JUNE 1973

electronics today INTERNATIONAL

20p

DIGITAL LOGIC — an introduction

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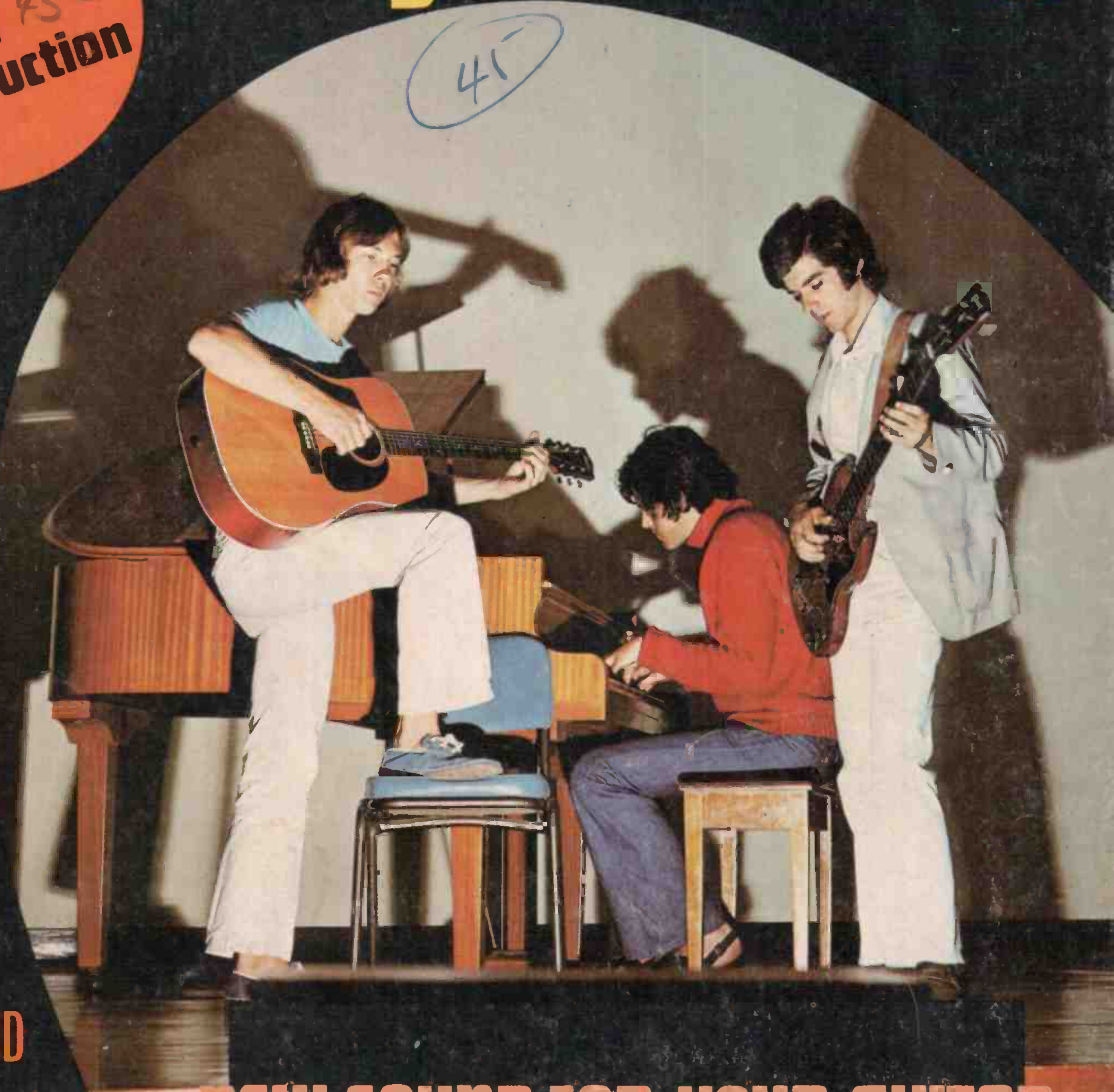

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reviews

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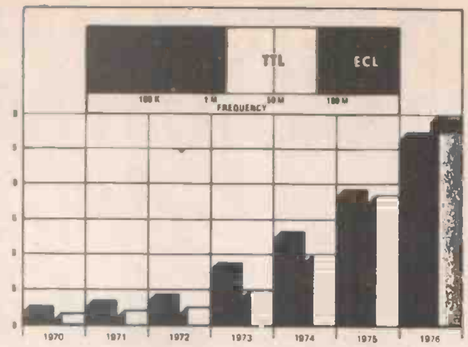
Cover: Add a completely new sound to your guitar, see the constructional project on page 30.



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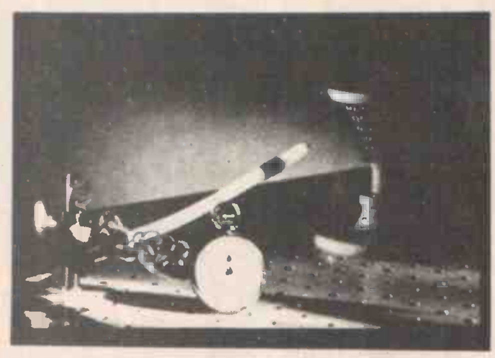

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WITHIN a few months additional kilowatts are going to be pumped into the airwaves over Britain. Already the IBA are conducting round-the-clock engineering test transmissions in the medium wave band in preparation for independent, local, commercial radio.

There has been considerable criticism of the fact that these stations are to be allocated medium wave frequencies at all. The critics seem to think that transmissions should be confined to the VHF band and that the medium wave stations will only add to an already hopeless situation. Now, say the critics, would be an excellent opportunity to change things over so that the VHF band is regarded as the primary medium with the medium waves serving a secondary role (that is even if they concede any use at all for this band).

Is this fair? Let us investigate the facts. Less than half the households in this country are equipped with an FM receiver and less than 10 per cent of the radio audience listen on this band. We have been slow in this country to convert to the use of the FM band for several reasons. Until recently they offered no additional programme choice, secondly there has been a tradition in this country of buying cheap radios. In continental europe, people think nothing of paying £30 for a receiver whereas the majority of receivers here cost about half that. Whilst most radios now sold have facilities for FM they are barely sensitive enough using the usual whip aerial (we are talking here about the portable models which account for the overwhelming majority of receivers sold).

Admittedly MW reception leaves a lot to be desired as regards quality but there is a tendency for the technically minded to overrate quality. The vast majority of the population are completely oblivious to quality, even when they have heard it. It is entertainment and information that most people want......if the quality is good, well, that's just a bonus. Radio Luxembourg, despite all the reception difficulties and poor quality remains a popular station. Most people want to use cheap radios without an awkward telescopic aerial.

If commercial radio is to be given a chance, and all but the most bigotted should give it at least that, then it is only right that the stations should be transmitted on the medium wave band as well as from the VHF band even if the quality offends the ear of the Hi-Fi enthusiast. Those of us who appreciate the better quality will not be denied this, in turn we should not try to deny the untechnical the right to be able to get the new stations on their simple radios with no fussing about.

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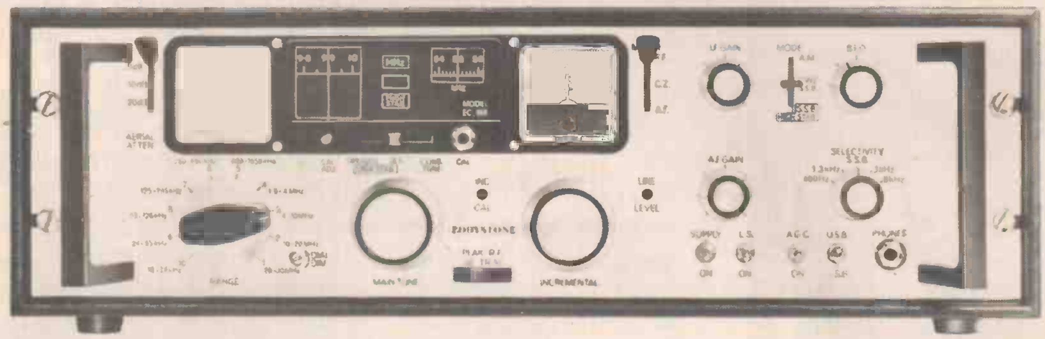

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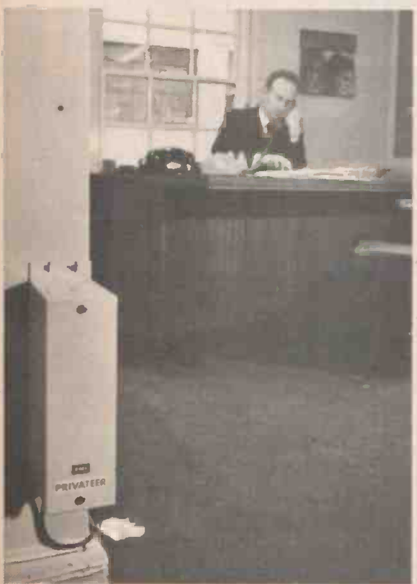
news digest

TELEPHONE SCRAMBLER

Industrial espionage is on the increase — or so we are led to believe from the makers of security devices. Latest system on the scene is the Privateer from EMI, a telephone scrambling device. No maker is going to release much technical information about such equipment otherwise the security aspect is obviously lost. These systems work in a number of ways, some extremely simple, others with a considerable degree of ingenuity, making it all but impossible for an eavesdropper to decode even if the conversation is recorded.

The Privateer is designed for both internal and public telephone systems but of course it can only be used to talk to someone who has a matching unit at the other end. The telephone used is a standard one but this feeds to the telephone network via a scrambling circuit. Anyone tapping this line will then hear nothing but a jumble of meaningless sound but when connected to a similar unit at the other end, which usually has a variety of codes that can be selected, the sound is restored at the other end. The EMI Privateer has the advantage that should the person using it forget to revert the system to normal before replacing the receiver, a built-in buzzer will sound.



COMMUNICATIONS HELMETS

The pressed steel helmet of World War II has come a long way in the last few years. An example of what is now used by the Army is the *Helmgard* made by Racal-Amplivox. Already in service with the Scorpion tanks, the British Army is now equipping the Chieftan and other vehicles with these

personal communications centres. It has its own built-in facility using either a throat or boom mike as well as having a patented 'acoustic valve' which allows the wearer to hear airborne sounds without the need to remove the helmet and yet still provides a substantial acoustic protection against unexpected explosive sounds.

FIRST POCKET CALCULATOR FROM SUMLOCK COMPTOMETER

Announcing its first pocket calculator, Sumlock Comptometer Limited have unveiled the ANITA 811, a powerful unit with accumulating memory and advanced automatic and design features found in few other machines of its type. Selling at £75 the 6oz ANITA 811 was designed in Britain, and high volume production at the Portsmouth factory marks an all-out challenge at home and overseas in the fast-growing pocket calculating market. The Anita 811 not only provides the four usual arithmetic functions but also takes in its stride all the most-used daily commercial calculations including automatic percentages, mark-up, discount etc.

The Anita 881

Measuring 2¾" x 4¾" x 15/16" it is truly pocket size.

The decision to distribute the calculator through normal trade channels marks a notable exception to the policy of direct sales which the company has adhered to until now.

TELEPHONE TIT-BITS

A pamphlet just published by the Post Office Telecommunications London Region gives a whole ream of statistics on the sheer magnitude of their operations. There are now over 2½ million lines in the capital with over 4½ million telephones, an increase of 5% over 1971, the London area phone books have a total of 6,300 pages and 14,000 tons of paper are used in their production.

It has been fashionable to knock the P.O. about their waiting list, but seen in context they seem to be doing a pretty good job; the waiting list at the beginning of year was just under 29,000 yet in the last six months of the year nearly half a million new phones were installed.

Although quite short, the leaflet even mentions the problem of finding fictitious phone numbers for films and TV etc. They give a few suggested numbers including 01-246 8071, but we're not going to tell you what will happen, you'll have to try that for yourself.

One last statistic, the 'Dial-a-Santa' recorded Christmas stories for children received nearly a million calls from all over the country. Even if no one else does, at least the P.O. believe in Santa Claus!

EUROPEAN COMPUTER TERMINAL MARKET

By 1977 there will be more than 300,000 general purpose computer terminals in use in Western Europe — almost four times the number in use now. In Eastern Europe there will be

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news digest

nine times as many terminals as there are now. This remarkable increase in the use of on-line computing in Europe over the next four years is one of the forecasts made in an important and wide-ranging survey of the European market for computer terminals which Logica Limited has completed.

The survey report has the title 'The European Market for Computer Terminals 1973-1976'. From it the United Kingdom emerges as the largest user of terminals among European countries. The survey also found that the UK has the most sophisticated users, but that the higher growth rates of France and Germany will have compensated for this by 1977.

Logica's analysis covered the terminal markets in 16 West European countries and eight in Eastern Europe. Particular attention was focused on the UK, Germany and France, which together account for 75% of the terminals now used on-line in Europe.

The European market for terminals was examined both by industrial sector and by country for five categories of terminal: keyboard printers, visual display units, remote batch terminals, accounting terminals, computing terminals. The report contains market forecasts of both the number of terminals in use and of shipments made.

In the UK and France, the survey found that there are approximately twice as many keyboard printers as visual display units. In Germany there are more VDU's, partly due to Germany's high PTT tariffs. Remote batch terminals are favoured more in France than in Germany, and the United Kingdom leads both the other countries in the use of accounting and computing terminals.

In the UK, Logica has measured the effect of last year's recession in the computer industry by comparing the latest results with those obtained 18 months ago in the company's previous survey of the UK market for terminals. The number of terminals now installed is 10% down on the expectations of 1971; but in compensation the present installation rate is higher than was anticipated then.

NEW RELAY STATIONS

Another 20,000 people have been added to those able to receive IBA's colour TV network with the commencement of two new relay stations. They are: *West Runton* Channel 23 carrying Anglia, this serves part of the Norfolk coast around Cromer and *Windermere* Channel 41 carrying Granada programmes to part of the Lake District.

WHAT TO SEE AT THE RECMF!

Let's be honest, a 16-pin DIL i.c. is not very glamourous but a brave attempt is being made by at least one company to give the semiconductor 'man-appeal'.

'Come and look at our components'.. that will be the invitation from these lovely ladies at the RECMF (London Electronics Components Show) to be held May 22-25 at Olympia. The girls are meant to represent Athena (the Greek Goddess of Wisdom) and it's the major distributor Athena who will have their help.

With the way things are going, in a few years can we expect the RECMF to compete with the opening day of the Motor Show?

ELECTRONICS BREAKTHROUGH FOR THE BLIND

For the first time, blind students will have a much better opportunity of taking up worth-while careers in engineering and science as a result of two technical breakthroughs recently achieved in the United States.

At Stanford University an 'Optacon' reading device has been combined with a Hewlett-Packard Model 35 pocket calculator to enable blind students to carry out complex mathematical calculations in a matter of seconds.

The Optacon portable reading aid developed at the university converts the visual image of a printed character or illuminated display directly into a tactile image that can be felt with one finger.

A miniature camera activates an array of 144 tiny rods, each one vibrating individually, re-creating the image seen by the camera. With his index finger on the vibrating rods as he moves the camera across the calculator display, a blind person can feel exactly what the camera sees.

With the small nine ounce HP35 calculator log, trig, exponential and mathematical functions are available with single keystrokes. Intricate equations are reduced to a logical series of keystrokes without the need to record intermediate steps and the answers are accurate to 10 digits.

According to a spokesman for Stanford University's Applied Electronics Laboratory: 'The combination of the Optacon and the HP35 makes it possible for a blind person to perform the kind of calculations utilized from school mathematics through university and business with a facility approaching that of a sighted person.

'Until now a blind person trying to work in a scientific or engineering field has been at a serious disadvantage when any sort of numerical computation was necessary. The result in the past has been to close off potential areas of employment to blind people and to push students away from those areas'.

A similar solution to the same problem has been developed at the University of New Mexico. Here a special device has been developed which directly transmits signals from the HP35 to a unit which converts them into Braille characters which can then be read by the blind person.

According to a spokesman for the university's Department of Electrical Engineering and Computer Science: 'In the past when a blind person needed a certain logarithm it meant using the cumbersome book of Braille mathematical tables. Now a similar calculation can be carried out in just a few seconds.

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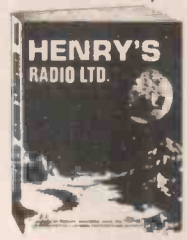

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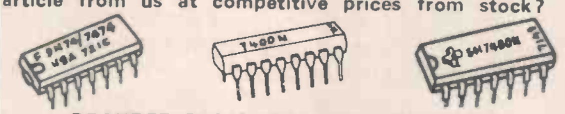

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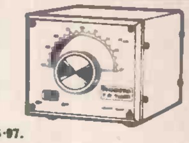

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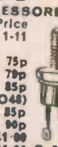
SC40A	100	85p
SC40B	200	90p
SC40D	400	£1·00
SC40E	500	£1·20
10 AMP RANGE (TO48)		
SC45A	100	95p
SC45B	200	£1·00
SC45D	400	£1·25
SC45E	500	£1·45
15 AMP RANGE (TO48)		
SC50A	100	£1·25
SC50B	200	£1·35
SC50D	400	£1·65
SC50E	500	£1·85
DIAC D32		25p
TRIACS—Additional Types		
40430	(TO66)	85p
40669	(Plastic)	£1·00
40486	(TO5)	80p


3 Amp T048


15 Amp T048

NEW BRIDGE RECTIFIERS

SMALL SIZE AND LOW COST

Type	Volts P.I.V.	Price 1-11
HALF AMP		
BO5/05	50	20p
BO5/10	100	25p
ONE AMP. ¼x⅜H TUBULAR		
B1/05	50	25p
B1/10	100	25p
B1/20	200	30p
B1/60	600	35p
ONE AMP (G.I.) TUBULAR		
W005	50	30p
W01	100	35p
W02	200	40p
W06	600	45p
TWO AMPS ⅜H x ⅜L x ¼		
B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
FOUR AMPS ⅜H x ⅜L x ¼		
B4100	100	60p
B4/200	200	65p
B4/400	400	70p
B4/600	600	75p
B4/800	800	£1·00
SIX AMPS ⅜H x ⅜L x ¼		
B6/100	100	70p
B6/200	200	75p
B6/400	400	90p
B6/600	600	£1·00

SILICON CONTROLLED RECTIFIERS

Type	Volts P.I.V.	Price 1-11
ONE AMP		
CRS 1/05	50	25p
CRS 1/10	100	30p
CRS 1/20	200	30p
CRS 1/40	400	35p
CRS 1/60	600	45p
THREE AMP (TO48)		
CRS 3/05	50	30p
CRS 3/10	100	30p
CRS 3/20	200	35p
CRS 3/40	400	45p
CRS 3/60	600	55p
FIVE AMP (TO66)		
CRS 5/400	400	60p
SEVEN AMP (TO48)		
CRS 7/100	100	60p
CRS 7/200	200	65p
CRS 7/400	400	70p
CRS 7/600	600	95p
SIXTEEN AMP		
SCR 16/100	100	65p
SCR 16/200	200	70p
SCR 16/400	400	80p
SCR 16/600	600	£1·00


1 Amp T05


3 Amp T048

TEST EQUIPMENT
Just a Selection

SE250B	Pocket Pencil Signal Injector £1·90
SE500	Pocket Pencil Signal Tracer £1·50
THL33D	Robust 2K/Volt £4·55. With case £4·95
TE15	Grid Dip Meter 440 KHz-280 mHz £13·45
500	30 K/V Multimeter £9·25 With leather case £10·50
200H	20 K/V Multimeter £4·20. With case £9·50
AF105	50 K/V Multimeter £8·50. With case £6·50
U4341	AC/DC Multimeter with transistor tester. Steel case £10·50
TE20D	RF. Generator 120KHz-500MHz £15·95 Carr. 35p
TE22D	Audio Generator 20Hz-200KHz £17·50 Carr. 35p
C1-5	3" Pulse Scope 10Hz-10mHz £39·00 Carr. 50p
TE65	Valve Voltmeter 28 ranges £17·50 Carr. 40p

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MW/LW TUNER
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ALL PARTS SOLD SEPARATELY

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GNP-7, GNP-8 0-9 side view with decimal points and data, 95p.
3015F 7 seg. £2 each, £7 per 4 with data.
12 and 24 hour clock circuits. Ref. No. 31 15p.

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Operate at 40kc/s up to 100 yds. Ideal remote switching and signalling. Complete with data and circuits.
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QUALITY SLIDER CONTROLS
60mm stroke singles and ganged. Complete with knobs. 5kΩ, 10kΩ, 25kΩ, 100kΩ, 250kΩ, 500kΩ. 1 meg. Log and Lin. 40p each, 10kΩ, 25kΩ 50kΩ, 100kΩ, 250kΩ, Log and Lin ganged. 60p each.

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4 TRACK MONO or 2 TRACK STEREO

"17" High Impedance	£2·00
"18" Med. Impedance	£2·00
"36" Med.-Low Imp.	£3·50
Erase Heads for above	75p
"63" 2 track mono—High Impedance	£1·75
"43" Erase Head for above	75p.

SILICON RECTIFIERS
WIRE ENDED PLASTIC

Type	P.I.V.	1-11
1 amp miniature		
IN4001	50	6p
IN4002	100	7p
IN4003	200	8p
IN4004	400	8p
IN4005	600	10p
IN4006	800	12p
IN4007	1000	15p
1.5 amp miniature		
PL4001	50	8p
PL4002	100	9p
PL4003	200	10p
PL4004	400	10p
PL4005	600	12p
PL4006	800	15p
PL4007	1000	18p

LINEAR (O/P AMPS)

702C TO5	75p
709C TO99	35p
709C D.I.L.	35p
723C TO99	£1·00
723C D.I.L.	95p
725C (TO99)	£4·50
741C TO99	55p
741C D.I.L.	55p
747C TO99	£1·10
747C D.I.L.	£1·10
72741P D.I.L.	60p
72748P D.I.L.	90p

SL4030D PLESSEY
3 WATT R.M.S. I.C.
Complete with 8 page Data Booklet and Circuits £1·50, (P.C. Board Stereo 60p; Heat Sink 14p).
Also Sinclair IC12 £1·80.
TH9013P—20 watt Power Amp Module £4·57.
TH9014P-IC Preamp £1·50.
Data/Circuits for above No. 42 10p.
ZN414 Radio IC £1·20.

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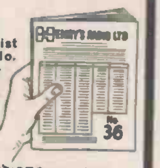
Stock List Ref. No. 36 Revised Regularly



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Any one type.
1½ Watt 5%
Wire Ends
Metal Case
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6.8-33 Volts
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All voltages
6.8-100 Volts.
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Model 8/9 meter movements with scale. Ideal base for test gear.
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news digest

'One of our blind students has estimated that the 'Braille calculator' has enabled him to do homework problems as fast if not faster than any sighted person using a calculator. In the past homework assignments used to take him from four to eight times longer than the average student working without a calculator'.

Present development work at the university is centred on a new component for the Braille calculator which will provide the facility for 'hard copy' figures or a permanent Braille printout.

NEW CATALOGUE

A new catalogue arrived on the ETI News Desk recently from Bywood. These people take some pride in offering the very latest devices, concentrating on the more exotic i.c.'s and readout devices. Also marketed by the firm are a number of calculators at cut-prices and calculator kits. Price of the catalogue is 15p from Bywood Electronics, 181 Ebberns Road, Hemel Hempstead, Herts.

TRIAL KIT OF I.C.'S

SDS Components Ltd are offering a special sampler kit of Plessey communications integrated circuits at a reduced price for a limited period. The i.c.'s have been selected from the popular SL600 family of communications circuits which have been designed for use in h.f./v.h.f. transmitters and receivers for operation in the a.m., f.m., or s.s.b. modes.

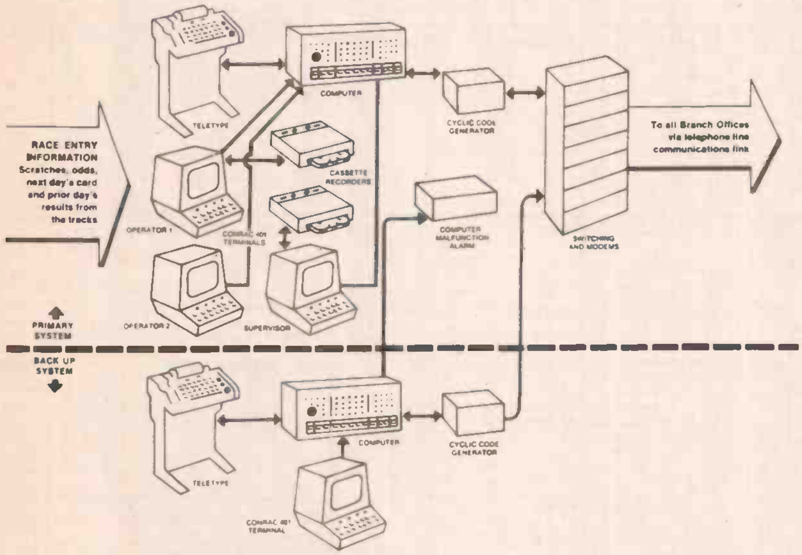
The kit comprises one SL610C r.f./i.f. amplifier, one SL621C a.g.c. generator and one SL640C double balanced modulator. Normally these devices cost £6.13, but, for the period of the offer, SDS is supplying the three i.c.s, complete with a detailed 56-page data book worth 50p, for £5.35.

The data book is divided into three separate sections describing different aspects of the SL600 family. The first section deals with each i.c. in the family in practical terms giving suitable input and output circuits and showing different methods of connection.

Section two is devoted to system design describing receivers of various types (including the synchrodyne), transmitters and a typical transceiver. The final section of the data book gives detailed technical specifications and performance information. The kit and the data book represent good value for money and provides the professional and the amateur alike with a useful opportunity to experiment with the SL600 series. The offer closes on the 30th June, 1973.

SDS Components Ltd, Hilsea Trading Estate, Portsmouth, Hants, P03 5JW.

MINICOMPUTERS AID OFF-COURSE PUNTERS



Off-course horse-racing followers in New York can now place their bets and collect their winnings with the aid of up-to-date information displayed on television screens, thanks to a minicomputer-based system developed jointly by Computer Automation Inc and the Conrac Corporation.

Already several of the hundred or more betting shops in New York that are run by the Off-Track Betting Corp. (OTB) have been successfully using the system, which incorporates three of Computer Automation's Jumbo Alpha 16 minicomputers. These control a centralised race-track information display network that features a series of safeguards to ensure optimum operational reliability, including a 100% redundant back-up control system.

The network, will enable off-course punters to receive the latest information on starters, scratched horses, jockey substitutes, starting prices, race results etc. from as many as four separate race tracks, all simultaneously. Up to eleven large-screen television displays are being installed in each OTB betting office, and these are all fed over telephone lines from a control and distribution centre where the three Alpha 16 machines are located.

The primary on-line minicomputer receives and processes information from each race track and distributes formatted data to the display systems at the betting shops.

Identical track data is fed into the main system computer by two operators using keyboard terminals, the outputs of which are compared to ensure consistency and accuracy. A third terminal is operated by a system supervisor, who displays and checks all information before it is released for distribution to the OTB betting shop monitors.

SO THAT'S HOW IT'S DONE

No one can say that the Ministry of Defence have not got a sense of humour! A superbly produced brochure appeared in our post the other day describing how the MoD selects contractors for supplying anything from a guided missle to pork pies. The text, of course, has to be pretty staid, almost legalistic, but at the bottom of one of the pages which includes details of Contractor Assessment *is the little drawing:*

The MoD's method of contractor assessment!

There can't be much wrong with any organisation which has a sense of humour; we sometimes take ourselves far too seriously.

The largest selection

BRAND NEW FULLY GUARANTEED DEVICES

AC107	0·20	AD162	0·33	BC148	0·10	BD137	0·45	BF188	0·40	OC19	0·25	2G371	0·16
AC113	0·20	AD161 &		BC149	0·12	BD138	0·50	BF194	0·12	OC20	0·63	2G371B	0·16
AC115	0·23	AD162 (MP)		BC150	0·18	BD139	0·55	BF195	0·12	OC22	0·38	2G373	0·17
AC117K	0·20		0·55	BC151	0·20	BD140	0·60	BF196	0·14	OC23	0·42	2G374	0·17
AC122	0·12	ADT140	0·50	BC152	0·17	BD155	0·80	BF197	0·14	OC24	0·56	2G377	0·30
AC125	0·17	AF114	0·24	BC153	0·28	BD175	0·60	BF200	0·45	OC25	0·38	2G378	0·16
AC126	0·17	AF115	0·24	BC154	0·30	BD176	0·80	BF222	0·95	OC26	0·25	2G381	0·16
AC127	0·17	AF116	0·24	BC157	0·18	BD177	0·65	BF257	0·45	OC28	0·50	2G382	0·16
AC128	0·17	AF117	0·24	BC158	0·12	BD178	0·65	BF258	0·60	OC29	0·50	2G401	0·30
AC132	0·14	AF118	0·35	BC159	0·12	BD179	0·70	BF259	0·85	OC35	0·42	2G414	0·30
AC134	0·14	AF124	0·30	BC160	0·45	BD180	0·70	BF262	0·55	OC36	0·50	2G417	0·25
AC137	0·14	AF125	0·25	BC161	0·50	BD185	0·65	BF263	0·55	OC41	0·20	2N388	0·35
AC141	0·14	AF126	0·28	BC167	0·12	BD186	0·65	BF270	0·35	OC42	0·24	2N388A	0·55
AC141K	0·17	AF127	0·28	BC168	0·12	BD187	0·70	BF271	0·30	OC44	0·15	2N404	0·20
AC142	0·14	AF139	0·30	BC169	0·12	BD188	0·70	BF272	0·80	OC45	0·12	2N404A	0·28
AC142K	0·17	AF178	0·50	BC170	0·12	BD189	0·75	BF273	0·35	OC70	0·10	2N524	0·42
AC151	0·15	AF179	0·50	BC171	0·14	BD190	0·75	BF274	0·35	OC71	0·10	2N527	0·49
AC154	0·20	AF180	0·50	BC172	0·14	BD195	0·85	BFW10	0·60	OC72	0·14	2N598	0·42
AC155	0·20	AF181	0·45	BC173	0·14	BD196	0·85	BFX29	0·27	OC74	0·14	2N599	0·45
AC156	0·20	AF186	0·45	BC174	0·14	BD197	0·90	BFX84	0·22	OC75	0·15	2N696	0·12
AC157	0·24	AF239	0·37	BC175	0·22	BD198	0·90	BFX85	0·30	OC76	0·15	2N697	0·13
AC165	0·20	AL102	0·65	BC177	0·19	BD199	0·95	BFX86	0·22	OC77	0·25	2N698	0·24
AC166	0·20	AL103	0·65	BC178	0·19	BD200	0·95	BFX87	0·24	OC81	0·15	2N699	0·35
AC167	0·20	ASY26	0·25	BC179	0·19	BD205	0·80	BFX88	0·22	OC81D	0·15	2N706	0·08
AC168	0·24	ASY27	0·30	BC180	0·24	BD206	0·80	BFY50	0·20	OC82	0·15	2N706A	0·09
AC169	0·14	ASY28	0·25	BC181	0·24	BD207	0·95	BFY51	0·20	OC82D	0·15	2N708	0·12
AC176	0·20	ASY29	0·25	BC182	0·10	BD208	0·95	BFY52	0·20	OC83	0·20	2N711	0·30
AC177	0·24	ASY50	0·25	BC182L	0·10	BDY20	1·00	BFY53	0·17	OC84	0·20	2N717	0·35
AC178	0·28	ASY51	0·25	BC183	0·10	BF115	0·24	BPX25	0·85	OC139	0·20	2N718	0·24
AC179	0·28	ASY52	0·25	BC183L	0·10	BF117	0·45	BSX19	0·15	OC140	0·20	2N718A	0·50
AC180	0·17	ASY54	0·25	BC184	0·12	BF118	0·70	BSX20	0·15	OC169	0·25	2N726	0·28
AC180K	0·20	ASY55	0·25	BC184L	0·12	BF119	0·70	BSY25	0·15	OC170	0·25	2N727	0·28
AC181	0·17	ASY56	0·25	BC186	0·28	BF121	0·45	BSY26	0·15	OC171	0·25	2N743	0·20
AC181K	0·20	ASY57	0·25	BC187	0·28	BF123	0·50	BSY27	0·15	OC200	0·25	2N744	0·20
AC187	0·28	ASY58	0·25	BC207	0·11	BF125	0·45	BSY28	0·15	OC201	0·28	2N914	0·14
AC187K	0·20	ASZ21	0·40	BC208	0·11	BF127	0·50	BSY29	0·15	OC202	0·28	2N918	0·30
AC188	0·22	BC107	0·09	BC209	0·12	BF152	0·55	BSY38	0·18	OC203	0·25	2N929	0·21
AC188K	0·20	BC108	0·09	BC212L	0·11	BF153	0·45	BSY39	0·18	OC204	0·25	2N930	0·21
ACY17	0·25	BC109	0·10	BC213L	0·11	BF154	0·45	BSY40	0·28	OC205	0·35	2N1131	0·20
ACY18	0·20	BC113	0·10	BC214L	0·14	BF155	0·70	BSY41	0·28	OC309	0·40	2N1132	0·29
ACY19	0·20	BC114	0·15	BC225	0·25	BF156	0·48	BSY95	0·12	P346A	0·20	2N1302	0·14
ACY20	0·20	BC115	0·15	BC226	0·35	BF157	0·55	BSY95A	0·12	P397	0·42	2N1303	0·14
ACY21	0·20	BC116	0·15	BCY30	0·24	BF158	0·55	Bu105	2·00	OCP71	0·43	2N1304	0·17
ACY22	0·16	BC117	0·15	BCY31	0·26	BF159	0·60	C111E	0·50	ORP12	0·43	2N1305	0·17
ACY27	0·18	BC118	0·10	BCY32	0·30	BF160	0·40	C400	0·30	ORP60	0·40	2N1306	0·21
ACY28	0·19	BC119	0·30	BCY33	0·22	BF162	0·40	C407	0·25	ORP61	0·40	2N1307	0·21
ACY29	0·35	BC120	0·80	BCY34	0·25	BF163	0·40	C424	0·20	ST140	0·12	2N1308	0·23
ACY30	0·28	BC125	0·12	BCY70	0·14	BF164	0·40	C425	0·50	ST141	0·17	2N1309	0·23
ACY31	0·28	BC126	0·18	BCY71	0·18	BF165	0·40	C426	0·35	TI843	0·30	2N1613	0·20
ACY34	0·21	BC132	0·12	BCY72	0·14	BF167	0·22	C428	0·20	UT46	0·27	2N1711	0·20
ACY35	0·21	BC134	0·18	BCZ10	0·20	BF173	0·22	C441	0·30	2G301	0·09	2N1889	0·32
ACY36	0·28	BC135	0·12	BCZ11	0·25	BF176	0·35	C442	0·30	2G302	0·19	2N1890	0·45
ACY40	0·17	BC136	0·15	BCZ12	0·25	BF177	0·35	C444	0·35	2G303	0·19	2N1893	0·37
ACY41	0·18	BC137	0·15	BD121	0·60	BF178	0·30	C450	0·22	2G304	0·24	2N2147	0·72
ACY44	0·35	BC139	0·40	BD123	0·65	BF179	0·30	MAT100	0·19	2G306	0·40	2N2148	0·57
AD130	0·38	BC140	0·30	BD124	0·60	BF180	0·30	MAT101	0·20	2G308	0·35	2N2160	0·60
AD140	0·48	BC141	0·30	BD131	0·50	BF181	0·30	MAT120	0·19	2G309	0·35	2N2192	0·35
AD142	0·48	BC142	0·30	BD132	0·60	BF182	0·40	MAT121	0·20	2G339	0·20	2N2193	0·35
AD143	0·38	BC143	0·30	BD133	0·65	BF183	0·40	MPF102	0·42	2G339A	0·16	2N2194	0·35
AD149	0·50	BC145	0·45	BD135	0·40	BF184	0·25	MPF104	0·37	2G344	0·18	2N2217	0·22
AD161	0·33	BC147	0·10	BD136	0·40	BF185	0·30	MPF105	0·37	2G345	0·16	2N2218	0·20

2N2219	0·20	2N3054	0·46	2N4059	0·10
2N2220	0·22	2N3055	0·50	2N4060	0·12
2N2221	0·20	2N3391	0·14	2N4061	0·12
2N2222	0·20	2N3391A	0·16	2N4062	0·12
2N2368	0·17	2N3392	0·14	2N4284	0·17
2N2369	0·14	2N3393	0·14	2N4285	0·17
2N2369A	0·14	2N3394	0·14	2N4286	0·17
2N2411	0·24	2N3395	0·17	2N4287	0·17
2N2412	0·24	2N3402	0·21	2N4288	0·17
2N2646	0·47	2N3403	0·21	2N4289	0·17
2N2711	0·21	2N3404	0·28	2N4290	0·17
2N2712	0·21	2N3405	0·42	2N4291	0·17
2N2714	0·21	2N3414	0·15	2N4292	0·17
2N2904	0·17	2N3415	0·15	2N4293	0·17
2N2904A	0·21	2N3416	0·28	2N5172	0·12
2N2905	0·21	2N3417	0·28	2N5457	0·32
2N2905A	0·21	2N3525	0·75	2N5458	0·32
2N2906	0·15	2N3646	0·09	2N5459	0·40
2N2906A	0·18	2N3702	0·10	2S301	0·50
2N2907	0·20	2N3703	0·10	2S302A	0·42
2N2907A	0·22	2N3704	0·11	2S302	0·42
2N2923	0·14	2N3705	0·10	2S303	0·55
2N2924	0·14	2N3706	0·09	2S304	0·70
2N2925	0·14	2N3707	0·11	2S305	0·84
2N2926 (G)		2N3708	0·07	2S306	0·84
	0·12	2N3709	0·09	2S307	0·84
2N2926 (Y)		2N3710	0·09	2S321	0·56
	0·11	2N3711	0·09	2S322	0·42
2N2926 (O)		2N3819	0·28	2S322A	0·42
	0·10	2N3820	0·50	2S323	0·56
2N2926 (R)		2N3821	0·35	2S324	0·70
	0·10	2N3823	0·28	2S325	0·70
2N2926 (B)		2N3903	0·28	2S326	0·70
	0·10	2N3904	0·30	2S327	0·70
2N3010	0·70	2N3905	0·28	2S701	0·42
2N3011	0·14	2N3906	0·27	40361	0·40
2N3053	0·17	2N4058	0·12	40362	0·45

DIODES AND RECTIFIERS

AA119	0·08	BY133	0·21	OA10	0·35
AA120	0·08	BY164	0·50	OA47	0·07
AA129	0·08	BYX 38/30		OA70	0·07
AAY30	0·09		0·42	OA79	0·07
AAZ13	0·10	BYZ10	0·35	OA81	0·07
BA100	0·10	BYZ11	0·30	OA85	0·09
BA116	0·21	BYZ12	0·30	OA90	0·06
BA126	0·22	BYZ13	0·25	OA91	0·06
BA148	0·14	BYZ16	0·40	OA95	0·07
BA154	0·12	BYZ17	0·35	OA200	0·06
BA155	0·14	BYZ18	0·35	OA202	0·07
BA156	0·13	BYZ19	0·28	SD10	0·05
BY100	0·15	CG62		SD19	0·05
BY101	0·12	(Eg) OA91		IN34	0·07
BY105	0·17		0·5	IN34A	0·07
BY114	0·12	CG651		IN914	0·06
BY126	0·14	(Eq) OA70-		IN916	0·06
BY127	0·15	OA79	0·06	IN414B	0·06
BY128	0·15	OA5	0·35	1S021	0·20
BY130	0·16	OA38L	0·21	1S951	0·06

FULL RANGE OF ZENER DIODES VOLTAGE RANGE

2-23V. 400mV (DO-7 Case) 13p ea. 1¼W (Top-Hat) 18p ea. 10W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

10 amp POTTED BRIDGE RECTIFIER

on heat sink.
100PIV. 90p each

NEW LINE

Plastic Encapsulated
2 Amp. BRIDGE RECTS.

50v RMS	32p each
100v RMS	37p ..
400v RMS	46p ..

Size 15 mm × 6 mm.

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UT46. Eqvt. 2N2646. Eqvt. TIS43. BEN3000 27p each, 25-99 25p 100 UP 20p.

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GENERAL PURPOSE NPN SILICON SWITCHING TRANS.

TO-18 SIM. TO 2N706/8. BSY-27 28 95A. A.L.1 usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

		£p
20	For	0·50
50	For	1·00
100	For	1·75
500	For	7·50
1000	For	13·00

SIL. G.P. DIODES £p

300mW	30	0·50
40PIV(Min.)	100	1·50
Sub-Min.	500	5·00
Full Tested	1,000	9·00

Ideal for Organ Builders.

TRIACS

VBOM	2A TO-1	6A TO-66	10A TO-88
	£p	£p	£p
100	30	50	76
200	50	60	90
400	70	75	1·10

DIACS

FOR USE WITH TRIACS
BR100 (D32) 37p each

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One 50p Pak of your own choice free with orders valued £4 or over.

BRAND NEW TEXAS GERM. TRANSISTORS

Coded and guaranteed

Pak No.			EQVT
T1	8	2G3713	OC71
T2	8	D1374	OC75
T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All 50p each pak.

