DECEMBER 1973

electronics today INTERNATIONAL

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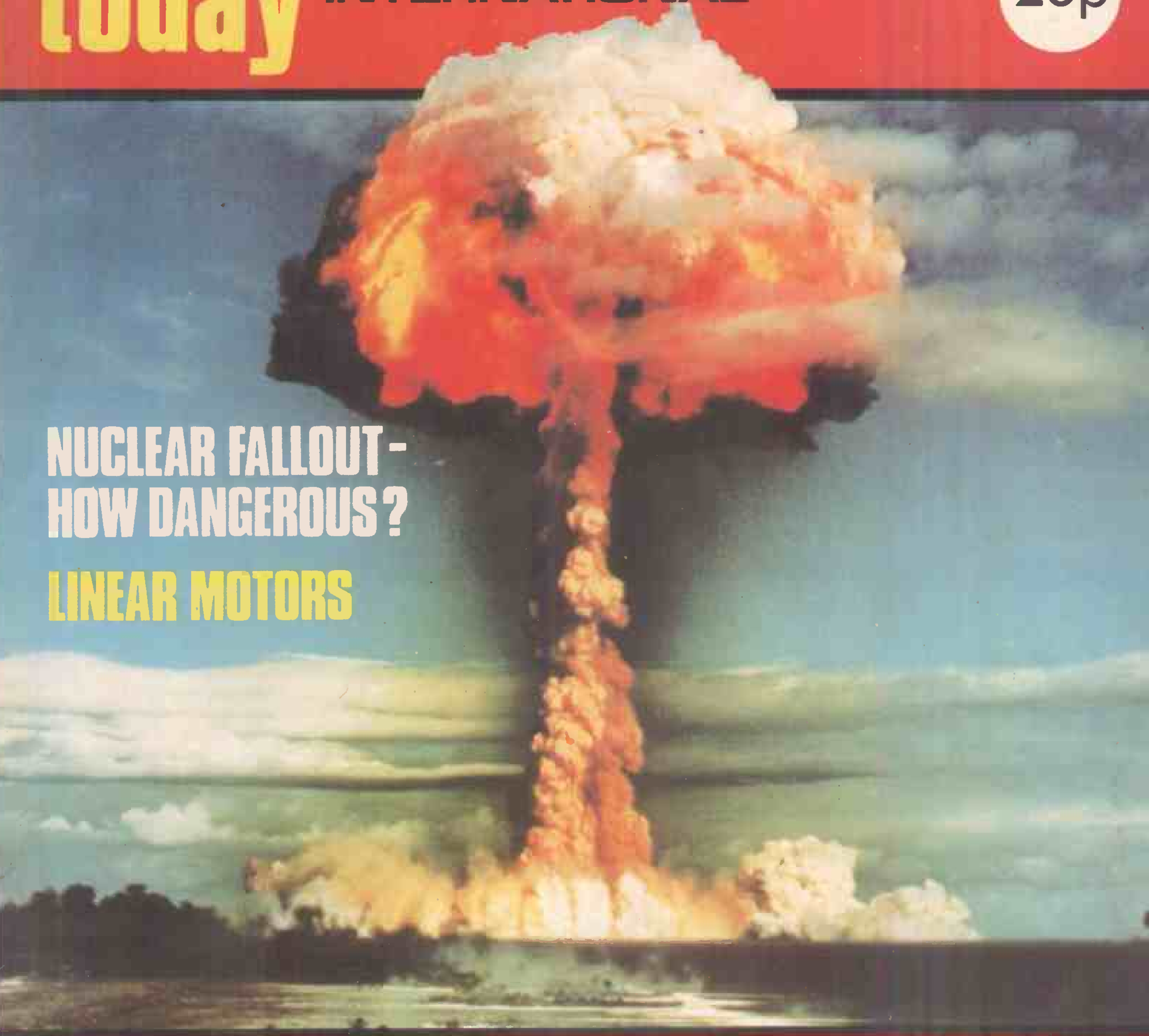


NUCLEAR FALLOUT - HOW DANGEROUS?

LINEAR MOTORS

**PLUS: CREATIVE AUDIO, MARANTZ 1120 REVIEW
MIXER PREAMPLIFIER**

HI-FI ... CONSTRUCTION ... COMMUNICATIONS ... DEVELOPMENTS

electronics TODAY INTERNATIONAL

DECEMBER 1973 Vol.2 No. 12.

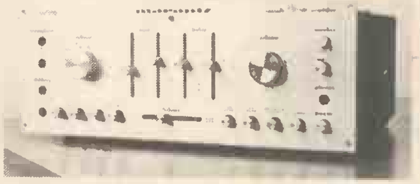
main features

projects

product tests

news & information

Cover: Official French picture of atomic bomb at Mururoa Atoll. How far will the fallout travel and what effect does it have at the other end? Find out on page 16.



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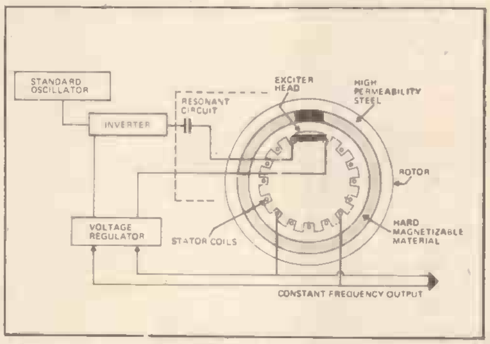

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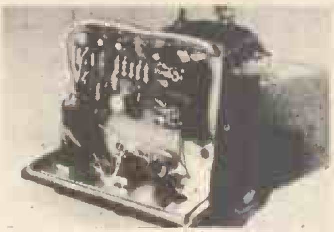

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LET'S TRY THE UNICORN!

RECENTLY there was a magnificent TV programme on BBC-2, 'The Road to Ruritania', written and narrated by Paul Johnson, ex-editor of the New Statesman. Now your editor's personal politics do not usually lie with this magazine's outlook, nor previously with Mr. Johnson's well-known views, but his appraisal as to what happened to Britain and why we are still unsettled as a nation was exellent.

A summary of the idea put forward was that the British have been successful in the past because we were the leaders; in the industrial revolution and the expansion of Empire we did well mainly because we were first. This was summed up with a rather clever analogy; the Royal Coat of Arms has two animals supporting the design, the lion *and* the unicorn. The lion, if it used at all, nowadays is represented as a toothless, motheaten beast which attracts more derision than fear. The lion represents (or represented) Britain's strength but the unicorn, who perhaps symbolises our imagination, has been forgotten. Out failure to use our imagination was proposed as a major contribution to our decline. This analysis and analogy is very near to the truth.

We have, as always, had our 'prestige' projects but recently these have shown little originality, they are variations on a theme or, worse still, direct copies of what has been done elsewhere in the World. Air traffic is growing and London's existing airports will soon be unable to cope. Our stagnant thinking has led us to propose the building of a bigger and better airport on Maplin Sands which when built, will still be a long way from the biggest and best. An imaginative nation faced with the same problems and the powerful opposition would use some fresh thinking: perhaps development of a VTOL aircraft or one with acceptable noise ratings, at the same time not requiring thousands of acres of ground.

When the industrial revolution got underway requiring more and better transport systems, we didn't expand the canal system, we built railways, which no one else had tried before and the spin-off paid handsome dividends (many of the important railways overseas were British built).

Our feature this month on Linear Electric Motors is an example of British imagination, but a project on which the Government has cooled. Right: Linear Motors may *not* be a panacea for future transport; on the other hand only a small sum (compared to Concorde, Maplin and the Channel Tunnel) is needed to find out for sure.

If we accept that the lion in the Coat of Arms has had his day, or at least needs a rest, then let us try adopting the unicorn as our national beast to see if using our imagination will help a declining Britain. — HWM.

news digest

£20 'HOUSEHOLD' CALCULATOR

A small UK electronics company, Advanced Telecommunications Equipment Ltd., of Woking, Surrey, is to launch a powerful new pocket calculator which, at £20, will undercut every calculator on the UK market including Japanese and American products.

This pocket-sized, four digit display machine, called the Calate 44, executes 'full flow' arithmetic operations with 8 digit accuracy providing constant, clear last entry, and floating point facilities, features often missing on more expensive machines. An interchange key displays the last four digits in any calculation.

Two factors account for the low cost of the battery powered Calate 44. Firstly the machine uses a locally manufactured mircocircuit carrying no import duty, the GIM C554. It performs all the calculator arithmetic functions and has been specifically designed to drive a low cost, four digit display while still providing 8 digits of accuracy.

Secondly, cost savings were achieved by the use of ATE's touch operated key-board which eliminates the moving parts of a conventional keyboard, while at the same time reducing manufacturing costs.

At present the new calculators are being sold directly to the public or to bulk-suppliers who market them under their name. But agents are actively being sought in the UK, and the 'Calate' will soon be available over the counter.

The new Siemens FM101 Colour Videcord unit, one example of the new TV tape recorders designed for the domestic market.

DOMESTIC VIDEOTAPE RECORDERS

The use of small (relative to broadcasting anyway) videotape recorders is growing steadily, though it is still on a small scale. According to BASF, who have conducted a world-wide survey on them, there are about 50,000 units in the USA and 20,000 in Europe though the majority of these are not in the home but are used in schools etc. Apart from a massive, but short-term, promotion recently by Sony, little publicity has yet been given to the availability of these videotape recorders.

The biggest problem remains in the standard to be adopted. As with the 'Four-Channel' conflict, many major manufacturers are sitting back to let others settle the conflict before they enter the field. The tape width (½in or 1in) is one unresolved problem and there are also the Philips Videocassettes.

At present the prices seem high, from £400 upwards, while the tape cost runs at about £15 for an hours recording but within the next few years there will probably be a considerable fall in real cost of both machines and tape.

In ten years time home videorecorders could be as common as good Hi-Fi systems are today; by no means everyone will have one but they will not be rare and cost will not be the prevention to growth.

The newest entrant to the field is the German Siemens Company which uses a Philips transport system. The unit comprises the videorecorder and a 26in monitor colour TV. It would not be correct to say that the controls are as simple as a regular cassette recorder, but they are nearly so; certainly most children would have little difficulty in operating it. The recorder is fitted with its own TV tuner to enable one programme to be recorded while another is being watched on the TV set. There is an automatic timer which will record automatically if you are out. A TV camera can be connected, though this is not part of the package. The complete system is currently priced at about £700.

HIPPOCRATIC OATH FOR ENGINEERS?

Engineers should take a Hippocratic Oath similar to the one taken by physicians, says an engineering educator at the University of California in a new book, "Understanding Technology", published by John Hopkins Press.

Professor Charles Susskind argues that engineers increasingly resemble

Continued on page 10

The largest selection

BRAND NEW FULLY GUARANTEED DEVICES

Type	Price
AC107	0·22
AC113	0·20
AC115	0·22
AC117K	0·32
AC122	0·13
AC125	0·19
AC126	0·19
AC127	0·20
AC128	0·20
AC132	0·16
AC134	0·16
AC137	0·16
AC141	0·20
AC141K	0·32
AC142	0·20
AC142K	0·28
AC151	0·17
AC154	0·22
AC155	0·22
AC156	0·22
AC157	0·27
AC165	0·22
AC166	0·22
AC167	0·22
AC168	0·27
AC169	0·16
AC176	0·22
AC177	0·27
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AC179	0·31
AC180	0·22
AC180K	0·32
AC181	0·22
AC181K	0·32
AC187	0·24
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AC188	0·24
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ACY18	0·22
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ACY31	0·31
ACY34	0·23
ACY35	0·23
ACY36	0·31
ACY40	0·19
ACY41	0·20
ACY44	0·39
AD130	0·42
AD140	0·53
AD142	0·53
AD143	0·42
AD149	0·55
AD161	0·37
AD162	0·37
AD161 &	

Type	Price
AD162(MP)	0·61
ADT140	0·55
AF114	0·27
AF115	0·27
AF116	0·27
AF117	0·27
AF118	0·39
AF124	0·33
AF125	0·33
AF126	0·31
AF127	0·31
AF139	0·33
AF178	0·55
AF179	0·55
AF180	0·55
AF181	0·55
AF186	0·55
AF239	0·41
AL102	0·72
AL103	0·72
ASY26	0·28
ASY27	0·33
ASY28	0·28
ASY29	0·28
ASY50	0·28
ASY51	0·28
ASY52	0·28
ASY54	0·28
ASY55	0·28
ASY56	0·28
ASY57	0·28
ASY58	0·28
ASY73	0·28
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BC107	0·10
BC108	0·10
BC109	0·11
BC113	0·11
BC114	0·17
BC115	0·17
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BC117	0·20
BC118	0·11
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BC125	0·13
BC126	0·20
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BC145	0·50
BC147	0·11
BC148	0·11
BC149	0·13
BC150	0·20

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BC214L	0·16
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BC303	0·35
BC304	0·40
BC440	0·34
BC460	0·40
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BCY34	0·28
BCY70	0·16
BCY71	0·22
BCY72	0·16
BCZ10	0·22
BCZ11	0·28
BCZ12	0·28
BD115	0·68
BD116	0·88
BD121	0·66
BD123	0·72
BD124	0·76
BD131	0·55
BD132	0·66

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BD135	0·44
BD136	0·44
BD137	0·50
BD138	0·55
BD139	0·61
BD140	0·66
BD155	0·88
BD175	0·66
BD176	0·66
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BD178	0·72
BD179	0·77
BD180	0·77
BD185	0·72
BD186	0·72
BD187	0·77
BD188	0·77
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BD190	0·83
BD195	0·94
BD196	0·94
BD197	0·99
BD198	0·99
BD199	£1·05
BD200	£1·05
BD205	0·88
BD206	0·88
BD207	£1·05
BD208	£1·05
BDY20	£1·10
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BF121	0·50
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BF127	0·55
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BF156	0·53
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BF159	0·66
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BF178	0·33
BF179	0·33
BF180	0·33
BF181	0·33
BF182	0·44
BF183	0·44
BF184	0·28

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BF187	0·30
BF188	0·44
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BF196	0·16
BF197	0·16
BF200	0·50
BF222	£1·05
BF257	0·50
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BF259	0·94
BF262	0·61
BF263	0·61
BF270	0·39
BF271	0·33
BF272	0·88
BF273	0·39
BF274	0·39
BFW10	0·66
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BFX84	0·24
BFX85	0·33
BFX86	0·24
BFX87	0·27
BFX88	0·24
BFY50	0·22
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BSY40	0·31
BSY41	0·31
BSY95	0·14
BSY95A	0·14
Bu105	£2·20
C111E	0·55
C400	0·33
C407	0·28
C424	0·28
C425	0·55
C426	0·39
C428	0·33
C441	0·33
C442	0·33
C444	0·39
C450	0·24
MAT100	0·21
MAT101	0·22
MAT120	0·21
MAT121	0·22
MJE2955	0·95
MJE3055	0·62
MJE3440	0·55

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MPF104	0·41
MPF105	0·41
OC19	0·39
OC20	0·70
OC22	0·52
OC23	0·54
OC24	0·62
OC25	0·42
OC26	0·32
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OC35	0·46
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OC44	0·17
OC45	0·14
OC70	0·11
OC71	0·11
OC72	0·16
OC74	0·16
OC75	0·17
OC76	0·17
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OC81	0·17
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OC82	0·17
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OC83	0·22
OC139	0·22
OC140	0·22
OC169	0·28
OC170	0·28
OC171	0·28
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OC202	0·31
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ORP12	0·48
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ORP61	0·44
P20	0·55
P21	0·50
P346A	0·22
P397	0·46
ST140	0·14
ST141	0·19
TIS43	0·33
UT46	0·30
ZN414	£1·20
2G301	0·21
2G302	0·21
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2G304	0·27
2G306	0·44
2G308	0·39
2G309	0·39
2G339	0·22

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2G344	0·20
2G345	0·18
2G371	0·18
2G371B	0·13
2G373	0·19
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2G377	0·33
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2G382	0·18
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2N388A	0·61
2N404	0·22
2N404A	0·31
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2N598	0·46
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2N696	0·14
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2N699	0·39
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2N711	0·33
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2N2147	0·79
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2N2194	0·39
2N2217	0·24

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2N2219	0·22
2N2220	0·24
2N2221	0·22
2N2222	0·22
2N2368	0·19
2N2369	0·16
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2N2907A	0·24
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2N2924	0·16
2N2925	0·16
2N2926(G)	0·14
2N2926(Y)	0·12
2N2926(O)	0·11
2N2926(R)	0·11
2N2926(B)	0·11
2N3010	0·77
2N3011	0·16
2N3053	0·19
2N3054	0·51

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2N3391A	0·18
2N3392	0·16
2N3393	0·16
2N3394	0·16
2N3395	0·19
2N3402	0·23
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2N3404	0·31
2N3405	0·46
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2N3415	0·17
2N3416	0·31
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2N3525	0·83
2N3614	0·74
2N3615	0·82
2N3616	0·82
2N3646	0·1
2N3702	0·13
2N3703	0·13
2N3704	0·14
2N3705	0·13
2N3706	0·13
2N3707	0·14
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2N3709	0·10
2N3710	0·10
2N3711	0·10
2N3819	0·31
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2N3821	0·39
2N3823	0·31
2N3903	0·31
2N3904	0·33
2N3905	0·31
2N3906	0·30
2N4058	0·13

Type	Price
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2N4062	0·13
2N4284	0·19
2N4285	0·19
2N4286	0·19
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2N4291	0·19
2N4292	0·19
2N4293	0·19
2N5172	0·13
2N5294	0·60
2N5457	0·35
2N5458	0·35
2N5459	0·44
2N6121	0·75
2S301	0·55
2S302A	0·46
2S302	0·46
2S303	0·61
2S304	0·77
2S305	0·86
2S306	0·86
2S307	0·86
2S321	0·62
2S322	0·46
2S322A	0·46
2S323	0·62
2S324	0·77
2S325	0·77
2S326	0·77
2S327	0·77
2S701	0·46
40361	0·44
40362	0·50

DIODES AND RECTIFIERS

Type	Price
AA119	0·09
AA120	0·09
AA129	0·09
AAY30	0·10
AAZ13	0·11
BA100	0·11
BA116	0·23
BA126	0·24
BA148	0·16
BA154	0·13
BA155	0·16
BA156	0·15
BA173	0·16
BY100	0·17
BY101	0·13
BY105	0·19
BY114	0·13
BY124	0·13
BY126	0·16
BY127	0·17
BY128	0·17

Type	Price
BY130	0·18
BY133	0·23
BY164	0·55
BYX38/30	0·46
BYZ10	0·39
BYZ11	0·33
BYZ12	0·33
BYZ13	0·28
BYZ16	0·44
BYZ17	0·39
BYZ18	0·39
BYZ19	0·31
CG62 (OA91Eq)	0·06
CG651– (OA70–OA79)	0·07
OA5	0·39

Type	Price
OA5	0·23
OA10	0·15
OA47	0·08
OA70	0·08
OA79	0·08
OA81	0·08
OA85	0·10
OA90	0·07
OA91	0·07
OA95	0·08
OA200	0·07
OA202	0·08
SD10	0·06
SD19	0·06
1N34	0·08
1N34A	0·08
1N914	0·06
1N916	0·06
1N4148	0·06
1S021	0·11
1S951	0·07

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100	For	1·92
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40PIV(Min.)	100..1·65
Sub-Min.	500..5·50
Full Tested	1,000..9·90

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U 4	40	Germanium Transistors like OC81, AC128	0·55
U 5	60	200mA Sub-Min. Silicon Diodes	0·55
U 6	30	Sil. Planar Trans. NPN like BSY95A. 2N706	0·55
U 7	16	Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0·55
U 8	50	Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0·55
U 9	20	Mixed Voltages, 1 Watt Zener Diodes	0·55
U10	20	BAY50 charge storage Diodes DO-7 Glass	0·55
U11	25	PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0·55
U12	12	Silicon Rectifiers Epoxy 500mA up to 800 PIV	0·55
U13	30	PNP-NPN Sil. Transistors OC200 & 28 104	0·55
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U16	10	3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0·55
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U20	12	1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0·55
U21	30	AF. Germanium Alloy Transistors 2G300 Series & OC71	0·55
U23	30	MADT's like MHz Series PNP Transistors	0·55
U24	20	Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0·55
U25	25	300 MHz NPN Silicon Transistors 2N708, BSY27	0·55
U26	30	Fast Switching Silicon Diodes like IN914 Micro-Min.	0·55
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U29	10	1 Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600	1.10
U30	15	Plastic Silicon Planar Trans. NPN 2N2926	0·55
U31	20	Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0·55
U32	25	Zener Diodes 400mW DO-7 case 3-18 volts mixed	0·55
U33	15	Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0·55
U34	30	Silicon PNP Alloy Trans. TO-5 BCY26 28302/4	0·55
U35	25	Silicon Planar Transistors PNP TO-18 2N2906	0·55
U36	25	Silicon Planar NPN Transistors TO-5 BFY50/51/52	0·55
U37	30	Silicon Alloy Transistors SO-2 PNP OC200, 28322	0·55
U38	20	Fast Switching Silicon Trans. NPN MHz 2N3011	0·55
U39	30	RF. Germ. PNP Transistors 2N1303/5 TO-5	0·55
U40	10	Dual Transistors 6 lead TO-5 2N2060	0·55
U41	25	RF Germanium Transistors TO-5, OC45, NKT72	0·55
U42	10	VHF Germanium PNP Transistor TO-1 NKT667, AF117	0·55
U43	25	Sil. Trans. Plastic TO-18 A.F. BC113/114	0·55
U44	20	Sil. Trans. Plastic TO-5 BC115/NPN	0·55
U45	7	3A SCR. TO66 up to 600PIV	1·10

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.		Description	Price
Q1	20	Red spot transistors PNP	0·55
Q2	16	White spot R.F. transistors PNP	0·55
Q3	4	OC 77 type transistors	0·55
Q4	6	Matched transistors OC44/45/81/81D	0·55
Q5	4	OC 75 transistors	0·55
Q6	5	OC72 transistors	0·55
Q7	4	AC 128 transistors PNP high gain	0·55
Q8	4	AC 126 transistors PNP	0·55
Q9	7	OC 81 type transistors	0·55
Q10	7	OC 71 type transistors	0·55
Q11	2	AC127/128 Complementary pairs PNP/NPN	0·55
Q12	3	AF 116 type transistors	0·55
Q13	3	AF 117 type transistors	0·55
Q14	3	OC 171 H.F. type transistors	0·55
Q15	7	2N2926 Sil. Epoxy transistors mixed colours	0·55
Q16	2	GET880 low noise Germanium transistors	0·55
Q17	5	NPN 2 × ST.141. & 3 × ST.140	0·55
Q18	4	MADT'S 2 × MAT 100 & 2 × MAT 120	0·55
Q19	3	MADT'S 2 × MAT 101 & 1 × MAT 121	0·55
Q20	4	OC 44 Germanium transistors A.F.	0·55
Q21	4	AC127 NPN Germanium transistors	0·55
Q22	20	NKT transistors A.F. R.F. coded	0·55
Q23	10	OA 202 Silicon diodes sub-min	
Q24	8	OA 81 diodes	0·55
Q25	15	IN914 Silicon diodes 75PIV 75mA	0·55
Q26	8	OA95 Germanium diodes sub-min IN69	0·55
Q27	2	10A 600 PIV Silicon rectifiers IS425R	0·55
Q28	2	Silicon power rectifiers BYZ 13	0·55
Q29	4	Sil. transistors 2 × 2N696. 1 × 2N697. 1 × 2N698	0·55
Q30	7	Silicon switch transistors 2N706 NPN	0·55
Q31	6	Silicon switch transistors 2N708 NPN	0·55
Q32	3	PNP Sil. trans. 2 × 2N1131. 1 × 2N1132	0·55
Q33	3	Silicon NPN transistors 2N1711	0·55
Q34	7	Sil. NPN trans. 2N2369, 500MHz (code P397)	0·55
Q35	3	Silicon PNP TO-5 2 × 2N2904 & 1 × 2N2905	0·55
Q36	7	2N3646 TO-18 plastic 300 MHz NPN	0·55
Q37	3	2N3053 NPN Silicon transistors	0·55
Q38	7	PNP transistors 4 × 2N3703, 3 × 2N3702	0·55
Q39	7	PNP transistors 4 × 2N3704, 3 × 2N3705	0·55
Q40	7	NPN transistors 4 × 2N3707, 3 × 2N3708	0·55
Q41	3	Plastic NPN TO-18 2N3904	0·55
Q42	6	NPN transistors 2N5172	0·55
Q43	5	BC 107 NPN transistors	0·55
Q44	7	NPN transistors 4 × BC 108, 3 × BC 109	0·55
Q45	3	BC 113 NPN TO-18 transistors	0·55
Q46	3	BC 115 NPN TO-5 transistors	0·55
Q47	6	NPN high gain transistors 3 × BC167, 3 × BC168	0·55
Q48	4	BCY 70 PNP transistors TO-18	0·55
Q49	4	NPN transistors 2 × BFY51, 2 × BFY52	0·55
Q50	7	BSY 28 NPN switch transistors TO-18	0·55
Q51	7	BSY 95A NPN transistors 300MHz	0·55
Q52	8	BY100 type silicon rectifiers	£1·10
Q53	25	Sil & Germ. trans. mixed all marked new	£1·65

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

PIV	1Amp TO5	3Amp TO66	5Amp TO66	1Amp TO64	7Amp TO48	10Amp TO48	16Amp TO48	30Amp TO48
50	0·22	0·27	0·39	0·39	0·52	0·55	0·58	£1·27
100	0·27	0·27	0·52	0·52	0·55	0·63	0·62	£1·54
200	0·27	0·32	0·54	0·54	0·62	0·67	0·67	£1·76
400	0·32	0·42	0·59	0·62	0·67	0·83	0·77	£1·93
600	0·42	0·52	0·75	0·75	0·84	£1·07	0·97	–
800	0·63	0·70	0·88	0·88	0·99	£1·32	£1·50	£4·40

SIL. RECTS. TESTED

PIV	300mA (DO7)	750mA (SO 16)	1Amp Plastic		1/5Amp (SO 16)	3Amp (SO 10)	10Amp (SO 10)	30Amp (TO 48)
50	0·05	0·06			0·08	0·15	0·21	0·60
100	0·05	0·07	1N4001	0·05	0·10	0·17	0·23	0·75
200	0·06	0·10	1N4002	0·06	0·12	0·22	0·25	£1·00
400	0·08	0·15	1N4003	0·07	0·15	0·30	0·38	£1·35
600	0·09	0·17	1N4004	0·08	0·18	0·36	0·45	£1·90
800	0·12	0·19	1N4005	0·10	0·20	0·38	0·55	£2·10
1000	0·14	0·30	1N4006	0·11	0·25	0·48	0·65	£2·50
1200	–	0·35	1N4007	0·12	0·30	0·58	0·75	£3·00

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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.

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2N3820	55p	2N5459	44p
2N3821	39p	BFW10	66p
2N3823	31p	MPF105	41p

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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

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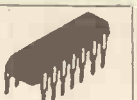

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7402	0·18	0·17	0·16	7451	0·18	0·17	0·16	74141	0·85	0·82	0·79
7403	0·18	0·17	0·16	7453	0·18	0·17	0·16	74145	£1·65	£1·55	£1·45
7404	0·18	0·17	0·16	7454	0·18	0·17	0·16	74150	£2·90	£2·80	£2·70
7405	0·18	0·17	0·16	7460	0·18	0·17	0·16	74151	£1·10	£1·05	£1·00
7406	0·39	0·34	0·31	7470	0·32	0·29	0·27	74153	£1·30	£1·20	£1·10
7407	0·39	0·34	0·31	7472	0·32	0·29	0·27	74154	£1·98	£1·90	£1·75
7408	0·20	0·19	0·18	7473	0·41	0·39	0·35	74155	£1·50	£1·45	£1·35
7409	0·20	0·19	0·18	7474	0·41	0·39	0·35	74156	£1·50	£1·45	£1·35
7410	0·18	0·17	0·16	7475	0·50	0·48	0·46	74157	£2·00	£1·90	£1·80
7411	0·28	0·27	0·26	7476	0·44	0·43	0·42	74160	£2·10	£2·00	£1·90
7412	0·39	0·34	0·31	7480	0·74	0·71	0·64	74161	£2·10	£2·00	£1·90
7413	0·32	0·31	0·30	7481	£1·30	£1·25	£1·20	74162	£4·40	£4·15	£3·85
7416	0·48	0·44	0·42	7482	0·96	0·95	0·94	74163	£4·40	£4·15	£3·85
7417	0·48	0·44	0·42	7483	£1·20	£1·15	£1·05	74164	£2·20	£2·10	£2·00
7420	0·18	0·17	0·16	7484	£1·10	£1·05	£1·00	74165	£2·20	£2·10	£2·00
7422	0·55	0·53	0·50	7485	£3·50	£3·40	£3·30	74166	£3·20	£3·10	£3·00
7423	0·55	0·53	0·50	7486	0·35	0·34	0·33	74174	£2·50	£2·40	£2·30
7425	0·55	0·53	0·50	7489	£4·00	£3·75	£3·50	74175	£1·75	£1·65	£1·55
7426	0·50	0·46	0·44	7490	0·74	0·71	0·64	74176	£1·85	£1·75	£1·65
7427	0·50	0·46	0·44	7491	£1·10	£1·05	£1·00	74177	£1·85	£1·75	£1·65
7428	0·55	0·53	0·50	7492	0·74	0·71	0·64	74180	£1·50	£1·40	£1·30
7430	0·18	0·17	0·16	7493	0·74	0·71	0·64	74181	£5·00	£4·50	£4·00
7432	0·50	0·46	0·44	7494	0·85	0·82	0·75	74182	£2·00	£1·90	£1·75
7433	0·75	0·73	0·70	7495	0·85	0·82	0·75	74184	£3·20	£3·10	£3·00
7437	0·70	0·68	0·65	7496	0·96	0·93	0·86	74190	£2·15	£2·10	£2·00
7438	0·70	0·68	0·65	74100	£1·50	£1·45	£1·40	74191	£2·15	£2·10	£2·00
7440	0·18	0·17	0·16	74104	£1·07	£1·04	£1·00	74192	£2·15	£2·10	£2·00
7441	0·74	0·71	0·64	74105	£1·07	£1·04	£1·00	74193	£2·15	£2·10	£2·00
7442	0·74	0·71	0·64	74107	0·44	0·42	0·40	74194	£2·98	£2·86	£2·75
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DEVICES MAY BE MIXED TO QUALIFY FOR QUANTITY PRICE& (TTL 74 SERIES ONLY) DATA IS AVAILABLE FOR THE ABOVE SERIES OF I.C.'s IN BOOK FORM. PRICE 35p.

The AL50 HI-FI AUDIO AMPL
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- Frequency Response 15Hz to 100,000—1dB.
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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.
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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.

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INTEGRATED CIRCUIT PAKS

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

Pak No. Contents	Price	Pak No. Contents	Price	Pak No. Contents	Price
UIC00 = 12 × 7400	0·55	UIC46 = 5 × 7446	0·55	UIC90 = 5 × 7490	0·55
UIC01 = 12 × 7401	0·55	UIC48 = 5 × 7448	0·55	UIC91 = 5 × 7491	0·55
UIC02 = 12 × 7402	0·55	UIC50 = 12 × 7450	0·55	UIC92 = 5 × 7492	0·55
UIC03 = 12 × 7403	0·55	UI351 = 12 × 7451	0·55	UIC93 = 5 × 7493	0·55
UIC04 = 12 × 7404	0·55	UIC53 = 12 × 7453	0·55	UIC94 = 5 × 7494	0·55
UIC05 = 12 × 7405	0·55	UIC54 = 12 × 7454	0·55	UIC95 = 5 × 7495	0·55
UIC06 = 8 × 7406	0·55	UIC60 = 12 × 7460	0·55	UIC96 = 5 × 7496	0·55
UIC07 = 8 × 7407	0·55	UIC70 = 8 × 7470	0·55	UIC100 = 5 × 74100	0·55
UIC10 = 12 × 7410	0·55	UIC72 = 8 × 7472	0·55	UIC121 = 5 × 74121	0·55
UIC20 = 12 × 7420	0·55	UIC73 = 8 × 7473	0·55	UIC141 = 5 × 74141	0·55
UIC30 = 12 × 7430	0·55	UIC74 = 8 × 7474	0·55	UIC151 = 5 × 74151	0·55
UIC40 = 12 × 7440	0·55	UIC76 = 8 × 7476	0·55	UIC154 = 5 × 74154	0·55
UIC41 = 5 × 7441	0·55	UIC80 = 5 × 7480	0·55	UIC193 = 5 × 74193	0·55
UIC42 = 5 × 7442	0·55	UIC81 = 5 × 7481	0·55	UIC199 = 5 × 74199	0·55
UIC43 = 5 × 7443	0·55	UIC82 = 5 × 7482	0·55		
UIC44 = 5 × 7444	0·55	UIC83 = 5 × 7483	0·55	UICXI = 25 Assorted 74's	1·55
UIC45 = 5 × 7445	0·55	UIC86 = 5 × 7486	0·55		

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

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

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 MK50 COMPRISING 2 AL50's, 1 SPM80, 1BMT80 & 1 PA100 ONLY £25·30 FREE p.&p

only £13·15

LINEAR I.C's—FULL SPEC.

Type No.	Case		1	25	100+
72702	DIL	14	0.50	0.48	0.45
72709	DIL	14	0.35	0.33	0.30
72710	DIL	14	0.45	0.43	0.40
72741	DIL	14	0.40	0.38	0.35
72741C	TO-5	8	0.45	0.43	0.40
72741P	DIL	8	0.38	0.36	0.34
72748P	DIL	8	0.38	0.36	0.34
SL201C	TO-5	8	0.50	0.45	0.40
SL701C	TO-5	8	0.50	0.45	0.40
SL702C	TO-5	8	0.50	0.45	0.40
TAA263	TO-72	4	0.80	0.70	0.60
TAA293	TO-74	10	£1.00	0.95	0.50
TAA350A	TO-5	10	£1.85	£1.80	£1.70
μA703C	TO-5	8	0.28	0.26	0.24
μA709C	TO-5	8	0.35	0.33	0.30
μA711	TO-5	10	0.45	0.43	0.40
ZN414	TO-18	4	1.20		

DTL 930 SERIES LOGIC I.C's

Type	1	25	100+
BP930	0.15	0.14	0.13
BP932	0.16	0.15	0.14
BP933	0.16	0.15	0.14
BP935	0.16	0.15	0.14
BP936	0.16	0.15	0.14
BP944	0.16	0.15	0.14
BP945	0.30	0.28	0.25
BP946	0.15	0.14	0.13
BP948	0.30	0.28	0.25
BP951	0.70	0.65	0.60
BP962	0.15	0.14	0.13
BP9093	0.45	0.43	0.40
BP9094	0.45	0.43	0.40
BP9097	0.45	0.43	0.40
BP9099	0.45	0.43	0.40

DUAL-IN-LINE SOCKETS.

14 & 16 Lead Sockets for use with DUAL-IN-LINE I.C's TWO Ranges PROFESSIONAL & NEW LOW COST.

PROF. TYPE No.	1–24	25–99	100up.
TSO 14 pin type	33p	30p	27p
TSO 16	38p	35p	32p
TSO 24	75p	70p	68p
LOW COST No.			
BPS 8 pin type	13p	13p	11p
BPS 14	16p	14p	12p
BPS 16	17p	15p	13p

NUMERICAL INDICATOR TUBES

Type	Description	
3015F	Minitron 7 Segment Indicator	£1.50
MAN 3M	L.E.D. 7 Segment Display 0.127" High Characters	£1.90
CD 66	Side Viewing 'Nixie Type' Tube 16 mm	£1.87
GR 116	Side Viewing 'Nixie Type' Tube 13 mm	£1.70

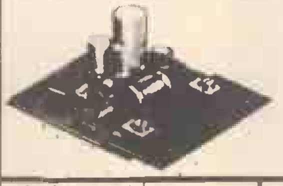
3 TERMINAL POSITIVE VOLTAGE REGULATORS

To-3 Plastic Encapsulation O.P. 1.5 Amps

μA7805	5V (Equiv. to MVR5V)	£1.76
μA7812	12V (Equiv. to MVR12V)	£1.76

BI-PAK
CATALOGUE AND LISTS
Send S.A.E. and 18p.

AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0·25%
LOAD IMPEDANCE	—	8 – 16 Ω
INPUT IMPEDANCE	f = 1KHz	100 k Ω
FREQUENCY RESPONSE @ 3dB	Po = 2 WATTS	50 Hz – 25KHz
SENSITIVITY for RATED O/P	Vs = 25V. Rl = 8 Ω f = 1KHz	75mV. RMS
DIMENSIONS	—	3" × 2½" × 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL = 8Ω f = 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.
PRICE	£2·20	£2·59	£3·3

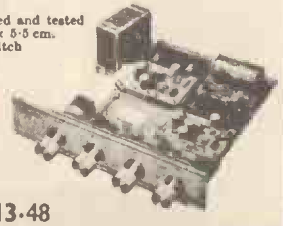
TEAK VENEERED CABINETS for:

STEREO 20
TC 20. £3·95 p&p 30p.

MK 50 KIT
TC 100. £6·50 p&p 40p.

E.M.I. LEK 350 Loudspeaker System Enclosure kit in Teak Veneer, including speakers. Rec Retail Price £45·50 per pr. OUR SPECIAL PRICE £35·50 per pair p&p £1. *ONLY WHILE STOCKS LAST!*

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, Transformer, Power supply and Power amps. 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. Bass control ±12dB at 60Hz typically 0·25% at 1 watt. Treble con. ±14dB at 14kHz.

£13·48

FRONT PANEL, 4 knobs. Headphone Socket, on/off switch and neon for PA 100/MK 50. FPK 100 £2·95.

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20) £1·93 P & P 15p
BMT80 (Use with AL30 & AL50) £2·15 P & P 25p

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 88p
SPM 80. (Use with also AL30 & AL50) £3·25

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm. PRICE £4·35

Frequency response—
20Hz – 50KHz (– 3dB)
Bass control—
± 12dB at 60Hz
Treble control—
± 14dB at 14KHz
*Input 1. Impedance
1 Meg. ohm
Sensitivity 300mV
†Input 2. Impedance
30 K ohms
Sensitivity 4mV

FRONT PANEL FP12 with knobs £1·20.

Giro No 388 7006
Please send all orders direct to warehouse and despatch department

BI-PAK

P.O. BOX 6, WARE · HERTS

Postage and packing add 11p Overseas add extra for airmail
Minimum order 55p Cash with order please

Guaranteed Satisfaction or Money Back

Continued from page 7

physicians in their concern for the human condition, but the engineering code of ethics still deals mainly with business relations among practitioners.

"Much of the responsibility for the uses of technology lies with society, not engineers," claims Susskind. *"Blaming engineers for the short-comings of technology makes about as much sense as blaming the failure of a new play on the stagehands."*

Yet neither are engineers mere spectators, Susskind says. They play a crucial part not only in opening new doors to knowledge, but also in deciding which doors to open. Therefore it is doubly important for engineers to be guided by the highest moral principles.

In "Understanding Technology," this theme is developed extensively. The book describes the historical development of modern technology, from the mechanization of the textile industry in the 18th century to the electronic computer in the 20th. There are dicussions of the effects of technology on fields with which it is not usually associated--new foods, the health sciences, the fine arts, education and humanities.

Dr. Susskind also discusses technology in a broader social and political context. He traces such "ideologies of technology" as technocracy, the managerial revolution, utopias and anti-utopias, and the work of contemporary thinkers such as Burnham, Ellul, Galbraith and the Marxist ideologues.

"Technology is too important to be left to the engineers", says Susskind in a paraphrase of Clemenceau's saying about war and the generals. *"But if engineers subscribe to a statement based on moral considerations, other leaders can do no less. Only by the concerted efforts of all the abuses of technology be avoided."*

Among other points, Susskind's Hippocratic Oath for Engineers states: *"I will not use my professional knowledge contrary to the laws of humanity; I will endeavour to avoid waste and the consumption of nonrenewable resources."*

A POCKET CALCULATOR IN EVERY HOUSEHOLD

"By the mid-70's the pocket electronic calculator will be as much an essential part of the household as the transistor radio is now". This is the prediction made by Sinclair Radionics.

Recent market research confirms that increasing numbers of the population are becoming aware of the possible applications of pocket electronic calculators. This is most marked in the educational field, at school and college levels although considerable interest is also being shown on the domestic front by husbands and wives who are able to use a calculator to help control the family budget.

The claim was made at the launch of a new publication the *'Sinclair Book of Management Calculations'*. This paperback (50p) is a condensation of present management practices in which a calculator can be used. Regular calculations applied to five specialist areas, finance and accounts, purchasing and stock control, production, marketting, sales and personnel are examined in separate chapters for easy reference. Examples range from amortisation and discounted cash flow to stock turnover rates, time forecasting for network analysis, assignment of machines through to sales forecasting by moving averages and the working out of recruiting costs per head and productivity agreements. Current sales of Sinclair calculators are 25,000 units per month. Turnover since the introducation of the 'Executive' calculator in June '72 has topped £2½ million of which the greater part is exported - major markets being the USA and Japan.

LITTLE BOXES

The housing of finished projects often presents a problem. RS Components have produced a range of attractive mini instrument cases. They are robustly built in mild steel with blue stove enamel covers and cream bases and should find favour with the home constructor.

The cases are ideally suited to the construction of small instruments or for housing electronic circuits with easy access for building or servicing the circuitry. Ventilation holes are provided in the cover.

There are two sizes available: 73 x 41 x 99mm and 97 x 75 x 179mm at 69p and 98p respectively.

18MM VIDICON TUBE

EMI have introduced an 18mm vidicon type 9831 which is designed to operate in standard 18mm scan and forcus coil assemblies and is primarily intended as a direct replacement in existing compact television cameras.

The new vidicon features a low wattage heater, separate mesh construction and high quality processing of the target layers. This offers better shading characteristics and improved sensitivity.

With an 18mm magnetically focussed and deflected vidicon, the size and weight of the associated scanning assembly can be considerably reduced. The tube in normally associated with industrial cameras, but higher grade versions will be offered for use in broadcast and educational television studio and telecine equipments.

A version with a fibre optic faceplate for direct coupling to an intensifier, eliminates the need for an intermediary coupling lens, providing a much higher light transmission.

PSYCHEDELIC LIGHT DISPLAY KIT

A small Essex company have recently introduced a psychedelic light unit which is primarily intended for home use. The circuits of these units have frequently appeared for the home constructor but the problem which most people face is in the housing and presentation and the company, Cosmic Electronics have made this easy for the constructor as everything is included.

Only one input is required, the mains: the input to the lamp circuits is via a built in mircophone thus overcoming one problem. The only control is one for sensitivity to suit the background.

The lamps are the usual Red, Green and Blue and these are back projected onto an opal tinted screen. Size of the cabinet is 24 x 12 x 2½in. and it can wither free stand or be hung on the wall. The complete kit retails for £19.50 and is available from Cosmic Electronics, 12 Grange Road, Romford, Essex RM3 7DU.

CONFERENCE COMPLEX

The recent opening today of Europe's most advanced conference complex - The Heathrow Hotel's York Theatre with its futuristic audio-visual aids concept - marks the completion of one of the most outstanding equipment contracts carried out by EMI in recent years and is worth over £250,000.

Characterised by its space-age delegate seating, incorporating electronic consoles, the York Theatre has been comprehensively equipped by EMI Sound & Vision Equipment Limited, of Hayes, Middlesex, working closely with Audio-Visual Consultants who designed these meeting facilities. In addition to manufacturing and installing the theatre's unique delegate seating, the company has supplied and installed the complexity of audio-visual and communications systems, upon which foundation, the philosphy of the conference complex is based.

