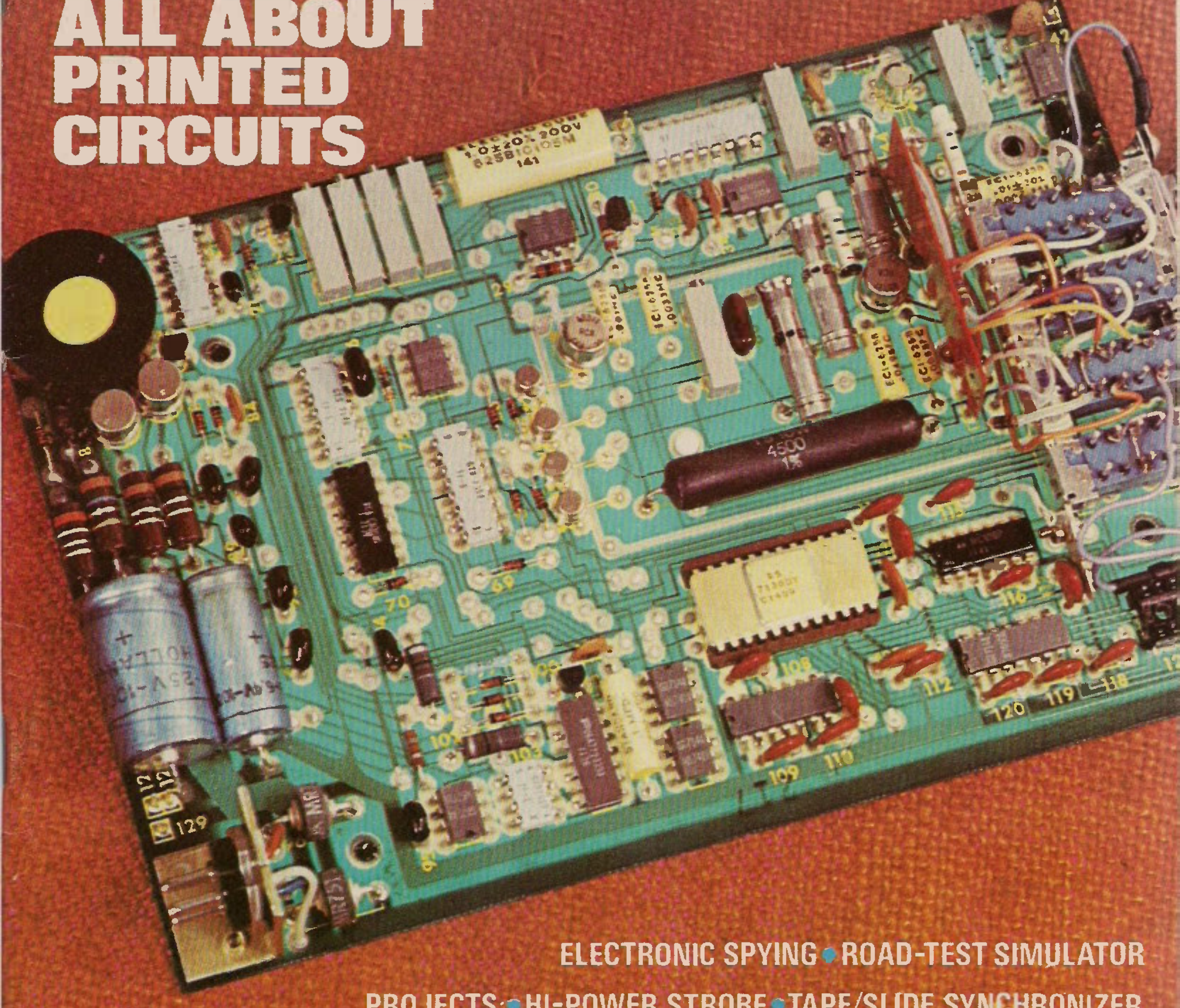
BRITAIN'S DYNAMIC NEW MONTHLY—NO.3 20p

electronics TODAY INTERNATIONAL

JUNE 1972

ALL ABOUT PRINTED CIRCUITS



ELECTRONIC SPYING • ROAD-TEST SIMULATOR

PROJECTS: • HI-POWER STROBE • TAPE/SLIDE SYNCHRONIZER

HI-FI TESTS: • DECCA 'LONDON' CARTRIDGE • GOODMANS D-8, SONAB OA-5 SPEAKERS

TTL 7400 SERIES INTEGRATED CIRCUITS

* MIX PRICES
* FULLY GUARANTEED
* LARGE QUANTITY PRICES ON REQUEST

Type No.	1-24	25-99	100 Plus	Type No.	1-24	25-99	100 Plus
SN 7400	.18	.16	.14	SN 7491	1.00	.95	.90
SN 7401	.18	.16	.14	SN 7492	.75	.70	.65
SN 7402	.18	.16	.14	SN 7493	.75	.70	.65
SN 7403	.18	.16	.14	SN 7494	.80	.75	.70
SN 7404	.18	.16	.14	SN 7495	.80	.75	.70
SN 7405	.18	.16	.14	SN 7496	1.00	.97	.95
SN 7406	.30	.27	.25	SN 7497	6.25	5.50	5.00
SN 7407	.30	.27	.25	SN 74100	2.50	2.30	2.00
SN 7408	.20	.19	.18	SN 74104	1.45	1.35	1.20
SN 7409	.45	.42	.35	SN 74105	1.45	1.35	1.20
SN 7410	.18	.16	.14	SN 74107	.50	.45	.40
SN 7411	.23	.22	.20	SN 74110	.80	.70	.60
SN 7412	.42	.40	.35	SN 74111	1.45	1.35	1.20
SN 7413	.30	.27	.25	SN 74118	1.00	.95	.90
SN 7416	.30	.27	.25	SN 74119	1.90	1.78	1.65
SN 7417	.30	.27	.25	SN 74121	.60	.55	.50
SN 7420	.20	.18	.16	SN 74122	1.35	1.25	1.10
SN 7422	.48	.44	.40	SN 74123	2.70	2.55	2.47
SN 7423	.48	.44	.40	SN 74141	1.00	.95	.90
SN 7425	.48	.40	.35	SN 74145	1.50	1.40	1.30
SN 7427	.42	.39	.35	SN 74150	3.35	2.95	2.15
SN 7428	.50	.45	.42	SN 74151	1.10	.95	.90
SN 7430	.20	.18	.16	SN 74153	1.35	1.27	1.20
SN 7432	.42	.39	.35	SN 74154	2.00	1.75	1.55
SN 7433	.70	.61	.44	SN 74155	1.55	1.47	1.35
SN 7437	.65	.60	.50	SN 74156	1.55	1.47	1.35
SN 7438	.65	.60	.50	SN 74157	1.80	1.70	1.50
SN 7440	.18	.16	.14	SN 74160	2.60	2.40	2.25
SN 7441	.75	.72	.70	SN 74161	2.60	2.40	2.25
SN 7442	.75	.72	.70	SN 74162	3.60	3.40	3.25
SN 7443	1.00	.95	.90	SN 74163	3.60	3.40	3.25
SN 7444	1.75	1.60	1.45	SN 74164	2.75	2.30	2.10
SN 7445	2.00	1.75	1.60	SN 74165	4.00	3.50	3.00
SN 7446	2.00	1.75	1.60	SN 74166	4.00	3.50	3.00
SN 7447	1.75	1.60	1.45	SN 74167	6.25	5.60	5.10
SN 7448	1.75	1.60	1.45	SN 74170	4.10	3.55	3.05
SN 7449	1.00	.95	.90	SN 74174	2.00	1.75	1.30
SN 7450	.18	.16	.14	SN 74175	1.35	1.27	1.15
SN 7451	.18	.16	.14	SN 74176	1.60	1.35	1.20
SN 7453	.18	.16	.14	SN 74177	1.60	1.35	1.20
SN 7454	.18	.16	.14	SN 74180	1.55	1.30	1.20
SN 7460	.18	.16	.14	SN 74181	7.00	6.00	5.50
SN 7470	.30	.27	.25	SN 74182	2.00	1.80	1.60
SN 7472	.30	.27	.25	SN 74184	2.40	2.00	1.80
SN 7473	.40	.37	.35	SN 74185A	2.40	2.00	1.80
SN 7474	.40	.37	.35	SN 74190	2.95	2.85	2.75
SN 7475	.55	.52	.50	SN 74191	2.95	2.85	2.75
SN 7476	.45	.42	.39	SN 74192	2.00	1.90	1.80
SN 7480	.80	.75	.67	SN 74193	2.00	1.90	1.80
SN 7481	1.25	1.15	1.10	SN 74194	2.50	2.25	1.90
SN 7482	.87	.80	.70	SN 74195	1.85	1.70	1.60
SN 7483	1.00	.90	.85	SN 74196	1.50	1.40	1.30
SN 7484	.90	.85	.80	SN 74197	1.50	1.40	1.30
SN 7485	3.50	3.30	3.00	SN 74198	4.60	3.70	3.35
SN 7486	.45	.41	.38	SN 74199	4.60	3.70	3.35
SN 7490	.75	.70	.65	SN 74200	21.00	18.50	13.40

DON'T FORGET THE £1 VOUCHER ON PAGE 68

Type No.	1—24	25—99	100 Plus
AC 107	.45	.40	.35
AC 126	.22	.20	.18
AC 127	.20	.18	.15
AC 128	.20	.18	.15
AC 176	.35	.31	.27
ACY 17	.30	.25	.20
ACY 18	.18	.15	.13
ACY 19	.22	.18	.15
ACY 20	.18	.15	.13
ACY 21	.17	.14	.12
ACY 22	.14	.12	.10
ACY 40	.15	.13	.11
ACY 41	.16	.14	.12
AD 149	.44	.38	.35
AD 161/2	.30	.27	.24
AF 114	.25	.21	.18
AF 115	.25	.21	.18
AF 116	.26	.22	.19
AF 117	.25	.21	.18
AF 118	.32	.25	.21
BC 107	.14	.10	.07
BC 108	.10	.08	.06
BC 109	.15	.12	.08
BC 113	.15	.12	.10
BC 114	.15	.12	.10
BC 115	.15	.12	.10
BC 116	.15	.12	.10
BC 118	.15	.12	.10
BC 125	.15	.12	.10
BC 126	.20	.18	.15
BC 132	.15	.12	.10
BC 134	.15	.12	.10
BC 135	.15	.12	.10
BC 136	.15	.12	.10
BC 137	.15	.12	.10
BC 147	.10	.08	.07
BC 148	.09	.07	.06
BC 149	.10	.08	.07
BC 157	.12	.09	.08
BC 158	.11	.08	.07
BC 159	.12	.09	.08
BC 167	.14	.10	.08
BC 168	.12	.09	.07
BC 169	.15	.11	.09
BC 177	.16	.13	.10
BC 178	.14	.12	.09
BC 179	.18	.15	.12
BC 257	.14	.09	.08
BC 258	.12	.09	.07
BC 259	.15	.11	.09
BCY 30	.35	.30	.25
BCY 31	.45	.40	.35
BCY 32	.90	.80	.70
BCY 33	.35	.28	.23
BCY 34	.35	.30	.24
BCY 70	.16	.12	.10
BCY 71	.22	.14	.13
BCY 71A	.23	.20	.15
BCY 72	.13	.10	.08
BF 115	.18	.14	.13
BF 167	.18	.14	.13
BF 173	.20	.16	.15
BF 180	.35	.28	.25
BF 194	.14	.12	.10
BF 195	.15	.13	.11
BFX 12	.30	.25	.20
BFX 13	.30	.25	.20
BFX 29	.30	.25	.20
BFX 30	.32	.27	.22
BFX 84	.24	.20	.16
BFX 85	.30	.26	.22
BFX 86	.24	.21	.17
BFX 87	.27	.23	.18
BFX 88	.25	.20	.16
BFY 39	.90	.80	.70
BFY 50	.16	.13	.10
BFY 51	.16	.13	.10
BFY 52	.16	.13	.10
BFY 53	.15	.12	.10
BSY 11	.32	.24	.18
BSY 26	.17	.15	.12
BSY 27	.20	.16	.14
BSY 38	.18	.15	.13
BSY 39	.18	.15	.13
BSY 95	.15	.12	.09
BSY 95A	.14	.11	.08
C 424	.15	.12	.10