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. Our price 25p each.

120 VCR MIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND 120, 1-24 17p each. TO.5 NPN 25 up 15p each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 5p each. Any Qty.

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Pak No.		Description	Price
U 1	120	Glass Sub-Min. General Purpose Germanium Diodes	0·50
U 2	60	Mixed Germanium Transistors AF/RF	0·50
U 3	75	Germanium Gold Bonded Sub-Min. like OA5, OA47	0·50
U 4	40	Germanium Transistors like OC81, AC128	0·50
U 5	60	200mA Sub-Min. Silicon Diodes	0·50
U 6	30	Sil. Planar Trans. NPN like BSY95A. 2N706	0·50
U 7	16	Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0·50
U 8	50	Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0·50
U 9	20	Mixed Voltages, 1 Watt Zener Diodes	0·50
U10	20	BAY50 charge storage Diodes DO-7 Glass	0·50
U11	25	PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0·50
U12	12	Silicon Rectifiers Epoxy 500mA up to 800 PIV	0·50
U13	30	PNP-NPN Sil. Transistors OC200 & 2S 104	0·50
U14	150	Mixed Silicon and Germanium Diodes	0·50
U15	25	NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	0·50
U16	10	3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0·50
U17	30	Germanium PNP AF Transistors TO-5 like ACY 17-22	0·50
U18	8	6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	0·50
U19	25	Silicon NPN Transistors like BC108	0·50
U20	12	1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0·50
U21	30	AF. Germanium Alloy Transistors 2G300 Series & OC71.	0·50
U23	30	MADT's like MHz Series PNP Transistors	0·50
U24	20	Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0·50
U25	25	300 MHz NPN Silicon Transistors 2N708, BSY27	0·50
U26	30	Fast Switching Silicon Diodes like 1N914 Micro-Min.	0·50
U27	12	NPN Germanium AF Transistors TO-1 like AC127	0·50
U29	10	1 Amp SCR's TO-5 can. up to 600 PIV CRS1/25-600	1·00
U30	15	Plastic Silicon Planar Trans. NPN 2N2926	0·50
U31	20	Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0·50
U32	25	Zener Diodes 400mW DO-7 case 3-18 volts mixed	0·50
U33	15	Plastic Case 1 Amp Silicon Rectifiers 1N4000 Series	0·50
U34	30	Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4	0·50
U35	25	Silicon Planar Transistors PNP TO-18 2N2906	0·50
U36	25	Silicon Planar NPN Transistors TO-5 BFY50/51/52	0·50
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U38	20	Fast Switching Silicon Trans. NPN MHz 2N3011	0·50
U39	30	RF. Germ. PNP Transistors 2N1303/5 TO-5	0·50
U40	10	Dual Transistors 6 lead TO-5 2N2060	0·50
U41	25	RF Germanium Transistors TO-5, OC45, NKT72	0·50
U42	10	VHF Germanium PNP Transistor TO-1 NKT667, AF117	0·50
U43	25	Sil. Trans. Plastic TO-18 A.F. BC113/114	0·50
U44	20	Sil. Trans. Plastic TO-5 BC115/NPN	0·50
U45	7	3A SCR. TO66 up to 600PIV	1·00

Code No's. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

QUALITY TESTED SEMICONDUCTORS

Pak No.			Price £p
Q1	20	Red spot transistors PNP	0·50
Q2	16	White spot R.F. transistors PNP	0·50
Q3	4	OC 77 type transistors	0·50
Q4	6	Matched transistors OC44/45/81/81D	0·50
Q5	4	OC 75 transistors	0·50
Q6	5	OC 72 transistors	0·50
Q7	4	AC 128 transistors PNP high gain	0·50
Q8	4	AC 126 transistors PNP	0·50
Q9	7	OC 81 type transistors	0·50
Q10	7	OC 71 type transistors	0·50
Q11	2	AC 127/128 Complementary pairs PNP/NPN	0·50
Q12	3	AF 116 type transistors	0·50
Q13	3	AF 117 type transistors	0·50
Q14	3	OC 171 H.F. type transistors	0·50
Q15	7	2N2926 Sil. Epoxy transistors mixed colours	0·50
Q16	2	GET880 low noise Germanium transistors	0·50
Q17	5	NPN 2 × ST.141 & 3 × ST.140	0·50
Q18	4	MADT'S 2 × MAT 100 & 2 × MAT 120	0·50
Q19	3	MADT'S 2 × MAT 101 & 1 × MAT 121	0·50
Q20	4	OC 44 Germanium transistors A.F.	0·50
Q21	4	AC 127 NPN Germanium transistors	0·50
Q22	20	NKT transistors A.F. R.F. coded	0·50
Q23	10	OA 202 Silicon diodes sub-min.	0·50
Q24	8	OA 81 diodes	0·50
Q25	15	1N914 Silicon diodes 75 PIV 75mA	0·50
Q26	8	OA95 Germanium diodes sub-min. 1N69	0·50
Q27	2	10A PIV Silicon rectifiers 1S425R	0·50
Q28	2	Silicon power rectifiers BYZ 13	0·50
Q29	4	Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0·50
Q30	7	Silicon switch transistors 2N706 NPN	0·50
Q31	6	Silicon switch transistors 2N708 NPN	0·50
Q32	3	PNP Silicon transistors 2 × 2N1131, 1 × 2N 1132	0·50
Q33	3	Silicon NPN transistors 2N1711	0·50
Q34	7	Silicon NPN transistors 2N2369, 500MHz (code P397)	0·50
Q35	3	Silicon PNP TO-5, 2 × 2N2904 & 1 × 2N2905	0·50
Q36	7	2N3646 TO-18 plastic 300 MHz NPN	0·50
Q37	3	2N3053 NPN Silicon transistors	0·50
Q38	7	NPN transistors 4 × 2N3703, 3 × 2N3702	0·50

ELECTRONIC SLIDE-RULE

The MK Slide Rule, designed to simplify Electronic calculations features the following scales:— Conversion of Frequency and Wavelength. Calculation of L, C and fo of Tuned Circuits. Reactance and Self-Inductance. Area of Circles. Volume of Cylinders. Resistance of Conductors. Weight of Conductors. Decibel Calculations. Angle Functions. Natural Logs and 'e' Functions. Multiplication and Division. Squaring, Cubing and Square Roots. Conversion of kW and Hp. A must for every electronic engineer and enthusiast. Size: 2 cm. × 4 cm. Complete with case and instructions. Price each: £3·35

NEW LOW PRICE TESTED S.C.R.'s

PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0·23	0·25	0·35	0·35	0·47	0·50	0·53	1·15
100	0·25	0·33	0·47	0·47	0·50	0·58	0·63	1·40
200	0·35	0·37	0·49	0·49	0·57	0·61	0·75	1·60
400	0·43	0·47	0·56	0·56	0·67	0·75	0·93	1·75
600	0·53	0·57	0·68	0·68	0·77	0·97	1·25	—
800	0·63	0·70	0·80	0·80	0·90	1·20	1·50	4·00

SIL. SECTS. TESTED

PIV	300mA	750mA	1A	1·5A	3A	10A	30A
50	0·04	0·05	0·05	0·07	0·14	0·21	0·60
100	0·04	0·06	0·05	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·86
800	0·10	0·17	0·11	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·14	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·38	0·57	0·75	—

POWER TRANS BONANZA!

GENERAL PURPOSE GERM. PNP
Coded GP100. BRAND NEW TO-3 CASE. POSSIBLE REPLACE:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. TI3027-3028, 2N250A 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30-170.

PRICE	1-24	25-99	100 up
	43p each	40p each	36p each

SILICON High Voltage 250V NPN
TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.
OUR PRICE EACH:

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50p	45p	40p

2N3055

115 WATT SIl POWER NPN 50p EACH.

SILICON 50 WATTS MATCHED NPN/PNP
BIP 19 NPN TO-3 Plastic. BIP 20 PNP. Brand new. VCBO 100/VCEO 50/IC 10A. HFE type 100/ft 3mHZ.
OUR PRICE PER PAIR:
1-24 prs. 60p   25-99 prs. 55p   100 prs. 50p

AD161/162 *PNP*

M/P COMP GERM TRANS. OUR LOWEST PRICE OF 55p *PER PAIR*

SILICON PHOTO TRANSISTOR
TO-18 Lens end NPN Sim. to BP × 25 and P21. BRAND NEW. Full data available. Fully guaranteed.

Qty.	1-24	25-99	100 up
Price each	45p	40p	35p

F.E.T.'S

2N3819	35p	2N5458	50p
2N3820	50p	2N5459	40p
2N3821	35p	BFW10	40p
2N3823	30p	MPF105	40p

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Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1·50 only.

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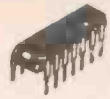

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SN7402	0·15	0·14	0·12	SN7453	0·15	0·14	0·12	SN74145	£1·50	£1·40	£1·30
SN7403	0·15	0·14	0·12	SN7454	0·15	0·14	0·12	SN74150	£3·00	£2·70	£2·50
SN7404	0·15	[illegible]	0·12	SN7460	0·15	0·14	0·12	SN74151	£1·00	0·95	0·90
SN7405	0·15	0·14	0·12	SN7470	0·29	0·26	0·24	SN74153	£1·20	£1·10	0·95
SN7406	0·35	0·31	0·28	SN7472	0·29	0·26	0·24	SN74154	£1·80	£1·70	£1·60
SN7407	0·35	0·31	0·28	SN7473	0·37	0·35	0·32	SN74155	£1·40	£1·30	£1·20
SN7408	0·18	0·17	0·16	SN7474	0·37	0·35	0·32	SN74156	£1·40	£1·30	£1·20
SN7409	0·18	0·17	0·16	SN7475	0·45	0·43	0·42	SN74157	£1·90	£1·80	£1·70
SN7410	0·15	0·14	0·12	SN7476	0·40	0·39	0·38	SN74160	£1·80	£1·70	£1·40
SN7411	0·25	0·24	0·23	SN7480	0·67	0·64	0·58	SN74161	£1·80	£1·70	£1·60
SN7412	0·35	0·31	0·28	SN7481	£1·20	£1·15	£1·10	SN74162	£4·00	£3·75	£3·50
SN7413	0·29	0·28	0·24	SN7482	0·87	0·86	0·85	SN74163	£4·00	£3·75	£3·50
SN7416	0·43	0·40	0·38	SN7483	£1·10	£1·05	0·95	SN74164	£2·20	£2·15	£2·10
SN7417	0·43	0·40	0·38	SN7484	£1·00	0·95	0·90	SN74165	£2·25	£2·20	£2·15
SN7420	0·15	0·14	0·12	SN7485	£3·60	£3·50	£3·40	SN74166	£3·50	£3·25	£3·00
SN7422	0·50	0·48	0·45	SN7486	0·32	0·31	0·30	SN74174	£2·30	£2·20	£2·10
SN7423	0·50	0·48	0·45	SN7489	£5·50	£5·25	£5·00	SN74175	£1·60	£1·50	£1·40
SN7425	0·50	0·48	0·45	SN7490	0·67	0·64	0·58	SN74176	£2·50	£2·40	£2·30
SN7427	0·45	0·42	0·40	SN7491	£1·00	0·95	0·90	SN74177	£2·50	£2·40	£2·30
SN7428	0·70	0·65	0·60	SN7492	0·67	0·64	0·58	SN74180	£2·00	£1·60	£1·40
SN7430	0·15	0·14	0·12	SN7493	0·67	0·64	0·58	SN74181	£5·50	£5·00	£4·75
SN7432	0·45	0·42	0·40	SN7494	0·77	0·74	0·68	SN74182	£2·00	£1·80	£1·60
SN7433	0·80	0·75	0·70	SN7495	0·77	0·74	0·68	SN74184	£3·50	£3·25	£3·00
SN7437	0·64	0·62	0·60	SN7496	0·87	0·84	0·78	SN74190	£1·95	£1·90	£1·85
SN7438	0·64	0·62	0·60	SN74100	£1·65	£1·60	£1·55	SN74191	£1·90	£1·85	£1·80
SN7440	0·15	0·14	0·12	SN74104	0·97	0·94	0·88	SN74192	£1·95	£1·90	£1·85
SN7441	0·67	0·64	0·58	SN74105	0·97	0·94	0·88	SN74193	£2·00	£1·80	£1·75
SN7442	0·67	0·64	0·58	SN74107	0·40	0·38	0·36	SN74194	£2·70	£2·60	£2·50
SN7443	£1·30	£1·25	£1·20	SN74110	0·55	0·53	0·50	SN74195	£2·00	£1·90	£1·80
SN7444	£1·30	£1·25	£1·20	SN74111	£1·25	£1·15	£1·10	SN74196	£1·80	£1·70	£1·60
SN7445	£1·80	£1·77	£1·75	SN74118	£1·00	0·95	0·90	SN74197	£1·80	£1·70	£1·60
SN7446	0·97	0·94	0·88	SN74119	£1·35	£1·25	£1·10	SN74198	£5·50	£5·00	£4·50
SN7447	£1·00	0·97	0·95	SN74121	0·40	0·37	0·34	SN74199	£5·50	£5·00	£4·50
SN7448	£1·00	0·97	0·95	SN74122	£1·40	£1·30	£1·10				

The AL50 HI-FI AUDIO AMPL
50W pk 25w (RMS)

0·1% DISTORTION! HI-FI AUDIO AMPLIFIER

- Frequency Response 15Hz to 100,000—1dB.
- Load—3, 4, 8 or 16 ohms. • Supply voltage 10-35 Volts.
- Distortion—better than 0·1% at 1kHz.
- Signal to noise ratio 80dB.
- Overall size 63 mm × 105 mm × 13 mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT—TESTED—GUARANTEED.

BRITISH MADE. only £3·58 each

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 Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63 mm × 105 mm × 20 mm. 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

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41/14 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£2·00

All indicators 0·9 + Decimal point. All side viewing. Full data for all types available on request.

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA1000 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.

SPECIFICATION:

Frequency response	20Hz—20kHz ±1dB	Bass control	±15dB at 20Hz
Harmonic distortion	better than 0·1%	Treble control	±15dB at 20kHz
Inputs: 1. Tape head	1·25mV into 50KΩ	Filters: Rumble (high pass)	100 Hz
2. Radio, Tuner	35mV into 50KΩ	Scratch (low pass)	8kHz
3. Magnetic P.U.	1·5mV into 50KΩ	Signal/noise ratio	better than +65dB
		Input overload	+26dB
		Supply	+35 volts at 20mA
		Dimensions	292 × 82 × 35 mm

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 COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £23.00 FREE p.&p

only £13·15

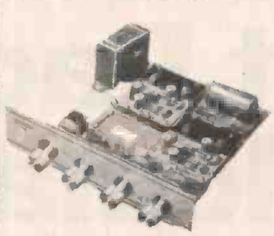
INTEGRATED CIRCUIT PAKS

Manufacturers "Fall Outs" which inclue 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=12×7400	0·50	UIC46=5×7446	0·50	UIC86=5×7486	0·50
UIC01=12×7401	0·50	UIC47=5×7447	0·50	UIC90=5×7490	0·50
UIC02=12×7402	0·50	UIC48=5×7448	0·50	UIC91=5×7491	0·50
UIC03=12×7403	0·50	UIC50=12×7450	0·50	UIC92=5×7492	0·50
UIC04=12×7404	0·50	UI351=12×7451	0·50	UIC93=5×7493	0·50
UIC05=12×7405	0·50	UIC53=12×7453	0·50	UIC94=5×7494	0·50
UIC06=8×7406	0·50	UIC54=12×7454	0·50	UIC95=5×7495	0·50
UIC07=8×7407	0·50	UIC60=12×7460	0·50	UIC96=5×7496	0·50
UIC10=12×7410	0·50	UIC70=8×7470	0·50	UIC100=5×74100	0·50
UIC13=8×7413	0·50	UIC72=8×7472	0·50	UIC121=5×74121	0·50
UIC20=12×7420	0·50	UIC73=8×7473	0·50	UIC141=5×74141	0·50
UIC30=12×7430	0·50	UIC74=8×7474	0·50	UIC151=5×74151	0·50
UIC40=12×7440	0·50	UIC75=8×7475	0·50	UIC154=5×74154	0·50
UIC41=5×7441	0·50	UIC76=8×7476	0·50	UIC193=5×74193	0·50
UIC42=5×7442	0·50	UIC80=5×7480	0·50	UIC199=5×74199	0·50
UIC43=5×7443	0·50	UIC81=5×7481	0·50		
UIC44=5×7444	0·50	UIC82=5×7482	0·50	UICX1—25 Assorted 74's	1·50
UIC45=5×7445	0·50	UIC83=5×7483	0·50		

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

The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak	Input 1 (Cer.) 300mV into 1M
Freq. res. 25Hz-25kHz	Input 2 (Aux.) 4mV into 30K
Harmonic distortion typically 0·25% at 1 watt	Bass control ±12dB at 60Hz
	Treble con. ±14dB at 14kHz

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BPS 16	16p	14p	12p

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Type No.	Price 1–24	25–99	100 up
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BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP 709—72709	36p	34p	30p
BP 709P—µA709C	36p	34p	30p
BP 710—72710	44p	42p	40p
BP 711—µA711	45p	43p	40p
BP 741—72741	75p	60p	50p
µA703C—µA703C	28p	26p	24p
TAA 263—	70p	60p	55p
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S.G.S. EA1000 £2·63			

ROCK BOTTOM PRICES LOGIC DTL 930 Series I.C's

Type No.	Price 1–24	25–99	100 up
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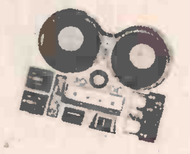
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application (DTL 930 Series only).

SYSTEM 12 STEREO



Each Kit contains two Amplifier Modules, 3 watts RMS, two loudspeakers, 15 ohms, the pre-amplifier, transformer, power supply module, front panel and other accessories, as well as an illustrated stage-by-stage instruction booklet designed for the beginner. Further details available on request.

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Hewlett Packard Calculator -Model 10

electronics TODAY INTERNATIONAL
product test

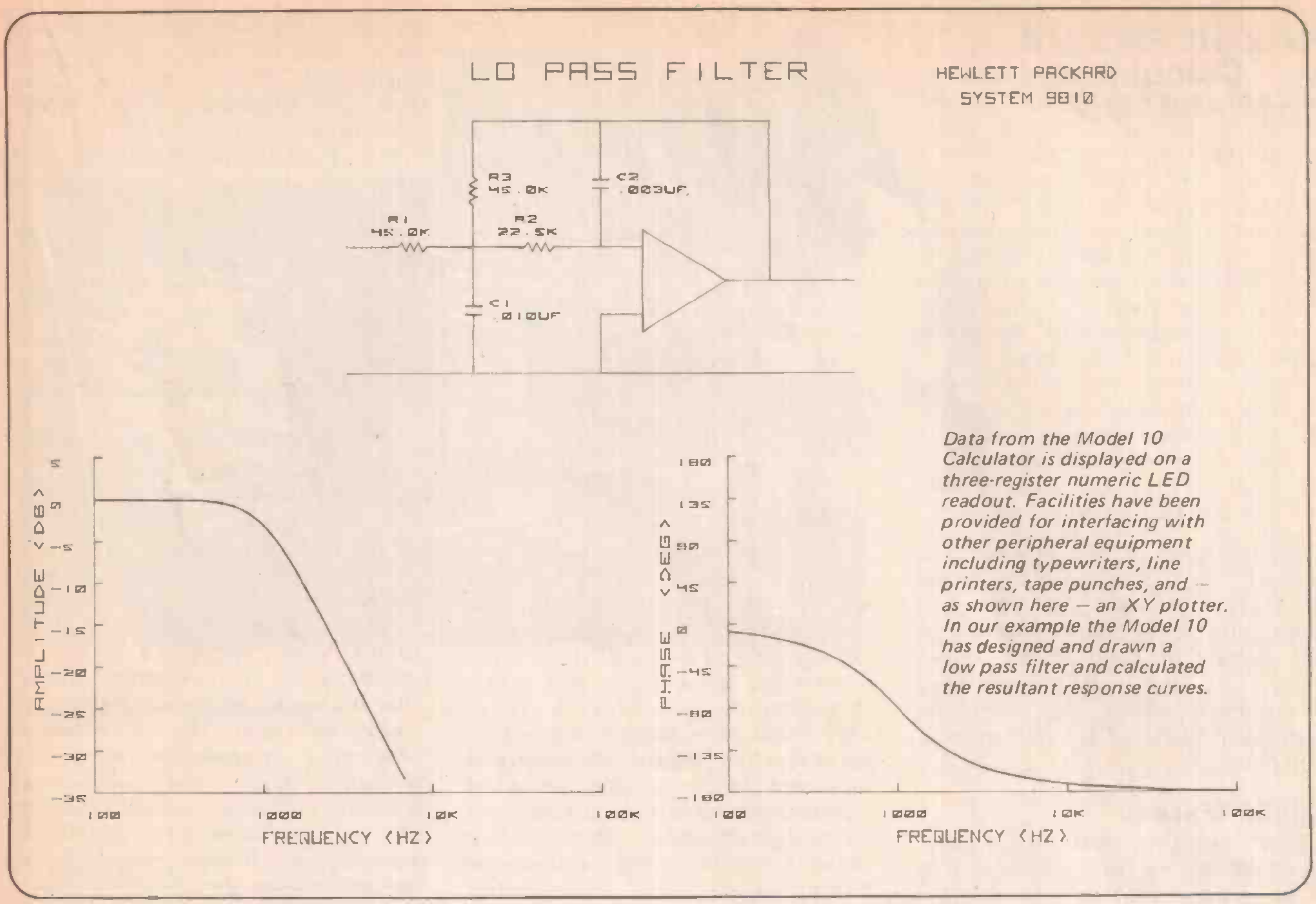
Tested for ETI by our Australian edition in one of the worst climates in the world for electronic equipment: Arnhem Land in the Northern Territory. Conducted by Louis A. Challis & Associates

HEWLETT PACKARD started as a very small company. It has since grown to be one of the largest manufacturers of professional electronic equipment in the world. The range of equipment manufactured by Hewlett Packard is vast. It covers everything from voltmeters to specialised processors for engineering, acoustics, biological studies, medicine – in almost every research field in which electronics is used.

The company's philosophy is to supply complete integrated systems (rather than a specialised range of individual instruments) which the user accumulates and fits together.

As systems became more complex and required a computer to control the many functions, Hewlett Packard entered this field also and developed a line of computers and calculators. Again, they concentrated on supplying an integrated system for each purpose. Here, we review one instrument from this line, the 9810 Programmable Calculator, Model 10.

Historically, the early valve computers were monsters which filled a large room. Yet by to-day's



Data from the Model 10 Calculator is displayed on a three-register numeric LED readout. Facilities have been provided for interfacing with other peripheral equipment including typewriters, line printers, tape punches, and — as shown here — an XY plotter. In our example the Model 10 has designed and drawn a low pass filter and calculated the resultant response curves.

standards, these were not particularly powerful. The advent of transistors markedly reduced the size of the machines in two ways. The transistors themselves were far smaller than the valves that they replaced but, even more important, was the increase in packing density brought about by a reduction in power dissipation, for apart from doing away with the heater necessary in thermionic valves, the transistor is a much more efficient switch, consuming and therefore dissipating, far less power when performing its switching function within the computer. But the use of transistors resulted in a machine which was compact but difficult to service, having thousands of resistors, capacitors and transistors crammed into a small space. The huge number of individual soldered joints also told against reliability.

INTEGRATED CIRCUITS

With the appearance of the integrated circuit, then medium scale integration (M.S.I.), and finally large scale integration (L.S.I.), literally thousands of components were formed on a single semiconductor chip. This led to a dramatic reduction in the size of equipment, a big improvement in reliability and a greater ease of servicing. It also led to better performance as the sheer physical delay in propagating electrical signals around a bulky rack of discrete components had become a significant part of the operation time. It is now feasible to measure operation times of individual components in nanoseconds (10^{-9} seconds). For comparison the velocity of light is approximately one foot per nanosecond, and signals travel in cables at around 70% of this rate.

The basic principles of MOS/LSI (metal-oxide semiconductor/large scale integration) are fairly well established and common to many components manufacturers. In 1969, MOS components represented only 3% of the total sales of digital electronics. In 1971 the total number of sales increased to 25%. The growth rate is due to the dramatic simplifications which these components can make to the manufacture of a computer or other digital equipment. A typical single chip integrated circuit may contain the equivalent of about 5000 transistors. These may be combined to form a 5120 bit random access memory or a 4480 bit read-only memory. And chips such as these cost but a fraction of the many transistors otherwise required.

The dramatic reduction in size, complexity, and price of integrated circuitry has produced a bewildering array of equipment, from huge "number crunching" computers, to pocket sized electronic calculating machines and many instruments which fall between these extremes, including the programmable calculator.

This is a device which, in earlier years, would have been regarded as a computer. As well as the normal arithmetic operations of addition, subtraction, multiplication and division, it has the ability to perform logic operations, that is, to make decisions. In addition, it is able to store a set of instructions on program which it will execute on command whenever the operator provides a new piece of data input.

The size of the instrument has made it possible to take the computer to the job, rather than the other way around — an important consideration to engineers and surveyors. This type of instrument is ideal for their requirements to manipulate relatively

Hewlett Packard Calculator -Model 10

small quantities of data in a complex manner. For this reason many of the Hewlett Packard Model 10 programmable calculators finish up on the tailgate of Land Rovers, rather than in the air conditioned environment which has been the traditional home of the conventional computer.

TOUGH TESTING

When testing any instrument or piece of equipment we have always felt that it is just as necessary to use the equipment the way it is intended to be used, as it is to test it for its compliance with specifications. With this in mind, we decided to put the Model 10 submitted for review through some arduous testing. We tried it out in one of the toughest working environments available anywhere in the world. This was on the Gove Peninsula in Arnhem land in Australia's Northern Territory. The ambient operating temperature averages between 85°F and 90°F during the day and 65°F to 80°F at night the whole year round, while the humidity is consistently in the region above 80%. The air contains abundant quantities of fine dust which has the ability to penetrate almost anything.

We thought that these were severe enough operating conditions, but found that, in addition, there were two other hazards to contend with. The first was transportation by the local airline, which resulted in the virtual destruction of the very well designed cardboard box in which the calculator was packed. This was achieved by the airline staff dropping it on one corner. The second problem was that the local power supply had a 20% fluctuation in voltage and suffered from large transients – which resulted in blown fuses on many of the other pieces of electronic equipment which we used. We felt that such a combination of arduous conditions could not be found in many places in which a calculator may be used. It is a credit to its careful design and rugged construction that the Model 10 did not seem to be aware of these minor distractions and did not miss a beat throughout the job.

We took the computer with us to simplify the manual computations associated with a long series of measurements involved in a dynamic balancing operating. Each set of measurements required the computation of 27 vectors (magnitudes and angles). Such a job would be typical of the uses to which a programmable calculator would be put. While the computations could have been performed on a normal calculator, the probability of performing the entire set of computations correctly would be very small (particularly after a long working day in such heat).

If the computer is programmed under more normal conditions, and the program checked on a couple of trail, computations which have known solutions, then it may be assumed that correct solutions will be given to the actual problems to be solved. This may not always be so, but when it is not it is usually due to a mathematical problem resulting from insufficient or incorrect data. The time required to perform these computations on a programmable calculator is in the order of 30 seconds; whereas, by hand on the same calculator, without the programming, it may take as long as one hour. In our case it took six hours to write and fully "debug" the program from the time we first opened the programming manual, so that the break even point comes after about six computations. On the project for which we used the computer the same type of computation was performed some 50 times. Thus, without the aid of the calculator, the same computations would have taken over 50 hours, and the accuracy of the results could not have been guaranteed. The saving in computation time was tremendous. The message was obvious.

The Hewlett Packard Model 10 calculator uses some very advanced hardware and novel design concepts to provide an extremely flexible performance. We could not determine from the Hewlett Packard handbook which integrated circuits were used. Although many of the I.C.s are commercially available from Motorola and several other well known manufacturers, the original part numbers have been replaced by Hewlett Packard part numbers.

The manufacturer's service handbook does not provide a great deal of information. Apparently this is deliberate and is done for a number of reasons. The first, and most obvious, is to stop the copying of the design by others. The second, is that the reliability of the electronics is such that the average machine will probably never need repair. The third reason is that repair of these circuits is very difficult, since one inadvertent discharge of static electricity (from clothing, or some other source) is sufficient to destroy many of the components on the integrated circuit boards. Because of this, Hewlett Packard do not intend that these boards should be repaired outside their workshops.

DESIGN CONCEPT

In concept the Hewlett Packard Model 10 calculator is divided into four logical sections controlled by the keyboard. These sections are, the Central Processing Unit, the Read Write Memory, the Main Read Only Memory (ROM) and the Input Output R.O.M.

The keyboard is divided into four blocks. The one on the right is the programming block, instructing the machine on what operations to perform. It includes IF statements, flagging, subrouting and input output instructions. The next block is the numerical block used for input of data and performing some calculation operations. The third is the data control block which guides the data into the correct storage registers. The fourth block contains keys whose function changes according to the requirements of the user.

The layout of the keyboard has been given careful consideration and contributes to the ease of programming and operation of the Model 10.

As in a general purpose computer, the Central Processing Unit is the controller and processor, performing

Model 10 brief Specification

	9810A
Language	Reverse Polish
Keyboard	Key per function
ROM size (bytes)	5K to 11K
RWM size (bytes) Available to user	908 to 2924
I/O structure	General
User definable Keys or functions	Optional— single key subroutine
Recording device	Card with Cassette optional
Display	3 register numeric LED
Primary Printer	Optional 16 column alpha-numeric

in order the operations in the program stored in memory.

The Read Write Memory is the main store of the computer. It contains all data and program steps entered by the user. With desk top computers it is usually the Read Write Memory which limits the effectiveness of the computer. The Hewlett Packard Model 10 offers a choice of three different sizes of Read Write Memory, allowing 500, 1012 or 2036 program steps and 51 or 111 data registers.

The Read Only Memories provide the directions for performing more complex mathematical operations in the form of microprogramming which is written into the ROM during construction. This enables the user to carry out operations such as logarithm, exponential etc. with a single key stroke as easily as an add or a multiply. The ROM is organized into two parts. The major part is integral with the machine and provides microprogrammed instructions for all the built-in keys, both for programming and some mathematical operations.

A unique Hewlett Packard feature is the Plug-in ROM and keyboard template. Using this approach a single set of keys can be re-defined to perform different operations simply by changing the ROM. To help the operator keep track of the different meanings for the keys, a template labelling all the key operations goes with each ROM.

There are currently available three plug-in Read Only Memories. These are:- the Mathematics ROM, Statistics ROM and the User Definable ROM.

The Mathematics ROM contains functions such as Polar to Rectangular conversion, sin x, cos x, tan x, x^y in x, e^x, set degrees, set radians, $\log_o$ x, 10^x degrees/minutes/seconds to decimal degrees, factorial x and roundoff. There is also a user definable function available which allows the user a function subroutine available with a single key stroke.

The Statistics ROM offers most functions which are commonly required for statistical computations. It also has a key which allows the removal of erroneous data.

The third ROM available is the User Definable ROM. This has nine User Definable functions of a type similar to that available on the Mathematics ROM. It also has several other interesting functions. One is a Protect function which enables the user-defined subroutes to be protected against over-writing with other programs. Two other very useful functions available are "insert" and "delete" functions. These functions enable programs to be corrected without completely reprogramming the machine. This is achieved by inserting "Continue" statements where new statements are to go, in the case of "Insert" statements or by simply removing a statement and reducing all the statement numbers by one in the case of the "Delete" statement.

The input output Read Only Memories are used for decoding the output of the computer to allow it to correspond with the outside world. A different decoder is needed for each of the peripherals used with the machine.

The range of peripherals available for use with the Model 10 is quite large. Two of these that can be mounted with the calculator are the standard magnetic card reader and line printer with a 15 character per line capability. If the standard printer is required for alpha-numberic output rather than straight numerical output, it is necessary to use the Alpha Printer ROM. This redefines the keyboard in letters and symbols for neat and storable outputs.

Other inputs available are:- paper tape, optical cards and magnetic tape. Outputs include graphical plotter, type-writer, paper tape and magnetic tape.

When considering such a powerful machine, it is reasonable to compare it with the range of mini-computers. The advantage of the programmable calculator is that it is easier to use, as programming consists of a set of calculator type steps, rather than a special programming language. There is no complicated start-up procedure to load an executive whose need will be to program and to look after the details of running the machine. It can accept data input from a variety of sources and output the results in a convenient way, either, for further processing on magnetic or paper tape, or for final use as lists of figures, or as plotted curves or charts.

With such facilities available why buy a mini-computer? Briefly, the answer is – that one obtains even more power. The calculator, using serial rather than parallel arithmetic, is considerably slower. In addition, although the range of peripherals is wide it reaches a limit eventually. But there is a considerable range of applications where a choice between a programmable calculator and a mini-computer must be made. The Model 10 programmable calculator proves to be quite competitive with the mini-computer range provided the data rate is not too high and only a few output peripherals are required. ●

input gate

'WHAT'S A WATT'

I was very interested — and pleased — to read Mr Brownlee's comment in the May 1973 issue about 'What's a Watt'. I must, however, take task with the answer to this. It is not true that 'almost without exception' the misnomer 'RMS Watts' is being used by testing consultants and manufacturers the world over. Quite a few manufacturers are now aware of the error of expression and few audio consultants or reviewers use the expression without qualification. For some time now I have been battling for the technically correct term of 'average power' or — better — 'average sinewave power' and have in fact written a fair amount about the subject. I am sure that if a manufacturer using the term were to realise (or his copywriter) that it technically, 'underpowers' his amplifier the practice would disappear over night!

When we buy an electric light bulb or fire the subscript 'RMS' obviously never accompanies the wattage rating! It arrived in the audio world to distinguish the sharp practice of expressing amplifier power in terms of instantaneous peak, which multiplies the average power by a factor or two, from the correct power rating. Thus by expressing his amplifier as 40W peak, a manufacturer (or copywriter!) might convey to the uninitiated that his amplifier is twice as powerful as a competitor's which is correctly rated as 20W average power. The term 'RMS Power' was introduced to make it clear that the power rating was derived from the product of the RMS voltage and current, or from the square of the RMS voltage across a resistive load divided by the resistive value of the load.

The RMS value of a sinewave [f(t)] can be defined as

$$\sqrt{\frac{\omega}{2} \int_0^{2\pi/\omega} [f(t)]^2 \, dt}$$

and if [f(t)]is equal to watts instantaneous we get

$$W_{inst} = \frac{E^2}{2R} (1 - \cos 2\omega f)$$

We can thus compute RMS power in reality thus:

$$W_{RMS} = \frac{E^2}{2R} \sqrt{1.5}$$

which is equal to 1.225 W_{avg}

Clearly then, a copywriter — or reviewer come to that — who rates a manufacturer's amplifier at, say '20W, RMS' is doing the manufacturer out of almost 4W, assuming that the measurement was made in terms of average sinewave power — as it nearly always is.

Although RMS power can be calculated, no amplifier that I know of has its power expressed in this curious way deliberately by measurement or calculation. Indeed, there is no power meter that I know of which is, in fact, scaled in terms of RMS watts!

—Gordon J King, T.Eng (CEI), Audio Consultant/Author, Brixham

DIY SPEAKER SYSTEM

You must be getting a little bored on being congratulated on an excellent magazine but you earn all your praise; please accept mine.

At the moment I am interested in your 100 watt amplifier and pre-amp, and have made the first move of buying the components for the first unit.

Can I now make a suggestion? As you have designed the amp and pre-amp, how about a speaker system and enclosures also designed by you with an attempt at keeping the price at a reasonable level, as is the amplifier kit.

—R.L.H. Suffolk.

No, *R.L.H, we do not get bored with letters congratulating us and yes, certainly you can make a suggestion and yours is a good one. The ETI boffins will be getting together soon to chew this one over.*

ELECTRONIC DECISION MAKER —MARCH '73

'Be right at least half the time — electronically' appears immediately below the heading of the article. Anyone who builds it in accordance with the component layout, Fig. 3, will need to revert to spinning a coin!

The component positions shown in Fig. 3 are correct if they are mounted on the plain side of the Veroboard shown in Fig. 2 after it has been turned over about the left hand edge. Fig. 3 is also misleading because not only is it difficult to read the numbers of the components which have been overprinted on a board with the breaks in the copper strips in the wrong places, but they also appear to be mounted on the copper strip side. —F.E., Oxford.

Sorry about this one, guv. The tint was laid onto the drawing the wrong way around. However, if you take account of this you will get it working OK and you can get rid of that double-headed coin you have been using.

TREASURE HUNTERS

I have taken your magazine since the first issue, and I am very pleased with the issues to date.

May I ask if you would run an article for the many people interested in a lesser known branch of electronics, ie the 'Treasure Hunters' (for want of a more apt name). Many of us are keen to construct our own detectors, mainly because the £70 plus models are beyond the average pocket. However very few circuits are available, except in the simple form and these are relatively cheap anyway.

—J.A.G. Bracklesham Bay, Sussex

Look out for our July issue which will describe a really neat version and includes a feature only found on the dearer models. Don't however be fooled by price or by manufacturers' claims. One of the dearest models now available is excellent for finding certain types of metal deep down but is of little use for smaller coins; in fact some of the cheapest locators can be better in this field. Treasure Hunting is one of the fastest growing hobbies in this country and there are a large number of retail outlets where you can try out the various types before you decide which method you want to use (BFO, Induction Balance or Pulse Induction).

The Editor does not necessarily agree with the views expressed on this page.
Letters intended for publication should be addressed to:
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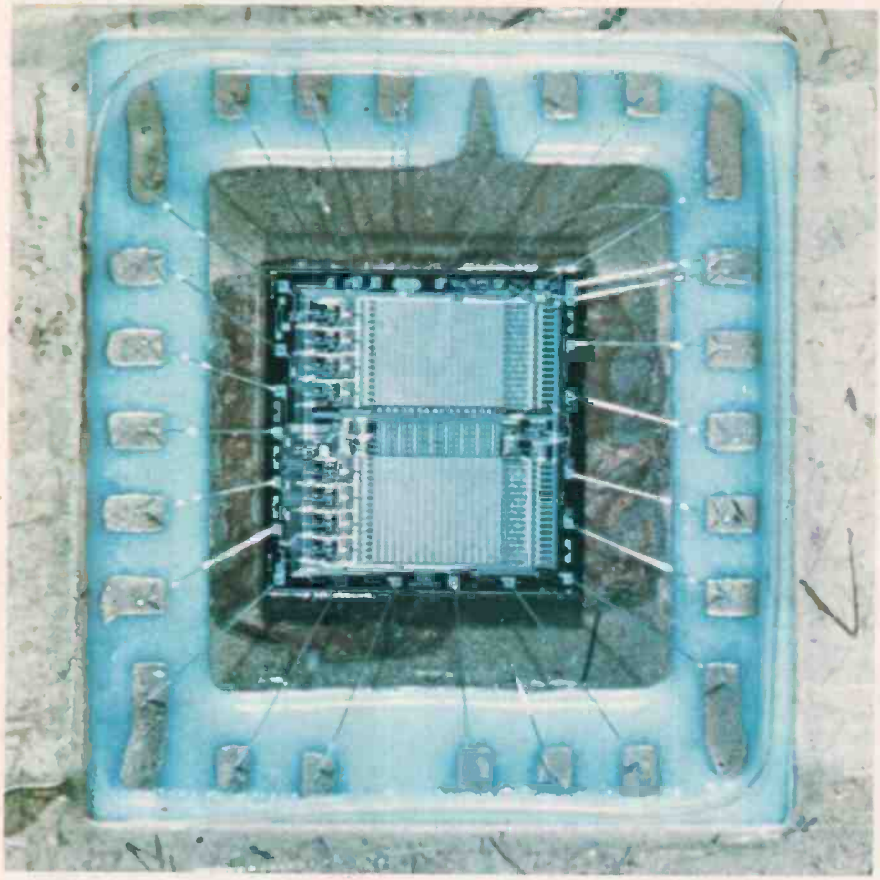
DIGITAL LOGIC-



This erasable read-only memory from National Semiconductor is a fine example of large-scale MOS integrated circuitry.

PITY the poor beginner in electronics these days – new components and new techniques are radically altering equipment design. In fact the total body of electronic theory is doubling almost every 15 years, and the exponential rate at which new applications are being found for electronics, in domestic as well as commercial fields, is making it difficult for even electronic whizz-kids to keep up-to-date.

Nowhere is this more evident than in the field of integrated circuitry. No sooner has one become used to a particular IC technology – than another one appears. We are sure that a lot of our readers are feeling a little dazed by it all, and in an effort to reduce their bewilderment, we have produced this summary of developments in the field of digital logic.

In the 1950's, the American aerospace industry was getting into gear for the space race and urgently required miniaturized, low-weight circuitry for rocket-borne instrumentation and control equipment. In

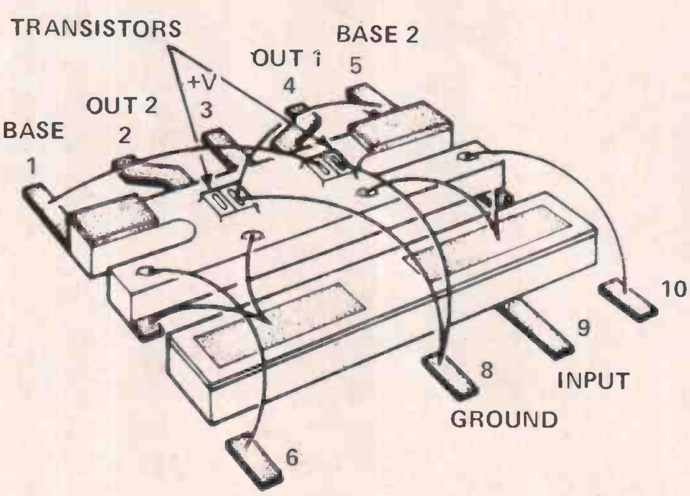


Fig. 1. The first integrated circuit developed by Texas instruments in 1959 used the "mesa" process. The device is a flip-flop and was the forerunner of the Resistor-Transistor Logic family.