The electronic systems include: a comprehensively-equipped colour television studio, monochrome closed-circuit television network, audio and video taping and telecine facilities, professional film projection equipment, document scanning by a CCTV camera, both stereo and quadraphonic sound reinforcement systems, public address systems, and internal audio communications network.

The 262 delegate seats in the auditorium are one of the major highlights of the complex. Each has a built-in console facing the delegate. This unit incorporates a 9in television monitor, mircophone, computer-controlled delegate response facilities, simultaneous translation earphones, folding desk and other aids.

NSF FUNDS SOLAR ENERGY STUDY

The National Science Foundation of America has awarded nearly $500,000 in additional funds to a University of Minnesota/Honeywell team of scientists for a second year of studies on the feasibility of converting solar energy to run a central power station. Readers may recall a detailed description of this research in ETI special article 'The Solar Solution' (September 1973).

"In our first year, we made substantial advances in determining the materials we will use for heat storage, reflective surfaces and the heat pipe," comments Mr. Roger Schmidt, Honeywell programme manager. *"The new funds will enable us to push forward toward the goal of capturing energy from the sun -- a relatively unused but unlimited non-polluting alternate source of energy."*

The project involves determining the best way to reflect solar energy off trough-like surfaces onto a heat pipe which would convert the energy to steam.

The second year of the study will involve building a working scale model collector 4ft. diameter and 15ft. long. The actual collector, if built, would be 10ft. diameter and 40ft. long.

A computer will compile data gathered from the working model, and analysis of this information will help determine the cost of converting solar energy to generate electricity from a central power station.

Honeywell scientists say a pilot power plant could be operating in the southwestern U.S. by 1990.

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news digest

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SOLID STATE IMAGE SENSOR

RCA have recently demonstrated the largest solid state image sensor to date - a key milestone in the creation of a new generation of tubeless TV cameras for government, commercial and consumer use.

The sensor - known as a Charge Coupled Device (CCD) (see last months ETI, page 11) - is a silicon chip the size of a small coin, containing over 120,000 electronic elements. Developed at RCA Laboratories, Princeton, N.J., it could be the forerunner of a new set of "eyes" for future colour and black-and-white TV cameras.

"This is a key achievement since manufacturable CCD image sensors of at least this size are essential if all-solid-state TV cameras are to have the resolution to satisfy a broad range of applications," according to Dr. Karl H. Zaininger, Head of Solid State Device Technology at RCA Laboratories.

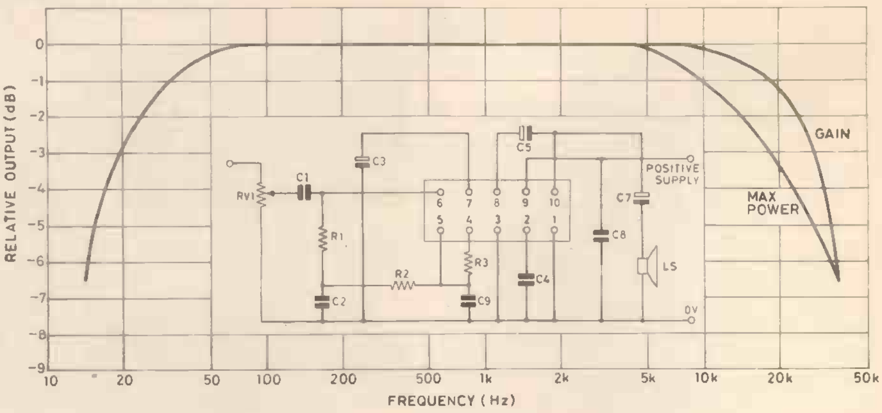
He said possible future TV cameras employing CCD's could be the size of a cigarette package or smaller, and would be rugged, highly reliable and potentially low in cost. They could be used in space exploration, closed circuit TV, military programmes, surveillance systems, telephone systems transmitting TV pictures, by consumers with home video recorders and in broadcast camera applications.

"A goal of RCA's CCD programme is to demonstrate before the end of 1973 the feasibility of a manufacturable CCD image sensor having performance substantially equivalent to that of a two-thirds-inch silicon target vidicon tube," Dr. Zaininger said. "At present, the programme is ahead of schedule. We believe this places us at the forefront of this important and exciting new technology."

The new CCD "eye" developed by RCA works as follows: When an image is focused on the CCD, the sensor's electronic elements transform the picture into individual electrical charge packets. These packets are then read out very rapidly by charge transfer techniques. The resulting information then can be processed and displayed as a TV picture.

In the RCA CCD, half the electronic elements form the imaging array and the other half are for storage and readout.

NEW AUDIO IC'S REPLACE SL402 AND SL403



RV1: 1MΩ(log)
LS: 7.5Ω
R1: 1MΩ
R2: 220kΩ
R3: 1.2MΩ
C1: 10nF
C2: 100nF
C3: 25µF
C4: 10nF
C5: 125µF
C7: 1000µF
C8: 0.1nF
C9: 680pF

Plessey have introduced two new integrated circuit audio amplifiers, types SL414 and SL415, which replace the earlier, popular SL402 and SL403. The amplifiers will deliver 3 and 5W r.m.s. respectively into a 7.5 ohm load. Designed for operation from a 20V (SL414) and 25V (SL415) supply rail, distortion is quoted as 0.1% r.m.s. (SL414) and 0.3% (SL415) with a power output of 1W at 400Hz.

Each amplifier has a built-in pre-amplifier consisting of a triple Darlington stage, thereby ensuring a high input impedance.

LIGHTWEIGHT GUNFIRE CONTROL SYSTEM

Two international leaders in naval weapon control systems have collaborated to create a new lightweight gunfire control system. The two companies, Marconi and Sperry Gyroscope, are well established in this field and between them account for many of the advances in weapons achieved since World War II.

Designed for any size of warship from fast petrol boats upwards, the System is capable of maintaining rapid and accurate control over small and medium calibre guns against air, surface or shore targets.

It is fully-automatic, thus keeping manning requirements to a minimum; with only one man required to operate the fire control system in an essentially supervisory role.

This new gunfire control system incorporates a Marconi Tracking Radar and a Sperry Predictor. The Marconi Radar Type ST802 has been selected from the Marconi 800 Series of weapon radar systems. It is an autonomous X-band tracking radar, designed specifically to function in naval gun/missile systems. The Sperry Predictor is based on the Bracknell designed 1412 general-purpose computer which is entering service with many navies including the Royal Navy as part of the Exocet missile system.

NEW EPOXY SEMICONDUCTOR ENCAPSULANT

A four-year research programme has resulted in Fairchild Semiconductors developing a new semiconductor encapsulant, the reliability of which closely approaches that of hermetically-sealed devices, which are, of course, on a higher price level.

It provides a high degree of protection from thermal and moisture stresses and significantly reduces device failure due to contamination.

"We believe that the new epoxy is superior to any plastic encapsulant available today," a spokesman for the Fairchild Analog Reliability department says. Almost two million device-hour tests have already been spent in proving the efficiency of the new plastic.

In announcing the epoxy development, Fairchild say: *"The need for increased reliability of semiconductors in the consumer and industrial marketplace has increased the demand for product reliability. The new encapsulant greatly decreases the failure rate of higher-voltage semiconductors."*

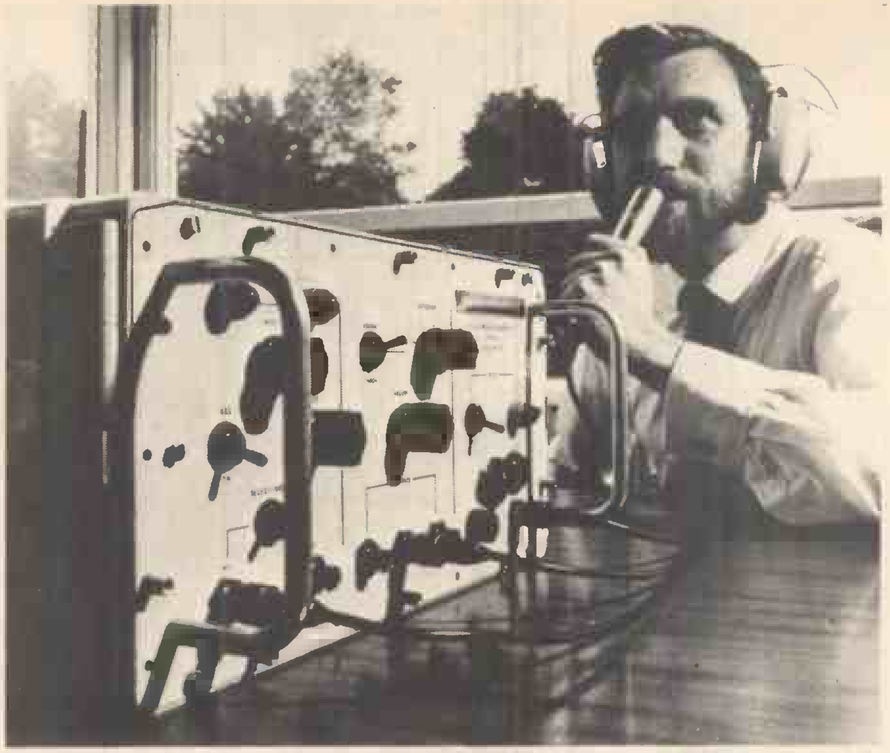
A plastic material suitable for encapsulation calls for many functions. It must provide protection against the ambients to which the device is likely to be exposed--high humidity and various chemical agents as well as wide temperature changes and mechanical shock. The protection must be provided with a minimum effect on device parameters over an extended period and, of course, be relatively inexpensive and easy to process.

'DONALD DUCK' ELIMINATIONS FOR U.S. NAVY

The U.S. Navy is buying British systems capable of overcoming the *'Donald Duck'* effect which oxy-helium has on deep-sea diver's speech. The systems were developed for the Royal Navy by Marconi Space and Defence Systems Limited from Admiralty Research Laboratories designs.

The *'Donald Duck'* effect results from divers having to breathe an oxy-helium mixture in depths of greater than 600 feet, where air cannot be used safely. The mixture, being much less dense than air, produces changes in the speed of sound, and therefore in the pitch of a speaker's voice. This rises to an extent where it becomes completely unintelligible to the listener. In emergency situations, the lack of effective communications can mean life or death to the diver.

It operates on a 'Time stretching' principle, where each sound is digitally analyzed, and the significant portion, typically about one third, is reconstructed at a slower rate, while the rest is rejected. This has the effect of lowering the frequency to about a third of its transmitted value, thus creating full intelligibility.



IF YOU CAN'T BEAT 'EM JOIN 'EM

John Hutchinson, a guitarist with the David Bowie Band, recently became worried about the increasing risk of deafness among customers and group members, as a result of playing with high powered P.A.s.

Realising the seriousness of noise induced deafness, Hutch has recently accepted an appointment with Castle Associates - the Scarborough based Sound Level measuring specialists - as stylist and consultant.

Castle Associates manufacture the 'Electronic Orange' and 'Electronic Lighthouse', which are equipments designed to limit the noise levels in clubs. They operate by measuring the noise level and, if a certain pre-set level is exceeded, the 'Electronics Orange' or a coloured light band on the 'Electronic Lighthouse' is illuminated. This gives warning that danger levels have been approached.

The 'Electronic Lighthouse' is more sophisticated in that ten levels of warning are given to enable larger groups to see more readily the level at which they are playing and thus give a better balance in the hall.

Costing about £400 and £100 respectively the 'Electronic Lighthouse' provide a solution to the growing problem of noise in clubs.

I.C. DATABOOK

Plessey Semiconductors has produced a comprehensive 235-page Databook giving details of its range of silicon I.C.s.

Continuous emphasis on the development of processes and circuits by Plessey has been demonstrated by the successful introduction of Bipolar Process III circuits and MNOS electrically-alterable non-volatile memories. The first products from these new processes are detailed in the Databook along with the wide range of both special and standard products currently available.

Sections of the Databook are devoted to MOS and MNOS circuits, bipolar linear circuits, bipolar digital circuits, consumer circuits, and package outlines and dimensions. Circuits diagrams, electrical characteristics, performance curves, operating notes and absolute maximum ratings are provided for each device.

Copies of the Integrated Circuit Databook are available on application to Plessey Semiconductors Limited, Marketing Services, Cheney Manor, Swindon, Wiltshire.

NUCLEAR FALLOUT – the effects

This report was specially written for ETI by nuclear geochemist Dr. John Kleeman B.Sc., Ph.D.

FALLOUT is the air-borne debris produced by nuclear explosions. The amount depends on the type of bomb, the power or "yield" of the explosion and its distance from the ground. Explosions are caused by fission or fusion reactions.

Fission bombs (also called A-bombs) use the rapid chain reaction of fission of super critical masses uranium-235 or plutonium-239. Each fissioning atom splits into two parts of unequal mass (called fission products), and produces an average of two neutrons which in turn induce fission of two more atoms of uranium 235 or plutonium 239.

There is also an enormous amount of energy. About fifty per cent of this energy yield is in blast effects, thirty five per cent is heat and light, and fifteen percent as prompt radiation, including neutrons. These neutrons can activate ordinary material, dust, soil, air into radioactive nuclides. The amount of soil activated depends on the proximity of the explosion to the ground. After a few seconds, the explosion is a fireball of hot vapours containing fission products. If the prompt radiation has produced radionuclides these will also be included, and if the fireball touches the ground, vaporized soil will be caught up.

Fusion devices (also called H-bombs, or thermonuclear explosions) use the fusion of two small nucleii (tritium or deuterium) to produce a bigger nucleus plus one or two neutrons, prompt radiation, and extremely large amounts of energy. These are much more powerful bombs. The fusion reaction requires temperatures around several million degrees; this is supplied by a fission bomb triggering device. The yield of the bomb can be increased by surrounding it with uranium-238, as the neutrons produced by the fusion reaction are energetic enough to cause fission of this uranium isotope. This is a "high yield device". The fireball of a fusion explosion will contain the fission products of the triggering bomb, and also any activated dust from the atmosphere. Since the triggering device is usually a small fission bomb, thermonuclear explosions can be relatively "clean", with quite small quantities of radioactive debris. However, if it is a high yield device, with uranium 238 casing, the fireball will contain a very large quantity of fission products, and contain vaporized soil and dust if it touches the ground. Part of this extra burden may be newly formed radionuclides if the explosion was low enough for the prompt neutrons to bombard soil. A large thermonuclear detonation can vaporize up to 20 000 tons of soil or sand.

Official French government photograph taken at Mururoa atoll.
Explosion is that of a 'small' atomic device – similar to that used to devastate Hiroshima.
An explosion of this magnitude is required to detonate the large hydrogen weapons that France is attempting to develop.

The radioactive debris in the fireball will eventually come back to the ground. This is fallout. The fireball may have a large, or relatively small burden of radioactive material, depending on the type and size of bomb, and how close the explosion is to the ground.

All of these factors, and the weather, will determine how the fallout is distributed.

DISTRIBUTION OF FALLOUT

Nuclear explosions, with yields less than 100 kilotons, form fireballs which reach altitudes of 11 kilometres or less, and thus do not leave the troposphere. The products of megaton and multimegaton detonations will reach 20 to 30 kilometres altitude, penetrating well into the stratosphere. Fallout will occur in three zones (i) local, (ii) intermediate, (iii) world wide.

Local fallout is fallout in the vicinity of the explosion, say a few hundred kilometres. The larger particles will be responsible for this type of fallout, and the amount will depend on how much soil is caught up in the fireball. Fission products and other radionuclides will condense on any larger particles present. For surface explosions, up to 80% of all radioactive debris will fall as local fallout. Depending on the size of the bomb, the remainder will go into the troposphere or stratosphere.

Detonations made at an altitude such that the fireball does not touch the ground will deposit 20% or less of their debris as local fallout. If this falls within a few days it will be extremely dangerous as a short term radiation hazard. It will include a large proportion of short lived isotopes. The gamma radiation dose can be high enough to induce radiation sicknesses or death. Beta emissions from dust particles on the skin will cause radiation burns. Food and water supplies will become unusable for a time. In a nuclear attack, fallout within 200 kilometres of the detonation, and falling within a day or so, could cause up to four times as many casualties as the blast.

Fine particles of radioactive debris remaining in the troposphere will be deposited within two months under average meteorological conditions. Within this time it will have travelled thousands of kilometres, and may have circled the earth. This fallout will usually be confined to a zone 40^{o} latitude wide. Being fine material, this debris will take several days to commence falling out. By this time many of the short-lived isotopes will have decayed away, so that an immediate threat to life will be unlikely. Isotopes of importance will be strontium 89 and 90, caesium 137, iodine 131 from fission products, plutonium 239 from activated uranium 238, and carbon 14 from activated nitrogen. If prompt neutrons have bombarded soil, calcium 45 and iron 55 and 59 will also be present. Any effects from exposure to these isotopes will be in the long term.

Radioactive material stabilizing initially in the stratosphere will take six to twelve months to precipitate, by which time it will have been distributed world wide, though not evenly. Only Plutonium 239, caesium 137, strontium 90 and carbon 14 will remain. The actual dose from these isotopes is small.

HOW FALLOUT IRRADIATES HUMANS

Radioactive debris will affect humans by internal and external exposure. External exposure comes from active particles in the air, on foliage and in soil. (That is external to the body). Gamma ray emissions are the most important here because beta- and alpha-particles are of very limited range. The gamma radiation background is measured using Geiger-Muller tubes, proportional counters, scintillometers or ionization chambers. As there is a natural radiation background, steps must be taken to distinguish normal background from additions by fallout. Outside local fallout zones, external radiation is not likely to be very significant; internal radiation is much more important.

Some fallout is taken up by the body, where it irradiates from within. This is potentially more important for long term effects. One route of entry is by breathing dust containing radioactive particles. This can be monitored by filtering large volumes of air and measuring its activity.

A more important route is via food and water. Iodine 131 has an eight-day half life. By the time most foods have been processed and marketed, there is not much left, but fresh milk is an effective agent. Cows eat grass over large areas and pick up surface contamination from precipitated debris. They also concentrate strontium 89 and 90 and caesium 137, so that monitoring fresh milk is one of the most effective ways of collecting data on the intake of these isotopes. Strontium 89 and 90 will also be present in many other foodstuffs. Much of the isotope 89 will decay away before consumption, but strontium 90 has a very long half life, and persists. Once in the body, strontium is fixed in bones, and iodine in the thyroid, but caesium is not particularly specific and does not remain long in the body. Plutonium is quite insoluble and does not appear to be taken into humans in noticeable quantities. Carbon 14 will take its place with normal carbon in our bodies, but will also become part of actual genetic material, a reason for special concern.

FALLOUT AND THE NATURAL RADIATION ENVIRONMENT

Apart from accidents, or miscalculations, massive local fallout is not a consideration in respect of bomb tests. Fallout from atmospheric testing from 1945 to 1962 has been recorded, with various degrees of accuracy. We know fairly well how *much* radiation populations have received, but very little is known about the *effects* of this exposure. One difficulty is that there is a natural radiation environment. World wide fallout adds to this background, and in some ways cannot be distinguished from it.

In one year the average person receives 125 units (millirems) of radiation. This is made up of 50 units of cosmic radiation, with the remainder from terrestrial sources. External radiation comes from naturally occurring uranium 238, thorium 232, radium 226, potassium 40, and some of their products including the gas radon 222. These isotopes occur in rocks, granites having more than double the amount found in common sediments, such as sandstone, and hence there are wide variations in natural radiation from place to place. Cosmic radiation intensity increases noticeably with altitude. A total contribution of 25 units of radiation is normally added by isotopes within the body. Potassium 40 is the major source, with minor contributions from radium 226 and 228, radon 222 and carbon 14. Medical X-rays may add up to 100 units.

Intermediate and world wide fallout will add to this background by enhancing external and internal radiation. Is the addition significant? In 1958, after a very extensive series of multi-megaton bombs by three nations, the external background from terrestrial sources was observed to rise by 20%. That is, by 10 units, much less than the difference in natural background between various population centres in Australia.

Additions to internal radiation background are almost entirely from strontium 89 and 90, iodine 131, caesium 137 and carbon 14. While other isotopes are included in fallout, they do not readily become part of our food chain, and hence do not enter the body. The doses of radiation from these sources have been calculated for 1955-1958, a period of very heavy bomb tests. Strontium 89 and 90 are fixed by the body in bones, as strontium can take the place of some calcium. Growing children are at a greater risk because they are forming new bone. A one year old child in 1955-1958 would have received 30 units (millirem) of radiation to his bones in the next year, reducing to eight units a year, and stabilizing to two to five units thereafter. Iodine 131 concentrates in the thyroid. During periods of heavy atmospheric testing additional doses to the thyroid were calculated at 40 or more units per year. Iodine 131 decays relatively quickly, and this exposure will cease soon after testing stops. New carbon 14 has added about one unit per year to natural background. These are all maximum values, reflecting over a decade (1945-1962) of hundreds of atmospheric explosions, many of them multimegaton high yield devices. Ten years have passed since that time.

It is true to say that nuclear weapons testing has permanently added five to 10 per cent to our natural radiation background. Every new test adds more, but more important, adds a burst of thyroid seeking iodine 131 and bone seeking strontium 89 and 90. Children are most vulnerable.

BIOLOGICAL EFFECTS OF FALLOUT

Is there a real danger to humans?

Large doses of radiation can cause death within days or hours. In a large scale nuclear disaster, local fallout may kill three or four times more people than detonation effects. Fatal doses could be received in an hour or so of

continued on page 57

CREATIVE AUDIO

The Ultimate in Creative Capability? — the computerised Electronic Music Studio belonging to Peter Zinovieff (a director of E.M.S. (London) Ltd.) Note the recorders on the right of the picture — a 4-track Ampex, a stereo Revox (beneath the Ampex) and a stereo Philips Console Machine. In the background is a PDP8 computer which can interface directly with the music synthesiser to its right.

PART ONE

A practical guide to creating and producing your own sound.

by Terry Mendoza, BSc(Hons)

SOUND, is, potentially, one of the most creative of all media. It combines the plasticity of tape manipulation (i.e. management by editing or copying in different order from that in which the events actually occurred in time) with the immediacy afforded by the 'aural' mode of perception. Indeed to many "creators", sound is superior to the visual arts, painting, television and cinema, because these, by providing their own pictorial imagery, act as boundaries for the audience imagination. On the other hand, audio on its own (tape, disc, radio and even to a large extent, events such as orchestral concerts where the visual impressions are subjugate to the audible ones) allows the mind a framework to build *from*, with minimal restriction. Consider the example of a radio announcer; unless previously encountered visually, one person's concept of the 'face behind the voice' will radically differ from another's mental picture.

THE COMPOSITION – PLANNING

There are two approaches to audio creativity, first there is the "inspired" artist who has his project completely mapped out on paper, or in his head, and he uses the tape merely as the most effective means of transposing his ideas.

The other common approach is that which we will call mutual feedback. The creator commences with a possibly diffuse idea. He collects varied material around this one theme. The collecting of the material helps him to crystallise the idea into a more tangible form. Removing all that he considers non-essential or unsuitable gives a more condensed, cohesive structure to the emerging composition. Now when the recordist listens to the recording he will sense a rather more definite theme that will bear a relationship of sorts to his original one. Searching criticism by the recordist of his piece under creation may suggest rearrangements, removals and additions which he will undertake to reinforce the now definite theme. It is by this 'feedback' the final piece emerges — but the recordist must know where to stop, for otherwise he will go for ever trying to reach perfection.

CHOOSING EQUIPMENT

The quality of equipment should be the best that finances will allow. With the possible exception of the microphones, all units should be of roughly similar performance. It is better to have a basic set-up with reasonable and *consistent* fidelity, than a fully comprehensive set-up of widely varying performance, for the latter can at least give only a mediocre performance.

The only general exception is the microphone as it can be advantageous initially to purchase one of a higher standard than the rest of the equipment. By so doing, later improvements in the remaining equipment will not entail changing one's microphone technique.

THE ROLE OF TAPE

Tape provides a 'carrier" between the imagination of the creator and that of his audience. He has the opportunity, at his own particular whim, to introduce as many or as few mental clues as to the visual imagery that should accompany his creation i.e. he may leave his audience to fill in a mental picture from a few sparse sounds, say in a science fiction fantasy, or he may overlay the sounds with a narrative, leaving them there just to enhance the effect.

CASSETTE VERSUS OPEN-REEL

Although equipment is available to enable the editing of tape cassettes — principally for overcoming the bugbear of broken or tangled tape, reel-to-reel (open reel) machines are more suited to creative audio work. Even if cassette equipment is used 'on location' it is still preferable to copy the collected material onto an open reel machine and then to edit this copy rather than the original. The original cassette is then still available for re-use or 'archive' storage.

Another difficulty with cassette tape is that apart from the inherent fiddliness of trying to manipulate 1/8" tape, edit cueing is awkward.

The editing procedure entails locating,*with a high degree of precision,* the exact moment of the commencement of a sound (the 'attack'). A typical example of remedial editing would be the removal of a click with a duration of 1/30 second. This would be relatively straightforward with tape running at 7½ inches per second, for there the sound occupies ¼" of tape length. The same click would be virtually impossible to *locate,* let alone *remove,* with a cassette tape running at the

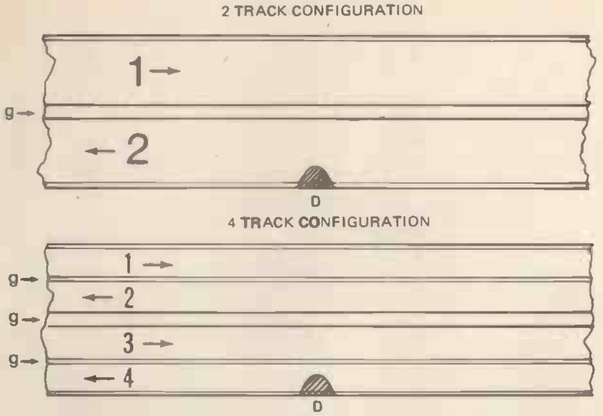


Fig. 1. Comparison of track configurations showing larger signal area affected by narrower (4) track width – tracks 1 and 4 are more prone to 'drop-out' affect.

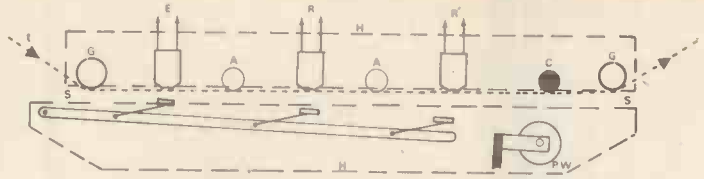


Fig. 2. E: erase head; r: record head; R': replay head; H: head cover; t: tape and direction of travel; C: Capstan; Pw: pinch wheel (rubber or neoprene); S: Sound channel; G: main guide; A: auxiliary guide.

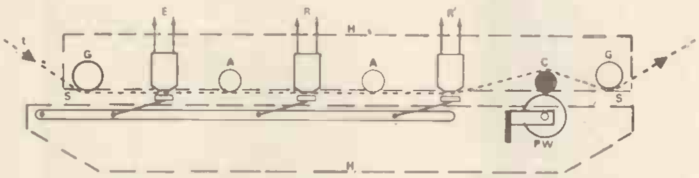


Fig. 3. Method of threading tape for "see-sawing" (bypassing capstan traction).

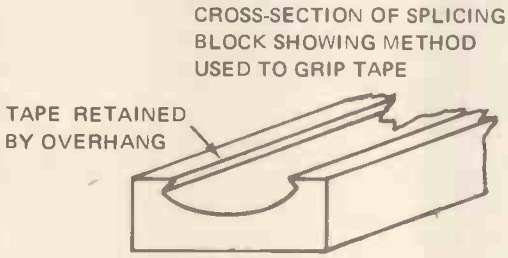


Fig. 4. Cross-section of splicing block showing method used to grip tape.

Topics to be covered in this series include:–

CREATIVE TECHNIQUES: editing; dubbing; mixing (and mixers); multitrack recording. duoplay.

MUSIC RECORDING: acoustics; microphone characteristics; microphone types; microphone placement; stereo recording; monitoring.

UNUSUAL EFFECTS: tape echo; pre-echo; extended loop feedback; phasing; speed change; reverberation.

LOCATION WORK: equipment; stereo problems; scripting and documentary programme compilation.

standard cassette speed of 1-7/8 inches per second.

One requirement for tape editing, is therefore a running speed of 7½ or 15 inches per second. (Editing *is* possible, although not very easy at 3¾ ips.) This 7½ ips speed requirement also goes part way to satisfying another recording characteristic necessary for creative work – a high grade of sound quality, very necessary for receptive audience response.

Sound quality may be fairly accurately equated with tape speed and track configuration on the basis of quality being proportional to the *area* of tape occupied by a standard length of sound (assuming the electronics of the recorder is not the limiting factor).

Thus a full-track 7½ ips recording will sound (slightly) better than a half-track 7½ ips version, which itself will be an improvement on the same recording made at half the speed, or on a quarter track configuration.

Relating versatility to price, the preference should be for a ½ track (three head) stereo recorder – the half track configuration giving enough width to avoid drop out. The edge tracks on a quarter-track recorder (usually tracks one and four) can be marred by oxide flake-off. This shows up as an annoying, momentary, loss of signal. (See Fig. 1).

This recommended track configuration, with the vast majority of machines, will allow the choice of stereo, ½ track mono and mono "pseudo full-track" operation.

The blank guard band will still be present between the tracks. If a *genuine* full track recording has been made and this is erased by replacing it with a "pseudo full-track" recording, the original recording will still be present on the guard band. Playback of this recording on a full-track recorder will reveal its presence. Similar effects can sometimes be encountered when playing back stereo tapes on different makes of machines due to different guard band widths. Half track stereo gives the added bonus of reverse play effects – having made the recording the feed and take-up spools are reversed so the recording is played from 'end-to-beginning'.

Possibly the next most important characteristic to take into account when choosing a machine is head accessibility. This contributes towards easy editing.

REASONS FOR EDITING

Editing is fundamental even to an elementary sound composition.

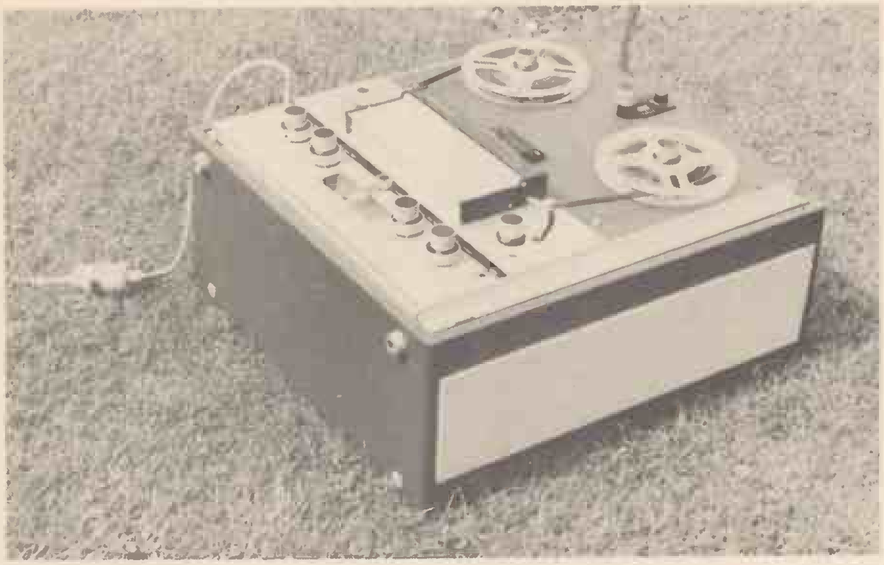
Initially it is a means of 'tidying up' recordings, removing unwanted passages, polishing speech by the removal of hesitations, fluffed lines coughs and stutters, and those most irritating of tape interruptions – the aperoidic transients due to electrical sources, the 'clicks and pops', can all be effectively eliminated. Once this process has been carried out, the results will sound acceptable, but the interest value may still be very low.

Editing as a creative process is the rearrangement of the material into a form and order pleasing to the aesthetic ideas of the editor.

A further possibility of the editing procedure may be the realization of effects which are not possible in actuality. The characteristic percepts of individual sounds can be completely altered by modifying, or removing their attack or decay (or both); This effect is well demonstrated by the difficulty encountered, even by musically-oriented individuals, when asked to identify recordings of various musical instruments from which the important first few milliseconds of attack have been removed.

THE EDITING SESSION

Standard or long-play tape is generally preferred as it is least affected by mechanical stress – It is important that the same brand and type of tape should be used throughout the compilation of the work to avoid any noticeable changes in background hiss levels.



The FERROGRAPH Series 7 stereo tape recorder — a sturdy semi-professional machine giving dependable quality and much creative scope including sound reversal, multitrack and speed change.

Fig. 5. Using the EMITAPE Splicing block — the two tape ends are just being abutted prior to applying the splicing tape (the tape is the black material).

The first stage in making an edit is to locate the edit-point. It is initially identified, roughly, by straightforward playback. The point where the cut should be made is directly adjacent to the replay head, i.e. the head nearest the take-up spool (see Fig. 2). To locate the edit-point with precision, the tape is carefully inched back and forth across the replay head with one hand on each spool. The tape replay drive has to be temporarily suspended prior to this operation.

Many recorders provide a pause control for retracting the rubber pinch wheel from its intimate contact with the capstan. The Revox is one particular example in which cut-out switches nullify the normal spooling tensions to facilitate normal tape movement. Even if neither mechanism is present, one can usually thread the tape on the 'wrong' side of the capstan to avoid the pinch-wheel traction. (See Fig. 3).

The Ferrograph, emulating its fully professional counterparts, incorporates variable speed spooling — a sort of gross "see-sawing" for cue location by monitoring the tape at different velocities. This type of monitoring is aptly termed "chatter monitoring".

The chosen point, adjacent to the replay head, is marked on the base (shiny) side of the tape with a Chinagraph (wax) pencil.

Should the construction of the sound channel be such that the tape cannot be marked 'in situ' a reference datum will have to be marked on the recorder deck. A distance, for example five centimetres, is accurately measured to the right of the replay head. Now a further mark is made the same distance to the right of the first mark as the first mark is from the head i.e. five centimetres. When the edit-point on the tape has been located, the tape is marked adjacent to the first deck mark. Spooling the tape on so that the tape mark is adjacent with the *second* deck mark brings the actual edit-point into coincidence with the first deck mark. The more useful alternative involves inscribing the 'head to first deck mark' distance on an editing block, to the right of the oblique-cut guide. Thus when the tape mark has been aligned with the mark on the block, the oblique-cut guide is in the correct position for cutting the tape.

At this point it is emphasized that *no metal objects* should be brought into

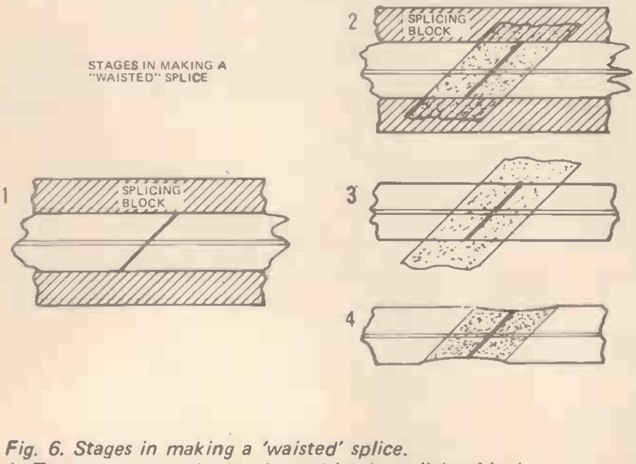


Fig. 6. Stages in making a 'waisted' splice.
1. The two tape ends are abutted in the splicing block.
2. A length of ½" wide tape is spread across the tapes and pressed into contact with them. 3. The partly-finished splice is removed from the block and the bubbles rubbed from beneath the tape.
4. Using a pair of demagnetised scissors or a razor blade the joint is now 'waisted' — here it has been exaggerated for clarity.

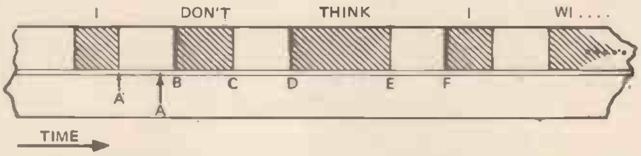


Fig. 7. Graphical representation of word spacing on tape.

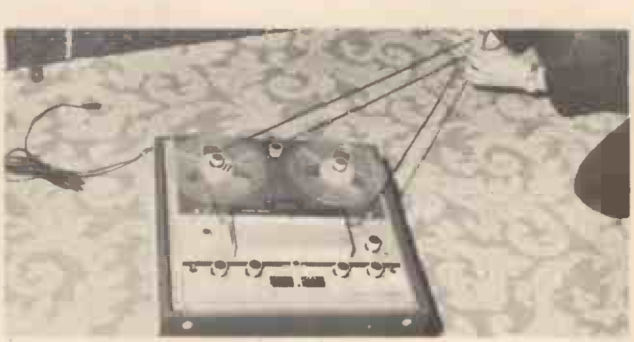


Fig. 8. Maintaining tension on a prepared tape loop, using a Chinagraph pencil.

contact with the heads, nor any item likely to damage their high finish.

The several semi-automatic splicers commercially available do not, in my opinion, match the reliability and performance of the humble slicing block. Consisting of an aluminium slab with a shaped channel to grip the tape (see Figs 4 and 5) the block has several deep cutting slots crossing the tape patch, one normally at 45° and the other at 90° angles.

Ideally a non-magnetic razor blade should be used for minimal edit noise — stainless steel blades are generally satisfactory.

The angle of the tape joint will also affect the level of edit noise, a 90° splice being the worst offender as the whole breadth of new tape edge passes the head at once. A 45° splice is preferable and gives the added advantage of greater physical strength. Actually the 45° splice may be considered as an ultra-rapid cross fade — one signal being rapidly curtailed as the other is brought up, as a respectively lesser and greater breadth of signal carrying tape traverses the vertical head gap.

Using a pair of scissors, elongated splices of up to around 6" may be carried out to give a more gradual cross-fade. Despite the above comments it is interesting to note that a number of professionals advocate the use of a 90° edit for stereo recordings to prevent apparent sound movement at the splice.

Ordinary adhesive tape should not be used for splicing or the heads and pressure pads will be fouled up — special pressure sensitive splicing tape has been formulated that will not stretch and avoids gum ooze.

One warning though, if it appears that the splicing tape has been in the shop for a long time, be careful, as it does tend very gradually to lose its adhesive properties.

Splicing tape is most commonly available in two widths, half inch and 7/32 inch.

Until fairly recently, magnetic tape stiffness decreed using the wider splicing tape, then 'waisting' the splice for easy passage through the sound channel. (See Fig. 6). Nowadays thinner splicing tape and improved magnetic tape pliability simplify the operation — once the two tape ends have been carefully abutted, a length of 7/32" splicing tape is laid across them, obviating the need for further trimming. For a secure, relatively permanent splice, between one and two inches of splicing tape should be used, taking care to rub the bubbles from under the join using a blunt non-magnetic instrument (the non-business end of the Chinagraph pencil is ideal).

Once a piece of tape has been removed it *must be kept* until the edited piece has been played back for once the 'sense' of a piece of speech or music has been upset, there is nothing more exasperating than searching through myriads of tape scrap on the floor trying to find the missing syllable or crotchet (the lost chord?!).

The 3" standard 8mm film spools are excellent for storing lengths of tape during the editing session — however don't be tempted to use them as feed spools when tape copying as some recorders do not have enough torque to cope with the small hub, and tape wow is the result.

It is always preferable to edit a tape *copy*, preserving the original intact. Then if any mishap should occur during the editing, it is an easy matter to re-copy the relevant passage again from the master.

We have so far covered the purely mechanical aspects of editing. Let us now consider editing in relation to basic material — speech and music.

EDITING SPEECH

Every speaker has his, or her, characteristic vocal inflection and rhythm of delivery, this is readily apparent when trying to edit interviews.

Let us carry out a simple exercise in editing speech using the sentence "I *don't* think I will go out tonight". We decide to reverse the meaning by removing the second word, 'don't. (See fig. 7). Figure 7 graphically illustrates the layout of the words on the tape. AB, CD and EF are the gaps between the words. The first stage will be to mark the beginning and end of the piece to be excised. The problem here is to decide which length (AB or CD) or what *modified* length should be interposed between A and D. In this particular example a suitable gap length would lay somewhere between that of AB and that of EF. 'See-sawing' the tape to the beginning of 'think', position D is marked. The tape is then manually rewound to B, the beginning of 'don't' and rocked back from this point to give an idea of the size of gap AB. With this knowledge a suitable gap length AA can be selected and edit points A' and D joined.

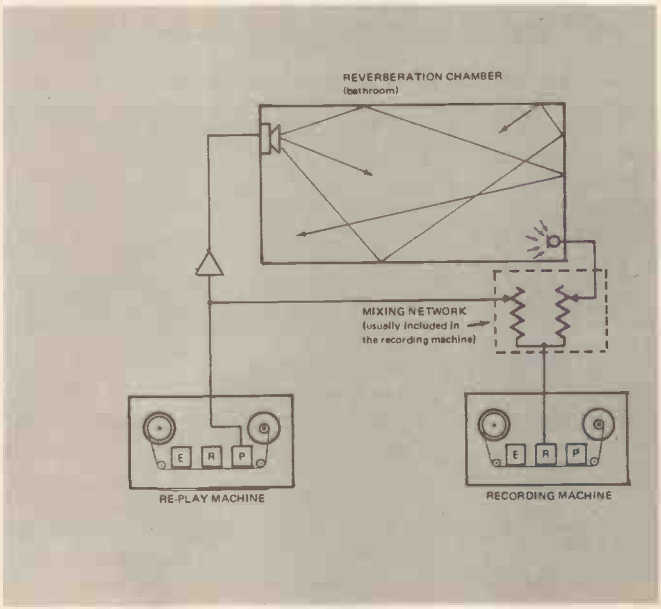
It may sound complicated but in practice this procedure takes a minute or less.

But no matter how carefully this cutting and splicing is done the results will sound neither natural nor convincing, for although the timing may be correct, the vocal emphasis will be wrong. A certain inflection is placed on 'don't' which is automatically followed by a complementary inflection on 'think'.

Although inflection and rhythm must always be considered in speech editing, in some ways our perception may be easily fooled. The remarkable conclusion from a research project utilising spliced speech is that inflection may carry as much, or more, meaning than the words themselves. As part of this project subjects listened to prepared sentences in which key words had been removed and replaced with neutral electronically-generated tones. It was found that the subject responded as if the key words had still been present!

The author has carried out a similar experiment, reversing syllables and even whole words, and has demonstrated a similar phenomenon.

Fig. 9. Diagrammatic representation of acoustic/electronic dubbing link (see text)



Whether or not to edit out, pauses, fluffs and hesitation, depends very much on the overall material. It could, if taken to extremes, convert what was an intimate interview into something very much resembling a commentary on the closing stages of a horse race.

Fluffed lines should in most instances be tidied, and the 'right' length for pauses will generally be determined by the type of production. Dramatic effect may be heightened by elongated pauses.

Probably the prime function of interview editing is to condense the material, to extract the very substance and character of what has been said. The character of a speech consists not only of rhythm and inflection but also of sniffs, coughs, stutters and 'verbal cabbage' like "you know" and "you see".

The padding that *should* be weeded out is that which impedes the clear flow of speech. However, to maintain consistent delivery it may be necessary to *add* breaths and pauses gleaned from the unused sections of the interview. A speaker's rhythm owes a great deal to short mid-sentence breaths and if parts of sentences are being removed it may be necessary to 'import' breaths to keep the flow.

If a length of silence is required during a speech tape use a piece of 'silence' taped at the occasion when the speech was recorded. Leader tape or virgin tape used as a spacer unfortunately draws attention to the presence of edits, audible as variations in the level of background noise.