Type No.	1—24	25—99	100 Plus
C 450	.15	.12	.10
OC 20	1.60	1.40	1.10
OC 22	1.10	.90	.70
OC 25	.40	.30	.24
OC 28	.70	.50	.44
OC 29	.75	.60	.48
OC 35	.56	.48	.38
OC 36	.62	.50	.40
OC 44	.40	.35	.28
OC 45	.38	.32	.26
OC 71	.35	.28	.20
OC 72	.35	.28	.20
OC 83	.18	.16	.13
OC 139	.45	.36	.28
OC 140	.70	.55	.46
OC 141	.90	.80	.70
OC 170	.28	.24	.21
OC 171	.32	.27	.24
OC 200	.45	.35	.28
OC 201	.80	.64	.52
OC 202	.85	.75	.60
OC 203	.45	.40	.32
OC 204	.45	.36	.30
OC 205	1.13	.90	.70
OC 206	1.00	.86	.68
OC 207	1.00	.82	.60
OCP 71	.80	.70	.60
V 435	.15	.12	.10
2N 696	.14	.12	.10
2N 697	.14	.12	.10
2N 706	.10	.08	.07
2N 706A	.11	.09	.08
2N 708	.12	.09	.07
2N 743	.15	.12	.10
2N 744	.16	.12	.10
2N 914	.16	.12	.10
2N 918	.42	.35	.29
2N 920	.18	.15	.12
2N 929	.20	.16	.13
2N 930	.24	.19	.16
2N 1131	.24	.20	.17
2N 1132	.24	.20	.17
2N 1613	.15	.12	.10
2N 1711	.20	.15	.12
2N 1890	.38	.34	.30
2N 1893	.45	.40	.35
2N 1899	.30	.28	.26
2N 1990	.40	.35	.30
2N 2017	.80	.65	.50
2N 2120	.50	.44	.34
2N 2218	.22	.17	.14
2N 2218A	.25	.13	.15
2N 2219	.23	.17	.14
2N 2219A	.36	.27	.22
2N 2221	.23	.17	.14
2N 2221A	.25	.18	.15
2N 2222	.23	.17	.14
2N 2222A	.25	.18	.15
2N 2646	.42	.37	.34
2N 2904	.18	.16	.14
2N 2904A	.32	.24	.20
2N 2905	.32	.24	.20
2N 2905A	.35	.27	.23
2N 2906	.24	.20	.16
2N 2906A	.33	.25	.20
2N 2907	.30	.22	.18
2N 2907A	.35	.28	.23
2N 2923	.12	.10	.08
2N 2924	.12	.10	.08
2N 2925	.12	.10	.08
2N 2926 Red	.08	.06	.04
2N 2926 Org.	.09	.07	.05
2N 2926 Yel.	.10	.08	.06
2N 2926 Grn.	.10	.08	.07
2N 3053	.16	.12	.10
2N 3054	.60	.50	.40
2N 3055	.60	.50	.40
2N 3442	1.80	1.50	1.20
2N 3563	.15	.12	.10
2N 3564	.15	.12	.10
2N 3565	.15	.12	.10
2N 3566	.18	.15	.11
2N 3567	.15	.12	.10
2N 3569	.18	.15	.11
2N 3611	.48	.40	.35
2N 3612	.55	.45	.37
2N 3613	.60	.50	.40

Type No.	1—24	25—99	100 Plus
2N 3614	.50	.42	.35
2N 3615	.60	.50	.40
2N 3616	.65	.58	.52
2N 3617	.70	.60	.54
2N 3618	.70	.60	.54
2N 3638	.15	.12	.10
2N 3638A	.15	.12	.10
2N 3641	.15	.12	.10
2N 3642	.15	.12	.10
2N 3643	.16	.13	.10
2N 3644	.18	.15	.12
2N 3645	.18	.15	.12
2N 3646	.25	.20	.15
2N 3691	.15	.12	.10
2N 3692	.15	.12	.10
2N 3693	.15	.12	.10
2N 3694	.15	.12	.10
2N 3715	1.60	1.40	1.00
2N 3716	1.70	1.45	1.10
2N 3740	1.50	1.25	.95
2N 3741	1.60	1.40	1.00
2N 3771	2.60	2.20	1.80
2N 3772	2.20	1.80	1.40
2N 3773	2.60	2.20	1.80
2N 3790	2.50	2.10	1.70
2N 3792	2.60	2.20	1.80
2N 4036	.52	.46	.40
2N 4037	.48	.42	.35
2N 4140	.15	.12	.10
2N 4141	.16	.13	.11
2N 4142	.18	.15	.12
2N 4143	.20	.17	.13
2N 4227	.16	.13	.11
2N 4228	.18	.15	.12
2N 4248	.15	.12	.10
2N 4249	.15	.15	.10
2N 4250	.16	.13	.11
2N 4286	.15	.12	.10
2N 4287	.15	.12	.10
2N 4288	.15	.12	.10
2N 4289	.15	.12	.10
2N 4290	.15	.12	.10
2N 4291	.15	.12	.10
2N 4292	.15	.12	.10
2N 4293	.15	.12	.10
2N 4964	.15	.12	.10
2N 4965	.15	.12	.10
2N 4966	.15	.12	.10
2N 4967	.15	.12	.10
2N 4968	.15	.12	.10
2N 4969	.15	.12	.10
2N 4970	.18	.15	.12
2N 4971	.15	.12	.10
2N 4972	.18	.15	.12
2N 5126	.15	.12	.10
2N 5127	.15	.12	.10
2N 5129	.15	.12	.10
2N 5131	.15	.12	.10
2N 5132	.15	.12	.10
2N 5133	.15	.12	.10
2N 5135	.18	.15	.12
2N 5136	.15	.12	.10
2N 5137	.15	.12	.10
2N 5138	.15	.12	.10
2N 5139	.15	.12	.10
2N 5142	.15	.12	.10
2N 5143	.15	.12	.10
2N 5172	.10	.07	.05
2N 5180	.15	.12	.10
2N 5294	.36	.30	.24
2N 5296	.38	.32	.28
2N 5298	.40	.36	.32
2N 5490	.42	.38	.34
2N 5492	.44	.40	.35
2N 5494	.52	.46	.38
2N 5496	.56	.48	.40

F.E.T. DEVICES

Type No.	1—24	25—99	100 Plus
UC 734E	.25	.21	.16
2N 3819	.28	.21	.17
2N 3823E	.40	.34	.28
2N 4302	.45	.38	.30
2N 4416	.88	.74	.64

LINEAR INTEGRATED CIRCUITS

Type No.	1—24	25—99	100 Plus
709C	.42	.36	.30
710	.60	.48	.42
711	.72	.65	.56
741C	.56	.48	.42
723C	.72	.65	.56

Please state T099 or D.I.L.

ZENER DIODES

BZY88 SERIES (400 mW)
3.3 volts to 30 volts

Prices:	1—24	25—99	100 Plus
	.15	.12	.08

E.F. Electronics

Dual-in-Line sockets

Beryllium Copper Contacts	1—24	25—99	100 Plus
8 pin	.26	.25	.20
14 pin	.28	.26	.21
16 pin	.30	.27	.22
24 pin	.90	.70	.60
40 pin	1.15	.95	.88

15 WATT IC AUDIO AMPLIFIER

PRICE **£3.95** SEND 10p FOR BOOKLET

SMALL SIGNAL DIODES

Type No.	1—24	25—99	100 Plus
BAX16	.06	.05	.04
OA5	.30	.25	.20
OA10	.50	.42	.35
OA47	.06	.06	.05
OA90	.05	.04	.03
OA91	.05	.04	.03
OA200	.08	.06	.05
OA202	.08	.06	.05
IN914	.05	.04	.03
IN916	.06	.05	.04
IN4009	.05	.04	.03
IN4148	.05	.04	.03
IN4149	.06	.05	.04

PLASTIC RECTIFIERS

1 AMP RECTIFIERS

Type No.	1—24	25—99	100 Plus
IN 4001/SD 05	.05	.04	.03
IN 4002/SD 1	.06	.05	.04
IN 4003/SD 2	.07	.06	.05
IN 4004/SD 4	.08	.07	.06
IN 4005/SD 6	.09	.08	.07
IN 4006/SD 8	.10	.09	.08
IN 4007/SD 10	.12	.11	.10

SEND 5p FOR FREE !! CATALOGUE

Semiconductor Supplies

55, Whitehorse Road, Croydon, Surrey. CRO 2JG
Tel. 01-689 0676/7 DEPT. E.T.I/1

TRADE ENQUIRIES WELCOME

CASH and CARRY COUNTER OPEN
9.30 – 5.30
MON – FRI

electronics TODAY INTERNATIONAL

JUNE Vol. 1 No. 3

main features

product tests

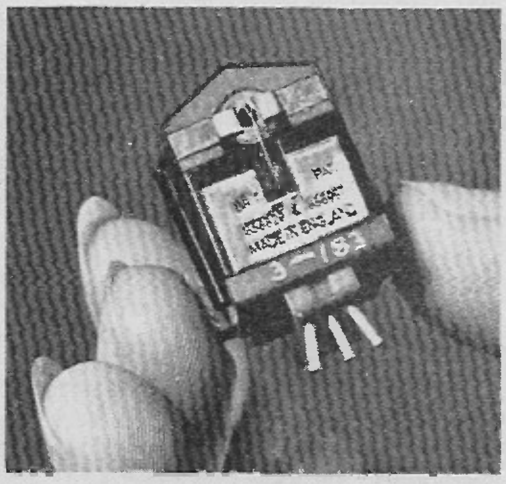
projects

reviews

news & information

COVER: Complex printed circuit board (from a Keithley digital multimeter) introduces one of this month's main feature articles – the hows and whys of printed circuit design and manufacture.

JULY ISSUE ON SALE JUNE 16th, 1972



ELECTRONICS TODAY INTERNATIONAL, 107 Fleet Street, London EC4. Phone 01-353 1040. Published by WHITEHALL PRESS LIMITED, 29 Palace Street, London SW1. Phone 01-834 0423/4. Australia: Modern Magazines (Holdings) Ltd, 21-23 Bathurst Street, Sydney 2000. Phones 26-2296, 26-6129. USA: A.C.P., Room 401, 1501 Broadway, New York. Japan: Bancho Media Service, Shinanomachi, Shinjuku-ku, Tokyo. Distributed by Argus Press Ltd. Printed in England by Alabaster Passmore & Sons Ltd, London and Maidstone.

Collyn Rivers
Editorial Director

Paul Godden
Editor, British Edition
Electronics Today International

Donn Donovan
Advertisement Manager,
British Edition
Electronics Today International

International Editions
Engineering Manager:
Barry Wilkinson

Production Manager:
Bob Izzard

Projects Adviser:
Kim Ryrie

Laboratory Technician:
Rob Giurnelli

Review Editor:
John Clare

Acoustical consultants
Louis A. Challis & Associates

Art Director:
Clive Davis

Advertisment Manager:
Howard Jenkins

needed: better quality control

ELECTRONICS TODAY INTERNATIONAL and our associates have over the past year tested more than 75 separate items of high-fidelity equipment.

From a British point of view some of our findings are rather worrying. Of the 22 British-made items we tested, nine had major failings mostly due to quality control – or the lack of it!

These faults were not confined to cheap equipment. For example, a world-famous brand of tape recorder; three units had to be checked before one could be found in reasonable working order.

In another instance, a speaker was delivered for review together with its own manufacturer's frequency response graph. The speaker had a splendid performance – according to this graph. But, on test it sounded dreadful – and understandably so. The tweeter had not been wired into circuit!

Our acoustical consultants tell us the problem is one of quality control rather than design, certainly in the case of the tape recorder described above. The performance of the unit we eventually tested was superb.

