 seconds.

Whilst the output is at +5V, adjust RV4 so that +5V is also obtained at

PARTS LIST

Transient Generator 1

R1,R2,16,	Resistor	12k	¼W	5%
R3	"	680	"	"
R4	"	15k	"	"
R5	"	470	"	"
R6	"	8.2k	"	"
R7,19,22,24	"	1M	"	"
R8	"	1.8k	"	"
R9	"	39k	"	"
R10	"	3.3k	"	"
R11,12,13,20	"	1.2k	"	"
R14	"	470k	"	"
R15	"	27k	"	"
R17,23	"	100k	"	"
R18,21,25	"	10k	"	"
RV1,2,3	Potentiometer	2M log rotary		
RV4,5	"	22k trim pot		
RV6	"	25k lin rotary		
DPDT	switch (plain pot for envelope gen)			
RV7	Potentiometer	2M log rotary		
DPDT	switch			
C1	Capacitor	4.7µF 25V tag tantalum		
C2,4	"	33pF ceramic		
C6	"	10pF ceramic		
C3,7,9	"	0.0033µF polyester		
C8,10,11	"	10µF 25V electrolytic		
IC1,5	Integrated circuit	SCL4016AE *		
CMOS				
IC2,3,4	"	LM301A		
IC6,7	"	SCL4001AE **		
CMOS				
Q1,3,	Transistor	PN3638 or similar		
Q2,4	Transistor	PN3643 or similar		
D1,2,3,	Diode	IN914 or similar		
SW1,SW2,	Switch	SPDT miniature toggle		
SW3	Switch part of	RV7		
PC board	ETI 601			
Metal bracket	to Fig.			
Recommended extras				
1 8 pin socket	Molex type	M 2139-8		
8 pins	Molex type	M2138		
4 14 pin IC sockets				

PARTS LIST

Envelope Control

All parts as for Transient Generator 1. Except that RV6 does not have a switch, delete R25. All parts for Voltage Controlled Amplifier Except Delete R3,R4,R5,R6,RV2,C3,C4,D1,IC1, metal work, socket and pins. SW1.

PARTS LIST

Voltage Controlled Amplifier

R1	Resistor	8.2k	¼W	5%
R2,15,16	"	22k	"	"
R3	"	4.7k	"	"
R4,7,8,10	"	12k	"	"
R5	"	3.3M	"	"
R6	"	10k	"	"
R9	"	39k	"	"
R11,13	"	330	"	"
R12	"	470k	"	"
R14,17,18,19,20	"	100k	"	"
R21	"	3.3k	"	"
RV1	Potentiometer	50k trim potentiometer		
RV2	Potentiometer	10k lin rotary		
C1	Capacitor	33µF 10V (tag tantalum)		
C2,3,6	"	4.7µF 25V (tag tantalum)		
C4,5	"	33pF Ceramic		
C7,8	"	10µF 25V (electro pc mounting)		
IC1,3	Integrated circuit	LM301A MINI		
DIP				
IC2	"	MC 1496 (or similar D.I.P. preferred)		
D1	Diode	IN914		

SW1 Toggle switch SPDT
PC board ETI 601
Metal bracket to Fig.
Recommended extras
1 8 pin socket Molex type M2139-8
8 pin Molex type M2138

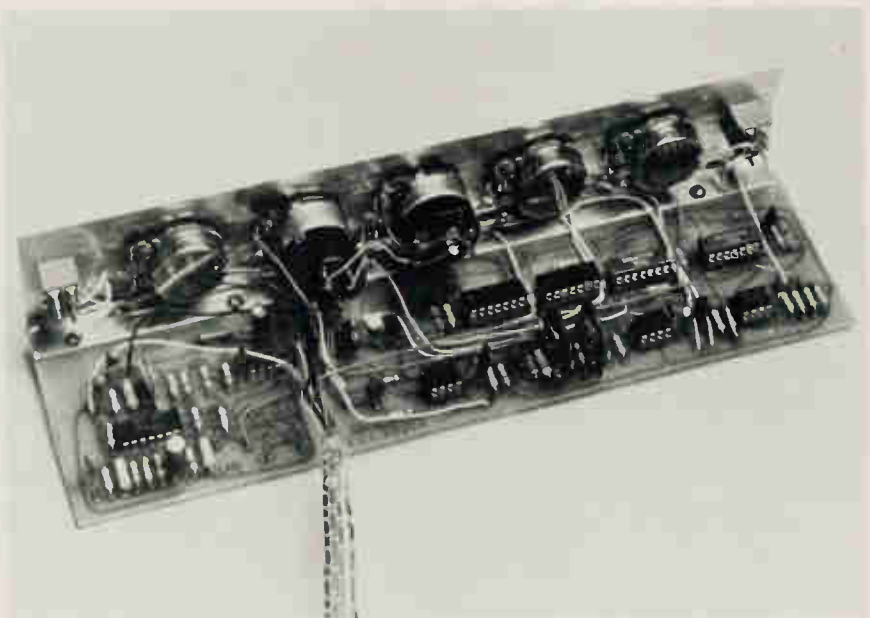
KS-309

the output of IC3. Recheck the 0V level and readjust if required. Repeat the procedure until both levels are correct.

When the module is returned to exponential mode check that the output of IC3 never goes negative.

Voltage Controlled Amplifier

The only adjustment required on this module is to null the output by adjusting RV1. With a signal applied to the input, and with 0V on the control input, set the switch to *amp* and adjust RV1 for minimum output.



The Envelope Control module. The Transient Generator 1 module is similar except that the VCA board on the left is not fitted.

INTERNATIONAL MUSIC SYNTHESIZERS

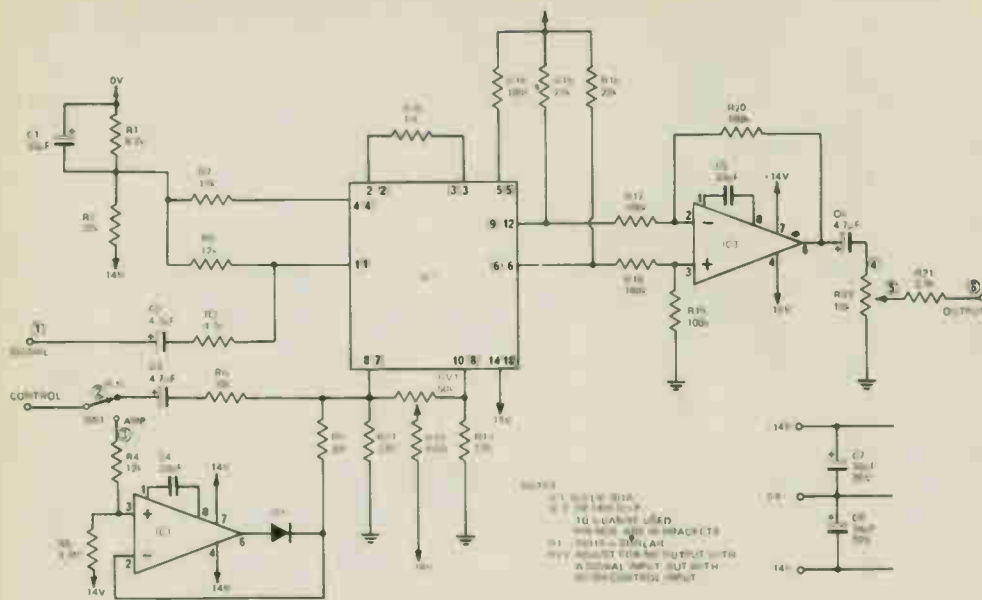


Fig. 3. Full circuit diagram of Voltage Controlled Amplifier. For use with Envelope Control module, IC1 and its associated components are omitted. See overlay, parts lists and text.

HOW IT WORKS

Envelope Control

This module is simply a combination of a Transient Generator Type 1 and a VCA, both of which have been described previously.

The only modification to the transient generator is the deletion of the hold-level switch and R25. (A hold level equal to the keyboard voltage is not required in envelope control).

The VCA is simplified by the omission of the rectifier (IC1) as the input is coupled directly from the output of the transient board and any zero error may be nulled out by the RV1. In addition the output potentiometer is not required and is therefore deleted.

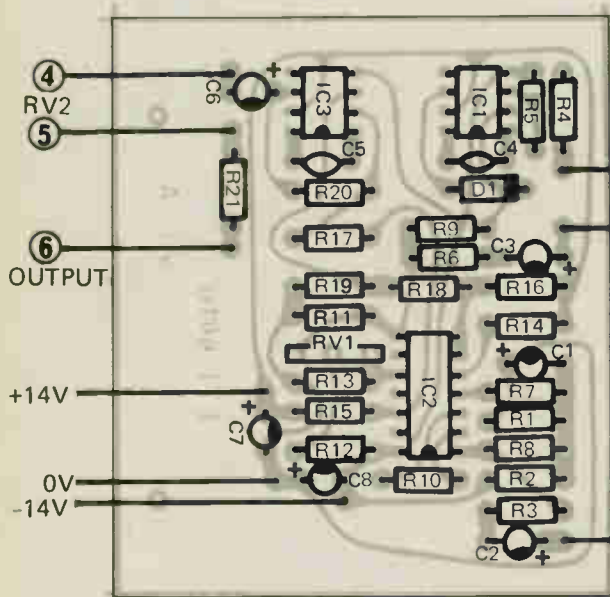


Fig. 4. Component overlay for the Voltage Controlled Amplifier when used as a separate unit.

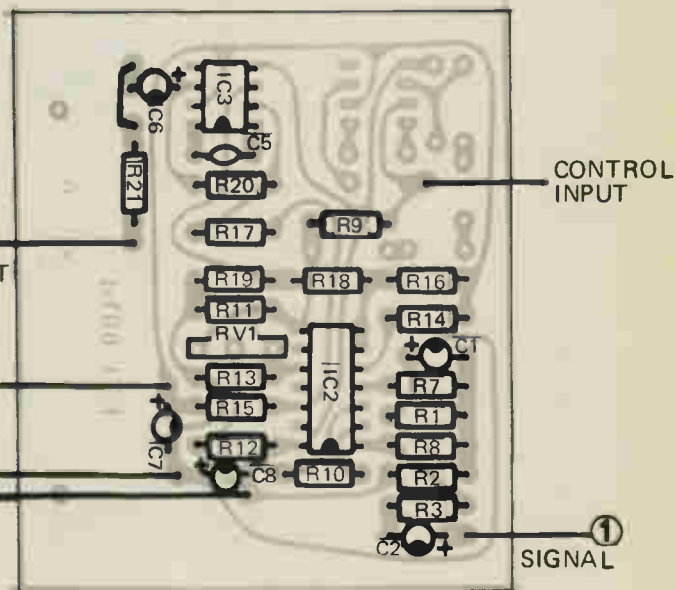


Fig. 5. Component overlay for the Voltage Controlled Amplifier as used in the Envelope Control module.

HOW IT WORKS

Voltage Controlled Amplifier

The voltage controlled amplifier is constructed around the MC1496 integrated circuit. This is a balanced modulator - demodulator, the internal circuitry of which is shown in Fig.10.

The 1496 has differential outputs, i.e. two outputs in antiphase, which are not referred accurately to the 0V line. A buffer amplifier (IC3) having

differential inputs, is therefore used to provide a single ended output.

In fact the 1496 has two sets of differential inputs, one set biased at about 0V, and another set biased at approximately -3V.

The input signal is injected into one of the -3V biased inputs (pin 1) whereas the control signal is fed to the other input (pin 8).

When using the circuit as a VCA, the maximum possible attenuation is

required when the input is 0V. However, due to tolerance variations, the 0V from other modules may be up to 20mV in error. Hence a rectifier, IC1, is used so that any voltage less than +50mV is regarded as 0V. The maximum attenuation at 0V control, is adjustable by RV1.

When the module is used as a ring modulator the control signal is ac coupled and the output will be the product of the two inputs.

HOW IT WORKS Transient Generator I

The transient generator consists, basically, of two sections.

(a) the wave-shaping circuitry (analogue).

(b) Control circuitry (digital).

The analogue section consists of integrator (IC2), exponential converter (Q2, IC3) and comparator (IC4). The comparator is a high gain differential amplifier whose output is normally either at +6 volts or at -6 volts. There is a small input region where the amplifier operates in the linear mode and the output voltage will then be somewhere between these two extremes. Negative feedback is applied by R14 so that this linear input region is approximately 30 mV wide.

Solid state switches select one of three voltage sources as input to the comparator. IC1/3 selects +5 volts, IC1/4 selects 0V and IC5/3 selects the output of level potentiometer RV6 or the output of the keyboard.

The switch potentiometer RV6, when in the off position, allows the keyboard voltage to be the third voltage.

The output of the comparator is connected back to the input of IC2 by R3 and a slope potentiometer as selected by IC1/1, IC5/2 and IC1/2. If the output of the comparator goes to -6 volts, the output of the integrator, IC2, will be a voltage, linearly increasing at a rate set by the selected potentiometer (RV1, 2 or 3). Conversely if the comparator output is at +6 volts the integrator will produce a linearly decreasing voltage.

When the two inputs are within 30 mV of each other the slope of the integrator will decrease, and when they are equal, (comparator output at zero) the system output will be stationary at the voltage selected by IC1/3, IC5/3 or IC1/4. This point will be stable as the comparator output is applied back to its input in a negative feedback loop, either directly, or via an exponential generator.

Generation of the exponential function is based on the collector - current to base-emitter-voltage relationship of a transistor, in this case Q2. The output of the integrator, after attenuation by R4, RV4 and R5, and level shifting by R6 and RV6, is applied to the base of Q2. Diode D1 biases the emitter of Q2 about 0.6 volts below zero and also provides temperature compensation for Q2. Resistor R7 applies a small bias and helps compensate different offset voltages in IC3. Integrated circuit IC3 produces an output voltage proportional to the collector current of Q2. Hence a linearly changing voltage, at the output of integrator IC2, will result in an exponential output from IC3. The range of the exponential generator is adjusted by RV4 and RV5.

When a key is pressed, the keyboard controller provides a -7 V to +7 V change. The positive edge of this transition is differentiated by C7 and R19, (the negative edge pulse is clipped by D2) to provide an approximately 3 msec wide pulse which turns on IC5/4 and Q4 thus discharging C8. In addition this pulse sets the flip flop formed by IC6/3 and IC6/4 so that the output at B is +7 V, and turns on IC5/1 and Q1 thus clamping the output line at 0V.

At the end of the 3 msec pulse, C8 begins to charge from -7 volts at a rate determined by RV7. When it reaches 0V, approximately, the output of IC7 changes from +7 V to -7 V and thus an internal delay is generated which is adjustable by RV7. Also immediately following the 3 msec period, the output B is at +7 V and hence IC1/2 is turned on selecting the attack potentiometer RV1, and IC1/3 is turned on, selecting +5 V as an input to the comparator. Thus, as pin 2 of the comparator is higher than pin 3, the

output will be low (-6 V) and the integrator will start to rise. The voltage divider formed by R15 and R16 will apply -2 V to the input of IC6/2.

At this point we pause to briefly explain the operation of digital logic NOR gates. The digital ICs used in this circuit contain four, 2 input NOR gates. In a NOR gate, if either one or both of the inputs are high, the output will be low. Only when both inputs are low can the output be high. This is illustrated below.

Input A	Input B	Output
0	0	1
0	1	0
1	0	0
1	1	0

Note for +7 V and -7 V supplies as used, 'O' means less than -1 V and '1' means greater than +1 V when applied to inputs, and '0' means close to -7 V '1' means close to +7 V in the case of outputs.

Thus to return to our circuit the -2 V input at IC6/2 is a '0' input and the output of IC6/2 will be high at +7 V.

When the output of the integrator (or exponential generator) reaches +5 V the comparator output will drop to zero volts causing an input of +2V to be applied to IC6/2. This is a '1' level and thus the output of IC6/2 will go to -7 volts. The output swing of IC6/2 is inverted by IC6/1 and differentiated by C9 and R24. The resulting positive pulse resets the flip flop (IC6/3 IC6/4) and the negative pulse is clipped by D3.

When the flip flop is reset its output goes to -7 V turning off IC1/2 and IC1/3 and a '0' is presented to IC7/2 and IC7/3 (pins 6 & 9).

If at this time the delay period has not expired (that generated by C8 & RV7) a '1' will still exist at the output of IC7/1. Thus IC7/3 has a '0' on pin 9 and '1' on pin 8 and its output will be a '0'. Hence both inputs of IC7/2 are '0' and its output will be a '1'. This turns on IC5/2 which selects DECAY 1 slope and IC5/3 which selects the output level set by RV6. The comparator now sees an error and drives the integrator to correct it. The output will stabilize again when the level set by RV6 has been reached. This output level will now be held until the "C" control is removed.

When the delay period is completed the pin 8 input to IC3 goes to '0', and since the other input is '0', the output will be '1' and the output at 'C' will be turned off.

We now have the 'D' output at '1' and this selects the DECAY 2 potentiometer and 0V reference to the comparator. Again the integrator drives to correct the error. Positive feedback is provided around IC7/3 by IC7/4 so that the input may change much quicker.