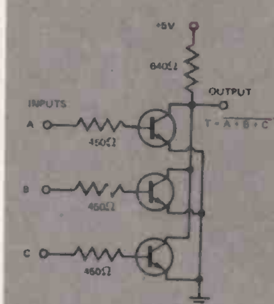


Fig. 2. A typical RTL circuit, in this case a "NOR" gate, in which the output is a "1" only if all inputs are at logical "0". Any input receiving a "1" will result in an output of logical "0".

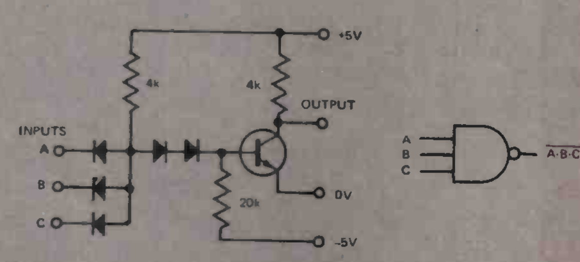


Fig. 3. The DTL "NAND" gate shown offers improved speed and fanout over RTL. The gate has a noise immunity of about one volt and a propogation delay of 50-1000 nanoseconds. The logic symbols for a "NAND" gate is shown at right.

a summary

The development and characteristics of digital logic families — Brian Chapman reports.

1957, in response to this need, Jack S. Kilby of Texas Instruments invented the first integrated circuit, for which he received the National Medal of Science in 1969.

WHAT IS AN INTEGRATED CIRCUIT?

This question is perhaps best answered by the definition: "An integrated circuit is the physical realization of a number of electrical elements inseparably associated on, or within, a continuous body of semiconductor material to perform the functions of a circuit." That is, the IC contains on the one chip of semiconductor, all the resistors, capacitors, diodes and transistors necessary to implement a particular circuit function.

THE FIRST IC's

The first integrated circuit used the 'mesa' process (see Fig. 1). The transistors were formed on small raised areas called 'mesas' produced by etching away unwanted material. The other components were mounted on small pieces of silicon and connections were made by gold bonding-wires to complete the circuit. Operation of this circuit was not entirely satisfactory, and it was not until the invention of the planar process, by Fairchild, that the IC success story began.

The planar process is a technique of manufacturing semiconductors or integrated circuits in which a mask is used to restrict the diffusion of dopant (i.e. the impurities that make transistor action possible) to those areas required for the transistor or diode structure. The etching stage, to isolate devices as in the 'mesa' process, is thus not required.

RESISTOR-TRANSISTOR LOGIC-RTL

The first logic family to be evolved using the planar process was Resistor-Transistor Logic, commonly known at RTL. RTL contains resistors and transistors, only, and requires a supply of from 3.0 to 3.6 volts. A typical RTL NOR gate, shown in Fig. 2, consists simply of a number of transistor switches in parallel. This logic family is economical to use, provides easy system design and interface with discrete components, and has a high speed/power product. Some of its main disadvantages are: the resistors consume a lot of chip space, thus preventing the integration of complex functions; noise immunity to transients and RF pickup etc. is low, and the gate fanout is low. i.e. only three to five gate loads can be connected to each gate output before performance is affected.

Circuit operation depends on resistor values, and current hogging can occur if the resistors are not all equal.

In spite of all the above disadvantages, RTL circuits found rapid acceptance in 1960/61, and because of their low price, are still used in some applications today.

DTL LOGIC

The next major logic family which was developed is known as Diode-Transistor Logic, DTL. The devices of this logic family contain diodes as well as resistors and transistors. Initial devices were integrated forms of discrete component design — such as shown in Fig. 3. Later devices replaced the input diodes by transistors. This reduced the input current requirement and hence allowed much higher fanouts. Similarly, a double emitter follower in the output stage of DTL logic devices increases the output current capability, and, because of the lower output impedance, lowers the noise pickup on output lines.

Typical DTL logic has reasonable power dissipation, speeds of about 4MHz for a flip flop, and a propagation delay of around 25 nanoseconds per gate. The disadvantages of DTL are low noise immunity, especially in the high state where the input impedance is high, rapid change of voltage thresholds with temperature, speed slowdown with capacitive loading and lower speed than many other logic families.

Nevertheless DTL, which requires a supply of 5.0 volts, has all the advantages of RTL plus ease of interface with TTL (see following) and a relatively high fanout, of around 10.

HTL LOGIC

A variation of DTL logic which is still widely used is HTL, High Threshold Logic. This logic family is designed for high noise immunity and uses Zener diodes in the input lines. A supply of 15 volts is used and power dissipation is consequently much higher. Principle application of these devices is in industrial equipment or environments where high noise levels are encountered. It has the added advantages of stable operation over large temperature changes and is easily interfaced with other discrete componentry such as relays and amplifiers etc. The disadvantages are inevitably higher cost and higher power dissipation than conventional DTL.

TRANSISTOR-TRANSISTOR LOGIC — TTL

TTL is basically another form of DTL but is notable for having achieved more popularity than any other logic form to date. It has higher speed and greater driving capability than DTL, and indeed has the highest speed of any saturated logic. (Saturated logic transistors never operate in linear mode, they are either saturated, or cut off.) The flip-flop toggle rate of 20MHz and a propagation delay of 10 to 15 nanoseconds satisfies many computer applications and hence, as a result of large volume sales, TTL is available from practically every manufacturer at very low cost. Again, because of acceptance by the computer industry, there is a wide range of complex functions available, making system design a relatively easy task.

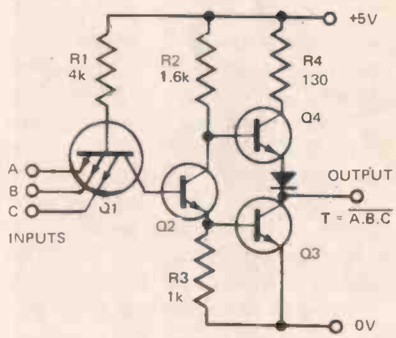


Fig. 4. A TTL positive NAND gate using a multi-emitter transistor in the input stage has same noise immunity and speed as DTL but propagation delay of only 13 nanoseconds permitting speeds up to 20MHz.

The TTL gate is an excellent example of how economical circuit improvements which would not otherwise be practical with discrete components become possible with integrated circuit technology.

A typical TTL gate is shown in Fig.

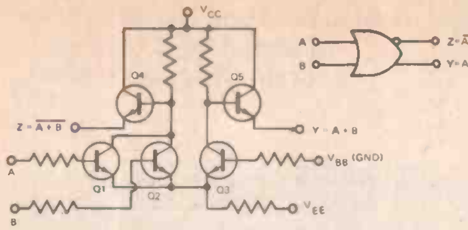


Fig. 5. The basic ECL gate configuration. High speed performance results from the non-saturation operation of high f_T transistor current switches.

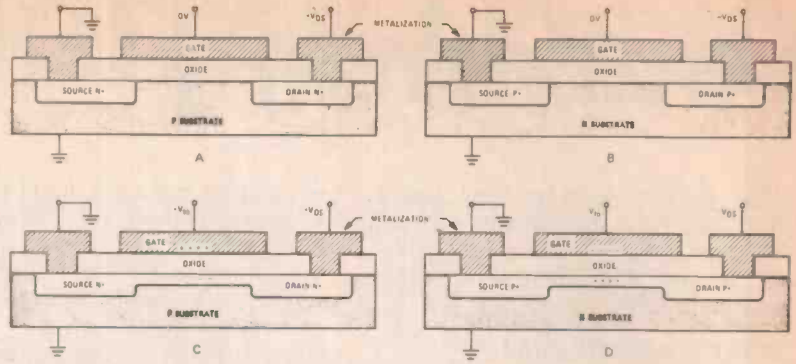


Fig. 6. (A) N-channel MOSFET in the "OFF" condition. (B) P-channel MOSFET in the "OFF" condition. (C) N-channel MOSFET in the "ON" condition. (D) P-channel MOSFET in the "ON" condition.

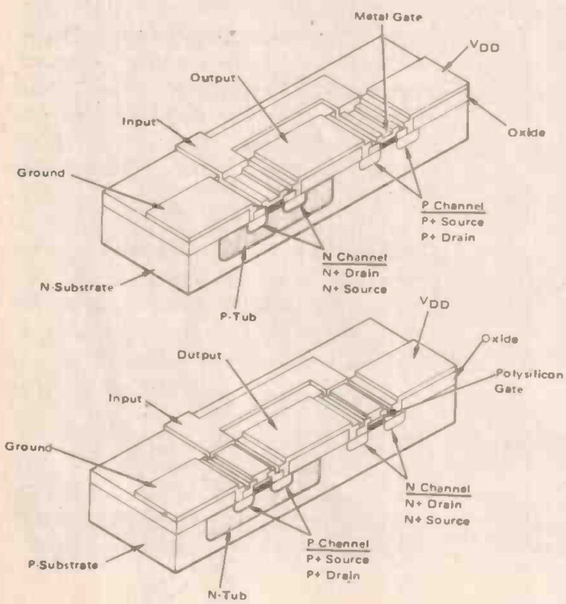


Fig. 7. Two basic processes of CMOS fabrication
(A) The aluminium metal gate process begins with a "P" tub diffusion and an N type substrate. In this tub the N^+ sources and drains are deposited to form the N-channel device of a complementary pair. P^+ sources and drains are located directly in the substrate to form the P-channel device.
(b) The silicon gate process differs considerably from the metal gate process. First, an N-type pot, or tub, is used in a P-type substrate. This is exactly opposite to the metal gate arrangement. Secondly, a layer of polysilicon gate oxide replaces metal as the gate electrode. The polysilicon gate layer not only provides for the self alignment of source and drain during production, but, also lowers the switching threshold of the MOS transistors themselves.

4. This differs from the DTL gate primarily in that the input transistors are replaced by one multi-emitter transistor. This is a simple device to produce in integrated form as the emitter area is small with respect to the base area, and in fact up to eight emitters can be connected to the base of a single transistor. This arrangement gives slightly superior performance to that of DTL in that the transistors provide a small gain. But of far greater importance is that input capacitance is reduced because the transistors are fabricated into a far smaller area. Leads are much shorter and have less inductance, and therefore higher speed is possible.

The action of the circuit is as follows: Referring to Fig. 4, grounding any one or more of the emitters of Q1 will turn Q1 on and Q2 off. This in turn, turns Q4 on and Q3 off resulting in a logic"1" output. However, if no input is grounded the reverse will apply, and the output will be at logical zero. As TTL uses a +5 volt supply, the level for logic "1" will be Vcc less Vce (sat) of Q4 plus the forward voltage drop across the diode and the drop across R4. Thus the logic "1" level is of the order of 3.3 volts. In the logic "O" state, the output voltage is Vce (sat) of Q3 and is of the order of 0.6 volts.

The diode in the circuit plays an important role. Firstly assume that Q3 is turned on. The base of Q3 will be Vbe above ground and the collector of Q2 will be Vsat of Q2 plus Vbe of Q3 above ground. Hence there will be a Vbe potential applied between Q4 base and output and Q4 could possibly remain on. The diode is inserted to ensure that Q4 cannot be on at the same time as Q3.

The fan out of TTL is about 10 and the noise immunity is typically one volt. Various manufacturing techniques may be employed to increase speed, such as gold bonding or the incorporation of Schottky diodes on the chip. However TTL is still not fast enough for today's third generation computers.

Considerable care in layout and mechanical design is required because of TTL's relatively high speed coupled with its sensitivity to noise. Additionally, TTL tends to generate switching transients that can cause system problems unless adequately suppressed. Although larger functions may be integrated into one package with TTL than with any previous technology, the degree of integration is not high enough for the reliability and space requirements of the new generation of equipment. The main limitation is the power-dissipation limits of the package and large scale integration must look to other technologies in the future.

EMITTER-COUPLED LOGIC – ECL

ECL is a high speed logic which is sometimes known as current-mode logic, CML. The main difference between this and the other forms of logic discussed previously is that it operates in a linear mode, i.e. it is non-saturating.

The input stage of ECL, see Fig. 5, is a differential amplifier and the logic therefore has higher input impedance than other forms. Additionally emitter follower type output stages, Q4 and Q5, allow driving 50 ohm transmission lines direct. It's chief advantage is, of course, high speed — 100 MHz or more but it has high power dissipation, is sensitive to noise, suffers speed degradation with capacitive loads and, because of its −5.2 volt (typically Vcc = 1.32V, Vee = −3.2V) supply requirement, is awkward to interface with other logic. Typical logic levels are 400 mV for logical "1" and −400 mV for logical "0".

MOS TECHNOLOGY

All the logic systems previously discussed are based on conventional transistor techniques and are hence known by the collective term "Bipolar" logic. The term bipolar arises because the operation of a conventional transistor depends on the movement of both majority and minority carriers.

There is another major logic technology based on the field-effect transistor (FET) and, in particular, the insulated-gate FET (IGFET), the basic structure of which is shown in Fig. 6.

We are concerned here only with IGFETs. These may be constructed as "N" channel or "P" channel devices and may operate in the 'enhancement' or 'depletion' modes. We will consider firstly the operation of an "N" — channel device. The drain and source regions are N^+ areas in a P-type substrate. Normally there is a high degree of isolation between drain and source — approximately 5000 megohms at 10 volts. When the gate is made positive relative to the substrate, electrons are attracted to the boundary between the silicon and the oxide layer in the region under the gate metallization. If the gate is made sufficiently positive, enough electrons are attracted to the area to reverse the surface conductivity from P to N. This provides a low resistance type-N path from drain to source and the device is turned "on" see Fig. 6c. The gate potential that turns the device on is called Vto.

For P-channel devices, the action is the same but all the polarities are reversed. In other words, when the gate is driven negative relative to the substrate by Vto, there is a low resistance P-channel path from the P-type source to the P-type drain.

In the operation just described, the application of a gate voltage increased channel conduction. Devices such as this where the inversion layer is created or enhanced by the application of a gate voltage of the same polarity as the drain are said to be Enhancement Mode devices.

Similarly, where the conductivity of the inversion layer is depleted (reduced) by the application of a gate voltage of polarity different to the drain, the devices are said to be operating in Depletion Mode.

Type	Symbol (Note 1)	Bias of Drain (Note 2)	Bias of Gate Cut-off Condition	Bias of Gate Conducting Condition
N–Channel Depletion		Positive	Negative	Positive
N–Channel Enhancement		Positive	Zero	Positive
P–Channel Depletion		Negative	Positive	Negative
P–Channel Enhancement		Negative	Zero	Negative.

Table 1. Characteristics of the four basic Field-Effect Transistor structures D = drain, G = gate, S = source. Biases shown are those required for normal operation and are measured with respect to the source.

Most conventional MOS devices are constructed as "P" channel enhancement mode devices and such logic is usually known as PMOS.

A comparison of the various FET types used in logic is given in Table 1.

The electrical characteristics of the MOSFET are:—

(1) Under normal operating conditions with Vg equal to zero, an external drain-source voltage produces a reverse-biased junction between the drain and the substrate. The source-drain resistance is, therefore, very high and any leakage current in the absence of a gate turn-on voltage is only of the order of nanoamperes.

(2) Since there is no dc current path between the gate and any other element of the MOSFET, the dc input resistance of the device is high. Typical dc input currents are of the order of a few picoamperes so the loading effect of the device is negligible. The impedance to ac is governed by the input capacitance, normally a few picofarads, and this places a practical limit on the number of devices that can be driven from a single driver whilst maintaining reasonable speed.

(3) From the structure of a MOSFET it may be seen that all current flow is restricted to the gate area encompassed by the source and drain. Therefore in an integrated circuit incorporating a number of MOSFET devices, no isolation between devices is required. Hence the chip area required for MOS circuits is very small in comparison with equivalent bipolar circuits.

(4) The MOSFET structure requires no critical diffusions or spacing. Hence the MOSFET is an easy device to manufacture in integrated form, much more so than bipolar devices. The yield is therefore high and fabrication costs are low.

The above characteristics make the MOSFET an ideal device for LSI circuits where circuit speed in the low nanosecond range is not required.

CMOS JOINS THE FIELD

A new MOS technology is now challenging TTL for market leadership. Called Complementary Metal-Oxide-Semiconductor logic (CMOS), this latest option is designed to have extremely low power dissipation, making it especially useful

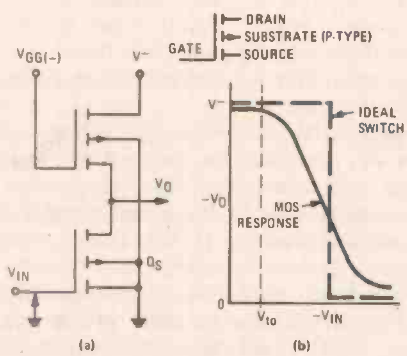


Fig. 8. Typical PMOS inverter circuit using a fixed-bias MOSFET as a load (a) typical transfer characteristics curve of the inverter circuit compared to the response of a perfect switch (b).

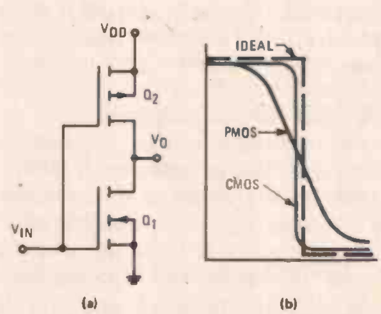
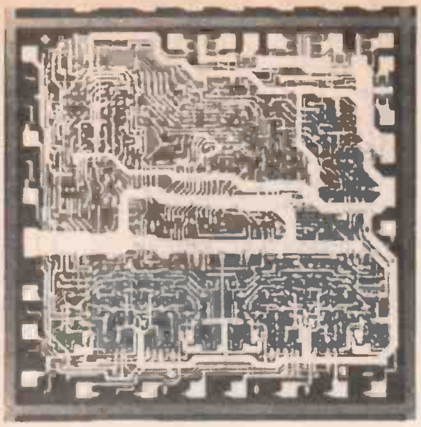


Fig. 9. Typical inverter circuit with P and N-channel MOSFETS connected in complementary symmetry. (a) Characteristic curves. (b) CMOS curve closely approaches ideal switch.



An example of emitter-coupled logic (ECL) large-scale integration (LSI) from Motorola. The device is the MC 10181, a 4 bit Arithmetic Logic Unit/function generator housed in a 24 pin DIL package.

for remote applications where power is scarce. But its other attributes, including high noise immunity, high fan-out, full power-supply logic swings, and the ability to accept a wide range of power supplies will ensure its success in the market place.

One parameter in which CMOS does not distinguish itself is speed. For the time being, therefore, the faster logic families, such as ECL and TTL, are safe from encroachment, at least in applications where high speed is a prime consideration. Moreover, the still limited number of available functions inhibits widespread implementation. Over the long haul, however, CMOS has all the features required to make it a strong competitor.

Some of the features of CMOS are attributable directly to the basic MOS transistor structure while others are the result of, or are enhanced by, the use of MOSFETs in complementary symmetry. For example, the MOS transistor structure inherently has a very high input impedance, thereby eliminating dc fan-out restrictions and providing low power dissipation. The use of CMOS provides an even greater reduction in power dissipation as well as greater speed, greater noise immunity, and full power supply logic swings.

MOS AND CMOS Compared

How complementary operation improves MOS switching performance can be readily appreciated by noting the characteristics of various types of MOS inverters. For example, a simple inverter utilizing an enhancement mode, P-type MOSFET and a load resistance consisting of another MOSFET is shown in Fig. 8. The use of a MOSFET in place of a conventional load resistor is particularly beneficial since a resistor requires far more chip area. Thus, for a given circuit complexity, MOS provides considerable cost savings by increasing the number of cricuits on a wafer.

For an input voltage, V_{in} between ground and V_{to} transistor Q_s is "off", so the output voltage, V_o approaches the V– state, as indicated by the transfer characteristics curve. As the input voltage is made more negative, transistor Q_s begins to conduct as V_{in} reaches V_{to} (threshold voltage), and for further increases of V_{in}, the output voltage is reduced. Note, however, that for a fixed MOSFET load resistance V_o can never reach zero because the resistance of Q_s never reduces to zero, regardless of the value of V_{in}. In fact, its saturation resistance is substantially higher than that of bipolar transistors. Therefore, the total output voltage swing is always less than the supply voltage V–.

When both P-type and N-type field-effect transistors are available, their connection in a complementary configuration, Figure 9, results in far more satisfactory performance. In this type of connection, the signal is applied simultaneously and in phase to both transistors. A little reflection will reveal that when the signal value is zero, the N-channel MOSFET, Q1, is off, while the P-channel device, Q2, is on. Under this condition, the output voltage is very nearly the full supply voltage. When the gate voltage goes high (positive), transistor Q1 is turned on while Q2 is turned off. This causes V_o to go virtually to zero because the current flowing through Q1 is the leakage current of Q2, which is very, very low. (The resistance of a MOSFET in cutoff is approximately 5000 megohms, resulting in a leakage current of less than one nanoampere.)

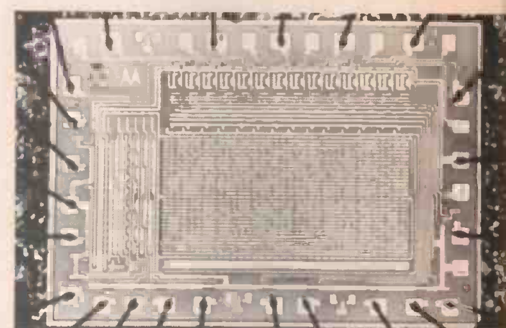
In Fig. 9b the transfer characteristic curve for the complementary circuit is shown in comparison with that of a single-ended circuit. Observe that in addition to a much wider voltage swing, the slope of the complementary circuit curve is much steeper in the transition region. This is caused by the input signal acting on both transistors in opposition – turning one device on and the other off.

Since the power-supply voltage is usually greater than the sum of the P and N device threshold voltages, both devices will be on for a portion of the transition region. If the devices are well matched, however, the "circuit" threshold will be approximately one-half the power supply voltage for any supply used, as shown in Fig.10. The resultant, near ideal, transfer characteristic provides noise immunity approaching one-half the power-supply value.

		POWER DISSIPATION mW/GATE	PROPAGATION DELAY nsec	DC NOISE IMMUNITY mV	DC LOADING FACTOR	LOGIC SWING V
mWRTL		6.5* 0.5†	27	100	4	1
RTL		19.5	12	100	5	1
DTL		11	30	1000	8	2.8
TTL	54/74	10	13	1000	10	3.3
	500/400	15	10	1000	15	3.3
	2100/2000	22	6	1000	11	3.3
	3100/3000	22	6	1000	10	3.3
HTL		44/13	110	6.5	10	12.5
MECL	1	37	7	250	25	0.8
	2	40	4	250	25	0.85
	3	60	1		HiZ LoZ 70 7	0.9
CMOS		0.0001 DC	50	45% OF V_{DD}	very,very high >500	up to 20 V depending on supply V

* Input High † Input Low

Table II. Specifications of main logic families.



The MCM 1131 from Motorola is a preprogrammed character generator used for displays. It stores 64 characters each of 35 bits (5 x 7 dot matrix) in the ASC11 code used by teletype machines. This chip is constructed with metal gate, High Threshold P-channel MOS (PMOS).

CMOS PROCESSING

Complementary circuits have traditionally offered higher performance than single-ended designs, providing that the positive and negative polarity transistors can be well matched. But, whereas high-performance NPN transistors are readily obtained with standard bipolar technology, it has proven quite difficult to produce monolithic PNP devices with equal degrees of logic freedom and performance. Fortunately, the fabrication process for complementary MOS transistors is far less formidable than for complementary bipolar devices, so that CMOS is a practical reality today.

The complementary MOS processing sequence, together with the resulting structure, is shown in Fig. 7. The starting substrate material is lightly doped N-type silicon that serves as the substrate for the P-channel devices. The first process step is to diffuse a lightly doped P-type area or tub that will serve as the substrate for the N-channel devices. This is followed by the N^+ and P^+ source-drain diffusions and lastly by the gate oxidation process. The N^+ and P^+ source-drain diffusions also produce the channel stops shown in the diagram. These serve to eliminate parasitic leakage paths that might be created by a positive or negative voltage on metalization passing over lightly doped P- or N-type substrate areas.

All of the processing is easily controlled and there are none of the critical diffusion steps (such as base-width adjustments) that are normally encountered in bipolar processing. As a result, processing is readily adaptable to automated techniques.

The complementary operating principles discussed for the inverter are easily adapted to more complex logic circuits, and CMOS has proved to be ideal for the fabrication of LSI devices.

Functionally, the basic capability of these devices is compared with similar specifications of some well known bipolar logic lines in Table 2. In many respects, the performance of CMOS circuits are unmatched. They have:

(1) Standby power in the nanowatt region
(2) High noise immunity, typically close to $\frac{V_{DD}}{2}$
(3) Full power supply logic swings, from 0 to V_{DD}
(4) The ability to operate from a single supply over a wide range of values, (4.5 to 20 volts).

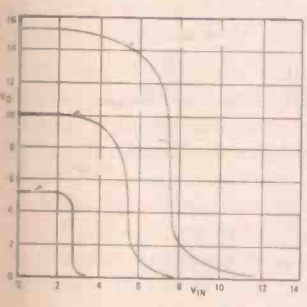


Fig. 10. Transfer curves of Motorola MC2597 dual NAND gate shows nearly symmetrical operation of CMOS for various power supply voltages.

In terms of speed, CMOS devices, when lightly loaded, are comparable with RTL, DTL, and the slower families of TTL. Thus, they are substantially faster than standard PMOS circuits. But, although capable of large dc fan-out to other CMOS circuits, there is a practical ac limitation in that complementary circuit speed is more influenced by current and capacitive loading than are bipolar circuits.

There is little doubt that sales of CMOS will surpass that of TTL by 1975 and supplant it as the logic system in most common use. ●

BIBLIOGRAPHY *"Another logic option for system designers" by Frank Barone, Bernie Schmidt -- Motorola.*

Layout of CMOS process masks is considerably enhanced by this coordinate digitizer machine. It is a convenient, efficient method for converting the designer's signal routing plan into data that a computer can understand and follow.

CMOS Logic of the seventies

All indications point to CMOS as the successor of TTL. This report by Jim Wiggins.

COMPLEMENTARY Metal Oxide Semiconductor Logic (CMOS) Technology will emerge as the major logic within the next few years.

Already it has undergone its trial period, with sales of off-the-shelf products rising at an exponential rate. The initial metal-over-silicon process has been supplemented with a laboratory proven silicon-gate technique that will soon add an impressive new low power dimension to available off-the-shelf products.

Already several manufacturers have announced standard product lines of over 40 functions, with others claiming custom capability.

These indications of product maturity, coupled with extensive market research programmes that project a potential world market upward of £80 million within the next five years, have prompted manufacturers to invest heavily in the CMOS up and coming technology. With strong commitments to research and development and production capacity, manufacturers expect to aid the industry in the early implementation of CMOS products, as well as provide assurance of a steady and reliable source of supply.

Advantages and Features of CMOS

1. The lowest power dissipation of any logic form developed so far, thus lowering cost and permitting battery operation of equipment.
2. Excellent noise immunity that

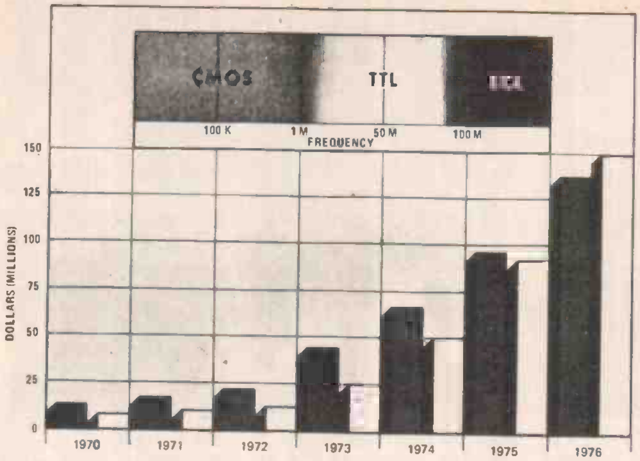
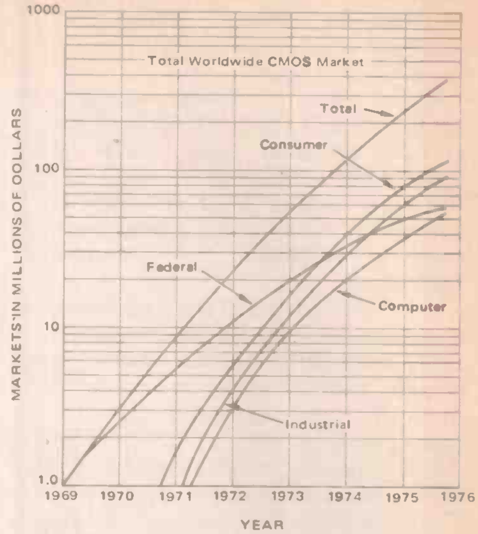


Fig. 1. — The wide dominance of TTL in the digital logic field is being seriously threatened. As seen in the frequency graph at the top of the figure, both CMOS and ECL are pushing into areas previously covered by TTL. In the bar graph portion of the figure the erosion of TTL's market dominance is depicted. Here, within the half decade, both CMOS and ECL market dollars are projected to bypass TTL.

LEGEND

TTL ECL CMOS

Fig. 2. The expected distribution of CMOS devices throughout the world.



increases with increased supply voltage immunity of up to 45% of supply voltage is possible.

3. Operation over very wide supply voltage range (1.2 volts to 18 volts). The technique requires only a single positive supply rather than the dual supplies required with some previous MOS.
4. Has packed density greater than bipolar technology, resulting in lower cost MSI and LSI functions.
5. Has lower output impedance than PMOS thus simplifying interfacing with saturated bipolar logic.
6. Generates very low noise and exhibits slow rise and fall times which simplifies system layout design rules.
7. Operates over wide temperature extremes with minimum performance degradation.
8. Very high input impedance results in the highest fanout of any logic form.
9. Logic swing is between power supply and ground.
10. Propogation delay is faster than PMOS and speeds will soon approach those of TTL.

The Economies of CMOS

Complementary MOS logic is a medium-speed logic expected to compete strongly with TTL and DTL families at frequencies up to 25MHz. Although it has a significant number of application advantages over bipolar logic forms, the competitive issue in the area of applications overlap is likely to centre on systems cost. In this category, CMOS is a strong competitor for the following reasons:

1. CMOS power dissipation is normally two to three orders of magnitude lower than the power required to drive bipolar logic. Accordingly, it permits the use of larger chips with greater packing densities, without exceeding the thermal limitations of the package — and without the need for expensive cooling methods. This affinity for large-scale integration is one of its principal cost-saving advantages.
2. CMOS processing is inherently simpler and less critical than TTL and DTL, thus promising higher yields for circuits of equal complexity.

Hence, within the next few years, medium-speed CMOS, in conjunction with high speed ECL, is expected seriously to challenge the overwhelming dominance that has been enjoyed by TTL Logic. (see Fig 1).

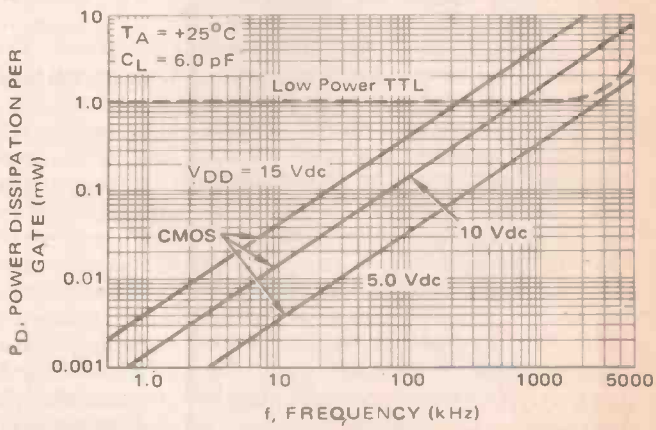
But the appeal of CMOS logic is far greater than the mere replacement of bipolar or other forms of MOS circuits. Primarily, it is in the development of new markets for which other forms of logic are not suitable. This is evident from the expected distribution of CMOS sales, which differs substantially from that of bipolar logic among the various markets. The projected distribution shown in Figure 2 indicates Motorola's estimates of the CMOS future on the world scene.

One of the interesting considerations emerging from this graph is the very strong projected penetration of the huge consumer market, where logic circuits have no usage at present. This is primarily due to the large expected use of CMOS in watches and clocks, and in various automotive safety and control devices that are now under active consideration. The consumer market, appliance controls and even the toy market are new areas of applications to be invaded by logic circuits.

In addition to the power saving feature, CMOS offers other advantages that result in low-cost system implementation. These advantages include:

... Single power supply operation
... Operating voltage ranging from 1 volt, for some silicon-gate circuits, up to 18 volts for standard products.
... High noise immunity, (30% of power supply)
... Extremely high CMOS to CMOS fanout (50).

Fig. 3. Comparison of gate-power dissipation for Low Power TTL and CMOS shows superiority of CMOS.



NOTE: Unused inputs connected to V_{SS}

Comparing CMOS with Bipolar Logic

There are several parameters that require discussion when comparing CMOS and TTL. First is the power supply voltage range. CMOS functions are operational over a wide range of power supply voltages. CMOS supply voltages can range from three to 18V, while TTL is generally limited to about 4.75 to 5.25V.

The second significant characteristic is power dissipation. Because of the extremely high off-resistance of MOS transistors, the dc current drain of a complementary MOS inverter approaches zero — as compared to 0.2 milli-ampere for a low power TTL inverter. If CMOS and TTL are compared at the system level, CMOS will out perform low power TTL by a substantial margin, because only parts of the system operate at high speeds at any given time. A CMOS system typically dissipates two to three orders of magnitude less power than low power TTL. (See Figure 3). CMOS transfer characteristics represent a very close approximation to an ideal switch. If multiple devices are stacked in series as shown in Figure 4, the transfer characteristics are shifted slightly, depending upon the number of inputs that are active. In the threshold region, all active devices are turned on slightly, giving a resistive divider effect that reduces device source-to-drain voltage and shifts the effective threshold slightly. This effect is illustrated in Figure 4.

Also note the dotted line that indicates supply current versus gate input voltage, at higher supply voltages the MOS devices are operating at lower impedance levels when switching though threshold, therefore the instantaneous power dissipated is a function of input voltage. This effect contributes to the ac power dissipation of CMOS but is normally small compared to the ac power dissipation caused by the charging and discharging of load capacitors. (Fig. 4 gives a comparison CMOS-TTL gate characteristics.)

CMOS presently has two limitations in comparison to TTL. One is speed of operation. The theoretical maximum frequency of operation of MOSFETS is in excess of 1GHZ,the limiting factor is the parasitic capacitance of junctions and substrate. By eliminating this capacitance, CMOS circuits will be able to operate at speeds near 100MHz and techniques for doing this are presently being developed by the semiconductor industry. Possibilities for solving this problem include silicon on sapphire/spinel, and ion implantation. The second disadvantage is that CMOS output impedance is not as low as that of TTL. This is not a problem on the chip, due to the very high impedance of CMOS, but can be a problem in driving off the chip devices. The lower impedance of silicon gate CMOS and CMOS/bipolar technology will be able effectively to eliminate this problem.

Is 1973 the right year for CMOS?

Complementary metal oxide semiconductor (CMOS) circuits have been available in quantity since 1969. A number of companies have entered the CMOS field since 1971 resulting in an influx of both new devices and second sources to the marketplace, especially during the last year.

"Is 1973 the right year to go CMOS?" Perhaps rephrased, the question could be put, "Is it now economically feasible to design systems with CMOS integrated circuits?"

Before any system design can be economically implemented with IC's, the proper mix of device types, to construct the system, must be available to the designer. The large variety of TTL functions (over 125 different types), coupled with availability from multiple vendors, created the proper environment for economical system designs using bipolar technology. Is CMOS at that crossroad today so that it too will emerge as an economical digital logic family?

To answer this multi-pronged question, we must first consider how many functions are needed to implement a complete system, and what the cost trade-offs are compared with other approaches. Although each "system" is separate and unique in its device requirements, Motorola has found that a typical digital IC system contains about 16 different device types. Obviously, more than 16 device types are needed to cover a wide range of systems, but how many more? Twenty-five? Thirty? Actual analysis of sales figures shows that over 85% of all TTL sales are concentrated in less than forty device types.

One might conclude then, that since the designer has available today a similar group of over forty CMOS functions, a "proper mix" of CMOS logic devices is available today. In other words, there should be no major design restraints today because of lack of proper CMOS logic functions.

As suggested earlier, the answer to the CMOS design question involves both the availability of the proper devices and the proper economic trade-offs. What are these economic considerations? To answer this question one merely has to examine the virtues of CMOS. What does it

The 1972 McMOS Family

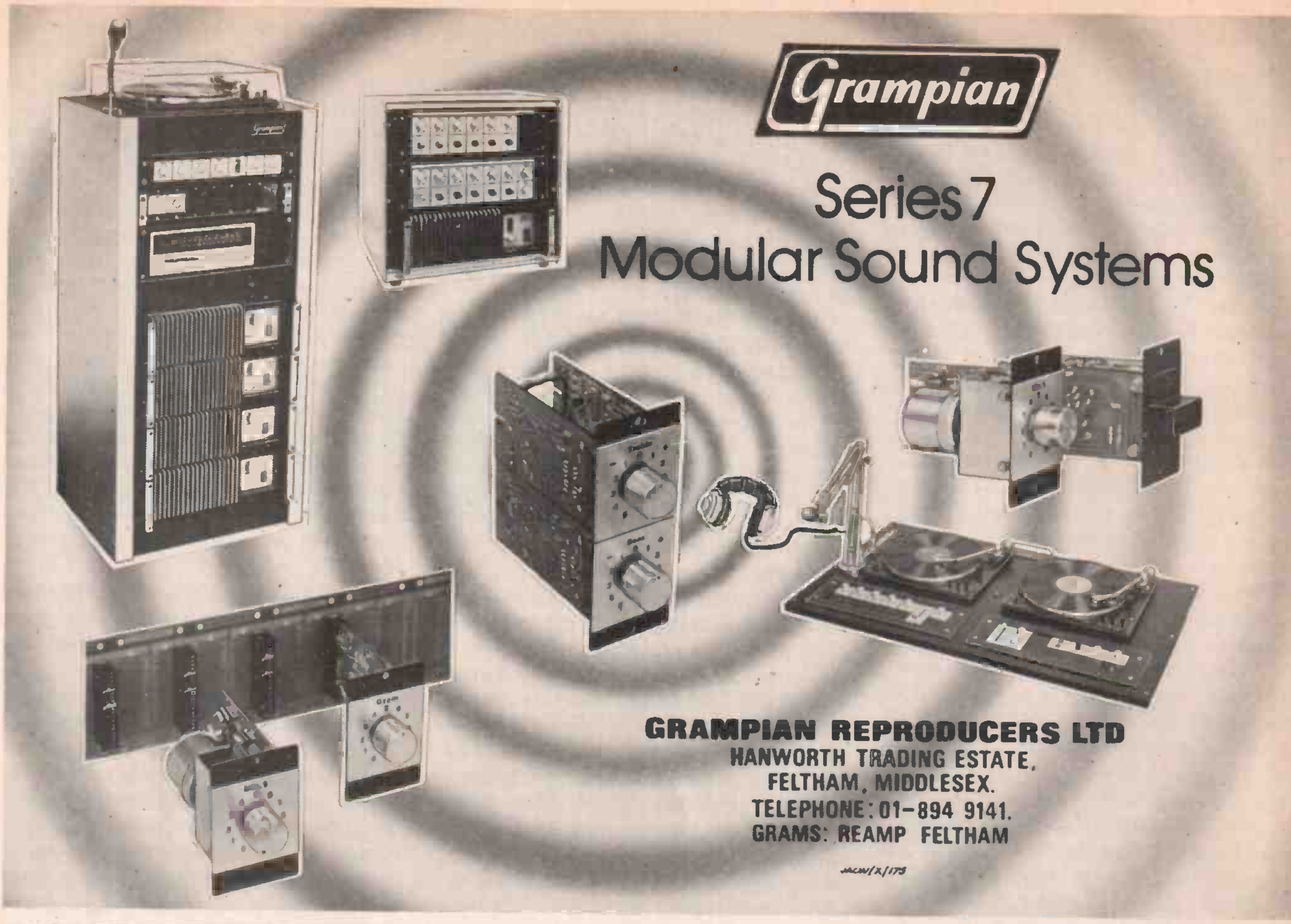
MC14000, 14500 Series

FUNCTION	MC # AL/CL
GATES	
Dual 3-Input NOR plus Inverter	14000
Quad 2-Input NOR	14001
Dual 4-Input NOR	14002
Dual Pair and Inverter	14007
Quad 2 Input NAND	14011
Dual 4 Input NAND	14012
Triple 3-Input NAND	14023
Triple 3-Input NOR	14025
Triple Gate	14501
Expandable AOI	14506
Quad Exclusive OR	14507
Dual 5-Input Majority Logic Gate	14530
BUFFERS	
Hex Inverter Buffer	14009
Hex Buffer	14010
Strobed Hex Inverter	14502
FLIP-FLOPS	
Dual Type D Flip Flop	14013
Dual JK Flip Flop	14027
SHIFT REGISTERS	
18 Bit Shift Register	14006
Dual 4 Bit Static Shift Register	14015
8-Bit Static Shift Register	14021
8-Bit Static Bus Register	14034
Dual 64 Bit Static Shift Register	14517

FUNCTION	MC # AL/CL
DECODERS, LATCHES	
BCD/Decimal Binary/Octal Decoder	14028
Dual 4-Bit Latch	14508
BCD-to-7 Segment Latch/Decoder/Driver	14511
4-Bit Latch, 4-16 Line Decoder-Output Active High	14514
4-Bit Latch, 4-16 Line Decoder-Output Active Low	14515
COUNTERS	
Decade Counter/Divider	14017
12 Bit Binary, Counter	14040
BCD Up/Down Counter	14510
Binary Up/Down Counter	14516
Dual BCD Up Counter	14518
Dual Binary Up Counter	14520
Programmable BCD Divide-by-N 4-Bit Counter	14522
Programmable Binary Divide-by-N 4-Bit	14526

FUNCTION	MC # AL/CL
ARITHMETIC FUNCTIONS	
4-Bit Full Adder	14008
Triple Full Adder (Positive)	14032
Triple Full Adder (Negative)	14038
ALU (74181 Type)	14581
Look Ahead Carry Block	14582
DATA ROUTING FUNCTIONS	
8 Channel Data Selector	14512
4-Bit AND OR Select	14519
MEMORY	
64 Bit Random Access Read-Write Memory	14505
SPECIAL FUNCTIONS	
Quad Analog Switch/Quad Multiplexer	14016
BCD Rate Multiplier	14527
Dual Monostable Multivibrator	14528
Dual 4-Channel Analog Data Selector	14529
12-Bit Parity Tree	14531

Table 1. Motorola's line up of standard device functions available at the end of 1972. Many more are promised for release in the current year.