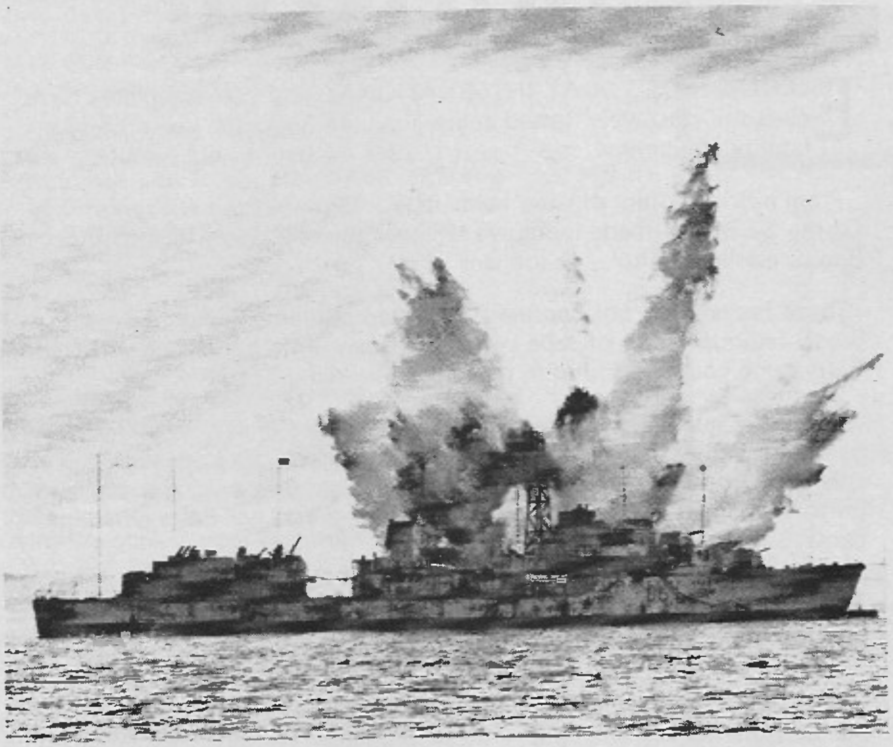
To a lesser extent foreign gear suffers in the same way. But – and here our consultants are adamant – these problems are rarely experienced with Japanese equipment.

ELECTRONICS TODAY INTERNATIONAL is a magazine run by engineers and as such we know from first-hand experience how easily good design can be compromised by careless assembly.

In the face of ever-growing competition from overseas, and in particular from the EEC, it is clear that a higher standard of quality control is essential if we in Britain are to retain our reputation as top manufacturers of quality engineered products.

news digest

UNDERWATER EXPLOSIONS



It is of vital importance for warship designers to know exactly what happens to a ship under attack. This must include knowledge of the various stresses and strains encountered by the hull and superstructure.

Currently the Naval Construction Research Establishment at Rosyth in Scotland are researching the effects of underwater explosions to surface craft, as they have found that near misses tend to have a far greater effect than was previously supposed.

To carry out this research the NCRE is using an ex-naval warship extensively fitted out with transducers of their own design. The old-timer is then fired at and the readings from the transducers passed to a monitoring vessel via hard-wired cables.

It is from the monitoring vessel – a converted wartime torpedo recovery vessel – that the whole experiment is controlled. Here four Bell and Howell VR3300 tape recorders simultaneously store 56 channels of information coming in from the target vessel. The data is conditioned by an array of amplifiers before being recorded.

When the results of the test have been recorded all the tapes are replayed on a shore based tape-deck, the exact time correlation being preserved by use of a 1 kHz reference signal on each of the five ship borne tape recorders. The data is then fed channel by channel into an uv oscillograph for visual analysis before being digitised and fed into a computer.

Although the efforts of the NCRE are primarily aimed at the defence effort, a vast amount of spin off is available to the civilian ship builder, especially in the design of super tankers – which tend to be a law unto themselves.

PIEZO PUMP

Britain's C.A.V. company have signed a joint development contract with Physics International of California to develop piezo crystals for us in diesel fuel injection systems.

The fact that crystals exhibit an almost instantaneous shape change when a voltage is applied could well lead to injection pumps more responsive than those in current use.

LIQUID CRYSTAL WATCH

NEW YORK – A major Swiss manufacturer of watch movements and components, Ebauches S.A. last week introduced a line of quartz electronic watches, including one unit with a liquid crystal digital time display.

The digital watch utilizes a quartz resonator and liquid crystal display developed in co-operation with Texas Instruments, Dallas, U.S.A.

Dr. Kurt Hubner, vice-president of Ebauches Electroniques S.A., said that the liquid crystal would last in "in excess of five years," but after that "no-one really knows" how long the crystal will retain its qualities or how it will show its age.

The new watch uses two bipolar chips measuring 6mm square and a small power cell claimed to last more than a year.

IBM MONOPOLY?

Speaking at the recent Infotech State of the Art Lecture '1980', Dr. Herbert Grosch of the US Bureau of Standards said that 'by 1980 most big names will have disappeared or withdrawn . . . from the computer field . . . 90 percent of the world computer market will be in the hands of one firm – IBM.

'The remainder,' said Dr. Grosch, 'will consist of small specialised companies outside IBM's sphere of influence.'

Dr. Grosch made a number of specific predictions. He forecast that Telefunken will retire from the market before the end of this year; Philips in 1973, Siemens in 1974, ICL perhaps in 1977. Nixdorf, he says may survive – but only if they keep in the 'visible records market.'

These assertions, says Dr. Grosch, are based on the fact that only IBM can continue to afford the enormous costs of developing new computing systems. Even at present IBM are known to spend over $400,000,000 a year on research and development alone.

Pessimistic though they may be, Dr. Grosch's remarks are being taken

Concluded overleaf

very seriously by the industry. Formulator of the so-called Grosch's Law of Computing, Dr. Grosch predicted 18 months beforehand – and almost to the day – that RCA would cease computer production in late 1971.

It is interesting that since RCA pulled out of the computer business, that company's last quarter earnings increased by no less than 52.5%.

PHILIPS PROFESSIONAL DATA CASSETTE

Philips are introducing a cassette for digital application. The Professional Cassette, LGH6003, has been specifically developed for the collection and retrieval of electronic data. Profiting from Philips' design and production knowledge in the field of the compact cassette, the Professional Cassette has outstanding qualities which it is claimed give it a marked superiority over punched paper tape and cards for digital data storage.

The cassette uses a precision metal frame with screwed-on side covers ensuring the highest possible precision in tape guidance. The metal frame eliminates static charges by providing a discharge path for any electro-static build up on the tape.

The precision metal reference surfaces are part of the frame and allow for an exact head-to-tape positioning. Lengthy tests have proved the performance and dimensional stability of the data cassette over long periods of use – more than 2,000 full passes and virtually unlimited storage.

Philips LGH6003 Cassettes contain 86 metres (approx. 300 feet) of high-grade splice-free computer tape, tested for signal amplitude. Each cassette is individually (and over the full tape length "in cassette") certified at 64 flux changes per mm (1600 f.c.p. inch) for drop-outs and drop-ins.

The tape is provided with a beginning-of-tape (BOT) and end-of-tape (EOT) marker by means of a hole for optical detection in the tape, which is attached to the hubs via specially strengthened non-magnetic transparent leaders.

Previously recorded data can be protected by removing the re-usable write-enable-plugs, individually recognised by an asymmetrical cut-out at the rear of the cassette.

The tape and cassette characteristics meet the requirements of the International Standard ECMA 34 for Data Interchange on Magnetic Tape Cassette. Consequently, the Philips data cassette is claimed to ensure trouble-free and reliable operation as well as interchangeability between information processing systems utilising the ASC11 7 bit code (American Standard Code for Interchange of Information).

We understand from Philips that this cassette may not be available outside the UK until later this year.)

MINIATURE TV CAMERA

Claimed by it's makers to be the world's smallest, this underwater television camera, only 1¾ inches (44.45 mm) in diameter and 7 inches (177.8 mm) in length was exhibited on the Seer TV Surveys stand at the recent Oceanology International '72 conference and exhibition at Brighton. Called the Falcon VE12 it is a specially developed ½ inch (12.7 mm) vidicon in a pressure proof stainless steel housing that contains a remote focus facility. The use of encapsulated electronics in the camera head contributes to its robustness, and printed circuit modules of advanced electronic techniques are employed in the camera control unit for reliability. The camera has unrivalled versatility due to its small size and is currently being used

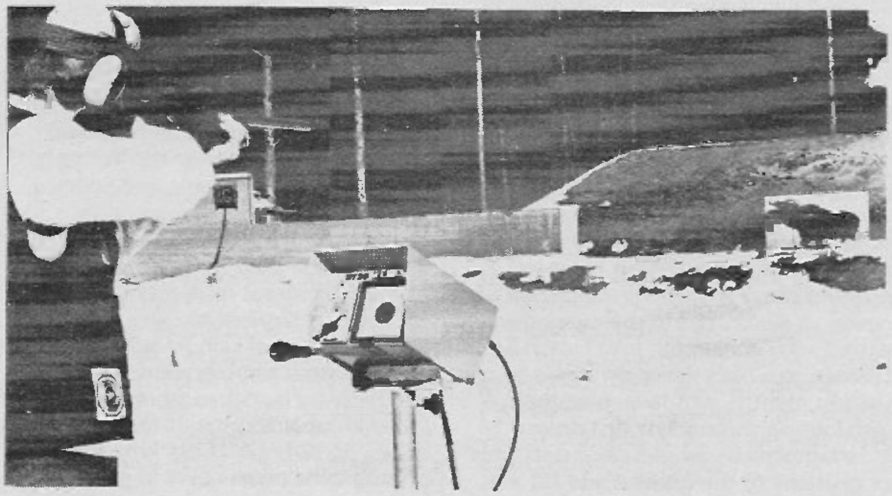
by BAC and Sud Aviation on the Concorde project. Seer TV Survey equipment is used in all parts of the world in oil rigs, submarine pipelines and cables, harbour defences, ship's hulls, boreholes and wells.

COMPUTERIZED SYSTEM GIVES MARKSMAN MOVING TARGET AND INSTANT REPORTS OF HITS

A new electronic shooting range system permits marksmen to manoeuvre targets from the firing point and simultaneously to receive results of their marksmanship. The system has been developed by the computer and electronics devision of Sweden's Saab-Scania group, Lindoping.

The wholly automatic system features moving targets made of rubber – usually in the form of an elk, favourite quarry of Swedish hunters – which incorporate a layer of electrically conductive material.

The latter short-circuits each time the target is hit and causes an electric impulse to travel to a special registration unit immediately beside the marksman. Complete data on his performance and scoring is registered on this device and is also recorded within, on a punched tape. A larger unit



news digest

beside the shooting range also performs this function.

Since the marksman needs no assistants to manoeuvre or adjust the targets or check scores, the new system — which also allows a shooting session to be completed in only half the usual time — is no more expensive than conventional alternatives besides being safer and more accurate, the manufacturers say.

The targets used are said to be highly durable and can be hit "several thousand times" before needing to be repaired or scrapped. They are mounted on electrically powered wagons which move backwards and forwards across the range.

DIGITAL COMPUTER AIDS CONSERVATION IN BRITAIN

A Digital Equipment timesharing computer, installed at the Merlewood Research Station in Lancashire, England, is providing valuable assistance to the Natural Environment Research Council (NERC) in its fight to conserve British wildlife.

Merlewood Research Station, one of the five major research stations of the Nature Conservancy (a component body of the NERC), is the main centre for the group's woodland research. It also houses a specialist group for research on soil ecology and a Chemical Section that provides analytical services for the whole of the Nature Conservancy.

The Systems Section provides computing and data processing services for the staff of 71, thirty of whom have regular use of the computer. However, only four of the 30 are "computer people", the rest being chemists, botanists, zoologists and statisticians.

Major areas of research currently underway at Merlewood, involving the computer include: (1) a large scale survey of the chemical composition of a wide range of vegetation types in order to gauge the background scale of chemical elements and their variation with time; (2) research into Dutch Elm Disease, in which the computer is being used to identify elm taxa, plot their distribution throughout Britain and ascertain which varieties are susceptible or resistant to the disease; and (3) a nation-wide survey of woodlands, containing species predominantly native to Britain.

The aims of the latter survey are to determine and describe the existing range of semi-natural woodlands and relate the variations of environmental factors such as climate, soil and the management — past and present — to which they have been subjected.

PHOTOMULTIPLIERS FOR OUTER SPACE PROBES

The Electron Tube Division of EMI Electronics Ltd., in Britain has recently supplied photomultipliers to the cosmic ray & space group of the Physics Department of Imperial College, London, for use in its investigation of outer space. The group is at present building four detectors, each of which uses four photomultiplier tubes, for high altitude probes by balloon.

Two successful preliminary flights two years ago paved the way for the four forthcoming flights which are to take place in southern India or Ceylon. The flights are being used to investigate the presence of anti-nuclei and the isotopic composition and energy spectrum of heavy elements. The Indian ocean area has been chosen because the terrestrial particles are at a minimum there.

It is planned to complete the detectors by September or October this year followed shortly by the four flights. Each detector will be launched by a balloon with a capacity of 1 million cubic feet which will raise the detector to a height of 125,000 feet in approximately 1½ hours. The detector has its own guidance system to keep it pointing due east and at an angle of 50° to the vertical. Each flight is designed to last 8 hours and then the detector will return to earth by parachute.