The background itself can pose awkward problems unless a brash actuality, or documentary, style is being attempted. A common fault encountered when editing a commentary with a background of, say, passing cars, is the ultra-sudden arrival or departure of the vehicles on the edited version. It is possible to disguise the effect if the background is not too prominent — by taping twenty seconds, or more, of the relevant background at the time the tape was made. (It is assumed that a stereo ½ track recorder with track to track recording facility is being used in conjunction with the location recorder.)

The location commentary is copied onto the lower track of the stereo recorder and this copy is edited down to the condensed essentials. The short length of location effect is copied onto the upper track of a separate piece of tape. Points are marked near the extremities of the sound effect where the characteristics accurately match i.e. in the example given, one point could be located just prior to a car fading up and the other just after a car has faded out. The two points are then spliced together to form a continuous loop that repeats once per revolution. The larger the tape loop, the less obvious will be the cyclic nature of the loop. The tape loop is replayed on the location recorder keeping it gently tensioned with a weighted jam-jar, or by running it around the ubiquitous Chinagraph pencil (See Fig. 8). Now the loop is copied onto the upper track of the stereo recorder whilst simultaneously copying the condensed commentary from the lower track to the upper one. The two sources are balanced to keep the loop sounds well to the background, although marginally louder than the erroneous background accompanying the edited commentary.

When preparing loops as described, avoid the inclusion of any discrete obvious sound i.e. a car horn or a shout. The repetition of any such sound will immediately identify the source as a loop.

Points to watch when editing speech are changing acoustics, acoustic balance or sound level. A change in sound level occurs when the subject moves relative to the microphone or the microphone position is shifted (all too easy with a hand-held microphone).

Change in acoustic balance is the result of trying to keep the tape equally modulated following a change of microphone subject position — if the microphone has been moved closer a more 'dead' acoustic results and vice versa.

A 'blanket' type correction can be used to 'equalize' recordings made indoors and outdoors by copying 'electronically' whilst using an additional acoustic link (See Fig. 9). An interesting variation is obtained by doing the copying with both recorders operating at twice the true speed — when the new copy is slowed down to the correct speed the reverberation time due to the acoustic link will have effectively been doubled. By siting the acoustic link in the bathroom, one can simulate a large hall or cavern.

A novel method of lending impact to a voice and/or sound effect is to find its counterpart (with a similar sound spectrum) and splice or cross-fade the two items together — several TV advertising agencies have linked the silibant name of the product with the sound effect of the product — in one instance the sizzling of bacon, and the hiss of gas escaping from a tonic-water bottle in the other.

MUSIC EDITING

A lot of the comments made in the last section apply equally to music editing, neverthless music editing also presents a further set of problems. For example, however strict the tempo supposedly is, it can never be an absolute quantity — splicing together different 'takes' of a piece of music may give rise to unfortunate and even comic changes of tempo. The best way to prevent this is to let the conductor hear the material already 'in the can' at frequent intervals as the session progresses.

The musician finds it naturally advantageous to work from the rests written in the score but herein lies a danger for the recordist — for the 'silence' of the rest will contain the decaying reverberation of the note played immediately prior to it. If one does split the score into short sections for the ease of the musicians, it is eminently preferable to commence each 'take' a bar, or more, *prior* to the edit point so that the correct spectrum of reverberation will be present at the edit point.

Much editing difficulty is found when trying to locate edit-points in music due to the complexity of the signal (music and reverberation). When combining 'takes' it helps to earmark a particular note. The initial tape is marked just at the attack of this note. The next piece of tape has the same note marked identically. The two are then mated together. This may seem obvious, but as any clear note can be chosen for the changeover it is far simpler accurately to maintain the beat.

When combining electronic music, or music concrete, greater latitude is present — note lengths may be altered at will using splicing techniques; additionally the attack and decay characteristics of the note may be modified by cutting the tape at different angles of obliquity. ●

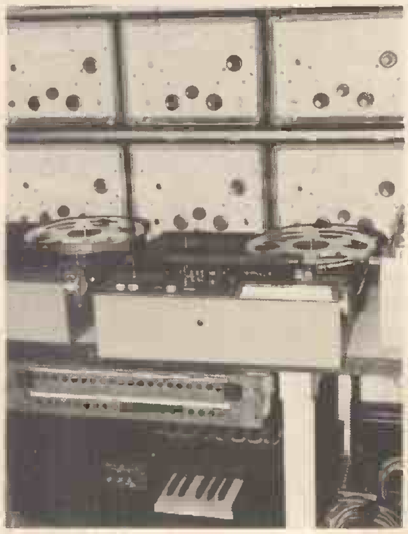
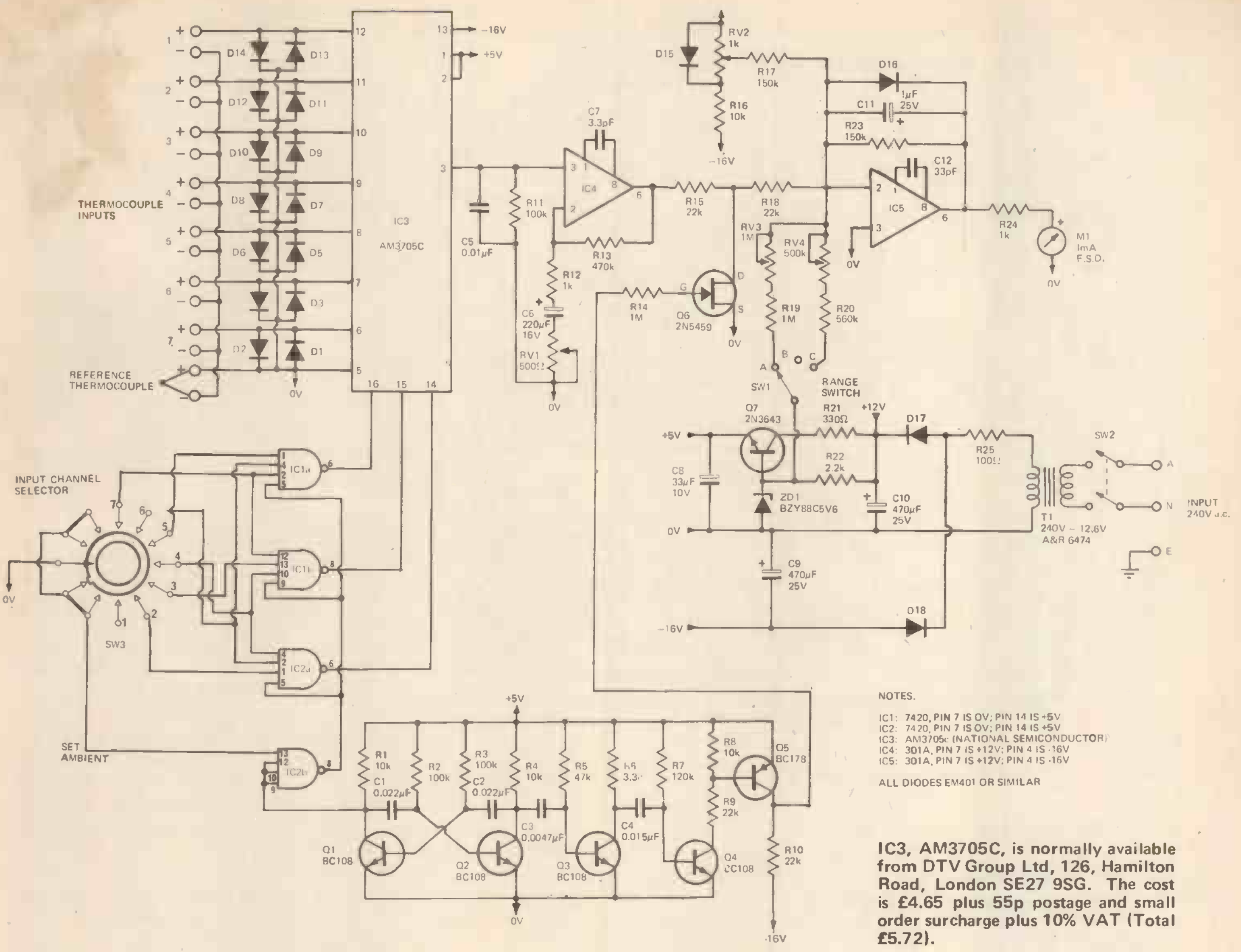


Fig. 10 — Corner of the BBC Radiophonic Workshop. Note, beneath the bank of oscillators the professional Telefunken editing machines with editing blocks bolted on the decks at front right. To the right of each recorder is a splicing tape dispenser.



IC3, AM3705C, is normally available from DTV Group Ltd, 126, Hamilton Road, London SE27 9SG. The cost is £4.65 plus 55p postage and small order surcharge plus 10% VAT (Total £5.72).

Fig. 1. Circuit diagram of the thermocouple meter.

INTERNATIONAL THERMOCOUPLE METER

The International 113 thermocouple meter enables 0 to 200°C temperature measurements to be made from up to seven separate points.

PROJECT 113

THE need to make temperature measurements, often from a number of different points virtually simultaneously, is a common requirement of experimenters — both amateur and professional.

But measuring the temperature of small objects is much more difficult than it at first appears.

A temperature measurement determines the degree of heat possessed by a body at a particular instant — if that body is small it is essential that the transducer used to make the measurement does not remove a significant amount of heat energy in the process of taking the measurement. Whilst thermistors and diodes may be used as heat sensing transducers, thermocouples are generally more satisfactory where accurate repeatable measurements need to be made of small devices.

The ETI thermocouple meter has

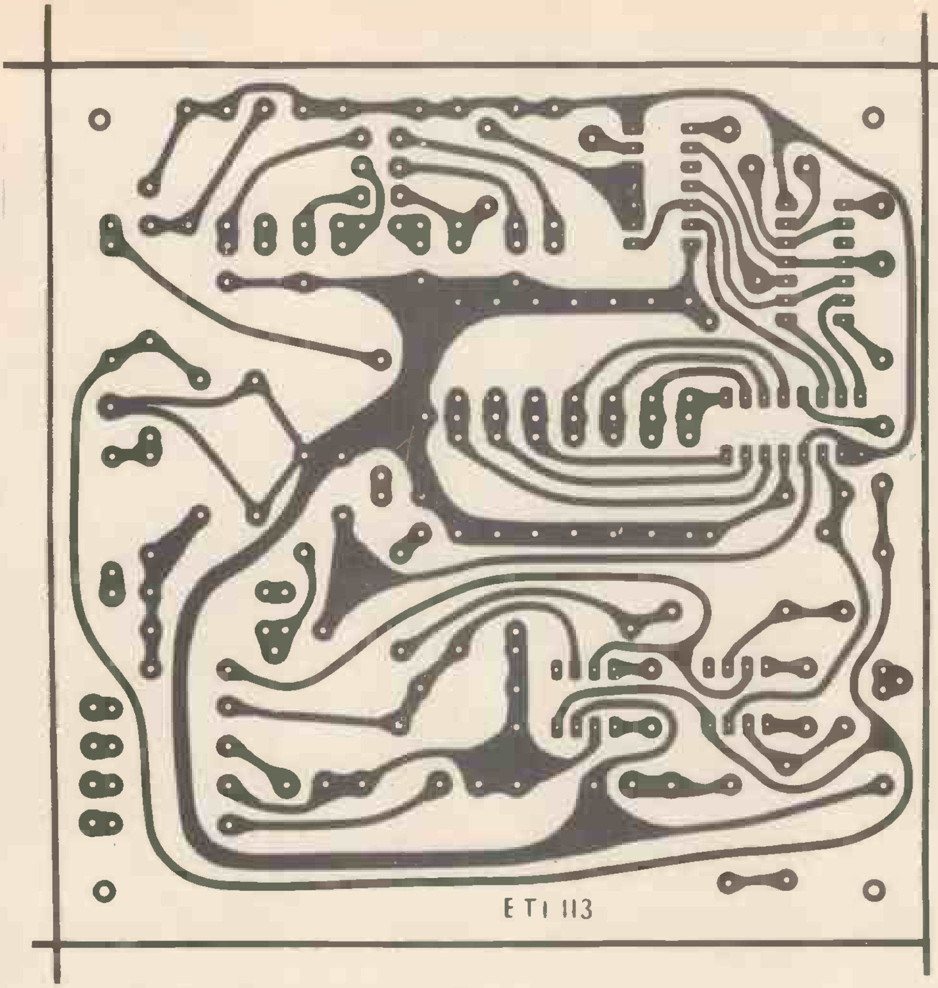
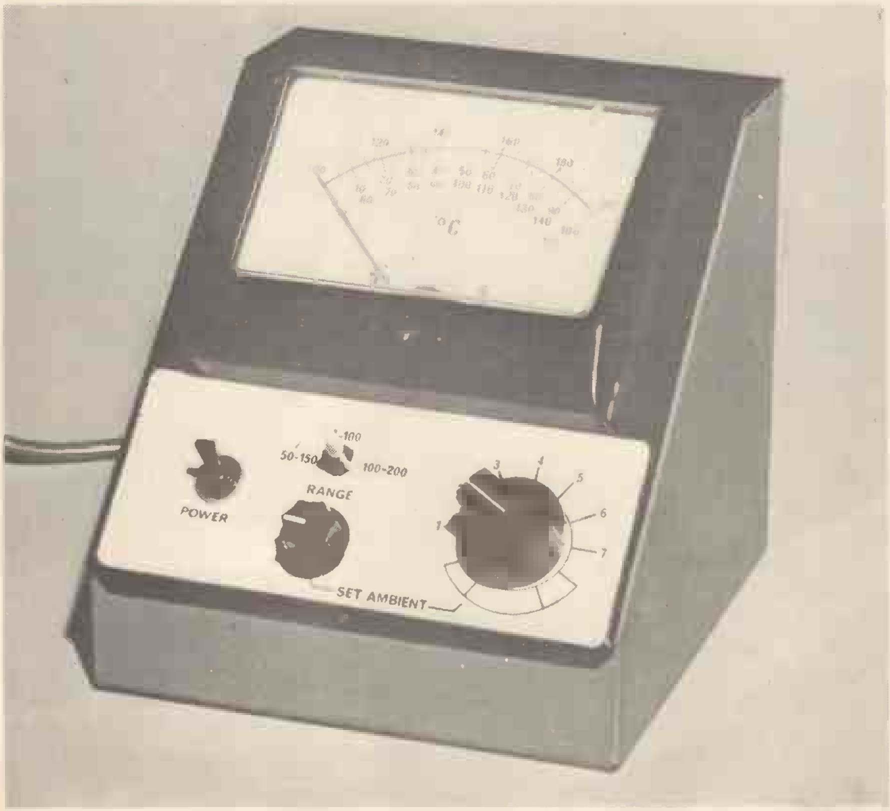


Fig. 2. Printed circuit board layout — full size.

INTERNATIONAL THERMOCOUPLE METER



been designed to suit the requirements of the average experimenter, nevertheless its specification is sufficiently good to enable it to be used satisfactorily for the majority of industrial and scientific applications.

Facilities are included for seven thermocouple inputs, thus enabling temperatures to be monitored at up to seven different points without the need to reposition thermocouple sensors.

Three, overlapping, temperature ranges are provided, so that any varying temperature in the range of 0° to 200° Celsius may be monitored without end-of-scale problems. The 200 degree range of the meter is more than adequate for the range of temperatures normally encountered in most applications.

CONSTRUCTION

Our unit was constructed using a 152 x 152 x 152 mm box with a sloping front panel. Any suitable box may be used as the layout is not critical.

Drawings of front panel and terminal strip art work are provided for those who wish to use the same box.

The meter is a standard 1 mA movement rescaled as shown in Fig. 5.

Do bear in mind that meters are delicate instruments, and great care must be taken whilst dismantling and re-assembly. If you are doubtful of your ability to tackle this operation it is better, either to find someone who can, or to purchase a 0 to 100 scaled meter and to add, mentally, 50 or 100 to the reading, depending on the range in use. If this latter course is adopted the range switch should be marked accordingly.

SPECIFICATION

Number of inputs	7
Ranges	0-100°C 50-150°C 100-200°C
Sensing element	iron/constantan thermocouple wire
Linearity	(see Figure 7)
Accuracy at full scale reading	±3°C ±linearity
Calibration points	ambient temperature 100°C
Ambient compensation	Manual

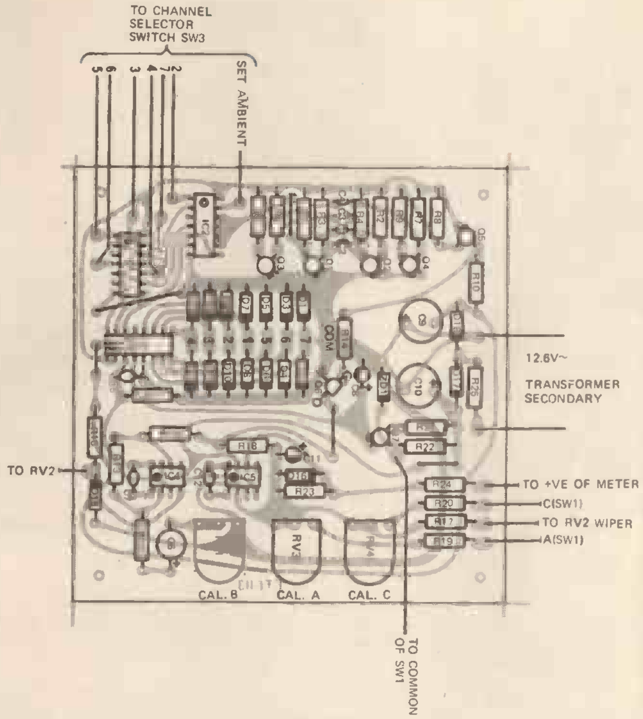
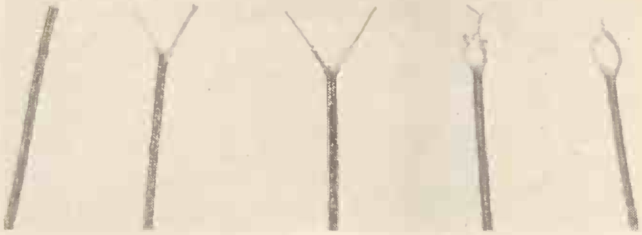


Fig. 3. Component overlay.



Preparation of a thermocouple.
(a) Unprepared wire
(b) Braid bared back
(c) Individual wires stripped
(d) Wires twisted
(e) Wires soldered and cut back.

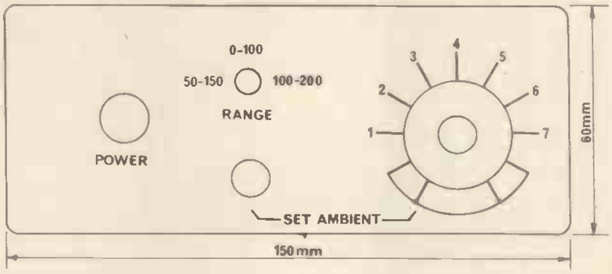


Fig. 4. Front panel artwork (half scale).

Figure 2 shows, full size, the foil pattern for a suitable printed circuit board. Whilst this unit can be built using veroboard or other forms of construction, we strongly advise that our printed circuit board be used.

Assemble all components to the board except IC3 (AM3705C). Make sure that the components, particularly ICs, diodes and capacitors are correctly orientated *before* soldering.

The AM3705C is a MOS device and is easily damaged by static electricity discharges or leakage currents from certain types of soldering irons. Because of this, do not insert this IC until all other components have been soldered in place.

Then, before soldering it in, check that the soldering iron is correctly earthed. Check this with a meter if possible. Finally, once you pick up the IC, do not let go of it until it has been correctly inserted in place. Then solder it in quickly and cleanly.

Instal the assembled printed circuit board, meter, switches and connector block into the case and complete interconnections in accordance with the component overlay and circuit diagram.

Note that all the negative thermocouple terminals are linked together on the terminal block, and that the reference thermocouple is mounted external to the unit (interior of box may be 5^{O} hotter than ambient). All unused thermocouple inputs should be shorted.

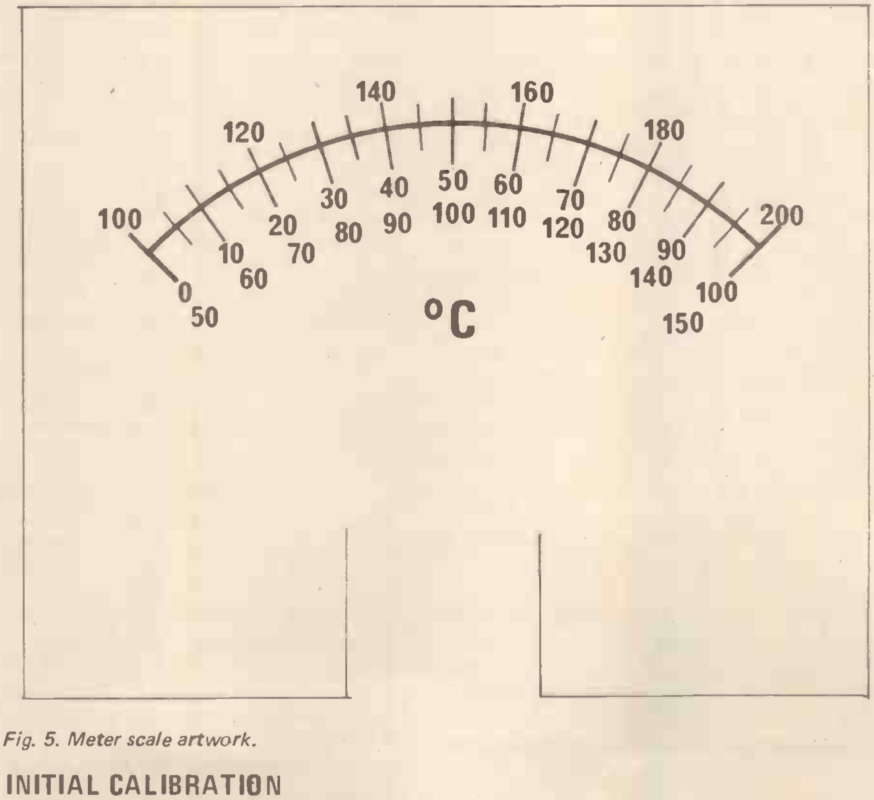


Fig. 5. Meter scale artwork.

INITIAL CALIBRATION

Following assembly, the instrument must be calibrated.

Firstly it is necessary to establish a reference standard for ambient temperature correction. This is best done by mounting an accurate mercury-in-glass thermometer, together with one thermocouple, in a small jar of oil. This jar should then be located somewhere where temperature is reasonably constant.

Leave the temperature of the reference standard to stabilize for a few hours and then connect the reference thermocouple to the reference thermocouple input of the meter.

Now connect thermocouples to all inputs — or short out those inputs that are not used — switch the front panel selector switch to any of the four 'Set Ambient' positions and adjust the 'Set Ambient' control so that the meter reads the same temperature as that shown on the reference thermometer.

Next select a thermocouple by means of the selector switch. Place this thermocouple in boiling water. Adjust RV1 for 100°C indication on the 0-100 range, RV2 for 100°C on the 50-150 range, and RV4 for 100°C on the 100-200 range.

This completes the initial calibration procedure.

CALIBRATION BEFORE USE

Before use, the reference thermocouple should be switched into circuit (any of the four 'Set Ambient' switch positions) and the meter adjusted to the temperature shown on the reference thermometer. This indication should be checked from time to time throughout the day if ambient temperature varies to any marked extent.

For some applications it is possible to set the 'Ambient Temperature' adjustment to read zero. If this is done, the instruments will indicate temperature rise above ambient. In other applications it is possible to use the reference thermocouple to establish a 'base' temperature, then the measuring thermocouples will register temperature rises above the reference level.

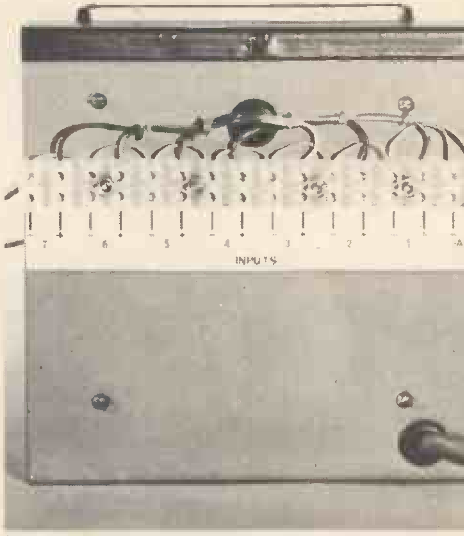
A thermocouple consists of two lengths of (dissimilar) metal wire. If these wires are joined together at one end, a voltage will be developed across them. This voltage will be proportional to the temperature at the point where the wires are joined.

The magnitude of this voltage depends on the types of wires used. It is not in any way related to their diameters.

Many types of thermocouple wire exist, but of these only four types are in common use. These, together with their characteristics, are listed in Table 1.

WARNING

The individual thermocouples are not isolated from each other. If two points, having different potentials are to be measured, the thermocouples MUST be insulated to avoid shorting the two points.



Rear of the meter — showing the thermocouple connector block.

Interior of the meter showing positioning of PC board and transformer.

The easiest to obtain are iron/constantan, and copper/constantan. Of these, we have chosen the former because of its superior linearity.

Because most thermocouples are non-linear (i.e. do not have a directly proportional relationship between voltage and temperature) they are usually compensated over the temperature range used. However with iron/constantan the non-linearity is less than 1°C from 0 to 140°C and less than 3°C up to 200°C. If greater accuracy than this is required, the correction graph (Fig. 7) should be used. It is possible to build correction circuitry into the instrument, but this is very complex and costly.

Thermocouple wire, and iron/constantan pairs, are not easy to come by. However British Driver Harris & Co. Ltd, Bird Hall Lane, Cheadle Heath, Stockport, Cheshire will supply small quantities to readers. Their constantan wire is known as *Special Advance* and matched Iron/Special Advance pairs can be supplied.

The junction should only be as long as is necessary to make a strong joint and the wires should not be allowed to touch before the actual junction.

The thermocouple should be taped or glued (using epoxy resin) onto the point where temperature is to be measured.

Temperature measurements of 'live' electrical devices requires especial care if the points at which temperature are to be measured are at different potentials. For such applications, the thermocouple *must* be insulated from

TABLE I
CHARACTERISTICS OF BASE METAL THERMOCOUPLES

THERMOCOUPLE TYPE	TEMPERATURE RANGE (DEGREES CELSIUS) MINIMUM	MAXIMUM 20 gauge	24 gauge	30 gauge	Microvolts per degree C	Error at 200°C
TYPE J (Iron-Constantan)	−18	480	370	370	53	+2.6°
TYPE T (Copper-Constantan)	−180	260	204	204	43	+14°
TYPE E (Chromel-Constantan)	−180	538	427	427	63	+10°
TYPE K (Chromel-Alumel)	−18	982	870	870	41	−3°

Note: Soldered thermocouples may not be used above 200°C.

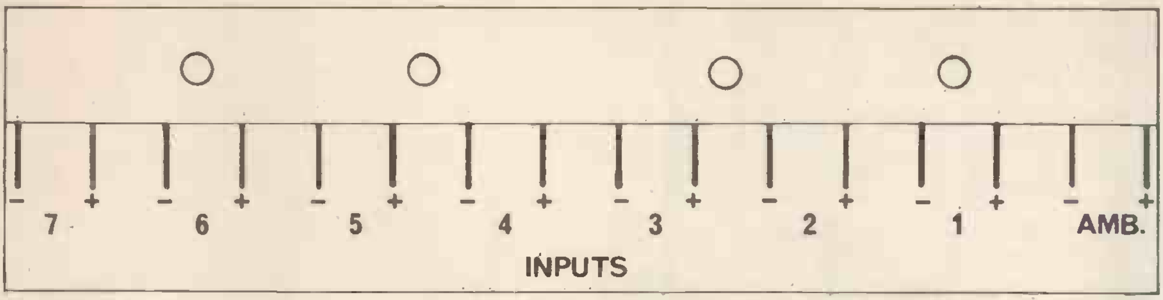


Fig. 6. Artwork for rear-panel connector.

the device.

Thermocouple wire is available in various diameters, however for most purposes 30s.w.g. is a good bet.

Ideally, the complete run from thermocouple junction right back to the meter input should be completed in thermocouple wire. In practice it is satisfactory to use copper wire between the thermocouple and the meter but it is absolutely essential that the two places where the copper wire is joined to the thermocouple wire be at the same temperature.

This is because each junction between the copper wire and the thermocouple wire forms in effect another thermocouple, however if the temperatures of these junctions are identical the voltages that they generate will be of equal magnitude but opposite polarity, and hence will cancel out. ●

TABLE II

COLOUR CODE FOR THERMOCOUPLE WIRE

TYPE	OVERALL COLOUR	POSITIVE COLOUR	NEGATIVE COLOUR
J	Brown	White	Red
T	Brown	Blue	Red
E	Brown	Purple	Red
K	Brown	Yellow	Red

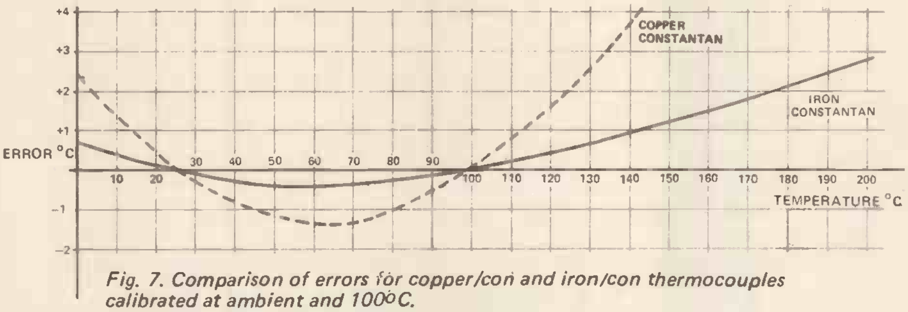


Fig. 7. Comparison of errors for copper/con and iron/con thermocouples calibrated at ambient and 100°C.

PARTS LIST

R1 resistor 10k 5% ½w
R2 resistor 100k 5% ½w
R3 resistor 100k 5% ½w
R4 resistor 10k 5% ½w
R5 resistor 47k 5% ½w
R6 resistor 3.3k 5% ½w
R7 resistor 120k 5% ½w
R8 resistor 10k 5% ½w
R9 resistor 22k 5% ½w
R10 resistor 22k 5% ½w
R11 resistor 100k 5% ½w
R12 resistor 1k 5% ½w
R13 resistor 470k 5% ½w
R14 resistor 1M 5% ½w
R15 resistor 22k 5% ½w
R16 resistor 10k 5% ½w
R17 resistor 150k 5% ½w
R18 resistor 22k 5% ½w
R19 resistor 1M 5% ½w
R20 resistor 560k 5% ½w
R21 resistor 330k 5% ½w
R22 resistor 2.2 k 5% ½w
R23 resistor 150k 5% ½w
R24 resistor 1k 5% ½w
R25 resistor 100k 5% ½w
RV1 potentiometer 500Ω trimpot
RV2 potentiometer 1k linear pot.
RV3 potentiometer 1M trimpot
RV4 potentiometer 500k trimpot
C1 capacitor 0.022uF polyester
C2 capacitor 0.022uF polyester
C3 capacitor 0.0047uF polyester
C4 capacitor 0.015uF polyester
C5 capacitor 0.01uF polyester
C6 capacitor 220uF 16V electrolytic pc mounting
C7 capacitor 3.3pF ceramic
C8 capacitor 33uF 10V electrolytic pc mounting
C9 capacitor 470uF 25V electrolytic pc mounting
C10 capacitor 470uF 25V electrolytic pc mounting
C11 capacitor 1uF 25V electrolytic pc mounting
C12 capacitor 33pF ceramic.
D1-D18 diode 1N4001 or similar
ZD1 Zener diode BZY88C5V6
Q1-Q4 transistor BC 108 or similar
Q5 transistor BC 178 or similar
Q6 transistor 2N5459 or similar
Q7 transistor 2N3643 or similar
IC1 integrated circuit 7420
IC2 integrated circuit 7420
IC3 integrated circuit AM3705C (National Semiconductors)
IC4 integrated circuit LM 301A (National Semiconductors)
IC5 integrated circuit LM 301A (National Semiconductors)
SW1 toggle switch single probe double throw with off.
SW2 power switch
SW3 rotary switch 1 pole 11 position.
T1 transformer 240V-12.6V 150mA.
M1 meter 1mA FSD scaled 0- 100 or scaled to Fig.7
Printed circuit board ETI 113.

HOW IT WORKS

The output voltage from a thermocouple is of the order of millivolts. Typical sensitivities are around 40 to 60 microvolts per degree celsius.

This small dc signal must be increased in level, in order to drive a meter. This is done by chopping between the signal level and zero and amplifying the resultant square wave. The amplified ac signal is then rectified for the meter.

An 8-channel MOS analog multiplexer (IC3) is used both to select the input and to provide the chopping action. Each input is protected by back-to-back diodes, and all the negative sides of thermocouples are joined to the negative side of the reference couple the positive side of which goes to zero volts. Thus the voltage generated is proportional to the difference in temperature between the selected and the reference couples (54µvolt/dc).

Transistors Q1 and Q2 form a 300 Hz multivibrator, the output of Q1 being fed via IC2 to an input on each of the IC2a, IC1a and IC1b. When a channel is selected by SW3, eg. channel 5, zero volt is applied to pin 1 of IC1. The gates of IC1 and IC2 are NAND gates and if any input to a NAND gate is zero its output will be high. Hence the output of IC1a will be high and the outputs of IC1b and IC2a will be low. This code when applied to pins 14, 15 and 16 of IC3 will cause it to select the input on pin 8, that is thermocouple 5.

However as the output of Q1 goes high, the output of IC2b goes low and IC2a, IC1a and IC1b outputs will all go high regardless of other inputs. The all-high state causes IC3 to select pin 5 which is zero volts, thus the signal from the selected thermocouple is chopped between signal level and zero.

This signal is amplified by approximately 300 by IC4, the output voltage of which will be centred about zero due to ac coupling. For a 75°C rise (4 mV from thermocouple) this voltage will be typically ± 0.6 volts.

Transistor Q6 chops the output of IC4 so that slightly more than one half of the signal is eliminated. Thus the signal now effectively has a dc component. The first and last 150 microseconds of the half cycle are discarded to allow IC4 to settle and eliminates switching errors. The effective sampling time is therefore about 42%.

The amplified signal is then summed in IC5 with an 'ambient set' current from RV2 and an offset current from either RV3 or RV4 on the two higher ranges. The output from IC5 is then used to drive the meter.

MARANTZ AMPLIFIER MODEL 1120

Top line US amplifier has three year guarantee.

THE first Marantz amplifier was manufactured in the USA in 1953. Subsequently, the company has built-up an enviable reputation for top quality equipment with a special emphasis on finish and durability.

In mid-1971 the company entered a new market with a line of low to moderate priced amplifiers and tuners all of which were manufactured in Japan. Careful attention to quality and quality control ensured that Marantz image as manufacturers of the finest and costliest equipment did not suffer unduly – if at all.

Nowadays, Marantz manufacture only their top-line products in the USA. The model 1120 amplifier reviewed here is the smallest of this range so produced.

The unit arrived adequately packed in expanded polystyrene. Once unpacked the first unique feature to catch our eye was a rigid plastic overlay protecting the front panel. In fact, the overlay is so designed that it can be left permanently in place without affecting the operation of the amplifier controls.

The front panel is of anodized aluminium with a very pale gold colouring overprinted with black lettering. Layout of this panel is completely symmetrical arrangement about the vertical centre line. The front panel controls are arranged in two rows with an exception at each end. The left hand end of the panel has four sockets mounted vertically in line: the top two are tip and sleeve sockets for microphone inputs; the second two are tip and sleeve sockets for a tape recorder, (in and out respectively). A large selector knob adjacent to the microphone sockets has six positions for microphone, phono, tape 1, tape 2, tuner and 'auxiliary'. Directly below the selector knob are four push buttons for tape 1 monitor, tape 2 monitor, mono in left channel and mono in right channel.

The centre of the front panel has five slide controls, four mounted vertically side by side, and one horizontally under the four vertical ones. Each potentiometer has a small indexing notch at the centre. The two left hand vertical potentiometers are for left and right channel bass boost and cut. Similarly, the two right hand ones are for treble boost and cut. The horizontal slide at the bottom is the balance control.

Next in line to the slide controls is the volume control, with four push buttons below it; these are for low electronics TODAY INTERNATIONAL **product test**

filter, high filter, audio muting (−20dB) and loudness control. Down on the right hand side there are two push buttons for speaker system 1 and speaker system 2 select, a ring tip and sleeve socket for headphones, and a power on/off push button. A small blue recessed bezel lamp is centrally located above the slide potentiometers to indicate when the power is on.

All input and output sockets are closely grouped together on the back panel, so close in fact that a number of our patch cords would not fit above one another in adjacent sockets. The intending user would need to be careful that he selected small RCA plugs and not the moulded type generally seen on commercially available patch cords.

Inputs and outputs are phono, tape 1 in and out, tape 2 in and out, tuner, auxiliary, preamplifier out, main amplifier in and scope out. In addition, two combination record playback DIN plugs are provided for tape 1 and tape 2. Speaker outputs are via two sets of four spring loaded terminals mounted directly below the heatsink fins.

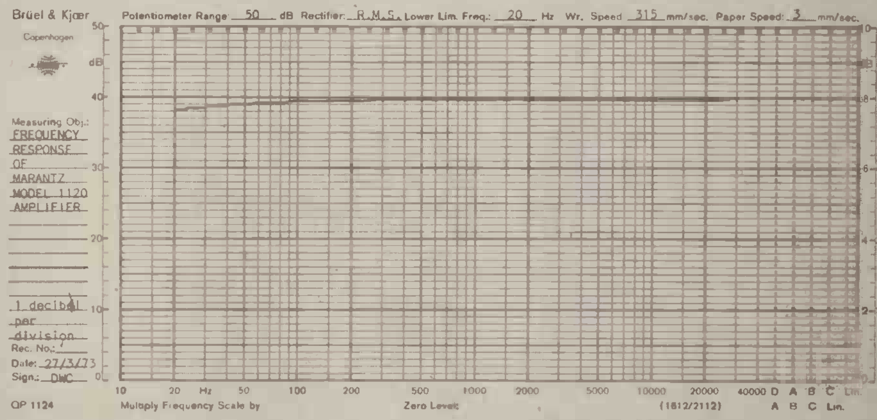
The left hand side of the back panel has three two-pin power outlets, one unswitched. A three amp power fuse is located directly below the outlets. The unit tested was designed for flush mounting in a panel, but the amplifier can be supplied with an oiled walnut veneered timber enclosure if required.

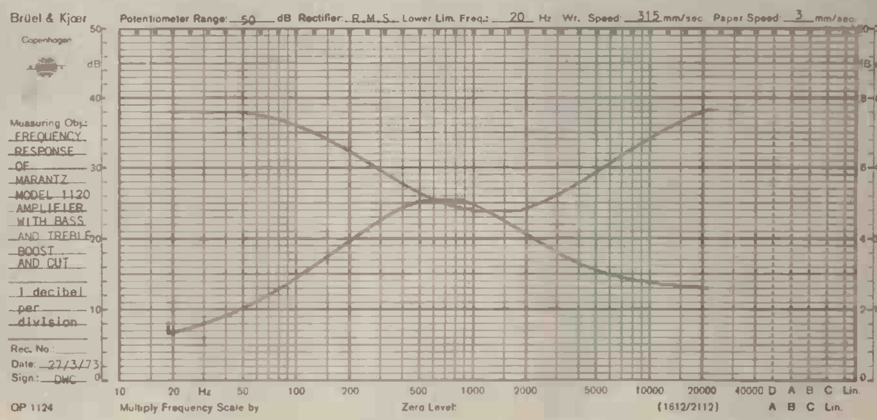
The internal layout is very interesting: firstly because the components only take up about 20 percent of the total volume of the enclosure, and secondly (the most interesting feature) because printed circuit boards are used virtually exclusively to replace wiring harnesses.

All sockets, switches and potentiometers are soldered directly on to the printed circuit boards. The main power amplifier board is awkwardly positioned behind two large capacitors. It was impossible to do tests on it with the board in-situ. However by undoing six screws, the heatsink complete with the power board may be easily lifted out and re-connected to the amplifier for testing. All other boards had adequate access for test probes. The power

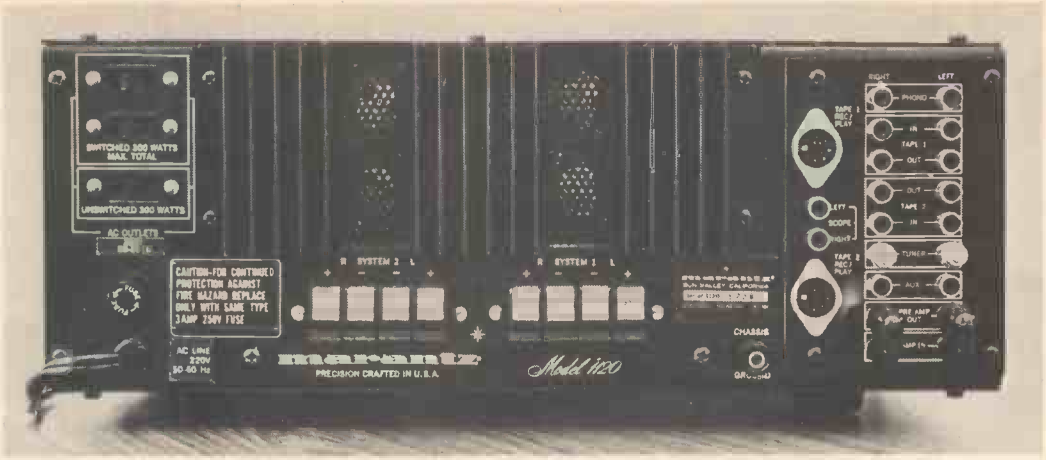
MEASURED PERFORMANCE OF MARANTZ MODEL 1120

Power Output	60watts		
Frequency Response:			
(Tone controls flat position)	20Hz to 20kHz $^{+1/2}_{-2}$ dB		
Channel Separation	100Hz	1kHz	10kHz
	60dB	43dB	26dB
Hum and Noise			
(With respect to rated power):	dB Lin,	db 'A'	
Auxiliary Input:	77dB	90dB	
Phono Input:	64dB	74dB	
Total Harmonic Distortion	100Hz	1kHz	6.3kHz
(At rated output:)	0.15%	0.15%	0.3%
Tone Controls:			
Bass:	14dB boost at 50Hz		
	15dB cut at 50Hz		
Treble:	10dB boost at 10kHz		
	11dB cut at 10kHz		
Loudness Control:	7dB boost at 50Hz		
	6dB boost at 10kHz		
Highpass Filter:	5dB cut at 50Hz		
Lowpass Filter:	4dB cut at 10kHz		
Dimensions:	390mm. wide by 140mm. high by 336mm. deep.		
Weight:	12.2 kg.		
Recommended selling price	£242.00 inc. VAT.		





MARANTZ AMPLIFIER MODEL 1120



supply board was inadequately supported at the rear end and with pressure applied, could be shorted out against the casing of the mains transformer. The only protection was the wiring harness from the transformer to the board which was pushed down between the board and the transformer.

It was intriguing to note the numerous brands of components used in this amplifier. Most of the capacitors were of European origin — the electrolytic capacitors, for instance, were mostly Austrian.

No doubt Marantz has selected the best, rather than the most economical components for each function. Such a policy would in any case be almost essential because of the three year warranty given on each Marantz amplifier.

LABORATORY TESTING

During the laboratory tests the amplifier protection circuits came into operation when the unit was driven continuously at 60 watts with a sine-wave input; demonstrating the unit's excellent protection against overheating.