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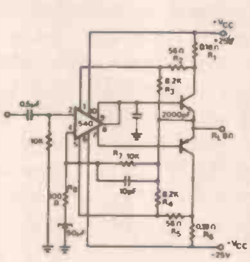
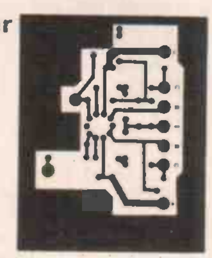
Device of the Month NE540L





35 Watt Amplifier
The Signetics 540 is a monolithic, class AB power audio amplifier designed specifically to drive a pair of complementary output transistors.
This device features: internal current limiting; low standby current; high output current capability; wide power bandwidth; low distortion – features which make this device ideal for use as an audio power amplifier.

Signetics power driver NE540L Yours for just £1·20 + VAT

including application notes.

Compatible device MC1339P

From Motorola, a monolithic dual stereo preamplifier for low noise preamplification of stereo audio signals. Just look at some of these features:

* Low audio noise
* High channel separation
* Single power supply
* High input impedance
* Built-in power supply filter
* Emitter follower output

Motorola monolithic duel stereo preamplifier only £1·20 + VAT

including applications notes.

To boost the violins, slide the fourth knob from the left upwards.

To boost the bass trombones, slide the first knob upwards.

To get Gigli or Sinatra to sing out, slide the third knob upwards. It gives the human voice more 'presence'.

We could go on, but by now you'll take the point.

With the new Eagle AA6 amplifier, you have complete control over the sound you hear.

Much more than you ever had with normal Bass and Treble controls.

Why?

Because the five slide controllers allow you to boost or cut five separate sectors across the whole frequency range, around 40, 200, 1,200, 6,000 and 15,000 Hz.

As opposed to ordinary Bass and Treble controls which simply give you 'blanket' cut or boost, generally around 100 and 10,000 Hz.

The difference is amazing.

With the AA6, you can literally pick and choose what you hear.

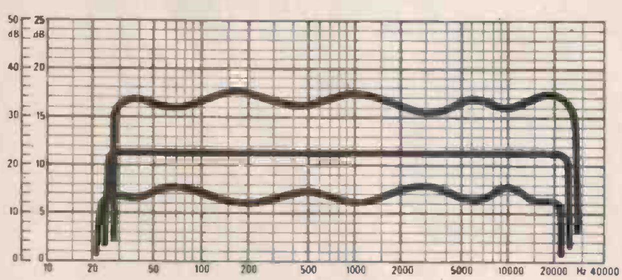
You can create entirely new balance by 'mixing.'

Or you can compensate for poor room acoustics.

Or poor recordings.

Or quirks in your other hi-fi components.

And when you're not listening so critically, you can revert to simple Bass and Treble controls merely by pushing a button.



Graph shows degree of control throughout frequency range with Sound Effect Controllers in maximum and minimum positions.

Now there's something you must do. Visit your Eagle dealer and ask for a demonstration.

More than any other amplifier, you need to have the Eagle AA6 demonstrated.

To hear it. And to experiment with the controllers.

Alternatively, you could send for our free instruction booklet. (For this or any other Eagle amplifier or tuner.)

That way, you'll be able to see exactly what you're getting.

Not what the salesman chooses to tell you you're getting.

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Eagle International Precision Centre Heather Park Drive
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- ☐ AA4 20 + 20 watts amplifier – £53.00
- ☐ AA2 10 + 10 watts amplifier – £38.00
- ☐ TSA 151 15 + 15 watts amp. – £43.00
- ☐ TSA 149 7 + 7 watts amp. – £31.00
- ☐ AA8 Stereo Tuner – £50.00
- ☐ TST 152 Stereo Tuner – £36.30

(All prices are exclusive of VAT)

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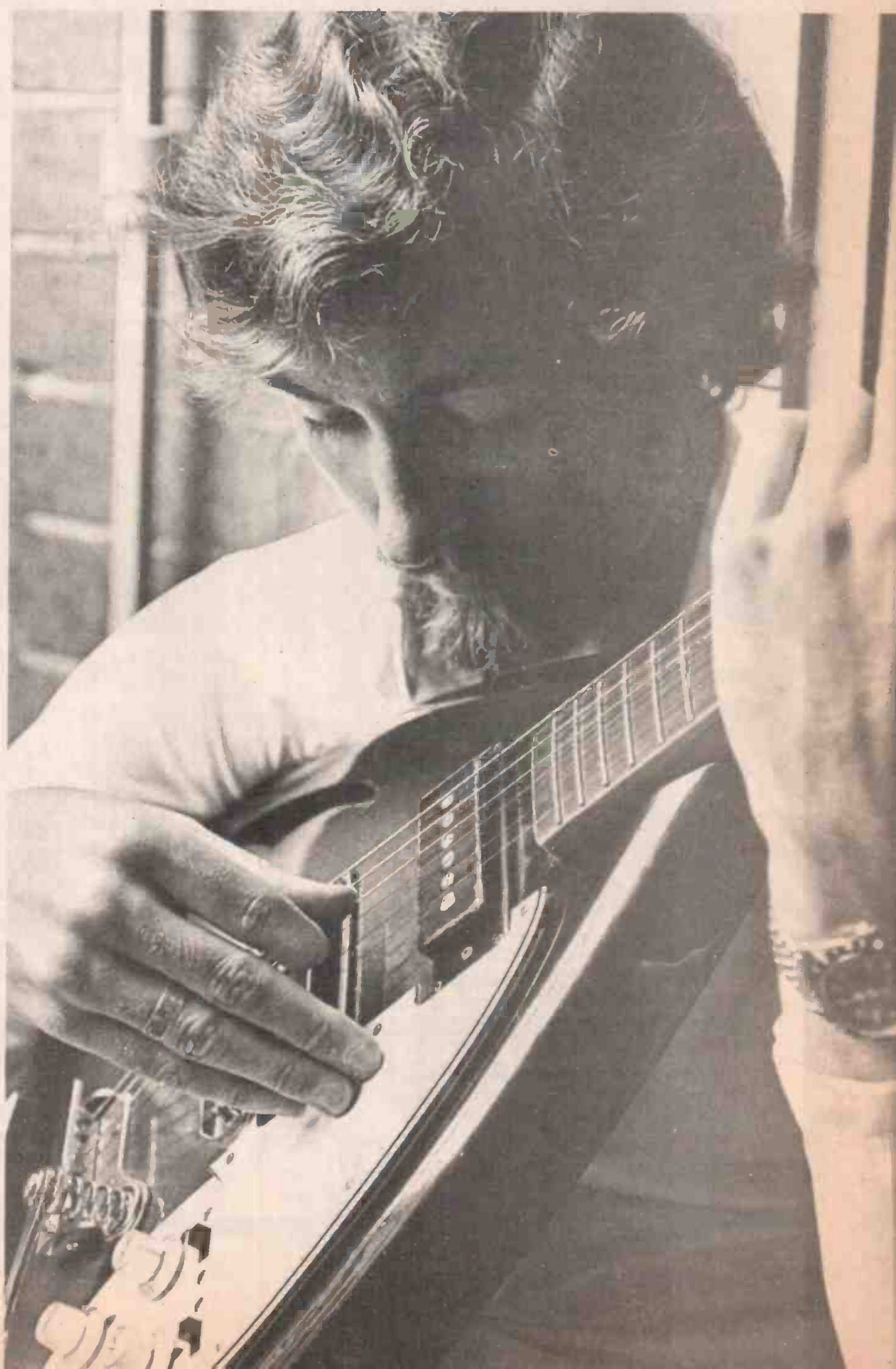
ET3

NEW SOUND FOR YOUR GUITAR

The normal guitar sound begins with a sharp 'attack'. This device removes the attack effect, producing a completely new and way-out sound, unlike that of any other instrument.



Every musical instrument owes its unique sound to a certain combination of inherent characteristics. For instance, the number of harmonics produced, combined with their magnitudes and phase relationships, play an important role in creating the instrument's distinctive sound.

Another important characteristic is attack time – the speed with which sound is built up after a tone is initiated. Reed instruments such as the clarinet produce sounds which can be described as 'soft' because they have a relatively slow attack, caused by the time it takes for the reed to build up to its maximum vibration. On the other hand, instruments such as the guitar have a very rapid attack because maximum amplitude vibration is started as soon as the string is plucked or struck.

By changing an instrument's attack, we can make it sound different and, at the same time, not like any other instrument. That is what the 'Attack Delay Unit' (ADU) does for the guitar. By slowing down the guitar's attack, a brand new sound can be obtained. The effect can also be produced by recording a guitar passage on tape and then running the tape backwards through the player. Instead of sharp, clean tones, a hard-to-describe 'whoop' is heard for each note played. Although the note is on pitch, it doesn't sound like it belongs to any known musical instrument.

Using the ADU, attack can be delayed for a very short period so that only the sound of the pick hitting the string is eliminated, or it can be delayed so that the music builds up over the length of a run. A foot control switch makes it easy to delay particular notes selectively.

CONSTRUCTION. The circuit of the ADU, shown in Fig. 1, is fabricated on a printed circuit board whose foil

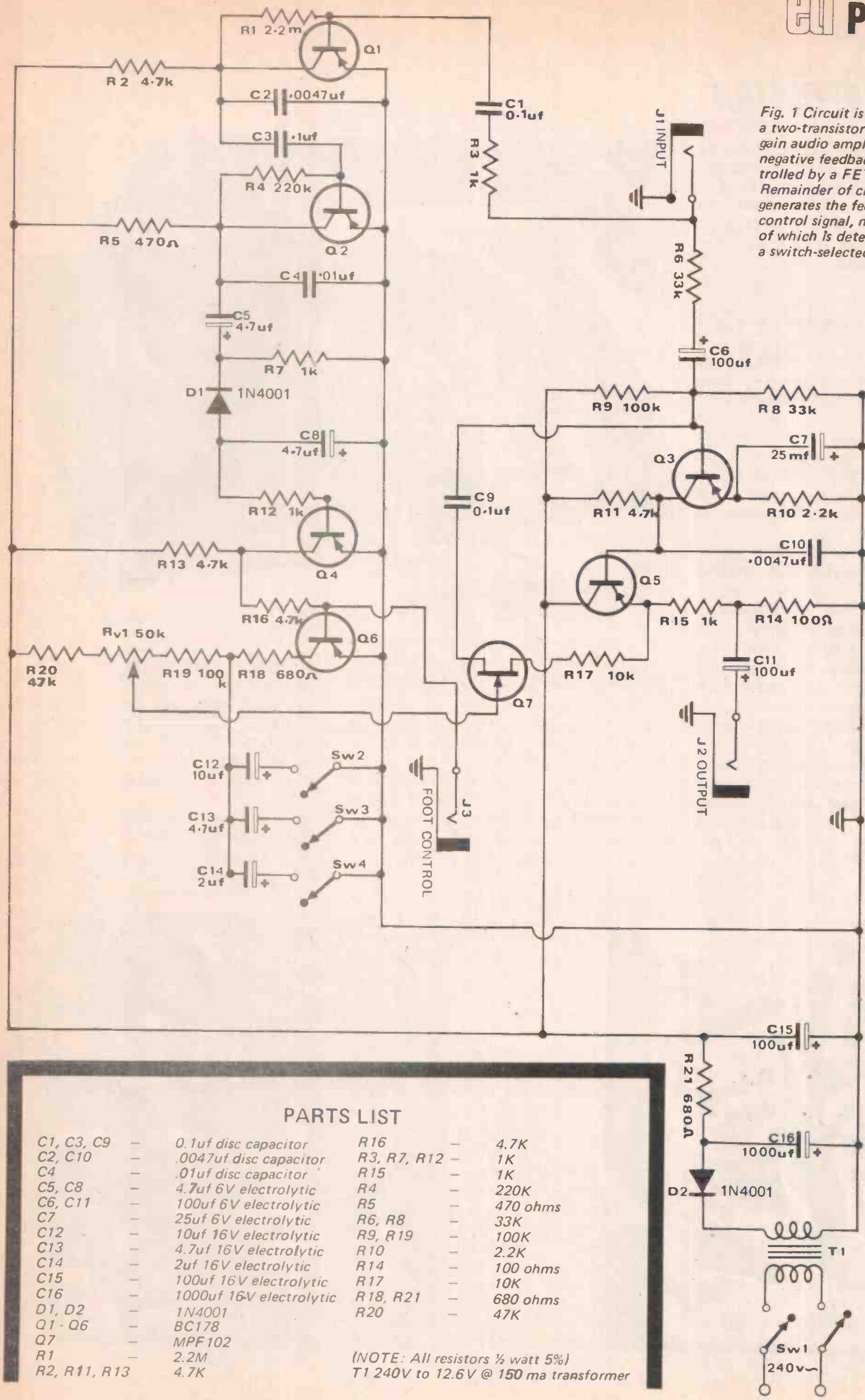


Fig. 1 Circuit is essentially a two-transistor, high gain audio amplifier with negative feedback controlled by a FET. Remainder of circuit generates the feedback control signal, magnitude of which is determined by a switch-selected capacitor.

PARTS LIST

C1, C3, C9	–	0.1uf disc capacitor	R16	–	4.7K
C2, C10	–	.0047uf disc capacitor	R3, R7, R12	–	1K
C4	–	.01uf disc capacitor	R15	–	1K
C5, C8	–	4.7uf 6V electrolytic	R4	–	220K
C6, C11	–	100uf 6V electrolytic	R5	–	470 ohms
C7	–	25uf 6V electrolytic	R6, R8	–	33K
C12	–	10uf 16V electrolytic	R9, R19	–	100K
C13	–	4.7uf 16V electrolytic	R10	–	2.2K
C14	–	2uf 16V electrolytic	R14	–	100 ohms
C15	–	100uf 16V electrolytic	R17	–	10K
C16	–	1000uf 16V electrolytic	R18, R21	–	680 ohms
D1, D2	–	1N4001	R20	–	47K
Q1 - Q6	–	BC178			
Q7	–	MPF102			
R1	–	2.2M			
R2, R11, R13		4.7K			

(NOTE: All resistors ½ watt 5%)
T1 240V to 12.6V @ 150 ma transformer

NEW SOUND FOR YOUR GUITAR

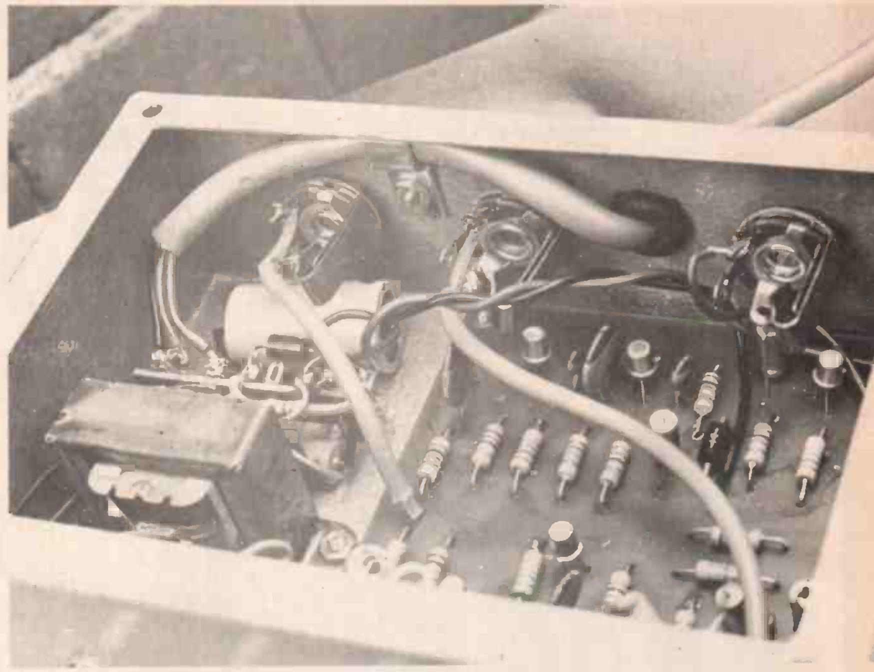
pattern is shown in Fig. 2. Once the board has been made (or purchased), install the components as shown in Fig. 3. Be sure to install the semiconductors and electrolytic capacitors correctly. Use a heat sink (such as long-nose pliers) on the transistor and diode leads while soldering to avoid possible thermal damage. Also, use a low-power (35 watts) soldering iron. Connect sufficiently long leads to the various external connection pads before mounting the board in the chassis.

Almost any type of metal chassis may be used as long as it will hold the PC board, the power transformer and the associated rectifier, and will permit the installation of four switches on the front and three phone jacks on the back.

The choice of switches for S2, S3 and S4 should be made carefully. During use, it may be necessary to manipulate these switches rapidly in various combinations, so they should have large paddle-type handles and operate with a light pressure. Any type of DPST switch rated at 240 volts ac may be used for power switch S1.

Do not ground either side of the ac to the chassis.

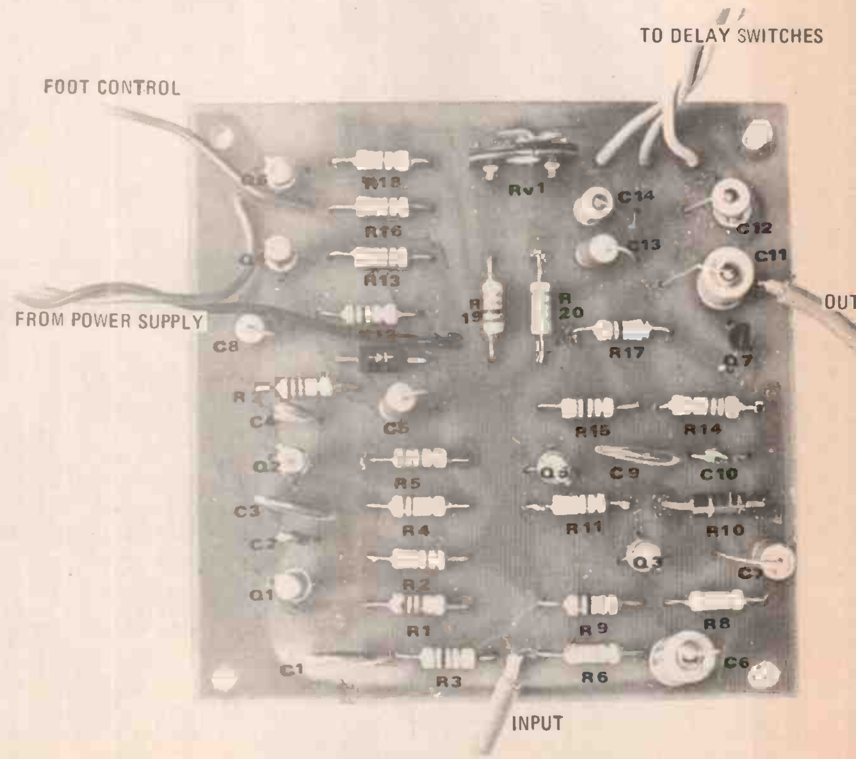
Mount the three capacitor-selector switches (S2, S3 and S4) on the front wall and three phone jacks (J1, input; J2, foot control; and J3, output) on the rear wall.

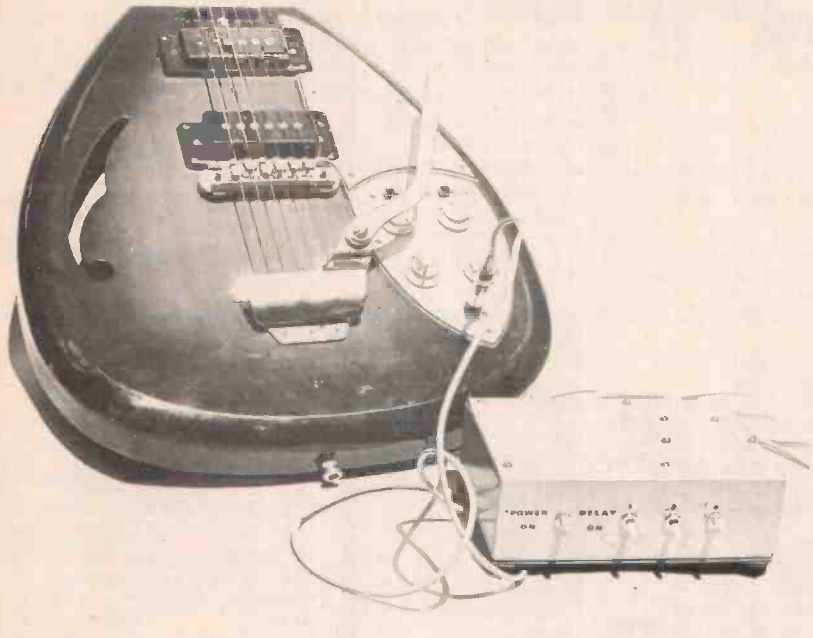


Interior of unit, showing power supply at left, main circuit board at right. Jack sockets for input, output and foot control are seen on rear panel.

FIG. 2 (below, left). Foil pattern of printed circuit board (full-size).

FIG. 3 (below, right). Component layout on printed circuit board.





Completed prototype unit connected to guitar.

Mount the PC board on four ¼" insulated spacers so that RV1 will be accessible from the side. Wire the complete circuit as shown in Fig. 1. Put four rubber feet on the chassis bottom to keep it from slipping around when in use.

SET–UP. Prepare the unit for operation by running a short length of cable from the output of the ADU to your amplifier input and plugging the instrument output into the ADU input. For the time being, do not use the foot control switch. Turn the ADU on and set the delay to 4.

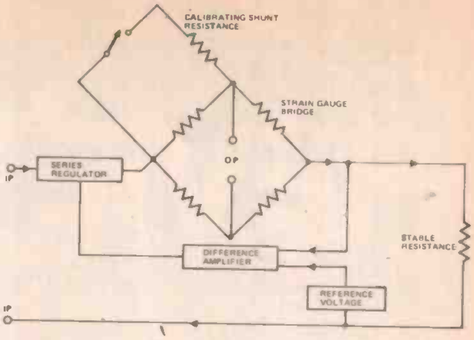
Since a certain minimum signal is required to operate the delay unit, the instrument's gain should be turned up almost all the way and the volume adjusted by using the amplifier's control.

The only thing that needs adjustment in the ADU is potentiometer RV1. At one end of this potentiometer's rotation there is little or no delay in the instrument attack; with the opposite setting, there is no sound for an instant and then the volume will come up full. Between these two extremes are a variety of settings which can be selected strictly as a matter of personal taste. Ideally there should be very little or no sound when the note is first struck, followed immediately by a noticeable increase in volume with a smooth glide to maximum.

OPERATION. The three delay switches on the ADU can be used singly or in combinations to yield up to seven different delays. The numbers above the switches represent some arbitrary unit of delay (which varies with the setting of RV1) and may be added together to get the longer delays. For instance, if switches 2 and 4 are down, the attack delay is 6 times longer than if only switch 1 is down.

Since the ADU requires a short, no-signal dead time for the circuits to reset, all strings on a guitar must be silenced before the next chord or note is struck. If single notes are being played, just lifting the finger from the finger board will ordinarily accomplish the deadening, but for chords with open strings it is necessary to deaden the strings with the palm of the strumming hand. The resetting time is actually very short (in the order of a tenth of a second), so very rapid runs can be played with the delay still occuring on each note.

The foot control switch is a single-pole, single-throw type and can be housed in a sturdy case of metal or a block of wood. The switch can be a push-on/push-off type, but experience has shown that a spring-loaded, normally closed switch works best. With this arrangement selective delay can be accomplished by pressing the switch when delay is desired and releasing it to sustain a note. ●



IMPROVING BRIDGE MEASUREMENTS

IN the course of making measurements of the pressure and thrust characteristics of rocket motors, using electrical resistance strain-gauge transducers the Australian Weapons Research Establishment, has developed a power supply with potential application of precision transducer measurements in other fields.

The WRE measuring equipment uses strain-gauges in a Wheatstone Bridge configuration. The conventional circuit has the disadvantage that the output voltage varies with the input voltage supplied to the bridge, for precision measurements the transducer must therefore be recalibrated in relation to the local supply voltage each time it is moved to a new site.

In the WRE development, a miniature high-stability current generator is used to control the stability of the bridge supply (as shown in the schematic diagram). The novel feature is that by making the generator an integral part of the transducer, the output from the bridge becomes independent of supply voltage for variations of up to ± 10% from nominal. Transducers can thus be calibrated at a central station and operated at other sites without the need for a constant supply voltage. In addition, the circuit improves linearity and decreases temperature sensitivity.

Transducers have been constructed which have maintained their accuracy and stability within ± 0.2% for more than a year.

Self-checking capability between calibration has been provided, as shown in the schematic diagram. Operation of a relay-type switch, incorporated in the transducer body, connects a calibrating shunt resistance across one arm of the bridge and allows the stability of the transducer circuit to be checked.

BOOK REVIEWS

REVIEWERS:
Brian Chapman, Halvor Moorshead

TRANSISTOR CIRCUIT DESIGN TABLES By D.S. Taylor. Published 1971 by Butterworth & Co. Ltd. Review copy supplied by publisher. Hard covers, 120 pages 8½" x 5½". Price £2.80

This valuable little book contains a set of eight design tables which enable the rapid design of semi-conductor networks containing up to two transistors and their associated RC networks.

The tables are:—

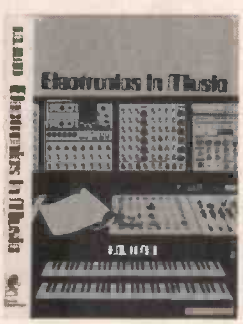
1. Parallel resistance and series capacitance
2. Potential dividers
3. Time constants
4. Capacitor and inductor reactances
5. Common emitter amplifier stages

6 & 7. Transistor astable and monostable circuits

8. Schmitt trigger circuits

Each table is preceded by a section which provides design criteria and helpful hints appropriate to the circuitry described.

The book should be invaluable to those in instrumentation and similar fields, who constantly require to design small interface circuitry. Due to component tolerances and differing transistor characteristics not being taken into account, the tables must be considered to provide a rough guide only. But this is more than adequate for the breadboard stage. — B.C.



ELECTRONICS IN MUSIC by F.C. Judd. Published 1972 by Neville Spearman. Review copy supplied by Publisher. Hard cover, 169 pages, 9½" x 6¼". Price £3.15

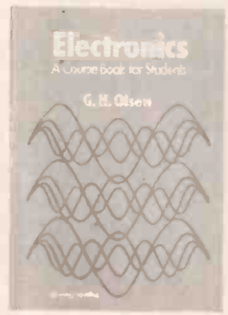
It is doubtful if there is anyone in this country who is better suited to write a book of this type than Fred Judd. He can rightly claim to be largely responsible for the popularising of do-it-yourself electronic music.

The throbbing theme tune of the TV series 'Dr. Who' was one of the earliest examples of electronic music that received wide public airing but now we have a large choice ranging from classical music to the odd effect introduced by pop groups.

Mr Judd knows his subject well and starts with the advantage that all his work has been done without the backing of a large company; he has financed all his own projects and experiments and this has resulted in the book being thoroughly practical in nature. It concentrates on techniques and circuits that the amateur can duplicate in his home with no undue expenditure. Photographs and circuits are plentiful.

Although the contents contains a breakdown of each chapter, the lack of an index is noticeable. Many readers will find so much information contained in these pages that referring to it later could be difficult. Another criticism is that advertisements are included at the end and, whilst this reviewer is certain that the book was written without any thought to this, a one-off book is hardly the place for these.

For anyone interested in electronic music, either academically or for experimenting, this book is excellent. — H.W.M.



ELECTRONICS — A COURSE BOOK FOR STUDENTS by G.H. Olsen. Published March 1973 by Butterworth and Co. Ltd. Review copy supplied by the publisher. Cloth cover, 351 pages, 8½" x 6". Price £2.60

The last time that I reviewed a similar book by the same publishers, I had to give it a real slating, something that few reviewers do lightly. It is therefore pleasant to have an opportunity to write an encouraging review if only to persuade the publishers that the previous one was not personal!

The title of the book is well chosen for it sums up the contents and approach of the book well. It is certainly not intended for the raw novice for, although it starts with absolute fundamentals, it moves rapidly into detailed and advanced explanations. However, even for the reader who has a hazy notion of the subject, this rapidity is excellent. The same approach also makes the book well suited as a revision for even more experienced electronics engineers who in their progress may have got some lines crossed.

Quite rightly valves are ignored; it should not even be necessary to mention this except for the fact that several books of this type *still* devote large sections to this field and succeed in confusing the reader.

There is nothing particularly novel about the presentation, this takes a standard form with chapters covering: Passive Components, Response of Circuits containing Passive Components, Semiconductor Devices, Indicating Instruments, Power Supplies, Amplifiers and finally Oscillators.

The mathematics and algebra have been dealt with sensibly; the book does not make the common mistake of trying to explain electronics without mathematics nor does the author make the error of overdoing this aspect.

The introduction claims that the book 'has been written for those who want an introductory account of the subject that is qualitative, informative, and not overburdened with mathematics and circuit analyses'. It succeeds admirably. —H.W.M.

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H4	250	Mixed Resistors. Approx. quantity, counted by weight	50p
H7	40	Wirewound Resistors. Mixed types and values	50p
H40	20	BFY50/2, 2N696, 2N1613 NPN Silicon uncoded TO-5	50p
H8	2	OCP71 Light Sensitive Photo Transistor	50p
H38	10	Integrated circuits. 6 Gates BMC 962, 4 Flip Flops BMC 945	50p
H30	20	1 Watt Zener Diodes. Mixed Voltages 6.8–43V.	50p
H36	100	Mixed Diodes, Germ. Gold bonded etc. Marked and Unmarked.	50p
H28	20	OC200/1/2/3 PNP Silicon uncoded TO 5 can	50p
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H41	2	Complimentary Power Transistors. BD131/BD132	50p

UNMARKED UNTESTED PAKS

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B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	50p
B86	100	Sil. Diodes sub. min. IN914 and IN916 types	50p
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METROSOUND FMS20 TUNER

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product test

REVIEWED FOR ETI BY ANGUS McKENZIE, C.Eng., M.I.E.R.E.

FOR many years in the United Kingdom, the VHF radio frequency spectrum in Band II has been relatively simple to receive, since in almost all areas only three B.B.C. networks have been receivable at a good signal strength. With the inception of the B.B.C.'s local radio stations, additional signals became receivable, usually at slightly lower strength than the main programmes. These are either relatively low power local stations, or are co-sited with existing VHF stations. Not too much trouble with cross modulation has therefore been experienced up to now with tuners designed in the last few years, although some earlier models which were in the main stereo equipped mono tuners, did sometimes give trouble.

PROBLEMS TO COME

A serious situation is looming on the horizon with the start of local commercial radio later in the year. It has now been announced, for example, that the two commercial stations in London will have their aerials in Croydon, sited with the London Band III aerials. This will mean that many listeners may well receive a very high signal strength from Croydon, whilst being in a poorer locality for Wrotham reception. It is important therefore to consider the cross modulation characteristics of tuners, and also any deterioration of performance in the presence of very high signal strengths from a local transmitter. Thus the approach to this review is not only to apply the normal laboratory tests, but to make other checks with the problems of receiving commercial radio particularly in mind.

GENERAL SPECIFICATION

The Metrosound FMS 20 has been designed as a companion to the ST20E amplifier, a simple but good hi-fi amplifier at a reasonable budget price. The appearance matches the amplifier. The tuner has a row of push buttons on the left and the tuning knob on the right. Slightly right of centre is a good size tuning scale calibrated from 88 – 108 MHz. The buttons operate mains on/off, muting, automatic frequency control, mono/auto-stereo, and local/distant switching. On the back panel are a co-axial input socket (75Ω), a five-pin DIN socket for audio output, muting, stereo threshold controls, individual audio output level controls for left and right, a fuse holder and a captive mains lead input.

This interesting tuner is one of the first British hi-fi models to incorporate two new R.C.A. integrated circuits. In one chip some 60dB of i.f. amplification is achieved with limiting and discrimination, whilst in the other chip, using the phase lock loop principle, the output of the discriminator is processed to give the left and right audio outputs. With the use of two ceramic filters and a Waller front-end the circuit is relatively simple, but its performance stands well against a number of tuners costing considerably more.

The 75Ω coax input socket (no 300Ω input is provided) connects directly to a tuned circuit which in turn feeds the gate of a single junction f.e.t. The amplified signal is then again tuned and mixed with the output of a varicap diode tuning local oscillator in an n.p.n. mixer transistor. The i.f. output is fed via a transformer in the collector circuit to a varitron ceramic filter. The output from this filter is impedance converted with another transistor to drive a second, but identical, ceramic filter. The first integrated circuit is driven by this second filter, and its high gain helps to give a very high degree of limiting so that all signals of usable strength received by the tuner will give substantially similar audio output levels. Some 3dB of limiting occurred for example for an input signal strength of only 1.2μV, and a 30dB signal-to-noise ratio was measured for a mono input level of only 1.6μV. This latter measurement was the ratio between a fully modulated 1kHz signal and the carrier noise present, together with any harmonic distortion introd-

THE METROSOUND FMS 20 TUNER

Facility	Manufacturer's Specification	Tested Results
Aerial Input	75Ω coax	Agreed
Tuning Range	87.5 – 108.5MHz	Agreed
Sensitivity	1.6μV i.h.f.	1.6μV
Limiting	1.1μV for 3dB limiting	1.2μV
AM Rejection	Better than –50dB	Better than –42dB
Image Rejection	–50dB	–66dB
IF Rejection	–75dB	–66dB
AFC Range	±200kHz	±200kHz
Local/Distance Switch	–30dB	–25dB
Channel Separation	Typically 38dB	At 1kHz: 39dB At 10kHz: 30dB At 80kHz: 25dB
Frequency Response	20Hz – 15kHz (±1dB)	20Hz – 10kHz (±1dB) (see text)
Output at 25kHz Deviation	0–250mV variable	0–300mV variable
Recommended Load Impedance	Greater than 50kΩ	Satisfactory over 15kΩ
Distortion	0.25%	Better than 0.3%
De-emphasis	50μS	50μS

Other Facilities (all agreed) : Decoder, integrated circuit RCA CA3090Q; Inter-station muting; Variable preset output level; Stereo signal level sensitivity control; Automatic mono/stereo switching with mono over-ride; Tuning meter; Stereo Indicator; Ceramic filters; Stabilised power supply.
Size: 15¼ x 3½ x 10in. Weight: 8lbs.

Price: £49.50 plus VAT (Recommended resale price)

uced. This order of sensitivity may frequently be specified by manufacturers, but is unfortunately rarely achieved in practice. In the case of the FMS 20 it allows the tuner to perform well in fringe reception areas. A capture ratio of just over 2dB was measured and this very good figure allows the tuner to discriminate fairly easily between two stations on, or very close to the same frequency, even when the two signal strengths are fairly similar, only the stronger station being heard. The performance of this and other modern tuners is of course very much better in this respect than tuners made some years ago, and this becomes most important in localities where two transmissions may well be on exactly the same frequency emanating from local radio stations at a fair distance. An aerial rotator used under these circumstances should enable the user to beam on to one or other station almost completely eliminating any interference.

The performance of the quadrature discriminator and phase lock loop decoder was very good. A 1kHz signal of 80 per cent deviation was applied to a stereo generator whose output was connected to the aerial input of the tuner supplying a signal strength of 1mV. Only 0.2 per cent second harmonic distortion was noted at the audio outputs of the tuner in both mono and stereo L + R modes, the third harmonic distortion measuring approximately 0.15 per cent. In the most unfavourable measurement, namely L – R (difference channel) at the same deviation, the figures did not exceed 0.5 per cent. The stereo separation at 1kHz was 39dB in both directions, and distortion components as well as fundamental cross-talk were included in the measurement.

The remarkably low cross-talk figure of 48dB was measured when only the fundamental was compared showing the review sample to be well aligned. The cross-talk figure at 10kHz measures 30dB and at 80Hz was 25dB. These figures are considered very good.

The decoder outputs are filtered passively and then amplified with a single transistor. The audio output is taken from the collector of this transistor via 10kΩ pre-set controls located at the rear of the tuner, to accomodate the requirements of virtually all hi-fi amplifiers and tape recorders. A maximum output peak level of 900mV r.m.s. is available and the source impedance varies from a few hundred ohms to 3.5kΩ depending upon the position of the pre-set level controls. The signal-to-noise ratio was measured under all conditions of operation, and for an input signal of 1mV normally varied from 60dB to 64dB unweighted, depending whether the tuner was switched to stereo or mono, and whether the muting and a.f.c. controls were depressed or not. The dBa weighted figure under normal operation measured 70dB below full modulation. This noise figure should be considered very reasonable.

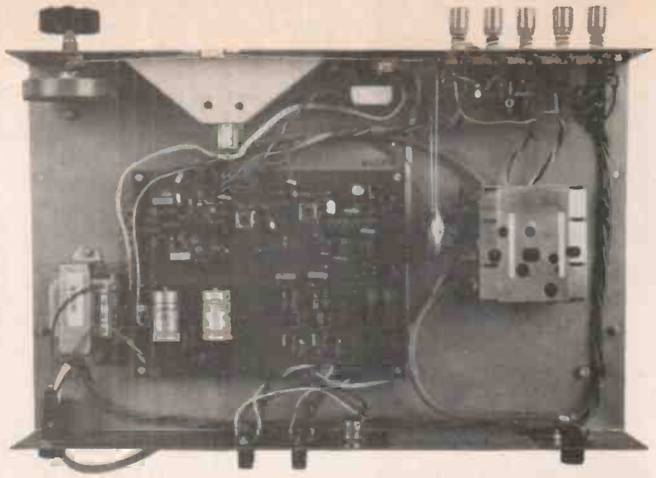
The best hum figure was obtained, surprisingly, with the live and neutral wires of the mains lead reversed, the 50Hz hum component improving some 4.5dB! I also noted that when muting and a.f.c. were in operation the pre-sets on the back for muting and stereo threshold auto switching degraded the hum level when either was wound fully clockwise or anti-clockwise. Such positions would of course not normally be used, and it is assumed that the extra hum is picked up by these controls from the mains wiring which is untidily laid out across the inside of the tuner to the mains switch and then back to the mains input transformer. This wiring should, in my opinion, be screened, or better laid out to obviate this condition.

MUTING AND AFC

The muting pre-set control can be set either to allow only very strong signals to be received, or most signals receivable but with muting between carriers. The stereo threshold control allows stereo signals below a predetermined strength to be received monaurally with very much improved hiss level. This is particularly useful, since some signals unacceptable in stereo may well be very acceptable in mono. I personally prefer to use the mono button on the front of the tuner which over rides stereo. This mono button has to be used in many areas when receiving Radio 4 programmes since, for internal reasons, the B.B.C. frequently transmit a 23kHz low level tone for switching transmitters. Without the mono button depressed the tuner attempts to lock on to this pilot and gives a whistle in the stereo mode. This problem is completely eradicated by depressing the mono button.

The automatic frequency control, when in use, pulls in a signal over a range of ± 200kHz for a reasonable level of distortion, although it still operates slightly outside these limits. No significant receiver drift was noted, but it was found very much easier to tune in stations with the a.f.c. button depressed. The i.f. bandwidth was checked using a v.h.f. sweep generator with an oscilloscope, and was found to be 260kHz. I consider this bandwidth ideal for the design of tuner.