When the delay potentiometer is switched off (SW4/1 and 2) trigger input will now be direct to IC7/3 pin 8 and the delay will be determined by the key-hold time only, and not by the internal generator.

If the DELAY time setting (either internal or external) is shorter than the time to complete DECAY 1, DECAY 2 will be initiated, provided the attack time is completed, immediately the delay expires.

If the DELAY setting is less than the ATTACK time setting the ATTACK will be completed, DECAY 1 eliminated and DECAY 2 initiated.

The trigger input from the patchboard is buffered by Q3 to ensure correct operating levels for the logic. It also provides an inversion which means that the trigger will occur on the negative edge of the input trigger pulse.

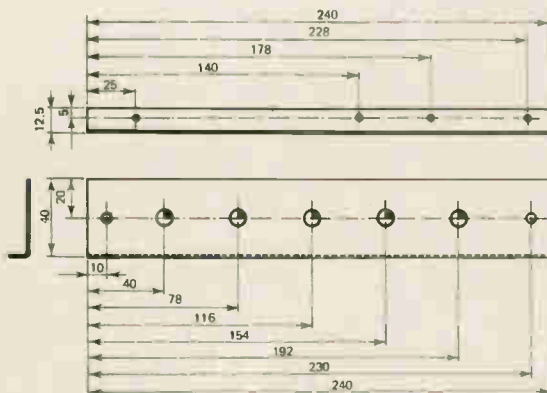


Fig. 6. Mounting bracket for Envelope control and Transient 1 modules.

ALL DIMENSIONS
IN MILLIMETRES

MATERIAL 18 GAUGE
ALUM. OR STEEL

- 5 HOLES 9.5 mm dia
- 2 HOLES 6.4 mm dia
- 4 HOLES 3.2 mm dia

ALL DIMENSIONS
IN MILLIMETRES

MATERIAL 18 GAUGE
ALUM. OR STEEL

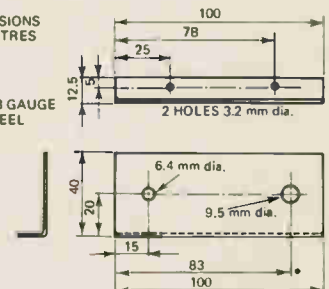
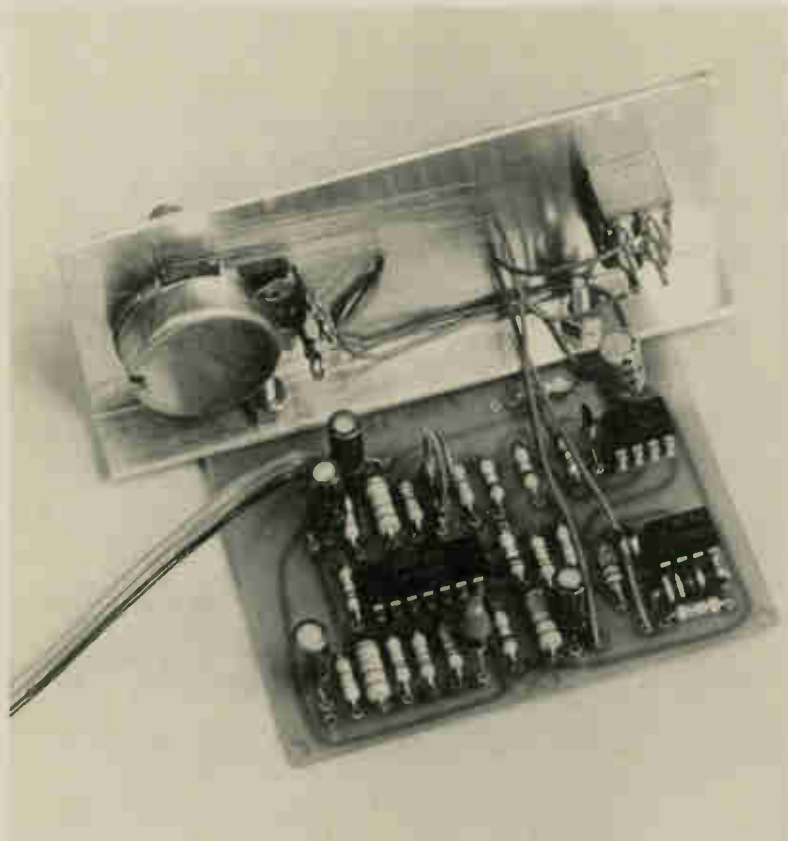


Fig. 7. Mounting bracket for the voltage controlled amplifier.

INTERNATIONAL MUSIC SYNTHESIZERS



The voltage controlled amplifier

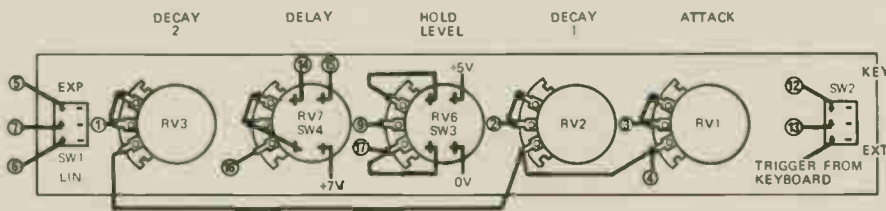


Fig. 8. Wiring to switches and potentiometer for Transient Generator 1.

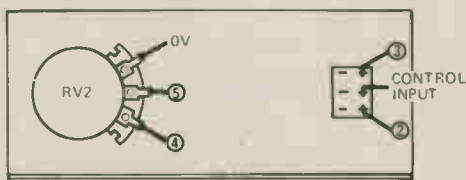


Fig. 9. Wiring to front panel of Voltage Controlled Amplifier.

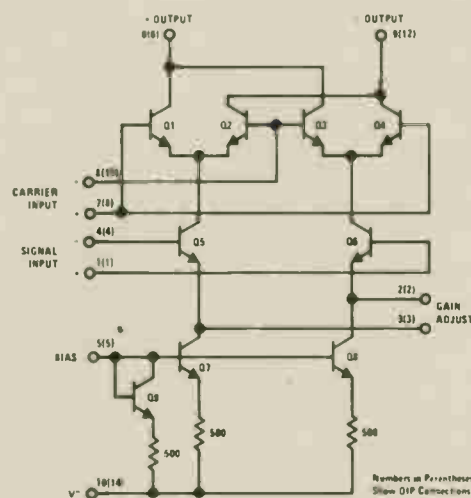
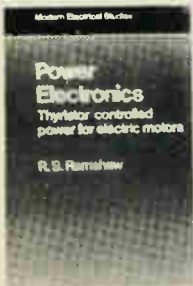


Fig. 10. Circuit diagram of the MC1496 balanced modulator - demodulator IC.

BOOK REVIEWS

REVIEWER: Brian Chapman



POWER ELECTRONICS – Thyristor controlled power for electric motors by R. S. Ramshaw. Published by Chapman and Hall 1973. Hard covers, 213 pages 230 x 155mm. Price £4.50.

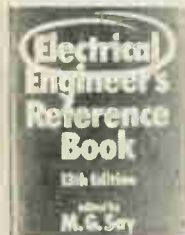
The speed control of dc motors in industry has grown enormously in recent years largely due to the advent of the thyristor. This solid state device replaces the thyatron of bygone days and, in conjunction with other solid state circuitry, makes possible the implementation of control systems having a degree of accuracy previously unattainable.

Control of induction motors by means of thyristor inverters is also increasingly being used and hence a knowledge of the characteristics and use of thyristors in power control circuitry is essential for the power or control engineer.

This book provides a discussion of the characteristics of transistors and thyristors without getting involved in the physics of the devices, and then concentrates on the methods of their application to power and motor control.

Control systems are described in fairly general terms, providing information on the types of feedback loops used, but not of the detailed control circuitry.

The book is suitable for degree or diploma students or practising engineers wishing to extend their knowledge in this field. – B.C.



ELECTRICAL ENGINEERS REFERENCE BOOK 13th Edition. Edited by Professor M. G. Say. Published by Butterworths October 1973. Hard covers, approximately 1400 pages. 215 x 135mm. Price £12.00.

Whatever the field of human technical endeavour, it generally has an associated text which may be considered the 'bible' for that particular discipline. For the electrical engineer, the Electrical Engineers' Reference Book must surely be considered in that category.

The very fact that the book is now in its 13th edition since its first appearance in 1945, says a great deal for its acceptance by the electrical fraternity.

This new edition has been extensively rewritten, the page size has been increased, and a new type style used. Although many of the chapter headings from previous editions have been retained, much new material has been added and the previous material extensively updated.

The list of contributors reads like a "Who's Who" of the British electrical and electronics industry, and hence one can be sure that each section is up to date and has been written by an expert in that field.

Typographic errors are found to happen in any text, but I can't resist mentioning one in this book that is of 'mammoth' proportions. On page 1-15 the mass of an electron is given as $9 \times 10^{28}g$. The error is only in the omission of a minus sign in front of the exponent – but what a difference, the figure given is about 100 times the weight of the entire earth!

If you are involved in electrical technology in any way you should have this book. – B.C.



COMPUTER PROGRAMMING MANAGEMENT by Jeff Maynard. Published by the Butterworth Group 1972. Hard covers, 99 pages 215 x 140mm. Price £2.80.

In the early days, computer programming was a highly specialized task requiring very specialised skills and abilities. As a result, programmers were considered a very special breed and were held in considerable awe by the rest of us.

This is no longer true as machine language has given way to high level languages which can be taught to anyone of average intelligence in a few days.

Hence in a company which relies heavily on some form of computer base, the programming department becomes merely another form of production department. In such departments the manager will usually be a young programmer of exceptional ability who has risen to the position in a relatively short space of time.

Unfortunately skill in programming does not necessarily imply skill in management and too often the management function is second best to the problem solving function – to the detriment of efficient departmental operation.

This book is specifically written to aid the programming manager to organize and run his department in the most efficient manner. It covers all facets of the task including estimating and scheduling, documentation, personnel management, the function of the programming manager and last but not least programming techniques. – B.C.



DICTIONARY OF ELECTRICAL ENGINEERING. By K.G. Jackson. Published by Butterworths, September 1973. Hard covers, 375 pages 215 x 135mm. Price £2.25.

Whether student or experienced engineer, a comprehensive dictionary of terms in the field of interest, is not only useful but almost essential.

This volume, although specifically designed for electrical engineers, has great breadth and scope. For it not only includes conventional terms, but also some of those used in allied fields. For example more and more thyristors and other semiconductor devices are being used in 'electrical' equipment. Additionally a good electrical dictionary should cover illumination and some mechanical engineering as these fields are becoming ever more involved in electrical engineering. This one does.

The dictionary contains many illustrations, (at least one every second page) and gives relevant formulae where necessary.

An appendix at the end of the dictionary gives Units, Abbreviations and Symbols commonly used – SI units in particular. And a final section provides a glossary of common semiconductor terms.

A well prepared dictionary that covers electrical engineering to a reasonable depth. – B.C.

ELECTRONICS -it's easy!

PART 3

This course, written in down-to-earth language, takes the mystery out of electronics — explaining it as the logical, fundamentally simple, yet far ranging subject it really is.

WE ARE unable to see electricity directly. But if electrical energy is converted to some other form, then a measurement of its magnitude can be made visible.

For example, the brightness of a light bulb is a measure of size of one of the electrical quantities. Such a method is, however, not nearly accurate enough as the eye is a very poor judge of light levels.

A much better way is to use the electricity to drive a mechanical pointer across a scale. The extent of movement indicates the size of the quantity we are measuring. Devices using this principle are called 'meters'.

Meters come in numerous sizes, shapes and types (as shown in Fig. 1) but detailed differences need not concern us as yet for each one of them can be represented by our "black box" concept — an electrical parameter feeds into the box producing an observable pointer movement, proportional to the voltage, current, resistance or power (etc) being measured.

The type of meter known as 'moving coil' is the most suitable (and hence most commonly used) meter for measurements in dc circuits.

A detailed description of the moving coil meter is given elsewhere in this article for those who wish to know more about its construction. However, such detailed knowledge is not necessary in order to make measurements with it, we can consider the meter purely as a black box device having two basic characteristics.

Firstly, it may be considered as having a fixed resistance between its two terminals. Secondly, it requires a certain amount of current to deflect the meter pointer to end-of-scale.

Meters of this type are described in terms of the amount of current required to deflect the meter pointer full scale. (This end-of-scale position is

known as — full scale deflection — often abbreviated to 'fsd').

Thus a meter, described as being 0-1 mA, indicates current values between 0 and 1 mA, and requires one milliamp of dc current to deflect the pointer to the end-of-scale (fsd) position.

At this stage, we should point out that the term 'meter' is loosely applied both to the basic *meter movements* (as in Fig. 1) as well as to complete instruments that incorporate switching and other electronics. These additions to the basic meter movement are required to measure the different kinds and quantities of the basic variables in circuits, ie, voltage, current and resistance. Each can be measured, using exactly the same meter movements, with the aid of external resistors and appropriate connections.

How the same meter movement can be used to measure the different quantities is easily explained by using Ohm's law and the rules of series and parallel connected resistors. We warned you that Ohm's law was basic! All electronic theory is built up logically piece-by-piece. So we reiterate — make sure you consolidate each piece of knowledge as we progress.

MEASUREMENT OF VOLTAGE

In our black-box representation of the meter, we stated that it could be regarded as a resistor. Hence a voltage is required, dependant on the movement resistance, to drive a current through the meter. This may be calculated by our, by now, well known formula $V=IR$.

Generally, meter movements are sold with the full scale deflection current specified. Some are sold as ready-to-use, specific range units modified to read 0 — 1 A, or 0 — 10 A, for example. These have built-in

resistors to modify the basic movement characteristics but for the moment we will consider only basic unmodified units.

Unfortunately it is not universal retail practice to quote the resistance of the meter movement. Manufacturers sometimes provide it on the actual unit itself — perhaps written on the meter face below the needle aperture, or in data sheets. (If not given, it can be measured, but as it requires a second accurate voltmeter this will be beyond the beginner).

If, as shown in Fig. 2 for example, the internal resistance of the meter movement is 1 k Ω (1000 ohms), and it requires a current of 100 μ A to deflect it full scale (a common specification) it will be fully deflected by applying a voltage of

$$\begin{aligned} V &= IR \\ &= \frac{100}{1000,000} \times 1000 \\ &= 0.1 \text{ volts, or } 100 \text{ mV.} \end{aligned}$$

So, although described as an amp-meter (we usually say ammeter) it may also be used as a voltmeter having 100 mV fsd.

Obviously the direct application of a voltage larger than 100 mV will cause the needle to deflect past the full-scale value. Excessive deflection can easily damage the movement. The excessive voltage may also cause more current to flow than the movement can handle — remember power is dissipated ($P = I^2R$) so unless adequately cooled, the coil in the meter movement may become too hot and burn out.

So to make our basic movement read higher voltages we add a series resistor, as shown in Fig. 3a. This resistor is called the *multiplier*. Its purpose is to limit the current, at the chosen voltage, to the fsd value of the meter.

For example, if when using the circuit of Fig. 3a, we require a 1 V fsd scale, we may calculate that the total series resistance (from $R = V/I$ must be

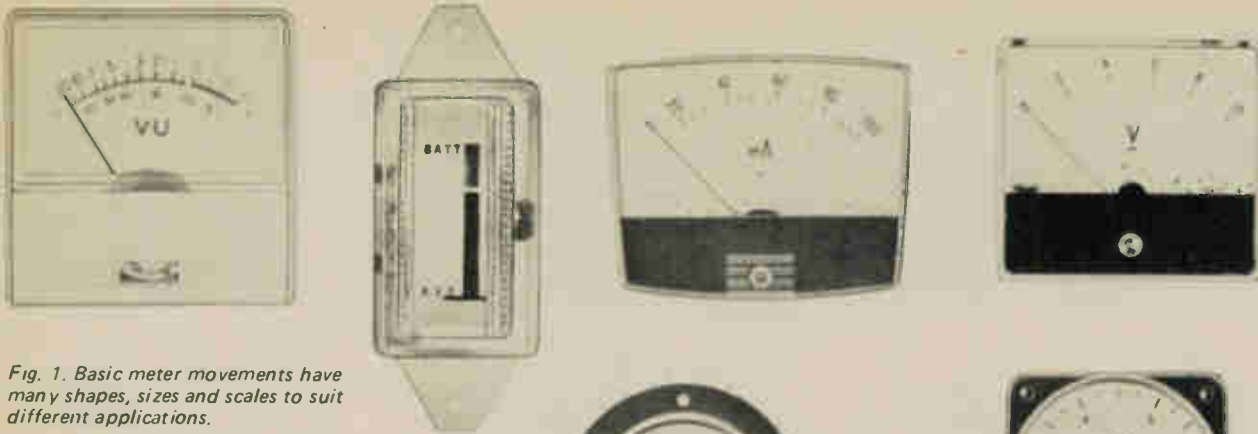


Fig. 1. Basic meter movements have many shapes, sizes and scales to suit different applications.

$$R_{\text{total}} = \frac{1 \text{ V}}{100 \times 10^{-6} \text{ A}} = 10^4 \Omega \text{ or } 10 \text{ k} \Omega$$

Remember the meter movement already contributes 1 kΩ so an additional multiplier resistance of 9 kΩ is needed. By a similar process the multiplier value for any voltage above 100 mV may be found. The upper limit is set by the insulation of the meter, but 1000 V full scale is usually possible.