Total harmonic distortion was quite good being 0.15% at 60 watts (at 1kHz), rising to 0.2% at 75 watts (at 1kHz). Harmonic distortion increased slightly with an increase in frequency, being 0.3% at 6.3kHz.

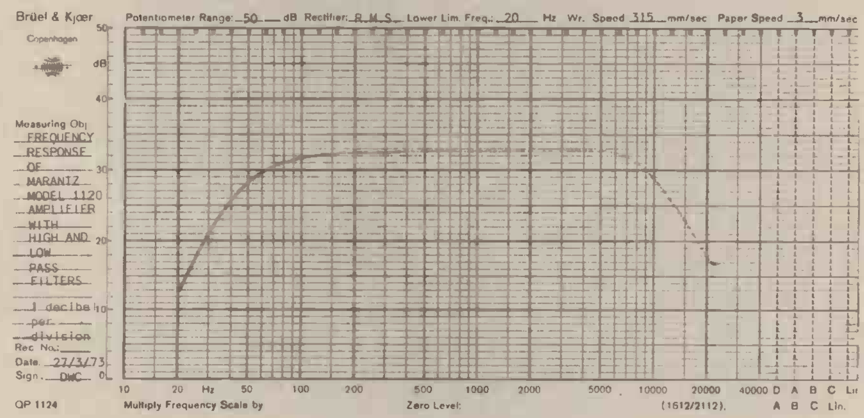
Frequency response, with the tone controls at the indexed flat position, showed a 2dB roll off at the bass end (see spectrogram). This could be corrected by moving the tone controls off the zero position — enabling a frequency response within ± 1dB to be obtained.

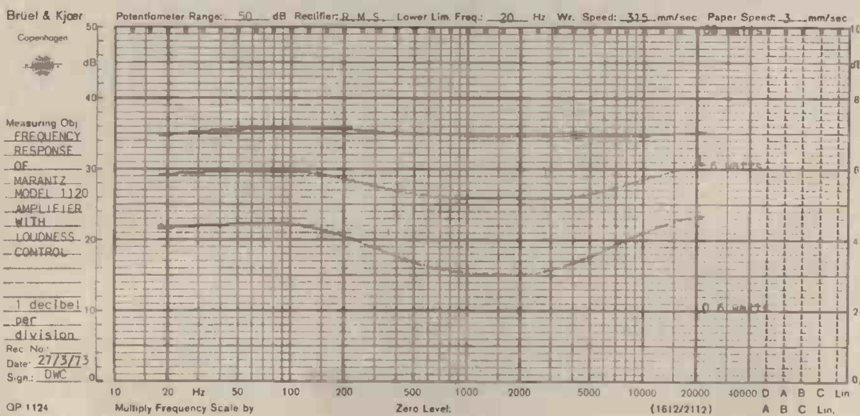
The equivalent noise, claimed by Marantz to be 140dB, has us puzzled. The best we could obtain was a still adequate measurement of 90dB ('A' weighted). All other parameters were close on specification.

The instruction handbook included unpacking and wiring details, operation, technical specification, block wiring diagram with two pages of circuit description, response curves and warranty information. The warranty basically covers the amplifier against normal operating defects for a period of three years. A panel mounting template and a wiring diagram with all of the part numbers shown was also included. The wiring diagram showed the preamplifier circuitry on one side and the power amplifier and power supply circuitry on the other side.

The Marantz 1120 amplifier has the excellent performance and attention to detail typical of previous models made by this company.

It is this attention to detail and quality that enables Marantz to provide the all but unique three-year warranty. ●





Recommended retail price inc.VAT: £173.87

YAMAHA TB 700 CASSETTE DECK

electronics TODAY INTERNATIONAL product test

'a state-of-the art product . . . equal to the best we have heard.'

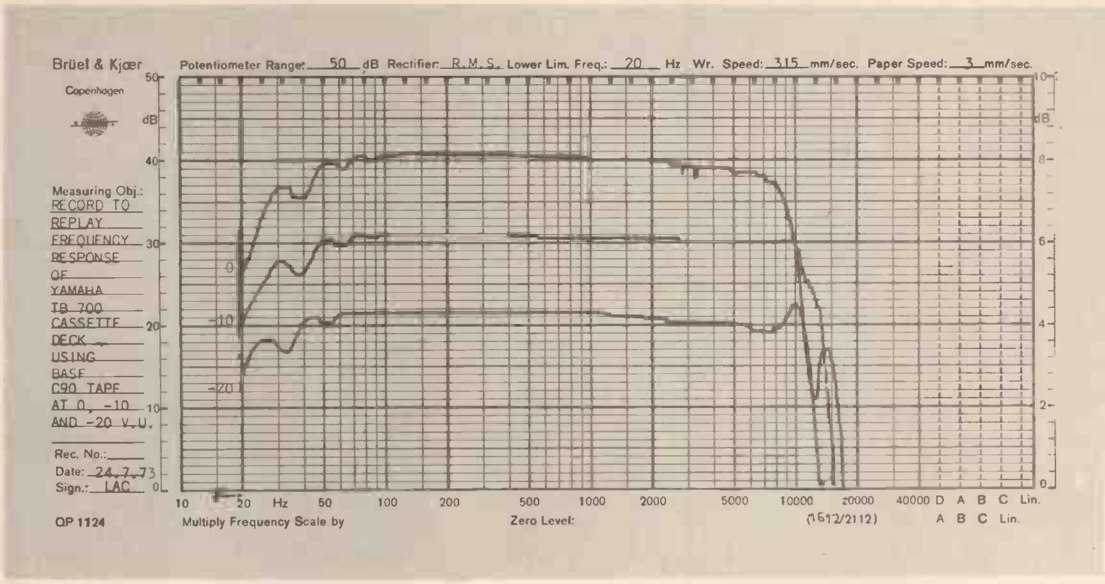
THE HISTORY of the Yamaha Company is a particularly long one, starting way back in 1887 when the Yamaha Company started producing reed organs and then pianos, thus setting them on the pathway to manufacturing a wide range of musical instruments.

Today, they produce such a wide range of musical instruments and other diverse electro-acoustic appliances that their products stretch from woodwind through to french horns, electric organs, Spanish and electrical guitars. Over the past three-quarters of a century, they have built up an enviable reputation, and have won many prizes and medals for quality. It is basically quality control, which they have utilised since the early days of the company, that has earned them this fine reputation.

The TB 700 cassette recorder is well packed in a strong carton. It is accompanied by a simple fourteen page instruction book in good English (but which does not contain a circuit diagram). The unit is also provided with a cleaning tape, a demonstration tape and a chromium dioxide tape.

The TB 700 is attractive in appearance, with brushed satin aluminium fascia, black plastic moulding on top and a veneered wooden enclosure.

The controls are set out in three



main groupings with the main operational controls, in the form of lever buttons, in front of the cassette holder. These controls are from left to right — Record — Fast rewind — Fast Forward — Play — Stop — Eject (this also opens the cassette holder cover) and a positive, and useful, pause button. The pause button is of the locking type and is a definite improvement over the non-locking type generally used.

To the left of these controls is a series of slider controls which is a feature of this deck. The first slider control for pitch or motor speed control is probably the most contentious, for its provision and its use is problematical. This control varies the dc servo-motor feedback control to provide a nominal ± 5% variation in the speed of the recorder.

This feature is required by musicians to enable them to alter the pitch of recordings, but is rarely used otherwise. It could be argued that it has been provided to simplify the design of the regulator for the speed control circuit. We found that the speed stability of the motor was temperature-sensitive, and that by raising the ambient temperature, we could readily change the motor speed by + 1.5%.

The next pair of sliders are the playback volume controls. These also adjust the monitoring volume during the recording mode. Following these are two microphone input volume controls, and finally their are two line input volume controls.

In the centre of the deck, set in a line above the slider controls, is a three digit counter with integral reset button. Next along, is a button and lever switch which between them provide for three bias settings. These bias settings are firstly for standard tape, with the button depressed; secondly, for high energy tape, and thirdly for chromium dioxide tape.

After these there are three lever switches — a Dolby switch, a limiter switch to preclude overmodulation, and a mains power switch.

At the top right hand side of the deck, set into the black plastic moulding, are two accurate VU meters, calibrated from -20 to +3 VU. In between these meters are two rectangular indicator lights, the upper one being the record mode indicator light, and the lower one, the "Dolby-on" indicator light.

The front of the deck has a recessed black section in which are located a ring tip and sleeve phone-jack for 8 ohm stereo headphones and two

YAMAHA TB 700 CASSETTE DECK

Record to Replay Frequency Response (standard C90 tape)	0 VU — 45 Hz to 8 kHz ± 3dB -10 VU — 43 Hz to 11 kHz ± 3dB
(Chromium dioxide tape)	0 VU — 50 Hz to 12 kHz ± 3dB -10 VU — 50 Hz to 16 kHz ± 3dB
Total Harmonic Distortion (at 1 kHz)	0 VU — 2% -10 VU — 0.6%
Intermodulation Distortion (1 kHz & 960 Hz)	0 VU — 1.8% -10 VU — 0.6%
Signal to Noise Ratio (at 0 VU, re 1 kHz)	58dB
Erase Ratio (1 kHz recorded at 0 VU)	65 dB (standard tape) 55 dB (chromium tape)
Wow and Flutter (% RMS)	0.15% weighted
Line Input Sensitivity (for 0 VU)	5 mV into 100 k
Microphone Input Sensitivity (for 0 VU)	0.4 mV
Line Output Sensitivity (for 0 VU signal level)	0.8 V
Dimensions	115 mm high 400 mm wide 250 mm deep
Weight	5.1 kilogrammes

YAMAHA TB 700 CASSETTE DECK

standard tip and sleeve microphone jacks, suitable for microphones from 200 ohm to 50 k impedances.

The rear panel contains a three metre cord, complete with standard earthed mains plug, and record playback DIN socket flanked by two pairs of RCA coaxial sockets for line-out on the left, and line-in on the right. To the right of the line-in sockets is a high level/low level switch for a 10 dB reduction of line level.

The internal construction of the TB 700 provides an indication of the quality and care with which the unit is constructed. On opening up the base, one is presented with a large main board from which a number of smaller boards are interconnected by neat wiring harnesses. These smaller boards are respectively, output circuit for line output and headphones, oscillator circuit board, power supply board, and the auto-stop and servo control circuit boards.

The quality of the printed circuits is to full professional standards, and they have been especially protected to resist corrosion and the effects of poor environment, which so often take their toll of less carefully produced boards.

The internal construction is equal to or better than any unit we have seen in this class, and the designers are to be commended for providing suitable test and monitoring points — which are all well labelled. In keeping with modern trends, the record-playback preamplifiers make use of four integrated circuit modules, produced by an associate company of the Yamaha Group. The preamplifiers in each stage use low noise silicon planar transistors, together with two integrated circuits, in each channel. The unit has a total of 28 transistors, 21 diodes and four integrated units.

One of the best features of the circuitry is the use of a regulated 27 volt supply for both the oscillator and preamplifier stages, and the provision of a very practical and virtually foolproof autostop circuit.

Whilst the handbook does not have a circuit diagram, the manufacturers do have available very excellent 36 page service manuals which, surprisingly, make reference to local requirements in terms of the circuitry, and carefully specify the difference between the power supply circuitry requirements for various countries.

In keeping with a large number of other reputable manufacturers, Yamaha thermally age the printed circuit boards prior to their inclusion in the final cassette deck. By so doing, intermittent problems and breakdown of components are reduced.

We took the deck home for a few weeks and used it as part of our system, to familiarise ourselves with its operation before returning it to the laboratory for exhaustive testing. This subject evaluation told us, even before we started testing, that here was a better deck than most other machines on the market. What our laboratory testing would tell us would be how much better.

MEASURED PERFORMANCE

Our first objective measurements were of frequency response. The makers claimed 30 Hz to 16 kHz using chromium dioxide tape, and 30 Hz to 13 kHz with standard tape (level unspecified). The resultant performance was nearly as claimed, the deficiency not being at the top end as we had expected, but at the low frequency end where it is unlikely to be missed.

Distortion was measured at 2% at 0 VU, and 0.6% at -10 VU with standard tape at 1 kHz. This is quite commendable, the manufacturers claim 2.5%, but do not specify level or frequency.

Wow and flutter can be a major weakness in cassette decks, as a result of the low speed tape speed used in these machines, the very thin capstan used to drive the idler wheel, and the very thin tape. Here Yamaha claim that their TB 700 is significantly better than other manufacturers'. Whilst we did not find any dramatic improvement, certainly their performance is slightly better than most (but not all) other decks we have tested. We measured 0.15% rms wow and flutter. This is significantly better than the manufacturers' claim of less than 0.5% weighted R.M.S.

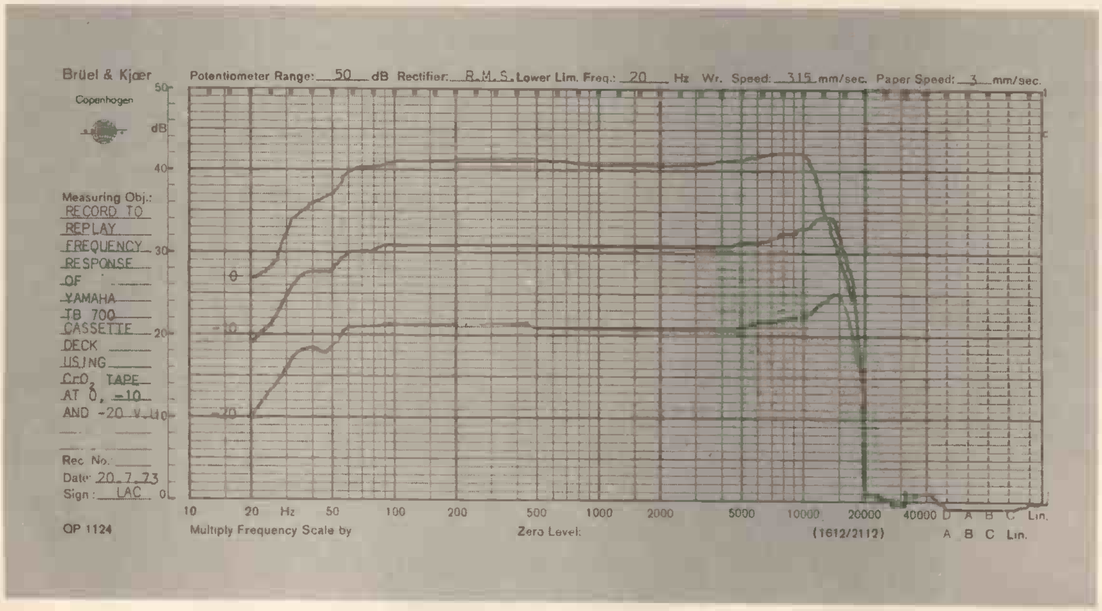
Yamaha do not quote a figure for intermodulation distortion, but this was typically 1.8% at 0 VU with standard tape.

Signal to noise ratio, without Dolby, was exactly 58 dB, as stated in the handbook, whilst with Dolby it was better than 59 dB linear, and 68 dB weighted.

The measured erase ratio was 65 dB at 1 kHz on ordinary low noise tape, and 55 dB on chromium dioxide tape.

None of our measurements showed any significant variation from the manufacturers' stated performance. This is as welcome as it is unusual, for many manufacturers of cassette decks have tended to be optimistic with their claims — particularly those of frequency response.

The Yamaha TB 700 is an excellent cassette player, and in keeping with only a small number of other machines, can lay claim to that very much abused term "High Fidelity Cassette Player". It is a "state-of-the art" product providing a performance equal to the best we have heard. ●



MAIL ORDER AND THE LAW

The vast majority of mail order companies who supply components are highly reputable and most take a pride in the service they offer. However there is a minority of companies who take advantage of the fact that the buyer is using mail order. Your rights and recourse are explained here by a solicitor who has made a study of the law relating to mail order and who has himself bought many components by this means.

If a dispute arises over a mail order contract, it may be expensive to take the course of resorting to the courts for redress. Where the amount of money at stake is small this course is rarely contemplated. What is required is a set of simple rules to inform the parties to the contract - the customer and mail order company - of their basic rights and obligations under the contract. Unfortunately these rules have not been forthcoming because of the complexity of the law in this field. It is to be hoped that this article will enable customers and mail order companies to distinguish between those problems with which they themselves can deal and those which are best left to lawyers; furthermore it is aimed at a number of sharp practices.

WHEN THE CONTRACT IS MADE

Many problems are solved by knowing *when* a valid contract is completed. In general a contract need not be in any particular form; it may be in writing, oral or even implied from the parties' conduct.

A contract is made when one party's offer is accepted by the other party's acceptance. The fundamental rule is that there *cannot* be a valid contract until both parties are agreed on all its terms. If there is the slightest disagreement on any term, there can be no contract. Usually the mail order company insert an advertisement in an electronics magazine or send a catalogue to the customer. In law they are merely inviting the customer himself to make offers; they are not themselves making any offers because they do not intend to be bound by the customer's reply ordering goods. If the position were otherwise, the mail order company would be bound by misprints in the magazine or catalogue and might be bound to supply goods, their stocks of which were exhausted.

When the customer writes in to the mail order company placing his order he is thus making an offer. Usually the terms of the offer will be the statements in the magazine or catalogue, but this need not be so. The customer may insert his own terms or bargain for better ones than those advertised or vary them in any way he wishes. There is nothing to stop the customer stipulating, for example, that he is making the offer on the basis of cash on delivery as opposed to cash with order, or that the goods must arrive by a certain day. Though there is no limitation of the terms of his offer, the customer will not usually stray far from the terms suggested by the company, for if he does so the company will usually invoke their right to reject the customer's offer.

When the order is received by the company, they have an option: they may either accept it or reject it. Once they have accepted it there is a valid contract which cannot be varied, except by further agreement. Thus, the company cannot accept the order and later state that the price is to be raised. Nor can the customer withdraw his order without the consent of the company. However, it must be borne in mind that the order can be withdrawn by the customer at any time before it is accepted.

Acceptance occurs at the time when the company writes to the customer accepting his offer or when they dispatch the goods ordered. In the latter case the acceptance is by conduct; there is no necessity for any words of acceptance. Because the company must actually be notified of the customer's cancellation of the order, he should waste no time and would be well advised to telephone the company immediately. He is too late if the company have already accepted the order before the customer notifies them.

If the company *reject* the order they may at the same time make a counter-offer to the customer, i.e. they may state that the terms he has offered are not acceptable but that others would be. Then it is up to the customer to accept or reject the new

MAIL ORDER AND THE LAW

terms proposed by the company. As an example, the customer may read an advertisement in which the company advertise transistors at say £1.00 each. The customer places his order for one, and sends his cheque for £1 plus the stipulated amount to cover postage and packing. The company write to the customer to inform him that unfortunately they have been forced to increase the price to £1.25. This letter constitutes a rejection of the customer's original offer and a counter-offer at the new price which the customer may accept or reject.

Thereoretically the process of offer. rejection and counter-offer can continue indefinitely, but it should not be forgotten that an offer or counter-offer, once rejected or withdrawn, cannot subsequently be accepted.

THE TERMS OF THE CONTRACT

Once a valid contract has come into existence, the next important question is: what are the terms of it? This is a very complicated legal question which cannot be investigated in depth here. It can be said, however, that very generally the terms fall into three main catagories.

First, there are the express terms, which are the terms which the parties expressly stipulate in their correspondence or which are contained in the company's advertisement or catalogue. As a rule these terms take precedence over all others.

Second, there are the terms which are implied by law. A contract for the sale of goods where the goods are to be delivered by mail order is governed by the Sale of Goods Act 1893 as now amended by the Supply of Goods (Implied Terms) Act 1973. It is important to note that the terms which are implied by law depend largely on the type of contract; different rules apply to contracts where the goods are exchanged for other goods, where goods are 'bought' on hire-purchase or where goods are hired or repaired. The 1893 Act implies certain important terms into the contract unless the parties stipulate otherwise.

The ability to stipulate otherwise has been severely restricted by the 1973 Act when the contract is one of "consumer sale". It is likely that most mail order contracts fall into this class. The most important term which cannot be now excluded is the term that the goods should be *reasonably fit for the purpose for which they are required,* so long as that purpose was made known to the company. In most cases the purpose is obvious. A transistor is normally required to perform according to its manufacturers' specifications; if it fails to do so it is clearly not reasonably fit for the purpose. However, if it is required for a purpose not obvious to the company, for example for use as a photo transistor, then he must make this purpose known to the company before he will be able to rely on this implied term.

This example should illustrate the legal complexities involved. Legal advice is almost always necessary on the effect of implied terms; it is unwise to act on one's intuition.

Third, there are the terms implied by custom *"to give business efficacy to the contract".* These terms are rarely encountered and will not be discussed here.

REMEDIES FOR BREACH OF CONTRACT – THE LEGAL POSITION

As pointed out above, it is a complex question what terms are implied into the contract. There is yet a further complication. If the company breaks a term of the contract, the breach *may* entitle the customer to reject the goods, recover the price, and sue for damages for breach of contract; but it may only entitle the customer to sue for damages. Whether the term is of the first kind (a "condition") or the second (a "warranty") is also a complex question. Generally speaking express terms are of the first kind because breach of them frustrates the main purpose of the contract. It is quite impossible to set out here the legal rules applicable.

If the goods are defective owing to having been damaged in the post, the legal position is fairly clear. Unless the parties agreed otherwise, the risk is normally on the customer except where the goods were inadequately packed by the company, in which case the company are liable for the damage.

REMEDIES FOR BREACH OF CONTRACT – THE PRACTICAL POSITION

For a customer and a company who are not contemplating resorting to the courts for redress, the most important precept is: try to avoid the problem arising in the first place. Once it has arisen it may be difficult to have it satisfactorily resolved. Thus the customer should order from reputable mail order companies and resist the temptation of ordering from the very small minority of companies which are likely to cause trouble; the lure of a slight price reduction should be resisted. Similarly the company should ensure that the customer with whom they are dealing is reputable and has not caused trouble in the past. If the company is in doubt, they should not accept the order placed by the customer.

If trouble does arise, the likely loser depends on whether the terms of the contract are cash with order or cash on delivery. If the former, the company have security for a customer's breach of contract. The likely loser in this case is the customer. If the latter, the position is reversed, and the likely loser is the company.

When trouble does arise the parties are place in a difficult position. The customer, having less ready access to legal advice and having less experience of mail order transactions, is probably placed in the worse position. Usually, when the customer makes his complaint known to the company, they will try to replace the goods if they are convinced that the complaint is *bona fide.* If the customer cannot obtain what he wants by the simple expedient of a friendly letter, then he will have to consider whether to seek legal advice. It is difficult to put a figure on the amount which must be involved before legal advice becomes worthwhile - each case is different, and it often turns out to be a 'matter of principle' - but a figure of some £25 may serve as a rough guide. The traditional method of consulting a solicitor may suit some customers, but nowadays it is possible to obtain free legal advice from a Citizens' Advice Bureau or a Neighbourhood Law Centre if there is one in the vicinity. Such legal advice would almost certainly include an explanation of the new procedure whereby disputes involving less than £75 can be referred to arbitration. This procedure, which is far cheaper than the usual procedure in the County Court, may well make litigation over smaller amounts than £25 a viable proposition. It is too early to tell yet.

A few examples of problems which occur frequently may help:

1. The customer orders a specific transistor, and the company send him one which the customer thinks is defective. The customer should write to the company and ask for the transistor to be replaced. He ought not to be too forthright about the fault lying with the company, for it may turn out that it is the circuit into which the transistor is being inserted which is faulty.

2. Again the customer orders a specific transistor, but the company, having exhausted their stocks of that transistor and wishing to save the customer inconvenience, send him an equivalent transistor. The strict legal position is that the customer is within his rights if he rejects the equivalent and demands the return of his money.

However, he should remember that the company will not in future try to help him if he does not try to help them.

In both these examples, the amount of money would not warrant the taking of legal advice. If, however, the articles concerned were worth £25 and the customer thought that the company were not fulfilling their obligations towards him, then it might be worthwhile to seek legal advice to check that the customer's complaints are well founded in law.

SHARP PRACTICES TO BE CONDEMNED.

It is unfortunately all too common to find a mail order company requesting a larger payment than that agreed upon in the contract. The author has personally encountered this sharp practice a number of times, but it must be emphasised that its occurrence is confined to a small number of companies. There are several variations on the theme.

The buyer sends in his order with a cheque for the price and postage as stated in the magazine or catalogue. The company then send the goods ordered but say that the price stated is out of date or that postage rates have recently been increased, and request the customer to send an extra sum of money. As previously explained, the company are not at liberty to accept the customer's offer and then increase the price. If they send off the goods, they have accepted the customer's offer and therefore they cannot demand more than the agreed price tendered by the customer. A customer when faced by this sharp practice should not send the extra money demanded.

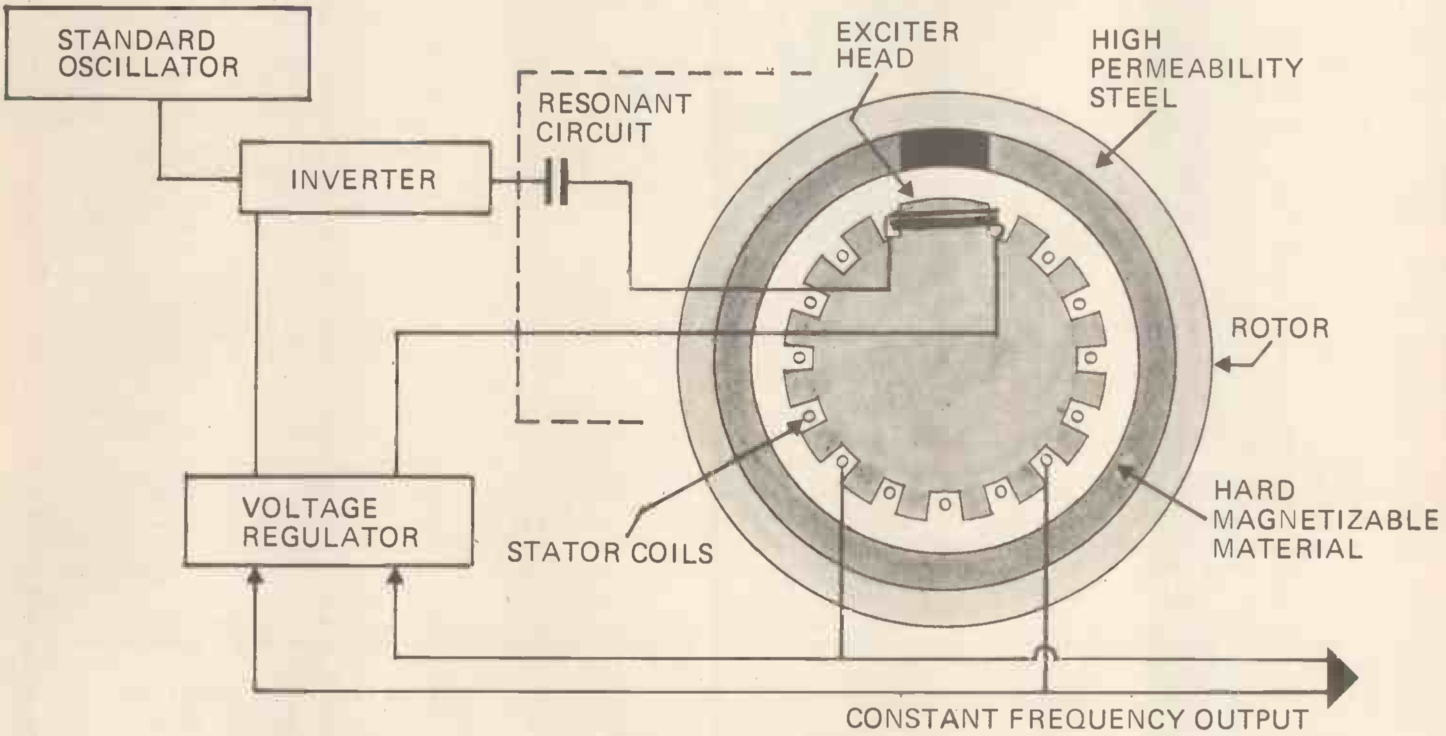
The company sometimes reply to the customer's offer and say that prices have been increased and that the customer will have to pay an extra sum before receiving the goods ordered. This in itself is not a sharp practice, but the author has known a company to insinuate that the original remittance is not refundable and in that way induce the customer to pay the extra sum demanded. Such an insinuation is of course to be condemned. The proper position is that the company's reply constitutes a rejection of the customer's offer and a counter-offer and he may demand his money back from the company. The customer cannot be denied his right to take the latter course and any suggestion that it is denied him is a sharp practice.

Even *when* the terms of the contract are cash with order it may happen that an unscrupulous *customer* can take advantage of the company's desire to please their customers. It has been known for a customer to order goods, enclosing a cheque and requesting that the goods be sent as soon as possible. He has previously or soon afterwards instructed his bank not to pay out on the cheque, but, before the company discovers this fact, they have dispatched the goods. A customer who resorts to this course of conduct not only is liable to be sued for the price, but also may be guilty of obtaining property by deception or of obtaining a pecuniary advantage by deception contrary to sections 15 and 16 of the Theft Act 1968, which carry severe penalties. The company, if they fear this fraud, should refuse to accept the order; they should not accept it *and* hold up the dispatch of the goods because they may then themselves be in breach of contract because of the customer's request for speedy delivery.

It has been known for a customer to threaten to blacken the name of the company if his demands are not met. Whether or not his claims are well founded, such a customer is guilty of blackmail contrary to section 21 of the Theft Act 1968 because threatening to blacken the company's name is not the proper method of enforcing a claim against them. ●

Constant frequency alternator

New alternator principle ensures frequency stability regardless of running speed.



ELECTRICITY authorities maintain the frequency of the power mains very accurately indeed to within fractions of a Hertz.

There may be very slow fluctuations, but over any reasonable period of time the number of cycles that has been generated will be very close indeed to the nominal frequency.

This is just as well, for many electronic devices depend upon the mains frequency to be accurate for their correct operation. Synchronous motors driving electric clocks, record players, tape decks and many digital instruments (they use the 50 Hz mains as a frequency reference), all rely absolutely upon closely controlled mains frequency.

PORTABLE POWER

Just so long as a 50 Hz *mains* supply is available, the average user has few frequency control problems. But, for the person who must generate his own 50 Hz supply, frequency stability becomes a very big problem indeed.

One approach is to use some form of inverter, converting dc power derived from batteries — or a suitable electric generator — to the required voltage and frequency. This works fairly well if low power output is required — or if the shape of the waveform is not important — but becomes extremely complex and expensive if a sinusoidial output has to be produced at high power levels (i.e. 100 watts upwards).

A second method is to use an alternator driven by a suitable source of motive power. This may be a petrol or diesel engine — or an electric motor energized by batteries. Alternators generate precisely the sinewave required and there is no real limitation on the amount of power that can be produced — in fact the larger the unit the cheaper the generating cost becomes.

But there is one very big drawback and that is that the frequency of a conventional alternator's output is directly related to rotational velocity:-

$$\text{freq (Hz)} = \frac{\text{number of poles}}{120} \times \text{rpm}$$

hence the frequency stability of the alternator depends entirely upon how rigidly one can control the speed of the device that drives it — and this is extremely difficult to do accurately.

This characteristic is true of every alternator that was ever built -- except one.

The exception is a brilliantly conceived machine recently developed by the Precise Power Corporation of Bradenton, Florida, USA.

Unlike conventional alternators, which have a fixed number of poles, this new machine has an outer housing lined with a continuous layer of magnetizable material. The stator of the machine, apart from its normal function, carries an excitation head that continuously imprints the required pole disposition onto the magnetic material.

The signal for the 'magnetic pole imprinting' is derived from an external precision oscillator and power amplifier thus, as the stator speed varies, the imprinted pole spacing varies accordingly. In other words the stator coils see the same number of poles per second regardless of actual speed of rotation. As a result, the frequency stability of the alternator is governed by the stability of the precision oscillator, and can be

Coil imprints 'pole pattern' on magnetizable rotor.

tailored to suit the individual application.

One example, demonstrated by the designers, held frequency within 0.01 percent whilst being driven by a very old lawn mower engine!

Another, powered by a straightforward induction motor energized from the mains, generated a 400 Hz sinewave with a frequency stability of better than 0.001%. Even a momentary break in mains supply voltage did not cause the output frequency to shift.

The power required for the pole imprinting process is approximately five percent of the alternator's output. Overall efficiency of the system is claimed to be not less than 65 percent for small units – and somewhat better than that for larger ones.

Voltage regulation is achieved by sampling the output voltage and then using this signal via a feedback loop to control the output voltage of the oscillator used to imprint the pole signals. This technique enables the output voltage to be maintained within three percent.

Apart from its obvious advantages as a source of portable regulated ac power, the new alternator will find many applications in no-break power supplies. There are many electronic devices, such as medical instrumentation, digital computers, etc, that cannot tolerate even momentary breaks in supply, and for such applications the new alternator is ideal.

Other uses include power generation from variable speed sources such as windmills, water wheels, solar powered motors. Here, the alternator will enable constant voltage, constant frequency power to be generated despite variations in speed of as much as 75 percent. ●

eti

WHAT TO LOOK FOR IN JANUARY...

NEXT MONTH A FULL SCALE MUSIC SYNTHESIZER TO BUILD

Next month we start on a feature that has been in development for over a year — a truly advanced synthesizer with an incredible range of facilities. This is not a toy or gimmick project and so original is the design that two provisional patents have been granted for parts of the circuitry. The design is so excellent that plans are being made for built models to be marketed. Independent authoratative opinions agree the ETI International Synthesizer is technically superior to practically all music synthesizers available today — yet it can be built for a fraction of their costs!

OTHER FEATURES:

DIGITAL STOPWATCH PROJECT
COOKING BY MICROWAVE
HOW TO REPAIR ELECTRONIC CALCULATORS.

Consider these features: 1. Fully voltage controlled. 2. Digital keyboard instantaneously adjustable to any musical scale. 3. 400 point matrix patchboard. 4. Digital (CMOS) circuitry. 5. Four voltage controlled oscillators, each generating triangular, sawtooth, reverse sawtooth, sine, or pulse waveforms. 6. All oscillators completely linear over upper ten octaves. 7. All oscillators fed from same control voltage will 'track' over entire keyboard. 8. Voltage controlled filters, lowpass, bandpass, highpass — cut-off 40 dB/octave. 9. Any filter and any oscillator will 'track' accurately — totally automatically. 10. Total control of attack and decay characteristics. ALL slopes variable from 10 milliseconds to five seconds. 11. Digital white noise generator — almost Gaussian noise. 12. Zero temperature drift!

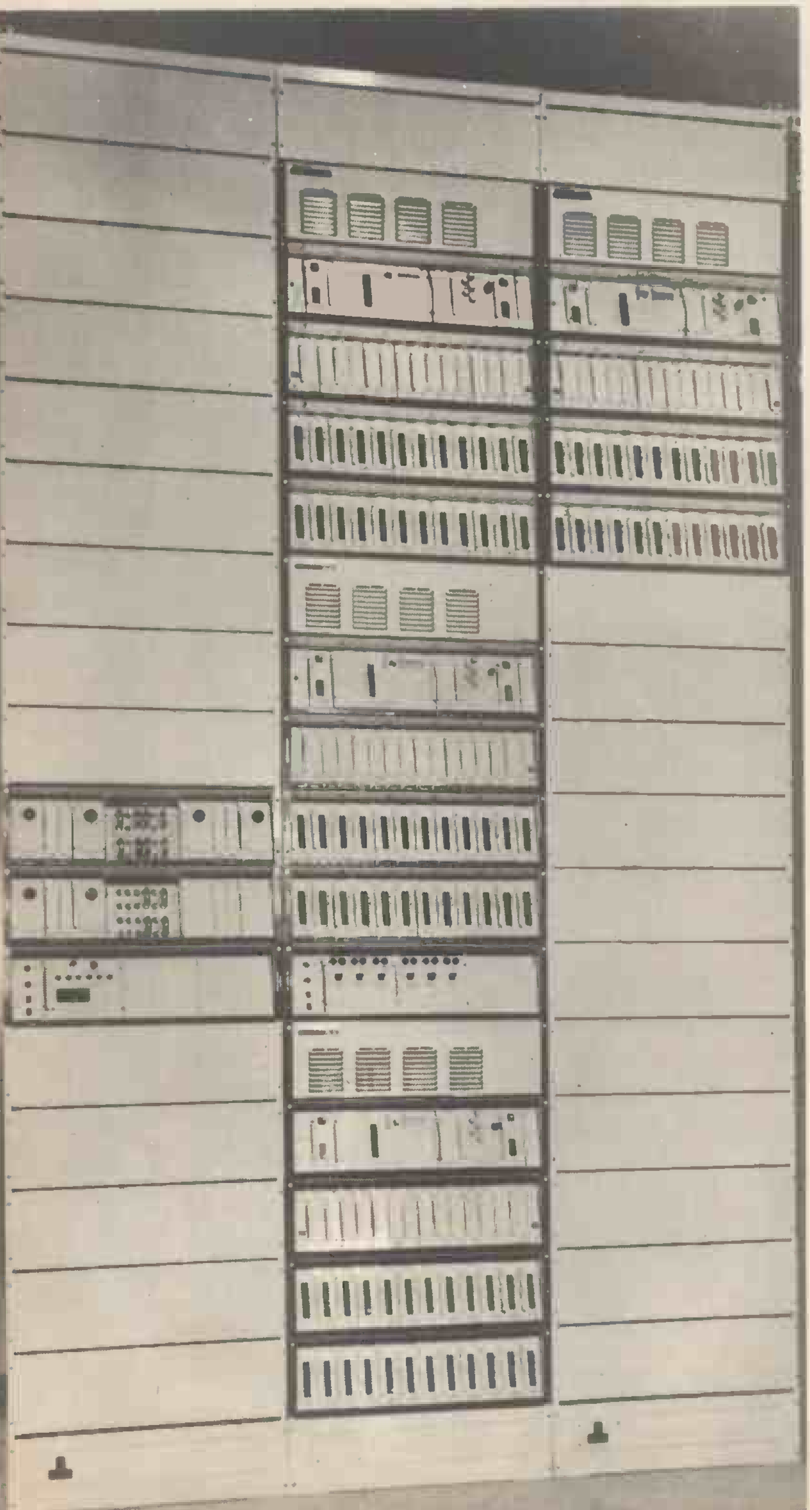
ON SALE MID-DECEMBER—20p

THE FORTHCOMING ARTICLES MENTIONED ON THIS PAGE ARE, AT THE TIME OF THIS ISSUE GOING TO PRESS, IN AN ADVANCED STATE OF PREPARATION. HOWEVER, ETI TAKES A PRIDE IN BEING REALLY UP-TO-DATE AND TOPICAL ARTICLES MAY REPLACE THOSE SCHEDULED.

electronics today INTERNATIONAL

DIGITAL TECHNIQUES

Samuel Morse invented a code which could utilise the limited communications link of his day - and it was basically a digital technique. Today digital techniques are once again finding their way into communications, making better use of the existing facilities while at the same time reducing distortion and noise levels.



PULSE CODE MODULATION is a digital technique by which information may be carried from one point to another. The signal is carried as a series of separate pulses or digits. The technique was invented by H. A. Reeves in 1938, but its economical exploitation has had to wait the development of cheap integrated circuits.

Pulse code modulation has the great advantage that no distortion is introduced and no information is lost from a signal unless a complete pulse disappears or unless a spurious noise pulse is formed which is large enough to be accepted by the equipment as a genuine pulse. Many channels of communication can be made available along a single connecting line.

TYPICAL APPLICATIONS

Pulse code modulation has a very wide variety of applications. For example, a single radio link between rocket and the earth can be used to convey information such as the temperature, pressure, ion density, etc. in the upper atmosphere.

Pulse code modulation is widely used by the British Post Office for communication over moderate distances and by other organisations such as British Rail, Electricity Boards, etc. It is also finding an increasing number of applications for remote measurements in industry.

A digital system is being introduced at the present time by the BBC for the distribution of programmes from the studio to the transmitters and from one transmitter to another. This should effect very real improvements in the quality of the transmitted signals when the stations are remote from the studios. In addition, digital techniques are employed in some types of television equipment for the convers-

The Marconi U1310 equipment for a 4 x 24 pulse code modulation system with the associated line terminal equipment.

IN COMMUNICATIONS

ion of programmes from one standard to another.

A further possible use for pulse code modulation is in the recording of audio signals in a digital form. This makes it possible to obtain much lower noise levels by the elimination of tape hiss.

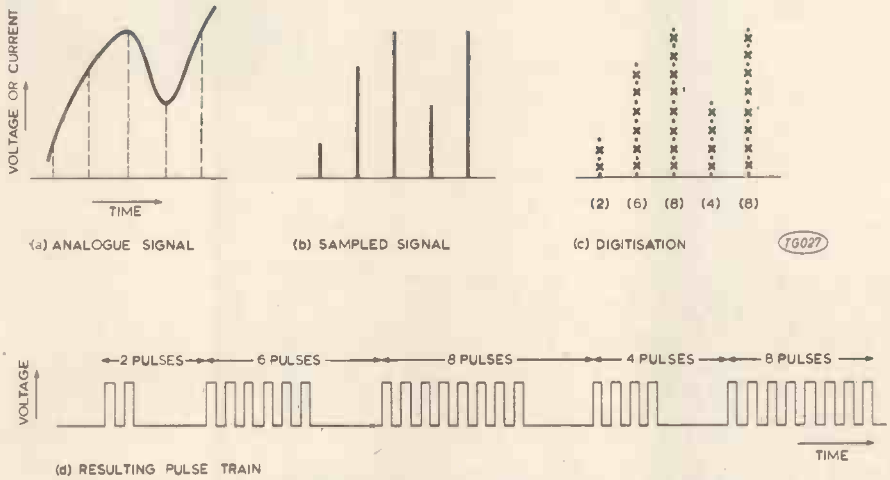


Fig.1. The conversion of an analogue signal into a train of pulses.

PRINCIPLES OF QUANTISATION

A simple way in which a signal can be converted into a train of pulses is illustrated in Fig. 1.

The input signal carrying the information is a voltage or a current which varies continuously with time. Such a signal is known as an 'analogue' signal, since the variations in the voltage or current are analogous to the quantity about which they carry information. This quantity may be pressure, temperature or, in the case of an audio signal, the variations in the voltage from a microphone or a similar signal source.

The analogue signal is sampled at regular time intervals, as shown by the dotted lines in Fig. 1a. The sampled signals consist of short pulses, the amplitude of which are proportional to the amplitude of the analogue signal at the instant of sampling. The sampled signal is shown in Fig. 1b.

QUANTISATION

The sampled signal must now be 'quantised' by means of an analogue to digital converter. That is, the information contained in the pulse heights of Fig. 1b must be converted into a train of pulses. In Fig. 1c each cross represents a pulse and the number of pulses in each of the five samples taken are shown by the numbers in brackets under this figure.

The pulses are then arranged as shown in Fig. 1d so that they can be carried along a single communication link. This is a digital signal, since the information is conveyed as a train of whole pulses or digits. The process of digitisation is known as 'encoding'.

Practical systems are much more complex than this. In order to obtain an accurate picture of the analogue waveform of Fig. 1a, one would need to sample the signal far more frequently than the intervals shown. In addition, if the height of each sampled voltage is to be measured accurately, each cross in Fig. 1c would have to represent a much smaller pulse height than that shown. One might, therefore, think that the number of pulses per second would have to be very great if it is necessary to measure the input signal accurately at frequent sampling intervals. A high pulse rate requires a large bandwidth and this is expensive.

BINARY CODING

The number of pulses per second which must be transmitted can be greatly reduced by coding the pulses representing any one sampling measurement according to the binary system.