Many makes of tape and cassette recorder made in the past, and regrettably still manufactured, have rather inadequate filtering frequencies well above the audio range. With some tuners, both pilot tone and its harmonics are insufficiently filtered, and in such tape recorders they become boosted so that any distortion present in the tape recorder's recording circuits results in whistles being audible on replay. These whistles are produced by beats of these harmonics with the tape recorder's bias oscillator. The pilot tone and its harmonics are very well rejected in the FMS 20 tuner by a well aligned filter, the pilot tone being about 45dB below full output level, and harmonics of pilot tone being well over 60dB down. I do not anticipate any trouble therefore with this tuner when used with almost any make of tape recorder.



An inside shot of the FMS20 which illustrates some of the comments made in the text

FREQUENCY RESPONSE

The frequency response is very flat indeed from 20Hz to 10kHz, being ± 1dB within these limits with respect to 1kHz. However, a boost of nearly 4dB was noted both in stereo and mono at 15kHz, above which the response falls rapidly due to the filter characteristics. On examination of the circuitry I found that a treble boost network had been employed in the emitter circuit of the audio output transistor to compensate for the filter treble loss characteristics. It is apparent that at some time a change must have been made in the type of filter employed since the correction in the model under review was overdone. I found it comparatively simple to adjust the response so that it became ± 0.5dB to 16kHz by changing only three components. The modification that I put in also had the effect of slightly reducing the distortion at very high frequencies and reducing the pilot tone break through by 8dB. When I informed the manufacturers about this point, they assured me that all their specifications are always under review, and as improvements become available they are liable to be incorporated, together with any minor modifications necessary, if they are considered worthwhile.

Readers may be interested in some further measurements made to check the specification. The image response measured 66dB down, whilst the intermediate frequency break-through from the aerial input socket was also 66dB down. Provided that a reasonable aerial is used, no difficulties with i.f. break-through should be experienced, but I would like to emphasise that a good aerial system will greatly improve qualof reception in general.

Readers may by now be wondering where the main snag is with this tuner. I feel it only right to report that trouble might well be experienced in some localities in which it is required to receive lower signal strengths in the presence of very high ones in the same band. The performance in this respect is fairly good when it is considered that only one r.f. stage with two tuned circuits is used, a fairly common practice in British tuners. A very brutal test for any tuner is to match two signal generators through a network in to the tuner, switching one generator to a low signal strength of between 25 and 50μV, with the other generator switched to a high signal strength of 50mV or above, applying a fully modulated tone to the strong signal and listening to a blank carrier on the weaker signal. Cross modulation can result which will cause the stronger signal programme to be heard on the weak signal. I first measured and listened to a 50μV silent carrier when an 80mV carrier fully modulated was set at a spacing of only 250kHz away. A cross modulation effect some 40dB down was noted. Although such cross modulation would be audible, it would not detract seriously, under programme conditions, from the enjoyment of the weak signal, and this relatively good performance is achieved by the f.e.t. circuitry and mixer not having too much gain. At a 2MHz spacing no cross modulation whatsoever was noted. When however the signal being received was reduced to a very weak signal of 2.5μV, and this was modulated fully at 1kHz a noticeable degradation of signal-to-noise ratio was audible when the other signal generator sent a carrier level of only 2.5mV. This measurement shows that the Metrosound FMS 20 tuner, and most other tuners having only one r.f. stage, cannot have their excellent input sensitivity used to the best advantage in the presence of strong signals across Band II. This of course is a pity, since the tuner's sensitivity can only be fully used when listeners hear virtually all stations comparatively weakly. It is doubtful, in the London area for example, whether continental stations could be received satisfactorily in stereo in the presence of the Wrotham B.B.C. transmitters and the new Croydon commercial radio transmitters. Listeners who are particularly interested in receiving distant stations will have to look to very expensive tuners in the future. The local/distant push button alters the bias on the front end of the tuner and decreases gain by 25dB. This may be found helpful when the tuner is used very close to the transmitter. For those who wish to receive their local programmes at reasonably high quality the Metrosound tuner can be recommended strongly. I feel that the product is highly competitive with imported ones and, because of its construction and the components used, should prove reliable and easy to maintain by any competent dealer if faults should arise. No doubt the performance could be improved in many details, but I doubt whether this could be done without a considerable increase in cost.

CONCLUSIONS

I have taken the opportunity of listening to many programmes on this tuner and have also recorded several of these broadcasts. The tuner was easy to operate and the tuning was quite smooth. The quality from Radios 2, 3 and 4 from Wrotham and also Radio London and Radio Medway was only very marginally inferior to that from a professional tuner which I normally use. My own standards are high, but I would be pleased to use one of these tuners myself, and would certainly not be ashamed of it despite its budget price. ●

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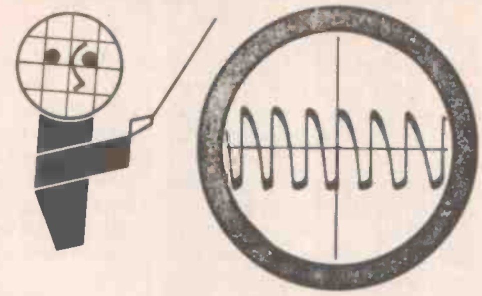

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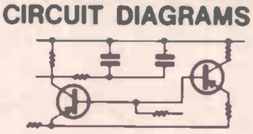

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Example 1	Goodmans 1–10 stereo tuner/amplifier		
	Price	V.A.T. rate	Total
Cash & Carry only	£88	£8.80	£96.80
Discount Plus	£98	£9.80	£107.80
Select Service	£119.46	£11.95	£131.41

Example 2	Pioneer SA 500A amplifier		
	Price	V.A.T. rate	Total
Cash & Carry only	£32.50	£3.25	£35.75
Discount Plus	£37.50	£3.75	£41.25
Select Service	£48.10	£4.81	£52.91

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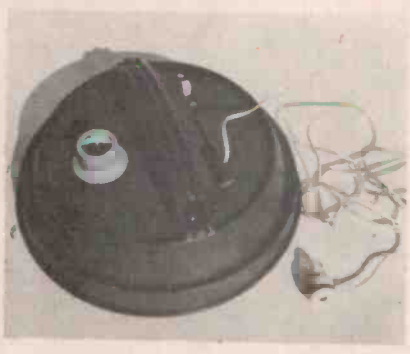

Buy next month's ETI and you too will be able to take part in the current craze of treasure hunting. What has made this hobby so popular is that you really can find a whole variety of items buried in the top few inches of the soil. The ETI COIN COLLECTOR is an ideal project for those who want to 'have a go'; it is easy and inexpensive to build and includes a Faraday shield, not usually included in features of this type. Shown in the photograph as a small hand-held version, the COIN COLLECTOR can also be fitted with a handle.

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GET A 4th TV CHANNEL NOW

This feature describes in some detail how you should set about picking up additional ITV stations, what sort of aerial to use etc. The feature also includes a brief summary of the less expensive commercial preamplifiers that are available. The whole article is also applicable to those who have problems with their normal reception.

MINICOMPUTERS

Minicomputers are rapidly taking over the mundane tasks in industry and commerce, yet their capabilities and proper roles are not widely understood. Next month we explain where these units can be used beneficially and describes their advantages (and limitations). A glossary of computer terms is also included.

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.

POLLUTION-

its measurement

This, the twelfth article in Dr. Sydenham's series on transducers in measurement in control, discusses pollution in its many aspects.

HARDLY a day passes without some mention of pollution, either in conversation or in the news media. Although much continues to be written on the harm being wrought on the Earth's ecological systems, its human inhabitants and to its resources, very little is ever said about the measurement problem itself.

Before pollution can be controlled, it must be detected, and that implies the need to measure. Some forms of pollution are obvious — litter that will not degenerate fast enough, thick smog, oil slicks, but many forms of pollution are insidious, going undetected until it is too late to take corrective action.

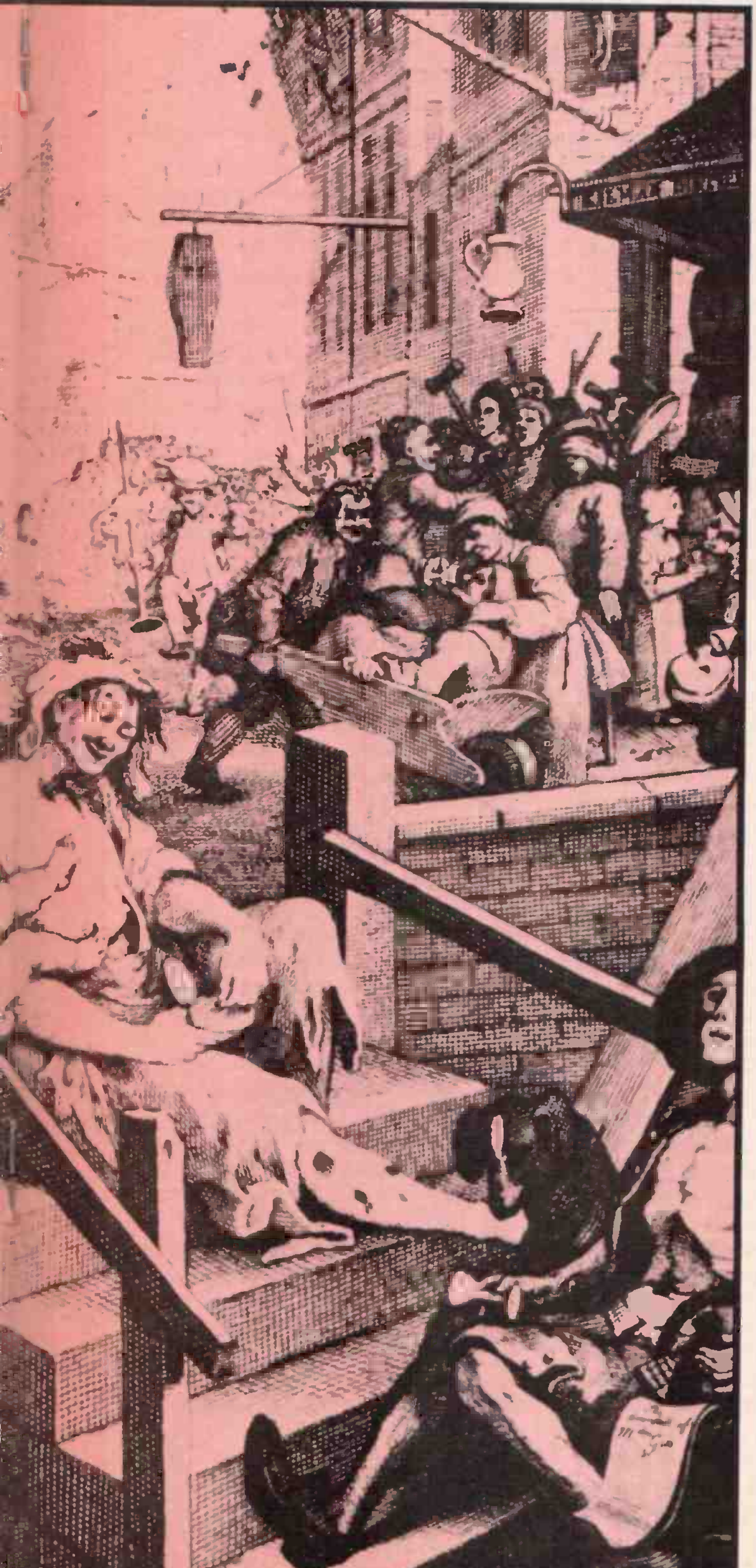
It is not the purpose here to further add to the literature on the problems resulting from pollution, but to provide a brief survey of some of the instruments used in the two main areas — the contamination of air and water.

CLASSES OF POLLUTION

Although we will not be covering all classes of pollution it is appropriate to mention them to put the discussion in perspective. One classification proposed uses five headings — air, water, land, noise and radioactivity. The first two are our main concern but as the last is also an important area of objective measurement it will be included.

Another way to regard the problems is by identifying the nuisance at source. Pollution is not a study of all contaminants but more of those of known annoyance to humans. In this way pollution divides into chemical impurities (lead, cadmium, oil, organochloride compounds, mercury, cyanide, sulphur and nitrogen compounds and hydrocarbons), biological waste and growth (sewage disposal and population excesses), radiation and ecological imbalance (wasteland deserts, loss of the natural insect and animal population control, disappearance of vital species) and noise (acoustic noise produced by transport machines, industrial processes). There are others of a more

t and control



subjective nature — litter, loss of clear view and the existence of unsightly buildings, but the task of measuring these is most difficult for it is hard to define and qualify standards of allowable nuisance level.

AWARENESS OF POLLUTION

The settling and subsequent growth of cities began many thousands of years ago and this process naturally concentrated the elements of pollution. Fires, human waste and rubbish are concentrated geographically, and unless controls exist, the freely available air and fresh water soon become spoilt.

The Romans recorded their displeasure of the air of Ancient Rome. In 1273 the British instituted a not very successful smoke reduction programme: the penalties were harsh, however, for it seems a man was hanged for burning soft coal. London has been regarded the worst example of city filth for centuries. In Hogarth's time, 18th century London was much like his etching "Gin Lane" (shown in Fig. 1). In the 19th century Parliament often rose prematurely to escape the stench of the River Thames. But now London is one of the cleanest cities and has shown what can be done to eliminate pollution.

Plagues were common throughout Europe, annihilating as many as 65% of the European population in early times. There is little doubt that this was the result of throwing all refuse and sewage into the street. Tudor houses had the outward projecting upper storeys to assist this practice!

It was not until the 20th century that a real awareness of pollution appeared. In Australia a Smoke Abatement Act was introduced in 1902. An Alkali Act was introduced in Britain in 1906. But to have Acts and to use them are different things, and it was not until the 1950's that improvement became evident. The British legislated a Clean Air Act in 1956 following the terrible 'smogs' of the early fifties.

Motor vehicles have added to the problem enormously, providing air-borne carbon monoxide, solid

"Gin Lane" — a famous etching by William Hogarth shows the highly polluted nature of life in London in the late 18th Century.

hydrocarbons and lead in great quantities. In the U.K. in 1971 we consumed energy equivalent to 323 million tons of coal, a high proportion of this being liberated as CO, SO_2 and hydrocarbons. In the United States, (see Fig. 2), and Japan, the problem is even greater. The new, seemingly unrealistic, Congress Act to reduce vehicle emission is forcing design changes at the source of pollution. In this way the user pays the penalty — it is not passed on to others.

It has recently been estimated by the Scientific Instrument Research Association (SIRA) that there will be an expansion of the market for pollution monitoring systems and devices from a current £300m to £1,500m in 1980. There certainly is room for improvement; for instance, few instruments exist that are within the price range of small companies and the domestic home. At present the accurate detection of most serious pollutants requires the use of a number of different, highly expensive instruments.

POLLUTION OF AIR

Let us now consider the contaminants of air and water. It will then be possible to study some of the transducers in use.

Air becomes contaminated mainly by man-made combustion processes. Fossil fuels (coal, oil and now natural gas) release gases and particles when the chemical process of burning takes place. The degree of harmful emission depends much upon the quality of the combustion process.

The main unwanted gases produced are carbon monoxide, carbon dioxide and sulphur dioxide. The first is physiologically dangerous for it can induce a deep fatal sleep without obvious signs. In lesser doses it produces severe drowsiness. It is, however, relatively easy to measure, especially at the exhaust of a vehicle.

Carbon dioxide, although not as harmful of life directly (as long as oxygen exists), does appear to have a far-reaching effect on the globe as a whole. This gas ends up in the upper atmosphere at an increasing concentration of some 0.7 parts per million ppm each year. Calculations indicate that a doubling up of the current concentration of around 300 ppm will reduce the heat loss of the Earth but not the Solar heat gain. This could, it is suggested, result in an increase in ambient temperature of a degreee or so and that might melt much of the icecaps. Depending upon which school of thought you belong to, this will mean either disaster by flooding or merely an increase in plant life that will compensate for the increase of energy gain.

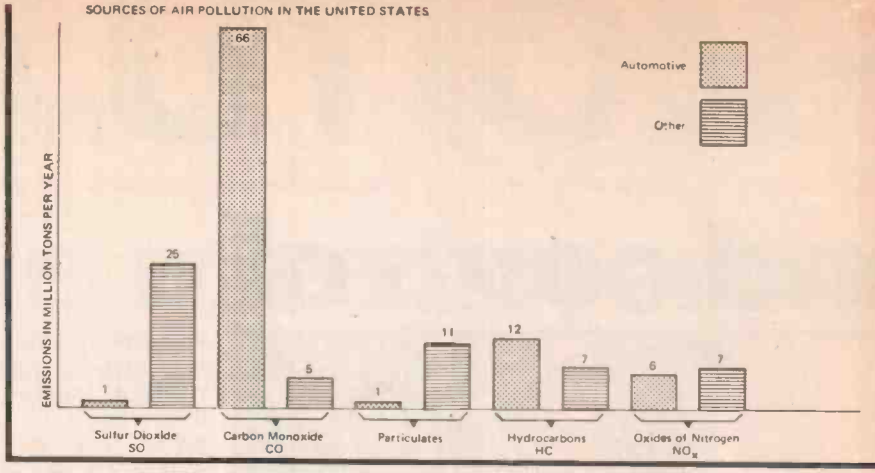


Fig. 2. A recent estimate of the quantity of air contaminants in the U.S.A.

Sulphur dioxide in the air oxidises to produce sulphuric acid.

Rainwater is made into dilute acid when it falls near an industrial chimney emitting the gas).

There are many other gases that pollute the atmosphere and waters — for more complete summaries refer to the reading list given.

Combustion also produces particulate matter ranging in size from 10 micrometers in diameter upward. Smog, smoke, haze and fog are predominantly made of particles, but not always, for optical dispersion effects can produce with gas alone the brown colours seen. Although not regarded as a pollutant in the same sense, pollen grains producing hayfever provide a similar measurement problem, for the grains are minute but powerfully annoying.

Measurement of contaminants in air, therefore, involves in the main, the determination of small quantities of gas impurities and the size and distribution of suspended particles.

POLLUTION OF WATER

In many areas of high density dwelling and industry there is a shortage of clean fresh water — 4,000 x 10^6 gallons are used each day by British industry. To say fresh water is our life blood is no overstatement, for it seems all processes require it in one way or another. Power stations require immense quantities for cooling purposes, and to charge the boilers, (salt water is often used). Paper making needs it when making pulp. It takes 44 gallons to produce a glass of beer, 100,000 gallons to make a car. In most processes it is used only as a transport medium to wash away impurities. Such discharges are termed industrial effluents.

Nature has provided a natural purification process in water courses, and this action can handle a small amount of contamination bacterialogically.

The evaporation rain cycle is invaluable. It is, therefore, reasonable to allow a very limited amount of suitably treated effluent to go into rivers and the sea, but the natural processes must not be overloaded or the whole action ceases. However, the convenience of discharging effluent into a rapidly moving river has enticed too many people to pass their waste on to others.

The main contaminants in water come from industrial waste, sewage, and from chemicals carried from the water-shed areas by rainfall drainage. There is an identifiable water cycle, (see Fig. 3); in it the various contamination courses are interrelated.

In the 19th century, it was a sport to set light to methane discharged from some of our canals! It is the absence of dissolved oxygen that is paramount in a water course, for bacteria need at least 2 ppm to convert organic carbon and nitrogen compounds into less harmful chemicals. The Biochemical Oxygen Demand (BOD) is a test designed to find the oxygen need of an effluent. It is arbitrary in nature but does provide, along with other tests such as the Chemical Oxygen Demand (COD) and Permanganate Value (PV), a measure of the degree of pollution.

Some chemicals can be most harmful, even in minute concentrations. Mercury, cadmium and lead are well-known poisons of the human metabolism, entering either through fresh water or sea-water paths. Mercury entering sea-water is concentrated in the bodies of many fish — tuna and shark have been banned for human consumption for this reason in some countries.

Cadmium is a recently declared danger. In 1971 the reason was found why hundreds of Japanese women were suffering from bone decay leading to painful death. It was established that industrial effluent from a factory up-stream contained cadmium. This entered their bones via water irrigation used for the rice they ate.

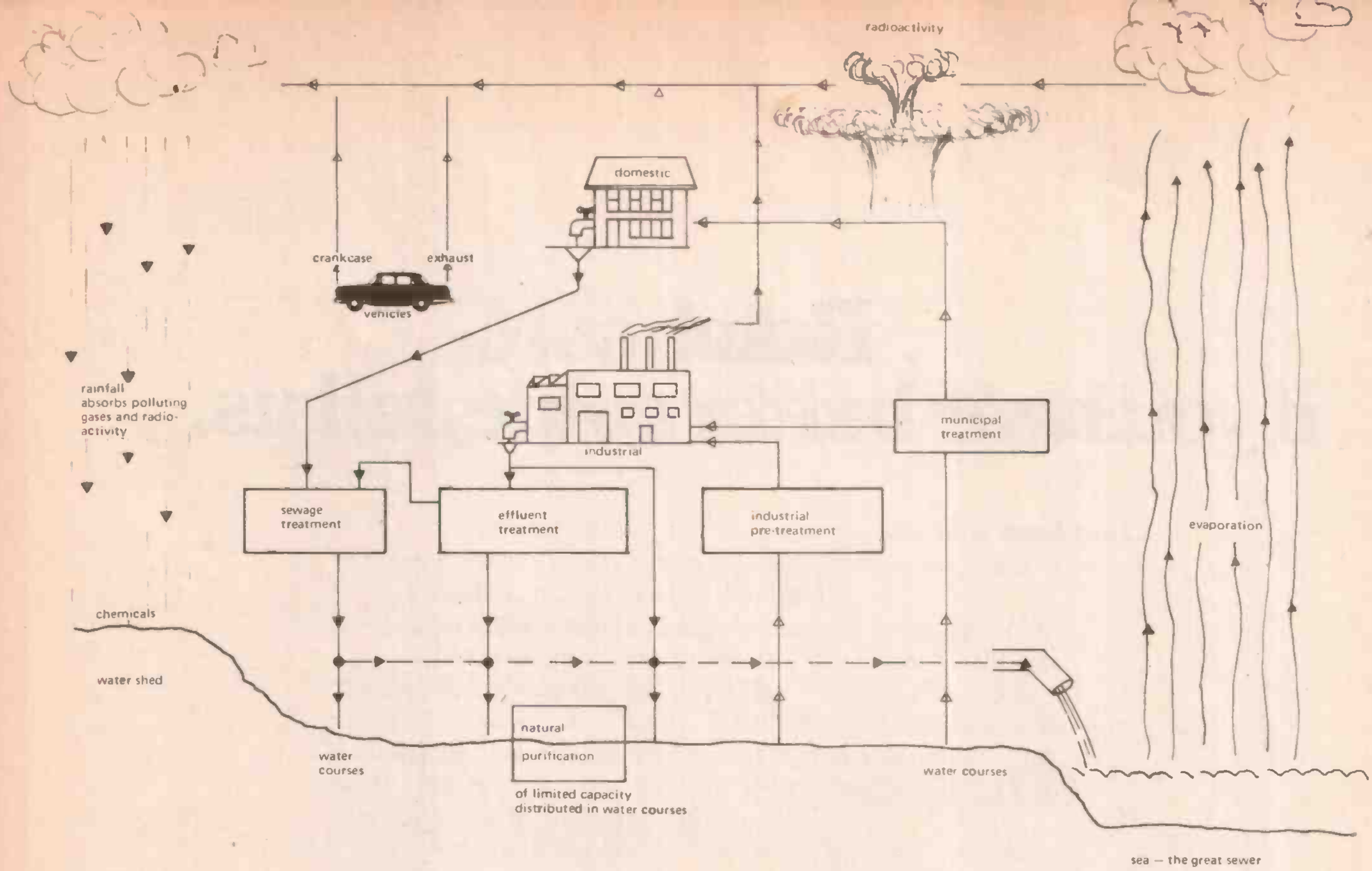


Fig. 3. Water is naturally recycled on a global basis. This basic diagram shows how pollutants enter and to some extent how they are purified.

Control of water pollution, therefore, also involves the need to measure chemical impurity levels, dissolved gas quantities and, as with air, the nature of particulates. Large solids also need consideration but their measurement is more straight forward.

Transducers needed for pollution measurement and control are, therefore, devices for measuring chemical parameters — acidity, ion concentration, specific gas content and composition, and particles. Radioactivity contamination is common to both air and water and will be covered later.

CHEMICAL ANALYSIS INSTRUMENTS

The simplest way to monitor unwanted chemical composition in a gas or liquid is to carry out conventional laboratory tests on samples. Special kits are sold to standardise the procedure. Some enable tests to be made on the spot by virtue of visible colour changes that can be matched against a chart.

Another simple way is to suspend treated paper (litmus for instance) in the fluid stream. The gas analyser in Fig. 4 is a relic used at the turn of the century to test for ammonia and sulphur dioxide in town gas.

Whilst there are cases where these inexpensive methods are satisfactory for spot checks, the need is often for a faster response and a continuous output signal that can be used to actuate control. Such instruments are almost always sophisticated and, therefore, costly. Space does not permit a complete study but those described are the commonly used instruments. Each has application in chemical analysis in general — there is nothing about chemical pollution that gives it a different need to normal analytical practices.

MASS SPECTROMETER

When a gas (which consists of atoms, or molecules made of atoms) is subjected to thermal agitation, some of it will be split into separate atoms with differing electron charges. If positively charged it is called a cation, if negative an anion. In 1907, J. J. Thompson reported a method for separating out different ions into separate locations where an individual measure of each can be made. This instrument, called a mass spectrometer is shown diagrammatically in Fig. 5. It can be used to monitor gas composition as a continuous process.

The example chosen is used in the iron and steel industry to monitor — on line — waste gas composition from blast, oxygen and electric-arc furnaces.

The gases to be studied are sampled

Fig. 4. This elegant coal-gas monitor of the 1900's has two treated papers hanging in front of the gas stream. The sampled gas passes through to be burnt at the top.

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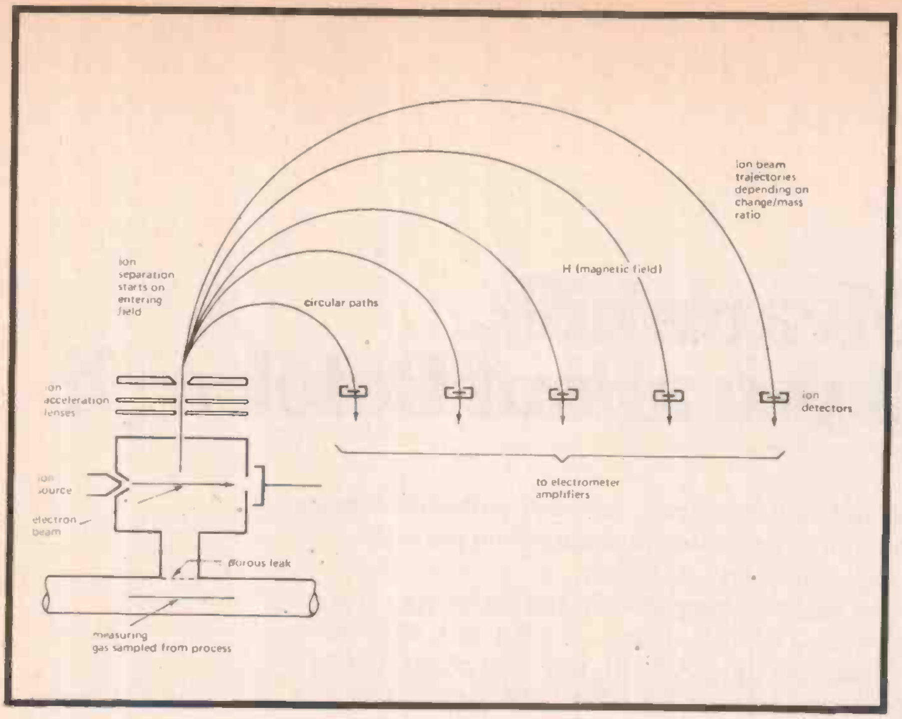

Fig. 5. In the mass spectrometer, ionised gas atoms and molecules are separated into groups depending on their electron-charge/mass ratio.

by bleeding some from the process. They are then pumped past the ionising chamber. An ion source ionises the gas mixture and ions are accelerated by electron lenses to follow the same initial path. Upon entering the magnetic field zone they take up circular paths of radius depending upon their charge/mass ratio. Finally they impinge on ion detectors that produce current proportional to charge. In this way the gas is separated into its constituent parts and a spectrum is formed in space (hence the name spectrometer). Detectors, if placed correctly, will sense specific ions only. Process control mass spectrometers are available commercially.

A chance of ambiguity exists, for there are a number of combinations of charges and masses that produce the same charge/mass ratio even though the element is different. Other tests may be necessary to reduce the risk of error. This is a common difficulty with most analysers, especially when the number of constituent gases rises.

The mass spectrometer is extremely versatile being able to detect any chemical substance that can be ionised. In the steel works example, it is used to measure nitrogen, carbon monoxide, hydrogen, oxygen, carbon dioxide, and water vapour. Other uses have been to analyse the smell of the land after rainfall, the odour of packed apples — it is the best general purpose sniffer available, (the biological sense of smell is however, more sensitive). Well designed instruments can distinguish separate ions having charge mass ratios differing by as little as one part in 10,000.

OPTICAL SPECTROMETERS

In this spectrum-based measuring device, it is the dispersion of electro-magnetic radiation into the various wavelengths (colours if in the visible region) that is used, not the deflection of ions. A sample of gas under study is heated or excited by forming an electric discharge, as shown in Fig. 6. A collimator unit provides an essentially parallel beam of the resulting radiation, as though the source were at infinity. This beam is dispersed into its 'colours' which spread out around the output area. Dispersion is achieved with either a prism, or as in many instruments, with a grating having ruled surface grooves at a pitch appropriate to the wavelengths of interest. Gratings of both transmission and reflection type are used. The output optics see a defined field of view that can be observed manually or with suitably placed photo-detectors (ranging from relatively insensitive photo-cells to photo-multipliers). The intensity of the radiation seen at the various angular positions provides a unique set of data for a given gas. Rotation is usually achieved by slowly scanning the dispersion element keeping the output stage fixed. Spectrographs using photo-detectors are known as spectrophotometers. Spectra (the radiation bands and lines) produced by a source including the gas to be analysed are obtained as emission in this type of spectrometer.

Black body radiation (see the earlier discussion on temperature) produces an emission spectrum that is continuously graded from colour to colour. In contrast, radiation from gases, contains one or more sharply defined lines at precisely known wavelengths. This is explained by quantum theory which shows that energy will be emitted at certain wavelengths only. Knowledge of the prism or grating and the geometry of the instrument enables the line set for particular gases to be determined and hence the analysis of the sample placed in the source.

Many adaptions of the spectrometer principle exist. In the spectro-photofluorometer shown in Fig. 7, identification of chemical compositions is by virtue of fluorescent and phosphorescent characteristics of compounds. The molecules of the sample are excited by ultraviolet or visible radiation producing luminescence that radiates at longer wavelengths — the energy is transformed in wavelength. It is claimed that the sensitivity of this fluorometry technique exceeds normal spectrophotometry by several thousand times: parts in 10^{12} sensitivity is often obtained. A lot depends upon the substance being analysed, of course.

In the absorption technique, use is made of the property of a gas to absorb radiation, an effect that depends upon the wavelength of the radiation supplied and composition of the sample. The atomic absorption flame spectrophotometer shown in Fig. 8. became generally accepted reality in the 1960's after a decade of research at the CSIRO. Originally it was considered that emission spectra monitoring was the better way because the gas produced large amplitude signals. Overall, however, absorption monitoring is superior. The gas (or liquid) to be analysed is fed into a flame, through which radiation from special spectral-line lamps is passed. Study of the spectrum of the energy leaving the flame provides wavelength — amplitude relationships that are again unique to each gas. The reason for the superiority of absorption is that the source, being spectrally pure, enables a better overall signal-to-noise ratio to be obtained — in the emission method the detection signals include many unwanted emission lines that cannot be eliminated in the same way.

In spectrometers each gas is defined by its lines and their positions. Often they are not sharply defined and, further, the spectra may be very similar. One way to increase the certainty of resolution is to feed the scan signal obtained into a powerful

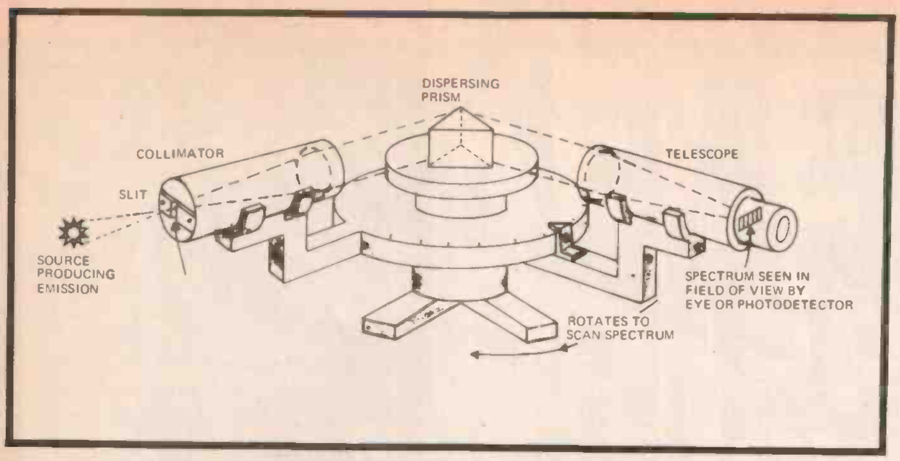

Fig. 6. In the optical spectrometer radiation from a gaseous source is dispersed to form a spectrum of lines and bands unique to each element.

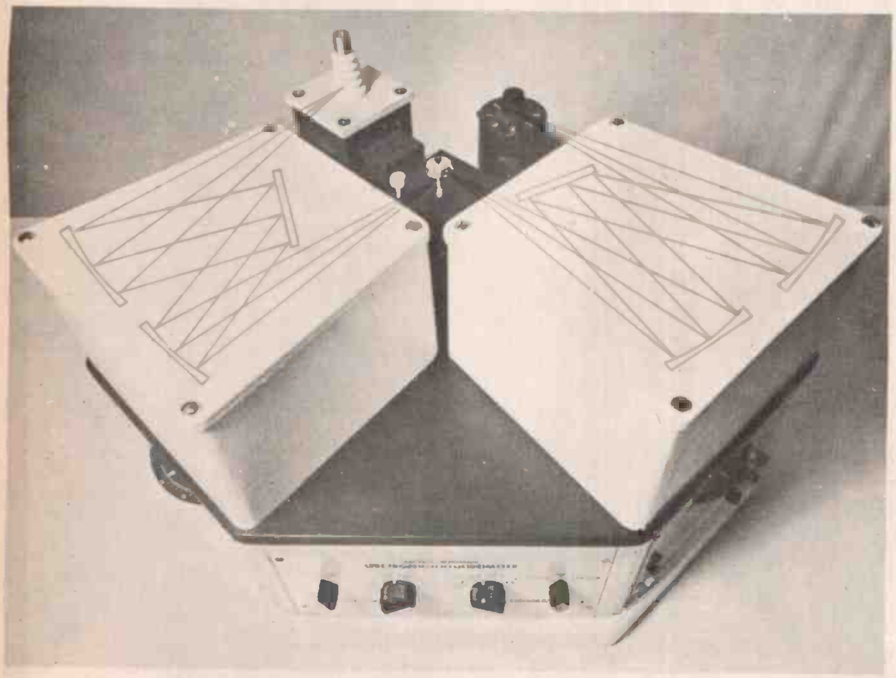

Fig. 7. The Aminco-Bowman spectrophotofluorometer. Lines superimposed show the optical paths of the excitation grating monochromator (on the left) that illuminates the sample placed in the centre and the emission dispersing grating monochromator (on the right) that is used to analyse the spectrum of the luminescence. The source is a Xenon lamp and the detector, a photo-multiplier of appropriate wavelength sensitivity.

Fig. 8. An atomic-absorption flame spectrophotometer.

digital computer and use correlation techniques (described earlier in flow measurement) to test the unknown with a standard spectrum. The use of a computer is, however, expensive. A more economical method uses a mask in the spectrometer exit slit that has a transmission-versus-position characteristic of the standard spectrum being sought. The unknown spectrum is vibrated across the slit and the total transmission of energy through both the mask and the exit slit is an optical correlation of the two. The amplitude of the signal with position of the mask provides a test of the match of the two spectra. The set-up used in a production correlation spectrophotometer is shown in Fig. 9.

The non-dispersive infared analyser, NDIR for short, is commonly used in air pollution measurements. Its principle is based on the selective absorption of gases but no dispersive element is involved, that is, no spectrum is formed. A heated wire provides broad-band infared energy which is split into two identical power beams, see Fig. 10. They are mechanically shuttered to first pass one beam, then the other at about 1Hz frequency. In the reference path, a transparent cell is inserted that is filled with a known non-absorbing gas at the infared wavelengths provided. In the other path the cell is filled with the sample gas. Both beams then impinge onto a common detector cell, also filled with gas. If the sample cell contains gas that absorbs energy the detector cell will be heated slightly less in one half of the cycle than in the other. This produces a cyclic heating effect that manifests itself as pressure changes in the detector. A microdisplacement transducer — capacitance perhaps, monitors the minute vibrations of a diaphragm mounted on the cell. Synchronous detection, derived from the chopper supply, enhances the signal-to-noise ratio. The fluctuations are rectified and converted to dc indicating the degree of absorption as the amplitude of the final output signal. Filter cells are used to reduce the risk of ambiguous operation by removing unwanted wavelengths before the radiation enters the sampling cell. The method is fast to respond having a response time of the order of seconds.

An NDIR instrument can detect carbon dioxide down to concentrations of 10 ppm but the pressure of carbon monoxide, water or methane can introduce considerable error. It can also be used to detect sulphur dioxide down to 2 ppm but again if water and carbon dioxide are present the results are invalid.

The principle used can also be worked in the ultraviolet range of the

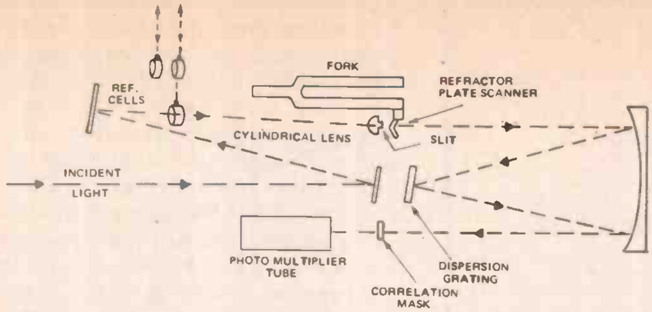

Fig. 9. Use of a mask to perform optical correlation of the spectrum of a vapour.

spectrum if a suitable source (tungsten lamp) and detector are used. Its main air pollution application has been for the detection of nitrogen dioxide from 5 ppm to 200 ppm concentrations.

To be continued next month . . . . .

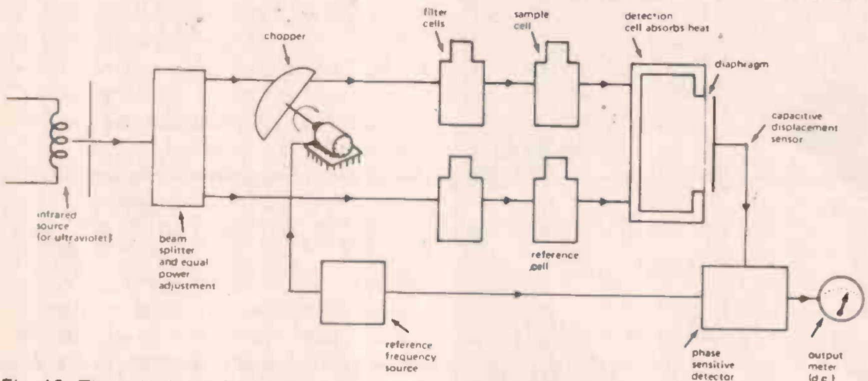

Fig. 10. The principle of the non-dispersive absorption analyser. The source is either in the infared (the NDIR instrument) or in the ultraviolet region.

"A Survey of measurement and control of pollutants" Garrod, D. J., *Trans. Inst. Meas. Control*, London, 1971, 4, 253-262.

"Where there's muck there's brass" Conway, A. *New Scientist*, 1972, 54, 376-378.