Let us now see what happens if we require 100 V f.s.d. We would need a total resistance of 10⁶Ω (1 MΩ). But now it is pointless to subtract the meter movement's resistance value for it is insignificant compared with the multiplier value (0.1 per cent). Note also that for every volt of f.s.d. range required, we need to add approximately 10 k in series (100 V – 1000 kΩ; 10 V – 100 kΩ; 1 V – 10 kΩ). We can, therefore, refer to the meter circuit in terms of this – saying it has a sensitivity of 10 kΩ/V. Meters are usually specified this way – not to help us design multiplier values but to enable the effective resistance of the modified meter to be quickly assessed. This is most important when connecting the meter into electrical circuits, as we shall see later.

Voltages up to 100 may now be read by connecting the leads of the meter and its series multiplier across the two points in the circuit between which we

require to know the voltage difference. There is no need to break any connections, so the procedure is very simple.

Make sure if you use such a meter in a permanent connection, that the metered voltage *never* exceeds the rating of the unit.

THE MULTIMETER

If we had a meter that was calibrated to read 1000 volts full scale, but were trying to read only three volts, the pointer deflection would be so small that we could not know with certainty whether the reading was two, three, or four volts. Obviously a more sensitive meter is required. Rather than unsolder our multiplier and instal a new one, it is much better to fit a switch that enables us to select a multiplier having a resistance appropriate to the magnitude of the voltage being measured. This arrangement is illustrated in Fig. 3. Such a modification produces a slightly more complex black box – the multi-range voltmeter. We will see below that various ranges of current and resistance may similarly be handled with switched ranges. When all these facilities are built into a multi-range, multi-function unit, it is commonly referred to as a multimeter.

MEASURING CURRENTS

Let us now examine how our 1 kΩ, 100 μA f.s.d. meter movement may be modified to measure larger values of current. Again it is done with resistors, but this time the resistor is placed across the meter and is thus in parallel with the resistance of the movement instead of in series as before. This parallel resistance is termed a 'shunt' as its purpose is to by-pass or shunt current around the meter, as illustrated in Fig. 4a.

From Ohms law (again!) we can see that when resistors are connected in parallel, the larger value carries less current than the lower value of resistance. As long as the resistances remain constant so does the ratio of currents.

For example, suppose we need the basic meter to read 100 μA f.s.d. instead of 100 μA. As the meter deflects full-scale with only 100 μA, 200 μA must be diverted by the shunt. Remember that the voltage across each resistor in a parallel arrangement is the same, so our shunt must be of such resistance that 200 μA passes for 100 μA of applied voltage (remember the meter movement is also 100 mV f.s.d.).

The shunt must be

$$R_{\text{shunt}} = \frac{100 \times 10^{-3} \text{ V}}{200 \times 10^{-6} \text{ A}} = 500 \Omega$$

Another way to look at it (provided the current range required is much higher than meter movement's normal

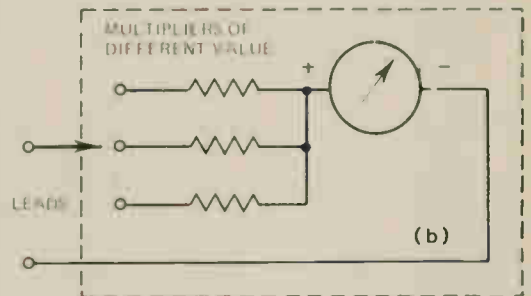
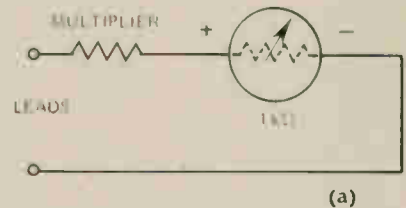


Fig. 3(a). Using a 'multiplier' resistor to provide a single voltage measurement range. (b) Adding a switch and extra multiplier provides more voltage ranges.

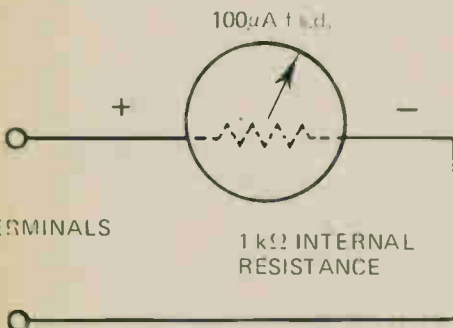
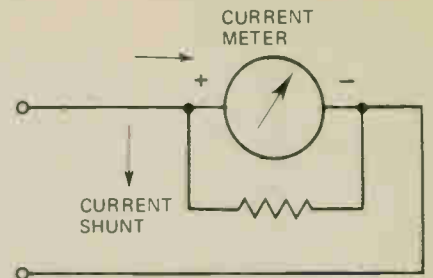


Fig. 2. Regardless of shape or size every meter movement may be represented as a 'black box' having two terminals and an internal resistance. The current required to produce full scale deflection must also be given.

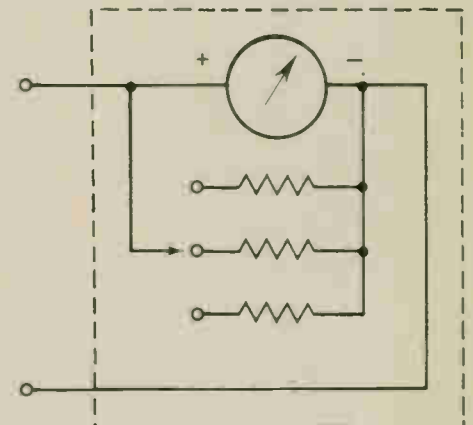
ELECTRONICS -it's easy!



Typical high quality multimeter, note the 'ohms' scale in which zero is at right hand end. Meters that indicate the measurement by a scale and moving pointer are known generically as 'analogue' instruments.



(a)



(b)

Fig. 4(a). In order to measure currents greater than the meter movement fsd a 'shunt' must be used to divert part of the current around the meter. (b) A switch and extra shunts may be used to obtain more than one range.

current) is to consider what value of resistance would develop 100 mV across it when the desired current flows. For example, 1 A fsd needs a shunt of

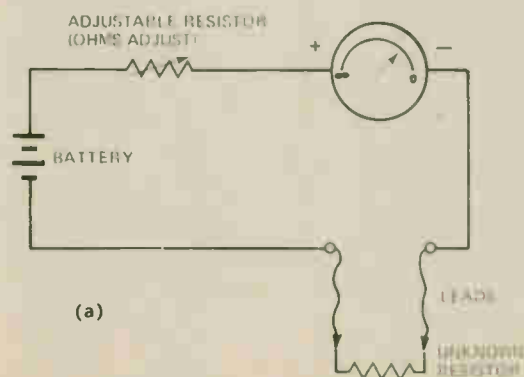
$$R_{\text{Shunt}} = \frac{V}{I} = \frac{100 \times 10^{-3}}{1} = 0.1\Omega$$

When designing shunts for large currents, thought must be given to the power dissipated in the shunt. In our previous example the power dissipated $P = I^2 R = 1.0^2 \times 0.1 = 100 \text{ mW}$ which is not significant. However if we were to require a shunt for 20 amps its resistance would be

$$R_{\text{Shunt}} = \frac{V}{I} = \frac{100 \text{ mV}}{20 \text{ amps}} = .01\Omega$$

$$\text{Power dissipated } P = I^2 R = 20^2 \times 0.01 = 4 \text{ watts.}$$

If our shunt is not to run too hot the resistor must be rated at two or three watts.



(a)

Fig. 5(a). The circuit required to measure ohms. (b). A typical multimeter scale - The Ohms scale is the centre one.



(b)

MULTIMETER
A.P.D. No 3

In practice the very low resistance required is usually obtained by using a short length of heavy-gauge wire and power dissipation is not usually a problem.

Shunts are usually made specially for meters, as there is little or no call for such low resistance values in the majority of electronic circuitry. Because of this they tend to be more expensive than normal resistors.

Measurement of current is made by breaking the circuit, in which it is required to find the current flow, and wiring the shunted meter in series with the lead and its original connection point so that the normal current passes through the meter and shunt.

We have seen how a shunt lowers the total effective meter resistance - especially as the current range rises. For this reason it is quite wrong to

connect a multimeter set to a current range across a component or section of a circuit. It will very effectively short the circuit out causing heavy currents to flow in components probably not able to support them. For example, our above mentioned 1 A meter (which has a 0.1 ohm shunt) placed across points in a circuit between which a voltage difference of 12 V exists, will cause a current to flow of

$$I_{\text{flowing}} = \frac{12}{0.1} = 120\text{A}$$

This current, if the supply could provide it, would melt the leads and components instantly!

To create a multi-range ammeter we again use a switch (Fig. 4b) to select the required shunt across the meter. As the same current flows through the switch contacts, the upper current range is limited mainly by the size of

AC AND DC

In all our discussion so far, we have considered electrical current flow as being in one direction only. This kind of current flow (as from a battery) is known as "direct current" and we usually abbreviate this to "dc".

There is another kind of current flow which continually changes direction, flowing first one way and then the other. This is known as 'alternating current' or 'ac'. The mains supply used in your home is a 240 volt "ac" supply, and the direction of current flow reverses 50 times a second. We will study ac in more detail later on, for the moment, just keep in mind the distinction between ac and dc.

the contacts and to a lesser extent by the size of the shunts. For this reason multimeters rarely have a range higher than 10 A fsd.

MEASURING RESISTANCE

As well as having voltage and current ranges, multimeters are usually capable of measuring resistance.

As described above, the multiplier of the voltmeter arrangement alters the effective fsd value of the meter to suit various applied voltages. But if we provide a fixed voltage (from a battery) to the meter, and place the unknown resistor in series, we can work backwards from the indicated current to obtain the resistance value. This may be explained with the aid of Fig. 5a as follows:

If the meter leads are shorted together, there is virtually zero resistance between them. This method is in fact used to establish the zero ohms point on the scale.

In practice the leads are shorted together and an in-built variable resistance is adjusted to give full scale meter indication (i.e. 100µA is flowing). Unlike the other meter ranges, on the resistance range full scale deflection represents zero.

At the other extreme, if the meter leads are not connected to anything at

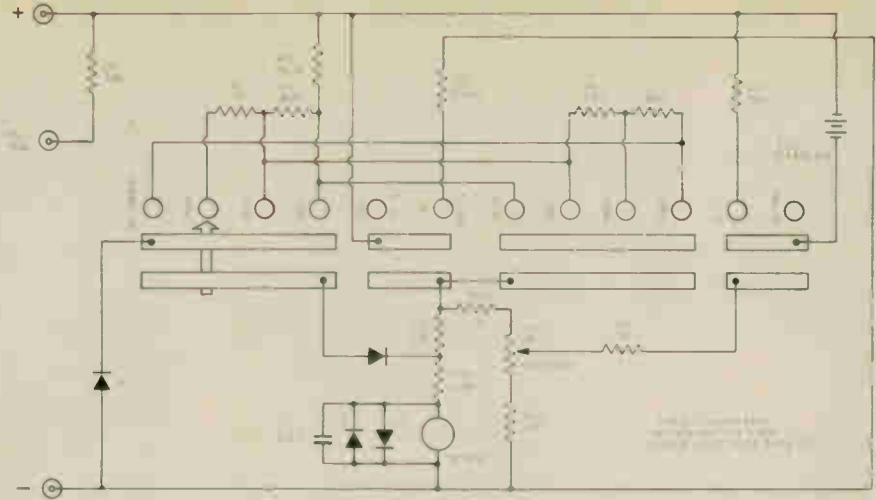


Fig. 6. Circuit diagram of a typical multimeter. The shorting bar, shown by the broad arrow slides along to make three connections at each position.

all, the resistance between them is virtually infinite. Hence no current can flow and the meter pointer will not move from the left-hand end of the scale. This point thus represents infinite resistance and is marked ∞ accordingly.

In between the 0 and ∞ values the pointer will assume a position proportional to the external resistance added. By applying Ohms Law it is easy to work out the position on the scale for any other value. A typical ohmmeter scale is illustrated in Fig. 5b.

For example, if we use a 1.5 V torch-cell as the voltage source, the adjustable multiplier needed with the 1 kΩ, 100 µA fsd meter, must be:—

$$R_{\text{total}} = \frac{1.5 \text{ V}}{100 \times 10^{-6} \text{ A}} = 15 \text{ k}\Omega$$

from which the value of the meter (1 kΩ) must be subtracted to get 14 kΩ. With shorted leads the meter will go to fsd, now marked 0Ω. The multiplier is adjustable so that the zero point can be reset as the battery becomes discharged (lower voltage). If we now insert 10 kΩ externally we get a total resistance of 25 kΩ. The battery voltage will cause a current to flow in the series loop (remember in a series circuit all components pass the same current) that is

$$I = \frac{1.5}{25 \times 10^3} = 60 \mu\text{A}$$

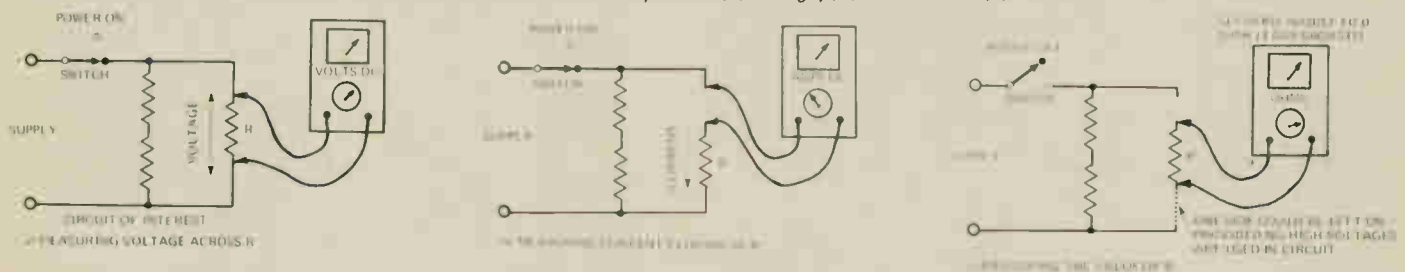
Hence, the meter, with 10 kΩ in series with its leads indicates its 60 µA value but is now marked 10 kΩ on our scale. The process is repeated for decade values — 100 Ω, 1 kΩ, 100 kΩ, then for spaces in between until the scale is adequately filled. Note that the divisions are not evenly spaced and that this form of ohmmeter has better resolution on some parts of the scale than on others. It is also clear that it measures 'back to front'. This is somewhat inconvenient but the simplicity of the arrangement more than compensates for this anomaly. More advanced (and therefore more expensive) multimeters usually read the conventional way.

It should be noticed that, in the example given, 10 kΩ gives approximately mid-scale deflection but, because of scale non-linearity, it is difficult to read values, around 100 kΩ at all, let alone with any accuracy.

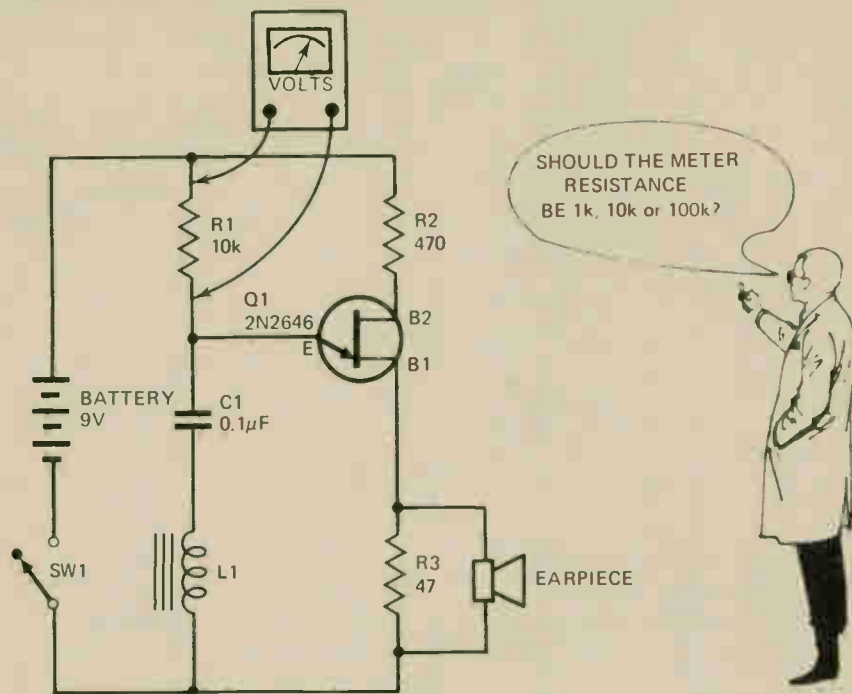
To resolve this difficulty, various battery voltages and/or resistance multipliers may be used to obtain centre scale readings either larger or smaller than in the example given. Use ohms law to determine what multiplier and battery voltage is required to obtain a mid-scale reading of 100 kΩ.