If one takes the number 843 as an example, one can write this as 512 + 256 + 64 + 8 + 2 + 1 or as $(1 \times 2^9) + (1 \times 2^8) + (0 \times 2^7) + (1 \times 2^6) + (0 \times 2^5) + (0 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0)$. If the initial '1' or '0' is taken in order, one can abbreviate this to the form 1101001011. This is said to be a binary number. If a '1' of the binary number is shown by the presence of a pulse and a '0' by the absence of a pulse, this number may be shown by the waveform of Fig. 2. Thus only nine pulse positions are occupied by the number 843. Any number can be coded in this way.

Nine binary digits (or 'bits') can represent numbers up to 1027 and can therefore provide an accuracy of better than 0.1 per cent in the measured

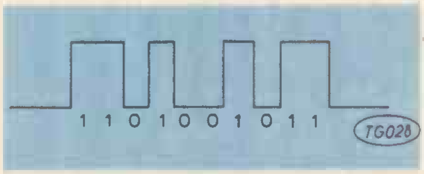


Fig.2. The number 843 can be represented in a binary code by the train of pulses shown here.

sample height. The amplitude of the pulse train is typically 5V in much commercial equipment.

The conversion of an analogue signal into a pulse coded signal always involves some distortion; the latter is known as 'quantisation distortion'. It effectively adds some white noise (or hiss) to the signal.

It should be noted that the equipment at the end of the line merely has to decide whether a pulse is present or absent. If the pulse shape is changed by the system, if the pulse height is reduced or if spurious noise pulses much smaller than the wanted pulses appear, no information is lost and the analogue signal can be reconstructed at the receiving end. In digital systems virtually all of the distortion is introduced at the transmitter or receiver.

The work of Shannon has showed that the sampling frequency must not be less than twice the highest frequency which must be transmitted by the system. In telephone communications the uppermost frequency is normally 3 – 4kHz and therefore an 8kHz sampling rate is commonly used.

DIGITAL TECHNIQUES IN COMMUNICATIONS

MULTIPLEX SYSTEMS

Figure 3 shows the basis of a 'multiplex' pulse code modulation system in which a number of completely separate input signals are combined together to form a train of pulses. The latter can be decoded at the receiving station and separated into the four outputs. Thus four separate communication channels are obtained using a single transmission line.

The input signals are fed through low pass filters to the switch S1. This connects each of the inputs in turn to the encoder circuit. Although S1 is depicted as a rotating switch in Fig. 3, semiconductor electronic switching circuits are employed and the number of inputs is normally much greater than that shown.

The output from the encoder is fed to the transmission line which has 'repeaters' (or amplifiers with pulse shaping circuits) stationed at regular intervals so that the pulse amplitude is kept well above the noise level. Alternatively the encoded signal can be sent to the receiving station by radio ininstead of by land line.

At the receiving station the signal is decoded so as to convert the pulses into analogue signals. The switch S2 (actually an electronic switch) connects the output from the decoder to each of the outputs in turn.

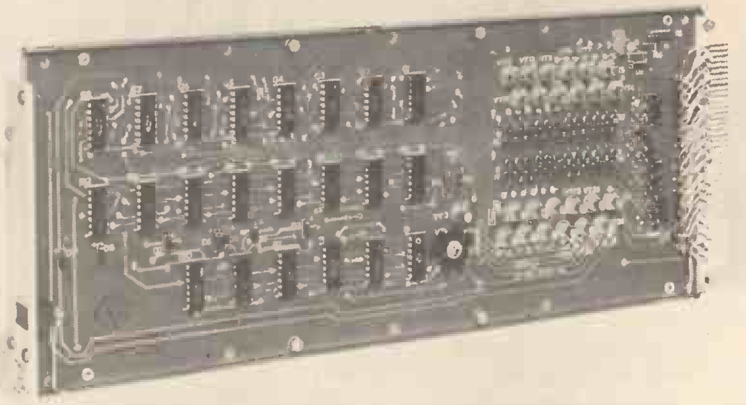
Figure 3 is very much simplified. In addition to the encoded signals, synchronisation pulses must be transmitted to the receiver so that the switch S2 is kept in phase with the switch S1. This ensures that the input signal marked 1 appears only at the output 1.

This type of communication system is known as *'Time division multiplex'*, since the transmission time is divided between the number of channels employed. That is, the different input signals are each assigned specific times at which they are transmitted so that these signals can share a single transmission system.

The series of pulses which represents one single sampling operation is called a word. The number of pulses (or bits) in the word determines the accuracy with which the sampled amplitude can be represented in the pulse code.

A complete sequence of sampling operations (including a word from each of the input signals) is known as a *frame*. Each frame normally commences with a special synchronising signal which is recognised as such at the receiver. The probability of a signal identical with the synchronising signal occurring in the data to be transmitted must be very small.

In many systems it can be arranged that some of the input signals are sampled more frequently than others. A greater fraction of the transmission time can thus be allocated to those signals containing the higher frequencies.



A timing card from the Marconi U1310 equipment showing the extensive use of integrated circuits.

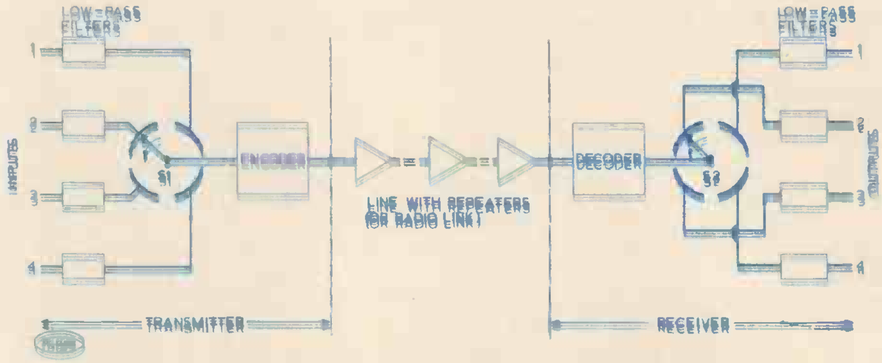


Fig.3. The basic form taken by a pulse code modulation system.

TELEPHONE EQUIPMENT

The number of telephone subscribers has roughly doubled in the last ten years, but the use of the telephone service has increased at a much greater rate. The U.K. telex service is growing at about 20 per cent per annum and new services such as 'viewphone' and 'confravision' will involve the carriage of much more information to enable pictures to be reproduced. The use of digital techniques, including pulse code modulation, can help to solve the resulting problem of channel congestion. Further services may appear in the future, such as the automatic reading of gas, electricity and water meters which will involve digital techniques.

Telephone communications over relatively short distances are normally based on a 'one channel per circuit' basis. Very long distance calls are more efficiently covered by a freq-

Two Marconi line regenerators with line equalisers housed in a common can.

uency division multiplex system where each channel has its own frequency band and the various bands are separated at the receiver.

In the range of about 10 to 30 miles, the cheap semiconductor devices which are now available make pulse code modulation systems most attractive. Much simpler systems can be employed than with frequency division multiplex equipment which requires a good signal to noise ratio, filters with very tight specifications and low intermodulation distortion.

It seems likely that future telephone networks for moderately short distances will be arranged as in Fig. 4. Only the circuits between a local exchange and the subscriber carry analogue signals. All telephone calls passing from one exchange to another may be converted into digital signals for transmission between the exchange.

Organisations outside the Post Office are employing pulse code modulation systems for telephone communications. British Rail was the first organisation to increase the capacity of its telephone equipment in this way. Initially they installed the Marconi U1310 24 channel equipment between Euston, London and Bletchley, but further similar equipment is being installed to cover certain regions in the Birmingham area. The same type of equipment is being employed by the London Electricity Board, the Eastern Electricity Board and various other organisations. Teleprinter and date facilities can be included in addition to the telephone channels.

MARCONI U1310 EQUIPMENT

A block diagram of the Marconi U1310 24 channel equipment is shown in Fig. 5. The multiplexer provides pulse coded signals by sequentially sampling the 24 analogue speech waveforms.

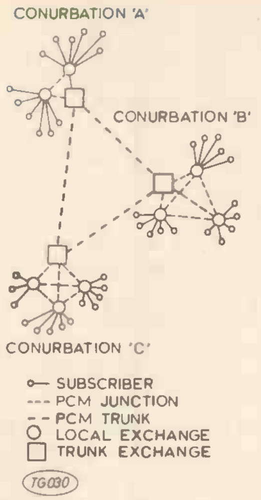


Fig.4. Typical arrangement of a telephone network.

The sampling rate is 8kHz so as to ensure that the highest speech frequencies are transmitted. A non-linear encoding process is employed to combine compression of the analogue signal pulses, quantisation of the pulse amplitudes and coding of the quantised pulses into a 7-bit binary code.

The first bit of the binary code represents the polarity of the sample concerned and the next 6 bits the instantaneous amplitude at the instant of sampling. Thus a total of 2^7 (=128) different amplitudes can be represented from the negative peak to the positive peak. A further bit is added to this 7-bit code to convey signalling information appropriate to the particular speech channel concerned. The overall signals are therefore 8 bit words. The signalling bit also provides synchronising information.

Each of the 24 code words are assembled together in time to form a frame of 192 digits (=8 x 24). Four frames are assembled in time sequence to form a multi-frame. Frames 1 and 3 are used for telephone, frame 2 for a teleprinter (which is optional) and frame 4 for synchronisation.

The multiplexed signal is fed via line terminating equipment to the transmission line. Alternate pulses are inverted in polarity to produce a signal more suitable for transmission. This effectively reduces the pulse repetition rate by a factor of two and decreases the bandwidth required. In addition, it removes almost all of the d.c. component and simplifies the use of transformers.

REGENERATORS

Regenerative line repeaters are spaced at nominal 1830 metres (about 2000 yards) intervals along the line; they may be housed in cast iron repeater cases suitable for manholes or may be merely buried in the ground. The regenerators receive their power (48 ± 2mA at 6V) from the terminal equipment.

The regenerators generate a timing signal locked onto the incoming signal and employ this timing signal to gate the regeneration circuits so that the effect of noise is reduced. Each time a pulse is received whilst the gate is open, a full amplitude pulse of the same polarity is generated. Thus the signal pulses are restored to their original shape and amplitude.

THE RECEIVER

At the receiver the digital signal is decoded using a non-linear weighting network similar to that employed in the encoder. The multiplex circuits then distribute the signals to the appropriate speech circuits.

The Engineer's Order Wire (E.O.W.) circuit is used as a means of communication between the exchange and the

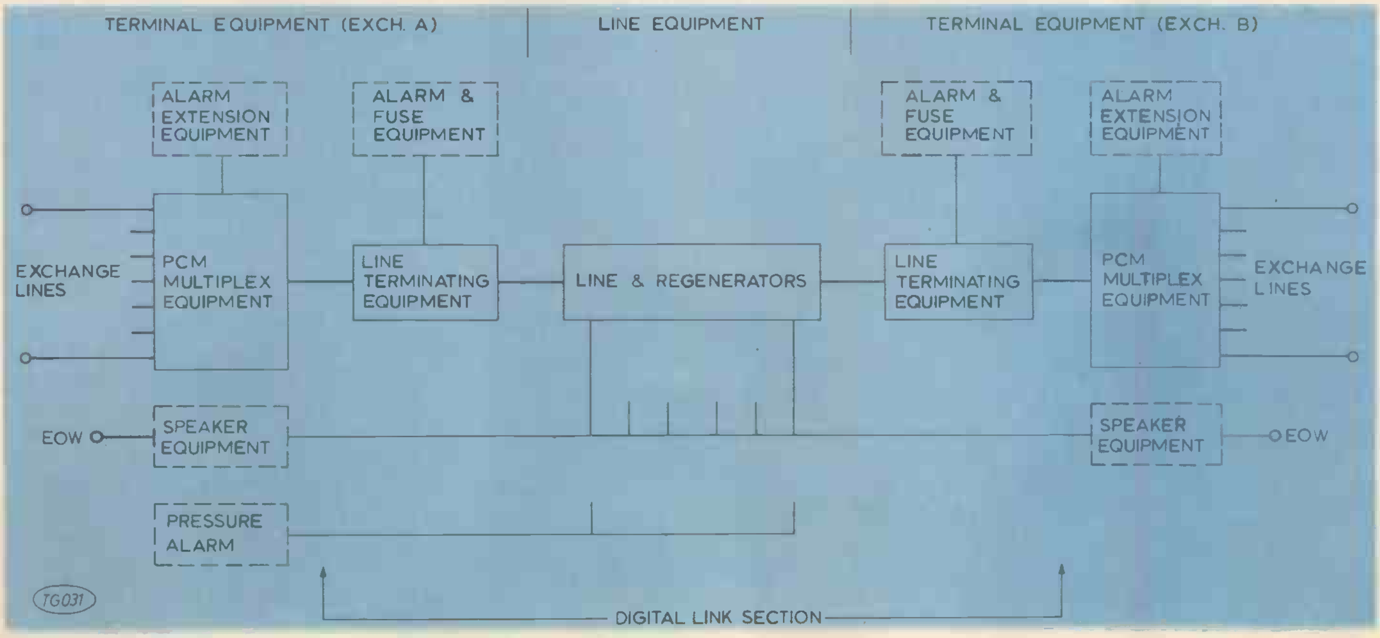


Fig.5. Block diagram showing the Marconi U1310 equipment.

DIGITAL TECHNIQUES IN COMMUNICATIONS

underground housings. The pressure alarm operates when the pressure falls below a predetermined level in any one of the underground housings.

Up to three complete multiple systems can be accommodated in a standard 2.73 metre (9 feet) high rack, the weight of each multiplex package fully equipped with 24 signalling sets being 168lb 2oz.

ITT PSC-24B EQUIPMENT

The ITT PSC-24B equipment (Manufactured by the STC Microwave and Line Division at Basildon) is essentially similar to the Marconi U1310 system. It provides 24 channel communication using a time sharing technique with 2 pairs of wires, one pair for communication in each direction. An 8kHz sampling rate is employed to convert the analogue signals into eight bit words. If synchronisation is lost, the time for its restoration is normally less than 5mS.

AE-1001 ENCODERS

The Akers Electronics AE-1001 equipment was developed at the Norwegian Defence Research Establishment during 1970-1971 for applications in sounding rocket telemetry. The United Kingdom agents are Guest International Ltd., Redlands, Coulsdon, Surrey, CR3 2HT. This encoder can be employed in research and industry for transmitting measurement and control signals and in computer based automation systems, etc.

The AE-1001 system can accept up to 960 analogue and digital signals simultaneously and converts them into a time division multiplexed pulse code modulation signal. The maximum bit frequency is 1MHz. The number of bits per word can be programmed from 1 to 16. 'Supercommutation' and 'subcommutation' techniques are employed and enable a choice of sampling rates to be made for the various inputs.

The AE-1001 unit employs TTL and MOS chips in a hybrid large scale integration (HLSI) system which enables the weight and volume to be reduced to a minimum. Indeed, it has been estimated that the volume has been reduced by a factor of between 50 and 100 as compared with conventional technique; this is most vital for use in rocket telemetry equipment. The modules can, however, be used for other purposes also.

The encoded signal from the AE-1001 unit can be transmitted along a coaxial cable, twisted wire pairs, radio beams, light or laser beams.

The data provided by the AE-1001 can be processed directly by digital computers or other digital equipment at the receiving station.

The Marconi U1310 equipment in use at the Hull Corporation Telephone Exchange.

BBC SOUND

The quality of the sound broadcast by the BBC transmitters has been excellent if the source of the sound has been relatively near to the transmitter concerned. For example, one could expect to receive first class sound quality from the Wrotham transmitter in Kent if the sound originated in a London studio. If, however, the transmitter is some hundreds of miles from the studio, the audio signal can be appreciably degraded before it reaches the transmitter. In particular, the high frequency parts of the audio spectrum and the signal to noise ratio are affected.

The BBC is installing a system of pulse code modulation at the present time for conveying signals from the studio to the transmitter and from one transmitter to another. This will ensure a consistently high quality of the signal from all transmitters in the United Kingdom, no matter whether the studio is near or far from the transmitter.

It must be emphasised that the changes being made involve only the method by which the signals are conveyed to the transmitter and between transmitters. There will be no changes whatsoever in the broadcast signals which the public can receive from the transmitters.

The BBC are using a system which samples the signal waveform at a frequency of 32kHz. The amplitude of the waveform measured at each of these sampling operations is expressed as a series of thirteen pulses or spaces in binary digital form. The thirteen binary digits allow 2^{13} (=8192) different amplitudes to be resolved at each sampling operation. This is adequate to enable the original signal to be reconstructed with negligible quantisation distortion. An additional parity bit is included for error protection.

The equipment being introduced by the BBC allows up to thirteen pulse code modulation channels to be transmitted using a single radio link. The bandwidth of this link is about 5.5MHz (equivalent to about one television channel).

The audio bandwidth of the new system will be level to within ±1db from 40Hz to 15kHz. A sharp cut off is introduced above 15kHz, but at the low frequency end there is some response down to 30Hz.

Each audio channel has its own encoder and decoder; the thirteen available channels can therefore be allocated to monaural channels and/or to pairs of stero channels. The ratio of the peak signal to peak weighted noise is 69db.

If an error is detected by the system at the receiving end, the output remains at the value of the last sample in which no error was detected until a further sample arrives in which no error is detected. This greatly reduces error signals in the system.

This pulse code modulation system is already in use in the South East of England and is being introduced into the Midlands. Although there have been some delays due to industrial problems, the system should cover much of the North of England later this year, the Bristol and Central Scotland regions next year and the North East of England and the Carlisle areas by 1975. It will, of course, be employed for signals being conveyed to both v.h.f. transmitters and those in the long and medium wave bands.

SOUND-IN-SYNCS

It is interesting to note that sound signals (encoded in a digital form) can be incorporated within the video waveforms of a television signal whilst it is being conveyed from the studio to a transmitter or between transmitters. The sound signal is transmitted during the time intervals between the line synchronisation pulses.

This system was originally used between London and Kirk o'Shotts in Scotland, but has since been employed between London and Copenhagen, etc. It is known as the 'sound-in-syncs' technique.

Marconi pulse code modulation equipment installed at the London Electricity Board.

TELEVISION STANDARDS CONVERTER

In 1972 the first television standards converter using digital techniques was developed by the Independent Broadcasting Authority for changing American or Japanese colour television signals into a form suitable for European receivers. The new equipment shows marked improvements in the quality of the colour pictures, is smaller than the existing standards converters and tedious line up adjustments are unnecessary. In due course the converter will be made bi-directional so that it can be used in a system for transmitting European pictures to the U.S.A. or Japan.

There are severe problems in changing from a 525 line NTSC television system using 30 pictures per second (a value set by the 60Hz power frequency used in the U.S.A) to the 625 line, 25 pictures per second PAL or SECAM standard of Europe. However, the problems are resolved in the new converter equipment located in racks 3'6" by 1'6" by 6' high containing some 8000 integrated circuits. There are about 2400 MOS devices in the main store representing about 15 million field effect transmitters. The earlier

A Post Office regenerator type 2A undergoing a pre-installation check with a Marconi TF2342 regenerator tester.

DIGITAL TECHNIQUES IN COMMUNICATIONS

converters occupied seven large equipment racks.

The new converter is designated by the acronym 'DICE' (Digital Intercontinental Conversion Equipment) and is basically one of the fastest digital computers available. It is virtually impossible to detect noticeable degradation of the picture quality at the output.

PRINCIPLES OF OPERATION

The converter has to perform three main functions.

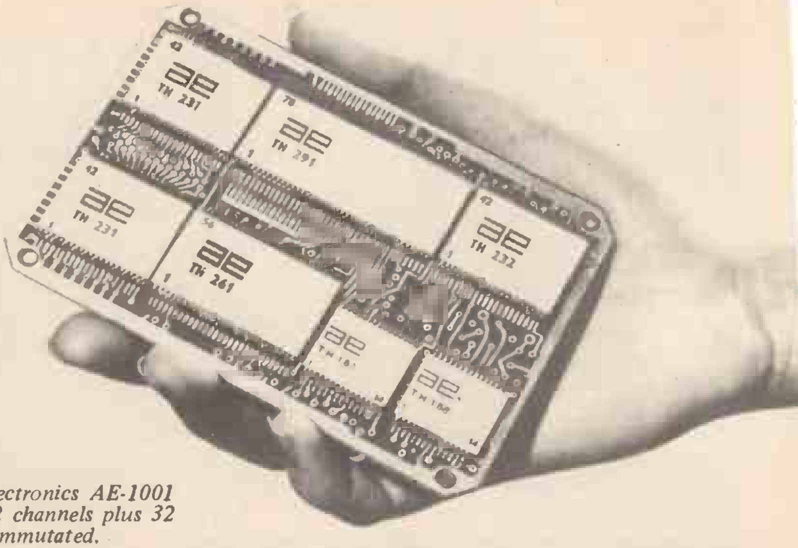
(i) The field rate must be changed from 60Hz to 50Hz and must be lengthened.

(ii) The 525 line scanning rate must be converted to the 625 line rate.

(iii) The colour subcarrier frequency must be changed and its modulation altered.

The incoming analogue signals are sampled at a rate of three times the subcarrier frequency (10.7MHz). Each picture element thus sampled is analysed into one of 256 equally spaced amplitude levels in order to produce an eight bit binary coded word.

If the incoming signal is produced by an American camera panning at, say, 6° per second ($=0.1^{\circ}$ per picture frame), the picture must be transformed so that the movement occurs at 0.12° per picture frame. In other words, the amount of horizontal movement per picture differs in the two systems. The standards converter combines appropriate proportions of each two successive pictures. Shift registers are therefore required to provide storage facilities. The rate is eight million words per second.



The Akers Electronics AE-1001 encoder for 32 channels plus 32 channels subcommutated.

The Independent Broadcasting Authority's digital standards converter being demonstrated by John Baldwin (left) who first sketched out the basic design and Tony Stalley who was responsible for the day-to-day management of the project.

CEEFAX

The BBC has recently been investigating the possibilities of a new broadcasting service known as 'Ceefax' which would enable viewers to have a service of news, information, weather, etc. displayed in the form of writing on a television screen. It could be displayed either on a black screen or superimposed on a normal programme. The information would be extracted from the vision signal by the kind of receiving terminal shown in Fig. 6; it would be stored in a memory until required.

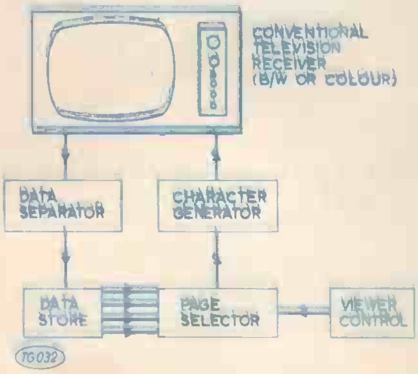


Fig. 6. A CEEFAX receiving terminal.

This type of system might provide about 30 'pages' of stored information at any time. The viewer could select whatever he required. The information would be transmitted during the periods between the line synchronisation pulses so that no extra bandwidth would be required.

It has also been suggested that the Ceefax system could be employed in conjunction with the telephone, possibly with a print out machine in the home making a print out of messages, etc.

CONCLUSIONS

The earliest types of communication equipment employed a digital system - namely Morse code. The communications field has used analogue techniques widely for many years, but in some applications the wheel is gradually turning full circle back to digital systems. We have seen that these systems can improve existing services and also provide completely new facilities. ●

TOWARD A BETTER ENVIRONMENT

Proposed automatic pollution monitoring system may result in cleaner cities. This report by Peter Sydenham M.E., Ph. D., M. Inst. M.C.

1. Location of SO_2 monitors in the Rijnmond supervisory network.

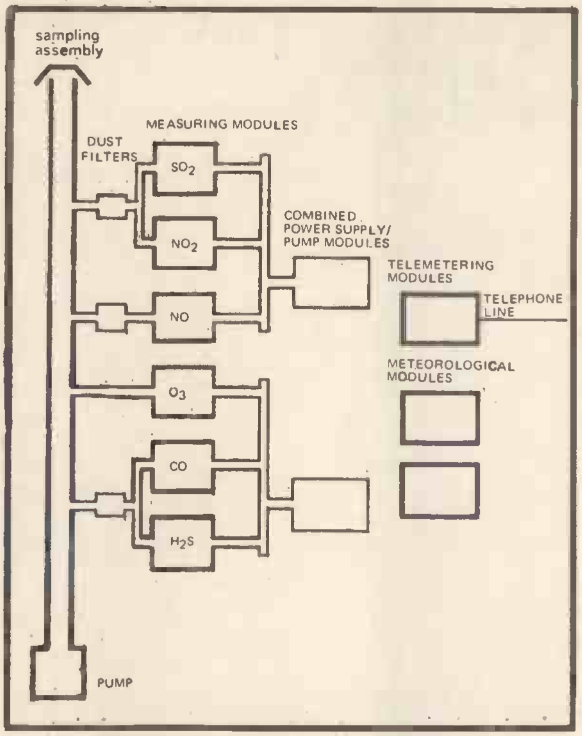
2. Inside the Rijnmond central control room.

3. Monitoring cubicle for up to nine modular units.

AUTOMATIC POLLUTION MONITORING SYSTEMS FOR CITIES

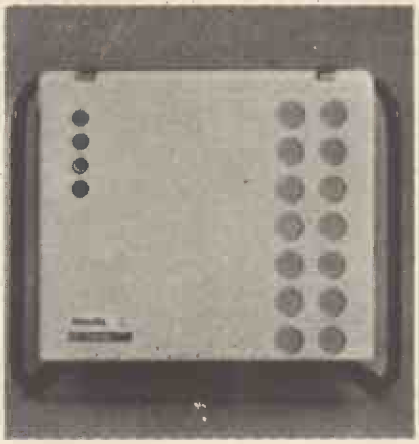
ALTHOUGH pollution control of the air and water has been in vogue since mediaeval times it has long suffered from the want of a way to *measure* the excess and pinpoint the source of the trouble. It is one matter to legislate against it, another to enforce the law.

Protection really starts with measurement, for subjective opinion can be misleading in this emotional area of our existence. Nature has inbuilt purifying mechanisms but our excessive generation of poisonous gases and wastes emitted into the air and water have overloaded natural methods in many places. Few large cities in the world can claim to have



4a. Schematic of the multi-measurement station.

b. Views of the module (coulometric unit).



the situation in control, for adequate awareness of the problem is a recent realisation occurring too late in many cases.

Motor vehicles pour out carbon monoxide, carbon dioxide and solid hydrocarbons. Factories and power-house furnaces pour out tons of dust each day along with sulphur dioxide, nitrous oxide and hydrogen sulphide. Sulphuric acid may rain down near the smoke stacks of unprotected furnaces!

Already the pollution levels in many cities exceed considered safe levels. Existence of contamination may be evident — dead fish in rivers, discolouring paint and buildings, obnoxious smells, floating debris, sickness due to lack of enough oxygen to breathe — the picture has been portrayed so many times in the news media one cannot fail to know of it. In such cases obvious action is needed.

Where pollution is not so clearly evident, it is even *more* important to monitor it with instruments, for our natural senses are inadequate to judge the level of contamination building up to critical proportions. Pollution penalties are now heavy but to *enforce* these penalties is not easy and usually needs evidence that can only be provided by continuous monitoring with rapid response instruments.

Not all recognised pollution is man-made. Even so, a warning of approaching unhealthy weather conditions given to the populace in time would enable people to reduce the severity by restricting the use of polluting sources normally operating at acceptable levels.

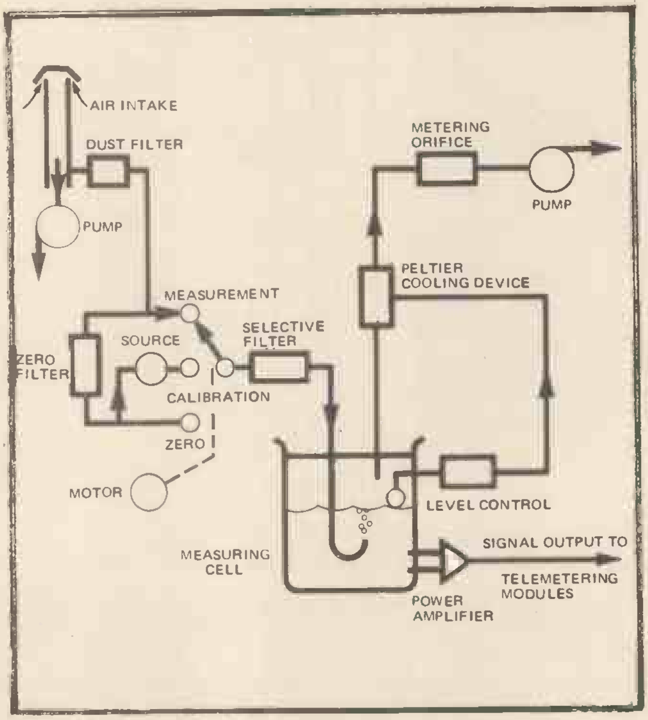
MONITORING SYSTEMS

The measurement (and hence control) of air and water pollution over a large area is usually a complex problem. It involves many sources, each being a contributory factor in different ways. The problem of control is compounded by political difficulties and international boundaries. The Rhine river is an example: the Swiss pass on their filth to the Germans who pass it to the Dutch who feed it to the North Sea. Pollution has no boundaries, so regional differences must be overcome in setting up satisfactory control schemes. It is essential that many sensors at many sites be used — not just one placed where high levels are known to exist.

One company who can claim to have answers to pollution measurement of cities is Philips. In 1969 they installed the first completely automatic pollution monitoring network in the world at Rinjmond, near Rotterdam in Holland.

By 1974 Philips will have a national, computerized network operating all over Holland — 250 stations will be in use, in conjunction with 10 mini-computers. They have 1000 pollution monitoring units working across the globe.

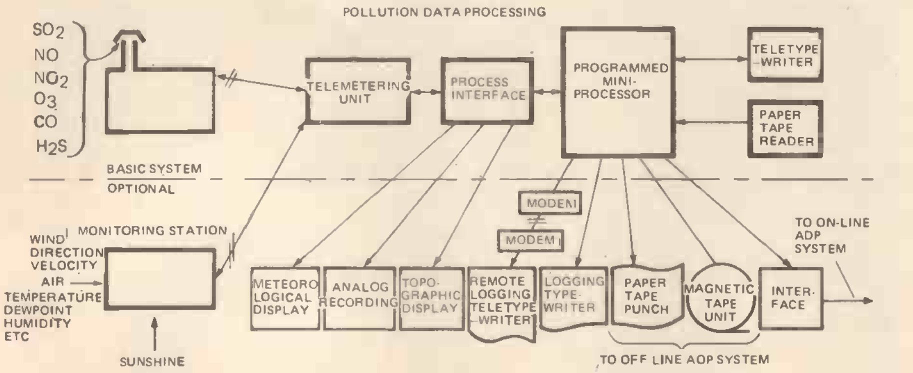
In essence, the system at Rijnmond consists of monitoring stations, detecting SO_2 placed at strategic locations over the city area (as shown in Fig. 1). Thirty-odd stations provide data on pollutant levels that are relayed back to a central control room (see Fig. 2). There, a small group of controllers visually watch the changing levels, accept public complaints by telephone, correlate the various information received and warn



5. Flow diagram inside a coulometric unit.

6. Performance specifications for the various gas pollutant sensors.

MODULES	SO_2		NO_2		NO		O_3		CO		H_2S	
	ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3
NOMINAL MEASURING RANGES	0,3 1 3	0,8 3 8	0,3 1 3	0,6 2 6	0,3 1 3	0,4 1,3 4	0,2 0,5	0,4 1	2 7,5 75 (200)	2,5 9 90 (250)	0,1 0,3 1	0,1 0,4 1
MINIMUM DETECTABLE CONCENTRATION	0,01	0,03	0,01	0,02	0,01	0,01	0,005	0,01	0,1	0,1	0,005	0,007
MAXIMUM ZERO DRIFT (24 H) NON CUMULATIVE	0,01	0,03	0,02	0,04	0,02	0,03	<0,005	<0,01	0,1	0,1	0,005	0,007
TIME CONSTANT (SEC) 63%	90		180		180		—		120		90	



7. Monitoring network having stored programme data processing for use in many-sensor systems.

factories in areas where levels exceed safe limits.

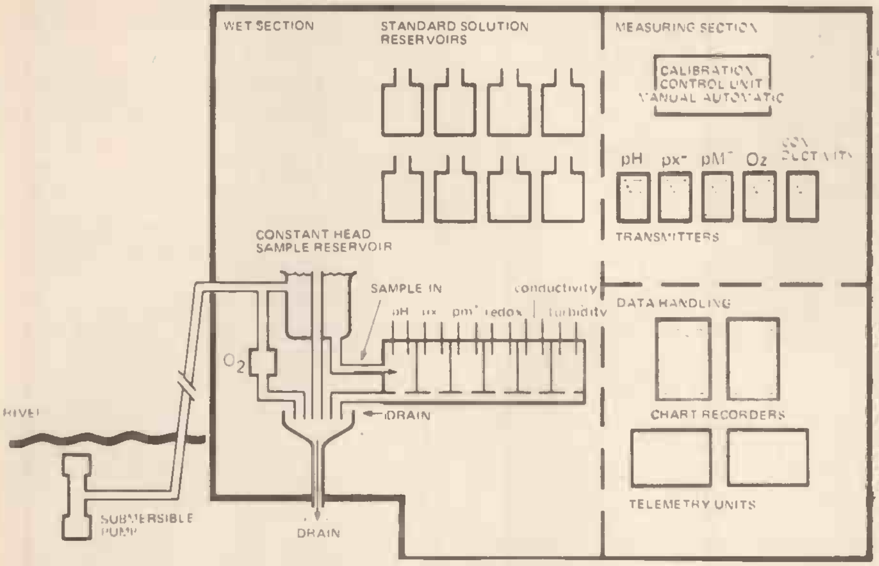
The network is represented by a mimic map in the central control room which has lamps placed at the corresponding locations of stations. Levels exceeding a preset value are indicated by the lamps, and the observers warned. Many lamps appearing as a group indicate that a relatively massive source has appeared. The preset levels can then be slowly increased to find the highest level,thus pinpointing the area. A quick phone call to an inspector — and remedial action is in progress within minutes. Already one Philips system has been instrumental in the closure of a refinery in Holland.

MONITORING THE AIR

Accurate measurements are the basis of successful air management. Because the major air polluting gases occur virtually independently of each other it is necessary to monitor them individually. (The level of SO_2 is regarded as a useful general purpose indicator but not a totally reliable one). Speed in measurement is important. Most cities already have monitoring services using manual data collection, but this method can take up to 12 hours or more to provide concentrated information. This is just not fast enough in many instances. For example, high speed factors such as weather conditions can change in hours from a safe cleansing situation to an unsafe situation where levels rise due to stagnation. So study of the problem of monitoring in cities adds up to the need for automatic, continuously operating, monitors having response times of minutes, reliabilities measured in weeks and capable of being centrally controlled. Let us now see how the Philips system fulfils these needs.

At the selected monitoring point there would be an instrument cubicle similar to that shown In Fig. 3. Outwardly, all that is to be seen is an air intake through which air is drawn by a small pump. Inside are a number of modules around 0.5 by 0.3 by 0.2m In size. Each is similar in respect to size and mountings, but has a different function to perform. It might contain a system for measuring a pollutant concentration, or power supplies, telemetry circuits or meteorological instruments. The actual number and type of the modules used depends on the requirements. Figure 4b is a block diagram of one of the modular measuring stations incorporating many different units. The drawing also shows a typical module.

Five of the possible six gas-measuring modules use the same coulometric principle to determine concentration



8. Schematic of water pollution monitoring station.

levels of SO_2, NO_2, NO, CO and H_2S. The sixth unit, for measuring O_3, uses chemiluminesence. Coulometry was chosen in preference to alternative analytical techniques, for it can be used to monitor a wide range of different gases with the same basic setup. It is also claimed to be more reliable over a long term — an important factor of the Philips system that can operate unattended for up to three months.

In the coulometric technique the gas of interest is bubbled through an electrolyte. A pollutant in the gas changes one of the components of the electrolyte and this is compensated by an electro-chemical reaction with a current proportional to pollutant concentration. A block diagram of the coulometric modules is shown in Fig. 5. Each module needs different pretreatment of the incoming gas — NO, for instance, is measured as NO_2 after oxidation. Specially designed selective filters ensure that such unit is sensitive only to the chosen gas. The Peltier cooling device is included to condense water back into the cell to maintain the level.

A special, three-way, flow switch enables the module to be periodically set; firstly to establish the zero of the cell output amplifier as zero mA.

(This is done by drawing air through a filter that removes all pollutants — thus providing pure air). Secondly, the tap is switched to draw this purified air through a standard source (a glass bulb containing pollutant gas of known concentration) where the 100% range of the cell output amplifier is set to be 20 mA. The output drifts less than 2% over a 24hr period following the calibration. Finally, the cell is piped to the incoming air and provides a signal proportional to pollutant concentration. This sequence, which is remotely initiated, ensures that the module is always calibrated, ensuring accuracy for legal validity.

The ozone module relies on the phenomenon in which light is emitted by Rhodamine B when it is exposed to O_3. The luminous intensity is proportional to the O_3 level but is, however, a low level effect requiring a photo-multiplier to sense it. This test is specific for ozone only. Research was needed in the development of this sensor to reduce the effects of the relative humidity of the incoming gas.

Measuring modules can detect concentrations as low as 0.005 parts per million (0.01 mg/m^3). Ranges have been designed in each case to cover expected levels of pollutants. They are summarized in the table of Fig. 6. The modules can be used independently, provided power and the intake pump are supplied.

HANDLING THE DATA OBTAINED FROM MONITORS

If there are only a few monitors involved, the data rate can easily be handled on locally-placed chart recorders. As the numbers rise, however, decisions must be made regarding the use of data, for it is not practicable to use numerous recorders. A system as large as that at Rijnmond, is best operated by continuously sending the signals of all cell modules back to the central control room in an on-line mode of operation. Telephone lines or microwave links can be used to relay the information via the signal processing units provided in each station. Within the CCR there is obviously a need for extensive and versatile data processing power to handle the incoming information effectively: a mini-computer is the natural trend. It is also vital to eliminate the topographical, meteorological and time factors that might otherwise bias the results. Warnings must also be given of excessive levels, these showing, perhaps, on the mimic diagram.

PARAMETER	MEASURING TECHNIQUE	MEASURING RANGES	*(zero) drift per day less than	*(zero) drift per 10 C variation in sample temp. less than
DISSOLVED OXYGEN	Membrane ampperometry	0-10; 30; 100% sat. O_2 0-3; 10; 30 ppm	1% f.s.d.	1% f.s.d
CHEMICAL OXYGEN DEMAND	Coulometry with zirconium cell	0-100; 300; 1000; 3000; 10.000 mg O_2/l	automatically corrected	—
pH	Glass electrode	2; 5 or 10 pH units span	0,1 pH	0.01 pH
CONDUCTIVITY	4 electrode cell	0-1; 0-3; 0-10 mg/l soluble salts 0.1; 0.3 mmho (and up)	--	0.5%
CHLORIDE	Ion selective electrodes	10^{-1} - 5 10^{-5}; mol/l	2 mV	—
FLUORIDE		1 - 10^{-5}, mol/l	2 mV	—
AMMONIUM		10^{-1} - 10^{-5} mol/l	1.5 mV	—
HARDNESS (pCa)		1 - 10^{-5} mol/l	2 mV	—
REDOX	Metal electrodes	—500 to 500 mV —100 to 100 mV etc.	1%	1% f.s.d.
TURBIDITY	Light dispersion	0-10 to 0-2000 ppm SiO_2	[illegible]	—
TEMPERATURE	Resistance thermometer	—10 to 30 C	negligible	negligible

* Figures given for drift are non-cumulative.

9. Performance specifications of the water monitoring sensors.

TOWARD A BETTER ENVIRONMENT

Considerable data storage is also needed to maintain runs of record for establishing long-term trends and for legal purposes. Options at the data-processing stage are many, ranging from simple direct recording, through fixed program arrangements to stored programs controlling large systems. Schemes available for a large network (with five to 250 monitors) are depicted in Fig. 7. The final choice has few restrictions: it depends upon the needs of the customer.

MONITORING WATER QUALITY

One estimate suggests that the demand for clean fresh water rises at about five percent per year. Discharge of used water is also rising and, as with air, water can become contaminated without obvious evidence. Again, the only satisfactory approach is to monitor various parameters. Philips have also developed water monitoring stations that can be linked to a central control room if need be. Parameters of interest might be the dissolved oxygen (DO) level, chemical oxygen demand (COD), pH, conductivity, level of concentration of the various specific ions, redox potentials, turbidity and temperature.

A typical water pollution station is shown in Fig. 8. The pump continuously feeds sample water to the row of measurement cells and to the oxygen monitor (that uses a different principle). As with the air sensors, the designers have incorporated remotely controllable switches that fill the sensors with standard solutions to define the 0 and 20 mA signal levels. A list of parameters monitored and the attainable precision and stability of measurement is given in Fig. 9. It is not practicable (as yet) to monitor all of the variables with a single principle to the same extent as the coulometric method. This increases the difficulty of obtaining long-term reliability: these monitors need fortnightly attendance.

Telemetry uses the same techniques as found in the air monitors.

BACK NUMBERS

A limited quantity of back numbers of Electronics Today International are available at 25p each plus 7p postage (32p in all). Requests for these should be addressed to:

BACK NUMBERS DEPT.,
Electronics Today International,
36 Ebury Street,
London SW1W OLW

HOW IT WORKS

The input signals are attenuated as required by RV1-RV4 before being summed by amplifier IC1. The gain of IC1 is determined by the value of the resistor in series with each input. The value of this resistor must be at least five times the value of the input potentiometer otherwise input impedance will change with variations in the potentiometer setting.

For dynamic or electret microphones (250 or 600 ohm) a 1 k potentiometer and a 22 k series resistor will provide full output with an input of 2 millivolts. For guitar inputs a 47 k potentiometer and a 220 k series resistor will provide full output with 20 millivolts input and an input impedance of 47 k.

Amplifier IC1 is followed by conventional tone controls and a further amplifier IC2 in which RV7 alters the gain and hence is used as the master volume control. This stage is configured as a positive, or in phase, amplifier in which a gain of less than one cannot be obtained. However the gain variation of 37 db will be found adequate for most purposes.

Two different power supplies are described. The first is a separate mains supply (where the unit is to be built into a separate box) which is simply a 12.6 volt CT transformer rectified to provide ±9 volts for the ICs. The second is used where the unit is built into the 100 watt amplifier and derives its supply by resistively dividing down the power amplifier supplies.

MIXER PREAMPLIFIER

Simple yet effective unit is specifically intended for use with our 100 W guitar amplifier.

OUR 100 watt guitar amplifier, ETI 413, has proven to be extraordinarily successful. A very large number have been built, and are in use in conjunction with the 8 channel master mixer for which it was specifically designed.

There has also proven to be a large demand, as evidenced by letters to parts suppliers and to ourselves, for a simple preamplifier to be used with the guitar amplifier. This project describes such a preamplifier, which may be built as a separate unit, or within the 100 watt amplifier as desired.

The basic preamplifier may have up to four inputs, each with separate volume control, and the sensitivity and input impedance of each can be tailored to suit individual requirements. The inputs are mixed in a summing operational amplifier and the combined signal is then operated on by a common set of bass and treble controls.

A master volume control is provided so that the level of the combined signal may be varied. Although specifically designed for the 100 watt amplifier, this unit is very flexible and may be used as a separate general purpose mixer/preamplifier.

PARTS LIST

R1	resistor)		
R2	")See text		
R3	")and Table I		
R4	")		
R5	" 470 k	½ Watt 5%	
R6	" 2.7 k	" " "	
R7	" 12 k	" " "	
R8	" 1.8 k	" " "	
R9	" 3.3 k	" " "	
R10	" 470	" " "	
R11 *	" 2.7 k	" " "	
R12 *	" 1 k	" " "	
R13 *	" 1 k	" " "	
R14 *	" 2.7 k	" " "	

* dc powered version only

RV1	potentiometer)	
RV2	") See text	
RV3	") and Table I	
RV4	)	
RV5	"	250k log.