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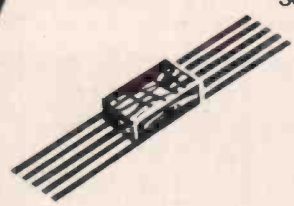

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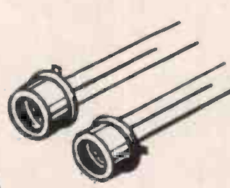

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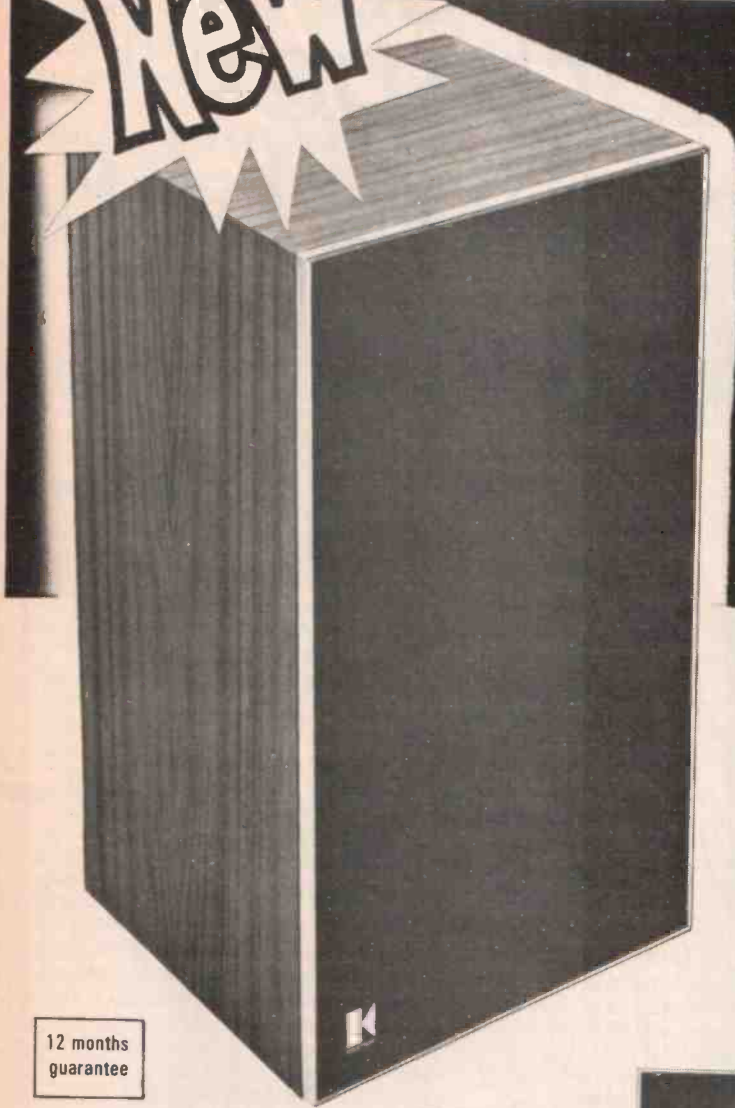

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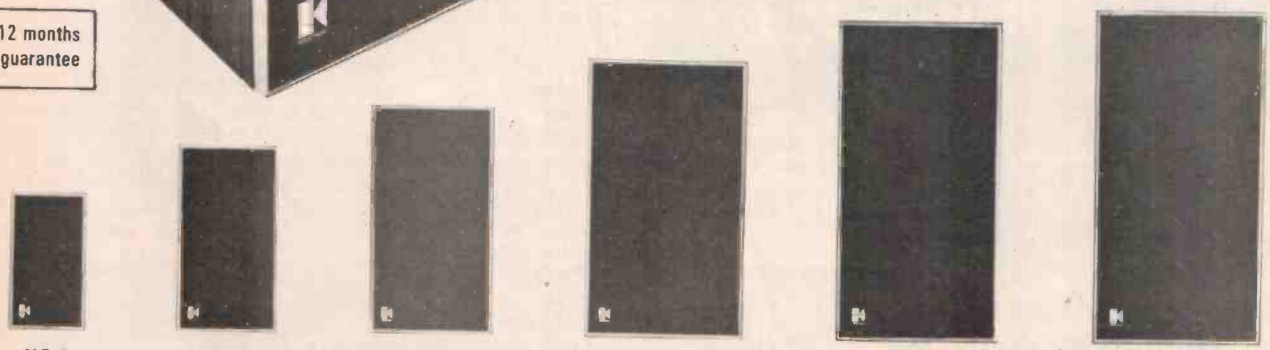

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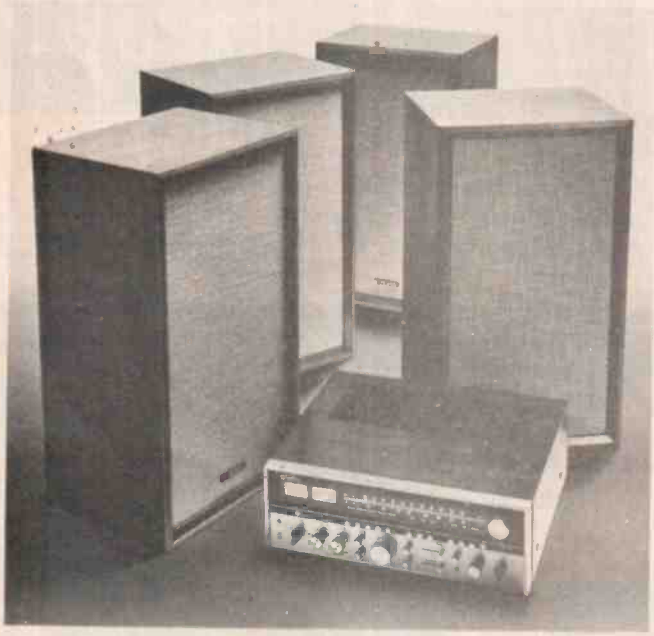

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Amplifier Section:	300 Watts at 4ohms
IHF music Power:	200 Watts at 8ohms
RMS Power	4×30 Watts into 4ohms 4×25 Watts into 8ohms
Harmonic Distortion: (at 1 kHz and rated output):	0.5%
Input Sensitivity and Impedance:	
Phono	3 mV/50 kohms
Aux	200 mV/50 kohms
Tape Monitor 1, 2, 3,	200 mV/50 kohms
Mic	2 mV/50 kohms
Frequency Response	20–50,000 Hz-3dB.
Residual Hum and Noise:	1.5 mV
Signal to Noise Ratio at rated output:	
Phono	73 dB IHF 60 dB DIN
Aux	85 dB IHF 80 dB DIN
FM Tuner Section	
Usable Sensitivity (IHF)	1.8 uV.
AM Tuner Section:	
Usable Sensitivity (IHF)	1.8 uV.
Image rejection @ 98 kHz	85 dB
IF rejection " " "	85 dB
Capture ratio	1.5 dB

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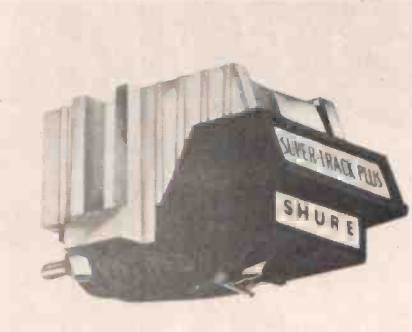
AUDIO NEWS

NEWEST SHURE CARTRIDGE

With the declaration 'anything II could do III can do better'. Shure Electronics Limited has announced the V15 Type III as the newest and finest pickup cartridge in the Shure range and a worthy successor to the V-15 Type II Improved.

The Type III significantly extends the state of art in pickup cartridge design to keep pace with advancements in both recording techniques and playback equipment, which are making ever-increasing demands on the capabilities of the pickup cartridge. As a result, the V15 Type III is claimed to establish new performance parameters for conventional stereo reproduction as well as setting new standards for performance in four-channel matrix systems.

Major contributors to the unique performance characteristics of the Type III are two new design achievements. One is an entirely new laminated magnetic core structure. The other is a new stylus assembly with a 25% reduction in effective stylus mass. When combined with other performance factors, the new core structure and stylus assembly give the V-15 Type III the following performance profile; Higher trackability at low tracking forces (¾ to 1¼ grammes); A virtually flat frequency response, with no noticeable emphasis to de-emphasis at any frequency; A significantly extended dynamic range, beyond even the V-15 Type II Improved.



Particularly noteworthy is the fact that all of the above performance features have been built into the Type III at no loss in output level.

Because of the low tracking force range, the V-15 Type III should be used only in arms specially designed for low tracking forces with low friction at all bearings. The Type III has a bi-radial elliptical diamond stylus. It is also available as the V-15 III-G with a spherical diamond stylus. A special bi-radial elliptical stylus, the VN78E, with a tracking force range of 1½ to 3 grammes, is available for playing monaural 78 rpm records.

Nominal list prices (including VAT) are as follows:–

Model V-15 Type III (with elliptical stylus £39.60

Model V-15 III-G (with spherical stylus) £37.95

Model VN35E Biradial Elliptical Stylus (as supplied with V-15 Type III) £16.17

Model VN3-G Spherical Stylus (as supplied with V-15 III-G) £14.52

Model VN78E Biradial Elliptical Stylus for 78 rpm records £15.18

Each purchaser of a V-15 Type III cartridge supplied by Shure Electronics Limited will receive a voucher entitling him to a free copy of a new test record called the 'Audio Obstacle Course – Era III'. The unique new record helps measure total cartridge performance by analyzing its most important performance characteristic: trackability.

For additional information write: *Shure Electronics Limited, Eccleston Road, Maidstone, ME15 6AU.*

GARRARD INTRODUCE QUADRAPHONIC TURNTABLE UNITS

Two new single play automatic transcription turntable units equipped with built-in decoders for reproducing 4-channel disc recordings have been introduced by Garrard.

In addition to playing 4-channel discs, these units are able to reproduce 2-channel stereo recordings in the normal way, or, by using the built-in Matrix decoder, the units can provide an enhanced 4-channel output from these 2-channel recordings.

To complete the 4-channel sound system these new units, the Garrard QZ 100S and the Garrard QSP 25 III, require a single 4-channel amplifier or two 2-channel (stereo) amplifiers, together with four loudspeakers, (L Front, L Rear, R Front and R Rear). As both these Garrard units provide high level equalised outputs, the amplifiers need not have high gain equalised inputs. Amplifier inputs commonly marked AUX or other inputs having a sensitivity of 200-500mV should be connected to the player output sockets.

The QZ 100S is the first system to combine an Automatic Transcription Turntable with built in decoders for both Discrete and Matrix 4-channel disc recordings. In addition stereo recordings can be reproduced in normal 2-channel or enhanced 4-channel modes.

The QSP 25 III system combines an Automatic Single Play Turntable with a built-in decoder for Matrix 4-channel disc recordings. Stereo recordings can also be reproduced in normal 2-channel or enhanced 4-channel modes.

LISTENING THROUGH FOAM

Speaker fronts of the future are likely to be made entirely of foam following a recent development by Declon Foam Plastics of Potters Bar, part of the Airfix Group. The company has completed research into cutting Selmat foam into a variety of patterns to give a 'sculptured' effect.

Selmat is a fully reticulated polyurethane foam which was originally developed for use by the air-conditioning industry as a long-life washable filter. When used as a speaker front it can be vacuum-cleaned.

In the United States, speaker front manufacturers have been using reticulated polyurethane foam for several years following the discovery of a chemical process which removes all the membranes from the foam to give 'accoustic transparency' (this is the process known as reticulation). It is believed that the quality of reproduction is, therefore, improved in speakers with foam fronts.

Further information from: *Robert Bevan, Hertford Public Relations Ltd, 193 Fleet Street, London EC4.* ●

MASTER

Assembly and operation of the power supply — overload indicator and metering circuits, and final assembly details are provided in this third article in the series.

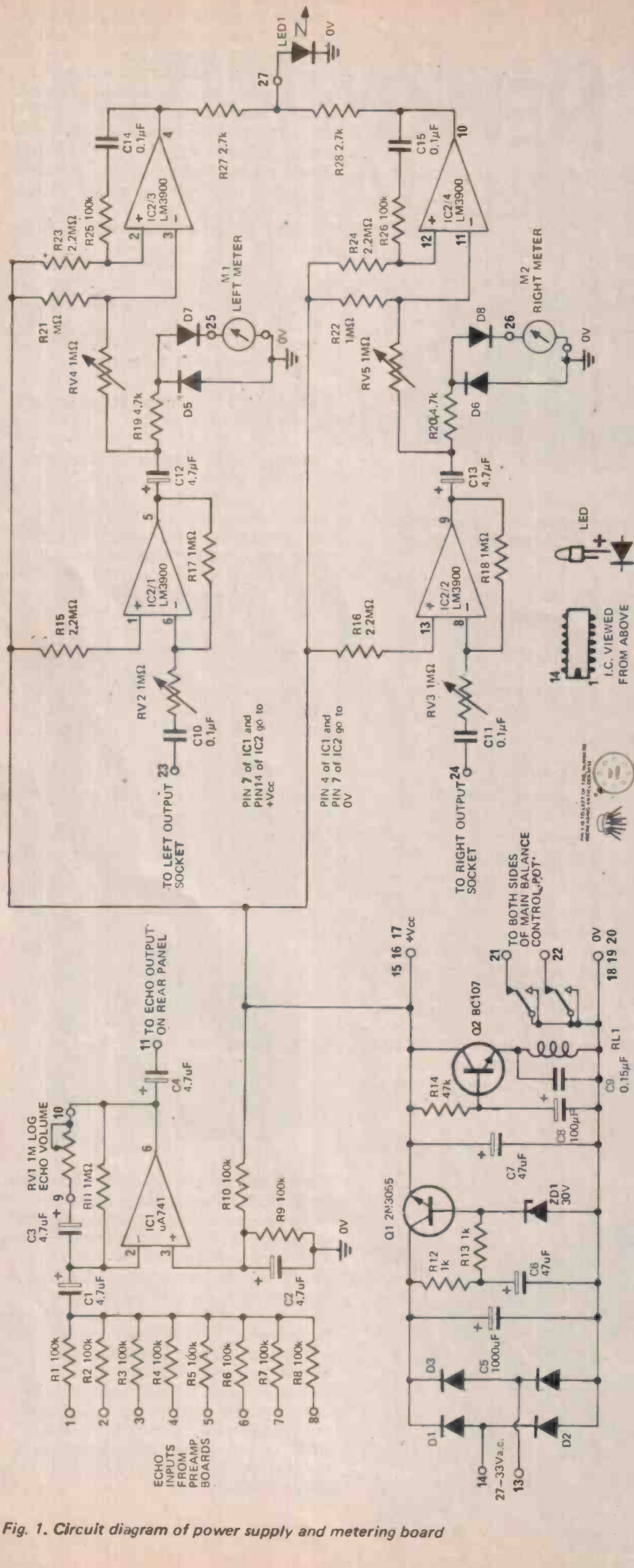


Fig. 1. Circuit diagram of power supply and metering board

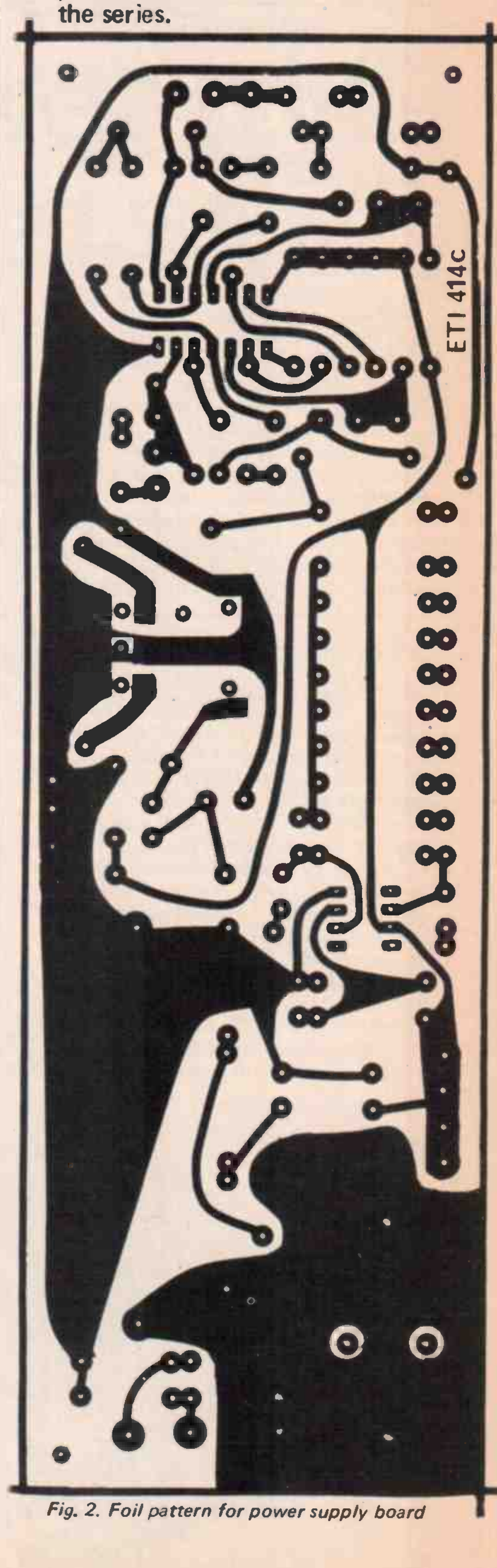
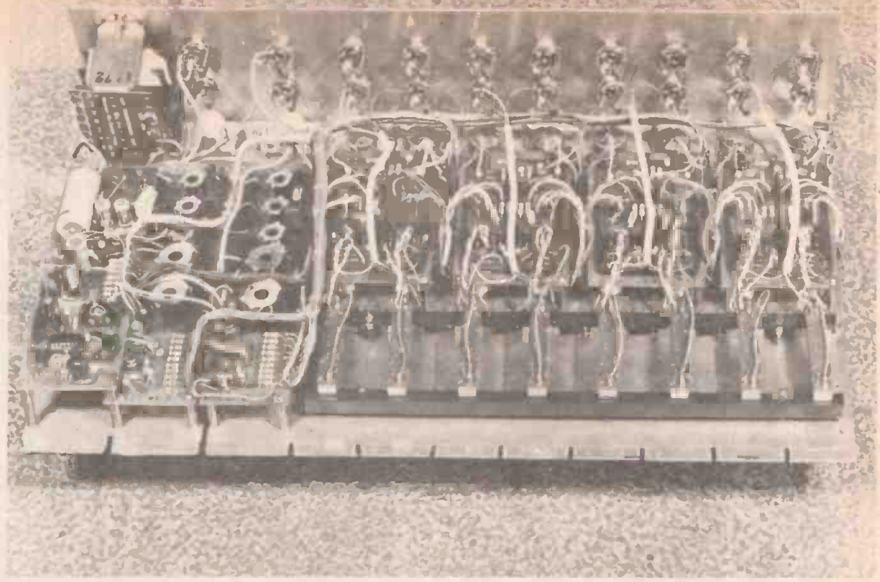


Fig. 2. Foil pattern for power supply board

MIXER



MASTER MIXER

THIS month we complete the last remaining board — that for the power supply and metering circuitry, and provide details of all wood and metalwork.

In the final instalment next month details will be given of how the circuitry can be modified and/or operating techniques devised to suit users' individual requirements.

CONSTRUCTION

Begin by assembling components to the power supply board in accordance with the component overlay (Fig. 3).

Ensure that IC's and tantalum capacitors are fitted to the board with correct orientation (refer to insets on circuit diagram. Use care, when soldering, to avoid heat damage to components — especially IC's. Use a

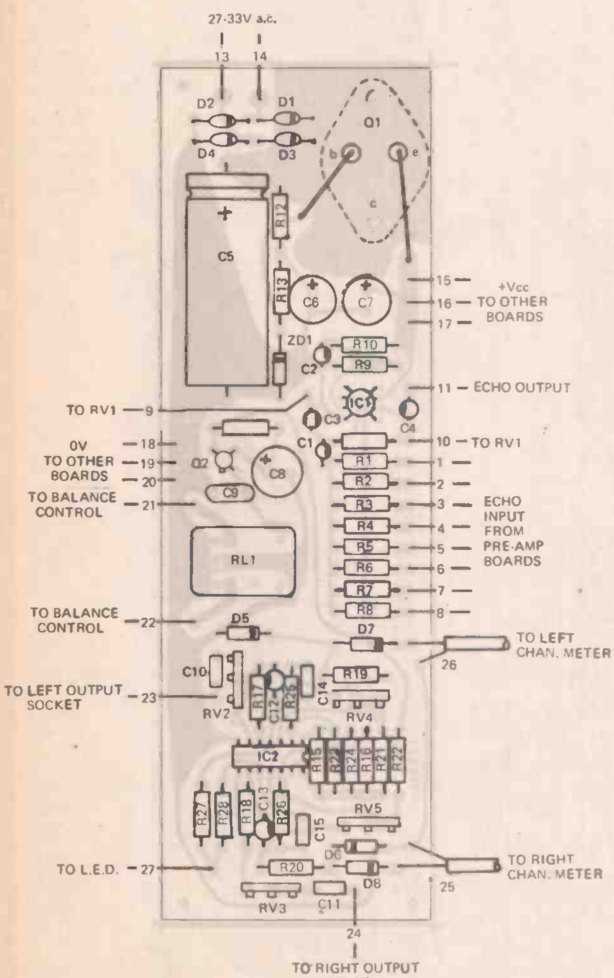


Fig. 3. Component overlay of power supply board.

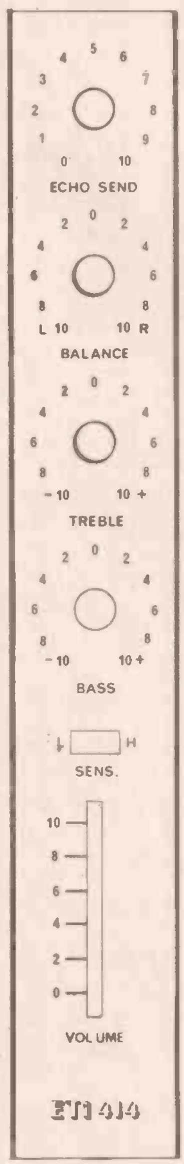


Fig. 4. Escutcheon for preamplifier (actual size 12" x 1¾").

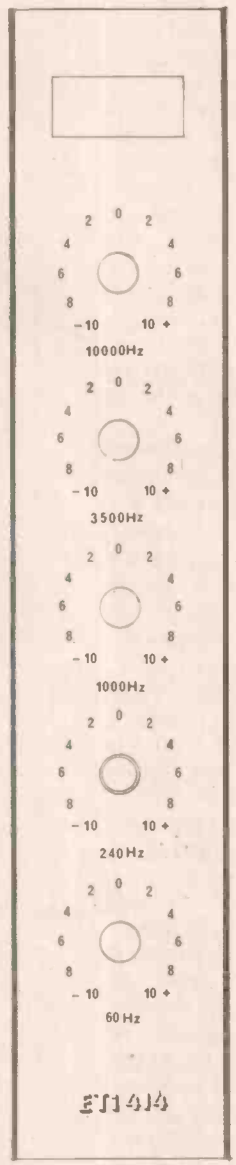


Fig. 5. Equalizer panel escutcheon (actual size 12" x 2¼")

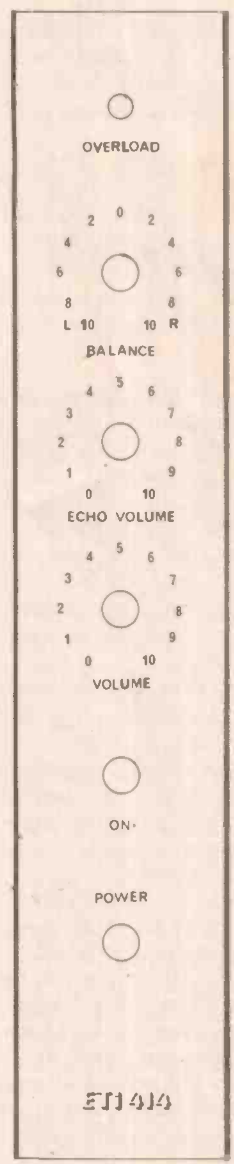


Fig. 6. Main control panel escutcheon. (actual size to be 12" x 2¼").

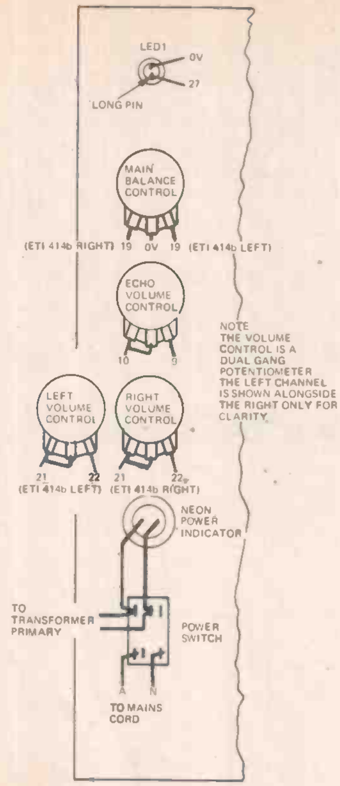


Fig. 7. Wiring to rear of main control panel.

light-weight, low-wattage soldering iron and work quickly.

Printed circuit boards purchased from suppliers may be varnished with resin or similar. Clean off the varnish where the 2N3055 regulator transistor is mounted, to allow electrical contact. Silicon grease should be used between the copper pattern and the transistor to aid heat transfer.

The pins of the relay are inserted into the holes provided in the board and bent to make contact with the copper tracks before soldering. We inserted pins to allow connection of the positive and negative supply leads which have to be routed to the various other boards.

There are three pins for positive leads and three for negative leads. Two leads connect to each positive pin (six leads total). The common leads from the four preamplifier boards and the two main mixer boards, are soldered to lugs secured between each respective board and one of its mounting pillars. Two of these leads are terminated at each negative pin on the power supply board.

By referring to the metalwork drawings and the photograph of the unit, boards and other components

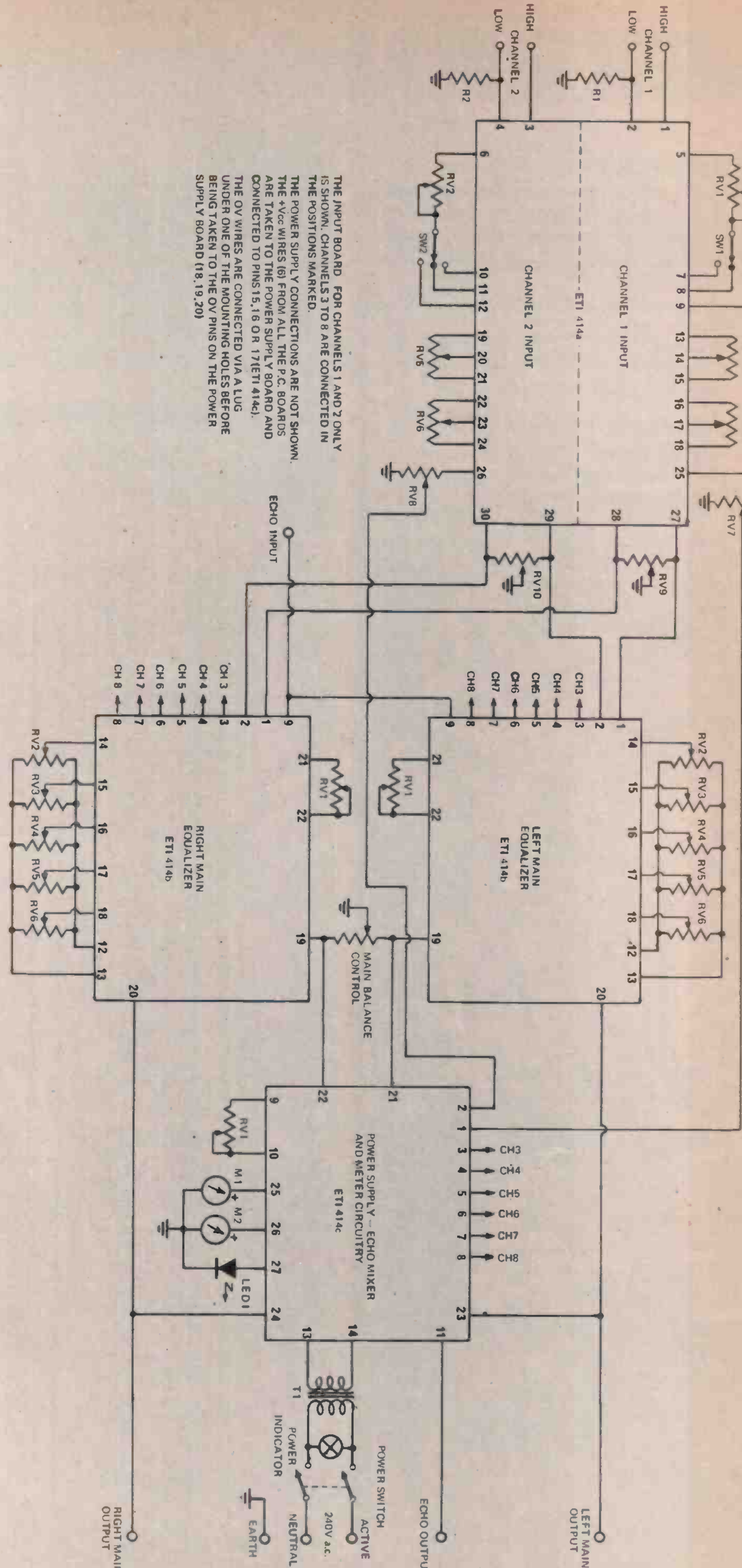


Fig. 8. Main interconnection diagram.

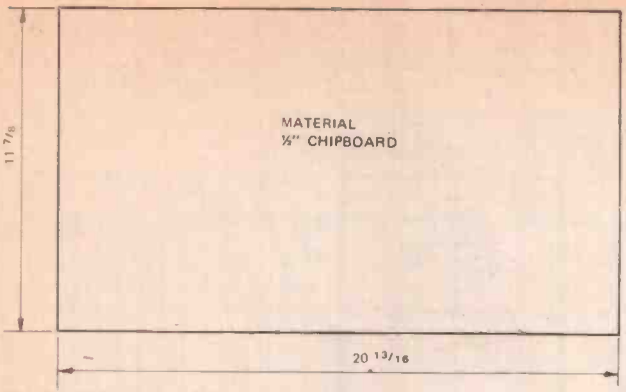


Fig. 9a. Cabinet baseboard.

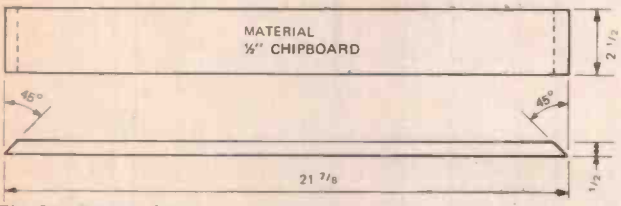


Fig. 9b. Cabinet front

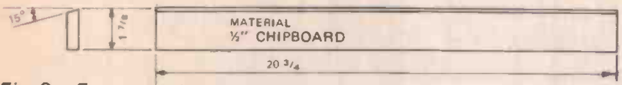


Fig. 9c. Front panel support

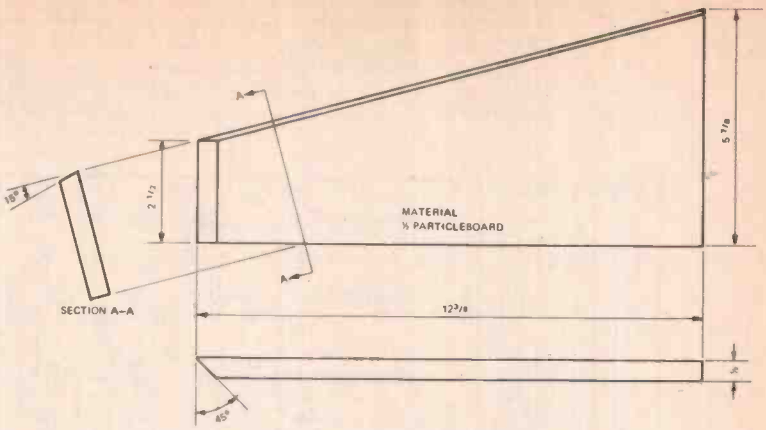


Fig. 9d. Cabinet sides — two required. Note that boards should be mirror image of each other, that is, chamfers should have opposite slope.

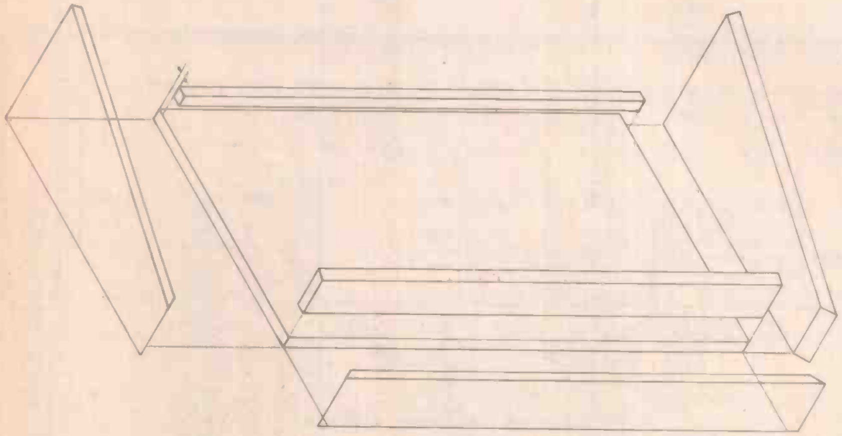


Fig. 10. Cabinet assembly details.

may be mounted to the panel in the following order.

1: Each preamplifier board is mounted on three 1" long threaded pillars. The main mixer – equaliser boards each employ four of these pillars which should be secured to the front panel with countersunk screws.
2: Mount the VU meters, with countersunk screws.
3: Mount the sensitivity switches.
4: The slide potentiometers are mounted on two rails, each of which is spaced from the chassis by four, ¾" long threaded pillars – eight in all. Ensure that pin 1 of each potentiometer is orientated towards the front of the panel.
5: Glue on the escutchions with contact cement and mount the rotary potentiometers, switches and indicator lights.

Note: Two of the escutchions will have to be drilled to allow the front panel to be secured (see the metalwork diagram).

6: Mount the input jacks on the rear of the panel.
7: Mount the transformer and the printed circuit boards.

This completes the front panel assembly and we can now make the interconnections.

WIRING THE UNIT

The interboard wiring should be carried out with reference to the underchassis photograph and to the interconnection diagram, Fig. 8.

All wiring should preferably be colour coded and should be routed down one side only of each board so that the board may be swung-up, sideways, if servicing is required at some later date.

Use one mil plastic tubing, or lacing twine, to tie the wiring into looms. This, as well as improving the appearance of the unit, also facilitates servicing.

Leads to the VU meters, output sockets, echo input and output sockets, and the main balance control must be in screened cable. These and, as far as possible, all other wiring should be kept well clear of the mains transformer to prevent hum pickup.

WOODWORK

Cut the five pieces shown in Fig. 9 from ½ inch chipboard, note that the two pieces cut as per Fig. 9d are mirror images of each other. Veneer the inside surfaces of the two sides (Fig.9d) and the front strip (Fig. 9b).

Assemble the box as per Fig. 10. Screws or nails should be used to hold the panels together while the glue sets. Take care to ensure that the sides are square to the base, otherwise the metal panel may not fit in place. In fact it is a good idea to use the panel as an assembly guide. The support piece (Fig. 9c) is assembled with the short side to the front. The rear panel support is merely a half inch square piece of timber, positioned 3/8 inches from the rear edge of the base (Fig. 10).

When the glue is set, the box can be sanded and all visible outside surfaces veneered, before final sanding and finishing operations are carried out. The inside of the box should be lined with cooking foil, and this earthed to the metal chassis. If the foil goes over the rear panel support, the metal panel will make contact with it and no other connection need be used.

TESTS AND ADJUSTMENTS

Before initially switching on, remove from the power supply board the +Vcc

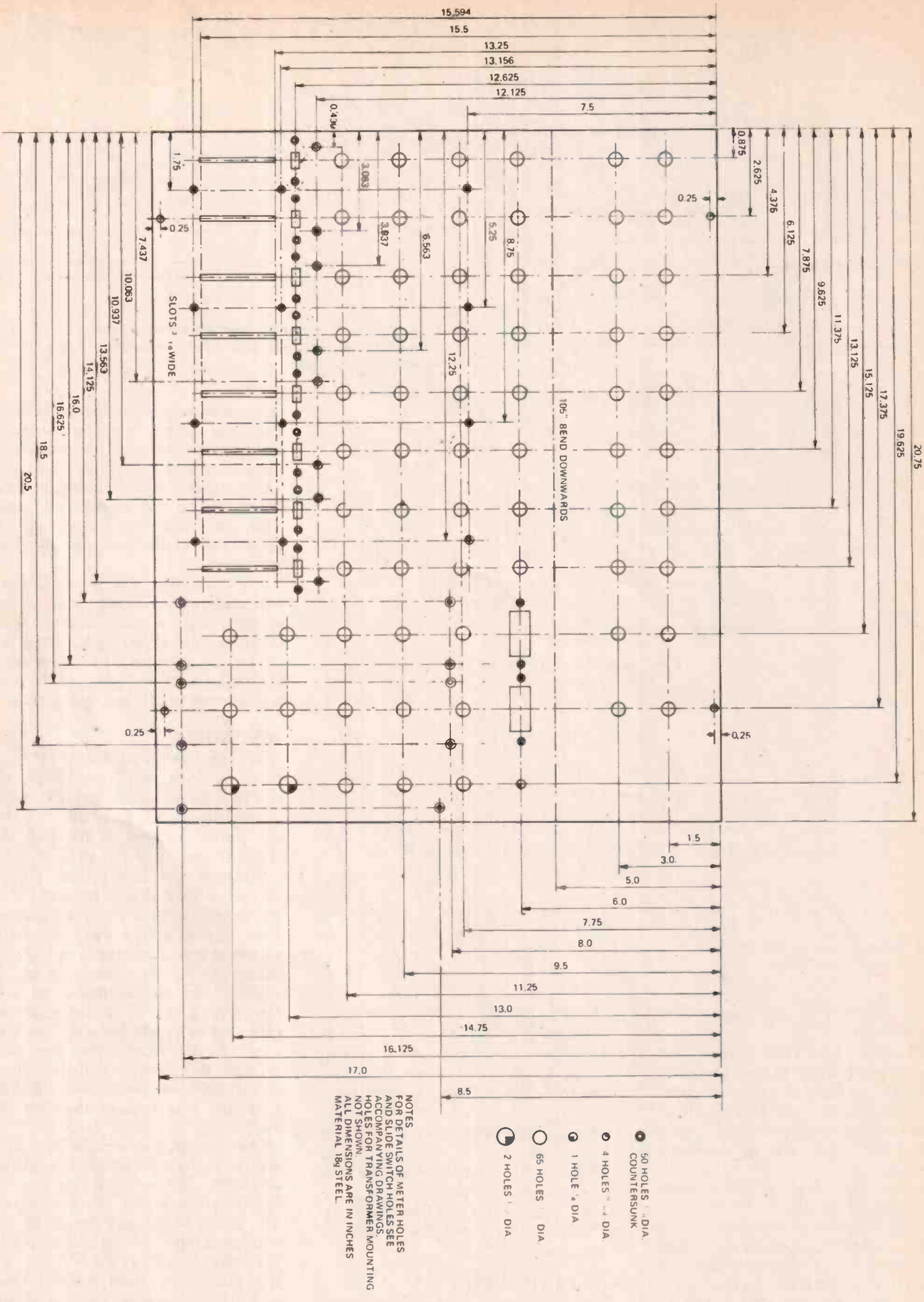


Fig. 11 Drilling details of front panel. The holes for the meters and slide switches should be cut to suit the type used.

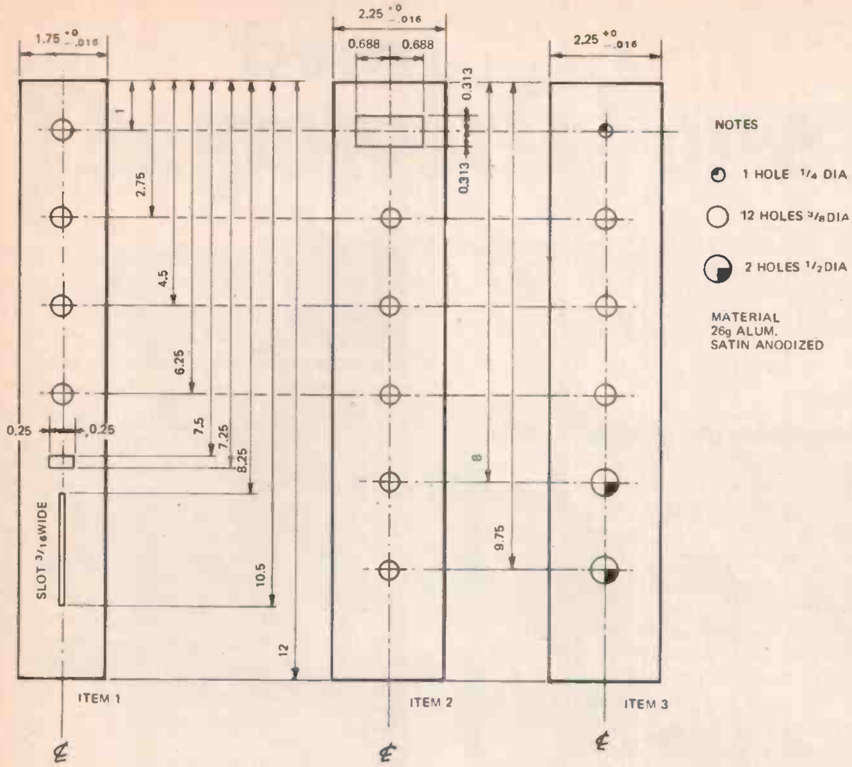


Fig. 12. Drilling details — Item 1: preamplifier panel. Item 2: equalizer panel. Item 3: main control panel.