When it is required to measure the resistance of a component in a circuit, it must be disconnected. (One side

Fig. 7. These diagrams illustrate the three basic measurement techniques for (a) voltage, (b) current and (c) resistance.



ELECTRONICS -it's easy!



The multimeter, when measuring voltage, always loads the circuit. It is the degree of loading that matters.

When using any meter with switched ranges, always start off by selecting a meter range much higher than your estimate of the quantity to be measured. This precaution safeguards the meter should the quantity be much larger than expected.

only will do, but it is often easier to remove it completely).

To make a reading the meter leads are first shorted together and the zero ohms adjuster set to obtain zero ohms reading (this compensates for battery voltage variations). The unknown resistance is then connected between the meter leads and its value read from the meter.

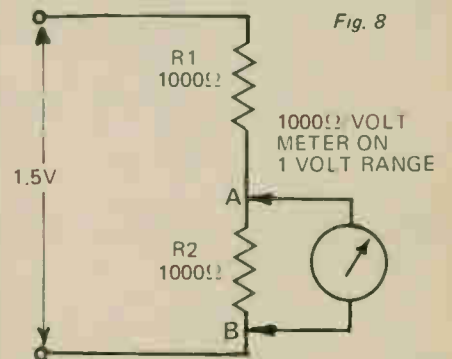
The measurement functions, namely, voltage, current and resistance form the basis of the multimeter. Other ranges may be provided for ac (or alternating current) quantities. These will be discussed later in this series. Figure 6 shows the full circuit for a small meter — can you trace out the various circuits that we have described? Ignore the ac slider position for the moment.

LOADING THE CIRCUIT

As we have seen, connecting a resistor in parallel with another resistor reduces the effective value of both — to something lower than the value of either. Thus, as a voltmeter is in effect a resistor, connecting it across a circuit will inevitably change the resistance of that circuit. In effect one has paralleled one resistor with another, and the meter must shunt current away from the circuit.

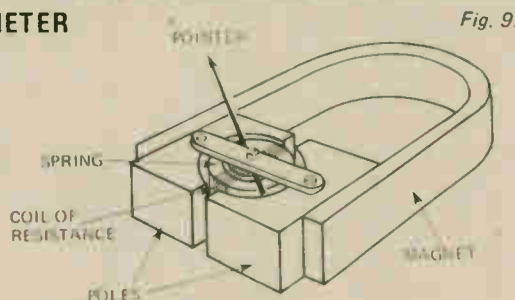
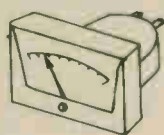
Because of this, when a meter is connected across a circuit, the operation of that circuit may well be affected, thus causing the meter reading to be in error.

This brings us back to the reason for quoting the sensitivity of voltmeters in ohms per volt. Multiplying the sensitivity by the fsd range in use, gives the resistance of the meter circuit that will be shunting the component. Cheaper multimeters will have sensitivities ranging from as low as 1000 Ω/Volt to as high as 100 kΩ/V.



To illustrate loading effects, consider the circuit in Fig. 8. By Ohms law we

THE MOVING-COIL METER



When electricity flows through a wire, a magnetic field is produced in a plane perpendicular to the wire. This magnetic field may be concentrated by winding the wire to form a coil of many turns, and still further by winding the coil around a soft-iron core.

Such a device is termed an electro-magnet, when electricity flows through it, it will attract magnetic material — such as iron.

One example of the way such an electro-magnet may be used, is the relay in last month's practical exercise.

A further example is in the moving-coil meter.

If the electromagnetic coil is suspended in the field of a permanent magnet, (a permanent magnet is made of steel — steel once magnetized, remains magnetized, whereas soft

iron loses its magnetism immediately the energizing field is removed) it will be caused to rotate, when energized, by a force proportional to the energizing current.

In the moving-coil type of meter, as Fig. 9 shows, the field of the permanent magnet is arranged to pass across a cylinder in which hangs the coil of the meter. A fine spiral tension-spring restrains the rotation by providing a linearly increasing torque as the coil rotates. Attached to the coil is a pointer that moves across a scale, thus indicating current.

As the number of turns is increased, to improve sensitivity, the designer must use finer wire to keep the mass of the coil small. As a consequence of this requirement, sensitive meters usually have a higher resistance, and are more delicate.

CHOOSING A MULTIMETER

Multimeters vary in cost from about £3 to several hundreds of pounds, commonest prices fall into the £5-£35 range for a moving-coil type; digital multimeters are very much dearer.

The more expensive types incorporate an amplifier to maintain a high input impedance (resistance) and/or elaborate circuitry to maintain high accuracy.

For the beginner, and even for the more advanced, high accuracy (better than 2%) is rarely necessary and quite cheap meters will enable one to take most measurements. However, unless your funds are very limited, the very cheap meters are not usually good value and if you can afford over £5 you will be able to get a decent one. If you want to get a cheap meter due to the lack of funds, don't worry, it will probably see you through until you can afford a better one and having two meters (albeit one of doubtful quality) is extremely useful, indeed almost essential for some work.

Assuming that you are not hampered by very small funds look out for the following features:

1. The sensitivity should be as high as possible, 20,000 ohms per volt or better.
2. It should be able to read volts (a.c. and d.c.), amps (d.c.) and ohms. An a.c. current range is useful but is rarely found in any but expensive meters.
3. Voltage ranges should be from at least 3V to 500V d.c. and 10V to 500V a.c.
4. There should be at least three resistance ranges.
5. Overload protection is now quite common and highly desirable especially for a beginner.
6. Look for a rugged construction and well made test leads. A multimeter should remain serviceable for many years.

know that the voltage between points A and B is 0.75 volts — don't we?

Now let us see what happens when we use a 1000 ohms/volt meter on the 1 volt range to measure this voltage. The 1000 ohms of the meter in parallel with R2 will produce a combined value of 500 ohms. Thus the

voltage read by the meter will be 0.5 volts instead of 0.75 volts — an error of 33 per cent!

It is the *degree* of this shunting effect that is important — in theory it can never be completely avoided, for some energy must flow into the measuring system from that being measured. In electronic measurements the rule of thumb is that for accuracy, the resistance of a voltmeter should be at least ten times that of the circuit — a hundredfold is better still.

This may not always be possible with an inexpensive meter, and some error will have to be tolerated. But remember — this error can be considerable if loading is severe. A check for loading is to make a reading on the next highest range. A much higher voltage reading will indicate that severe loading is occurring on the lower range. When this occurs we must take our reading on the lowest range that does not produce visible loading and put up with the lack of resolution. It should now be clear that the higher the sensitivity of the meter the better.

A similar thing happens when measuring currents, the series resistance of the meter may introduce undesirable voltage drops. In this case the combined resistance of the movement and shunt should be one-tenth, or preferably less, of the series circuit resistance.

This discussion of multimeters is restricted to those units that do not include electronic amplifiers — these will be discussed later when we have covered amplifier operation. Amplifier type multimeters are usually characterised by having a quoted fixed input resistance (called impedance in some data sheets) that is typically 1 M Ω or higher. With these there is seldom need to worry about connection loading.

Although we have discussed loading with reference to meter measurements, the same principles apply to the connection of any kinds of circuits — the black-box approach tells us this. Each circuit having input and output terminals will load those coupled to it — output is parallel with input of the next and so on. It is important to remember this, for all so often a circuit stage is developed that fails to operate into the following stage because of loading effects.

We have spent much time on actual multimeter circuits, for the calculations involved illustrate the kind of thinking that is continually required when building circuits — especially of your own design. If you have stayed with us so far you are well on the way to having the theoretical aspects of basic electronics under control. ●

TD BE CONTINUED

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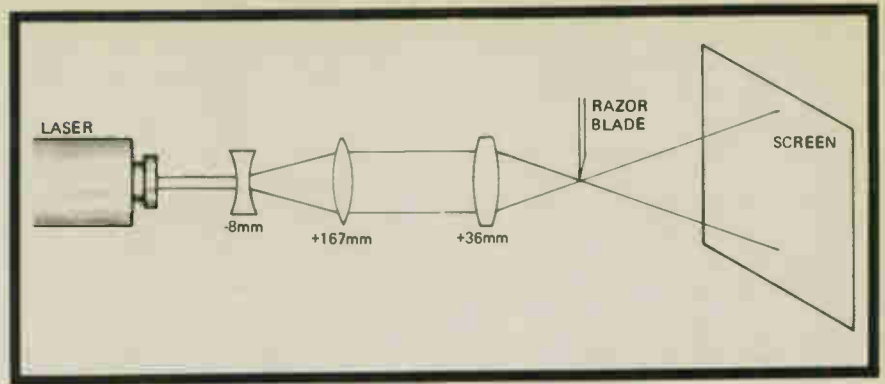


Fig. 1. Foucault knife edge test.

LASER EXPERIMENTS

THE EXPERIMENTS described last month required little additional equipment other than the ETI 524 laser itself, and hence, were of a very basic nature.

However, merely by adding a handful of cheap and readily available optical components, a number of surprisingly sophisticated and elegant experiments may be undertaken.

These advanced experiments will provide the student with considerable insight into the physical laws that so many of us merely learnt by rote.

FOUCAULT KNIFE EDGE TEST

The Foucault knife edge test is a standard technique employed by astronomers to determine the quality of lenses and curved mirrors, although this test has traditionally been

performed with ordinary white light, a monochromatic laser gives better results and is therefore preferable.

When white light is used, chromatic aberration tends to mask the lens defects resulting from faulty grinding, or from the use of poor quality glass. When monochromatic laser light is used, the masking effect does not occur and defects are much more easily seen.

The experiment is set up as shown in Fig. 1. A diverging and converging lens system (-8 mm and +167 mm our example, although focal lengths are not critical) is used to collimate the beam. A collimated beam has constant diameter with distance, this is obtained by adjusting the position of the long focus lens and checking beam diameter at various distances with a white card until negligible difference is

observed in the diameter at various distances.

The lens to be tested is now inserted into the collimated laser beam. This lens converges the laser light to a fine point, after which, it diverges again, as shown in Fig. 1.

If the edge of a new razor blade is gradually inserted into the beam at the cross-over point, the spot on the screen should darken uniformly as the razor blade cuts the beam. If the lens is imperfect however, instead of the beam darkening uniformly, irregularly shaped areas will be produced on the screen, some of which are brighter than others. These areas indicate the size and position of defects.

If you are interested in photography — try different camera lenses. The cost versus quality trade-off will be readily observed.

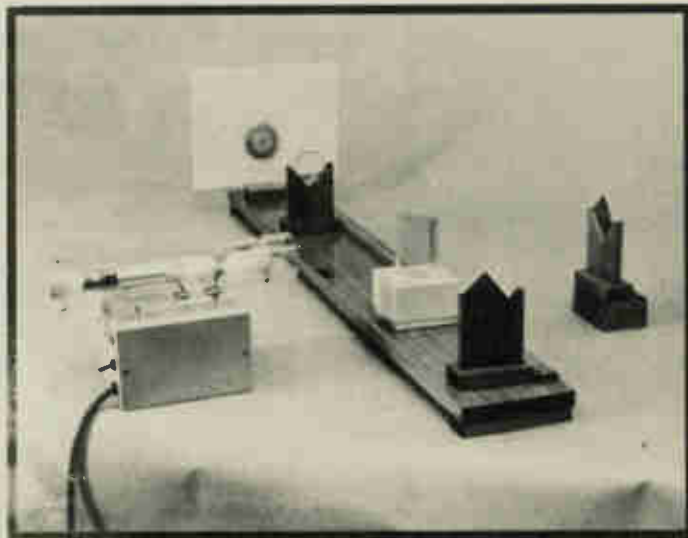
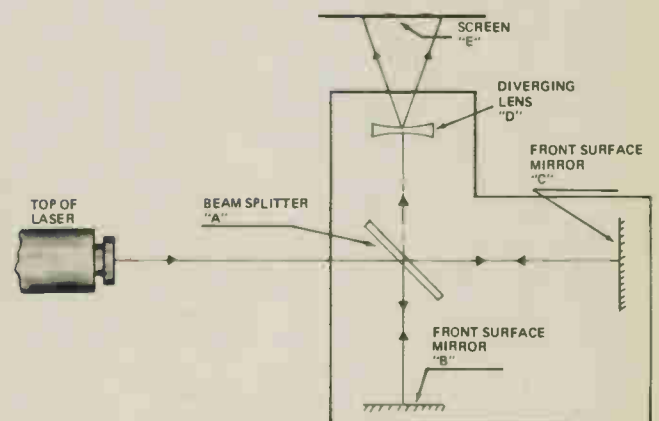


Fig. 2a. Laser and simple optical bench set up as a Michelson interferometer.

Fig. 2b. Diagrammatic presentation of equipment shown in Fig. 2a.



MICHELSON INTERFEROMETER

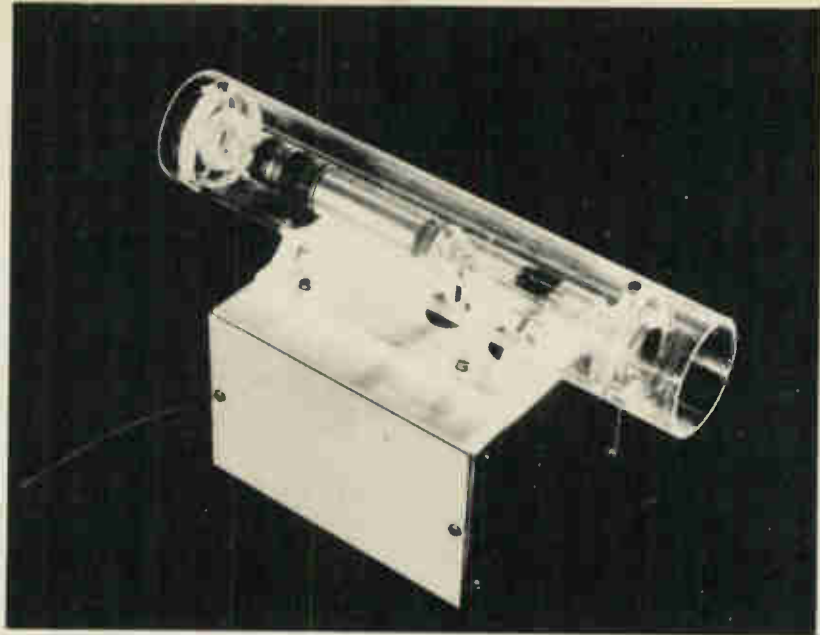
The Michelson interferometer provides a means of making precise measurements of distance and movement, and has many applications in science and industry. Before the advent of lasers, the alignment of components in an interferometry experiment was extremely difficult — even under laboratory conditions, and thus, expensive and very intricate alignment apparatus was required. Using a laser, however, alignment can be achieved in a few seconds.

We performed the experiment using a low cost optical bench setup as shown in Fig. 2 and accompanying photograph.

The beam from the laser is split into two components by the partially silvered mirror 'A'. One component travels directly to the mirror 'C' and is reflected back towards the laser. The second component is reflected by mirror 'B' back through the beam splitter, and then through the diverging lens onto a screen. A component of the beam reflected from mirror 'C' also passes through the diverging lens and the mixture of the two components thus creates an interference pattern on the screen.

Careful alignment of all components is necessary to achieve the interference pattern, but once obtained, it will be found to be affected by even the slightest vibration, change in path length, or change in refractive index of the air between the mirrors.

In many scientific and industrial applications, the diverging lens and screen are replaced by a highly sensitive detector. Such laser interferometers are used extensively for high-accuracy micro-positioning of



machine tools. A typical interferometer (the Hewlett Packard model 552A) is able to measure position or displacement to within 1×10^{-8} metre, ie, one hundred-millionth of a metre.

THE SPEED OF LIGHT

A special application of the interferometer is in the measurement of the speed of light. The set up for this is as illustrated in Fig. 3.

The experiment is conducted between two fixed points exactly 120 metres apart. This distance should be determined as accurately as possible. It is perfectly feasible to perform this

experiment outside in the open, but for optimum results it is best done in the early morning or evening when there is little wind and a minimum of thermal air currents.