ROCKET PROVES EARTH RESOURCES SURVEY SYSTEM

A Skylark rocket built at the Royal Aircraft Establishment, Farnborough in collaboration with British Aircraft Corporation's Electronic and Space Systems Group, has successfully demonstrated a remote survey system which can be used for the management of Earth's natural resources.

The first Skylark to carry this unique system of remote sensing of multi-spectral photographic equipment was recently launched from the Australian Woomera range. It reached a height of 184 miles (294 km) and the photographs taken cover in great detail a specially-selected ground area the size of the United Kingdom.

The picture quality indicates that the location and measurement of Earth's resources can now be made from a rocket, adding to the already well proven scientific role of Skylark.

Skylark sounding rockets — originally designed by the RAE, Farnborough, in 1955 — are now produced by BAC at Bristol and nearly 300 Skylark's have been successfully launched in the British and European Space Research programmes.

DRIVER-GUARD COMMUNICATIONS SYSTEMS FOR TRAINS

A direct telephone communications link between the driver and guard of a passenger train can be established by installation of an ENTEL 390 series system, manufactured and marketed internationally by Nelson Tansley Limited (UK).

This equipment normally requires no additional wiring, apart from simple power supply connection, as it is designed to utilize as the transmission path, any electrical circuit which is continuous throughout the train. The signal is transmitted as low-deviation fm on a 110 kHz carrier, this frequency being well above existing train control frequencies, yet low enough to avoid matching and attenuation problems in wiring not intended for radio frequency transmission.

The fm signal can be transmitted over existing circuits which also carry dc switching voltages or audio frequencies without disturbance. (100 volt dc isolators are available for power circuits). Indeed, in one version of the ENTEL 390 series, tailored for British Railways trains, the lighting control wires are used for the fm driver-guard link, and the same wires carry the speech frequency of an in-transit public address system.

Identical terminal units are fitted in the driving cab and the guard's van, each comprising a bulkhead-mounted electronic control panel, containing the transmitter and receiver, with an attached telephone handset. Operation of a call button on the panel produces a call tone from the handset earpiece at the distant terminal (or a separate call unit can be fitted if louder calling is required). The call is answered by lifting the handset and operating the "Press-to-talk" push-button switch located at the earpiece end of the handset.

Energising power is drawn from the guard's van or locomotive batteries, the equipment being available with a range of operating voltages to meet the requirements of individual customers.

INPUT GATE

LETTERS FROM OUR READERS

SIMPLE MODIFICATION

First of all sincere congratulations on your first issue – full of interest and with some high class articles and projects.

Of particular interest to someone like myself is the section in each project that describes "how it works".

I am very interested in your Wide Range Voltmeter but there is one modification I would like to make – I would like to make use of a very good 100 milliamp meter which I already have in my possession. Can I simply amend the circuit to bypass the balance of 9/10th of the current by means of a parallel resistor.

I would also appreciate some indication of the source of supply of the ICs for this circuit. – L.J.C., Aldershot, Hants.

*Thank you for your kind remarks about our first edition.

The meter you have, I presume is a 100 microamp meter. If so, there are two alternatives. These are to do as you suggest and bypass 9/10 of the current. The second is to increase the value of RV3, RV4, R22 and R23 by a factor of 10.

If the meter shunt method is used it could be possible to have it "switchable" and thus increase the meter sensitivity by a factor of 10.

The LM301A is made by both Fairchild and National Semiconductor while the LM308 is made by National Semiconductor. Both of these companies either manufacture or carry stocks in England and you should be able to obtain them at most of the larger retail-trade outlets.

COMPONENT SOURCES

May I congratulate you on your first edition of what I consider to be an excellent magazine for the Electronics Engineer.

I particularly enjoyed reading the articles on various projects and in particular the one concerned with a wide range voltmeter and this I have envisaged building for a number of years.

However, I find that I have had no success in locating a source of supply for the particular ICs used in the project and I am sure other readers must have experienced similar difficulties.

I would appreciate any information you can supply me on this matter and may I respectfully suggest that in any future articles involving out of the usual components the source of supply be given in the article in question. – J.A.C., Cardiff.

*See letter above – we are actively investigating the problems of ensuring that components will be readily available and hope to be able to make an announcement shortly.

THANKS, FRIEND. . .

I have purchased No. 1 of your "Electronics Today" magazine and it seems to be exactly what has been needed for a long while – a magazine for enthusiasts and technicians i.e. for people who are neither dabblers and gropers in the dark nor mathematical geniuses to whom all is revealed in three pages of calculus (good luck to 'em I wish I was).

Enclosed is cheque for one year's subs starting from issue 2 (May 1972). Best wishes for every success. – D.V.E., Durham.

AND AGAIN. . .

I have been concerned with electronics in general for over twenty years and never have I been able to buy a magazine which covers every angle. You have even got a record and book review – fantastic.

Congratulations on a superb mag. It really has got everything – space, time, construction, reviews, tests, Hi-Fi etc.

We have at last left the era of electronic comics and psuedo hi-fi magazines.

Dynamic new monthly – without a doubt, and I wish you every success. – R.G.H. Bristol.

COMMENT FROM DOLBY

I was interested to see your review of our Series 360 professional noise reduction units, (ETI April 1972).

There are a few points which I feel should be clarified. The attack and release time of the Dolby compressors are not fixed at any one value. By using non-linear integration techniques, the time constant is continuously changed to suit the instantaneous programme. Under the conditions where overshoot in the main channel would be significant, the time constant is about 1 msec, not 100. In general the overshoot produced by any compressor is quite independent of the time constant, and is usually equal to the amount of compression. Because our system is conceptionally different from conventional companders in that the output from our compressors is added (or subtracted) with a pure untreated component in the main path, we can use overshoot suppression techniques to ensure that the overshoot never exceeds 2 dB.

As you point out, the B-System uses a single channel whereas the A-System uses four; however the band in the B System does not cover the same frequency range as band 2 of the A-System since this would give no high frequency noise reduction at all. The B-System band at low levels provides significant noise reduction from about 300 Hz and above; the actual amounts are 6 dB at 1 Hz and 10 dB at 5 Hz and above. The band is not a fixed band as in the A-System and does in fact change its lower cut-off frequency to maximise the noise reduction in the presence of programme.

It is extremely important that a Dolby encoded signal be decoded before any mixing is performed on the signal. Each Dolby encoded signal contains within the same signal the information needed by the decoder to correctly reconstitute the signal to its original dynamics. Thus if we mix two encoded programmes, the decoder cannot make a satisfactory job of the decoding process. The only procedures which can be carried out without decoding are editing of two sections together or making a 1:1 dub from one tape to another.

I hope that you will be able to bring these points to the attention of your readership to clear up what otherwise was a most interesting review. – D.P. Robinson, Chief Engineer, Dolby Laboratories Inc.

*In our introduction to this article we stated that this was the first independent evaluation of the Dolby 360 system. It has been brought to our attention that a review was previously published in 'Studio Sound' in February. We apologise to 'Studio Sound' for this error which was made in all good faith. – Ed. ●

FARADS GALORE

Introducing the ESD — a brand-new component with a myriad of applications in electronics.

A new energy storage device, the ESD, is an electrochemical capacitor with quite a few unique features. Among those of greatest interest to engineers and experimenters are:

Very high capacitance — Values are rated in *farads*, not in μF or pF as are conventional types. Currently made in 0.01, 0.1, 0.5, 1.0, 5 and 50 farad units.

Very high capacitive density — The 50-farad unit occupies less than 0.33 cu. in. Density averages 160 farads per cubic inch.

Very high leakage resistance ($\cong 10^{10}$ ohms) — Retains more than 97% of its initial charge after 16 months of storage.

Very low leakage current — Typically less than 1 pA. A particularly useful factor when charging current is a few microamps or less and discharge current is in milliamperes.

Stores large amounts of charge at low voltages. — A 50-farad unit stores up to 25 coulombs at 0.5 volt.

ESD cells can be paralleled or series-connected. — Follow conventional capacitor and battery arrangements for greater voltage and higher current capability.

Low equivalent series resistance (R_{es}), R_{es} is inversely proportional to the diameter of the device — less than 1 ohm for a 5-farad, 1-inch diameter device and less than 10 ohms for a similar device 0.5 inch in diameter. The R_{es} is the sole factor limiting the ability of the ESD to transfer its charge to a load.

The ESD is composed of chemically stable compressed powders and there is no danger of damaging or destroying adjacent components due to leakage. Shelf-life is said to be indefinite, even when stored under random temperatures ranging from −65°C to +140°C. It is a sturdy component, not prone to catastrophic failure. It takes large amounts of energy to destroy an ESD used outside its ratings.

When used as a power source, it has a low power density when compared with batteries. Further, both its maximum voltage and current per cell (500 mV and 1 mA) are much lower than most other electromotive cells. ESD's can be connected in series, parallel and series-parallel for the desired current and voltage ratings.

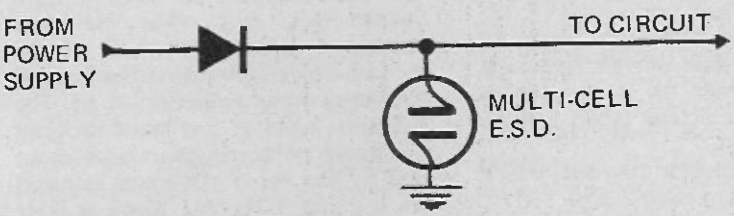


Fig. 1a. Circuit symbol ESD represents dual dunction of a filter capacitor rated in farads, and as a low capacity storage battery.

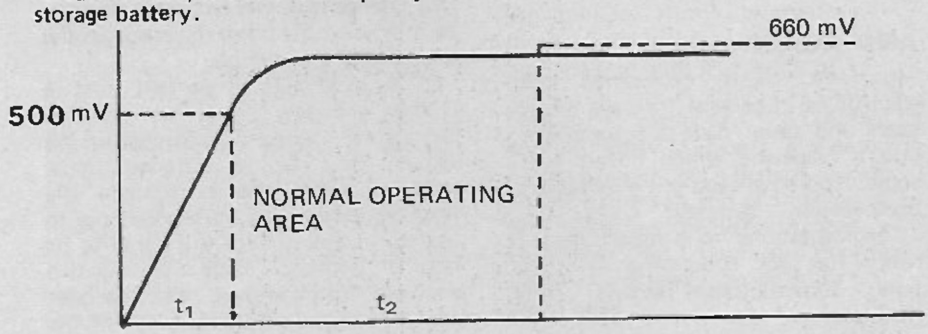


Fig. 1b. Discharge/time curve for ESD at constant current. Normal full charge is to 500 mV. Charging to 600 mV increases operating range by at least ten times.

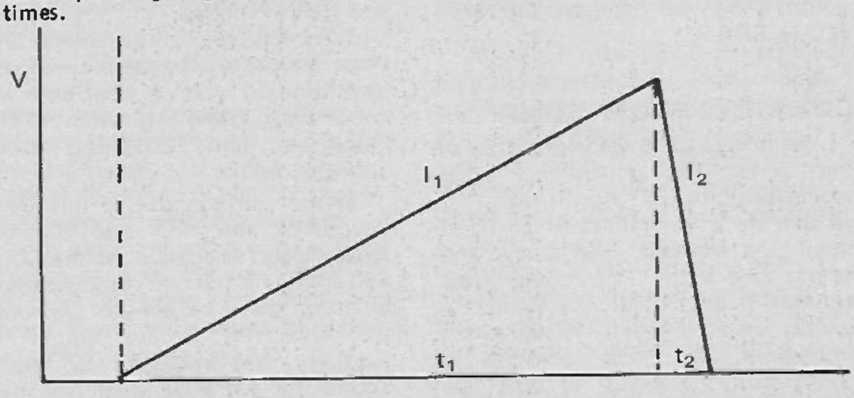


Fig. 1c. ESD timer uses charge and discharge time of device. Short circuit discharge is prevented by current rating of device.

Figure 1-a shows the symbol the manufacturer uses for the ESD. Figure 1-b is the constant-current discharge curve for a typical ESD. When used purely as a capacitor, the current-time characteristic capacitance is

$C = I_t/V$, where V is 500 mV.

When used as an energy source, ESD's can be operated at up to 625 mV per cell for an increase in energy storage capability of approximately ten times.