PARTS LIST FOR POWER SUPPLY BOARD ETI 414

R1	Resistor	100k	½W	5%
R2	"	100k	"	"
R3	"	100k	"	"
R4	"	100k	"	"
R5	"	100k	"	"
R6	"	100k	"	"
R7	"	100k	"	"
R8	"	100k	"	"
R9	"	100k	"	"
R10	"	100k	"	"
R11	"	1M	"	"
R12	"	1k	"	"
R13	"	1k	"	"
R14	"	47k	"	"
R15	"	2.2M	"	"
R16	"	2.2M	"	"
R17	"	1M	"	"
R18	"	1M	"	"
R19	"	4.7k	"	"
R20	"	4.7k	"	"
R21	"	1M	"	"
R22	"	1M	"	"
R23	"	2.2M	"	"
R24	"	2.2M	"	"
R25	"	100k	"	"
R26	"	100k	"	"
R27	"	2.7k	"	"
R28	"	2.7k	"	"

RV1	Potentiometer		1 Meg Log
RV2	"		1 Meg Trim type
RV3	"		1 Meg " "
RV4	"		1 Meg " "
RV5	"		1 Meg " "
C1	Capacitor	4.7µF	35V Tantalum
C2	"	4.7µF	35V Tantalum
C3	"	4.7µF	35V Tantalum
C4	"	4.7µF	35V Tantalum
C5	"	1000µF	50V Electrolytic Wire leads
C6	"	47µF	50V Electrolytic PCB mounting
C7	"	47µF	50V Electrolytic PCB mounting
C8	"	100µF	50V Electrolytic PCB mounting
C9	"	0.15µF	100V Polyester
C10	"	0.1µF	100V "
C11	"	0.1µF	100V "
C12	"	4.7µF	35V Tantalum
C13	"	4.7µF	35V Tantalum
C14	"	0.1µF	100V Polyester
C15	"	0.1µF	100V "

D1-D4	Diodes 1N4001, or similar
D5-D8	" 1N914
LED1	TIL209
ZD1	Zener Diode BZY8830V
IC1	Integrated Circuit LM307, µA741 (metal can or minidip)
IC2	Integrated Circuit LM3900 (National Semiconductor)
Q1	Transistor 2N3055
Q2	" BC107
PC board	ETI 414c

Level indicator edge meters 400µA 410ohms, type PV31 or similar (two required).
Brass spacers, ½" by 1/8" clearance hole (three required).
Brass spacers, 1", tapped 1/8" (two required).
Phone jacks 6.5mm (two required).

Transformer 240V primary 27-33V secondary —200mA.
Power switch dpdt (or similar).
Neon indicator 240V (chassis mounting).
Three-core flex and plug, nuts, bolts, etc.
Relay 1250 ohm, miniature type, two change-over contacts.

wires leading to the preamplifier and mixer boards making sure they cannot touch other circuitry. Rotate the trim potentiometers to their mid position and switch on. Check the voltage between the Vcc and OV terminals. This should be between 27 and 32 volts. If not, there is a fault in the supply which should be located before proceeding further.

Using an oscillator, feed a signal into the output socket of the left channel. An indication should be visible on the left hand meter. Set the input level to that required to drive the power amplifier to full output (1V for the ETI 413 amp.), and adjust RV2 to give full scale deflection. Now adjust RV4 to the point where the LED just stops flashing. Now repeat the process for the right channel, adjusting RV3 for full scale deflection and RV5 for LED indication. This completes the metering circuit calibration.

Now connect the equalizer boards and one of the preamplifier boards. This preamplifier can be checked either with an oscillator or a microphone. Check that the gain increases when the sensitivity switch is moved to the right, also that the tone controls give maximum boost when moved clockwise. Make sure that the balance control operates correctly and the wires going to the mixers have not been crossed.

Add the other preamplifiers one at a time testing each as above. When all the above procedure is complete the unit is ready for operation.

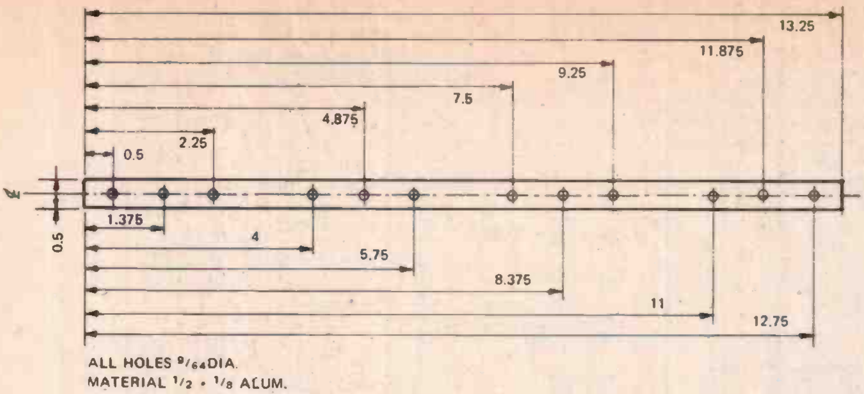


Fig. 13. Slide potentiometer support bars (two required)

HOW IT WORKS

MASTER MIXER POWER SUPPLY

The power supply is of conventional design. Any transformer which will supply 27 to 33 volts at 200mA will suffice. The regulator employs a 2N3055 as a series regulator, and by virtue of the 30V zener diode between the transistor base and the negative rail, maintains the output voltage at approximately 29.5 volts.

At switch-on Vcc rises immediately but the output of the unit is shorted out by relay RL1 for approximately four seconds while C8 charges exponentially via R14. Transistor Q2 is simply an emitter follower driving relay RL1. The voltage at its emitter is approximately 0.5 volts less than that on capacitor C7. After approximately four seconds the voltage across the relay rises sufficiently to activate it, removing the short from the output.

This prevents accidental damage to power amplifiers due to switching transients or other warm-up anomalies.

ECHO MIXER

The echo mixer is straight forward. As indicated earlier there are eight separate inputs. These receive signals from the input channel echo-send controls. The gain of the echo amplifier is controlled by RV1 which varies the negative feedback. The output goes to the echo output socket on the rear panel. From here it is intended to pass through an echo tape, reverberation unit, or similar type of device before returning to the unit and being split equally to provide an input to each main mixer stage.

METERING CIRCUITS

The metering and overload indicator circuits employ a quad-amplifier IC type LM3900 from National Semiconductor. This package accommodates four independent, internally compensated amplifiers which are designed to operate from a single power supply voltage and to provide a large output voltage swing. Each amplifier makes use of a "current mirror" to provide the non-inverting input.

Unlike a normal operational amplifier, the two inputs are current driven, not voltage. This means that when used as an amplifier the output tries to balance the current in the two inputs. Therefore an initial bias is required. This is provided by R15. For the amplifier to be balanced, an equal current must flow in R17. This sets the quiescent output voltage to approx. 15V.

The ac voltage gain is equal to R17/RV2 where RV2 is the preset value of RV2. The meter is driven by R19 and rectified by D5 and D7.

The second stage (IC2/3) is a comparator-monostable. Both inputs of this amplifier are biased from the supply rail although the current is higher into the negative input. Since this is outside the linear region the output is almost at 0V. When in use current is being added and subtracted to the current into the negative input.

If enough current is subtracted, such that it is less than the current into the positive input, the output of the IC will go high. Due to the positive feedback of R25 and C14 the IC will stay in the high state for approximately 0.1sec, even if the initiating signal has ceased. The overload light LED1 is on while either monostable (IC2/3 or IC2/4) is high.

If the output is continuously high the light will flash rapidly.

Two of these amplifiers are employed in each of the metering indicator circuits. A variable resistor in series with the input to the first amplifier allows zero VU to be adjusted for outputs in the range of 100mV to 3V.

If a single transient exceeds a preset level the indicator light will flash for approx 100 ms. This will allow the "transient" to be seen and thus act as a warning. On a continuous overload the light will flash rapidly. With the ETI413 amplifier this level should be approx 1V rms.

Protecting reed relays

SEALED contact reed relays provide the designer with a versatile means of interrupting current flow. They are inherently reliable and can be actuated in a wide variety of ways. In common with all contact switches, however, life can be substantially reduced unless action is taken to protect the contacts from excessive current or voltage surges.

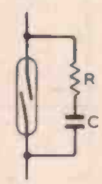
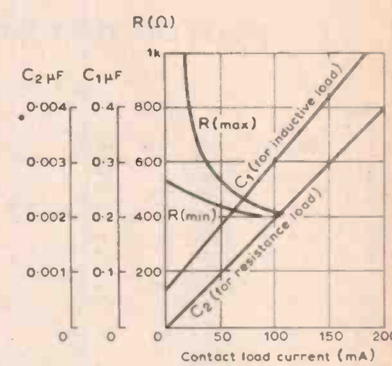


Fig. 1. The circuit arrangement is shown on the left. The values for C and R should be selected from the chart shown below.



Experience has shown that contact failure is often due to transient overloads of which the designer may be unaware. It is good engineering practice to connect a series CR network across the contacts to prolong contact life as shown in Figure 1 (a). Such a network will protect the contacts against damage which may otherwise occur when the current through resistive or inductive loads is interrupted. Figure 1 (b) gives the values of both C and R for various currents and loads.

The low cold resistance of incandescent lamps and the low initial impedance of capacitive loads cause very high currents to flow when the controlling relay contacts close. To protect the contacts under these conditions a limiter should be connected in series with the load; i.e., thermistor or choke.

The powerful one

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ET14

BSR McDONALD

It's a sound start

DX MONITOR

Compiled by Alan Thompson

STARTING A NEW DX feature is as problematical as playing the horses: the odds are heavily stacked against you and it is a miracle if you manage to break even, let alone win ! Who's going to read it? Do you 'beam' it at the novice or the expert, or do you play safe and write the piece for the mythical Mr Average? One aims for lots of positive feedback from one's readers so your letters and comments will be read with the greatest of interest. If you want a personal reply, then, please, enclose a s.a.e. with your letter — you'll find my address later in this article.

What is this DX business all about? Folk-legend has it that DX is an an old telegraphic abbreviation for 'distance' — could be, but I'm not that old! Anyway, these days it is a nice simple way of expressing an interest in the reception of radio stations which are, either (a) very far away, or (b) not so far away but difficult to hear for some reason or other. (By the way, I shall be writing about broadcast DXing, shortwave mainly, leaving the esoteric pastimes of chasing amateur DX and medium-wave DX to the specialist in those fields).

EQUIPMENT

That photograph of my receiving set-up may give you the idea that DXing is not possible without a great deal of complex equipment. Nothing could be further from the truth! I would not suggest that a medium-priced transistor receiver is the *ideal* for serious DXing but one really needs nothing much more complex to get well established in the DX hobby. There are still a goodly number of ex-government professional Communication receivers on the second-hand market and most of them will leave you some change from £60 or so. Some worthwhile acquisitions in this field are the old Marconi CR100 (now selling at around the £20 mark); the famous R.C.A. model AR88D and the fine G.E.C. BRT-400 and 402 series of receivers. Do, though, buy from a really reputable radio dealer and be cautious of private sales or you may acquire a receiver so mucked-about by its late owner that even he — who knows what mods he has made to it! — can't get it to work properly again. Truly, *caveat emptor!*

So........why have I got all the gear that appears in the photograph? What happens is that you start off with an ordinary Communication receiver and a suitable loudspeaker or headphones. Sooner, rather than later, you will decide that a few additions to the gear are in order, and a suitable order for such buys would be a Q-multiplier (to help you separate adjacent stations); a pre-selector (to add a bit more signal at the aerial terminal); a frequency meter (for measuring frequencies accurately). Now you need some system of switching those items in and out of circuit and, probably, a choice of a couple of aerials, too. This is where the complications start (!) and if you continue along this course you, too, will end up with a set-up like mine which does simplify switching this to that, and back again, and — let's face it! — looks quite impressive if not akin to an advanced game of cat's cradle!

PROPAGATION

Propagation of long-distance radio signals is a subject not lacking in literature! Most advanced DXers will know of Kenneth Davies' book 'Ionospheric Radio Propagation' (published by the U.S. Department of Commerce at $2.75). Far be it for me to quarrel with any of Mr Davies' conclusions — the book is a standard work that no DXer interested in propagation can afford to be without even if the treatment is somewhat mathematical for our Mr Average.

Any professional radio-physicist whose eyes have strayed to this page can now go and hide in the corner — this explanation is not for you. To quote Mr Davies: 'To a first approximation, the earth's magnetic field is that of a sphere uniformly magnetized in the direction of the centered dipole axis', with the Boreal Magnetic Pole at 78.3°N., 69°W., and the Austral Magnetic Pole at 78.3°S., 111°E. This magnetic field is subject to disturbance by solar activity causing the field to move south (in the Northern Hemisphere), sometimes with the visual appearance of the Aurora Borealis. These days the extent of Geomagnetic Activity is commonly denoted by an index known as A_{FR}, the values of which are broadcast at 18 and 48 minutes past each hour by the U.S. National Bureau of Standards station, WWV, on, inter alia, 5, 10 and 15MHz, in plain language.

Considerable work has been done in the U.S.A. by Gordon Nelson, of the National Radio Club, on the way in which the A_{FR} index affects trans-Atlantic reception of medium-wave stations, and,

INTRODUCING ALAN THOMPSON

Alan Thompson joined the World Communications Club in 1964, and soon became General Editor of 'CONTACT' (1966-1969) when he left to set up his own private bulletin for specialist DXers, known as 'Bandspread' — now a very active, private, restricted membership DX Club.

Prominent in European BC-band DXing from the early days of European DX Council, ABT — as he is universally known — became its Secretary-General 1969-70, after being an active member of EDXC's Statute Committee. Active, too, as a broadcaster on DX topics, ABT was an early, and regular, free-lance contributor to B.B.C.'s 'World Radio Club', leaving it in October 1969 to start a new DX programme for Deutschlandfunk's English Service. That programme, 'DX-CIRCLE', is still running and now approaches its 100th edition, all written, presented and hosted by ABT. Radio Nederland, Radio RSA and Radio Finland have all heard Alan's voice in their DX sessions at one time or another.

His articles have appeared in 'World Radio-TV Handbook' and in 'How to Listen to the World'. DX bulletins all over the world have carried his serious, and tongue-in-cheek, output over the last 10 years. DX achievements amount to something over 200 broadcast radio 'countries' heard and nearly 200 verified. Currently, the main receiver is the superb 'Racal' RA17K with (as the photo shows) auxiliary gear galore, and a choice of half-a-dozen aerials. Areas of special interest are Africa and Asia and topics of special appeal are long-distance propagation of DX signals, as well as an absorbed fascination in the Russian and Chinese stations of which so little is still known. ABT says this brings out the cross-word addict in him — it's very similar! Just putting this little piece of knowledge or inspired guess into the immense jig-saw that will never be completed!

basically, the conclusion is that A_{FR} values exceeding 30 have the effect of absorbing those signals and making such reception impossible. Recently Don Jensen (U.S.A.), John Taylor (of Manchester) and myself — amongst others — have been looking at the A_{FR} figures in relation to reception on the low-frequency short-wave bands (i.e. the 120, 90, 75 and 60 metre bands). First conclusions are that A_{FR} figures over, say, 30, reduce the likelihood of reception of paths that travel through the auroral zone which moves south in such conditions. However, the plus part of this is that reception from a southern direction is enhanced under these conditions so it is worth keeping an eye on those A_{FR} figures if you are an African DX fan. A lot more checking needs to be done but it is a theory worth checking out for oneself.

WHAT TO LISTEN FOR

What's there to hear in mid-Summer? Putting on my clairvoyant's hat as so much depends on day to day conditions, the probabilities are that the international broadcast bands from 49 metres down to 13 metres will be active in the daylight hours with activity increasing on the higher metre bands as darkness falls. Try some of these which ought to make some nice DX catches (all frequencies in kHz times GMT).

3331	ORTF Comoro Is	In French fade-in about 1900 to 1930 s/off with 'La Marseillaise'
3380	Radio Malawi	In English and vernaculars usually around 1900 to 2100
3970	Radio Buea, Cameroon	Mixed French and English programme from about 2000 to 2200 or so
4627	Radio Sahara	Can be heard in Hassania (an Arabic-dialect) and Spanish: carries RNE news in Spanish at 2100
4905	Radio Relogio	Interesting Brazilian station heard 2200 onwards with time signals from National Observatory over the programme
4926	R Bata, Rio Muni	Often heard 2000 onwards with much light music and Spanish announcements
4976	R Kampala	English Service here through evening: try 1930-2100 approx. also try the alternative service on 5026kHz.
5010	HIMI R Cristal Dominican Republic	Has lots of nice light LA music and Spanish announcements: good after 2300
5015	Radio Grenada	Used to be Windward Islands Broadcasting Service: this is a Home Service channel closing about midnight
5970	RTV Dominicana	Has just re-appeared here with a high-power transmitter: has some English but mostly Spanish, say 2300 to as late as 0400 GMT
15230	ABC Melbourne	Not an easy one this! Is the Australian Broadcasting Commission Home programme — try it around 0230 when often quite fair.

Last of all, keep watch on the 120m.b., in the range 2200 — 2500kHz about 0001-0200. There were some surprising receptions of South America here last year in the few days around mid-summer.

Any old books meant for the junk-man? I'm interested in 'World-Radio Handbooks' and copies of 'How to Listen to the World' of the period 1946-1964. Part of my collection was lost in a house move some years back and I would like to build up the library again. Do get in touch with me if you have any items of this period that you would be prepared to dispose of — I can promise them a really good home! My address is Alan Thompson, 16 Ena Avenue, Neath, Glamorgan SA11 3AD and your letters, news and comments will be much appreciated — but don't forget that s.a.e. if you want a personal reply, will you? Until we meet again, the best DXing to you all! ●

(Continued from page 27)

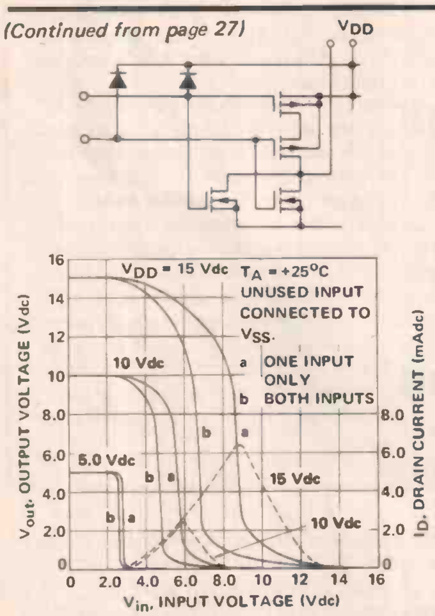


Fig. 4. The schematic of a CMOS two-input NOR gate and typical dc voltage and current transfer characteristics.

offer that is unique? Basically, there are three main advantages to CMOS: ultra low power; very high noise immunity; and wide operating voltage ranges. How then do these attributes create a favorable economic picture for CMOS?

Let's look at system power costs. A typical cost for a commercial system power supply could be 50p per watt of delivered power. To understand the significance of this power cost, consider that three MSI bipolar functions consume about one watt, or 17p per function for power supply costs. As CMOS elements only consume microwatts of power (1 watt would power about 50 CMOS devices) the cost per function would be only 1p, a dramatic difference.

A small-system bipolar design using a 5V/15 A supply would as a result cost about £35 for just the power supply alone. The same system using CMOS would probably run on 10V/150mA, which could be implemented with a low cost IC regulator for a few pounds. Where do these "lost" pounds go in a bipolar design?. . . They are swallowed-up by the cost of large filter capacitors, big heat sinks, hefty 15 or 20A transformers, power-draining cooling fans, and large power transistors. Eliminating these parts highlights another inherent advantage of CMOS — space savings!

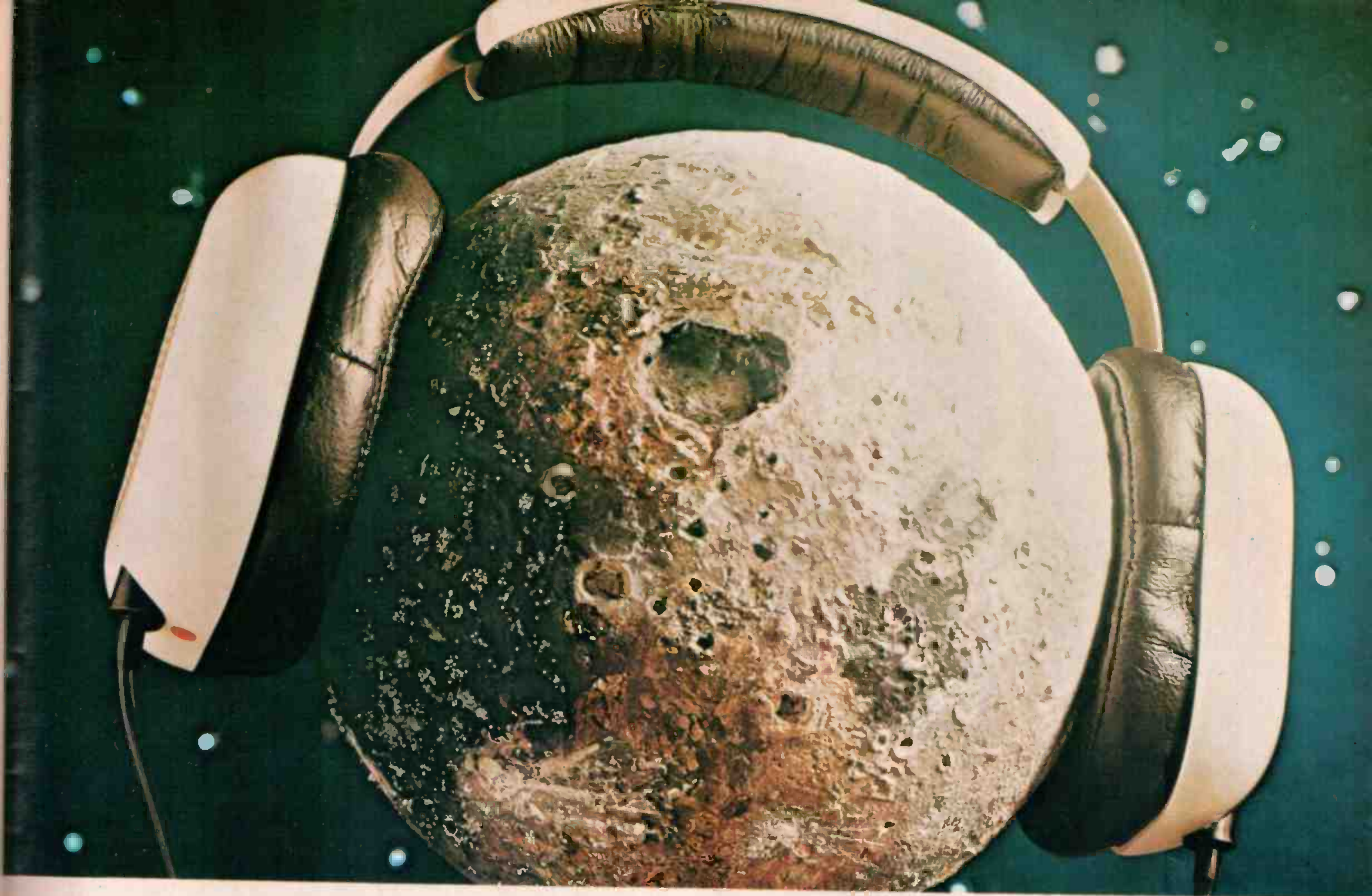
Other system savings that help make CMOS an economic reality today are: single-sided PC boards (no need for exotic ground planes); no bypass capacitors (slow rise and fall times); smaller PC boards (more complex functions in CMOS); single power supply operation (CMOS operates at any voltage from 3V to 18V depending upon system need, for instance, 15V for hybrid analog/digital systems); and finally space savings (since CMOS runs cool to the touch it can be packaged in high densities without the need for forced air cooling).

Clearly, there must be both a rapidly growing market for CMOS as well as a number of suppliers building that market. A look at Figure 1 shows recent Motorola CMOS market projections for the coming half-decade.

As for the suppliers, in the great CMOS standard product race, the list now includes, in addition to Motorola, RCA, Solid State Scientific, Solitron, Hughes and National.

The question we started out to answer was, "is 1973 the right year for CMOS?" The overwhelming weight of evidence shows that the right number of complex functions are available today; there are multiple vendors in the business; system economics favor CMOS; and, finally, that the market growth figures all clearly point to 1973 as the pivotal year for CMOS. Thus, 1973 is the right year for new system design with CMOS — "The Logic of the Seventies." ●

Acknowledgements: R.P. Komatz Motorola Semiconductors.



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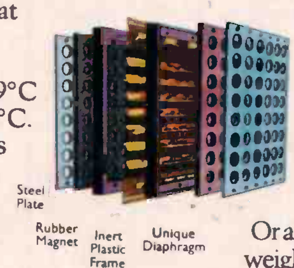

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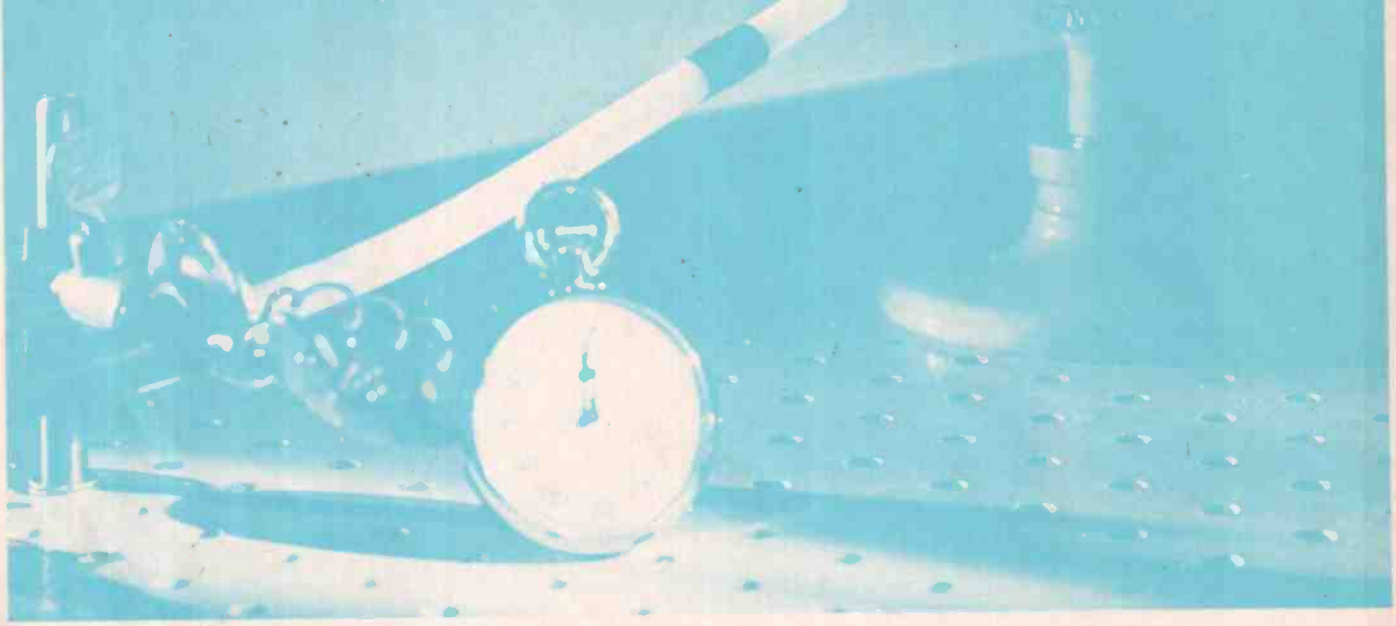
ELECTROSTATIC COOLING

Has Oscar Blomgren discovered a fundamental new principle?



LIKE philosophy, science has many examples of workable conclusions arrived at by what are later found to be the wrong reasons.

Oscar Blomgren's discovery of electrostatic cooling may well be the ultimate extension of this phenomonen – for here is a workable concept for which there are no really satisfactory explanations at all!

What Blomgren appears to have discovered is a new fundamental principle. In essence, his discovery is that heat may be removed from hot objects by the effect of a non-arcing ionic corona discharge from the negative ends of high voltage probes.

The technique is as simple as it is effective – the equipment required is merely a thin probe connected to an electrostatic generator, (even a basic van de Graaf generator may be used to demonstrate the effect). The probe is simply pointed at the (earthed) object to be cooled.

Cooling is rapid – a red hot sheet of metal may be reduced in temperature by several hundred degrees in a second or two – a Kleenex tissue prevented from igniting whilst suspended directly over a lighted gas jet.

Blomgren says that the precise mechanism of the effect is not understood. One explanation appears to be that a thin boundary layer of air clings to heated surfaces, and this boundary layer acts as an insulating barrier, inhibiting the rate at which adjacent cooler air can carry away the heat.

By creating an electrostatic field, vortex columns are created that 'pull in' cooler air from regions *beyond* the normal boundary layer. The swirling, turbulent air currents thus produced apparantly enable the heat transfer rate to be enormously increased.

Only a small amount of power is required to reduce temperatures through hundreds of degrees. In one experiment, a 1000 watt electric heating element was reduced from 1675°F to 975°F in less than two seconds using a 30kV, 200μA (six watts) discharge.

Independent Investigation

A thorough and independent investigation of the phenomonen has been carried out by Dr. K.G. Kibler, senior research scientist at General Dynamics' research laboratories at Fort Worth, Texas.

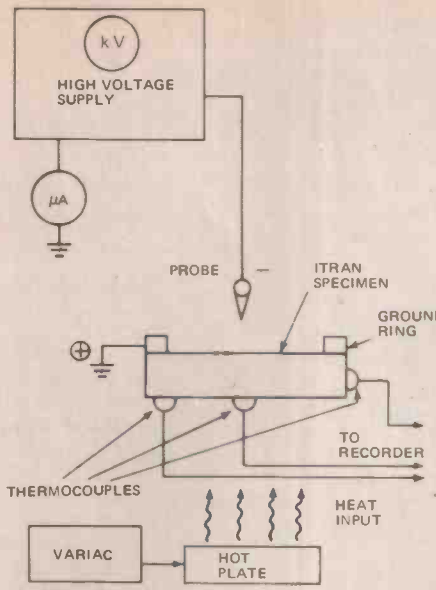
Dr. Kibler is quoted as agreeing with Oscar Blomgren's explanation of how the phenomonen works, but qualifies it by stating that the effect is highly dependent on the individual situation. It is almost impossible to make generalisations or formulate any laws – at least at this stage of experimentation.

Many of Dr. Kibler's experiments have been to assess the prospects of electrostatic cooling in high power CO_2 lasers. A major problem in development of such lasers is heat generated in the optical elements through which the beam must pass. The heat generated can be of such magnitude that the optical elements may be distorted or even destroyed.

Fan or blower cooling is often used but is not really satisfactory because of the physical size of the units required. Hence the interest in electrostatic cooling.

A number of experiments were conducted with germanium and Irtran 2 (a polycrystaline zinc-sulphide window produced by Eastman Kodak). Both germanium and Irtran 2, because of their long wavelength transmission characteristics are widely used in infra-red lasers. Dr. Kibler states that electrostatic cooling was 'effective' for both materials.

Figure 1 shows a typical experiment in which flat cylindrical Irtran



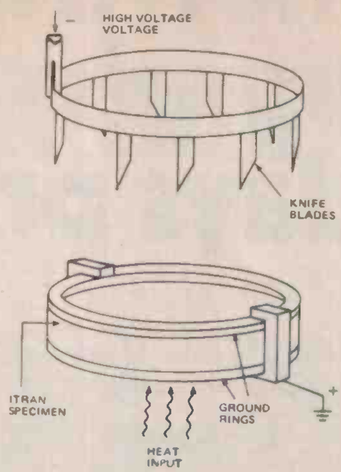


Fig. 1. Data on electrostatic cooling of laser optical elements was provided by this basic test setup.

Fig. 2. Best electrostatic cooling of the Irtran window was obtained as shown above.

specimens were placed horizontally over a hot plate and surrounded by heat insulating bricks. The Irtran specimen was heated and then maintained at a constant 270°F. When the probe was energized – at 25 kV – the temperature of the speciment was reduced to 130°F.

Further experiments showed that it was possible to shape the electrostatic field by shaping the probes, or as shown in Fig. 2, by using an array of probes.

All probe configurations tried by Dr. Kibler lowered the temperature of the Irtran specimen, but by various amounts. Maximum cooling effect was in fact achieved by the method shown in Fig. 2.

For any given probe, cooling appears to depend upon the ionic current flow. In most experiments no cooling was apparent until a current of about 10 μA – saturation was reached in most cases at currents of about 60μA. (Fig. 3).

Electrostatic cooling is fast becoming more than merely a laboratory curiosity. A number of manufacturers are using the technique (for which Blomgren has practically airtight patents) in commercial applications.

One large European company has been using electrostatic cooling at its plant in Switzerland since early this year and now intends to extend it to its operations in Austria and Germany.

In the USA, the Inland Steel Co has entered a licencing arrangement to work on applications in the steel industry. The Bundy Corporation (tubing manufacturers) has also signed a licencing agreement.

Again in the USA, Cleveland Hard Facing Inc. has found that electrostatic cooling eliminated problems previously encountered in coating delicate parts with certain alloys. The failure rate was reduced from 50% to virtually zero.

General Dynamics is currently believed to be investigating the use of electrostatic cooling for integrated circuit boards and other electronic components.

Electrostatic fields are also being investigated in welding. Blomgren's company Interprobe Inc. (1539 Morrow Ave, North Chicago, Ill. 60064) has found that when an electrostatic field is applied during certain welding operations metallurgical effects take place. These changes include control of grain size and hydrogen content, and virtual elimination of inclusions and voids.

At present it is not clear if the improved metallurgical qualities are due to more effective cooling of the weld – or whether perhaps the electrostatic field contributes to crystal orientation of growth. ●

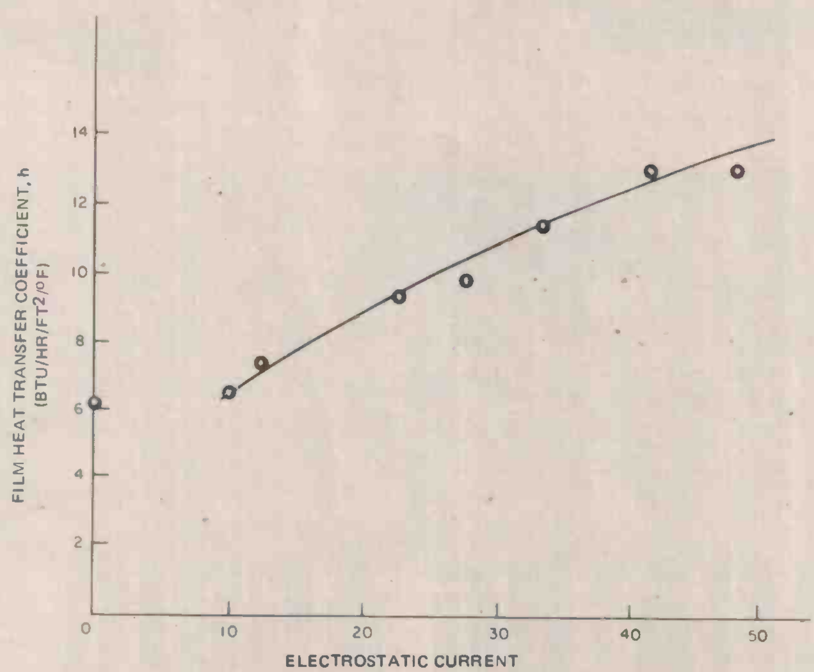


Fig. 3. Electrostatic cooling depends strongly on the current flow. Here, cooling of an Irtran-2 element with a needle probe begins at 10 μA.

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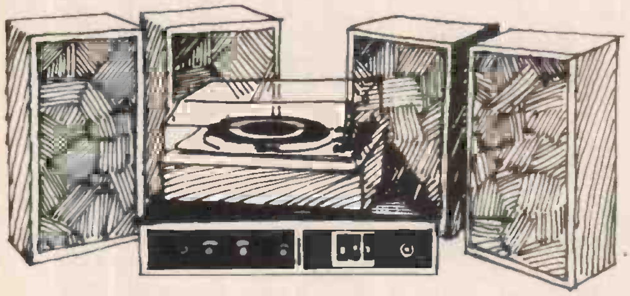

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SP25 Package Unit.
4 speakers Analog 8TC
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£51.50+VAT
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with 4 Analog 8+3 speakers
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ROITONE AMPLIFIER SYSTEM
15 watts RMS per channel 1PR ANALOG 152 speakers. SP25 with G800 in plinth and cover fully wired.
TODAY'S VALUE £138
ANALOG PRICE
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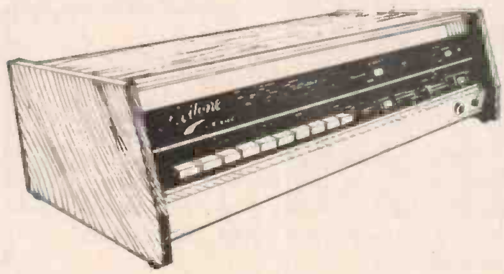
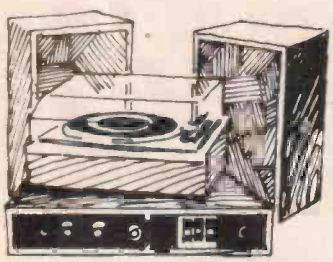
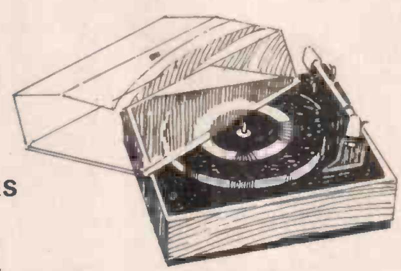




TELETON SAQ 206B/307 SYSTEM
Complete with Garrard SP2S Mk. III, Goldring G800 cartridge, plinth and cover, 2 ANALOG speakers each with 8" bass+3" tweeter.
£49.00+VAT
Post & Packing £2.50

TELETON GA202 SYSTEM
Comprising Teleton GA202 amplifier 16×16 watt RMS GARRARD SP25 Mk III with plinth and cover and Shure M75-6 cartridge. One pair of ANALOG 12T speakers or 152 speakers.
TODAY'S VALUE £140
£63.00+VAT
Post & Packing £3.00

RECORD DECK PACKAGES



GARRARD SP25 Mk. III
with GOLDRING G800 with diamond stylus. Supplied in Teak veneered plinth with tinted perspex cover. Fully wired i.e. mains lead and 5 pin Din or Phono plug.
ANALOG PRICE £13.20+VAT
Fitted with Shure M75/6 **£13.60**+VAT
Fitted with Goldring G800H **£14.00**+VAT
Post & Packing £1

AMSTRAD 8000 SYSTEM
Garrard SP25 Mk III fitted Goldring G800 plinth and cover matched with a pair of Analog 8TC speakers.
£38.00+VAT
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STEREO AMPLIFIERS

Albany House 108 or 208	£18.60
Amstrad Integra 4000	£21.50
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Leak Delta 70	£55.00
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Teleton 206B or 307	£21.40
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Philips RH702	£61.50
Philips RH781	£42.00
Rogers Ravensbrook	£60.00
Teleton TSF50 or TSF55	£52.50

TURNTABLES

Garrard SP25 Mk III	£8.00
Garrard AP76	£15.00
Garrard 401	£21.00

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component news

SOLID STATE 'ANALOGUE' METERS

Light emitting diodes have been used widely in alphanumeric displays, and are very suitable for instance, for voltmeter readouts. Sometimes, however, such digital displays are not the ideal form of showing data. Old-fashioned moving coil meters can be better, for example, in process control plants where the state of a manufacturing plant can be quickly assessed by a glance at the dials on the control panel. What is needed is the robustness and stability of the solid state devices with the advantages of a dial type readout.

The digital-analogue display, which has been developed by the Central Applications Laboratory of ITT Components Group, is basically a column of dots (100 for 1 per cent resolution) with a scale at the side. The voltage to be read is fed in in analogue form, converted to digital form and written up the column as dots. The writing process takes 3 milliseconds, and is displayed for 30 milliseconds, so that the voltage is sampled and displayed 30 times a second. With such a unit the column can be read either as a digital or as an analogue meter. The displayed column can be either thermometer-style or shown as a single moving dot.

This device is in the experimental stage and is not yet available commercially.

50 AMPERE SCHOTTKY BARRIER DIODE

The new 50 Ampere 20 Volt hot-carrier Schottky Barrier Diode with exceptionally low forward voltage drop and improved long term stability, Type 50HQ020, is now available from International Rectifier. The Schottky Barrier Diode, has a maximum peak forward voltage drop of 0.87V at 157A at a junction temperature of 25°C thus enabling high efficiency rectifier systems to be designed, resulting in savings in power costs, heat sinks and cooling system requirements.

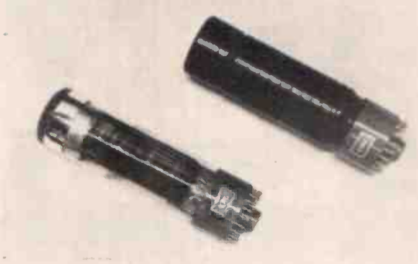
Due to the low reverse recovery losses this type of hot-carrier Barrier Diode is particularly suitable for high frequency (over 50 kHz) rectifier circuit operation.

The unit features epitaxial construction with unique metalization and oxide nitride passivation, exhibiting excellent parameter stability over the operating temperature range. Both forward and reverse polarity units are available within a rugged, industrial preferred D0-5 package.