The laser is modulated by an adjustable frequency source of around 625 kHz. Part of the direct output beam is deflected by a tiny mirror through a converging lens to a photo-detector. The output of the photo-detector is then displayed on an oscilloscope as a reference. The remainder of the direct beam passes to a mirror mounted precisely 120 metres away where it is reflected back to a third mirror and again to the

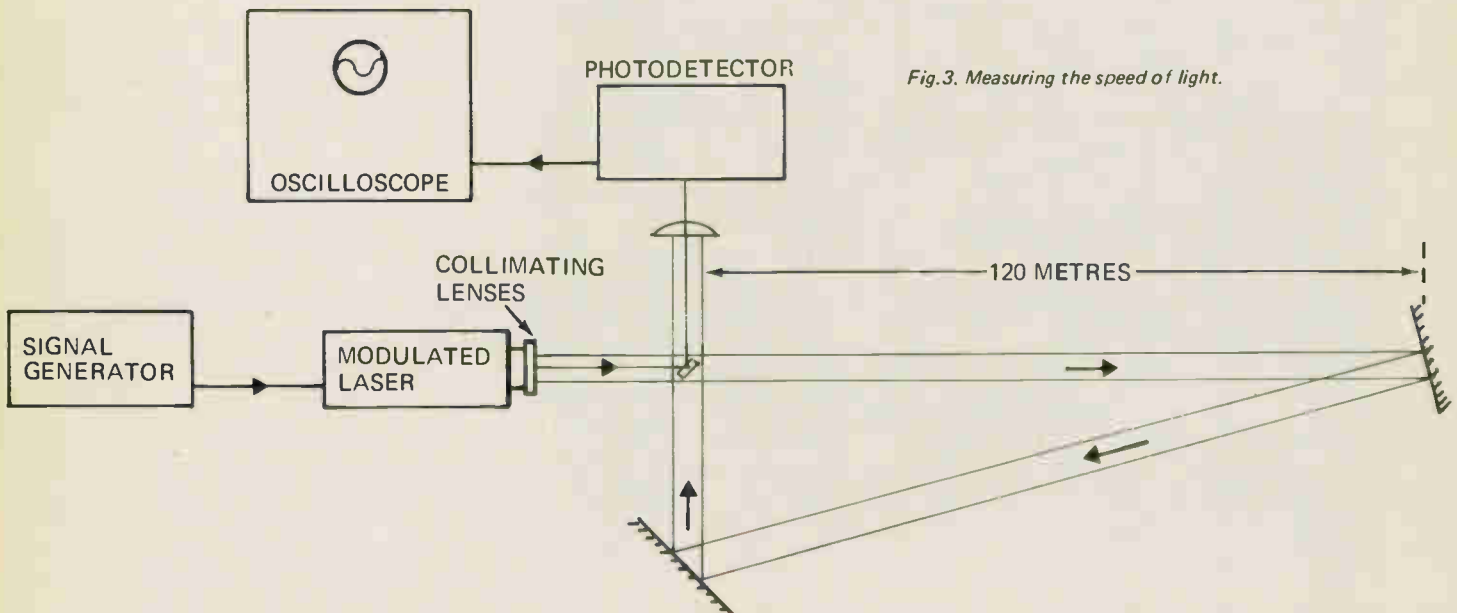


Fig.3. Measuring the speed of light.

LASER EXPERIMENTS

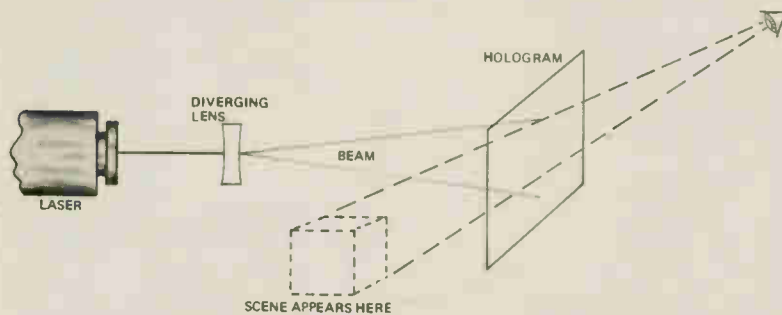


Fig.4. How holograms are produced.

photo-detector as shown in the diagram. Thus the longer path is 240 metres further than the reference beam. If the amplitudes of the two beams are equal and if the longer beam arrives at the photo-detector one half wavelength after the reference beam, (180° phase shift) complete destructive interference will occur and the waveform on the oscilloscope will disappear.

To create this interference, the beam path is made *exactly* 240 metres (two times 120) and the signal frequency adjusted accordingly.

The modulation frequency required to produce this null should be

624.5687kHz — corresponding to a period of

$$\frac{1}{6.245687 \times 10^5} \text{ seconds}$$

Thus the time for light to travel a half wavelength is half this period — i.e.

$$\frac{1}{12.491375 \times 10^5} \text{ seconds}$$

The speed of light equals C.

$$\begin{aligned} C &= 240 \div \frac{1}{12.491375 \times 10^5} \\ &= 240 \times 12.491375 \times 10^5 \\ &= 2.99793 \times 10^8 \text{ metres/sec.} \end{aligned}$$

In practice of course it will be

impossible to measure either frequency or length sufficiently accurately to obtain precisely this answer. Because of this some error must be expected.

If a quick simple experiment is sufficient, an oscillator frequency of 600 kHz may be used. The corresponding half wavelength period is $1/(12 \times 10^5)$ seconds, hence the result will be a measurement of 2.88×10^8 metres a second — an error of approximately 3%.

HOLOGRAPHY

One of the most interesting, and promising, applications of the laser is in its ability to make three dimensional photographs. These are known as holograms.

Considerable research is being conducted in this field, and the technique may one day lead to true, three-dimensional colour television.

A hologram is made by exposing a photographic negative to a scene that is wholly illuminated with laser light. The negative is simultaneously exposed to a reference beam that comes directly from the laser. Thus, as light from two separate sources is incident upon the negative, an interference pattern is recorded. The interference pattern is so fine that individual lines can only be seen with the aid of a high-power microscope.

The holograms thus made, are viewed by illuminating them with a diverged laser beam and looking at them, towards the laser beam.

It is perfectly safe, in this instance, to look towards the laser beam as when the beam is diverged, its intensity will be less than 1/1000 of the normal value. The method is shown in Fig. 4.

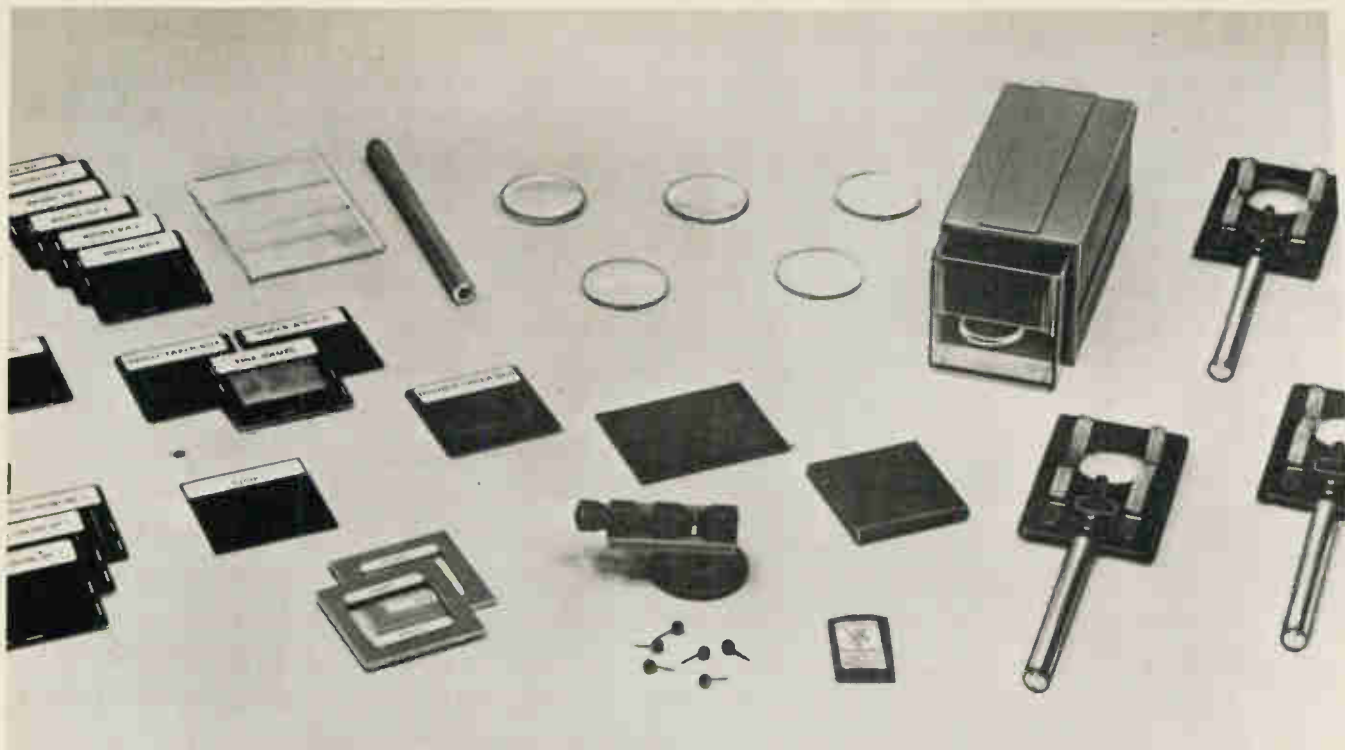
Whilst viewing the hologram move your head around and you will find that it is possible to see the sides, and maybe even the back of the object. Use your finger to try and pinpoint areas on the image. You will find considerable depth to the image.

DOPPLER EFFECT

Doppler effect is a well known phenomenon by which the frequency of acoustic radiation (including frequencies above and below the audible range) and electromagnetic radiation is varied due to motion of the source, or of the receiver.



A typical optical experimenter's kit. Whilst not designed specifically for use with lasers, such kits are very useful.



A accessories kit designed for use with a low-power helium-neon laser is available to educational establishments (not private individuals) from Griffin and George Limited, 285 Ealing Road, Alperton, Wembley, Middlesex. This consists of tapered slits, diffraction gratings, circular apertures, a variety of gratings and lens among other things. It also includes a hologram. Included with the kit is a comprehensive book of experiments. The price is £28.00. (Photographs on this page by courtesy of Griffin and George).

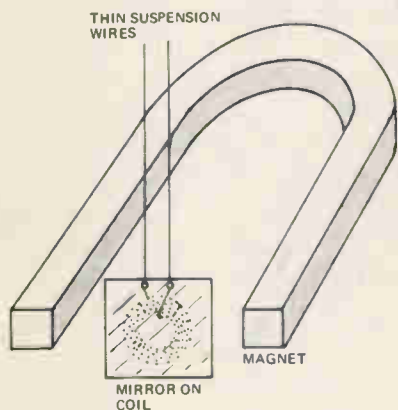


Fig.5. Constructing a simple laser galvanometer.

To demonstrate this effect at optical frequencies, set up the equipment as for the Michelson interferometer. Superimpose the two reflected beams on a photodetector instead of the diverging lens and screen.

Connect the output of the photodetector to an audio amplifier and then slowly move one of the mirrors backwards and forwards. The doppler effect causes an apparent change in the wavelength of the beam falling on the moving mirror. The intermodulation of the two beams at the detector will produce an audio output whilst the mirror is moving. Rapid movements of the mirror will cause the doppler frequency to be above the audible range (ultrasonic)

and consequently a tone will not be heard.

OPTICAL AMPLIFICATION

The facts that the laser beam is very bright, and that the beam divergence is very small, make the laser a useful tool for amplifying very small, in fact almost imperceptible, mechanical movements.

Using the principle of optical amplification, many interesting devices may be constructed, two of which are discussed below.

LASER GALVANOMETER

Construct a small coil, from light gauge (around 36 s.w.g) enamelled copper wire, by winding 20 turns on a cylindrical former such as a pencil or piece of dowel rod. Tape or glue the turns of the coil together and then attach two thin strands of wire to the ends of the coil. (Individual strands of wire from conventional three core flex are ideal). Cement a small mirror to the coil, and use the wires to suspend the coil between the poles of a horseshoe magnet as shown in Fig. 5. The longer the wires — the greater the sensitivity of the resulting instrument will be.

Now, being careful that neither the laser beam nor its reflection enters anyone's eyes, aim the laser at the mirror and observe its reflection on the wall.

When a small current is allowed to



A laser beam splitter available from Griffin and George.

flow through the coil, it will turn, thus deflecting the laser beam. We have thus constructed a mirror galvanometer and a long scale may be used on the wall to make quantitative measurements. Using appropriate shunts and multipliers, the optical galvanometer, thus constructed, may be calibrated to read volts and amps, or any other quantity that produces an electrical current in some way.

Using adhesive tape, fasten a small mirror to your wrist directly over the point where the pulse beat is felt.

Again, taking the precaution mentioned above, aim the laser at the mirror. With your wrist held as steadily as possible on the table or some other support the amplitude and beat rate of your pulse will be observed by the deflection of the laser beam spot on the wall.

CREATIVE AUDIO

PART FIVE

A practical guide to creating and producing your own sound.

THE commentator acts as the eyes of his future audience, the location microphone as their ears.

At first it is not easy to be fluent when talking into a microphone — with the inevitable onlookers staring curiously. All one can do is to go out on the streets and try it a few times. This should help to conquer self-consciousness.

Obvious comments should be avoided, i.e. 'The brass band has just started to play'. The commentator should concentrate instead on the visual aspects, the colour of the bandsmen's uniforms, the route being taken and the size of the crowd. A second important duty that falls to the commentator is to cover the history and background of the situation in a digestible manner.

Before going on location, thorough research is necessary, short notes being made of relevant statistics and dates. It is also helpful to record 'mind-jogging' key phrases to be discussed. This homework not only allows the commentary to flow, but is also most beneficial when interviews are to be carried out. A subject will warm towards his interviewer if he feels that the latter has made an effort to find out about the topic being covered.

Sometimes complicated microphone placement is necessary on location, as when recording a brass band on the move. There is no reason in these circumstances why one should not over-dub the commentary later back at home, and often this gives a better balance.

INTERVIEWING

Inconspicuous equipment handling contributes a great deal to successful interviewing. The subject is liable to become microphone-shy if he keeps catching sight of the revolving spools, or has the microphone waved around inches from his face. It is also distracting if the interviewer gyrates around every few seconds to check the recorder is not over-modulating and the tape has not run out. The level should be appropriately set beforehand, so that a microphone



Recording the departure of a ship from Piraeus Harbour (Greece). Equipment used to make this stereo recording includes Neumann KM76 condenser microphones and windshields. Sennheiser headphones are being used to monitor the output from the Stellavox SP7 recorder.

distance of at least 1/3 metre can be used. A directional microphone is a good choice for interviewing, its pick-up pattern operates well in poor acoustics and high ambient noise levels.

The comments of the subject are of prime importance, and the choice exists between keeping the microphone static, pointed at the subject (the interviewer will come out much softer on the recording), or re-directing it to pick up the interviewer's questions. The latter procedure may be adopted with a conventional question/answer situation, and here it is better to arrange seating positions to minimise microphone movement. This is aided by increasing the record gain control to permit a longer pickup distance.

ACTUALITY DOCUMENTARIES

An actuality documentary differs from the conventional form as the final programme contains only the interviewee without the accompanying questions.

The quintessence of an actuality documentary is facts about a situation.

The aim of the interviewer is to extract these facts from his subjects in an interesting manner. This invariably entails in-depth interviewing — an hour's raw interview may yield five minutes of useful material.

It is important when interviewing to utilize a close microphone position as

this leads to a better acoustic match when cross-cutting tapes made in different environments. For the same continuity reasons a relatively dead acoustic with low ambient noise is helpful. If necessary blanket background effects can be added after the interview-editing stage.

The style of interviewing differs from the normal question/answer format insofar as the interviewer tries to make the subject do most of the work.

The subject should be told *before the interview is started*, what the tapes will be used for, and why his help has been requested. He can be reassured that the question/answer routine will not be followed strictly, but will rather take the form of a chat, with the subject telling the interviewer in his own way what the topic is all about.

When putting on a fresh reel of tape, try to completely stall the conversation, or good material will be lost which will never sound quite the same if repeated.

Indirect questions prefaced by 'tell me' will provoke a greater response than direct questions. Instead of asking a cross-channel swimmer 'was it difficult?' which would probably lead to a monosyllabic answer, the question would get a better response if phrased, 'tell me, how was the crossing?'

More animated response still will be obtained if the interviewer assumes some naivety. Especially if he makes a statement he knows to be diametrically opposed to the beliefs of

his subject. In the above example he may venture, 'I have been told that cross-channel swimming is quite easy'. Naturally this technique should not be taken too far!

The interviewer will have some preconception of the angle from which he wishes to tackle his subject matter. During the course of the interview he should be ready instantly to follow up the topics which provoke the liveliest reaction, relating them to his prior ideas of the final programme.

Subtle persuasion pays dividends. Encourage the interviewee, as he warms to his subject, with "Tell me more". In the early stages of an interview, the subject's speech is often stilted as he tries to say the grammatical 'right thing'. The interviewer must demonstrate that it is unnecessary to 'play up' to the microphone. The interviewer's voice will not be on the final tape in any case, so it is not so important for him to guard against what he says.