For example, with a 5-farad, 10-cell ESD a 1-volt drop (from five to four volts), 100 mA drain can be sustained for about 50 seconds. With a 1-mA drain it would take about 500 seconds for the charge to drop 1 volt. The same ESD charged to 6.25 volts would have a power increase of at least ten times. This allows an increase in current or time, or a reduction in device size.

APPLICATIONS

Source of standby power in cases where loss of primary power can be either dangerous or extremely inconvenient. For example, in a crystal-controlled digital clock, a simple circuit like that in Fig. 1-a might be used to supply the oscillator and counters so they won't lose step during power interruptions. The same applies to memory systems in computers.

An excellent decoupling device for use when large numbers of circuits are operated from a common power supply.

Pulse-power source to minimize overall power drain in devices with low-current power sources which must have an occasional low duty-cycle, high-current output. A typical example might be a remote weather station or flood-warning system powered by solar cells. Power is stored slowly over relatively long periods and then pertinent information is telemetered out in one short burst of energy.

In timing circuits, the charge-storage capability and low leakage-current make the ESD an excellent current-time integrator whose performance is limited only by the characteristics of the external circuit components. Fig. 1-b shows the time versus constant-current charge/discharge curve for the ESD. Note that regardless of the charging current, time t is linearly proportional to voltage. Due to the low voltage at which a charge can be stored in an ESD, the device can be charged from a voltage source through a resistor that holds the current constant.

Since time equals KV (where K is a constant and V is voltage), *time can be set as accurately as voltage can be measured.* Although some ESD's show capacitance increases up to 0.1% per degree C, the voltage/time repeatability is better than 0.1% when temperature is held constant.

For indefinite life, the maximum charge and discharge currents of an ESD should be limited to 1 mA although occasional higher currents can be tolerated.

In most electronic timers, a capacitor is charged to a given voltage level and then discharged rapidly through a short circuit to reset for the next timed cycle. This method is not particularly suited to this new device. For example, a 0.5 F, 1-inch diameter ESD — when shorted — has an R-C time-constant of about 0.5 second (R_{es} is less than 1 ohm) and takes around 3.5 seconds to discharge to 0.1% of its initial charged value. When discharged through a 500-ohm resistor — to limit current to 1mA at 0.5 volt — the R-C time-constant is 250 seconds and the period required to discharge to 0.1% is 1750 seconds; *nearly 30 minutes.*

However, when timing is based on the R-C time-constant — the time in seconds required for the voltage across the charging capacitor to rise to 63% of the applied voltage or to lose 63% of its charged voltage — the long discharge-time required by the ESD

Continued on page 75

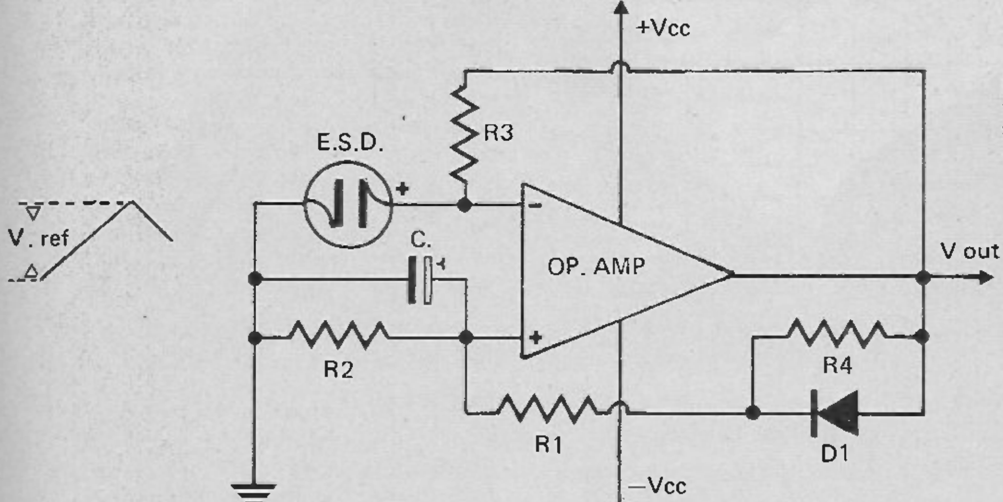
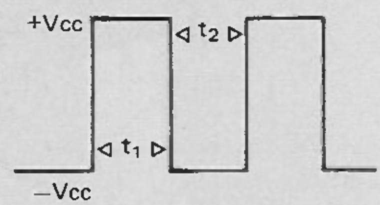


Fig. 2a. Op-amp flip-flop uses an ESD to provide periods up to several million seconds with symmetrical mark space ratio.



WHO STOLE

Why those bass notes drop out of hearing when you turn down the volume. Jan Vernon, B.A., explains the Fletcher–Munsen effect.

HI–FI salesmen everywhere should honour the names of Messrs. Fletcher and Munsen – and their employers, the Bell Telephone Company.

These two engineers were the first to explain where all the bass goes to when the volume is turned down.

'Actually', they said, 'it doesn't go anywhere – it's right there all the time. You just can't hear it.'

They said that it's a physiological thing – and short of a long-term reliance on Darwin's theory of evolution, or linear physiological progressions, there's not much to be done. Unless, of course, you turn up the bass and treble boost.

But, of course, that's anathema.

Forty-one years have passed since the Fletcher-Munsen paper was published, but to most hi-philes they might never have been. In they come – amplifier under one arm, response curve under the other, bass and treble padlocked precisely at mid-position, indignation everywhere.

Just try to explain that the bass disappears precisely BECAUSE the amplifier has a flat response. They think you're out of your mind.

Yet that's what happens.

In fact, if the sound level is reduced to that of a sofly-playing quartet, the loss of bass will approach 30 db – it will be inaudible.

The effect is shown graphically in Fig. 1. The curves show the sound intensities required to produce equal loudness at various sound levels. They illustrate the need to boost bass frequencies substantially, and to boost the treble to a lesser extent, when listening at reduced volume levels. If this is not done, bass and treble will appear to be lost during replay.

The knowledgable hi-fi purist is aware of all this. He knows that, as he reduces the volume, the bass and treble will decrease at a greater apparent rate.

This, he insists, is how it should be.

He points out that, as one moves from the front of a concert hall to the rear, the same effect will be apparent. The contra-bassoons and double basses will lose their fullness – and whatever happened to the triangle?

The argument seems reasonable enough. But the difference in sound levels throughout a concert hall is only a few db – even at the back it's still quite loud.

In the home it's a different matter. Sometimes one reproduces music at concert-hall levels – which typically cover a dynamic range of 40-100 db – at other times one prefers music at much lower levels. The range of preference is certainly greater than one would ever experience while moving around a concert hall.

The purist insists that, if one is philistinic enough to play music at 'unnaturally' low levels, then the loss of bass and treble is exactly as it would sound if it were heard approaching a concert hall some yards away – and that, he insists, is how you SHOULD hear it.

But most people listen to music at low sound levels not because they wish to experience the Albert Hall from half-a-mile away, but because they just want a pleasurable audio experience at a soft level. It sounds a damn sight better if the bass and treble are still there.

There are two ways of achieving this – either with interconnected tone and volume controls (electrically or mechanically) or physically, by turning up the bass and treble controls when the volume is reduced.

Some amplifiers do, in fact, have 'loudness' controls which correct for the 'Fletcher-Munsen' effect – but these are regarded by purists with the same distaste as Graham Kerr would exhibit when contemplating a railway sandwich.

One eminent writer described them as "irrelevant' – 'unrelated to musical reproduction' – pseudo-scientific. He stopped short of insisting that, to appreciate Shostakovich, you must recreate the siege of Leningrad. Just.

Me? – I just wind up the bass. ●

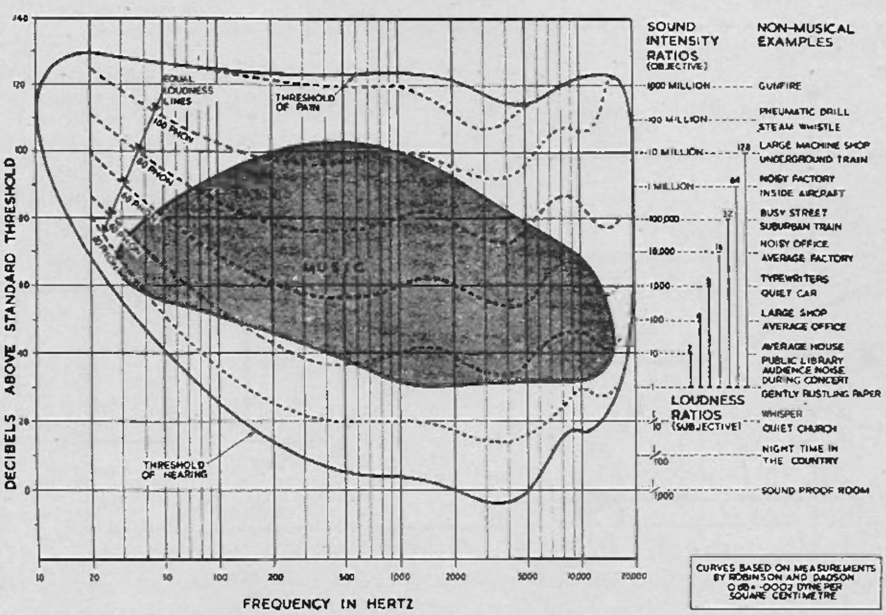


FIG. 1. Graph shows sound intensities required to produce equal loudness at various sound levels. Note the need to boost low frequencies when listening at reduced volume.

THE BASS?

"Industrial espionage is a serious subject, far more serious than we suspect" — Sir Richard Powell, Bt. M.C. Director-General, Inst. of Directors.

WHAT'S

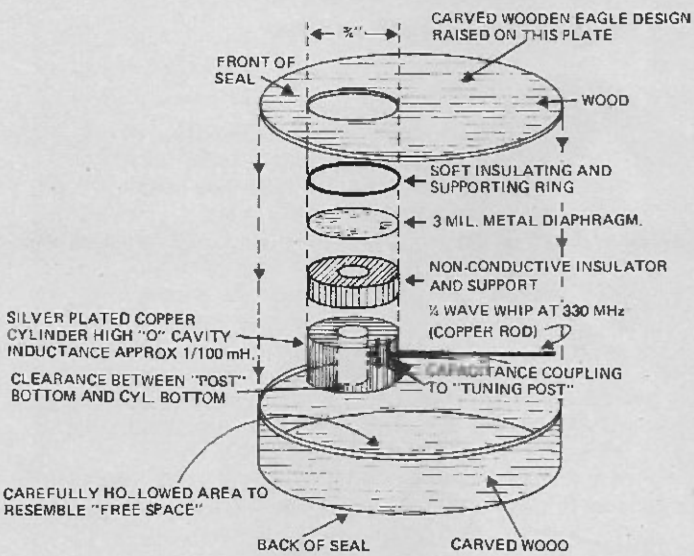


Fig. 1. Probably the most famous, bug of all time, this ingenious device contained an externally energized uhf cavity and was implanted by the Russians in the US Embassy in Moscow.

> *"Industrial espionage is very rarely committed as a deliberate act of board policy. It is almost invariably initiated by senior sales or marketing personnel and concealed from the top management". — Leading US security agent.*

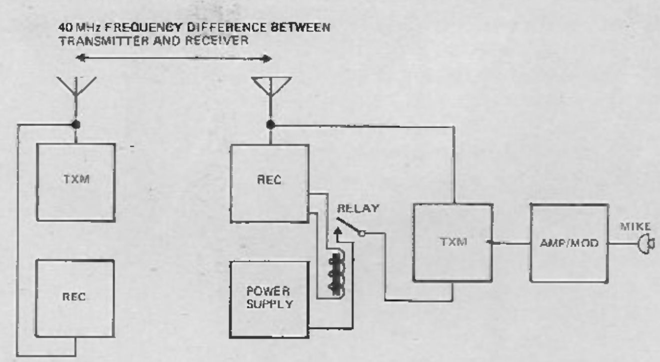


Fig. 2. This bug was planted in the office of the US Under-Secretary for State in 1966. A remotely operated transmitter was used to send a switch-on signal to the implanted bug, and thus extend battery life.