C1	capacitor)
C2	") See text
C3	") and Table I
C5	33 pF ceramic
C6	0.0022µF polyester
C7	0.022µF "
C8	0.022µF "
C9	0.22µF "
C10	33 pF ceramic
C11	1µF 25V tag tantalum
C12	47µF 16V electrolytic PC mount
C13	47µF 16V " " "
IC1	integrated circuit LM301A mini-dip or T03
IC2	" " LM301A mini-dip or T03

PC board ETI 419
* Transformer
* D1-D4 diode 1N4001 or similar

* 240 volt ac version only
Plugs, sockets, knobs to suit individual requirements.

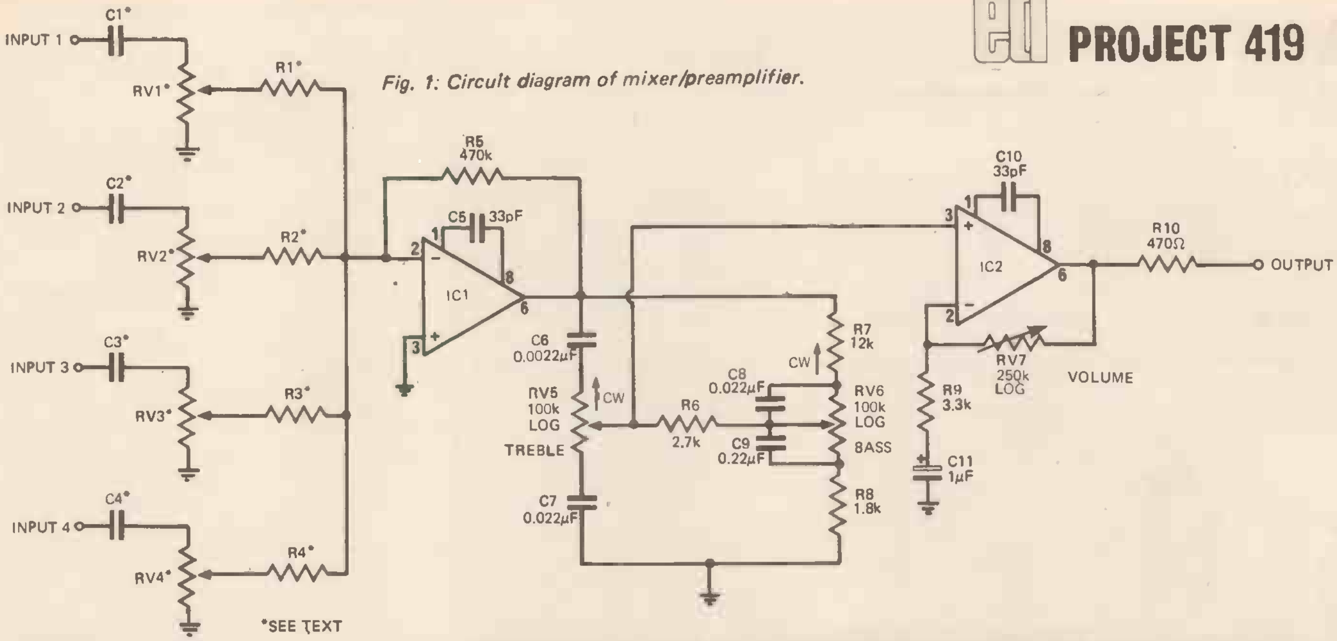


Fig. 1: Circuit diagram of mixer/preamplifier.

CONSTRUCTION

We mounted our prototype unit within the existing 100 watt amplifier: This is a simple and neat method of housing the unit, but has a limitation in that there is only room for two sets of input channel controls – so if this arrangement is used, R3 and R4 should be omitted from the printed circuit board.

Apart from limitation of space, due to the proximity of the power transformer, mounting the unit within the main amplifier increases the possibility of hum pickup. This may be minimized by using twisted leads or shielded cables for wiring to the controls and using a single earth only for the preamplifier, namely the shield of the input cable to the main amplifier. In addition the input sockets should be of the insulated type to prevent earth loops. If the insulated types are unavailable, then standard types may be mounted on a piece of bakelite or fibreglass board. These precautions will enable a hum level of –65 dB to be obtained.

If the unit is constructed in a separate box with its own power supply a much lower hum level should be realised. In this case the resistors shown in Fig. 3 are omitted from the board and the power supply of Fig. 2 should be used. In the latter case diodes D1 – D4 are mounted on the board.

Mount the components to the PC board in accordance with the overlay applicable to the ac or dc version as required. Ensure that ICs and capacitors are correctly orientated.

Select values for the input components from Table I depending on your individual requirements. We used a 1 k microphone input and a 47 k guitar input on our prototype.

SPECIFICATION
(when used with ETI 413 amp)

Number of inputs	4
Input level	
Input impedance 1 k	2 mV
" " 47 k	20 mV
Distortion	
at 80 watts	< 0.5%
Tone control range	
bass	± 10 dB at 100 Hz
treble	± 10 dB at 10 kHz
Master volume control range	37 dB
Hum level	
referred to 100 watt output	–65 dB
Noise level (excluding hum)	
referred to 100 watt output	–75 dB

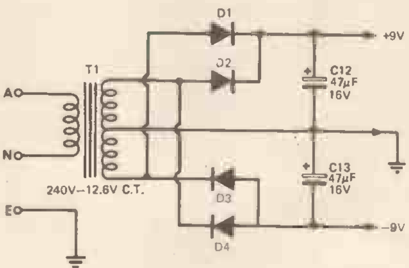


Fig. 2. Power supply for preamplifier as a separate unit.

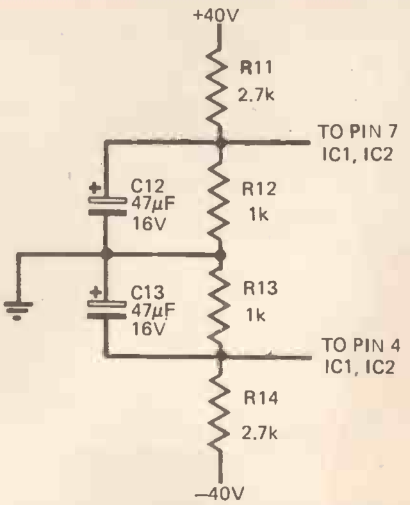


Fig. 3. Divider network; resistors as shown are fitted to PC board if 100 watt amplifier power supply is used.

MIXER/PREAMPLIFIER

TABLE I

APPLICATION	RV1	R1	C1	SENSITIVITY
Microphones (600 or 250 ohms)	1 k log	22 k	4.7μF	2 mV
Microphones or guitars (47 k)	47 k log	220 k	0.1μF	20 mV
Crystal microphones, line inputs, ceramic pickup etc	1 M log	2.2 M	0.1μF	200 mV

The preamplifier is mounted in the bottom of the existing power amplifier and the controls and input sockets on the right-hand side.

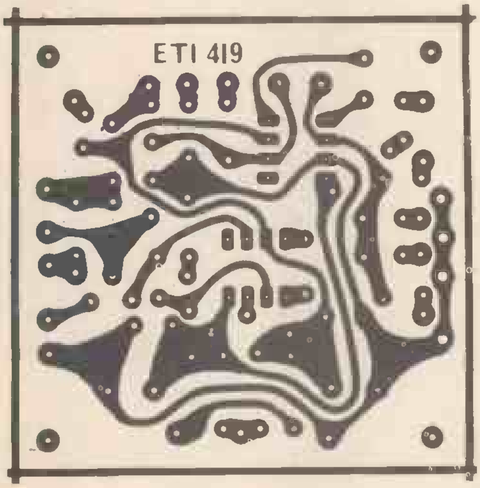
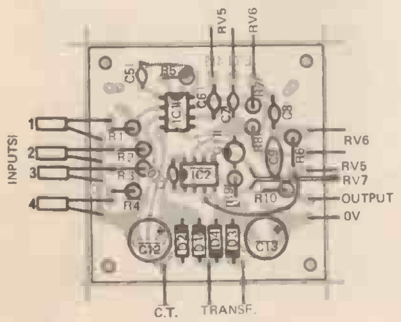
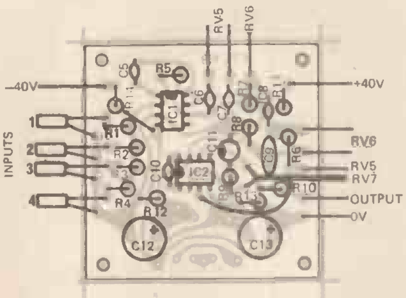


Fig. 4. PC board layout (both versions).

Fig. 5, Bottom left: Component overlay for ac powered preamplifier.

Fig. 6, Bottom right: Component overlay for preamplifier powered from 100 watt amplifier supply.





NUCLEAR FALLOUT

continued from page 17

exposure to radioactive debris less than a day or so old.

Such exposures are most unlikely to result from bomb tests, as steps are taken to minimise local fallout, and populations are excluded from the danger zone. In general we need only consider the doses from intermediate and world-wide fallout. It has been shown above that the doses of radiation are relatively small, although during heavy testing children may receive almost as much again as the natural background for periods up to one year. In the long term everyone gets 5-10 percent more background radiation. It is a matter for debate whether such levels will cause harmful effects.

These levels of extra radiation are clearly insufficient to cause death in the short term.

Possible additional risks are mainly bone cancer, leukemia and other blood disorders from radioactive strontium in bones; cancer of the thyroid from iodine irradiation; general cancers from increased overall background; increased genetic defects from increased exposure to the reproductive system.

There are two schools of thought regarding the potential dangers: some believe that a distinct amount of threshold of radiation must be exceeded to produce these effects. Others maintain that there is *no* threshold, that any increased radiation exposure is potentially harmful.

The problem is a difficult one. Current evidence seems to suggest that there is no threshold. This then suggests that some proportion of cancers, leukemias, genetic defects are precipitated by the natural radiation environment, and the number of cases will be increased by any additional exposure to radiation. However, given the fallout doses mentioned above, this increase will be a small percentage, and it will be well nigh impossible to distinguish the cause in individual cases. Only careful statistical studies will be able to confirm that there has been an increase in the number of these disorders in whole population.

LINEAR ELECTRIC

From heavy transport systems to laboratory chart recorders, the linear motor is revolutionizing design.

THROUGHOUT the history of technology many devices have been invented, publicised for a while and then forgotten, only to be reinvented or popularised many decades later. Looking back on their original lack of acceptance and eventual rise to dominance we can often remark (with hindsight, that is) that they were the obvious best choice in the first place and should have emerged then, not having been delayed until now.

Many examples of this phenomenon exist. The electric car is one. In the late 1890s a number were built (Porsche designed one for the Prussian army that had hub motor drives and regenerative braking). But electrics were ousted by the internal combustion engine, an alternative that rapidly became so well developed from the manufacturing viewpoint that many other undesirable factors were soon outweighed in the economic

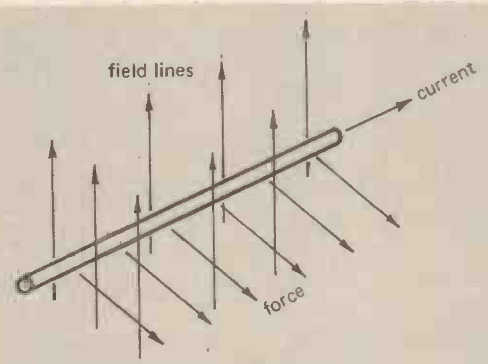


Fig. 1. Relative directions of current, field lines and resultant force — the basic principle of all electric motors.

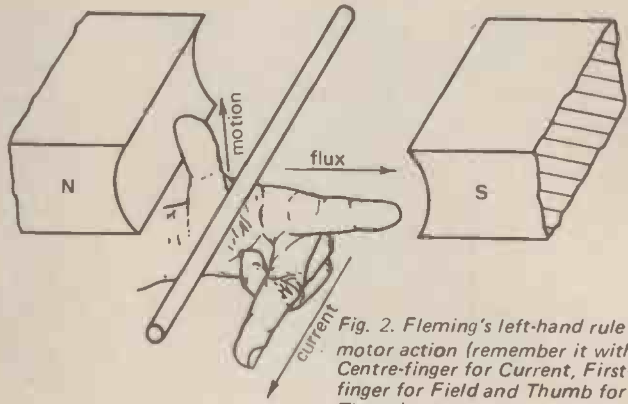
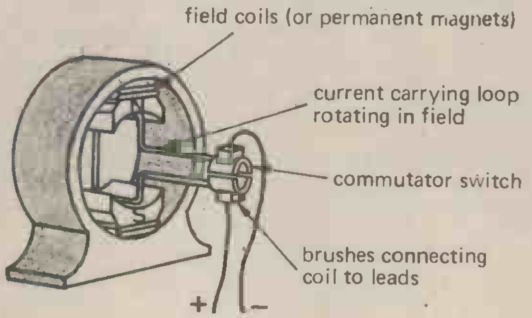


Fig. 2. Fleming's left-hand rule for motor action (remember it with Centre-finger for Current, First-finger for Field and Thumb for Thrust).

Fig. 3. The commutator of a dc motor ensures that the force exerted on the loop is unidirectional.



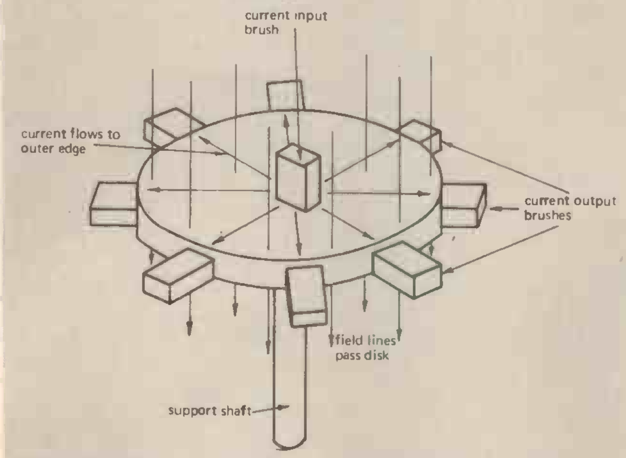


Fig. 5. Schematic of a homopolar machine running as a motor.

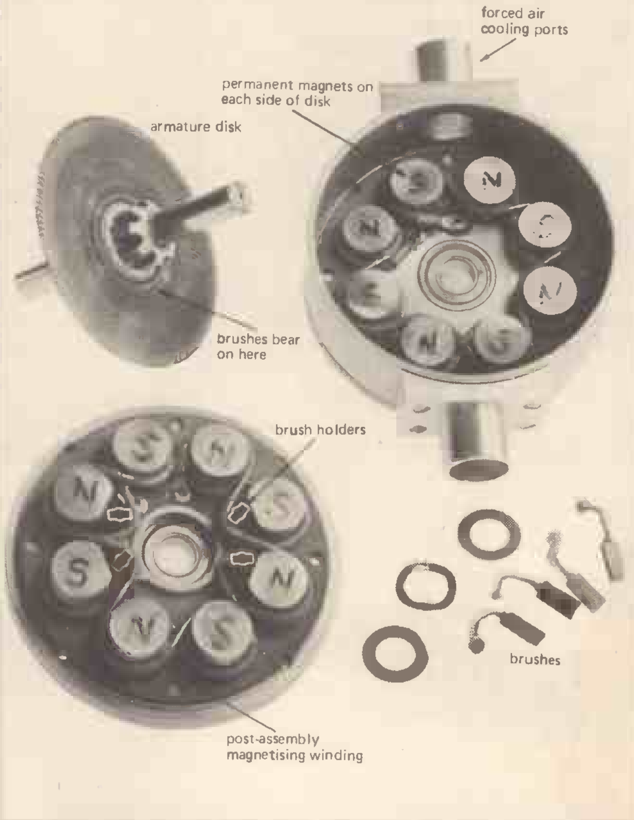


Fig. 4. Exploded view of printed armature winding motor.

MOTORS

by Dr. P.H. Sydenham

decision to produce an alternative form of propelling transport vehicles.

Electric motors are another example of the absence of logical basic development — it has taken over a century for simple forms of motor to emerge like those originally proposed by the founders of electrical knowledge.

Such aberrations of logical technological progress are not always brought about by the lack of technology available to the designer. It is more a case of the designers being able to break loose from subconscious traditional design constraints, and not always assuming that a design built from sophisticated technique and deep understanding will be a winner. The seemingly impossible may, in fact, be possible even though experience *suggests* it is not. Thought processes and paper-studies are not enough — they must be combined with practice. The development of electric motors is full of these lessons.

In normal usage the term electric motor implies, without further thought, that it is a machine that provides rotary torque from a shaft — after all, electric motors providing linear force have never made the scene until recent years.

To provide a linear motion from these rotary machines it is necessary to add a mechanical, hydraulic or pneumatic converter to get from rotation to translation. Power hacksaws use a crank to reciprocate the blade; chart recorders often use a wire around a pulley, or a rotary pointer combined with a linearizing linkage; presses use a piston ram. Effort has seldom been expended on designing a linear electric motor to avoid the *need* for racks and pinions, cranks and tapes/wires around drums.

In this last decade we have become more aware of the promotion and application of various forms of linear electric motors, with the accent on their use in transportation. Principles used in linear motors are not more complex than those of rotary motors. In fact, they are the same. Furthermore, linear versions are able to realise the fundamental ideas more simply in practice. It is hard to understand why the 'obvious' remained untapped for so long.

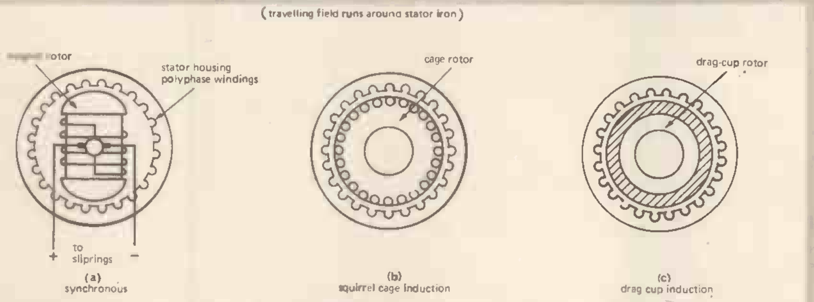


Fig. 6. The travelling field of ac machines is harnessed in various ways.

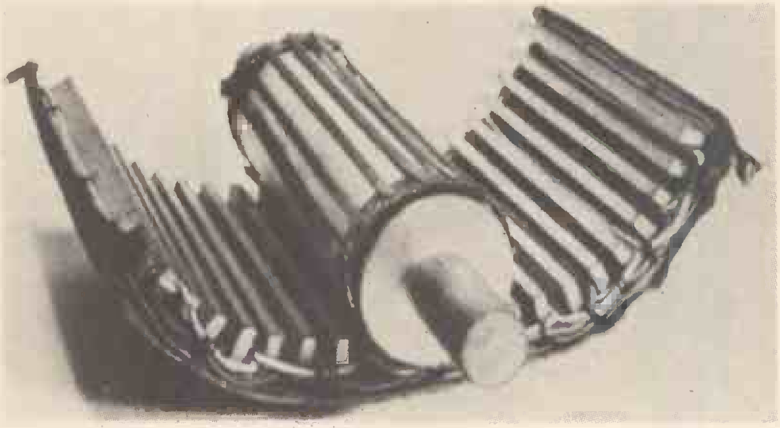


Fig. 7. Unrolling the rotary polyphase motor to yield the one-sided linear form.

FUNDAMENTALS OF ELECTRIC MOTORS

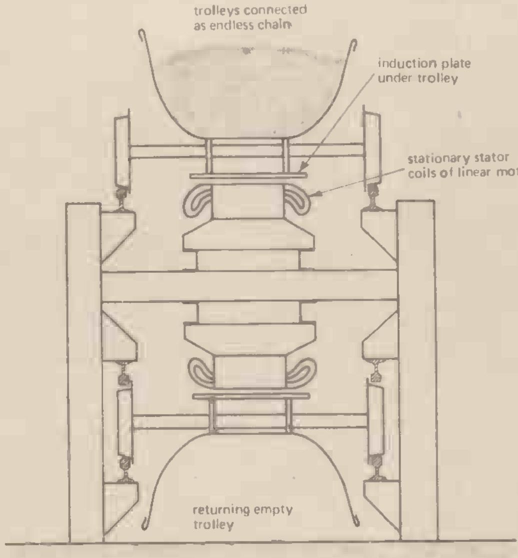
In order to comprehend the various styles of linear motor and their development we must get back to the basic principles invoked.

In 1812 Michael Faraday showed experimentally that an electric current flowing in a wire would cause it to react against a magnetic field producing rotary mechanical motion. By 1831 (about the time that Stephenson's "Rocket" raced along at the record speed of 40 miles per hour to win a place for steam-powered trains, and at the time when convicts formed chain-gangs in Van Diemens Land) Faraday had developed the laws of electro-magnetic induction which form the basis of understanding electro-mechanical machines. Joseph Henry also discovered the laws in the same year and he went on to build the first practical electric motor. There was nothing in the law of electro-magnetic induction that restricted its use to rotary motion. The electric motor is in fact a linear force producing mechanism.

By 1837, Davenport was using an electric motor to drive tools in a workshop. Two years later, Jacobi used one to propel a small boat along the Dnieper River in Russia — we still haven't taken up this idea except in submarines and scuba-divers' craft. There was no lacking of applications for electric power.

Early motors made use of direct current — the first use of a travelling field, made possible with polyphase ac currents, came in 1885. Regardless of whether dc or ac is used, the fundamental principle is the same — a combination of current and magnetic field produces a force. (as shown in Fig. 1). Electrical energy is converted to mechanical.

When a conductor is moved at right angles to the lines of a magnetic field (produced by permanent or electrical means) a current is induced in the conductor. Somewhere in history the Fleming right-hand rule was coined to express the relative directions of this generator effect. A left-hand version,



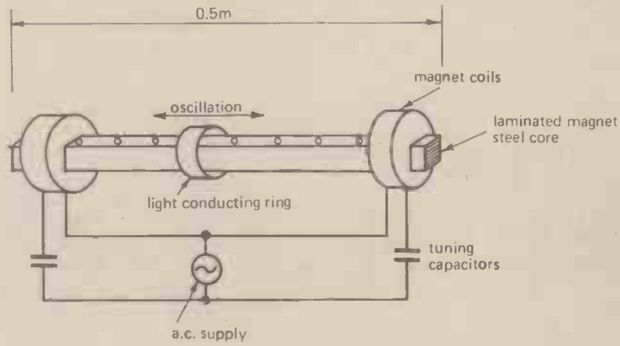


Fig. 9. Horizontal form of the ac oscillating linear motor.

Fig. 8. Cross-section of the Gardanne coal handling plant.

LINEAR ELECTRIC MOTORS

shown in Fig. 2 works for motors. This rule, combined with a simple mathematical expression relating force produced with current, field strength and length of conductor in the magnetic field, enables electric motors to be designed and built with reasonable ease and accuracy of prediction. Although the principle of motor action is the same in all cases the practice varies considerably when it comes to harnessing it to the real world.

Actually in a motor (or generator) both motor and generator effects occur together. In the motor, the generator effect produces what is known as a back-emf (electro-motive force). Back-emf must be allowed for in the design: it does not defeat or nullify the motor action but does curtail it. The net difference, however, produces enough current to provide useful linear force. The efficiency of the energy conversion is high; back-emf is not a particularly wasteful problem.

A current-carrying conductor in a magnetic field will keep moving across that field until it leaves the area of concentrated field lines. The easiest way to provide a continuous force action, wherein the conductor is always in the field, is to have a loop of wire rotating in a circular field space, using a switch to ensure that the current flows the right way in the loop at all times. In this way a unidirectional torque is produced. The switch is called the commutator in a dc motor. It is shown in a simplified manner in Fig. 3. The simplicity of a rotary motor — ease of switching, ease of air-gap control in the magnetic circuit and ease of flux concentration — probably accounts for rotary motors having been developed instead of the linear versions that are now coming into use.

The laws of magnetic circuits show that flux is best concentrated by containing it in a magnetic circuit, where possible keeping the airgaps as small as is feasible. For this reason early motors soon incorporated a rotating magnetic support for the rotating windings, and this has been carried down to us as the normal design procedure.

It was only in the 1960s that new motors appeared, in the form of printed-wiring armature motors (one is shown in Fig. 4) using no iron in the armature. These high performance motors can also be made using a potted free-standing winding that is connected to a commutator — a method that could have been used at any time in the past. Air-cored motors, such as these, are simpler to build and have far greater ability to accelerate a load than the cylindrical forms. They are a big step forward (or is it backward) towards realisation of the basic principle. One type of dc motor — the homopolar motor (or generator) — is even more basic than these. It uses a conducting disc that has current passing from the outer edge to the centre — see Fig. 5. A field, applied through the disc. reacts with the current's field — thus providing motor action. Few motors have used this principle (that is, until recent times) for they have an extremely low resistance armature circuit resulting in a motor that is typified by very high currents and low voltages. This does not suit most sources of dc energy.

But they do exist — the biggest of all is probably the generator version used by the School of Engineering Physics at the Australian National University. Their generator consists of 10 m diameter disks of steel, 250 mm thick, that have banks of brushes at the centre and periphery. These discs are spun up to speed to store energy in kinetic mechanical form. The generator is then virtually short circuited (a field is applied through the discs) into various experiments to study effects at extremes of power. (It stores around 500 MJ and can sustain mega-amperes for durations of a second).

In this decade we have seen the manufacture of the first superconducting homopolar motor. Superconducting windings are also high current, zero voltage devices so the homopolar motor is the logical choice if cryogenic technique is to be applied. Superconducting systems seem certain to become everyday reality in this decade — we have, therefore, gone around the loop arriving right back at the motors that the nineteenth century scientists probably envisaged a century ago.

In the rotary dc design of motor the commutator is a component worth eliminating on grounds of reliability and cost. A polyphase ac supply can be used to produce a travelling field without the need for a switching mechanism. The minimum number of phases needed is two, but the three-phase system is more commonly used. The stator of a three-phase ac motor has three sets of coils embedded in the iron circuit. These are placed at 120 electrical degrees to each other, and fed with sinusoidal currents from the three supply lines (that also are out-of-phase with each other). Field strength at a point on the stator is the total instantaneous effect of the currents in the three coil sets and it is easy to show that the maximum field force actually travels around the stator with time, moving at the synchronous speed, (for a two-pole machine on a 50 Hz supply, this is 50 revolutions a second). It is as though magnet poles are rotating in the stator space. This effect is easily demonstrated — a ball bearing placed on the inside surface of a three-phase stator (energised at a reduced safe voltage) will run around the stator following the moving poles.

It is also possible to obtain the travelling field in single-phase motors, but they need special starting arrangements to run the rotor up to speed.

There are a number of ways to harness the travelling field in order to produce torque. The most obvious, but not the cheapest, is to have an armature that consists of a magnetic pole-pair that can rotate, following the field as shown in Fig. 6(a). This is the synchronous motor — small units actually incorporate a permanent magnet, larger ones an electro-magnet fed via slip/rings. A synchronous motor, however, must be run up to speed to a point where the rotating magnet is synchronous with the travelling field 'magnets' so that it can lock in.

There is another way to utilize the travelling field. In the induction motor, a very low resistance, high current capacity, electrical conducting cage, see Fig. 6(b), is made inside the slots of the iron rotor — it is usually of copper or cast aluminium. This squirrel-cage (the popular name for this) is a short-circuited winding and it, therefore, has currents induced in it by the stator field. The induction motor operates by virtue of these induced magnets in the armature reacting with the travelling field. A most valuable feature of this method is that it can produce torque from standstill to quite close to synchronous speed. (It does not quite approach synchronism, for a lag is required to induce sufficient current to overcome the load torque).

It is polyphase motors of these types that have attracted the most attention of linear motor designers — for, to date — they seem to offer the cheapest way of obtaining linear propulsion where long fixed tracks are involved.

LINEAR MOTORS FOR TRANSPORTATION

We have spent some time describing the principles of rotating motors in order to develop a background, for this is the path through which motor designers have passed.

We will see that there are more types of linear motors than the many articles on transportation drives suggest. Firstly, then, motors for transport.

The squirrel-cage rotary induction motor normally has a distinct winding on the rotor (in the form of coils or bars) but it is also possible to use a continuous cylinder of conducting material as shown in Fig. 6(c). These are known as drag-cup rotors. Imagine a very large diameter cup type motor. This could be 'cut' and rolled-open producing a flat magnetic circuit which has imbedded stator coils and a conducting plate formed by the opened up 'cup'. Normally the latter moves relative to a fixed winding but in transport motors it is sometimes more convenient to build the conducting sheet on the track surface, and then move the coils.

Many alternatives exist — single sided (as would be produced by unrolling a rotary motor) double sided, conventional flux and, more recently, transverse flux motors. We need not dwell on these, for this issue also includes an article on transport motors by the leading British designer, Professor Eric Laithwaite of London's Imperial College.

It is interesting to watch the development of motors under the direction of Laithwaite. In recent years he has written a number of papers (see reading list) that illustrate how the inventive mind operates. He has traced his ideas from the reasonably obvious step of 'unrolling' the induction motor (his model for demonstrating this is pictured in Fig. 7) through to his current topological era in which he and his colleagues visualize motors as basic interacting shapes of magnetic and current loops. This approach has led to several new designs not made obvious by normal means.

Linear induction motors have many uses. At MIRA (Motor Industry Research Association) they use one to accelerate a mass of 3500kg, (a car body, perhaps) to impact at 30 m.p.h. as part of a structural and impact studies. Chain-conveyors have already been made to replace the noisy mechanical units used in production lines. The French have a bulk, coal-handling, facility in the prototype stage; a coal mine in Gardanne uses it to shift several hundred tonnes of coal per hour over a distance of 500 m. A cross-sectional view of the continuous bulk-handling equipment is given in Fig. 8.

Yet another idea being worked on is to drive a flat conveyor belt via a conducting surface on the underside.

One very intriguing application summarized by Dr. Michel Poloujadoff (he is another world leader on the design and application of linear induction motors and works at the University of Grenoble) is a two-axis positioning system for automatic movement of pallets or cars in store. The proposed floor has square elemental cells in which motor windings are built to provide motive force in the two perpendicular horizontal directions. A suitably made pallet placed on the floor can be made to move over the surface to any square. It is envisaged that this could be used to store 99 cars in the space of 100 whilst retaining the same ease of access. (Have you ever tried to solve those little number puzzles where one space is left and the numbers have to be slid around to get a special order — such a car park would need to be computerized if this claim is to be met). Poloujadoff has written two excellent review articles on linear induction motors — these are also listed.

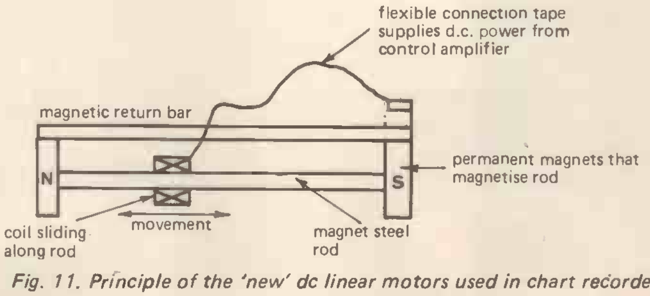


Fig. 11. Principle of the 'new' dc linear motors used in chart recorders.

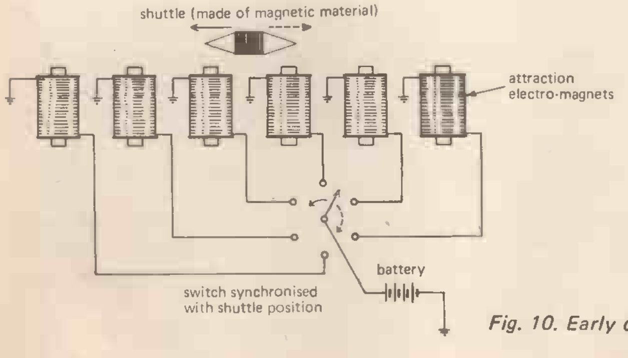


Fig. 10. Early dc form of linear motor controlled with commutating switch. (1895)

LINEAR ELECTRIC MOTORS

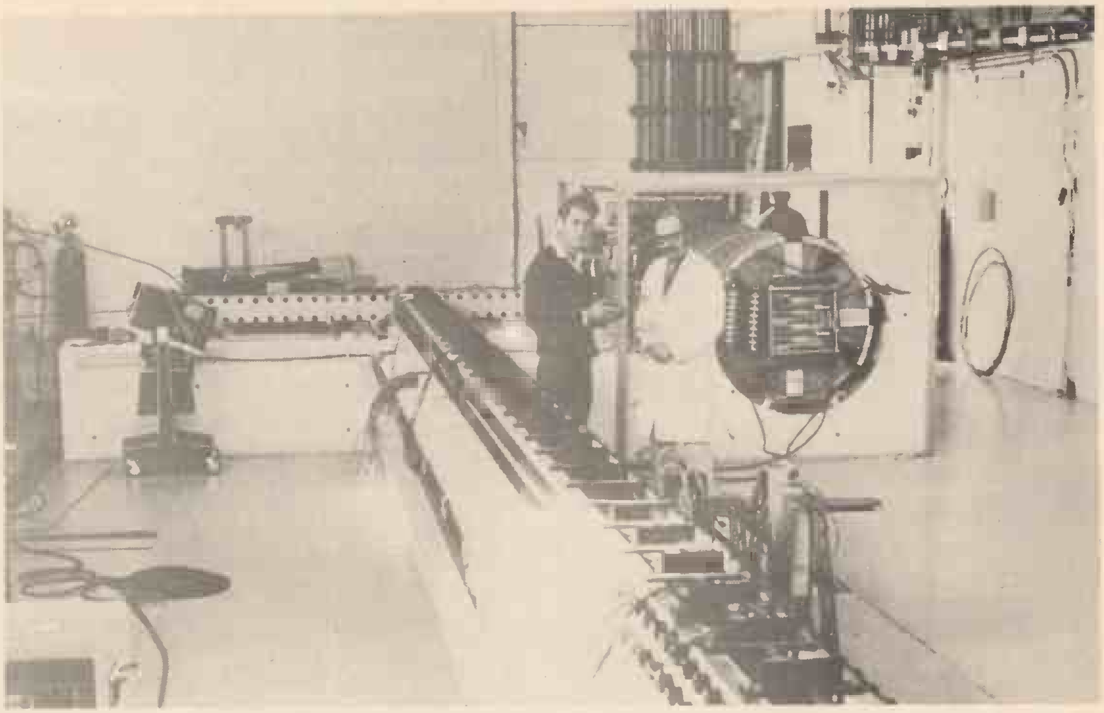


Fig. 12. Railgun for driving copper projectiles up to 2 Km.s^{-1}. The storage inductor is the round coil in the centre left. The rail switch runs across the rear with the railgun coming to the foreground.

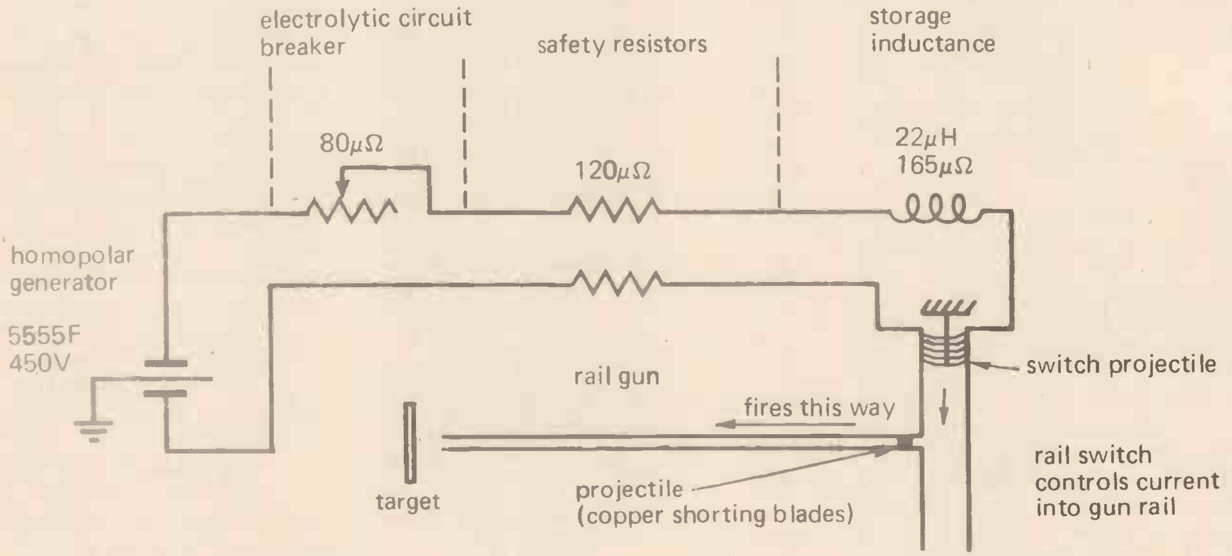


Fig. 13. Schematic diagram of the ANU railgun. Current drawn from homopolor generator is stored in 22μH inductor. Switch projectile is held back until peak current is reached. It then flies down the switching rails, crossing the rail gun opening at 300 ms. The main inductor current is thus transferred suddenly into the rail gun.
Field around rails at maximum 500 kA current is 600 k gauss. Acceleration of projectile is 50 million G!

OSCILLATING AC LINEAR MOTORS

The ac linear motors discussed so far are capable of providing infinite travel, running on until the stationary induction or plate windings end. If oscillatory motion is desired, switches are needed to reverse the thrust and this introduces more complications.

Another principle exists that provides rapid reciprocating action (for ranges to a metre or so) without the need for switching. So far, however, the method is unable to provide much power, but the principle is inherently fascinating and does find some use — applications suggested mainly include weaving shuttle drives. The construction of the motor is incredibly simple.

A vertical action motor consists of a long slender stack of magnetic iron laminations with a coil wound around the bottom. An electrically conducting ring placed over the iron will float (when the coil is energised with ac) by virtue of the induced currents producing a second magnetic field that reacts with that of the main coil. This causes the ring to lift to a stable place. This motor will not oscillate continuously, but only in a damped mode, settling to rest after a few overshoots. If, however, the coil is tuned to resonance with a capacitor, there is no stable position — the ring moves towards the coil increasing the resonance current that repels it, as it moves away resonance also falls away, reducing the thrust and so on.

The same idea works for a horizontal motor (see Fig. 9) except that a second tuned coil is placed over the other end to provide the restoring force provided by gravity in the vertical motor.

The force exerted by these motors

has been limited to-date by the heating of the short circuited ring – a higher current ring weighs more and so there is little gain. A workable motor once built by the writer to a design by West and Jayawant – see reading list – consisted of 2000 turns of 0.5 mm diam. wire tuned with 19μF to resonate the 0.7 H coils on a 50 Hz supply. The 0.5 m long core was built of laminations to a section of 25 by 25 mm. Oscillation occurs at around 100 V (where the coils draw 1 A each) and a light aluminium or brass ring reciprocates from between 400-800 traverses per minute.

There has apparently been little further development of these motors since their fortuitous discovery in the 1960s. (History has it that magnetic levitation was being studied with an untuned coil. It was decided to tune the coil to increase the current. The resulting oscillation was quite unexpected).

DIRECT CURRENT LINEAR MOTORS

Much has been and will continue to be said about the ac linear motor: this might lead the designer to assume that linear dc motors are impracticable. But study of the basic motor law of current in a field shows that the dc motor is also a distinct possibility.

Suggestions for linear motors, as depicted in Fig. 10, were dc coils switched in turn with a linear commutator. The simple idea of an electromagnet sliding along a magnetised bar escaped attention until this decade. Several chart recorder manufacturers are, right now, extolling the virtues of their new 'revolutionary' linear pen drive motors – in reality they consist basically of a coil of wire sliding on a round bar that is magnetised by permanent magnets at each end, as shown in Fig. 11. The iron circuit is closed with a flat bar. The coil is connected to the end with a printed wiring tape, through which a dc current is passed causing it to either attract or repel from the permanent field forcing it to move one way or the other. Traverse times for a 0.25 m stroke are around 200 ms. The sheer simplicity alone makes them superior to the earlier used, rotary drive systems and there is the further advantage that the drive element is directly connected to the pen, reducing backlash errors. Yet another instance where the obvious has been completely overlooked in motor development.

It might be thought that this is the simplest dc motor that can be devised. If, however, we return to basic operation we remember that a single current – carrying conductor moves perpendicular to field lines. A dc linear motor using just this has been built and it has some unusual performance figures.

It consists of two closely placed copper rails in which a sliding copper contact can run. This latter component acts as a shorting-bar. When high currents are fed to the rails a field is created around the rails and around the contact. The two react, pushing the contact along. This is the principle of the railgun, shown in Fig. 12. The enormous energy of the homopolar generator (mentioned earlier) is stored in a 22μH inductor that releases 2.5 MJ of energy for just 150 mS. The 0.1 gm copper projectile accelerates down the rails to impact onto a target at 100 000 ms. The force on the projectile is 50 000 N. A similar 'gun' principle is used to switch the current into the gun rails. A 50 x 10^6 G schematic circuit of the equipment is given in Fig. 13.

Obviously these engineering-physicists are not studying new transportation motors! The experiment is to provide a test facility for creating pressures (at impact) akin to those found in the core of the earth.

The parallel of this linear version with the rotary homopolar motor is striking, for it too has basic simplicity and low-impedance characteristics that might be right for us with superconducting conductors. Perhaps this is really the form future linear transport motors will take – not the ac versions currently being popularized. Who knows, only time will tell!

THE LATEST DEVELOPMENTS

The most recent development to emerge from the Laithwaite and Eastham team is a simple method that provides both linear motor drive with magnetic levitation – with the same common magnetic circuits and coils. They have coined the phrase 'magnetic river' for their idea. In its conceptual form it appears as in Fig. 14. The U cores provide stable levitation of the upper aluminium plate with the transverse flux propulsion motor. The magnetic river is still to be improved. Development of this form, like the discovery of the linear oscillating motor, was also largely fortuitous, for a wrong connection led to the realisation of stable levitation – which was unpredicted. This dual concept could be a rival to superconducting levitating systems.