The art of the actuality interview is to get the subject to say what *he* wants to say, but in the way the *interviewer* wants to hear it.

Examine the following example —

Interviewer — "Was it easy swimming across the channel?"

Subject — "No, of course it wasn't."

Interviewer — "But I understood that you had done it before."

Subject — "Yes, but it never gets much easier."

Interviewer — "What doesn't?"

Subject — "Swimming across the channel. It is just as difficult every time. There is no such thing as an easy swim."

The interviewer may appear to be stupid, but he has succeeded in making the swimmer more demonstrative. The swimmer's last responses, when cut from the tape, and without any further alteration, will form an ideal introduction.

It is quite likely that during an interview the subject may commence his answer before the interviewer has stopped speaking. The interviewer in this case can use the same re-cap technique as illustrated above; interjecting with "sorry, you were saying", he will get the answer repeated in a useful form.

It is essential that the interviewer remains quite silent during his subject's replies. The subject communicates with the interviewer, but the only response from the interviewer should be by way of facial expression. Nodding, smiling and frowning are preferable to ums, aahs and sniggers.

At the end of the interview, one should naturally thank the subject and ask if he or she would like to hear a replay.

LOCATION RECORDING

It is incidental sound effects and music that add flavour to a location documentary, the combination is more powerfully evocative than a commentary on its own.

Prior research will indicate possible characteristic sounds. At a carnival, for instance, there will be coin jingling collectors, motorcar horns and brass bands. Less obvious are the fascinating results to be chanced upon if one can discreetly get into the middle of a crowd, and collect 'candid' comments with a hidden microphone. When collecting general background effects and repetitive sounds, one should tape at least two minutes of each. This would include such 'aural snapshots' as a busy street, the interior of a train, sea, restaurant and birdsong. With plenty of material, extended loops can be made of the useful sections, which at a later date can be over-dubbed onto the actuality interviews — without repetition giving the game away.

Microphone position is just as important when collecting sound effects as it is with the other sound sources discussed in this series. If one is not self-conscious, headphones simplify matters considerably, revealing the existence and whereabouts of background sounds to which one would normally be oblivious until the replay stage.

The biggest bugbear of location recording is the thundering noise caused by even quite gentle breezes impinging on the microphone diaphragm. Obviously the first line of attack is to try to record in areas sheltered from the wind and to use a windshield whenever outdoors. Many microphones are manufactured with a wire cage surrounding the pickup area, and for others a windshield is available as an optional accessory. Failing this, one may be constructed from foam-rubber or open-weave cloth such as hessian, which is fashioned into a 'hat' which slips onto the mike, and is secured with an elastic band. Even a handkerchief doubled over the microphone will allow an acceptable recording to be made in an emergency.

Another potential source of unwanted noise is the handling effects due to the microphone lead and casing. This is more bothersome with medium and high impedance microphones, and almost non-existent with low impedance versions. Advice here is rather negative — try to find a mike that is little affected; it should be held between the first finger and thumb, using another finger to retain a loop of cable, as the majority of the trouble is caused where the cable exits from the microphone body.

Location music balance is a rather

chance affair, even when headphones are used. Really the only way to record a brass band on the march, is to march along with them, holding an omnidirectional microphone on a boom-arm, the exact position being determined with headphones. A makeshift boom can be constructed with a chemistry clamp on a 'broom' handle. The difficulty, the same for any hand-held microphone music recording, is in keeping a static aural balance.

Stereo location recording demands the same care; a slight waver of a 'crossed pair' of microphones will cause the panorama to veer round alarmingly. Incidentally, it will considerably ease compilation at a later date if each tape is commenced at zero level, and faded down again before switching off the recorder.

EQUIPMENT COMPLEMENT

On location, spares are as important as the recorder itself. A stout, weatherproof shoulder-bag is best used to contain the following:—

A spare microphone and lead, terminated in a plug;

Enough batteries for the recording session ahead, with plenty to spare;

Mains power pack for the recorder (if available).

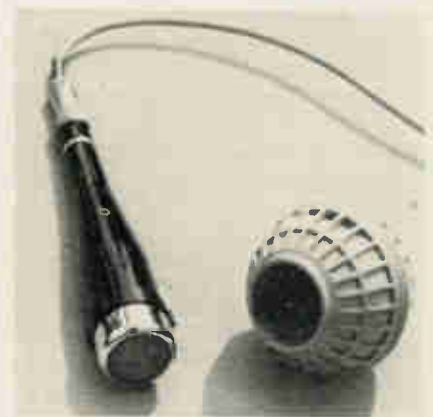
Extra tapes to cope with the unexpected;

Plugs and leads — soldered joints have a knack of coming adrift at awkward moments, so several ready-made connectors should be carried, including a plug to screened lead, with bared ends for taking feeds from PA equipment (check that it is not a 100 volt line!)

Microphone extension lead — not vital;

Razor-blade and editing tape to repair breaks in the tape should they occur.

A small screwdriver, pair of pliers,



Grampian DP4 microphone with polypropylene-strengthened foam rubber windshield.

CREATIVE AUDIO

wire strippers and cutters, box of matches, and packet of low melting point (match) solder.

A square of aluminium baking foil for quickly screening joints;

Insulating tape, and heavy duty carpet tape for fixing mike leads out of the way of clumsy feet.

A pocket torch may be needed for checking meter level in adverse lighting conditions;

A small pad for logging battery time and other notes, and finally, a pen.

PROGRAMME COMPILATION

Once all the material has been gathered, it will have to be knitted into a cohesive end product. The first stage is to find a quiet room and play all the tapes through at least once; an overall picture will begin to emerge of the type of presentation possible with the available material. The tapes are played through again, this time making careful notes of each item, its duration, quality and content. Interviews should be written out verbatim. It is helpful to log the items with reference to the tape position indicator.

Studying the logging sheets, one can now select the most apt pieces, which

are played yet again and reconsidered. In this way, a collection of a dozen or more top quality items will be selected.

Preconceived ideas will now have to be modified to fit in with the useable material, and a logical running order worked out for the items on the short list.

A factual documentary will need some type of commentary to make it flow; this may be derived in part from the location tapes, and a visit to the local reference library will provide a source of ideas for the remainder of the bridging commentary.

A start can now be made on a 'rough-cut'. It is advisable to dub the short list material onto a separate tape, editing only this copy, so as to guard the original tape against unfortunate accidents.

It will be evident at the rough-cut stage that the intended approach doesn't quite come off in some places, but elsewhere works better than expected. The recordist should be quite open to the 'feed back' from the tape; ruthless editing is difficult when one is aware of the effort that went into obtaining the material, but this pruning is the only way to a crisp, fast-moving result.

Variety sustains interest, as has been stated before. It is beneficial if the recordist can break the final bridging

script down into a number of sub-sections, each to be read by a different person.

The final mix of location material/studio commentary may be carried out using the multi-track system described last month, i.e. re-playing the 'effects' tape (with leader tape between each item) on one recorder, and recording it on another together with the commentary fed in directly by a microphone.

If a stereo machine is being used for the record side of this operation, cross-mixes between effects tracks are possible. The (stereo) bottom track is prepared with one set of effects, complete with a fade-down at the end. The upper track is set to record, and the effects material dubbed from the lower track. Previously a second effects tape has been prepared, and is cued on the second machine, with the output level turned down, though also fed to the upper track of the stereo machine. As the lower effects track nears its end, the second machine is started, fading up its replay output as the signal fades from the lower effects track. Both machines can now be stopped, and the second tape spliced to the tape on the stereo recorder, just after the double fade, to preserve the quality of the second set of effects.

This series will be continued next month.

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DX MONITOR

Compiled by Alan Thompson

A few days away from the office with an attack of one of the "itis" of the shivery, snuffly type gave me the chance to read some of the piles of DX bulletins, booklets and publications which always seem to congregate atop the hi-fi until the lady of the house orders their banishment to the "shack", where they join the great disorder! The arrival of the "bug" coincided with the long-awaited "Conversion Day" on which Natural Gas replaced the old-fashioned "town" variety chez-Thompson and I spent several hilarious hours, over a period of days, explaining to various representatives of British Gas that my gear was nothing at all to do with the winter's spate of storms: I didn't broadcast (at least, not in the Amateur Radio sense) and that it wasn't a tracking station for space exploration vehicles - each to their own thing, hi.

Last month, as you may recall, we had an African Safari in "DX MONITOR" and writing about Sierra Leone I was less than optimistic of your - or mine for that matter - chances of hearing this elusive country. Well . . . if you happened to be listening to the 90 metre band on the evening of 26 January and if you happened to try 3316kHz about 2240 G.M.T. you would have been rewarded with the Sierra Leone Broadcasting Service loud and clear until it signed off at 2330 G.M.T. Interestingly, geomagnetic activity was fairly strong on that evening and it turned out to be a stupendously good evening for African reception providing further support for the theory that when geomag. activity is high the auroral belt moves south and the African signals sneak in under the southern edge of the auroral belt and gain from the fact that east-west signals suffer varying degrees of attenuation, whilst those from the south are pretty well unaffected. If you want to test the theory for yourself, try tuning to WWV Fort Collins, the U.S. Standard Frequency Station operating on, inter alia, 5, 10 and 15 MHz, and listen for the plain-language propagation forecasts broadcast just after 15 and 45 minutes each hour. Suggested "A"-index figures greater than 30 appear to be good signs of African openings.

Many a pleasant hour was spent reading the latest (8th Edition) of "How to Listen to the World" (published by World Radio-TV Handbook, P.O. Box 88, Hvidovre, Denmark, at £1.90 (postage paid)). The 8th Edition has been "produced in association with the BBC" and is 168 pages containing a real miscellany of articles on all aspects of radio.

Two articles which particularly interested me were "BBC Monitoring Service: the ears of Britain", by John G. T. Sheringham, former Assistant Head of the Service, and "The Management of the Radio Spectrum" by S. B. Duke, Supervisor of Engineering Services, CBC. BBC Monitoring Service has a special place in my DXing memories as back in April 1972 I was fortunate enough to be invited to visit their headquarters at Caversham Park (the first Dxe^r qua^d Dxe^r, so I was told): as John Sheringham says "it is not as well known as it might be partly because it has not courted publicity, while willing quietly to provide its services to anyone who discovered them . . ." Several technical descriptions of "BBCMS" can be found in various BBC publications but anyone who is interested in a non-technical account of their activities (from a Dxe^r's viewpoint) might be interested, after reading the article referred to above, in an account of my visit: duplicated copies are available from me for a stamped 9" x 4" envelope and 15 pence (stamps/postal order) to cover duplicating etc costs. "Monitoring Service" is one of the most interesting aspects of the BBC and it has kept its light well dimmed over the 30-odd years that it has existed.

S.B. Duke is better known as Basil ("Pip") Duke to all listeners to Radio Canada's Shortwave programmes and his article provides a most readable exposition of the problems that face the International Frequency Registration Board in trying to allocate short-wave frequencies when there just aren't enough of them to go round. The magnitude of the problem is illustrated by the fact that "at present more than 1,300 broadcast transmitters use the short-wave bands for a total of slightly more than 17,000 frequency hours daily. It has been estimated that the effective capacity of the short-wave broadcasting bands . . . is reduced to about 6,000 frequency hours daily" during periods of

low sunspot activity. Small wonder that the "Tentative High Frequency Broadcasting Schedule" for each frequency period seems to get thicker year by year with "Column 8" (which gives details of likely interference with other broadcasters) getting more and more congested! One can't help but wonder whether broadcasters who seek the assistance of DX organisations in finding them "clear channels" for their broadcasts aren't, in fact, causing annoying interferences to other transmissions in the secondary service area of their transmissions.

Tape-recording has a very considerable part to play in the DX hobby. Two ways which spring to mind are the taping of a station identification for subsequent re-play, over and over again, until the identification becomes clear: the other is the building up of a permanent record of stations heard (especially some of your real DX catches), or a tape-library of interval signals or announcements, or, even, of National Anthems - this latter is invaluable in the case of Latin-America and Africa! From personal experience, cassette recorders (but with low-noise tape! There's already enough noise on the signal if it's good DX so don't add anything to it) are ideal for station identification work, but for a permanent tape then reel-to-reel has the edge since, for Mr. Average, it is a lot easier to handle and to edit. Also - dare I say this? - if you are building up a "library" of tapes then single track is far and away preferable to 2-track or 4-track. In my (sad) experience, if you use 4-track and do some editing you can be SURE that the really super bit of DX that you treasure will end up in the waste-bin and it's loss will not be noticed until it is languishing on a rubbish dump and lost for ever.

My bookshelves are choc-ful of various standard works and recommended texts on tape-recording and invaluable they are if you are involved with taping in a professional or semi-professional way. Every now and then, someone asks whether I can lend them a book on the subject and this always turns into a real hunt for a text that is neither bristling with complex formulae nor written for a somewhat backward 10-year old. Two booklets which have recently come my way go a long way towards providing the text I require on occasions like this - there have been others of a similar type but fractured English isn't the best medium for sorting out a newcomers doubts! These two are published by Agfa-Gevaert Limited, Great West Road, Brentford, Middlesex: the first is their Publication 701E entitled "Tape Recording Manual" and it costs 41 pence (including postage): the other, Publication 702E, is called "Recording with Compact Cassettes", and this one is 71 pence (including postage). Just in case anyone else is as cynical as I can be (!!!) - I don't recommend publications in this feature (nor equipment for that matter) unless I am prepared to stand by any comments I make, whether manufacturers/publishers send along items or not. A-G Ltd did not send along copies to me, BUT they did dispatch them on the day of receipt of my order and that deserves an accolade.

With just a few lines left . . . a few quickies! BHUTAN - one of the last countries to be missing from the radio spectrum is reported to be on 7050kHz from 0730-0930 (some reports say 1030) GMT on Sunday only in English, Nepali and Bhutanese. No check reports yet from contacts around the world. GRENADA - ex Windward Islands, became independent on 7 February. Should be easy with its service to residents in U.K. on 11930 and 15105kHz from 2000-2130 GMT. Programmes consist mostly of record requests and some local news. If you want to try for it the hard way, keep listening to 5015kHz after about 2230 and you may be lucky. Good clue? Can you hear WWV on 5MHz? If you can, then you might hear Radio Grenada - incidentally, it puts accent on first syllable which can be disconcerting; GREN-ada not Gren-AH-da!

Posers, tips, questions, comments, brickbats and bouquets to me, Alan Thompson, 16 Ena Avenue, Neath, West Glamorgan SA11 3AD, by about the 10th of each month. Please enclose a s.a.s.e. if you want a personal reply but, even then, I'm afraid there are times when delays are just inevitable. Anyway, that's it for this month, so, from me . . . 73.

Electronics by John Miller-Hirkpatrick Tomorrow

WE DON'T LIKE TO harp on the 'We told you so' type of point but it was quite a few months ago that we told you to expect the NE556 dual 555 timer from Signetics. Recently we informed you that it had already been second sourced by another company and now it had actually been officially released by Signetics Europe. There is not much extra to be said for a dual 555 over the use of two separate 555s except for matching of temperature, etc and possibly the price. The one-off price has not been given but it would seem to be about £1.60. i.e. just under the price of two 555s. With the problems of availability that there have been on the 555 it would seem that the 556 may cause the same sort of havoc so get your order in early. Devices: 1, Data 1 or 2.

On the subject of the 555 there is a circuit which was mentioned here a few months ago and which has caused so many enquiries that we have decided to publish a circuit diagram of this and of another novel 555 circuit.

BATTERY VOLTAGE MONITOR

The 555 timer can conveniently function as the heart of an automatic battery charger, the circuit is intended to maintain a full charge on a standby battery supply for an instrument that is always connected to the mains, whether in use or not. It can also be used for the charger unit for pocket calculators, etc. The circuit uses the timer's two on-chip comparators, the flip flop and driver amplifier.

A zener provides a reference voltage somewhere near the battery voltage with an allowance for adjustment. The two potential divider networks supply the comparators with adjustable voltages, one for LOW (switch on) and the other for HIGH (switch off). When on, the output gives a maximum of 10V and when off gives 0V, the maximum current is 150mA which is limited by the 47 ohms and protected by the diode.