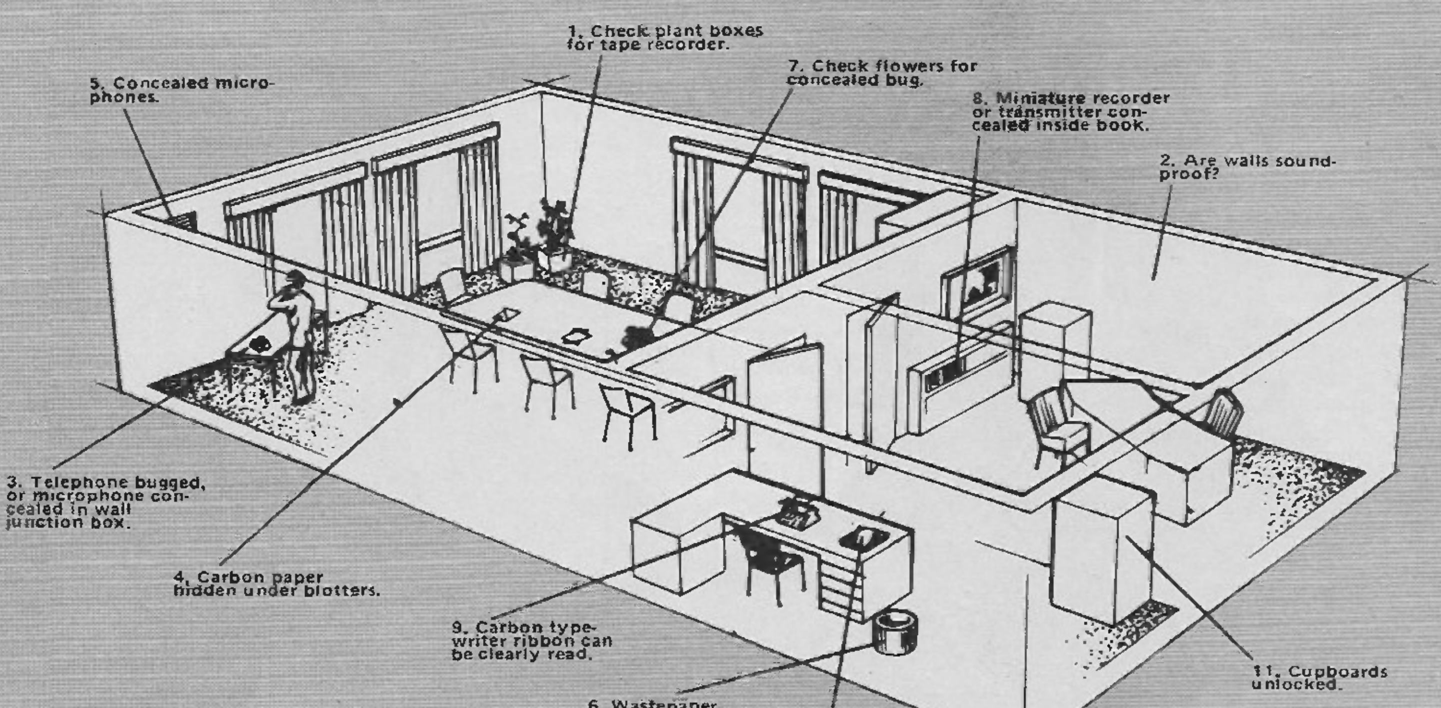


Fig. 3. This drawing shows the most common ways of gaining access to confidential information.

BUGGING YOU?

– a serious look at industrial espionage

In 1945, the Soviet Government presented Averill Harriman — then US Ambassador to the Soviet Union — with a magnificantly carved American Great Seal (Eagle) for the newly built USA Embassy in Moscow.

Subsequently, it was discovered that the Russians' motives were somewhat less than altruistic, for the Great Seal contained one of the most ingenious bugs yet devised.

Brilliant in its simplicity, this bug was a ¾" diameter, silver-plated copper cavity capacitively coupled to a ¼ wave antenna also concealed within the wooden carving.

A thin metal diaphragm sealed one end of the cavity. Any speech within the room containing the bug would modulate this diaphragm, which in turn would change the resonant frequency of the cavity.

The cavity was energised by radiated rf — at thenormal static frequency of the cavity — and then as the diaphragm moved — the cavity in effect behaved as a modulated oscillator.

The cavity was energized at 330 MHz by a small transmitter and narrow-beam high-gain antenna concealed within a van parked outside the Embassy grounds.

Another nearby vehicle, also equipped with a narrow-beam high-gain antenna, tuned in to the bug and detected the modulated 330 MHz signal.

After many years service, the bug was discovered by some British technicians who accidentally tuned across its operating frequency. (In the resulting brouhaha the CIA also uncovered no less than 60 other microphones hidden throughout the Embassy building).

Figure 1 shows our artist's impression of this now famous bug — which was shown to the UN in 1960 by Henry Cabot Lodge. (The wooden carving has now been replaced by a new — and hopefully, non-performing, Seal).

As the reader will appreciate, this system required neither maintenance, nor internal power source, and operated only when the cavity was energized by external rf energy at exactly the right frequency.

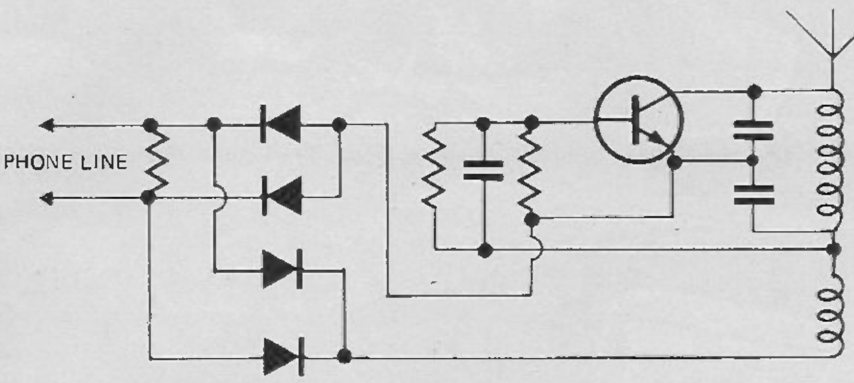


Fig. 4. This is the most common type of telephone bug. It is often incorporated within the existing microphone of the telephone handset and derives both its modulation and power from the telephone system. The antenna is usually capacitively or inductively coupled to the phone lines.

In 1966, two Communist Czechoslovakian diplomats were charged with attempting to bug the offices of US Under Secretary for State, George W. Ball.

The eavesdropping system that they used is shown, schematically, in Fig. 2. The implanted equipment is shown to the right of the drawing. A remotely operated transmitter was used to send a 'switch-on' signal to the implanted bug. When this signal was received, a relay in the bug closed and connected the inbuilt batteries to the remainder of the equipment. This technique extended the life of the inbuilt mercury batteries many times over.

Once again this bug was found, not because of US bug detectors, but from information received from political enemies of Czechoslovakia.

Circuits and schematic diagrams shown in this article are included solely to clarify the written text. For obvious reasons, 'bug' circuits have been shown without component values and with minor components excluded.
Again, for obvious reasons, neither the Editor nor any member of our staff will enter into any correspondence relating to the construction or installation of this type of equipment, the use of which is generally illegal.

To many of our readers it may come as quite a surprise to hear that industrial espionage methods only slightly less sophisticated than those just described are used, to an ever-growing extent, throughout the world.

The term 'industrial espionage' is emotive. It is intensely disliked by its practioners, who prefer the euphemism 'aggressive market research', which they define as the practise of securing knowledge about competitors by any and every possible means.

Generally, industrial espionage operates on a non-technical basis, relying on simple well-proven techniques of bribing employees, obtaining access to private documents, board reports, salary files etc. Other, rather more sophisticated methods are detailed in Fig. 3.

But despite the more common non-technical approach there are many occasions when very sophisticated electronic equipment is used. In fact the manufacture of this equipment has become big business for over 50 large companies (mainly, but not exclusively, in America), and several of these companies back the field both ways by also producing a range of bug detectors.

GPO technician – or? . . . . .

A telephone can never be considered secure.

In most countries, Government security organisations use direct wire tapping, or rearrange the phone wiring using an elementary 'third wire' technique so that the microphone becomes 'active' even though the handset is on the rest.

TELEPHONE TAPPING

Industrial espionage agents generally use more elaborate methods, for the direct wire tapping techniques draw current from the telephone lines and are readily detected by conventional telephone line monitoring equipment.

The most commonly used telephone bug is a small transistor oscillator – operating around 90 MHz – mounted on the back of a standard telephone microphone insert, or actually built into a standard insert. Either way the bug is a direct plug-in replacement for the standard microphone insert and can be fitted in a second or two. The bug is powered by the telephone line current and, if undetected, can operate practically for ever. The telephone line itself acts as an antenna.

The bug's operating range is of course limited by the lack of a tuned antenna. Normally, coupling to the local telephone lines provides a range of less than half a mile The schematic circuit of the most commonly used unit of this type is shown in Fig. 4. (Engineers will notice that we have deliberately omitted one or two components from all schematics shown in this article – nor are component values given – our reasons for doing this are obvious). In this circuit, the transmitter is modulated by the rectified but unfiltered telephone line voltage upon which is impressed the voice frequencies existing on the line.

Yet another telephone bug utilises the magnetic field that exists around the hybrid transformer in the base of the telephone handset. The bug, often disguised as a 'telephone diary', or ashtray, is placed close to the telephone so that an inbuilt coil can detect the handset's local magnetic field. Following detection and amplification, the signal is then sent to a nearby receiver via a miniature FM transmitter operating in the 88 to 108 MHz band. A more 'refined' version of these units inccorporates a miniature microphone, so that room conversations as well as telephone conversations may be detected.

Perhaps the most ominous of all telephone tapping devices is one known as the 'infinity transmitter'. The device has almost 'infinite' range, hence its name, and can be used over telephone lines thousands of miles long.

A block schematic diagram of the infinity transmitter is shown in Fig. 5. The actual bug consists basically of a frequency sensitive decoder that actuates a miniature multi-pole relay. The eavesdropper has a tone generator with an audio output that he holds to his telephone mouthpiece immediately after dialling his victim's number. The moment this tone is decoded by the bug, the relay is actuated: this simultaneously opens up the bell ringing circuit and connects the handset's transmitter and receiver to an inbuilt audio amplifier the output of which is connected to the telephone line.

Thus the victim's telephone bell is deactivated before it can ring, and his telephone handset now transmits all sound within the room to an eavesdropper who may be thousands of miles away, *whilst the handset is still on its rest.* If a third party rings the number whilst the bug is operating he receives the normal 'busy tone'.

Infinity transmitters are difficult to

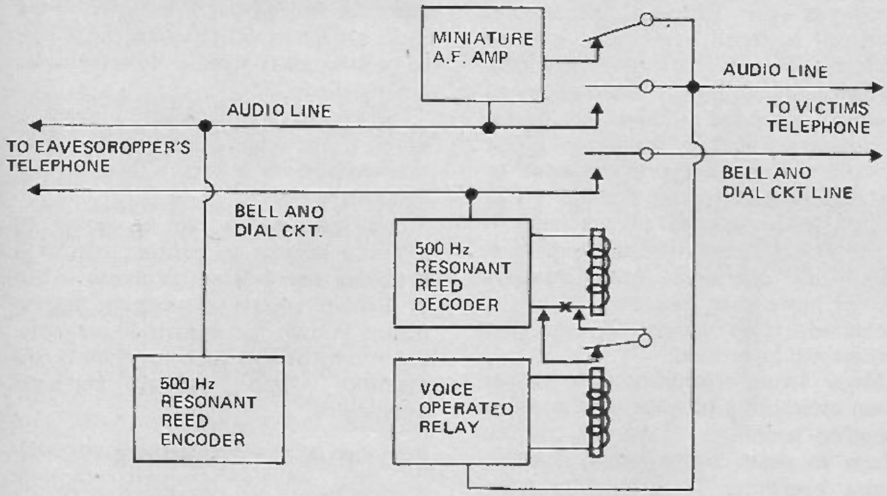


Fig. 5. Block schematic drawing of infinity transmitter. This bug enables an eavesdropper to listen to sounds within a room thousands of miles away.

detect as the electronic tone decoding equipment may be located some distance from the telephone. One method, commonly used in the USA, is to sweep the telephone line with an audio oscillator — meanwhile checking the voltage across the line. A tone operated bug will cause a significant dip in the line voltage.

Yet another method of detecting these bugs is to dial the number of the suspect telephone — having first arranged that it is not answered — and then to sweep the line with the oscillator — this will energize the tone operated relay and cause the number to stop ringing. (Fig. 6 shows a detector specifically developed for this purpose.)