International Rectifier, Hurst Green, Oxted, Surrey.

FAST PHOTOMULTIPLIERS

A new range of fast photomultiplier tubes developed specifically as high-speed detectors in the measurement of fast nuclear events and pulsed light sources has been introduced by the Electron Tube Division of EMI Electronics Limited, Hayes, Middlesex.



Illustrated are just two examples of EMI's 50mm diameter fast photomultiplier tubes. On the left, is shown a tube prior to receiving its conductive coating which forms an electrostatic screen. The tube on the right is shown after it has been coated and covered with protective electrical tape.

EMI Electronics and Industrial Operations, Hayes, Middx.

POWER CONTROL CIRCUIT

SDS Components Ltd now have the Plessey i.c. type SL440 available for immediate delivery by their normal Securicor service.

The device is described as a power control circuit, a title which does little to indicate the enormous potential it has in industrial and domestic equipment. It consists of a triac firing circuit, a zero crossing detector, a servo amplifier and a timing circuit in a single package. In operation, a capacitor connected to the SL440 is charged up when the mains passes through zero. The capacitor discharges during the following half cycle of mains until a preset voltage is reached. When the voltage across the capacitor reaches this value a 50μsec wide trigger pulse is generated which fires the triac.

The rate of discharge of the capacitor, and hence the triac firing angle and the power in the load, are controlled by the servo amplifier. If the voltage at the input of the servo amplifier is changed the power dissipated by the load changes by a proportional amount. In this way, basic lamp dimmers and motor speed control circuits can be implemented.

The servo amplifier can be connected as an integrator (both input and output connections being brought out to pins) so that the rate of change of power in the load can be set within wide limits. For instance, a light dimmer with a 250μF capacitor connected

—Continued overleaf

ELECTRICAL/ELECTRONIC AEROSOLS

New from PBRA is a range of aerosols with applications in the electrical/electronics industries. The aerosols – part of PBRA's Crown range – include switch and contact cleaners; an anti-static spray; a magnetic tape head cleaner; insulating varnishes and an inner electric motor cleaner.

Also in the range is an aerosol called Electrical 88, which deposits a hydrophobic film – displacing and repelling moisture. The film will not emulsify or harden, will not flake and is non-staining.

PBRA Ltd, 33 Holmethorpe Avenue, Redhill, Surrey.

between the input and the output of the servo amplifier can be used to fade lamps automatically over a period of 20 to 30 minutes. With a 250μF integration capacitor connected, the rate of fade is so slow that it is virtually imperceptible.

The servo amplifier can be used to great effect in motor speed control of d.c. motors using the velocity servo loop principle. The SL440 produces a 50μsec, 60mA, pulse to fire the triac and provides a stabilised 11.3V power supply for external circuitry. The internal servo amplifier has a typical static gain of 75.

SDS Components Ltd, Hilsea Trading Estate, Portsmouth, Hants.

HEXADECIMAL LED DISPLAY

The 'Diode-lite' type 745-0007 solid state hexadecimal readout with integral t.t.l. circuit accepts, stores, and displays 4-bit binary data in characters 6.8mm high with bright wide-angle visibility.

The GaAsP display and t.t.l. m.s.i. chip with 4-bit latch, decoder, and driver are mounted on a lead frame assembly and cast within a transparent red plastic compound.

These readouts can be used with separate l.e.d. and logic 5V and 6V power supplies, the t.t.l. m.s.i. chip is designed with a wider supply voltage range than standard 54/74 circuits, and will operate from either 5V or 6V. A relatively constant 5mA current through each l.e.d. forming the hexadecimal character is virtually independent of the l.e.d. supply voltage within the recommended operating conditions.

Changes in the logic supply voltage result in a change in luminous intensity.

The display has left and right decimals with decimal point anodes connected to external pins.

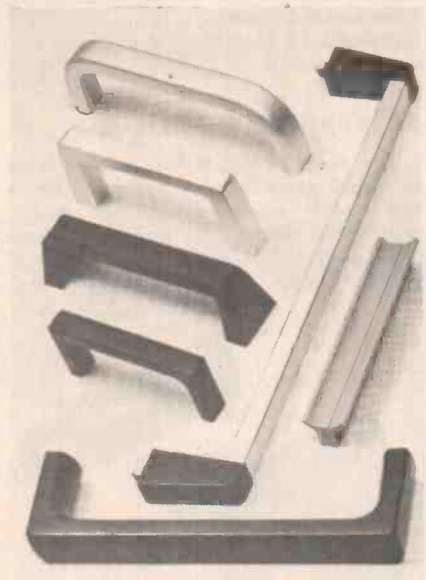
Price for 1-off is £8.64p.

Sasco Limited, P.O Box 2000, Gatwick Road, Crawley, Sussex RH10 2RU.

HANDLES

Manufacturers and designers know that attention to detail is a vital principle. In outward appearance this same consideration for detail turns an ordinary product into an outstanding piece of equipment. How often have designers complained of the difficulty of finding panel and case fitments which not only 'work right' but look right as well.

Consideration of the 'handling' of a case is equally vital. It is therefore good to find that West Hyde Developments have had these factors well in mind when introducing their new 'Contil' range of handles, which combine sound ergonomics with attractive finish and appearance.



There are twenty five handles from 45mm to 254mm long in aluminium and plastic and some will support very big loads. One Contil handle weighing only 20gms will lift 100kgs! Prices range 20p to 99p according to size and type.

West Hyde Developments Limited, Ryefield Crescent, Northwood Hills, Northwood, Middlesex, HA6 1NN.

PICTURE FRAME PANEL INSTRUMENTS

In introducing their new EZ type moving coil instrument to the now well established President Series, Ferranti Limited have greatly increased their customers' choice both in style and size of instruments. The case surround is slim and of uniform width, thus giving an elegant and modern look to the instrument face. It is felt by the designers that this picture frame case surround will allow greater freedom in the design of instrument panels.

Also of benefit to the panel designer is the choice of size of instruments available. Customers can choose from five sizes having scale lengths of 38mm, 50mm, 71mm, 96.5 mm and 122mm; both moving coil and rect-

ifier moving coil instruments are available in each size. The instruments will cover self contained ranges of 30μA to 30A, and 20mV to 600V. Higher ranges can be obtained by use of external shunt or series resistors.

Ferranti Limited, Moston, Manchester, M10 0BE.

METALLIZED FILM CAPACITORS

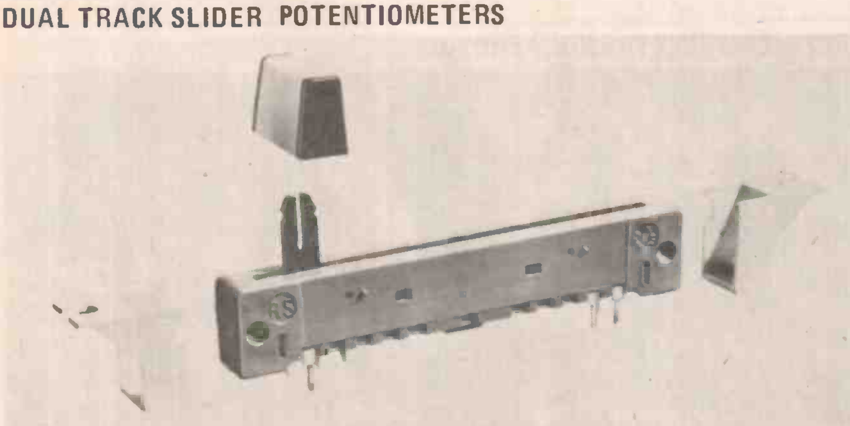
Intercontinental Components Ltd announce the availability of a new range of resin coated metallized film capacitors from Ashcroft Electronics Ltd. The devices are rectangular in shape, encapsulated in a flame retardant, humidity-resistant epoxy resin.

The values range from 0.1 to 2.2μf with an operating temperature from –40°C to +85°C. Standard tolerance is ±20%, but also available are ±10% or ±5%.

Working voltages are from 160V to 400V within the range. Body sizes are commensurate with capacitance value and working voltage requirements. The dielectric is of polyester film, but polycarbonate is also available on request.

Intercontinental Components (Maidenhead) Ltd, Electric House, 18 King Street, Maidenhead, Berks.

DUAL TRACK SLIDER POTENTIOMETERS



A large range of dual track slider potentiometers with an internal screen between the tracks has been introduced by RS Components (the new name for Radiospares). The bodies are moulded in glass-filled nylon with snap-on brackets for easy panel mounting. The terminations are suitable for either direct wiring or p.c.b. mounting.

Maximum dissipation is 0.4W and 0.2W for linear and logarithmic types respectively with better than 2dB track matching. The tolerance is 20 or 30% depending on the resistance value. There is an ideal knob that matches.

RS Components Ltd, 13/17 Epworth St., London EC2P 2HA.

Philips set a new high in Hi-Fi

Philips have used advanced technology to develop one of the world's finest integrated audio systems.

It is based on the very sophisticated Philips RH720 tuner-amplifier, which offers a high power output of 2 x 30 watts sine wave, every facility for the precise control of sound, and beautifully clear reception on long, medium, short and VHF/FM wavebands, including FM stereo.

You can select any of six preselected FM stations instantly by just laying a finger on any of six controls that are sensitive to the touch. They make ordinary pushbuttons seem clumsy. There's a switch to silence inter-station noise when tuning on FM, and another for Automatic Frequency Control to ensure stable FM reception. Variable bandwidth on AM gives a wider range of tones where reception conditions allow, or increases even further the tuner's remarkable ability to separate crowded stations. You can connect two pairs of loudspeaker enclosures, perhaps in separate rooms, selecting either pair for stereo, or all four in one room for Philips STEREO-4 surround-sound.

The GA212 'electronic' record deck sets new high standards in record reproduction, with touch-sensitive speed selectors, photo-electronic switch-off, strobe for precise speed adjustment, electronic brain to keep speed constant during play, SUPER M magneto-dynamic cartridge, and many other top-quality features.

The RH405 enclosures each have three loudspeakers . . . for low, middle and high notes independently . . . giving beautiful full-frequency reproduction.

For a free 36-page Audio Guide, write to Philips Electrical Limited, Dept SP, Century House, Shaftesbury Avenue, London WC2H 8AS.

PHILIPS

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of damage to expensive transistors and integrated circuits, when soldering?

Use Antex low-leakage soldering irons

Model X25
220-240 Volts or 100-120 Volts

The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live." Tested at 1500v. A.C. This 25 watt iron with it's truly remarkable heat-capacity will easily "out-solder" any conventionally made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8".

2 other bits available 3/32" and 3/16".

Totally enclosed element in ceramic and steel shaft Bits do not "freeze" and can easily be removed.

PRICE: £1.75 (rec. retail)

Suitable for production work and as a general purpose iron

Model CCN
220 volts or 240 volts

The 15 watt miniature model CCN. also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32".

4 other bits available 1/8", 3/16", 1/4" and 1/16"

PRICE: £1.80 (inc. retail)

OR Fitted with triple-coated, iron, nickel and Chromium bit 1/8"
PRICE: £1.95 (rec. retail)

A SELECTION OF OTHER SOLDERING EQUIPMENT.

MODEL CN
Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 1/16" to 3/16". Voltages 240, 220, 110, 50 or 24
PRICE. £1.70 (rec. retail)

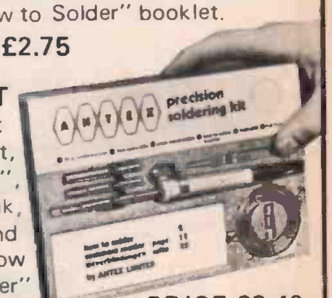
MODEL CN 2
Miniature 15 watt soldering iron fitted with nickel plated bit 3/32". Voltages 240 or 220.
PRICE: £1.70 (rec. retail)

MODEL G
18 Watt miniature iron, fitted with long life iron-coated bit 3/32". Voltages 240, 220 or 110.
PRICE. £1.83 (rec. retail)

MODEL SK.1 KIT

contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.
PRICE: £2.75

MODEL SK.2 KIT
contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, and booklet. 'How to Solder"



PRICE £2.40

MODEL MES. KIT Battery-operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder" **PRICE: £1.95**

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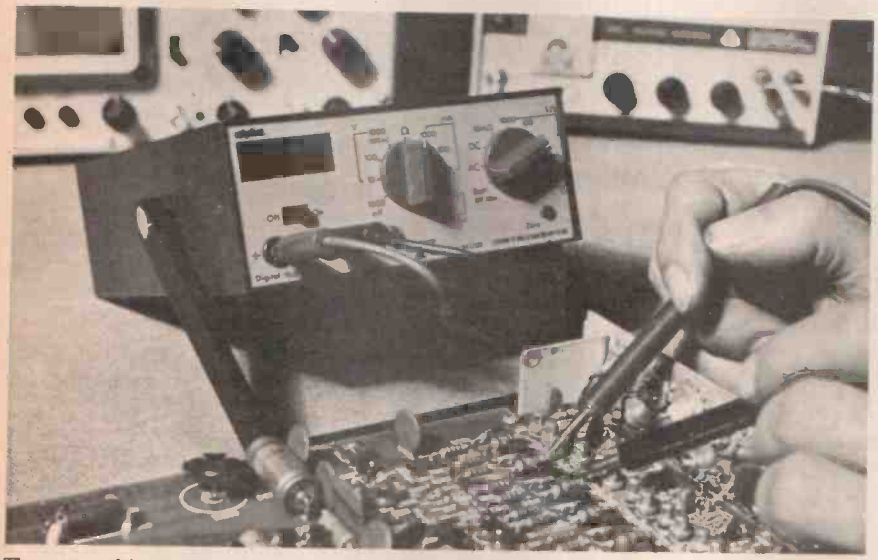
DIGITAL MULTIMETER FROM ADVANCE



The way things are going, the adjective 'digital' will soon be dropped when talking about test gear. The advantages of digital readout are overwhelming compared to the standard meter (which has of course an analogue readout) and most new quality test equipment utilises direct digital readout.

One of the recently introduced DMM's is the Alpha from Advance Electronics; amongst the many attractive features is the price of £55.

Utilising a PP9 battery (optional mains p.s. or rechargeable batteries are also available), the Alpha has 24 ranges: d.c. volts can be read from 1mV to 1kV, a.c. from 1mV to 500V. Both a.c. and d.c. current ranges run from 0.1μA to 1A and useful resistance readings can be taken from one tenth of an ohm to 10MΩ. The maximum reading is 999 (with an overrange up to 1200).

An Advance, custom designed m.o.s. l.s.i. circuit provides all digital functions. Advantages of this are very high reliability compared to a wholly discrete approach, compactness and low power consumption.

The unit employs an l.e.d. display; there is no delicate meter to damage and because of the digital display there can be no ambiguity of the readings.

Accuracy depends on the range but varies from 0.2% ± 1 digit on the 1V d.c. voltage range to 1% ± 2 digits on the a.c. voltage ranges.

A single PP9 battery will last for up to 300 hours but the time varies with the brightness of the display which can be adjusted to suit conditions.

The unit measures 60mm x 140mm x 18 mm excluding knobs and feet; the total weight is about 1kg including the battery.

Advance Electronics Ltd, Raynham Road, Bishop's Stortford, Herts.

THREE-CHANNEL SOUND/LIGHT CONTROLLER

The new Type 3 Sound/light controller from Albol Electronic & Mechanical Products Ltd is claimed to be the lowest-priced unit available, and certainly brings such modulated-light systems into the range of the private user. Audio input from a tape-deck or recorder player modulates three channels that can be connected to lamps that flash in the way made popular by discotheques. In fact one or most of these units could be used for the heavier-wattage circuits found in discotheques. The unit's own power supply uses the mains, and audio input is 0.5 to 20V into 8Ω. Band-pass filters separate the channels into bass, medium and treble response and each channel has its own control of light intensity. Each channel can control up to 500W of lighting.

An input of 0.5V is just sufficient to start the lamps flashing, and they are fully modulated by the upper range of 20V. The solid-state circuits and controls are held in a plastics case measuring 150mm x 80mm x

50mm and coloured either red, blue or orange.

At £14.00 each, Albol say that the price each unit is well below that of similar controllers on offer. The makers are looking for agents for this product, and invite enquiries from interested firms handling electronic products.

Albol Electronic & Mechanical Products Ltd, 3 Crown Buildings, Crown Street, London, SE5.

CUSTOM DESIGNED POWERCARD GOES INTO VOLUME PRODUCTION

New from ITT Components Group Europe is the 250D Powercard – first addition to the five basic models announced when the Powercard range of low-cost, p.c.b-compatible power supplies was introduced last year.

The 250D Powercard was initially produced as a custom-designed variant, offering 250mA at 24 to 30V output, but this specification has now been standardised for volume production.

Complementing the existing range which is performance-matched to the major integrated circuit families, the 250D is particularly suited for lamp and relay operation, typically in industrial control and computer console applications.

The 250D is designed to the standard Powercard profile, with robust heat-sink metal cover, and may be employed alongside other p.c.b.s in plug-in or chassis-mounted use.

Operating off mains supplies at 99-132 and 198-264V, 48 to 65Hz, it provides a single adjustable 24-30V output, with remote sensing of the load voltage to compensate for voltage drop along output leads. Overvoltage protection is optional.

ITT Components, Edinburgh Way, Harlow, Essex.

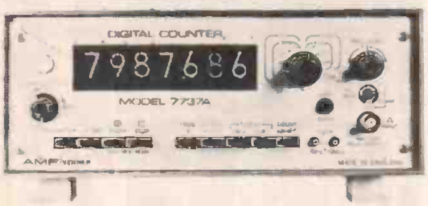
100MHz DIGITAL COUNTER/TIMER

AMF Venner have increased the specified maximum counting rate of their Model 7737A Digital Counter from 80MHz to

eti EQUIPMENT NEWS

100MHz with no increase in selling price.

Model 7737A is the most comprehensive of the '77' series, AMF Venner's range of advanced counters utilizing purpose designed m.o.s. l.s.i. modules for counting and dividing functions. It measures frequency up to 100MHz with input levels of 50mV or more, and below 80MHz it has an input sensitivity better than 10mV. The instrument also measures waveform period or multi-period at frequencies up to 1MHz and time interval with single-line or two-line start/stop input to 100nS resolution. Additional facilities include frequency-ratio measurement and event counting, either continuously or over a gated time interval.



The readout is a seven-digit in-line display with automatic positioning of the decimal point, and the instrument features a switchable display-storage memory.

A special feature of this counter is its adjustable trigger level, enabling the user to set the input voltage at which the counter trips, so that noise and spurious transients do not affect the measurement.

An unusual attribute, which presents an important economic flexibility, is the availability of a choice of built-in frequency references. The standard instrument is fitted with an internal 10MHz crystal reference oscillator with a maximum drift of 5 parts per million over the temperature range –10°C to +55°C. The counter can, however, be supplied with either of two optional reference oscillators having stabilities of 1 part per million and 0.3 parts per million respectively.

Performance and reliability have been achieved largely by the extensive use of integrated circuit modules and other advanced circuit techniques. These techniques have also contributed to economic production, enabling the maker to keep a low selling price (£275) in the face of generally rising costs.

AMF Venner, Kingston By-pass, New Malden, Surrey.

MOTOR SPEED CONTROL MODULE

A small motor speed control module is now available from the Thermistor Product Division of ITT Components Group Europe.

This module is primarily intended for the speed control of small, single-phase, shaded-pole, induction motors with respect to room temperatures. Applications are mainly in central heating, ventilation and refrigeration where the speed of a fan or pump needs to be a function of temperature.

The MT1 module has a narrow proportional band of approximately 5°C and has provision for remote temperature sensing and adjustment. The specified temperature control sensor is a KT472CW or KQ472CW thermistor which must be so positioned that the control medium is sensed directly. Other types of thermistors may be used to adjust the temperature range, provided that the maximum ratings of the thermistors are not exceeded.

Control temperatures are selected using a potentiometer, which can include an on/off switch to switch the whole circuit, and is intended to be mounted away from the module for ease of adjustment.

ITT Components, Edinburgh Way, Harlow, Essex.

R.C.S. EXTENDED RANGE OF COUNTER TIMBERS

The original R.C.S. Type 501, 8 digit 4Hz to 32MHz frequency counter is now part of a range of four instruments covering frequencies up to 200MHz.

The Type 401 is an economy version of the Type 501, having a 6 digit display and an unovened crystal standard which gives the unit a stability of 1 part in 10^6 per degree C. The input sensitivity is 10mV (10Hz – 20MHz), 30mV, (4Hz – 32MHz). The other units in the series have an 8 digit readout.

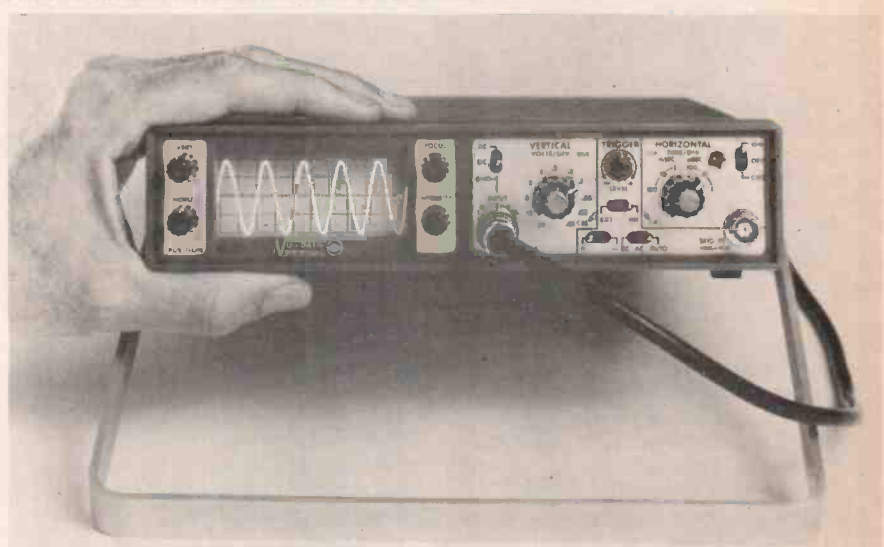
The R.C.S. Type 701 is a 50MHz equipment with an input sensitivity of 10mV (10Hz – 50MHz) and to measure frequencies up to 200MHz the R.C.S. Type 801 is available with a typical sensitivity of 80mV at 200MHz. The sensitivity below 32MHz is as for the R.C.S. Type 501.

All units, except the R.C.S. Type 401, are fitted with an unovened crystal standard, giving a stability of 3 parts in 10^8 and the instruments are fitted with overload protection.

Versions of all the instruments can be supplied with memory and electrical Start/Stop facilities.

Radio Control Specialists Ltd, National Works, Bath Road, Hounslow, TW4 7EE.

20MHZ MINI-PORTABLE OSCILLOSCOPE



The introduction of the Vu-Data Model PS910A by Fluke International Corporation has greatly extended the feasibility of on-site field service and maintenance by providing DC-20MHz wide-band operation in a miniature, line- or battery-operated portable oscilloscope. Truly a 'mini-portable' because of its unusually small size and weight (44mm x 215mm x 305mm, weight 7lbs) the PS910A can go places where other oscilloscopes just can't fit – in a tool case, a glove compartment, or in the slimmest attache case.

Designed mainly for the serviceman who travels, the PS910A also operates from the mains and mounts directly in existing equipment to provide full-scale monitoring capability in minimum panel space. All controls are located on the front panel.

Batteries are internal and may be nickel-cadmium, alkaline or even flashlight cells. Recharging circuitry is integral and batteries are electronically protected against over-discharge. Up to five hours operation can be obtained from nickel-cadmium cells.

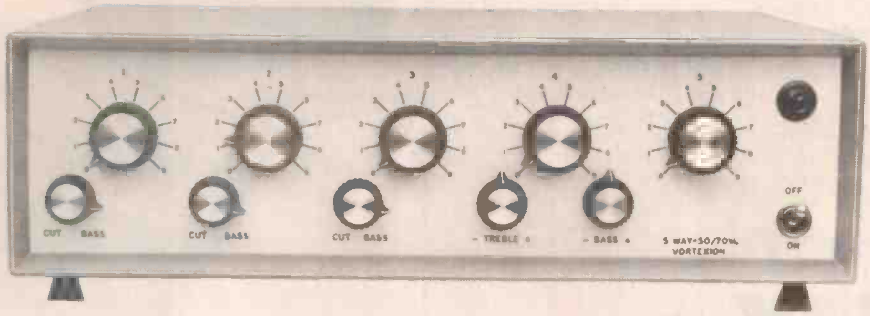
Other specifications include: Risetime, 18 nsec; Vertical Sensitivity, 10mV/div; Time Base, 100nsec/div to 100msec/div; Trigger, internal or external with automatic or manual level and slope selection; CRT, 4 x 10 div with ¼in divisions.

Fluke International Corporation, Garnett Close, Watford WD2 4TT.

Vortexion

50/70 WATT ALL SILICON AMPLIFIER

WITH BUILT-IN 5-WAY MIXER USING F.E.T.s



THIS is a high fidelity amplifier with bass cut controls on each of the three low impedance balanced line microphone stages and a high impedance (1·5 meg.) gram stage with bass and treble controls, plus the usual line or tape input. All the input stages are protected against overload by back to back low self capacity diodes and all use F.E.T.s for low noise, low intermodulation distortion and freedom from radio breakthrough.

A voltage stabilised supply is used for the pre-amplifiers making it independent of mains supply fluctuations and another stabilised supply for the driver stages is arranged to cut off when the output is overloaded or over temperature. The output is 75% efficient and 100V balanced line or 8-16 ohms output are selected by means of a rear panel switch which has a locking plate indicating the output impedance selected. The mixer section has an additional emitter follower output for driving a slave amplifier, phones or tape recorder, output ·3V out on 600 ohms upwards.

50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4-WAY MIXER

(0·3% intermodulation distortion) using the circuit of our 100% reliable 100 Watt Amplifier with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer Amplifier, again fully protected against overload and completely free from radio breakthrough. The mixer is arranged for 2-30/60Ω balanced line microphones, 1-HiZ gram input and 1-auxiliary input followed by bass and treble controls. 100 volt balanced line output or 5/15Ω and 100 volt line.

100 WATT ALL SILICON AMPLIFIER

A high quality amplifier with 8 ohms-15 ohms or 100 volt line output for A.C. Mains. Protection is given for short and open circuit output over driving and over temperature. Input 0·4V on 100K ohms.

THE 100 WATT MIXER AMPLIFIER

with specification as above is here combined with a 4-channel F.E.T. mixer, 2-30/60Ω balanced microphone inputs, 1-HiZ gram input and 1-auxiliary input with tone controls and mounted in a standard robust stove enamelled steel case. A stabilised voltage supply feeds the tone controls and pre amps, compensating for a mains voltage drop of over 25% and the output transistor biasing compensates for a wide range of voltage and temperature. Also available in rackpanel form.

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CP50 AMPLIFIER

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200 WATT AMPLIFIER

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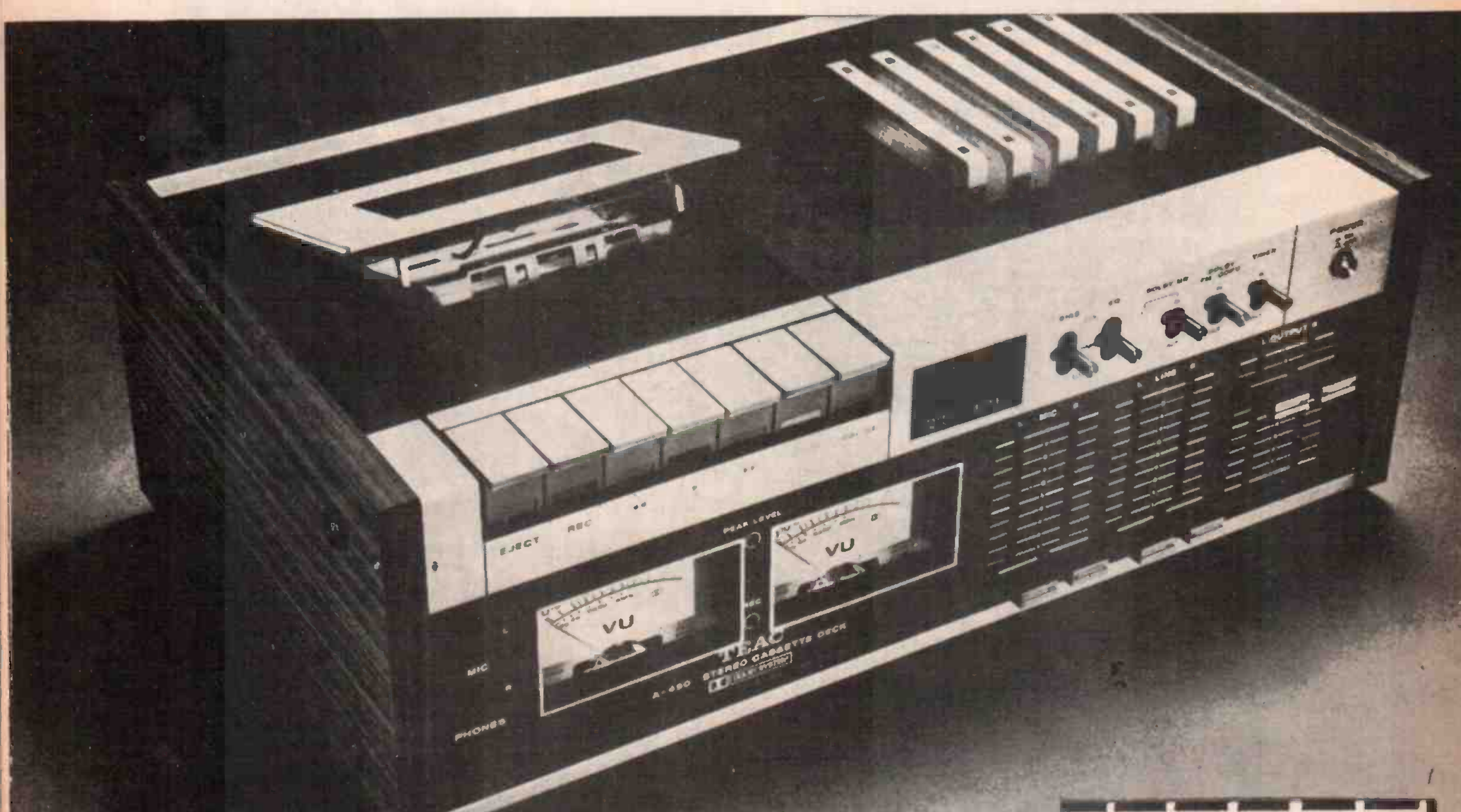

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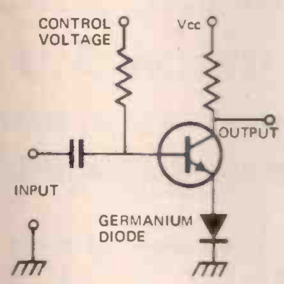
eti TECH—TIPS

GAIN CONTROLLED AMPLIFIER

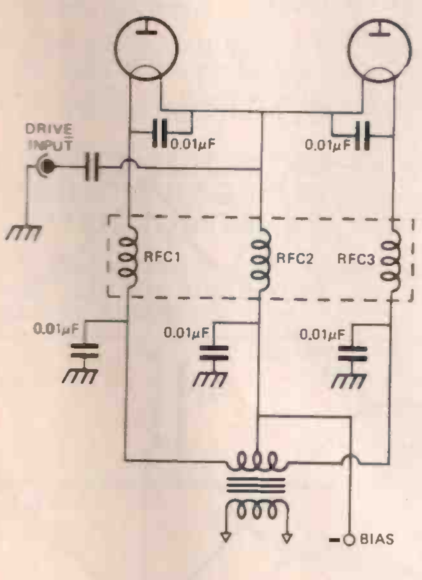


In this circuit a germanium diode is used to effect gain control of a common-emitter amplifier.

This circuit is very useful for AGC controlled stages, or where wide dynamic range and instant response is required.

The diode selected for this application should have wide impedance variation and a relatively gradual rate of change. Types IN 34A, AAY 30 etc. are suitable.

FILAMENT CONNECTIONS



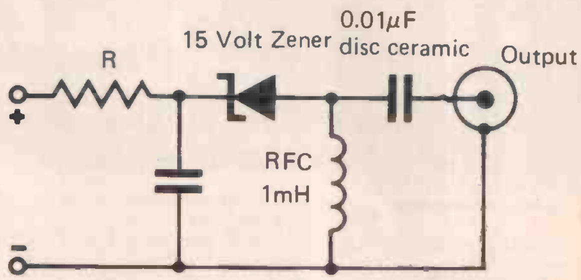
High power linear amplifiers using twin valves in the grounded grid configuration are quite commonly used.

But problems can occur if series filament connections are used, for the filament of one tube will often warm up quicker than that of the other. This prevents the second tube warming up, as the first tends to 'hog' the available current.

The circuit shown above overcomes the problem by using a centre-tapped transformer. (two back-to-back diodes across the filament lines will do the same job)

The filament chokes consist of about 50 turns of wire trifilar wound on a ferrite rod, 6" long.

SIMPLE NOISE SOURCE

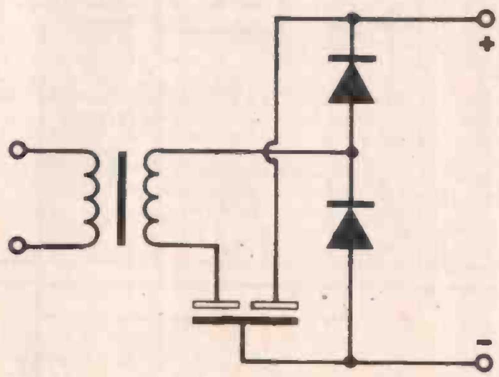


Zener diodes generate substantial amounts of internal noise. The level of this is typically 30 dB above thermal noise at frequencies up to 150 MHz.

Whilst the noise output is not sufficiently accurate to make noise figure measurements this circuit is very useful for adjusting VHF converters or receiver front ends, or as a noise source in antenna impedance bridges.

Resistor R should be adjusted to draw between six and eight mA from the power supply.

MODIFIED VOLTAGE DOUBLER

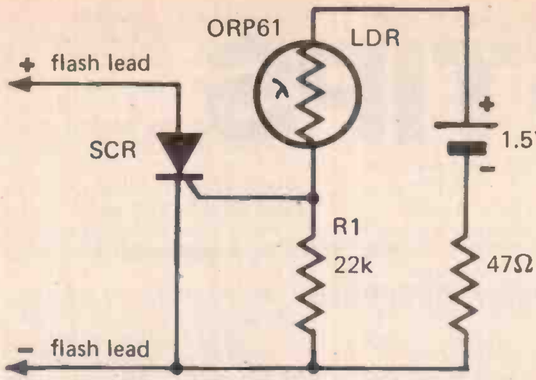


Twin electrolytic capacitors take up less space than two separate units but cannot normally be used in voltage doubler circuits.

However a slight modification to the circuit allows twin electrolytics to be used, with the can connected to chassis.

Alternatively, in low voltage circuits where high value electrolytic capacitors are used, two capacitors may be used without the necessity of insulating the case (generally the negative terminal) of one of them.

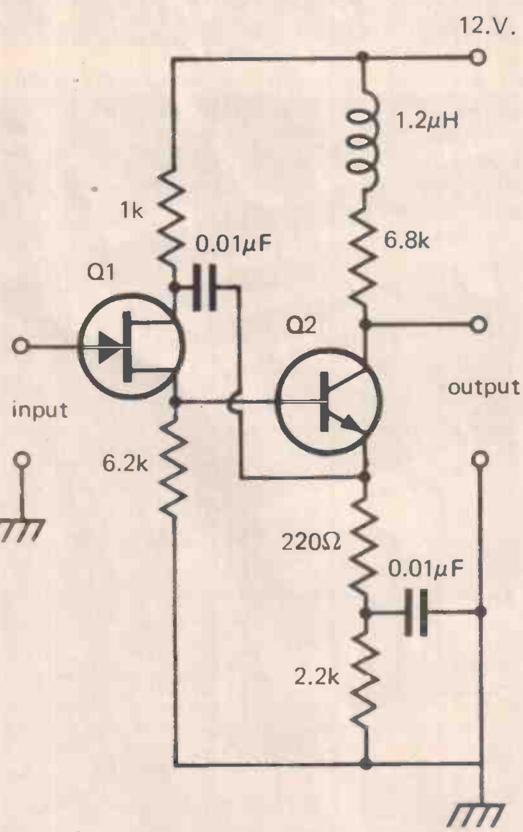
FLASH SLAVE DRIVER



In photography, a separate flash, triggered by the light of a master flash light, is often required to provide more light, fill-in shadows etc.

The sensitivity of this circuit depends on the proximity of the master flash and the value of R1. Increasing R1 gives increased sensitivity.

BROAD BAND AMPLIFIER



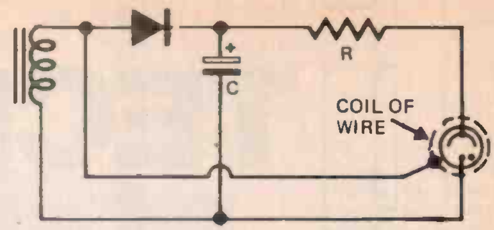
This circuit has a typical gain of 10dB and bandwidth of 90 MHz.

Input impedance is around 10 megohms in parallel with 1.0pf. Output impedance is reasonably high and depends mainly on Q2; output capacitance will be around 2 to 3pf with careful construction.

FET, Q1, should be an n-channel type with low gate source capacitance and a high cutoff frequency.

The Transistor, Q2, should have a high gain-bandwidth product and low collector-emitter capacitance. Careful selection can extend the bandwidth beyond 100 MHz.

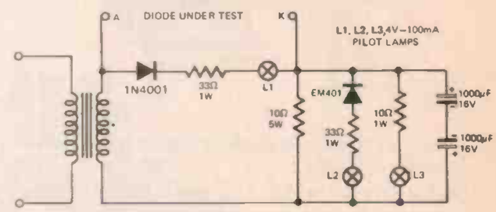
BOOSTING VR TUBES



In some applications, VR tubes prove reluctant starters. This can often be overcome by wrapping a coil of insulated wire around the tube and then connecting it to the high voltage ac side of the supply.

This circuit is particularly useful when a number of VR are to be operated in parallel.

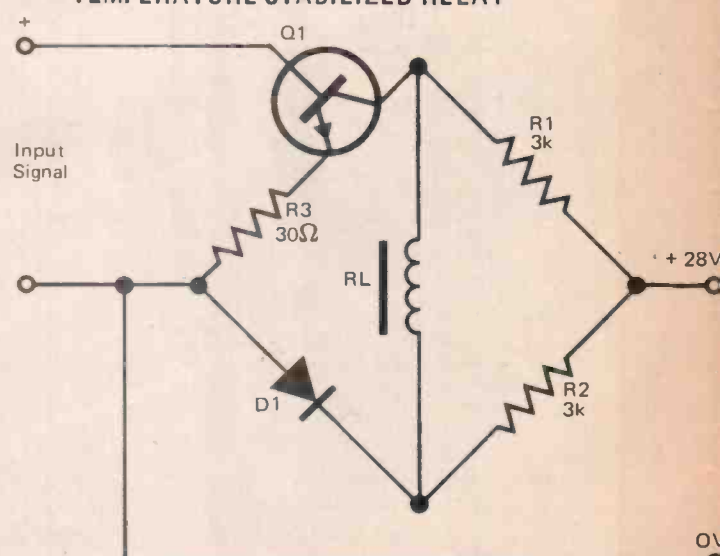
DIODE CHECKER



A simple unit for checking diode condition is shown above.

The diode to be checked is connected across the points shown as A and K (observing the polarity indicated). If the diode is functioning correctly, both lamps will light; if the diode is shorted, lamp L2 will light; if the diode is open circuit, Lamp L1 will light.

TEMPERATURE STABILIZED RELAY



Accurate relay trip-point operation can be obtained over an ambient temperature range from -50°C to +90°C using this simple circuit.

The temperature sensitivity of the silicon transistor Q1 is balanced out by the silicon diode D1. Gain/temperature stabilization may be obtained if required by using a positive temperature co-efficient resistor for R3.

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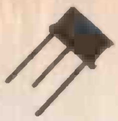

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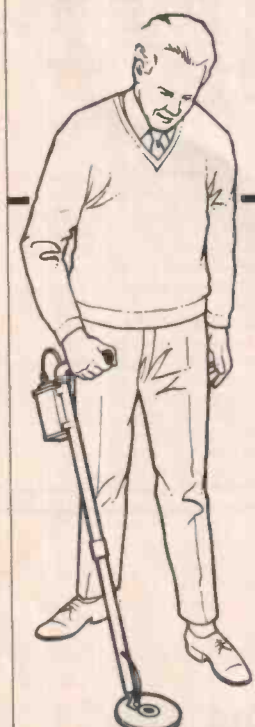

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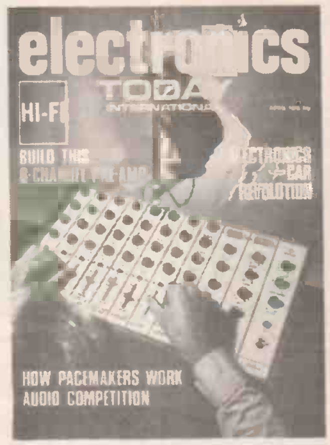

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