The circuit is calibrated by substituting a variable voltage supply for the NiCd batteries. The HIGH adjustment is set first so that the output

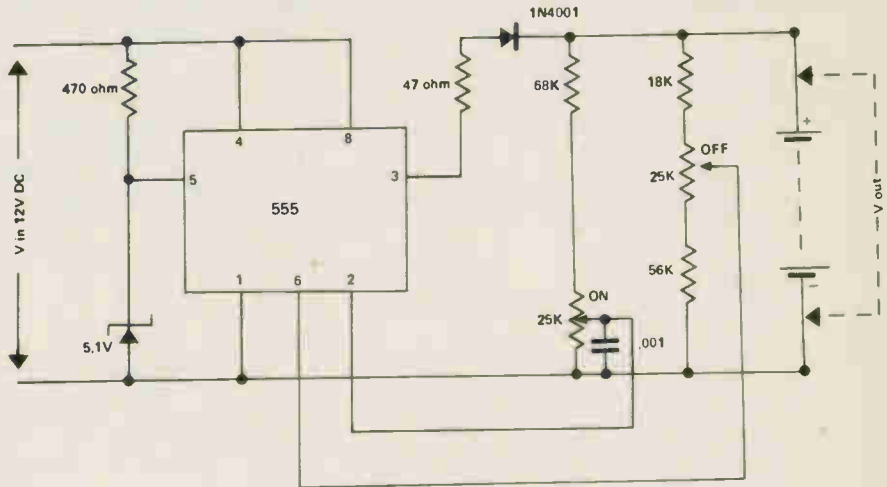
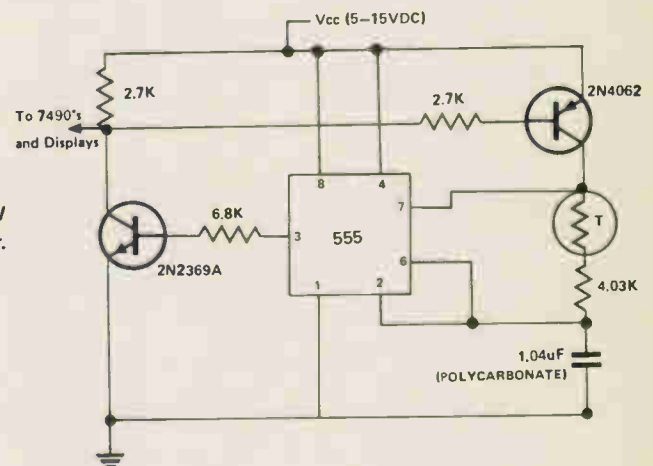


Fig. 1. Battery voltage monitor.

Fig. 2. Digital Thermometer.



switches off at the maximum battery voltage and then the LOW is set for minimum battery voltage. It is simplest to leave the output disconnected from the resistor until after the setting up procedure.

DIGITAL THERMOMETER

This circuit we haven't tried yet but it looks very good, anybody who tries it, let us know how you get on. The circuit's output frequency varies in a nearly linear manner from 38 to 114Hz as the temperature changes from 37°F to 115°F. The 555 is set up in the

normal astable configuration with one resistor replaced by a thermistor/resistor network and the other replaced by a transistor. The transistor's near zero on-resistance and very high off-resistance results in equal charge and discharge intervals that depend only on the thermistor/resistor network. The thermistor is one with a value of 5000 ohms at 25°C and a resistance ratio of 9.06:1 over the temperature range 0°C to 50°C. The capacitors need to be temperature stable and may need to be hand selected and added to give the best results. It would seem that a similar circuit for Centigrade might also be possible — any ideas?

It is rumoured that Signetics have published a booklet of circuits for the 555 and 556 timers, we have not seen it (hint, hint) but if the rumour is true try contacting Signetics: 2. 555s are available from 3.

ANOTHER MULTI-CIRCUIT DEVICE

One of the reasons for the success of the 555 is the number of different uses that it can be put to. A new device from National Semiconductor (UK) Ltd, is termed the LM3900 and can also do many tricks. National have a data sheet showing 47 different circuit applications, surely as many, if not more than 555 applications.

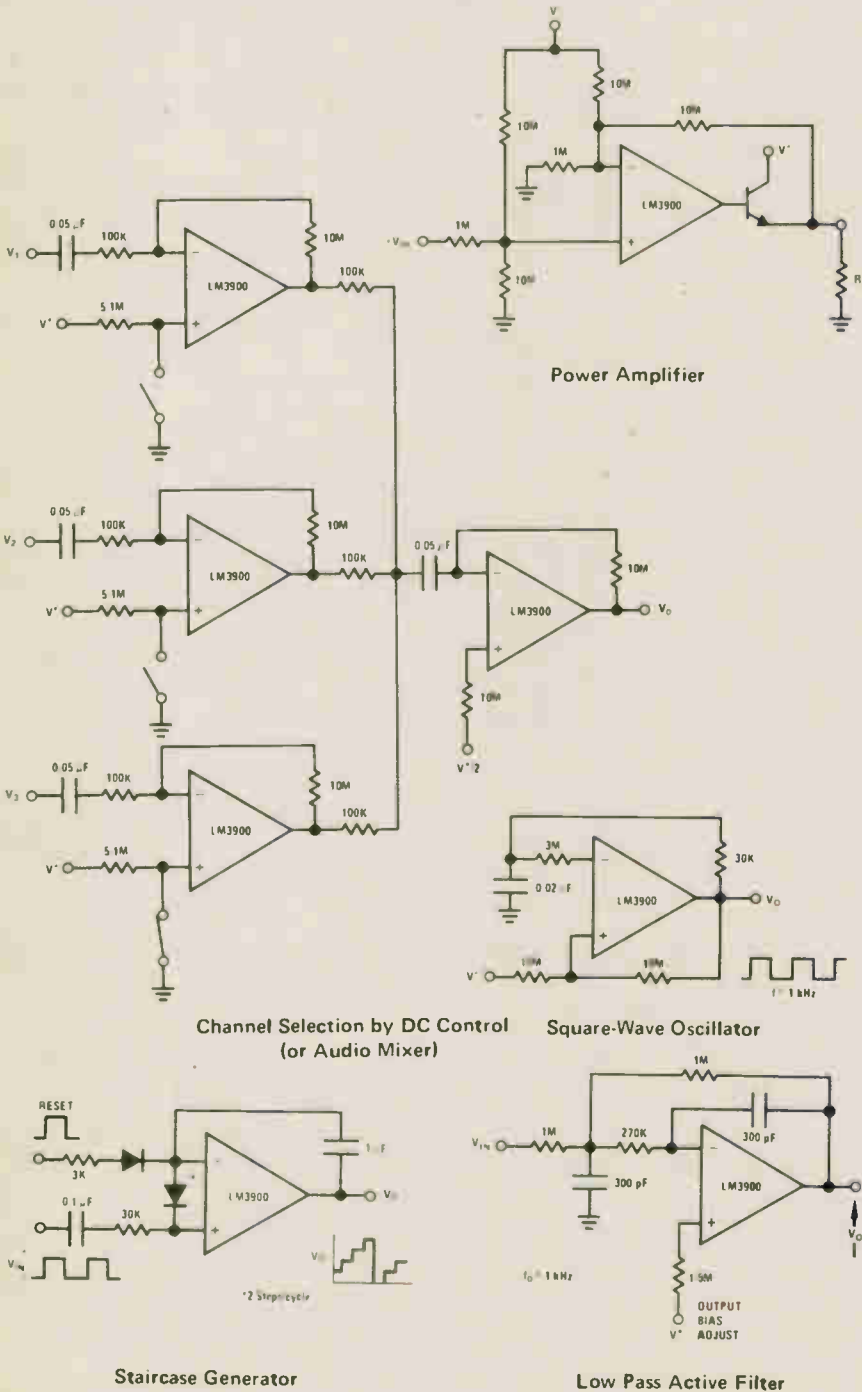
The LM3900 consists of four independent, dual input, internally compensated amplifiers which were designed specifically to operate off of single power supply voltage and to provide a large output voltage swing. These amplifiers make use of a current mirror to achieve the non-inverting input function. Application areas include a.c. amplifiers, RC active filters, low frequency triangle, square-wave and pulse waveform generation circuits, tachometers and digital logic gates. The voltage supply range is 4–36V, quiescent current 6mA and open loop gain typically 2800. Some of the 47 applications are reproduced below. The data sheet is available from 4 and the LM3900 from 3 at £0.69.

PRODUCTION LIQUID-CRYSTALS

1974 is supposed to be the year of the Liquid-Crystal display, it looks doubtful but that's what they say. Perhaps they mean that 1974 will be the year that manufacturers decide to use LCs in equipment as an alternative to other displays. Each type of display (digital, alpha-numeric or warning lamps) has one type or another of disadvantage, Sperry's and Nixies require high voltage, LEDs and filament are high current and fluorescent (phosphor-diode) require high current heaters. The liquid-crystal display has none of these disadvantages, drive voltages are 3V (FE) or 30V (dynamic scattering), current is in microamps, direct interface to MOS circuits is possible. What is the problem? - well there are two. The first is that the drive required is a.c. and only a few chips will supply an a.c. output such as the MM5316 clock chip, there are interfaces to run from TTL or CMOS but they are complex and /or expensive. The second may not be a problem in some cases, basically a liquid-crystal has no light output and thus relies on incident light. This light can be from behind the unit or from in front, thus in cases where there is plenty of light available no problem exists but in other cases festoon type filament lamps are needed.

Siemens have a range of 10 displays for many applications, they range from a single digit about four inches high at £33.22 to a single one inch at £7.13. The multi-digit displays include 3½ digit instrument units at £15.66 and four digit at £13.07, four digit clock displays at £13.07 and six digit clock display at £18.42. All prices include socket and are for a transmissive display, reflective units are a little more expensive.

Most of the problems of LC displays only lasting a few months or days have now been overcome and these units will now last longer than a lot of other types of display if driven correctly. Learn more about liquid-crystals (we may have an article in a later issue) as they may well be the display of 1975 if not 1974. Data and displays from 5.

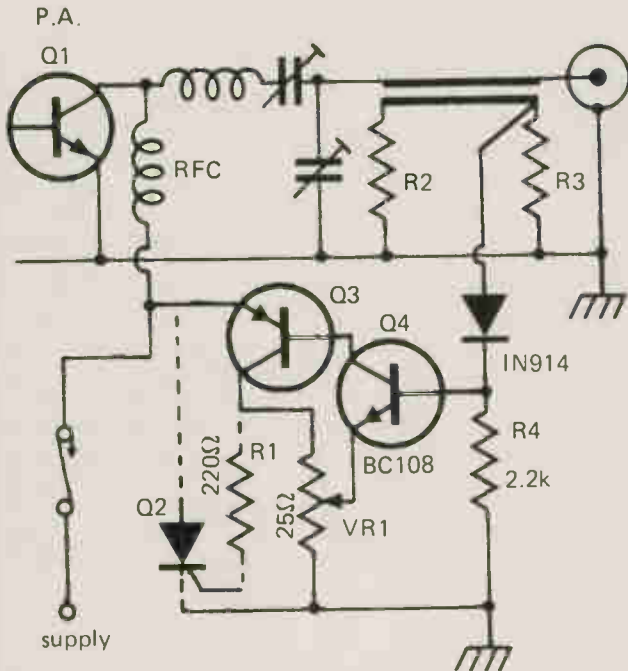


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- 1 Semiconductor Specialists, Premier House, Fairfield Rd, West Drayton.
- 2 Signetics, Yeoman House, 63 Croydon Road, London S.E.20.
- 3 Bywood Electronics, 181 Ebbens Rd, Hemel Hempstead, HP3 9RD.
- 4 National Semiconductors, The Precinct, Broxbourne, Herts.
- 5 JVN Components Ltd, 204-206 High St, Bromley, Kent.

Tech-Tips

RF AMPLIFIER PROTECTION



RF power amplifier output transistors may be destroyed by high standing wave ratio loads.

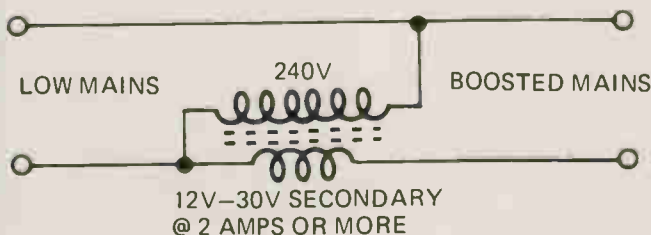
This circuit senses the SWR conditions existing at the transmitter output. If the SWR exceeds a predetermined level, the PA collector voltage will automatically be reduced: in the event of a really high SWR the protection circuit will blow the supply fuse.

The SCR — shown in dotted lines — should be included if the circuit is to be used to protect a high power stage. Otherwise Q3 is used to draw an excessive current from the power supply, this transistor must be rated to dissipate the maximum power necessary to cause the fuse to blow. Potentiometer VR1 must also be rated accordingly.

The SWR sensing element employs standard SWR bridge techniques and should present no difficulties.

Make sure that you have the right size fuse though!

BOOST YOUR MAINS

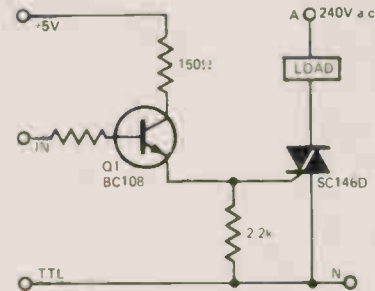


Mains voltage may be boosted by up to 10% by using a standard filament transformer connected as shown above.

POWER SUPPLY OR BATTERY?

If you want to work out if it is worth building a power supply rather than using a battery a quick rule of thumb is that the juice from a battery comes to between 1,000 and 100,000 times the expense. The cost of a typical power supply which is comparable to a battery will cost between £1 and £3 so if you are likely to purchase that value of batteries in the lifetime of the equipment and if portability is not a consideration, plump for the power supply.

TTL-MAINS INTERFACE

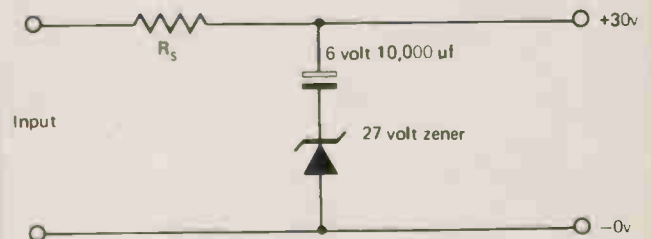


Here is a useful circuit for driven mains operated devices direct from TTL logic circuits. Although it works well, it has the inconvenience that the neutral line is connected to circuit ground.

For inputs other than TTL levels a 10k series resistor may need to be connected between Q1 base and ground to reduce leakage.

Approximately 1mA at 1.4 volts is required to switch Q1 on. If driving from a low impedance, some means of current limiting will also be required.

ZENER DIODE LIFTS CAPACITOR RATING



Electrolytics combining large capacity and high working voltage are bulky, expensive, and frequently difficult to obtain.

A drastic reduction in the voltage rating required is achieved by the connection of a series zener diode. In this example a 27 volt zener in series with a 6 volt electrolytic filters a 30 volt line.

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.

... WITH KNOBS ON!

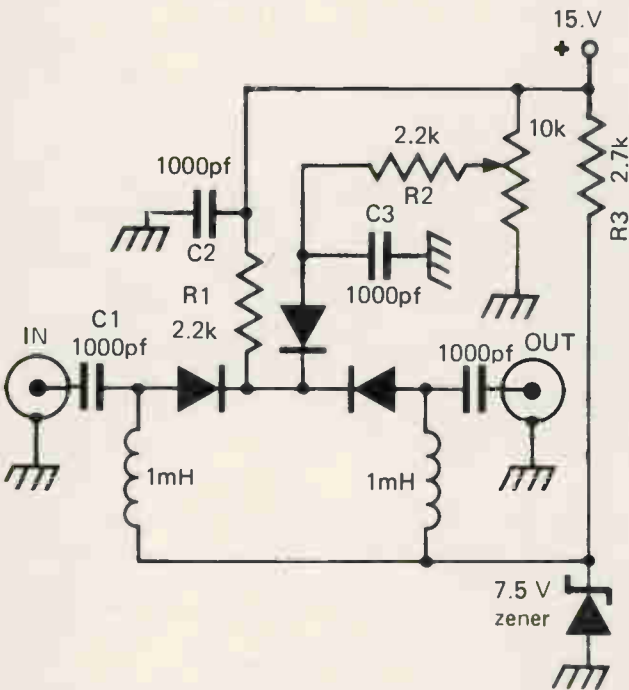
The screw caps of some tubes of glue and toothpaste can make very attractive control knobs. Epoxy resin glue will not stick well to most plastics but will stick to the control spindle and fill into the thread of the caps making a reasonable fixing.

VARIABLE RF ATTENUATOR

This circuit can provide variable in attenuation from 1dB to approximately 40dB.

If intended for use up to UHF, the components should be mounted in a shielded enclosure and feedthrough capacitors used for C2 and C3. Leads must be kept short. Low capacitance high speed diodes are recommended.

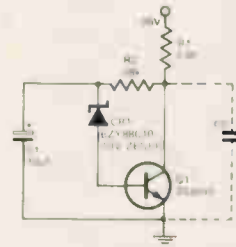
The potentiometer can be mounted remotely if desired, along with R3 and the zener.



NOW, WHERE ON EARTH IS THAT SCREW?

Keeping track of the various nuts, bolts, washers and other fixing hardware when you take apart a piece of equipment can be a problem. A good way to overcome this is to get hold of a roll of double sided Sellotape and stick this across a flat part of the casing. You can use this to hold the various bits and pieces in the right order for reassembly.