One certain defense against the infinity detector is to use an extension telephone that is connected through a manually operated switchboard, for this type of bug can only be used on direct lines. It is ironic that many senior executives prefer direct lines in a mistaken belief that this provides them with a higher level of security!

If one's line does not go via a manual switchboard, the only other successful defense is to install a white noise generator, with an audio output, close to the mouthpiece of the telephone handset. If your telephone is being bugged then this will saturate the line and prevent speech being understood.

Normally of course, the white noise generator cannot affect the telephone system in any way for the telephone is disconnected from the line until lifted from the handset.

It is practically impossible to estimate the extent to which telephone tapping occurs in this country. But our own discrete enquiries indicate that it is far more common than we had previously believed.

The miniature electronic bugs, featured so often in spy stories and films are very much a reality.

TRANSMITTERS AND RECORDERS

They consist of a small radio transmitter (usually FM), a hearing aid microphone and batteries. They have a range of about 400 yards and sound can be picked up within 20 to 30 feet of the microphone.

Another variation uses a flexible plastic tube fastened to the front of the microphone. This is done not only to enable the microphone to be installed in 'difficult' locations, but also to prevent the microphone or transmitter being located by metal detectors.

Other types of detectors are used to receive sounds through concrete and brick walls. One type commonly used is based on a record player cartridge and stylus, it works very well, providing no-one drops something heavy on the floor, or bangs the wall that is being bugged. Either happening is prone permanently to deafen the eavesdropper. (The US manufacturer of this device has apparently not heard of clipping circuits).

The FM transmitters used in these bugs are very simple, many are based on tunnel diode oscillator circuits such as that shown (incomplete) in Fig. 7

Power for these transmitters is usually derived from miniature batteries, and to conserve battery power the more sophisticated units incorporate circuitry that switches on the transmitter only when there is a sound signal to transmit.

Another power source occasionally used consists of what is basically a simple tuned circuit, diode and large storage capacitor. The source is connected to a short antenna and when tuned to a local broadcasting station, receives and stores sufficient power to operate a low powered bug practically for ever. (Fig. 8)

Many microphone/transmitter bugs openly on sale in the USA and UK are built inside or around furniture and electrical fittings and appliances.

One company, Mosler Research Products, manufacture a range of framed pictures. A microphone concealed within the moulding receives sound signals via a number of strategically placed holes in the frame, whilst extra long-life batteries are evenly placed so that the complete picture has a balanced feel. The pictures are said to be presented to the victims as gifts.

Other companies, manufacture bedside lamps, pencil sharpeners, an; other electrical devices incorporating inbuilt microphones and FM transmitters; generally the power cord doubles as the antenna.

A number of American companies also produce domestic radio sets constructed so that when switched off, the speaker acts as a microphone. Additional circuitry within the set transmits the received voice signals — again using the power cord as an antenna.

DETECTING RADIO TRANSMITTER BUGS

Fortunately it is fairly simple to detect the presence of radio transmitter bugs.

The simplest and most efficient way is to use a portable FM receiver to establish an acoustic feedback loop. The receiver must cover the complete FM band — ideally it should range

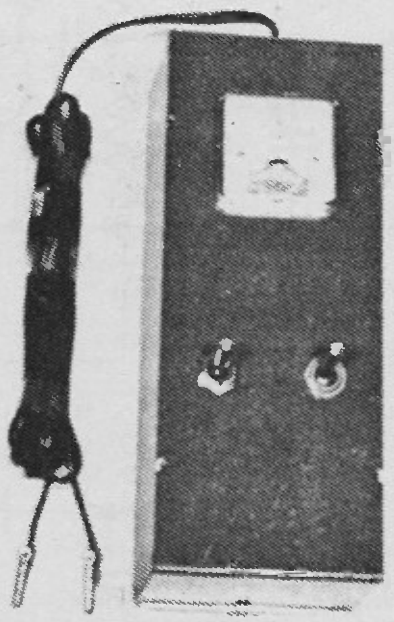


Fig. 6. This device, manufactured in the USA, is specifically designed to detect infinity transmitter devices.

from 40 MHz to 300 MHz – and should have good sensitivity.

To check for bugs, switch on the receiver and turn the volume control to a high setting. Pull out the antenna and then smoothly and *very slowly* sweep the tuning control over its entire range. This *must* be done slowly – taking about four or five minutes to cover the range.

If the room has been bugged with a radio transmitter, at some point along the tuning scale a howl will be heard in the receiver caused by feedback between the loudspeaker and the concealed microphone. It may be necessary to repeat the operation at several points if the room is larger than 15ft. square.

The actual location of the bug can be found by decreasing the volume control setting until the howl just stops and then tapping a pencil on various surfaces in the room. The tapping signal will be quite clearly heard in the receiver as one approaches the microphone's location.

Do not use an earphone for this procedure – the receiver's loudspeaker is an essential part of the acoustical feedback loop.

Another detection method – commercially available for a few hundred dollars – uses a straightforward rf field detector (Fig. 9). In this circuit a tunnel diode is used as an untuned broadband detector (a sensitivity control ensures that the device is not triggered by local broadcasting stations). The detector is used to sweep the required area, and if it detects an rf field, the tunnel diode circuit causes an audio oscillator to generate a loud warning signal.

Technicians should always bear in mind that experienced industrial espionage operators nearly always install more than one bug. If one is detected, it is almost certain that others will be around.

Many large organisations – rather than attempting to solve their possible bugging problems – merely trample them to death by installing rf white noise generators. These then flood the surrounding area with rf noise and effectively jam any radio transmitter within several hundred feet. These rf generators are at least as antisocial as the bugs against which they afford protection, for they jam all radio signals within their area – legitimate or otherwise. But several companies are known to have even used spark gap transmitters for this purpose.

SECURE ROOMS

The best protection against microphone/transmitter bugging is probably that used by many governments for high security areas – especially in their overseas embassies. This consists of prefabricated rooms of which the walls are constructed from layers of acoustical and rf screening material. Any power lines entering the room are fitted with by-pass capacitors to remove all rf signals. No telephones are installed.

The rooms are thoroughly checked after manufacture and then re-assembled as a 'secure' area within an existing room.

This may appear to be going to extreme lengths to protect against a probably non-existent problem – but in Britain several companies, by no means known for industrial paranoia, use rooms of this type for their board meetings and other top-level discussions.

SHOT-GUN MICROPHONES

These have been developed from the directional microphones used by radio and film recording companies. They consist of a microphone transducer with a series of tubes of various lengths mounted in front of the microphone diaphragm. The tubes vary in length from two inches to 60 inches and are bound together to form a rigid structure (Fig. 10).

Sound originating on the axis of the tubes first enters the longest tube and then successively enters each shorter tube in order of tube length. Thus all sounds originating from the front of the device travel the same distance and arrive at the microphone diaphragm in the same phase relationship.

Any sounds originating at, say, right angles to the tubes, enter all tubes simultaneously, thus a sound entering the longest tube may travel five feet before it reaches the microphone, whilst the same sound entering the shortest tube may travel only an inch or two. Thus off-axis sound will arrive at the microphone with varying phase relationships and considerable sound cancellation will occur.

A well designed shot-gun microphone can readily pick up a conversation across a wide street, and will be so

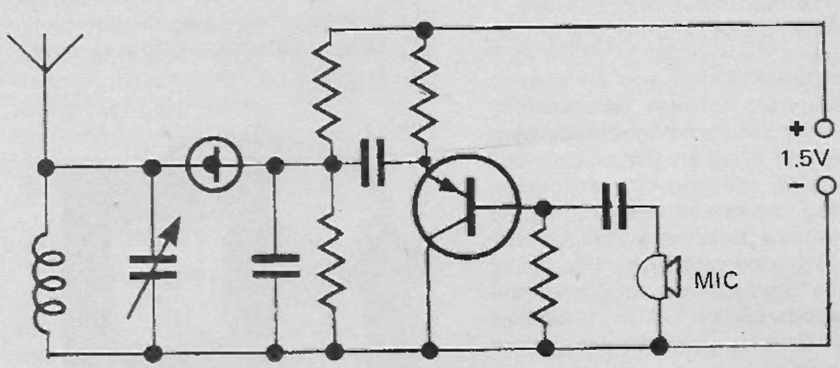


Fig. 7. Typical of simple FM bugs, this device uses a tunnel diode oscillator and radiates in the 90 – 100 MHz band.

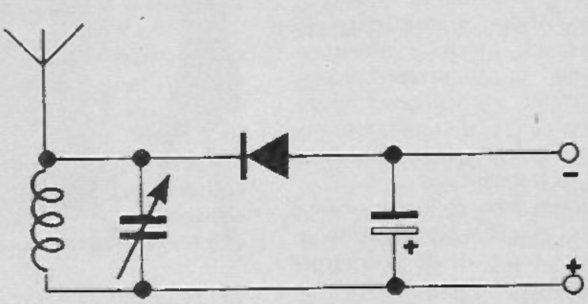


Fig. 8. Simple rf receiver provides 'free' power for implanted bugs.

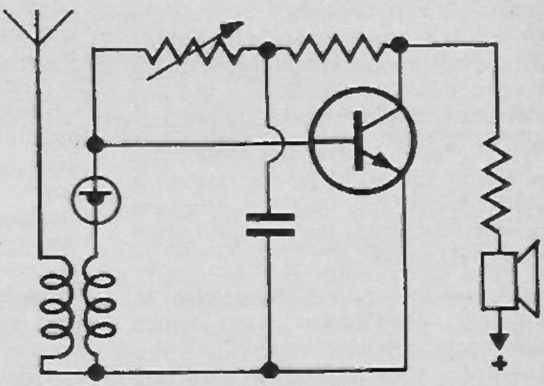


Fig. 9. This is an rf field detector frequently used to detect and locate concealed transmitters.

directional that it will virtually ignore traffic and other unwanted sounds. In quiet surroundings the range may exceed a hundred yards.

The best defence is not hold 'confidential' discussions out-of-doors, nor near an open window or door.

BUMPER BEEPERS

Once again, these 'fictional' vehicle tailing units really do exist. One commonly used unit — made in the UK — is powered by in-built nickel-cadmium batteries and operates in various frequency ranges, from 30 to 150 MHz. The transmitter, which is modulated by a pulsed audio tone, is housed in a rugged magnetized metal case. The unit is merely slapped onto any concealed metallic part of the vehicle.

The following vehicle is equipped with an FM receiver — often connected to switchable antennae mounted on the front and rear of the vehicle to provide null-sensing directional facilities.

Apart from their use in espionage, these tailing units are commonly used by security companies to enable following vehicles to keep an unobtrusive check on vehicles carrying valuables.

DOPPLER LASER SYSTEMS

People talking within a room, cause slight air movements that in turn will cause any windows to vibrate at speech frequency. If a laser beam is now directed at the window, the reflected beam will be modulated at speech frequencies.

Several companies are known to be actively working on bugging units using this principle, but as far as we are aware, none is yet in production.