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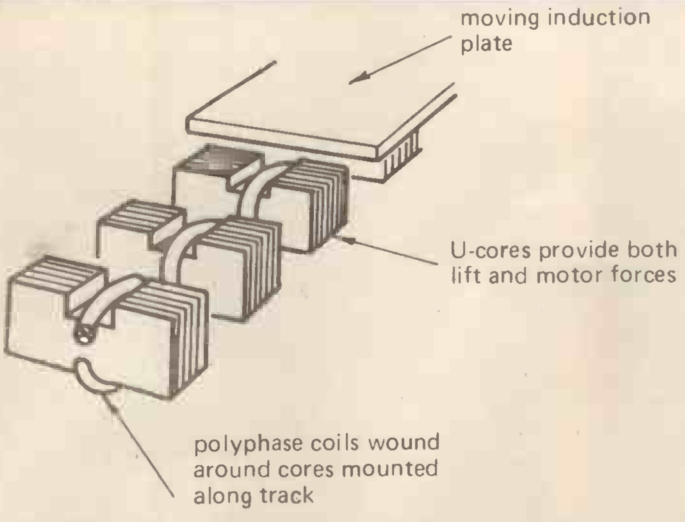
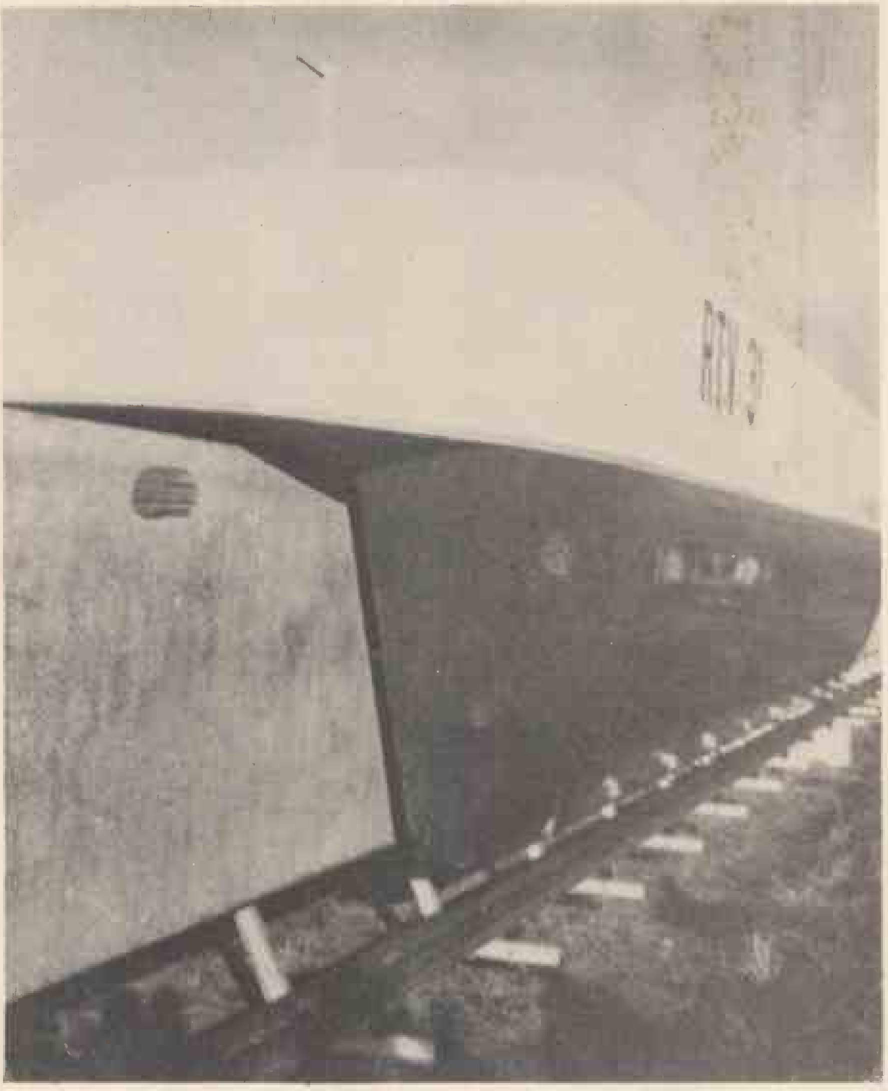


Fig. 14. This combination of U-cores and aluminium plate provides both lift and thrust using the 'magnetic-river' principle.

LINEAR MOTORS

by Professor E. R. Laithwaite, Imperial College of Science & Technology, London.



The British experimental tracked hovercraft powered by a Laithwaite linear motor travelling at speed during trials. Early in 1973 the unmanned experimental vehicle achieved 107 mph on a one-mile stretch of track, subsequent development of magnetic levitation has subsequently caused the hovercraft principle to be abandoned (for this type of transport) but has not affected the principle of linear motor propulsion.

It is now certain that future high-speed ground transportation will be provided by magnetically levitated vehicles.

Here Professor Eric Laithwaite describes recent developments in the new and exciting technology involved in high-speed transportation research.

THE linear electric motor is believed to have been invented around the middle of last century, but it was little more than a scientific curiosity until comparatively recent times. Now many uses are being found for it, in step with marching technology. Conventional, cylindrical induction motors produce rotary motion and are easily the most popular forms of electric drive, owing to their contactless, brushless, intrinsically robust design. The linear type, which is basically a rotary motor unrolled into a flat form, has all the virtues of the cylindrical machine and functions in an equivalent way to produce a straight line drive.

The idea of effectively 'unrolling' a rotary electric motor so as to produce linear motion directly is quite an old one, in terms of the advances made in

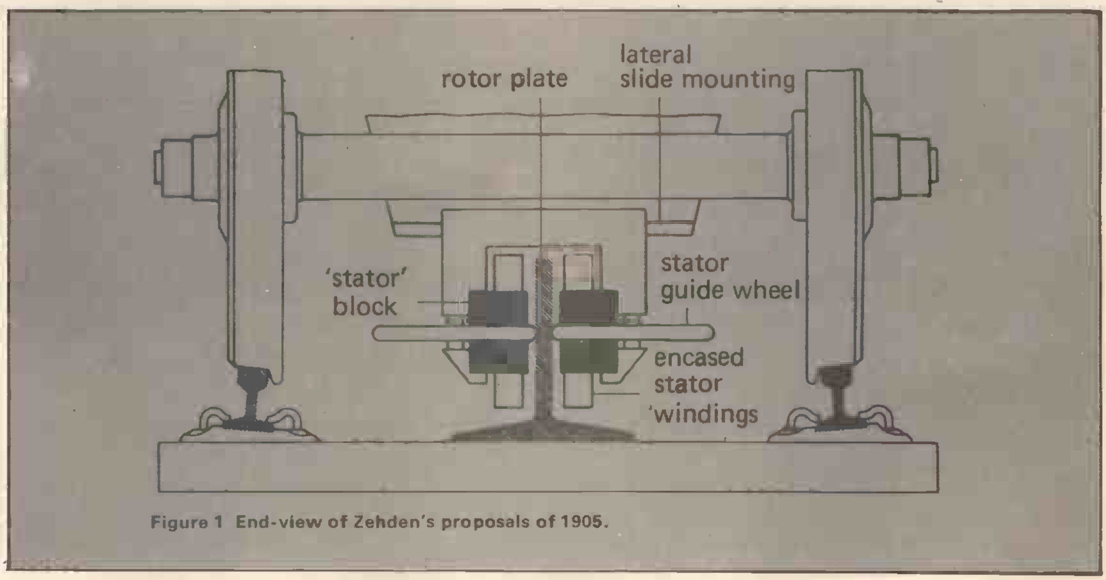


Figure 1 End-view of Zehden's proposals of 1905.

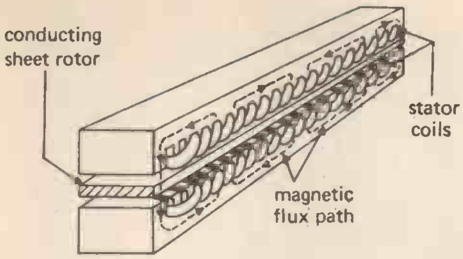


Figure 2 Double-sided sandwich motor with aluminium sheet rotor.

electrical technology in the last 25 years.

The first linear motor was probably built about 1845 and consisted of a row of coils switched on to a dc supply in sequence. The induction motor, even in rotary form, was not invented until 1888 and thereafter dominated the world of electric drives because of the intrinsic robustness of the rotor and the fact that the motion of the latter demanded no brushes or rubbing contacts and was therefore inherently reliable and required little maintenance.

The secondary member of an induction motor member ('rotor' in the case of a rotating machine) requires neither electrical nor mechanical contact with the driving member or stator. Seldom exploited in rotary machines — perhaps only in motors having gas bearings — this fact opens up exciting possibilities for driving very high speed vehicles where absence of contact with the ground is highly desirable, if not essential. It may be achieved by the use of the 'hovercraft' principle, by an amplifier-fed set of electro-magnets attracted to steel strips in the track or by currents induced in a conducting sheet on the track, either by superconducting dc magnets, or by ordinary ac electro-magnets in the vehicle itself.

Use of linear motors to propel railway vehicles was first proposed by Zehden in 1905 and it is interesting that his proposed layout was almost identical to those being currently developed in the United States of America, Japan, France and Germany.

A cross-section of this layout is shown at Fig. 1, in which the following points should be noted particularly:

(i) The primary member, consisting of rows of coils set into laminated steel blocks, is carried on the vehicle, whereas in rotary motors the primary member is the stationary part or 'stator'. The reason for this is fairly obvious, for the costs of providing a precise coil system and of feeding it with power, possibly for hundreds of miles, is clearly prohibitive unless the traffic density is extremely high — for example a vehicle passing any one point every 15 seconds.

(ii) The secondary member, which is secured to the track, has been made as simple as possible, containing no ferro-magnetic material but consisting of a simple aluminium plate mounted on its edge. The magnetic circuit is closed by having two primary rows of coils (as opposed to one only in the conventional rotary induction motor) arranged as shown at Fig. 2 (a plan view of the system). At any instant in time, a N-pole on one side of the sheet is opposite a S-pole on the other and the two sets of coils assist each other in forcing the magnetic field pattern through the conducting aluminium. Such an arrangement is now known as a 'double-sided sandwich motor' or 'sheet rotor motor'.

A FIFTY YEAR GAP

Zehden's patent was not exploited, presumably because of the high capital cost even of conducting initial experiments, or because the engineers of the day did not believe it possible to design machines of high efficiency with a large gap in the magnetic circuit — or both (the magnetic gap includes the thickness of the secondary plate, which is non-ferrous).

Linear motors reappeared, this time successfully, as liquid-metal pumps designed to pumpl sodium/potassium mixtures required in nuclear power stations, but so far as high speed transport systems were concerned there were but two landmarks between 1905 and 1957. In 1914 a Frenchman named Bachelet showed how to levitate and propel a conducting sheet by electro-magnetic induction and he formed a company in America to develop a linear motor for launching aircraft. This machine ('Electropult') was built and accelerated aircraft to a take-off speed of 225 miles/hour (360 km/h). Up to the present it remains the fastest man-carrying linear motor built, though this record is likely to be smashed in 1974 if not in 1973.

The 'Electropult' is interesting from another viewpoint, however, in that it was not a sheet rotor motor but was single-sided and carried a ladder-network of copper bars in slots in a laminated steel slab in the track. The arrangement is shown at Fig. 3. The penalty for carrying the primary coils on the vehicle is that high power must be fed to the moving part via brushes and slip tracks, but the penalty for not doing so is many times greater.

The late 1950s and early 1960s saw a revival of interest in linear motors, especially for driving tracked vehicles such as railway coaches. The double-sided sandwich motor was developed to a state where its properties were comparable with those of a rotary motor of equal power, because theoretical studies culminating in the concept of a factor of 'goodness' had shown that a large airgap was not per se responsible for low efficiency but that 'goodness' increased with increase in speed. By 1966 engineers had accepted the idea that the sheet rotor motor was the only possible shape for vehicle traction, for only the simple aluminium sheet was possible, economically, for hundreds of miles of track.

INVESTIGATION

In 1967, a British company known as Tracked Hovercraft Limited (THL) was set up to investigate the possibilities of combining linear motor drive with air-cushion suspension and guidance. Following design studies by two large manufacturers, also in Britain, it was realised that a frequency higher than the industrial 50 Hz was needed for motors whose speeds were in excess of 150

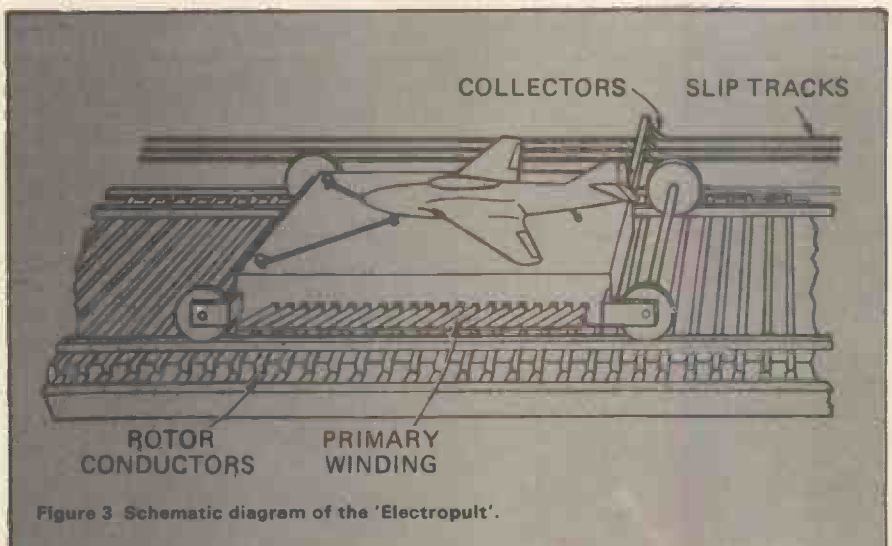
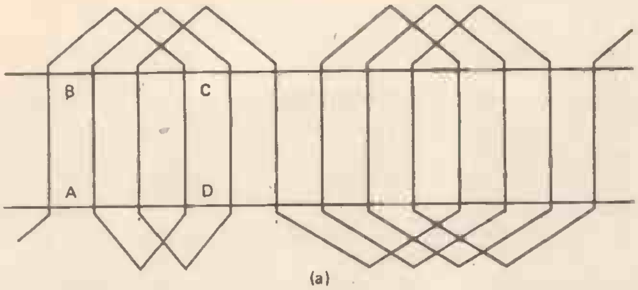


Figure 3 Schematic diagram of the 'Electropult'.



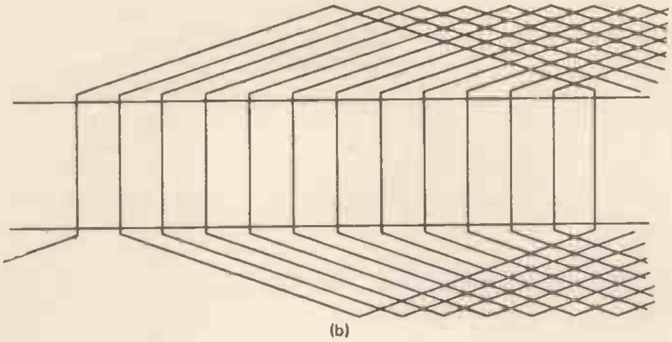


Fig. 4a & 4b. Difficulties resulting from the use of large pole pitches.

miles/hour (240 km/h), and this for the following reasons.

Reference to Fig. 2 shows that the whole of the flux emanating from one complete pole pitch of the motor surface must pass longitudinally (in the direction of motion) through the iron core of both sides of the primary. The depth of iron (d) behind the slots is therefore required to be of the order of half a pole pitch (assuming equal widths of slot and tooth). The speed of the travelling field, and therefore the terminal speed of the machine, is such that the magnetic field traverses two pole pitches in one cycle of the supply. Thus for supply-frequency f, the speed v is given by $2pf$ where p is the pole pitch. For 250 miles/hour (400 km/h) the value of p for $f = 50$ is about four feet (1.2m).

Examination of the method of winding primary coils in slots shows at once one of the difficulties resulting from the use of large pole pitches (Fig. 4). In (a) the use of roughly square poles means that the useful portions of the electric circuits such as AB and CD are nearly as long as the useless end-portions BC and DA, and the latter are not so long as to produce a great deal of leakage field, which would otherwise manifest itself as a low power factor of the machine overall. Moreover the coils can be laid one over the other by a relatively easy shaping of the 'elbows' in a plane perpendicular to that of the pole face.

Contrast this with the corresponding geometry of Fig. 4(b) where the motor is one foot (30cm) wide and has a pole pitch of four feet (1.2m). The end winding power losses are some five times those of the useful conductor, and the leakage field dominates the performance in that the equivalent primary reactance rivals the main magnetic circuit reactance; but, worst of all, it is virtually impossible to find space to accommodate the enormous bunch of overlapping end-sections.

The second difficulty with regard to large pole pitches can be seen from Fig. 2 in that even if each primary slot is three times as wide as a tooth, the dimension (d) is more than one foot (30 cm), making the motor excessively heavy.

The penalty of using a higher frequency to reduce the value of p is that of carrying a frequency-changer onboard, whose weight may be 10 tons or more, or that of a transmission and pick-up system at high frequency with all its attendant cost and fundamental limitations.

PROBLEMS ENDED

Until 1969 it appeared that there was a maximum speed for mains-fed linear motors which could have been as low as 100 miles/hour (160 km/h). The invention of the transverse flux motor, in February of that year, removed all the major problems of mains-fed linear motors up to 250 miles/hour (400 km/h) or more. Fig. 5 shows the almost philosophical arguments which led to the invention. In (a) the electric and magnetic circuits are seen to be in planes which intersect at right-angles, which is a necessary condition for the generation of force by electro-magnetism. But considering the direction of this force — that is the direction of travel — both circuits are seen to be elongated unprofitably and if one of these be turned through a right-angle, as in (b), it is immediately shortened and improved. What is more, its length is now independent of pole pitch. The magnetic circuit of a machine is 'weaker' than the electric for there is no magnetic equivalent of an electric insulator and therefore the benefits of a shorter circuit are properly assigned to the magnetic.

What this means in practice is that cross-sections of transverse flux machines (TFM) are as shown at Figure 6, some of which are single and some double-sided. The improvement in magnetic circuit is twofold. First, the core depth d is now only half a tooth width so that single-sided motors become technically feasible, even for tracks hundreds of miles in length. Second, the lower reluctance means that liberties may be taken in design so as further to cheapen the track cost — that is the core iron can be run well into saturation until its effective value of μ falls from 1000 to perhaps 50. It now becomes possible to run 250 miles/hour (400 km/h) motors from 50 Hz supply on a sheet of aluminium on the track backed by a solid sheet of boiler plate.

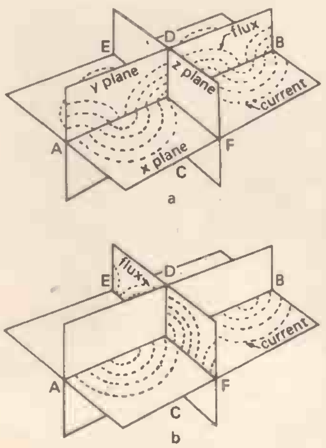


Figure 5 Topology of linear machines:
(a) 'Conventional' linear motor.
(b) Transverse flux machine.

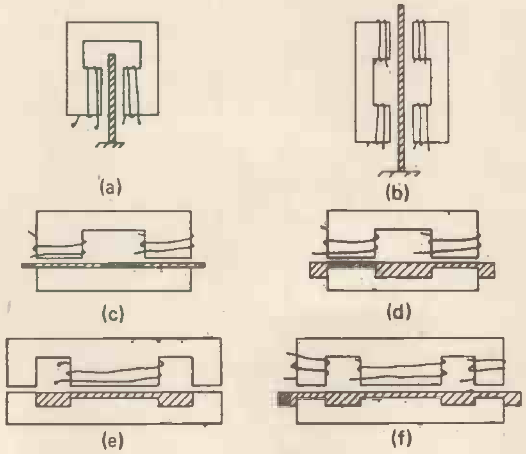


Figure 6 Cross-sections of transverse flux machines:
(a) and (b) Double-sided motors
(c)—(f) Single-sided motors with composite secondary.

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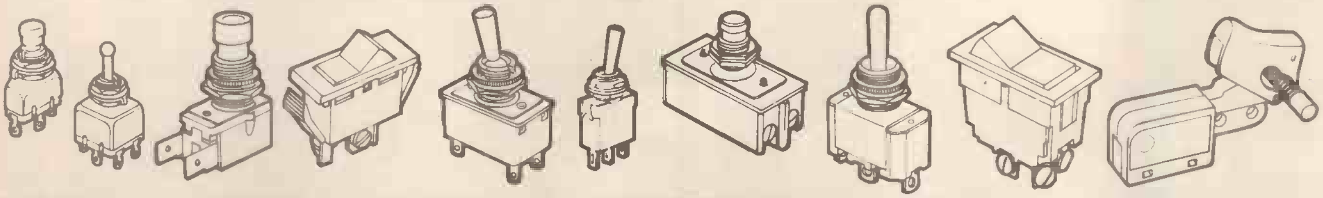

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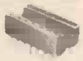

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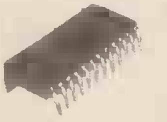

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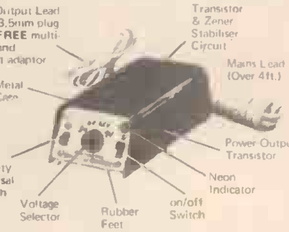

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ACY17	24p	BC147	9p	BCZ11	28p	BF185	27½p	D13V	53p	TIS43	36½p	2N3566	18p	2N4443	£1.45	BA110	45p	BB105	42p
ACY18	21p	BC148	9p	BD115	74p	BF194	15p	MJ4000	£1.49	TIS73	£2.10	2N3638	20p	2N4444	£2.09	BA111	55p	BB141	99p
ACY19	25p	BC149	9p	BD124	82p	BF195	17p	MJ4010	£1.49	TIS91	33p	2N3702	11p	2N4871	60p	BA112	99p	BB142	82p
ACY20	22p	BC157	13p	BD131	68p	BF196	16½p	MJE340	52p	2N697	16½p	2N3703	10p	2N5129	16½p	BA114	9p	OA5	99p
AD140	40p	BC158	10p	BD132	83p	BF197	16½p	MJE2955	£1.82	2N706	13p	2N3704	11p	2N5172	9p	BA115	19p	OA10	94p
AD149	38p	BC159	14p	BD131/2 pr.	£1.49	BF200	35½p	MJE3055	92p	2N708	16½p	2N3705	10p	2N5459	36½p	BA116	9p	OA47	11p
AD161	29p	BC168B	11p	BD133	82p	BF220	27½p	MPF102	27½p	2N914	24½p	2N3706	10p	2N5777	47p	BA128	11p	OA79	10p
AD162	29p	BC169	22p	BD135	42p	BF244B	27p	MPF103	41p	2N1302	20p	2N3707	12p	2N6076	14p	BA129	23p	OA81	8p
AD161/162 pr	59p	BC171	20p	BD136	50p	BF262	25p	MPF104	45p	2N1303	24p	2N3708	9p	3N140	£1.81	BA143U	75p	OA85	10p
AF114	14p	BC172	17½p	BD137	57½p	BF263	25p	MPF105	45p	2N1304	24p	2N3709	10p	3N141	89p	BA143V	67p	OA90	8p
AF115	14p	BC174B	35p	BD138	74½p	BF272	£1.21	MPF106	49½p	2N1305	24p	2N3710	11p	3N152	£1.01	BA144	20p	OA91	8p
AF116	14p	BC177	22p	BD139	78p	BFS90	37p	OC28	45p	2N1306	24p	2N3711	11p	3N153	89p	BA145	22p	OA95	9p
AF117	14p	BC178	22p	BD140	91½p	BFS28	£1.01	OC35	38p	2N1307	27½p	2N3771	£1.82	40360	61p	BA148	22p	OA200	11p
AF118	52p	BC179	24p	BD201	£1.55	BFW10	67p	OC36	38p	2N1308	27½p	2N3772	£2.75	40361	50p	BA154	20p	OA202	12p
AF124	24p	BC182L	9p	BD202	£1.37	BFW11	67p	OC44	13½p	2N1309	27½p	2N3773	£2.20	40362	50p	BA155	15½p	OA210	19½p
AF125	22p	BC183L	9p	BD203	£1.55	BFW87	39p	OC45	13½p	2N1613	22p	2N3819	28p	40408	55p	BA156	16½p	OA211	30p
AF126	22p	BC184	9p	BD204	£1.37	BFX29	37½p	OC71	13½p	2N1711	26p	2N3823	99p	40430	£1.39	BA182	26½p	IN914	8p
AF127	22p	BC184L	9p	BF109	75p	BFX30	37½p	OC72	13½p	2N1893	52½p	2N3903	16½p	40432	£2.17	BA220	7p	IN916	10p
AF139	35p	BC187	27½p	BF115	25p	BFX88	26p	OC75	15p	2N2160	£1.54	2N3904	19p	40673	55p	BA221	7p	IN4148	5½p

ZENERS

All 5% tolerance

BZY88	400mW	3.3v to 33v	11p
1ZS	1 Watt	3.3v to 100v	18p
BZX70	2.5W	7.5v to 75v	27p

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UNLESS SHOWN OTHERWISE P&P ON U.K ORDERS IS 8p. OVERSEAS ORDERS AT COST

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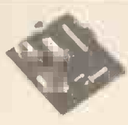
Varactor diode tuned, F.M. tuning heart **£4.15** as described in P.E. May 1973. **LP1185** matching I.F. strip.

£4.85

THE TEXAN

20+20 Watt Integrated stereo amplifier Kit. Superb state-of-the-art design by engineers of Texas Instruments.

£31.35 + p & p 49p



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3 Watt amplifier module. Price including handbook and **FREE HEATSINK** (Quantity discounts).

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A1005S

F.M. tuner chassis, fully transistorised. 9 volt positive earth operation.

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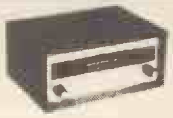

A1018

F.M. tuner, similar to A1005S but in oiled walnut case, black & silver-fascia etc.

Our Price £9.38

A1005MS

Multiplex Stereo Decoder fully built & aligned to match A1005S.

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Audio I.C. Leaflet No.12 (circuit data etc.) **FREE** with I.C.'s – 10p separately

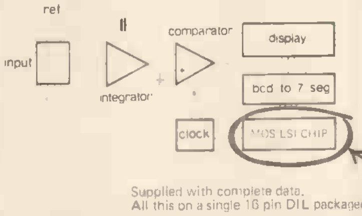
PRE-AMPLIFIERS

Dual	MC1303L	£1.89
Low	Noise Dual: MC1339P	£1.29

AMPLIFIERS

250mW	MFC4000A	49p
1 Watt	TAA300	£1.79
2 Watt	LM380	£1.59
5 Watt	TBA800	£1.59
15 Watt	BHA0002	£3.95
35 Watt Driver	NES40L	£1.32

3½ decade DVM



- Maximum Display + or – 1,999V
- Minimum Display + or – 1mV
- Can be scaled up to 1,999V
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- Automatic Overange Indication
- Up to 50 readings per second
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Supplied with complete data.
All this on a single 16 pin DIL packaged MOS LSI Integrated Circuit.

A State-of-the-Art Digital Voltmeter I.C. **for only £7·79**

Coil-less Phase-Locked Loop I.C. Stereo Decoder

Motorola MC1310, supplied complete with our FREE leaflet No. 11

Our Price **£3.05**

MC1312 decodes CBS SQ. **FREE** leaflet No.11 gives full circuits and details. Including license fee.

QUADRISONICS

Our Price £6·89

Including all parts for decoder inc. Veroboard, V.A.T., p.&p. (leaflet alone 10p.)

Linears

	8 pin Dip	T099	14 pin D81
709	34p	40p	35p
710	35p	40p	39p
711	–	45p	39p
723	–	96p	95p
741	42p	45p	43p
747	–	–	92p
748	42p	45p	43p

CA3046	95p	MVR5V (L005)	£1.65
CA3075	£1.65	MVR12V(L036)	£1.65
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LM301	£1.05	NE561B	£4.92
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LM308K	£1.45	NE565	£3.49
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MC1351	£1.10	TAA263	99p
MC1352	£1.10	TAA293	99p
MC1357	£1.59	TAA310	£1.37
MC1358	£1.69	TAA320	99p
MC1456G	£1.75	TAA350	£2.54
MC1458CPI	£2.42	TAA370	£5.15
MC1495	£5.65	TAA550	81p
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MC3401	77p	TAA700	£4.49
MC4010A	62p	TAD100	£1.66
MFC4060	78p	TAD110	£1.65
MFC6030A	83p	TBA550	£1.65
MFC6040	£1.10	ULN2111A	£1.59

the component people

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telephone: 883 3705

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MULLARD block filter **LP1175** as used with TAD100 now only **£1.49**

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TRANSISTOR RANGE
Series 1T to 5T inclusive Blue; Yellow; Red & White **all 44p each.**

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IFT.13, 14; 16 & 17 **55p** ea.
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Type C804				Type O	
5pf	61p	50pf	66p	365pf	80p
10pf	61p	60pf	79p	365 + 365pf	96p
15pf	61p	75pf	79p	Type OO	
20pf	64p	100pf	75p	208 + 176pf with screen & trimmers	99p
25pf	61p				

p & p all types 10p

NEW FERRANTI RANGE

ZN414 The Radio I.C. in a 9 TO 18 Can – Supplied with our **FREE** data leaflet No.11 giving circuit and component details. Leaflet alone 10p. **Our Price £1.32**

BFS59	15p	ZTX302	17p	ZTX450	17p	ZS121	10p	ZS272	18p
BFS60	20p	ZTX303	14p	ZTX451	17p	ZS122	13p	ZS274	19p
BFS61	20p	ZTX304	21p	ZTX500	12p	ZS123	16p	ZS276	26p
BFS96	15p	ZTX310	9p	ZTX501	13p	ZS124	18p	ZS278	37p
BFS97	23p	ZTX311	10p	ZTX502	17p	ZS140	25p		
BFS98	20p	ZTX312	10p	ZTX503	14p	ZS141	43p	KS030A	
		ZTX313	11p	ZTX504	43p	ZS142	33p	Zener	
ZTX107	9p	ZTX314	13p	ZTX510	17p	ZS170	10p	Series	
ZTX108	8p	ZTX320	31p	ZTX530	21p	ZS171	13p	as	
ZTX109	11p	ZTX330	15p	ZTX531	22p	ZS172	16p	BZY88	
ZTX212	14p	ZTX331	16p	ZTX550	17p	ZS174	17p	Series	
ZTX213	14p	ZTX341	22p	ZTX551	17p	ZS176	23p	11p	
ZTX214	15p	ZTX382	13p			ZS178	38p	each	
ZTX300	12p	ZTX383	15p	DIODES		ZS270	11p		
ZTX301	13p	ZTX384	18p	ZS120	8p	ZS271	16p		

ELECTROLYTICS

µF	4V	6.3V	10V	16V	25V	40V	63V	100V
1							6½p	8p
1.5							6½p	
2.2							6½p	
3.3							6½p	
4.7							6½p	8p
6.8						6½p	6½p	
10					6½p		6½p	9p
15				6½p		6½p		
22			6½p		6½p		6½p	11p
33		6½p		6½p		6½p		
47	6½p		6½p		6½p	6½p	8p	
68		6½p		6½p			10p	
100	6½p		6½p		6½p	8p	11p	23p
150		6½p		6½p	6½p	10p	13p	
220	6½p		6½p	8p	10p	11p	19p	31p
330	6½p		8p				22p	39p
470		6½p	10p		13p	19p	26p	48p
680		10p		13p	20p	23p		59p
1000	10p		11p	17p	22p	25p	44p	79p
1500		12p	20p	23p				
2200		18p	20p		36p	44p	79p	149p
3300		20p						
4700	29p			44p	68p	79p	149p	252p
6400				75p	93p			
100000							299p	333p

Potentiometers

5KΩ	250KΩ
10KΩ	500KΩ
25KΩ	1MΩ
50KΩ	2MΩ
100KΩ	

log or lin less switch (& 1K Ω lin)	13p
log or lin with switch	26p
dual less switch	44p
dual with switch 10K, 100K & 1M log only	57p
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10KΩ	Single
25KΩ	40p
50KΩ	Dual
100KΩ	60p

New Silver and Black Knob 16½p

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Vertical or Horizontal
0.1 watt 5½p 0.25 watt 7p

100Ω	1KΩ	10KΩ	100KΩ	1MΩ
250Ω	2.5KΩ	25KΩ	250KΩ	2.5MΩ
500Ω	5KΩ	50KΩ	500KΩ	5MΩ

Cermet Type, to 1MΩ only 41p

VDR's & Thermistors

A15B	82½p	GL16	£1.10	R53	£1.49
CZ1	16½p	GL23	£1.10	R54	£1.61
CZ4	14½p			VA1005	16½p
CZ13A	14½p			VA1026	14½p
CZ19	14½p			VA1033	11p
E298CD/A258		13p		VA1034	11p
E298ED/A258		11p		VA1039	16½p
E298ED/A260		11p		VA1040	11p
E298ED/A262		11p		VA1053	11p
E298ED/A265		11p		VA1055S	11p
E298ED/P268		11p		VA1056S	11p
E298ZZ/05		13p		VA1066S	11p
E298ZZ/06		11p		VA1067S	16½p
E299DD/P336		11p		VA1077	14½p
E299DD/P338		11p		VA1098	21p
E299DD/P342		11p		VA1104	29p
E299DD/P348		11p		VA1107	29p

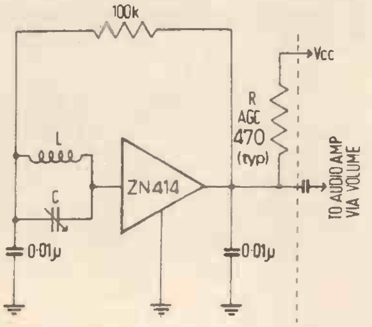
Other types obtainable upon application.

electronics tomorrow

BY JOHN MILLER-KIRKPATRICK

BIRTHDAY OFFER

Happy Birthday to the ZN414! This little IC which revolutionised radio circuitry is now only just over one year old. In the December 1972 issue of ETI we offered you these devices for 50p and received about 4000 orders for only 1000 devices available so we know that there are a lot of disappointed customers who did not order early enough. The normal retail price of these devices is about £1.20 plus VAT and post and package thus totalling about £1.40. We have managed to persuade Minikits Electronics to give us this month's special offer of the ZN414 at £1.00 including VAT. The offer is open to the first 500 customers and each order must be accompanied by the order form in this issue. With all of our special offers you should send a stamped, self-addressed envelope for the return of the device or, if you are unlucky, your money. Minikits will be sending a basic data sheet including a couple of circuits with the devices but if you write to Ferranti they will send you a full data sheet, again send an s.a.e. or label. Devices: 1; Data: 2.



Basic circuit using the ZN414

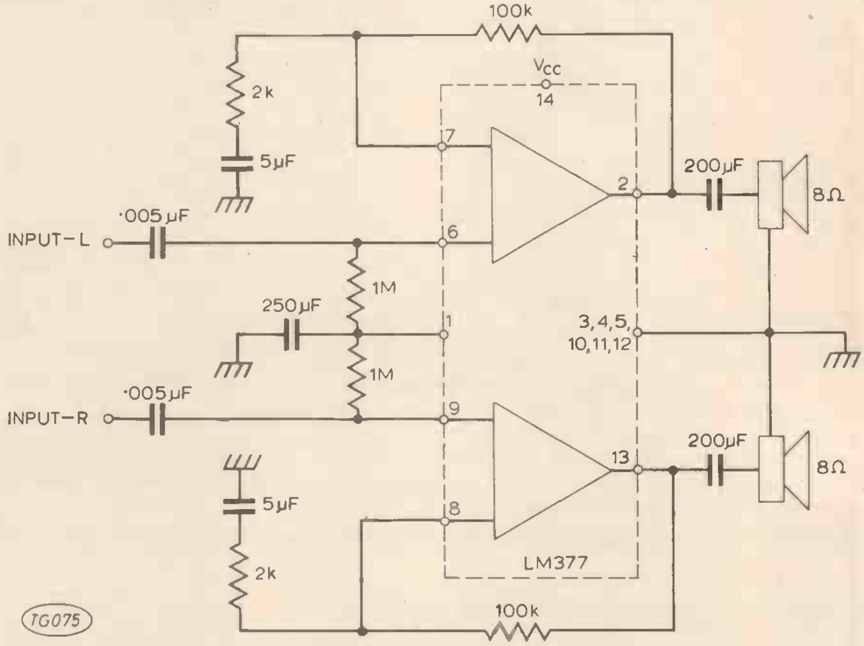


Fig.1. Simple 2.5W stereo amplifier using a single IC, the LM377

IC AUDIO AMPLIFIERS

To go with your ZN414 you may like to have a small audio amp, or perhaps you would like to build a stereo system or a TV sound system separate from the set or even perhaps a TV. National Semiconductors (UK) Ltd have a whole range of consumer linear ICs to perform all of these miracles.

The LM380 was mentioned in *Electronics Tomorrow* two months ago and has since received a lot of coverage in other magazines and is now being sold by some retailers. It is a versatile 2W audio amp requiring a minimum of external components to run from almost any audio input source and sells at about £1.65.

LM377 is a similar device to the LM380 but its 14 pin DIL package gives 2½W STEREO from inputs of about 10mV. A circuit for this is shown as Fig. 1, and other circuits to give a 4W bridge amplifier or a 15W stereo amp have been designed. The LM377 sells at about £2.90. If you want a stereo preamplifier, then the LM381 or LM382 is what to look out for. The LM381 is a dual pre-amplifier with two independent amplifiers and individual internal power supply de-coupler-regulator. (At present there are no supplies of either LM381 or LM382 in the U.K. but this should shortly be rectified). Gain is 112dB and power supply is from 9 to 40V. The LM382 has a similar specification but with a gain of 100dB, also a resistor matrix is provided on the chip to allow the user to select a variety of closed loop gain options and frequency response characteristics. A magnetic phono preamp with RIAA equalisation using the

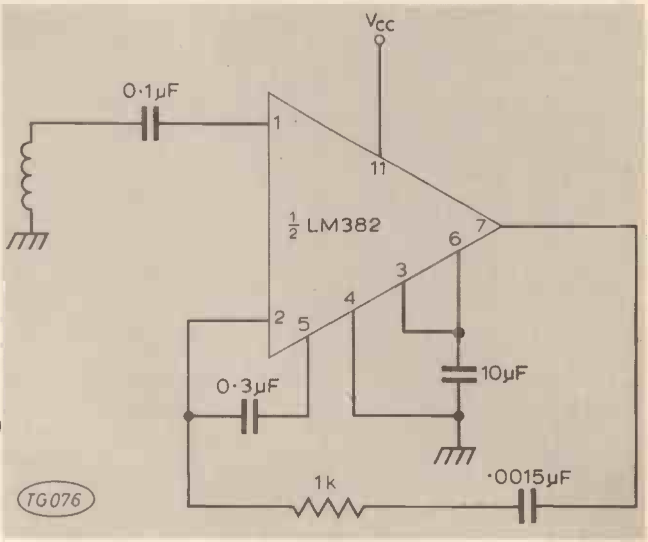


Fig.2. Magnetic phono preamp (RIAA equalised) only one channel shown

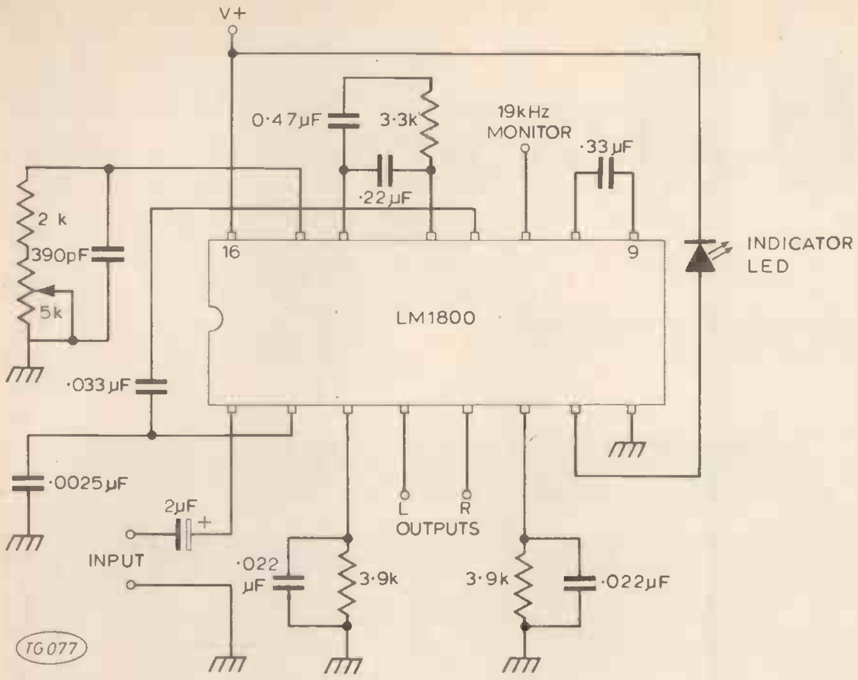


Fig.3. Phase Locked Loop stereo decoder using the LM1800

LM382 is shown as Fig. 2. Prices are approximately £2.25 each.

The LM1310 and LM1310E are integrated FM stereo demodulators using phase locked loop techniques to regenerate the 38kHz subcarrier. The LM1310 is a 14 pin version while the LM1310E offers buffered emitter follower outputs in a 16 pin package. A third version is the LM1800 also in a 16 pin package and adding superb power supply rejection to the basic phase locked decoder circuit. A circuit using to LM1800 is shown as Fig. 3, prices are in the £2.80 area and are available as yet only in development quantities.

Other National Semiconductor consumer ICs are:

LM370	AGC/squelch amplifier.
LM372	AM IF strip.
LM373	AM/FM/SSB IF amp detector.
LM374	AM/FM/SSB IF video amp detector.
LM567	Tone decoder.
LM733	Differential video amp.
LM746	Colout television chroma demodulator.
LM3064	Television automatic fine tuning.
LM3071	Television chroma IF amplifier.

The list could continue to cover 50 more consumer ICs but room is obviously limited.

Three new National Semiconductor ICs have been announced but are not yet available or priced, they are-

LM378 4W per channel stereo amp, LM383 5W amplifier with an open loop gain of 15,000 and includes an internal but separate preamp. The third is the LM1805 a complete 2W TV sound system, this presumably can be built to run completely separate from the TV set giving two main advantages, the first of getting Hi-Fi sound to go with the pretty pictures and the second for deaf or partially deaf people who require very loud signal which is obviously annoying to other people; with this system they could listen through a headset with the sound on the actual TV set turned off. Devices: 3, 4; Data: 5.

CLOCK CHIP MARKET DIVERGES

Two recent news items have started separating the digital clock chip market, National reduce some prices and CAL-TEX announce an all-singing, all-dancing clock chip.

National Semiconductor have reduced the price of their MM5314 clock ship due to large orders received for production units. The MM5314 is a six digit clock chip with options of 50 or 60Hz inputs, and 12 or 24 hour running. The outputs can drive common anode LED displays via a very simple transistor interface which itself can be simplified by using a CA3081 - seven transistors in one 16 pin pack. The new recommended price is £7.20 for one off and comes down to the £3.00 level for thousand off quantities, at these prices, and with large LED prices dropping, the commercially priced digital clock may only be a couple of years away. The present price of over £100 for a retail digital clock will soon drop to the £60 to £70 area and then later start dropping to £20 to £30 range. In the meantime Bywood have a new kit using this IC and Litronix DL747 and DL707 LEDs at £27, plus a Perspex case at £3. You have to supply your own transformer, resistors, capacitors, etc but a very nice clock can be built for under £35. Devices: 4; Data: 5.

CAL-TEX Semiconductors of California have announced the CT7001 clock chip and this one does nearly everything. Input frequencies can be mains 50 or 60Hz or an external 100.8KHz supply, outputs are six digit in 12 or 24 hours format. The functions of the clock are time (HHMMSS), date (MMDD), alarm (HHMM) and sleep (HHMM). The date only needs to be reset for February 29th and will be available in a European DDMM format in the near future. The sleep can be set for a maximum of 9 hours and 59 minutes and can be used so that either the sleep will switch the sleep output on, or the alarm will switch the sleep output on for the specified time. What this means is that in one mode the sleep can be used to switch on a radio whilst you go to sleep and to switch off after say 40 minutes, in the morning the alarm output will go on and wake you up with a buzzer. In the second mode the sleep will switch the radio off after 40 minutes again but the alarm will switch the sleep output again in the morning, thus waking you with the radio instead of the alarm. In the third mode the sleep is set for say 32 minutes and the alarm set for 1859, at 1859 the sleep output will be switched on for 32 minutes. If connected to a radio and tape recorder the clock will thus record your favourite programme whilst you are away. The chip also has a ten minute snooze alarm which allows you to sleep in for an extra ten minutes and features such as AM/PM indicator, date display every ten seconds, etc. Bywood are distributing this chip in this country at about £18 one off, quantity prices have yet to be announced. Devices: and Date: 4.