NOISE GENERATOR

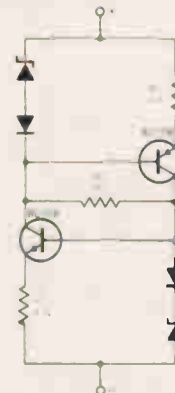


In this circuit the Zener diode, as well as providing a source of noise, stabilizes the amplifier transistor collector operating point. The gain of the transistor is about 75 and the noise output of the circuit is about 15 volts. Capacitor C2 may be added to filter out high frequency noise – in which case the output drops. For example with C2=0.1μF, the output falls to 0.5 volt.

CHEAPIE VARICAPS

Varicap diodes are not all that cheap or easy to get hold of. What is not widely known is that all diodes exhibit a variable capacity effect when reverse biased. Generally speaking the higher the current rating, the larger the capacity and the change when the voltage is varied across it. Even the 1N4000 series with a 1A capacity can be used when small capacity changes (a few picofarads) are required.

CONSTANT CURRENT SOURCE



This unique two terminal circuit can be used to define a constant current in the same manner as a Zener diode may be used to define a constant voltage.

The values of R1 and R2 shown are for a current of 1mA. Maximum applied voltage with transistors shown should be limited to 50 volts. Minimum should be at least 8 volts.

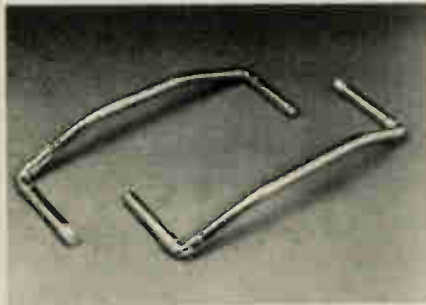
more easily represented in their inverted form, an option is provided to allow for either the true or complement of the function on each output.

The PLA is intended for use as the control logic in digital systems. Applications range from fairly slow appliance sequencers and traffic light controllers for complex intersections, to the control logic delay of only 90 nanoseconds and dissipates about 550 milliwatts. Two output formats are available. The DM7575/DM8575 has a conventional totem-pole output and the DM7576/DM8576 has a passive pull-up output which is used in systems requiring more than one PLA.

The arrays are available in a 24 pin Epoxy B dual in-line package for operation over the 0°C to 70°C temperature range (DM8575 and DM8576), or a 24 pin ceramic DIP for operation over wider temperature ranges (DM7575 and DM7576).

National Semiconductor, The Precinct, Broxbourne, Herts.

BENT HEAT PIPES

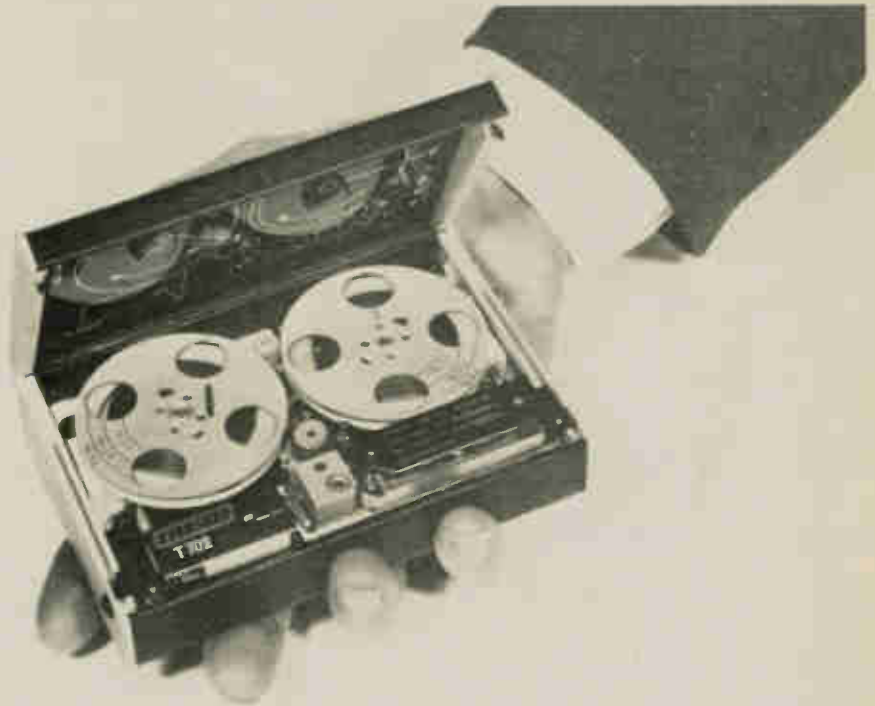


Over the last year, the use of heat pipes has increased rapidly. Economy heat pipes down to 10p each have been in great demand. The principal manufacturer of heat pipes in the U.K. is Redpoint Associates Limited who are now able to supply heat pipes to customers' specifications, such as flat plate, cryogenic, flexible and bent heat pipes. These specials are available on short delivery and at prices which compete with more conventional equipment.

The photograph shows a special 3/4" O.D. heat pipe, bent to a customers' pattern. Although it might appear to be a pair of dropped handlebars, this matched pair is used on a development project by Trinity House, to improve heat transfer efficiency where difficulties have arisen due to the relative positions of the heat source and radiator.

A free data sheet "How to Specify Heat Pipes" is available from Redpoint Associates Limited, Cheney Manor, Swindon, Wilts.

MINIATURE TAPE RECORDER



A new breast pocket sized security tape recorder which provides two hours non-stop recording and has a matching range of small, concealable microphones and accessories is now available from Evershed and Vignoles Ltd of Chiswick, London. The two hours continuous recording time provides high speech fidelity to allow reliable voice identification on playback. The high-frequency bias system ensures quality recordings with low background noise. These features make the instrument especially useful in certain applications where silent running recording, that is when negligible audible noise or electrical radiation, is required.

Designed to fit into a breast pocket, the recorder is housed in a rugged all metal case to withstand tough

conditions. Size is 81 x 131 x 31 mm and weight, including battery and tape is 0.55 kg.

Control for the tape drive and record/play functions is completely remote. The main control switch has record, off and playback positions. This is usually on the microphone, but a separate switch is available if required.

Two models are available in the series, the Type T702 for passive microphones only and the Type T704 which allows use of microphones with built-in amplifiers. A wide range of accessories is available, including headphones, headsets and earpieces, a variety of microphones including miniature and completely concealed etc., a bulk erase unit and remote control cable and switch.

HIGH FLUX SOLAR CELL

At the present time, the high cost of photovoltaic solar cells prohibits their use in the large scale generation of electricity from sunlight. However, R. Davis and J. R. Knight of the Plessey Company's Allen Clark Research Centre have now shown that suitably designed gallium arsenide/gallium aluminium arsenide heterostructure junction semiconductor solar cells can be operated at light intensities of 2000 times full sunlight, to produce specific outputs between 20 and 40W per square centimetre, whereas with silicon cells the maximum usable sunlight concentration is about 10 times.

This high concentration is possible because the (Ga.Al) AS material is

relatively transparent to sunlight so that the surface layer over the junction can be much thicker than is the case with silicon, giving a lower electrical resistance and allowing much higher power to be generated.

Cheap concentrators such as curved mirrors or Fresnel lenses can thus be used to focus the sun's rays onto small solar cells, thereby greatly reducing the unit cost of the electricity produced. The optimum working voltage and efficiency of gallium arsenide solar cells increases with light intensity, and at 2000 times full sunlight an efficiency of 24 per cent is forecast. Efficiencies approaching this value have already been achieved with non-bloomed and non-optimised cells of this type.

NEW AUDIO CASSETTE BODY FROM EMI



EMI Tape Limited is now using its own design of audio cassette which is being made exclusively by two U.K. engineering firms.

The specification of the new cassette adheres precisely to the recommendations set down in the relevant section of the I.E.C. but the moulds have been made so as to be easily modified if this is changed or a new specification is introduced.

Alan Parker, development manager with EMI Tape commented, "Our researches showed that a customer's first requirements is reliability and so we built-in factors which we know will give this quality. For instance most of the 450 separate measurements in the cassettes are calculated to within one thousandth of an inch. We have a great deal of knowledge gained from examining design parameters in cassettes and we have applied this in the Emitape cassette. We have not

endeavoured to build down to a price, although we will be saving money by having the parts made especially for us and this will help to contain rising costs of raw materials."

Exhaustive physical tests on the cassette body were carried out by EMI's tape applications engineers, John Homewood. Tests for dimensional stability after the cassette had been subject to a range of temperatures from -20° to $+70^{\circ}\text{C}$ were followed by specific tests in recommendation I.E.C.94A on the mechanical reliability and structural dimensions of the cassette housing.

John also carried out tests on magnetic shield efficiency, continuous play, play wind, and play re-wind reliability and audio performance on both mono and stereo.

The new EMI cassette is already in production.

TEN-YEAR BATTERIES

A chemically-powered battery lasting as long as a nuclear cell (approximately 10 years) has recently been developed by General Electric in the USA.

Intended primarily for heart pacemakers the new 3.6V unit consists of a bromine cathode, a sodium anode, and an aluminium ceramic electrolyte.

General Electric say that, because the electrolyte is a solid, reactive materials are kept apart. This, the company says, eliminates self-discharge and internal shorting.

The new chemically-powered battery should substantially reduce the cost of

long-life pacemakers — from their present £1,500 to less than £180.

MOTOROLA TO MAKE WATCH DISPLAYS

Motorola's Timepiece division in Phoenix will start to manufacture liquid crystal watch displays early in 1974.

Until recently the division had been manufacturing C/MOS, quartz crystals and other watch components, however the new development will now enable them to offer a complete watch module with digital display.

TRUCK THIEF TAGGER

Truck hijackers and thieves may soon be foiled if a new 'electronic tag' system becomes commercially available,

The new system, developed in the USA by Californian company Hoffman Electronics, has just successfully completed field trials by the US Dept. of Transportation.

Installed in the vehicle is a battery-powered receiver, transmitter, and a decoder whose function is to recognise a unique digital signal.

If the vehicle is reported as stolen, a police helicopter transmits a digital signal 'personally addressed' to the stolen vehicle.

The receiver and decoder in the stolen vehicle responds to the unique digital code and switches on the associated transmitter.

The transmitter now generates a signal indicating the vehicle's position and direction of travel.

It is also possible to arrange for ground-based stations to maintain selective calling procedures.

ECONOMY POWER SUPPLIES



New Ranges Of Modular Power Supplies, types DPS, SQ and P741 from Guest Distribution offer a wide choice of output voltages and current ratings.

The DPS has an output of 5V at 1A and has short circuit protection. The line and load regulation is 0.5%. Case size is $3\frac{1}{2}'' \times 2\frac{1}{2}'' \times 7\frac{7}{8}''$.

The SQ has a smaller case size of $2'' \times 2'' \times 7\frac{7}{8}''$ with an output of 5V at 250mA. The line and load regulation is 0.2%. The P741 series has 3 types in its range. Outputs are $\pm 12\text{V}$ dc or $\pm 15\text{V}$ dc at $\pm 100\text{mA}$, and 5V dc at 500mA single output. Again the line and load regulation is 0.2%.

Guest Distribution, Redlands, Coulsdon, Surrey.

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EASY PARKING

EARTH LEAKAGE DETECTOR

A new electronic safety device manufactured by an Australian firm detects faulty equipment and switches off power in less time than it takes a human heart to beat once.

The unit, known as Powersafe measures earth leakage through an amplifier. It switches power off immediately any supply current flows to earth. It can also be used as a portable unit for use in a doctor's surgery; or on a production line where it will disconnect power to one operator without interruption to the whole line.

The core-balanced earth leakage detector was developed primarily for medical use at the request of a major hospital in Melbourne. While the heart cycle is approximately .75s the ventricular valve opens and closes in 15ms and the machine had to detect and cut off faulty supply within that time.

In the State of Queensland, where climate conditions permit day and night use of swimming pools, it is now mandatory for swimming pools with underwater lighting.

The portable unit measures 6 x 6 x 4 in. and is for use in surgeries or factories where it will isolate and disconnect the faulty piece of equipment, without affecting supplies to other appliances. Units are sensitive to leakages as low as 10mA or better and will handle through currents up to 60A. For factory use, leakage current levels can be set to customer requirements.

*Physical Applications Pty. Ltd.,
43, Cochrane's Road, Moorabbin,
Victoria, Australia 3189.*

'LAYMANS' GUIDE TO HI-FI

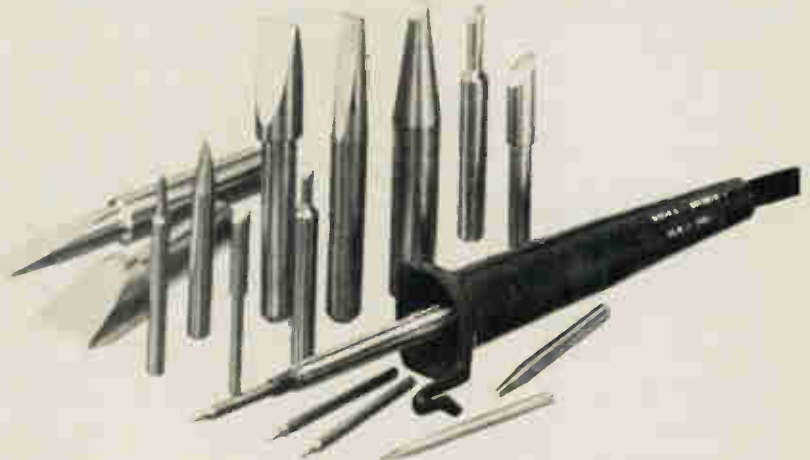
A new 12-page colour booklet has recently been published by Sinclair, as an introduction for the first-time buyer of hi-fi equipment.

The object of the booklet, available free from Sinclair and most hi-fi retailers, is to give a step-by-step guide to unravelling the often baffling array of technical terms thrown at the would-be-purchaser.

'Sinclair Introduction to Hi-Fi' is divided into five sections starting with a page devoted to a simple explanation of the difference between hi-fi and stereo. Subsequent sections cover 'What equipment do I need and how much will it cost?', 'Where do I put it?', 'Can I build it myself?'

The final part of the booklet is an alphabetical glossary of the 20 most common words and phrases used to described hi-fi equipment. Subjects range from 'acoustics' to 'coloration',

STANDARD RANGE OF SOLDERING BITS



Soldering instrument efficiency is largely dependent upon the design and shape of the soldering bit, so for 1974 Adcola Products Ltd is launching an extensive range of almost 100 different soldering bit designs as a standard, off-the-shelf service to industry.

The range has been developed to meet the requirements of production engineers in the electronics and electrical industries, and includes both copper and iron plated long life bits in

a variety of popular shapes - standard, taper, and reduced chisel, 80° PCB, conical and screwdriver.

In addition to soldering bits for Adcola's own tools, the new range has been extended to cover other manufacturers' soldering irons to allow for the purchase of a total supply of soldering bits from a single source.

*Adcola Products Ltd. Adcola House,
Gauden Road, London S.W. 4.*

'frequency response', 'RMS power' to 'rumble' and 'wow and flutter'.

For further information and copies of the booklet, contact Russ McAnulla, *Hi-Fi Division, Sinclair Radionics Ltd, London Road, St. Ives, Huntingdonshire, PE17 4HJ.*

COLOUR PICTURE—PLUS SOUND ON STANDARD TAPE CASSETTES

Japan's Hitachi Ltd have developed a cassette system that records still colour pictures, as well as sound, on standard cassette tapes. Reproduction is via a conventional colour TV set.

The system is intended to record and play back colour slides, opaque cards, or still frames of TV images for periods of up to 12 seconds per picture. Sound reproduction is in stereo form.

An Hitachi spokesmsn said that the system will be commercially available from October 1974. Selling prices are not yet known.

KOREA GOES NUCLEAR

During 1975 Korea will become the fifth Nation in the world to draw on nuclear power for its supply of electricity. Whilst work has already begun on building Korea's first nuclear power station, the Alfa-Laval Co. Ltd. have also achieved another breakthrough in having secured an

order for the supply of plate heat exchangers for cooling the general service water for the Westinghouse Light Water Reactor being used in this contract.

Although Alfa-Laval plate heat exchangers (PHE) are currently in use at five of the six Advanced Gas and Heavy Water Reactor nuclear power stations in the U.K., the Korean station will have the first Light Water Reactor to use PHE's in favour of the more conventional shell and tube type of cooling system.

Situated at Ko-Ri on the SE coast of Korea, some 250 miles south of the capital Seol, the 600MW station is being built by the British Nuclear Design and Construction Company, acting on behalf of Westinghouse and G.E.C., who are controlling the total project.

BACK NUMBERS

A limited quantity of back numbers of *Electronics Today International* are available at 25p each plus 7p postage (32p in all). Requests for these should be addressed to:

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3W TAPE AMPLIFIERS

Polished wood cabinet 14x13x9" containing a sensitive (20μV) 4 valve amplifier with tone and volume controls. 3 watts output to the 7x4" 3 speaker. Also included is a non-standard tape deck. Supplied in good working condition with circuit. Mains operated. £3.30 (£1.25). Amplifier chassis complete and tested (2xECC83, EL84, EZ80) and speaker £2.20 (45p).

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