The last new product this month is a new 7 segment LED display from Litronix called the DL747 nicknamed, for obvious reasons, the "jumbo". It is a 0.6 inch version of Litronix's DL700 range of light pipe displays with a brightness of 5mcd at 20mA and is pin compatible with the company's DL62 LED. The price, however, is not compatible - the DL62 costs £6.50 and the Jumbo costs only £2.62 for one offs and £1.98 for 1000 quantities. Devices: 3 & 4; Data: 6.

REFERENCES

1 Minikits Electronics, 35 Langley Drive, Wanstead, London E11 2LN.

2 Ferranti Ltd, Gem Mill, Chadderton, Oldham, Lancs.

3 Atlantic Components, 143 Loughborough Road, Leicester.

4 Bywood Electronics, 181 Ebberns Road, Hemel Hempstead, Herts.

5 National Semiconductors, The Precinct, Broxbourne, Herts.

6 Litronix, Bevan House, Bancroft, Hitchin, Herts.

Please remember that prices do not include VAT (except where indicated), send a reasonably sized sae with any equiry and mention ETI as a common reference source.

cut

To — MINIKITS ELECTRONICS,
35 LANGLEY DRIVE,
WANSTEAD,
LONDON E11 2LN.

Please supply one ZN414 radio IC as mentioned in Electronics Tomorrow in the December 1973 issue of ETI. I enclose a cheque/PO for £1.00 and a stamped, self-addressed envelope for the chip or the return of my money if the offer is over-suscribed.

Name ....

Address ....

....

....

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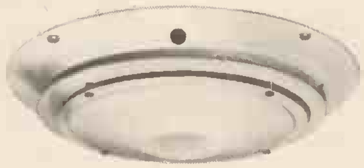
Offer open until 31 January 1974 or until 500 devices have been sold.

AUDIO NEWS

SLIMLINE CEILING SPEAKER

The new FF.22 Ceiling Speaker from Eagle achieves a very low profile of only 70mm using an inverted magnet speaker. This slim surface mounting unit requires no cutting or recessing, minimising installation problems.

The 165mm diameter speaker provides a high standard of clarity and definition. Its power handling of 8W continuous rating affords adequate capacity for use in hotels, supermarkets, hospitals, garages and similar locations.



An important safety feature of the FF. 22 is its finish, in stove enamelled metal, which eliminating fire risk. The unit has a frequency range of 60 - 14000Hz with 8 ohms impedance. Recommended price is £5.25 plus VAT.

Eagle International, Precision Centre, Heather Park Drive, Wembley, Middlesex.

REVOLUTIONARY NEW TURNTABLE MOTOR

The Mirco-motors division of Matsushita Electric Industrial have perfected a new direct-drive motor for use in record reproducing equipment, the MPL 10H, now available from Symot Ltd.

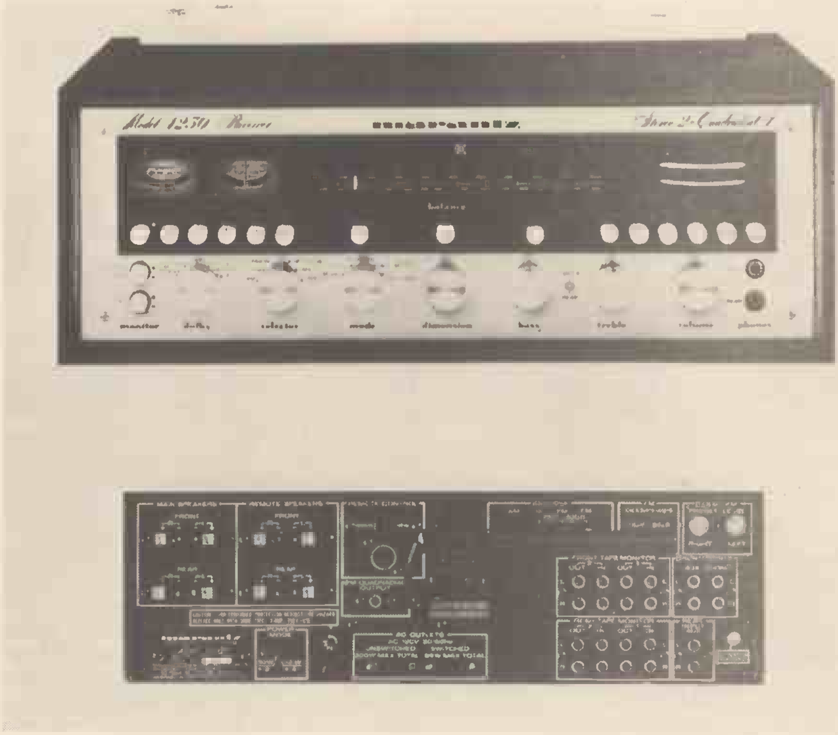
It has many advantages over conventional systems, the most important being a significant improvement in its wow and flutter specifications due to the elimination of all belts and pulleys and the slow rotational speed of the motor. The claimed figures, with suitable turntable fitted, are: wow and flutter - less than 0.30 per cent WRMS; rumble - better than 60dB.

Other advantages claimed are better speed stability through the use of a 15V stabilised d.c. power supply which isolates the motor from mains frequency and voltage fluctuations. The circuit uses a.c. voltage generated within the motor which is compared with a reference and used to control the power to the windings.

The motor employs electronic commutition, thus dispensing with the problems of noise and wear associated with the brushes. The speed change from 45 to 33½ rpm is achieved through electronic switching, removing the need for mechanical linkages.

Symot Ltd., 17 Market Place, Henley-on-Thames, Oxon.

NEW MARANTZ RECEIVER WITH BUILT-IN DOLBY



The Marantz 4230, first of a new series of receivers and amplifiers with built-in Dolby for tape-recording, play-back and FM, has recently become available in the U.K.

This receiver, claimed to be one of the most advanced in the world, features a new phase lock loop decoder which assures maximum separation and minimum distortion on FM stereo broadcasts, and a bridging circuit which combines the rear channel amplifier with the front channel amplifier, producing full power two channel and full power four channel. Rear panel facilities are provided for connecting an RC4 optional remote control permitting convenient four channel balancing.

The 4230 is rated at 30W per channel in the stereo mode and 12W per channel in the four channel mode. In common with other Marantz four channel receivers, an under-chassis pocket is included to accept the optional Marantz SQ decoder, or any future advancement in matrix decoding.

Additional four channel facilities are provided by Marantz's exclusive Vari-Matrix circuitry which synthesises four channel sound from ordinary stereo and matrix encoded sources. The user can create a realistic four channel effect by using the dimensional control.

The FM Dolby B circuit is unique in that the sound heard from the speakers is a completely deprocessed signal, giving the benefit of noise reduction, while the signal fed through the tape recorder outputs is not deprocessed, allowing the user to make a Dolbyised recording while listening to the noise-reduced signal.

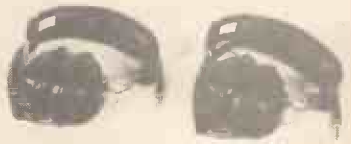
Experimental FM Dolby broadcast begins in the London area later this year and it is probable that this will become a standard in broadcasting before long. In the 4230, Marantz have put the Dolby in the receiver where it has the widest possible application.

Pyser-Britex (Swift) Ltd., Fircroft Way, Edenbridge, Kent.

INEXPENSIVE HEADPHONES

Plustronics have introduced a range of headphones starting from as little as £4.16 including VAT.

There are two models in the range, both with all-black styling. There are ear-cushions on the individual phones together with a head cushion across the top bridge. All the cushions can be removed, the bridge top cushion being press-studded for positive fixing when in position. The phone cushions simply slip over the raised outer rim of the phone heads so that they can easily be removed for cleaning.



The headphones have an impedance rating of 8 ohms, have a maximum power input of 0.5W and a frequency response of 20-20000Hz.

Plustronics Ltd., Hempstalls Lane, Newcastle, Staffs ST5 OSW.

eti AUDIO NEWS

NEW HI-FI RANGE

A new range of Hi-Fi equipment, made in Korea and called Teledyne, is now available in the UK. The distributors of these products are Pyser-Britex (Swift) Ltd. (already UK distributors of Marantz Hi-Fi equipment).

Four models are available, two stereo receivers and two four channel receivers. The RA618, costing £79.00 (excluding VAT), is a Phase Power Stereo AM/FM Receiver, giving 15W per channel into 8 ohms. This unit has incorporated circuitry for giving out of phase signals through a pair of rear speakers, a system called four channel phase power.

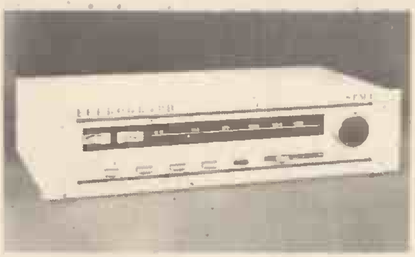
The second stereo receiver, model RA 655, is similar but with 5W per channel and costs £59.00 (excluding VAT).

The RA632, costing £110.00 (excluding VAT), is a Four channel AM/FM Receiver, giving 15W per channel. The RA660 Four channel AM/FM Receiver costing £89.00 (excluding VAT), is similar but with 5W per channel. Both these four channel units have incorporated SQ decoders and built-in joystick balance control.

Pyser-Britex (Swift) Ltd., 2nd Floor, Roussel House, North End Road, Wembley, Middlesex HA9 ONR.

VHF STEREO TUNER

Styled to match their 60W stereo amplifier announced recently, Ferrograph have introduced a VHF Tuner designed for maximum compatibility with amplifiers of virtually any make. It is self-powered and has switched AFC. Other facilities include stereo/mono switching, continuously-adjustable muting which can be switched out altogether without disturbing the adjustment and a 'Separation' control. The latter can be used to reduce the difference between left and right channel signals, from full stereo to mono. This feature provides a



reduction of subjective noise level.

Usable sensitivity of the tuner, designated SFM1, is quoted as 1.5 mircovolts and there are connections for balanced line or coaxial antenna leads. Two meters indicate signal strength and precise tuning, respectively. The SFM1 is priced at £95 (plus VAT) and is available finished in teak, walnut or satin white, with grained aluminium trim.

The Ferrograph Co. Ltd., Auriema House 422 Bath Road, Cippenham, Slough, Bucks. SL1 6BB.

NEW TURNTABLE

Two new turntable units were shown for the first time in the UK by Garrard, at this year's Audio Fair.

Both of these new units, the Zero 100SB and the 86SB, are powered by a screened four-pole synchronous motor fitted with a two-step pulley. A synthetic-rubber drive belt links this to a large turned hub forming an integral part of the machined and and balanced die-cast turntable. The belt is shifted between the motor pulley steps by the movable belt guide when actuated by the speed selector control.

The Zero 100SB incorporates the Garrard tangential tracking arm with its pivoted pick-up head, which has reduced the tracking error of the stylus in the record groove, and the consequent harmonic distortion, virtually to zero. Another innovation is an automatic record counter to help monitor stylus wear.

The new 86SB is a logical development from the AP76 with belt drive, revised styling and a number of other features.

Broadly, the unit is similar to the Zero 100SB in most of its features and performance factors but it incorporates a pick-up arm of the more conventional type.

QUADRAPHONIC HEADPHONES

Among recent products from Eagle International are the FF.29 four-channel headphones. Four 50mm transducers are carefully angled in such a way that the effect achieved is similar to strategically-placed loudspeakers.

Using two coded jack plugs, the FF.29 is compatible with practically all quadraphonic systems. Recommended price is £16.80 plus VAT.

Eagle International, Precision Centre, Heather Park Drive, Wembley, Middlesex, HAO 1SU.

TWELVE YEAR CLEAN UP

By using a BASF cleaning cassette for just a couple of seconds each week the makers claim that you will be able to keep the tape contact parts of your cassette machine clear of deposits for up to 12 years without buying another cleaner.

Each cassette holds over 180 feet of chrome oxide (not to be confused with chromium dioxide tape which is chemically a different substance altogether) tape which gives approximately 600, two-second bursts of cleaning. BASF technicians consider two seconds to be ample time to clean away normal deposits. To get the best results at each cleaning session an unused length of tape should be used.

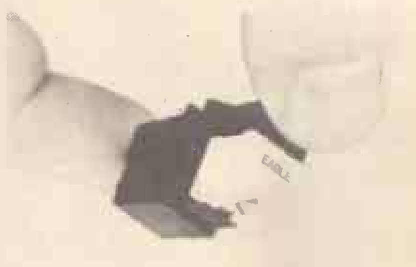
The recommended retail price of the cassette is £1.62p plus VAT.

BASF United Kingdom Ltd., P.O.Box 473, Knightsbridge House, 197 Knightsbridge London SW7 1SA.

NEW CARTRIDGES

Because it has never been easier to obtain good quality turntables and tone arms at reasonable cost, Eagle have introduced two new cartridges so that audio enthusiasts can up-grade their equipment economically.

The FF.12E elliptical stereo cartridge is priced at £8.40 plus VAT and is a high-compliance, low mass type, designed for use with only high-grade, transcription turntables and arms. Its polished diamond stylus is mounted in a specially annealed, lightweight alloy cantilever assembly, to ensure precise and consistent performance.



The FF.20E at £11 plus VAT has a similar specification, and is similarly restricted to high-quality transcription units. The stylus assembly, available separately, is interchangeable with the Eagle LC.07 cartridge, presenting an economical method of upgrading from a spherical to elliptical type cartridge.

Eagle International, Precision Centre, Heather Park Drive, Wembley, Middlesex HAO 1SU.

eti component news

MINIATURE DC MOTOR

New from Portescap is a d.c. mircomotor, the Escap 16C11-210, which like others in the series has a skew-wound ironless rotor that offers several striking advantages over conventional miniature motors. It features an extremely low rotor inertia (4×10^{-4} gcms^2), very rapid response (a mechanical time constant of 60msec), and high power-to-volume ratio (0.45W from the 16mm diameter, 16mm long version).

Applications for the Escap 16 lie mainly in driving such professional electro-mechanical and electronic equipment as cassette recorders, motorised potentiometers, graphical plotters and other data loggers, servo systems, medical and laboratory instrumentation, camera film transport, remote controls, airborne apparatus and similar advanced equipment. A range of reduction gearheads is also available for use with these miniature motors.

Portescap (U.K) Ltd., 204, Elgar Road, Reading RG2 0DD.

AVALANCHE TRANSISTOR

A new range of avalanche transistor has been introduced by Ferranti Limited. These avalanche transistors which are the first to be produced in Britain are designed to handle the switching of tens of amperes in a matter of nanoseconds.

The avalanche transistor allows the controlled switching of large currents with very fast risetimes by the use of the negative resistance region of its V/I characteristic. Until recently the operation of transistors in the secondary breakdown area of the characteristic has been very erratic due to a tendency for the transistor to go into catastrophic failure and be ruined.

Ferranti have now produced a reliable range of transistors to operate in this secondary breakdown area. These transistors can be used to produce 20A pulse trains of 15nS wide pulses with a 3nS risetime at a repetition rate of up to 10kHz.

The devices are designed for work in pulse forming for laser driving, Radar and Magnostrictive delay lines. The characteristics of the device coupled with the low power dissipation make it ideal for use in any type of equipment requiring a high amperage fast risetime pulse train.

Ferranti Ltd., Gem Mill, Chadderton, Oldham, Lancashire OL9 8NP.

GAS DISCHARGE DISPLAY WITH INHERENT MEMORY

A new d.c. gas discharge (plasma) matrix display panel with inherent memory, the first of this type to be commercially available, has been developed by the Special Components Department of Ferranti Limited. This new display is at least three times and more typically ten times as bright as any comparable flat pack display system.

The Plasma display panel is intended for use as a visual display for both alphanumeric and graphical information. Since the panel is d.c. operated and therefore lit 100 per cent of the display time the risk of flicker is completely eliminated. This type of d.c. operation allows a much greater overall panel brightness to be achieved, than was previously available from comparable systems.

Due to the matrix form of the panel a direct binary input can be used without the need for a digital to analogue conversion system. This coupled with the high brightness and rugged construction of the panel make it ideal for use in a wide range of applications including computer display systems. The small size of panel, only 22m thick, and high brightness available are perfectly suited to use in high illumination environments such as offices and public places where the panel can unobtrusively be built into equipment such as office desks and furniture.

A thick film printing process is used in the manufacture of the matrix panel, making it possible to change the cell spacing. Panels with higher resolution and alternative colours will be available in the near future.

Each panel comprises a series of common anode lines run at right angles to a series of common cathode lines with a neon gas cell at each intersection. A maintaining voltage is applied to the panel and by using appropriate voltage pulses on the anode and cathode lines each cell can be selectively lit or erased.

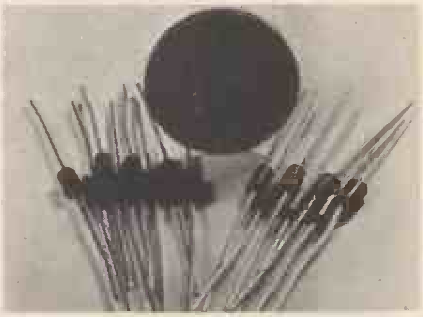
The panels are available as separate components or complete with a small electronic drive unit.

Typical characteristics:- Characters per line, 40 maximum; Lines of characters, 32 maximum; Character format, 7 x 5; Cell resolution, 1.2 cells/mm; Cell diameter, 0.45mm; Brightness, 3000 units; Power dissipation per character, 60mW.

Ferranti Limited, Gem Mill, Chadderton, Oldham, Lancashire.

NEW RECTIFIER RANGE

General Instrument (U.K) Limited, have announced a new family of miniature plastic fast-recovery rectifiers, the R.P.1. series. Packaged in the popular DO-41 outline, the high current diffused-junction series is rated at 10A from 50 to 1000V. Maximum reverse recovery time is 250nS for voltages up to 600V and 500nS for the 800V and 1000V types.



The introduction of this family now means a total package choice for fast recovery rectifiers including the glass DO-29 outline and the recently introduced glass passivated package. The rectifiers will be of particular interest to the TV market, where they are used in scan rectification circuits, and fast response power supply applications.

General Instrument (U.K) Ltd., Cock Lane, High Wycombe, Bucks.

LOW-COST, HIGH GATE SENSITIVITY, TO-92 THYRISTORS

A miniature, TO-92 packaged, thyristor capable of handling 800 mA continuously (d.c) is now available at low cost from Jermyn. At the present time, the company have five versions of the device in stock ranging from the 30V BRX44 to the 200V BRX47.

Manufactured by Raytheon Tag for such applications as lamp driving, alarm systems, counters, switching, etc., over the junction temperature range of -40 to $+125^\circ$C the device, typically, only require the very low gate trigger current of 20 uA.

The 100V version, BRX46 costs 33p each in quantities below 25.

Jermyn, Vestry Estate, Sevenoaks, Kent.

component news

RADIAL LEAD/PANEL MOUNTING HIGH BRIGHTNESS L.E.D.

Now included in the range of products stocked by Guest International Limited are the Red - Lit 4403 and 4440 high brightness LED lamps.

The Red - Lit 4403 is a high brightness Gallium Arsenide Phosphide solid state LED lamp, with a large full flooded front radiating area and wide angle viewing. It has a luminous intensity of 1.2 med at 20mA, and a power dissopation of 200mW.

The Red - Lit 4440 is a lower cost version, with a luminous intensity of 0.8 med at 20mA. Both can be soldered directly to a p.c. board, or mounted in a panel with a snap in mounting clip. Typical applications include circuit status indication, visual indicators, warning lights and numeric displays.

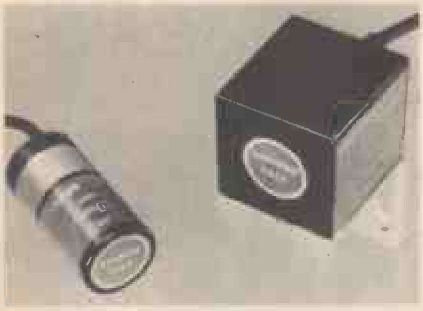
Guest International Ltd., Redlands, Coulsdon, Surrey CR3 2HT.

PROXIMITY SWITCH

Bremar Engineering of Watford have introduced two new versions into their range of Inductive Proximity Switches. These are the Types A.450 and A.850 giving maximum sensitivity of 20mm and 30mm respectively.

An electrical output is produced when a metal object leaves the sensing face of the switch. These new types are therefore complementary to the existing 'B' range of switches where an electrical output is produced in the presence of a metal object.

The output from the 'A' series switch - in the absence of metal - is a d.c. voltage which is applied across the load. The maximum load current of 125mA and the low output resistance of the switch permits direct operation of relays, electro-magnetic counters, etc.



A potentiometer adjustment is provided to set the sensitivity of the switch to any desired value up to the maximum. This control may also be used to de-sensitize the switch from the effects of surrounding metal objects that are not required to be detected.

The incorporation of a Schmitt trigger stage into the solid-state circuit results in a precise switching action, the leading and trailing edges of the output waveform being almost vertical. These switches are ideally suited for 'logic' applications.

These switches operate a nominal 24V unstabilised d.c. supply and are fully protected against accidental reversal of the supply voltage leads and against short-circuits across the load.

Bremar Engineering, Queen Mary's Ave., Watford, Herts WD1 7JR.

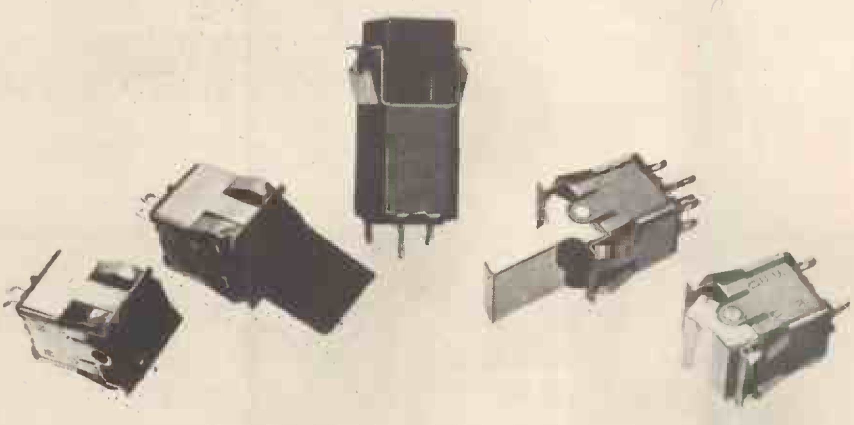
LOW NOISE FETS

A new range of FETs (2N3365-67) offers a guaranteed low-noise level in addition to meeting all the type number requirements specified by Jedec.

Just introduced by Motorola, the range comprises three silicon n-channel junction field effect with interchangeable source and drain connections. Drain current at zero gate voltage when the drain/source voltage is 30V varies with device type from 50 to 250μA for the 2N3367 to between 800μA and 4mA for the 2N3365.

Motorola Semiconductors Ltd., York House, Empire Way, Wembley, Middlesex.

NEW SWITCHES



A new range of miniature switches with snap-in fixing facility is now available from Eagle.

Their design and construction helps to simplify and speed up chasis panel assembly, since no screws, nuts or bolts are required.

The new range includes miniature push-button, rocker and toggle types, with finishes in black and silver. All switches in the range are size-interchangeable, and all are ergonomically designed, requiring minimum pressure for activation.

There are also a number of new standard toggle switches, DPST and DPDT, complete with on-off mounting plate.

Eagle International, Precision Centre, Heather Park Drive, Wembley, Middlesex.

EQUIPMENT NEWS

NEW OSCILLOSCOPES

Hewlett-Packard have recently been bringing out a number of new products which are aimed outside their traditional market, i.e. research laboratories, universities etc. The hand-held multimeter, details of which were given in last month's issue, is one of these new products and this has quickly been followed by two new 'scopes which are well down-market for Hewlett-Packard.

At around the £300 mark, the two new 'scopes are certainly the cheapest in the company's range. The casing is one of the most unusual features, being a plastic moulding in two parts, one of which is the cover; screening is in the plastic case itself. ETI were invited to the launch of these 'scopes at which a photograph was shown of one wheel of a car resting on the case to demonstrate the strength.

The 15MHz oscilloscopes are available in single and dual channel models, all have a sensitivity from 2mV/cm to 10 V/cm, making them useful not only for basic analyses of audio, video, and logic circuits, but also for such low-level uses are measuring FM IF performance, or the direct output of mag pickups and heads. Special facilities are included to simplify television servicing.

The CRT screen is large, 8 x 10 cm, and its display is calibrated vertically and horizontally. Vertical accuracy of 30% and time base accuracy of 4% approach the limit of the eye's ability to detect inaccuracy. DC coupling can be chosen, so the 'scope can directly measure absolute voltage levels, even of mixed a.c. and d.c. signals. A times-ten expander makes it easy to examine details.

The graticule is internal, so there is no possibility of parallax error when reading

the screen. There is a pushbutton beam finder to return the trace to the screen under any conditions so set-up is quick.

Built-in TV sync separation assures stable, automatic triggering on frame or line for convenient TV troubleshooting. With the instrument's times-ten magnifier, vertical interval test signals can be pulled out easily. Since sweep is calibrated, it is easy to identify timing problems in vertical or horizontal TV circuits. The external horizontal input allows vector presentations of drive signals for colour TV's and the dual channels allow the proper setting of colour demodulator circuits.

Both Model 1220A and 1221A are entirely of solid-state design (except for the CRT) including 16 integrated circuits. One consequence is low power consumption, and therefore low heat. Low heat, along with conservative ratings on all components, ensures a long, trouble-free life. Inputs are protected to 400V, reducing chances of accidental electrical damage.

The basic stability of circuits and components is such that internal adjustments have been reduced to only 17. While it is expected that these will rarely need resetting, recalibration is simple and straightforward when compared with most other oscilloscopes. There are no external screwdriver adjustments. Should troubleshooting become necessary, the operating and service manual spells out procedures which make it easy for the user to handle any problems by himself, if he chooses.

Price of Model 1220A is £313 and Model 1221A is £250.

Hewlett-Packard Ltd., 224 Bath Road, Slough, Bucks.

SHORT RANGE BURGLAR BEAM

Photain Controls Limited have announced the introduction of a new short range Gallium Arsenide Burglar Beam. Each beam consists of two housings, one of which contains a solid state infra red emitter, the other one containing a photoelectric cell with amplifier and switch circuits. The miniaturised burglar beam was primarily developed for use in domestic premises and its small size allows the unit to blend into the decor of the most luxurious of surroundings. Contained in a standard switch box the units are most suitable for flush mounting and with only a small black perspex square fitted over the front of each housing, the entire unit forms a most unobstrusive method of intruder detection.

Photain has carried out a considerable amount of field research into the production of this new beam so as to eliminate the

false alarm problems that have been associated with burglar alarms in the past.

The projector emits an invisible pulse modulated infra red beam of light that leaves the projector at a wide angle in the form of a solid cone which expands slightly as it travels towards the receiver. The receiver can detect the light anywhere within the larger diameter cone and a large solar cell in the receiver allows for considerable misalignment. To ensure extremely high tolerances, facilities are provided to ensure that the beam is aligned to give maximum performance. Connections are provided to light a small bulb to indicate when the beam is in line and additional facilities allow for connection to any quality multimeter to indicate when the beam is perfectly aligned.

Both projector and receiver units are mounted in pressed steel housings 80mm x 80mm x 45mm and operate from a 12V d.c. supply. They have a combined current consumption of 60mA and therefore can operate for long periods from dry cell batteries. When the beam is broken a relay provides a changeover action to initiate a remote alarm circuit and the unit then automatically re-sets 1 second after the beam is re-made. The range is 15 metres maximum, subject to local conditions and the price is £32.00.

Photain Controls Ltd., Randalls Road, Leatherhead, Surrey.

EQUIPMENT NEWS

A NEW DESK–TOP VERSION OF THE HP–80 AND A NEW MASS MEMORY

Hewlett-Packard have introduced two new companion products for their growing calculator line. They are the HP-81, a desk top version of the successful HP-80, and a new 'mass-memory' system which is compatible with Hewlett-Packard's Model 9830 office calculator.

The new HP-81 combines all the features found on the HP-80 plus others totalling fifty functions, with twenty memories, and a paper tape printer with special alphabetical capabilities and an optional lighted display. The powerful unit will be of special interest to businessmen who deal with the relationship of time and money.

Hewlett-Packard's two new 'mass-memory' systems have the capability to handle either 300,000 or 600,000 items and are adaptable to the Model 9830 calculator. The resulting combined installation solves inventory control, accounts receivable, payroll and many other commercial, scientific and industrial problems which previously have required much more expensive systems.

Hewlett-Packard, 244 Bath Road, Slough Bucks.

SIMPLE SOLVENT AIDS NON–DESTRUCTIVE ANALYSIS

A new solvent, available from Teleproduction Tools Ltd, is designed to dissolve epoxy and polyester resins, 'Araldite', etc., to leave basic components/substrates clean and clear for analytical purposes. Manufacturers concerned with potted components, circuits or assemblies; or with polyurethane painted finishes or glass-fibre structures, will appreciate the benefits of such a solvent, though the companies who pot circuitry to prevent it being copied will not exactly raise their hands in excitement!

Stironol, as the solvent is known is simple to use - merely pour the required amount into a suitable container and immerse the article to be reduced. Dissolution time will vary from a few hours to perhaps a day or two, dependent upon the volume of resin and the degree of curing.

The solvent is suitable for de-potting miniature transformers - where individual wires and windings can be readily separated; it will reduce plastic-packaged electronic components to basic substrates; it will separate polyurethane paint from spray-plant, guns, etc. - such paints are normally

untouched by commercial strippers. Industrial uses are manifold; wherever plastic coatings or similar encapsulations are used, it has many likely applications.

The photograph shows a commercially available touch-sensitive lighting switch, which is supplied in fully-potted form to protect components from environmental atmospheres, etc. The unit was semi-immersed in stironol for a few hours and the clean untouched components can be seen ready for test/inspection analysis. Even glass-fibre structures, which are generally considered indestructible, respond to treatment.

Teleproduction Tools Ltd., 28b Hamlet Court Road, Westcliff-on-Sea, Essex.

MINI-DRILL

The Mini-Drill type D-1 (now available from Guest Distribution Division) has been designed for drilling prototype PC boards and is designed for use in laboratory, home. or in the field by service personnel.

Each Mini-Drill is supplied complete with battery pack accepting 4 x HP7 type batteries, a combined chuck key/centre punch

and a 1.0mm diam. drill. The size of the drill is 41mm diameter x 181mm, and the chuck accepts drills from 0.8 to 1.4mm.

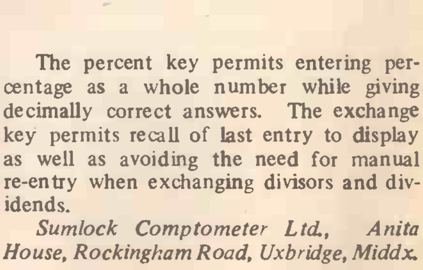
For constant use, a mains adaptor type AD660 (available as an extra) can be supplied giving 6V at up to 600mA.

Guest International Ltd., Redlands Coulsdon, Surrey, CR3 2HT.

ANITA 1216 DISPLAY CALCULATOR

The new Anita 1216 is a versatile, low-cost calculator from Sumlock. The unit includes memory; automatic chaining; automatic decimal system; constant, percent and exchange keys. The display is a big, easy-to-read 12-column Panaplex system.

Individual problems can be worked and accumulated in the independent memory register, while the 12-column capacity coupled with advanced float in/fixed out decimal system and underflow ensure that Anita 1216 can tackle everyday calculations with ease. Mixed calculations (e.g. 2 x 3 + 4) are carried out in a single continuous flow operation.



The percent key permits entering percentage as a whole number while giving decimally correct answers. The exchange key permits recall of last entry to display as well as avoiding the need for manual re-entry when exchanging divisors and dividends.

Sumlock Comptometer Ltd., Anita House, Rockingham Road, Uxbridge, Middx.

DX MONITOR

Compiled by Alan Thompson

CHEERIO 1973 - Hello 1974, that could well sum-up our feelings at this time of year! For many reasons, 1973 has not been the greatest of great years for a large number of us and not least in the DX sphere, where, apart from a few bright spots to relieve the monotony, it has been the sort of year that one very quickly forgets — it has not brought us any great surprises or outstanding reception conditions, nor have we been blessed with any (audible in the U.K.) new countries to chase after. So it is with very little regret that DXers see 1973 coming to a close and we hopefully look forward to better things in 1974.

December issues of magazines are rather different from those of the other 11 months, if my experience is anything to go by. Either you hunt through them looking for Christmas presents hoping against hope that your order will beat the usual pre-Christmas rush, or else they get pushed on one side until the holly and the tinsel are safely in position, the turkey and the Xmas pud are consumed and you can't stand the joke slip in the tenth cracker which asks *"What did Gladstone say on Jan 1st, 1881?"*, and, THEN, about a month after you bought it (the magazine, not the joke!) you decide to have a quiet browse. Whatever your approach to a December issue it means that the feature-writer gets mild schizophrenia trying to please his readers!

For the present-hunters in the DX market there are lots of goodies found in the pages of the radio magazines and catalogues — enough to satisfy all depths of purses and all kinds of interests. Should anyone be looking for a few suggestions then a couple of books that will be of use throughout 1974 are *"World Radio and TV Handbook 1974"* (price £3.00) and *"How to Listen to the World, 8th Edition"* (price £1.95). Your local bookseller can obtain either of the titles for you and they should be available by the turn of the year. The *"World Radio Handbook"* is the *vade mecum* for all DXers and those interested in broadcasting since it gives details of virtually all radio and TV stations in the world, their operating schedules and frequencies and lots more data besides. If you have any interest in DXing you just can't afford to be without it as it is the nearest to a complete list of radio stations that one can find anywhere.

On the technical side of the hobby, choice is virtually unlimited ranging from nice new receivers at anything up to (or over!) £1,000 a time: through preselectors, Q-multipliers, specialist aerials, digital clocks and frequency standards (all those in the up to £20 range): right down to multi-way switches (useful for connecting various aerials to a receiver), spare valves (what a difference a couple of new r.f. and i.f. amplifier valves can make!) or some nice new plugs and sockets to replace that lash-up that you've been meaning to replace for the last two years. The choice is yours - just get the appropriate catalogue, mark the items in bright ink and leave it where the YL or XYL can see it and hope that the message will get through in time for the required item to appear in *your* stocking on Christmas morning, hi!

On the operational DX front, Christmas is always a rather pleasant time for a spot of DXing if you can manage to get away from the festivities for an hour or so. The fact that the holiday falls just as the days are at their shortest means that afternoons come into their own for good Asian DX and, dare I say this, there is rather less communications traffic about than at other times of the year. Another factor is that many stations extend their schedules at this time of the year and one never really knows what one may hear as these schedule extensions seldom get any publicity in the radio press as they are so short-lived.

It is the 60 metre band which provides the happiest hunting ground for the serious DXer around this season - there's rarely an afternoon when there isn't something to be heard! The Australian Broadcasting Corporation's station at PORT MORESBY in NEW GUINEA is a good place to start one's search around the dial: Port Moresby signs off for the night at just after 1405 GMT on most days (although sometimes on a Saturday it can be heard with sports commentaries until about 1600), on 4890kHz, and when conditions are good it can often be heard as early as 1230 or so. Another ABC station which often appears at good strength around about Christmas is the domestic outlet at BRISBANE on 4920kHz. This one frequently appears over the long-path across South America between about 0730 and 0930 GMT.

Moving over Asia, RANGOON has two outlets in the 60 metre band — the Burmese service is to be heard on 4725kHz until 1445 GMT, whilst the English service has recently moved to 5020kHz (from 5040kHz) and goes on for an extra hour or so. The Burmese Broadcasting Service is one of those that does not verify very easily but some QSLs have been reported by determined reporters.

RADIO SINGAPORE is a pretty regular sound in most DXers headphones at this season: there is a choice of two frequencies in the 60 metre band — on 5050kHz, or thereabouts, the English Service is often heard from about 1500 until it signs-off at 1630, rather less powerful, and so less easy, is the Chinese Service on 5010kHz using the old British Forces Broadcasting Service 10kW transmitter. Give them a try, too, around about 2230-2330 in the late evening.

RADIO MALAYSIA offers quite a choice of frequencies in the 60 metre range. The two which are most commonly heard (usually from 1500-1630 or 2230-2330, approximately) are the English Service on 4985kHz or the Indian Service on 4845kHz.

INDIA, PAKISTAN and BANGLADESH all use outlets on this active band for their evening (our late afternoon) transmissions and they crop up on all sorts of different frequencies as they are Home Service outlets from a great variety of locations. A few to try for are — Bangladesh broadcasting for Dacca on 4790kHz: Radio Pakistan from Karachi and Islamabad on 4875 and 4975kHz: All India Radio on a host of channels including 4775, 4800, 4820, 4920, 4940 and 4990kHz. For AIR I have not given the locations as these change fairly often and are usually identified in the station announcements. This part of the world, too, is best heard from around 1530 to about 1800, or again after 0030 when their morning services start up.

Last country for a mention this time is the remote kingdom of

Nepal. RADIO NEPAL, located in Kathmandu, uses 5000kHz for its Home Service on a 100kW transmitter. Like the Indian sub-continent stations, it fades in around about 1500 but there is the added complication that 5000kHz is one occupied by Standard Frequency and Time Signal stations so reception is usually in the 5 minute gaps when the British MSF is off the air. Most programmes are in Nepali and contain a great deal of Indian film-music. Nepal's local time is 5 hours 40 minutes in advance of GMT which accounts for the evening sign-off coming at 1720 GMT, and their re-starting the morning transmission at 0020 GMT.

That's our round-up of DX for this month - all times are in Greenwich Mean Time as usual. A very Merry Christmas to one and all, and may 1974 bring you everything you wish for you and yours.
PS. *What did Gladstone say? Happy New Year, of course!*

QSL COLLECTORS CORNER

Many of the more exotic DX stations have QSLs which would only evoke a thrill in the breasts of the keenest DXer - such is RADIO GAMBIA. The Gambia achieved independence in 1965 and recently changed the name of its capital city from the familiar Bathurst to Banjul. One of the smaller countries of Africa with a population of something over 300,000, Gambia's radio voice is small, too -- a mere 3.1kW reception of which in the U.K. is made even more difficult by the fact that the maximum lobe of its aerial lies in an east-west direction. Nevertheless, Radio Gambia may often be heard on 4820kHz in the evening hours, often putting in a strong signal over the powerful Angolan transmitter that shares its frequency. Much of the programming is in Wolloff, Mandinka, Fula, Sarahule and Jola but BBC World Service news is relayed at 2000; there is National news at 2100 and 2255 in English (and local languages) and sign-off is at 2300 GMT. In good conditions, try catching this one when it signs-on at 0625 with a programme summary followed, at 0630 by Koran recitations until the news at 0700. (Sunday sign-on is not until 0830 GMT).

Radio Gambia,
Bathurst,
The Republic of the Gambia.

RG/06B/Vol.IV/( )

.......................19,......

Dear Sir,

Thank you very much for your communication of ....enquiring about Radio Gambia. I have pleasure in confirming/am unable to confirm that the station heard was Radio Gambia.

Radio Gambia is a Government-owned broadcasting service, and is on the air from:-

6.30 a.m. - 8 a.m.)
12.00 p.m. - 2 p.m.) Mondays - Fridays
5.00 p.m. - 11 p.m.)

6.30 a.m. - 9 a.m.)
12.00 p.m. - 2 p.m.) Saturdays
5.00 p.m. - 11 p.m.)

9.00 a.m. - 2 p.m.)
5.00 p.m. - 11 p.m.) Sundays

Most of the programmes are produced and recorded locally by Radio Gambia staff, although some use is made of recorded material supplied by the BBC and other organisations. Most of our programmes are in English, Wolloff or Mandinka, the languages most widely spoken in The Gambia; we do however, broadcast in the other African languages spoken here, namely Fula, Sarahule and Jola.

The transmission of our programmes is carried out by Cable & Wireless Ltd., who use a Marconi HS-31 transmitter with a power of 3.1 KW and a vertical incident radiator orientated so that the maximum lobe is in a East-West direction. The frequency is 4820 Kc/s in the 60 metre band.

Radio Gambia started regular broadcasting on 1st May, 1962, and the aim has been to provide a service of broadcast information, education and entertainment; there are also a religious broadcasts by the Islamic religion and by three Christian denominations.

The Gambia, which attained Independence on 18th February, 1965, and became a republic on 24th April, 1970, is the closest English-speaking tropical country to Europe. There is a population of some 316,000 people (1963 census) about 28,000 live in and around the capital city, Bathurst. The rest of the people live in rural districts. The people of The Gambia are predominantly Muslim.

Thanking you for your interest in Radio Gambia.

I remain,

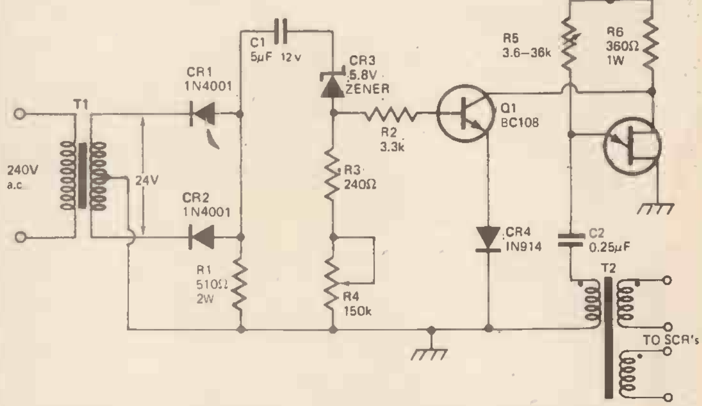
Yours faithfully,

DIRECTOR OF INFORMATION & BROADCASTING.

To:-
....
....
....

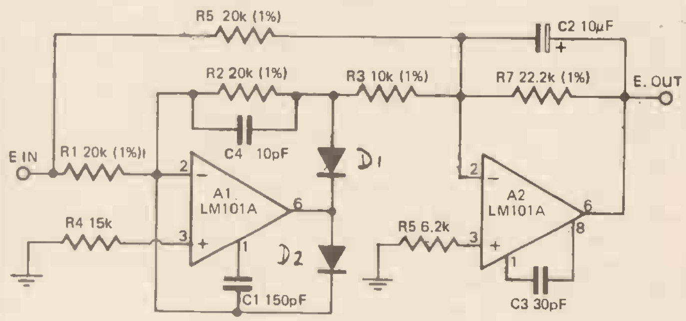
TECH TIPS

ZERO CROSSING SYNC CIRCUIT



Zero crossing control of SCRs or Triacs is preferable to phase control because less RFI is generated. The circuit shown was developed for a temperature control system and effectively maintained temperature at any set point from ambient to 100°C. Resistor R5 may be a potentiometer, a thermistor or any type of sensing device. R4 is adjusted so that the breakover point of CR3 is at the peak of the reference voltage (zero crossing point of ac wave).

PRECISION AC TO DC CONVERTER



The circuit shown provides better than 1% conversion accuracy of ac signals up to 100 kHz. The output is calibrated to read the rms value of the sine-wave input with less than 1% ripple at 20 Hz.

Amplifier A1 with diodes D1 and D2 forms a precision half-wave rectifier and the amplifier A2 sums the half-wave rectified signal and the input signal to provide a full-wave output. For negative input signals, the output of A1 is zero and no current flows through R3. Neglecting the effect of C2,

the output of A2 is $-\frac{R7}{R6}$ E in.

For positive input signals A2 sums the currents through R3 and R6

$$E\ out = R7\left(\frac{Ein}{R3}\quad\frac{Ein}{R6}\right)$$

If R3 is ½ R6, the output is $\frac{R7}{R6}$ Ein

Hence the output is always the absolute value of the input.

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