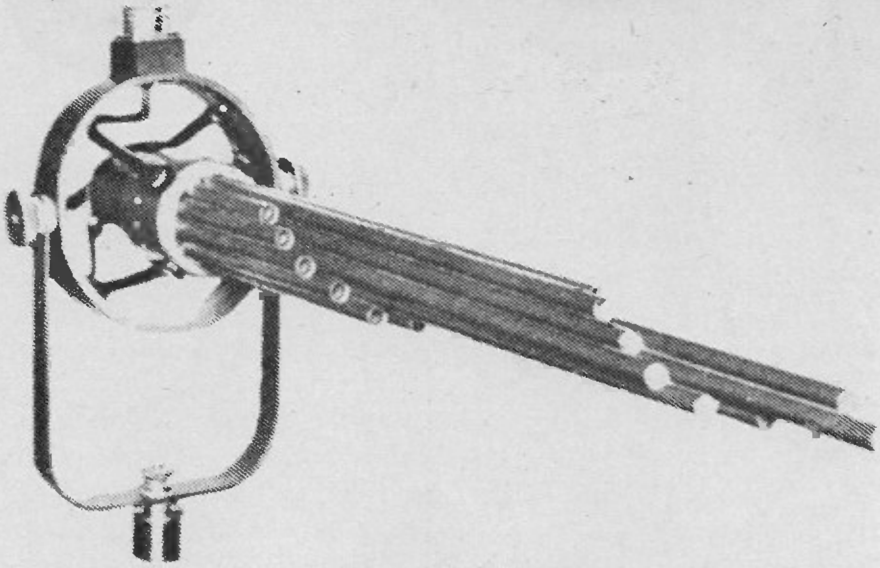


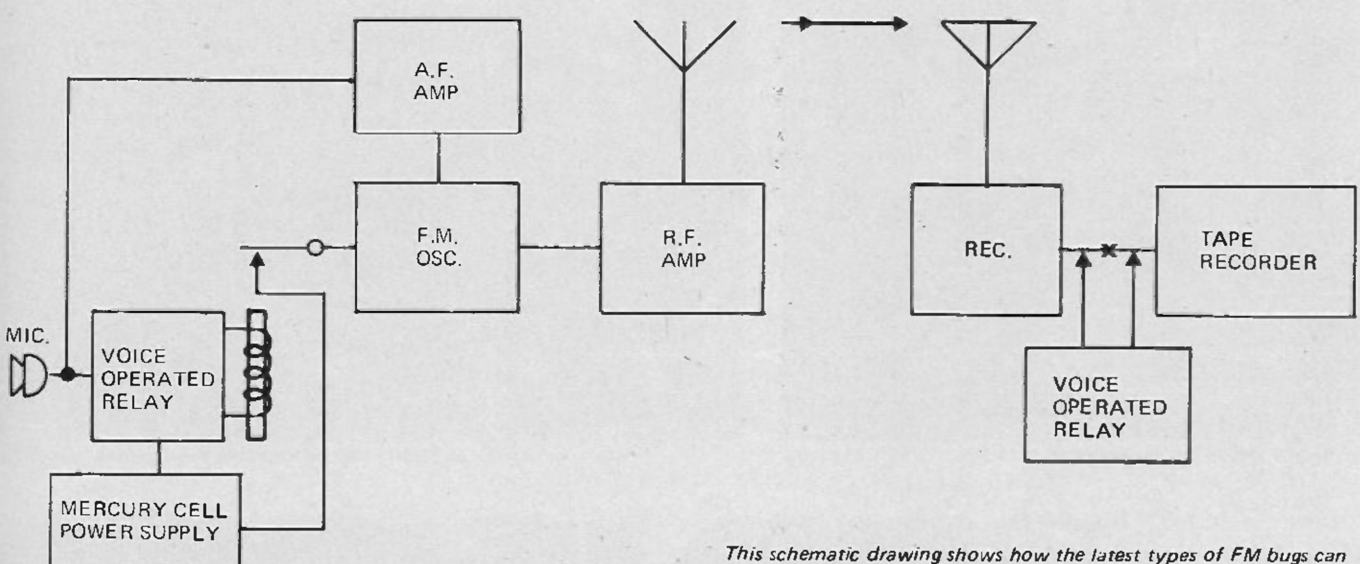
Fig. 10. This RCA shotgun microphone can easily pick up a conversation several hundred feet away despite ambient noise.

IN BRITAIN

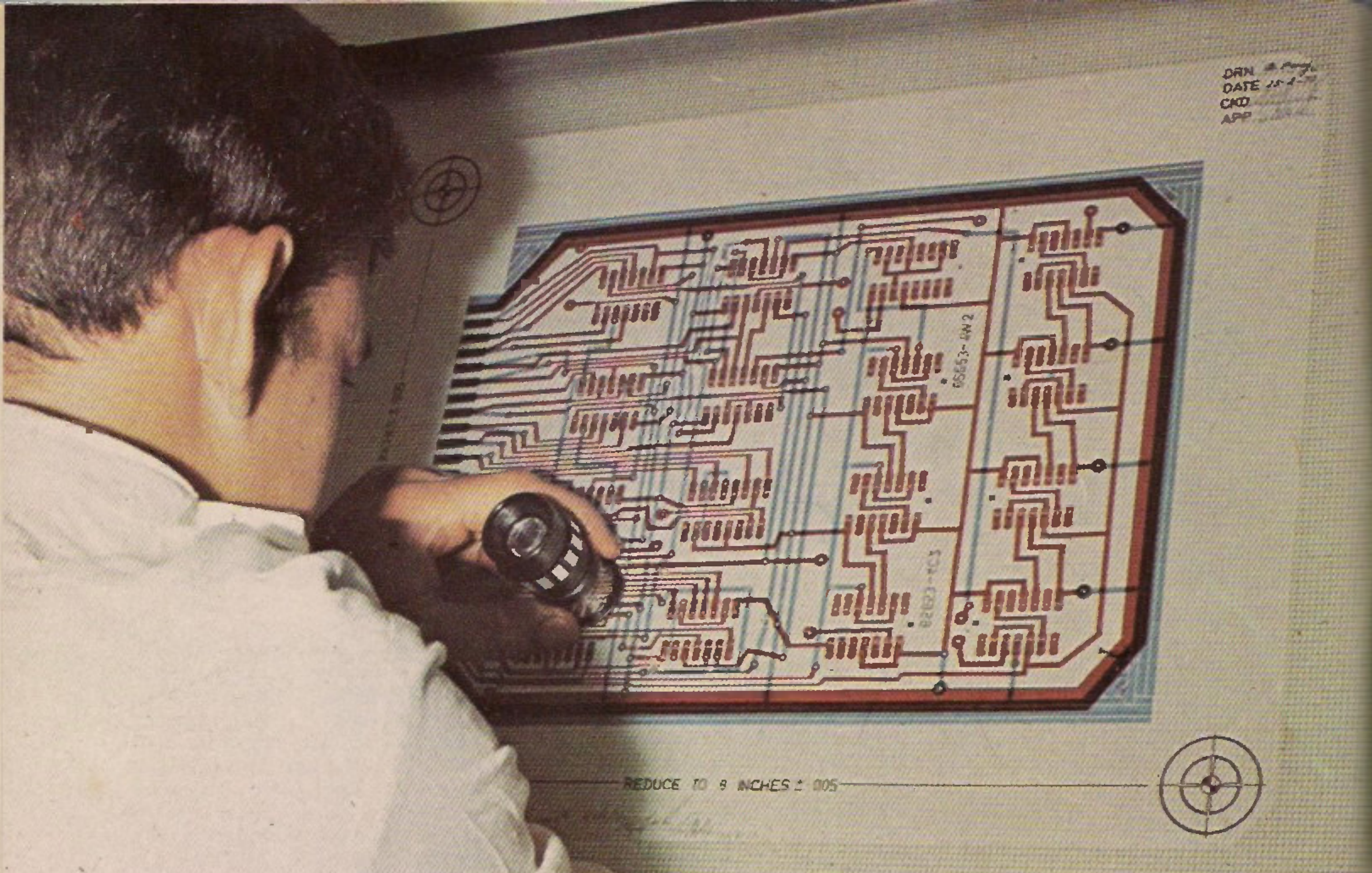
We have established quite positively, that every item of equipment described in this article has been imported into Britain, or is made in Britain. We know that most people find industrial espionage very difficult to take seriously — it is something that happens in films or only in the USA. But this attitude is naive in the extreme. Industrial espionage is an increasingly grave problem. So much so that in England the Institute of Directors has actually sponsored a book called 'Industrial Counter-Espionage'. In a foreword, Sir Richard Powell, Bt. M.C., Director General of the Institute, says: "Industrial espionage is a serious subject, far more serious than we suspect."

His warning is being taken very seriously indeed. ●

All the equipment described in this article is openly advertised and sold — mostly via mail-order — throughout the world. Nearly every one of these items is known to have been sold in Britain.

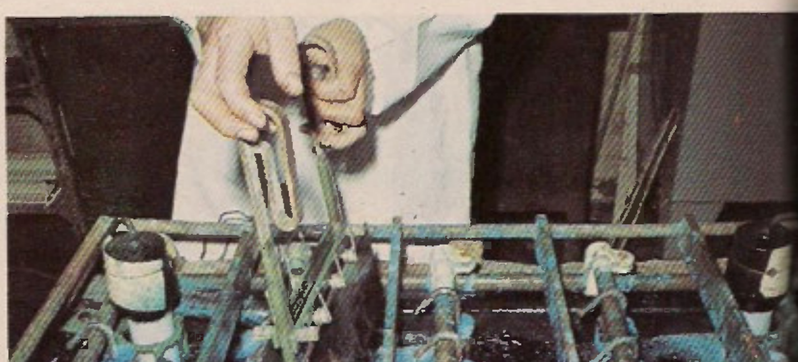


This schematic drawing shows how the latest types of FM bugs can be left unattended for long periods. The voice operated relay on the left of the drawing connects the power supply to the transmitter only during the time that someone is speaking within the room. At the receiving station a second voice operated relay ensures that the tape recorder operates only during signal conditions.



Master pattern is drawn over a grid accurate to ± 0.002" in 10 inches.

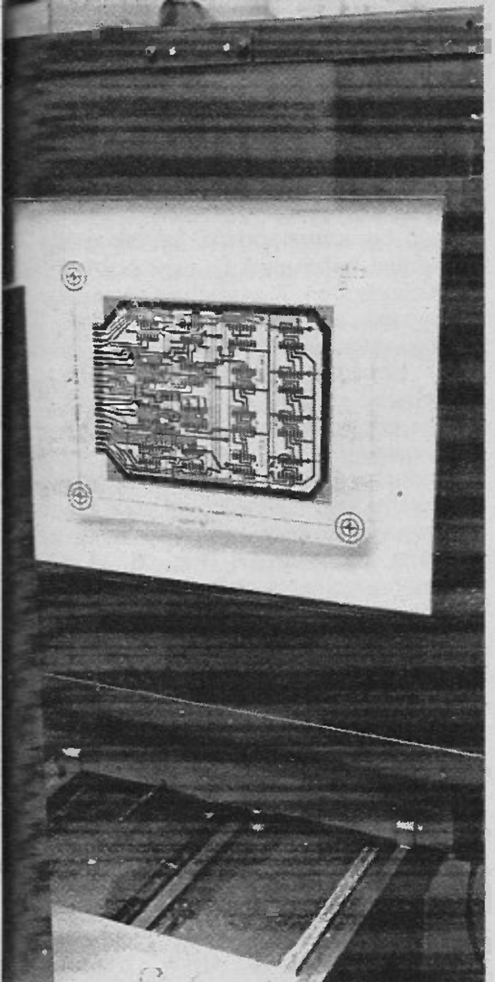
Silk screen process imprints circuit pattern onto board prior to etching.



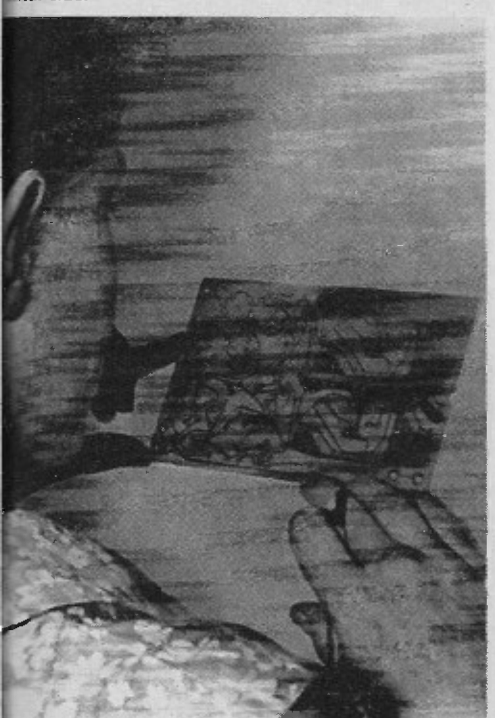
Unwanted section of copper is removed by etching in acid bath.

PRINTED

Simply constructed and highly versatile, printed circuits have taken over the functions of earlier conventionally wired circuits. Brian Bork, of Tecnico Electronics, explains how printed circuits are designed and manufactured.



Precision camera reduces master pattern to required final size.



Finished circuit board is checked for faults.

ANYONE who has had occasion to look into a modern electrical or electronic device will have noticed that very little wire is used to connect component parts. Indeed, the transistor radio has in the strict sense become a 'wireless'. This is largely due to the advent of the printed circuit – or printed wiring, as it is known by the semantically cautious.

Because of their simple construction and high degree of versatility, printed circuits have paved the way for automation and rationalised mass-production. Rapidly advancing semi-conductor techniques depend more and more on printed circuits as the interconnecting link. Virtually every electrical and electronic device produced today – be it a television set, a computer, a business machine, a scientific instrument or an entire telephone exchange – has as the backbone of its circuitry one or several printed circuits.

What is a printed circuit?

In broad terms, a printed circuit is an insulating board or card provided with conducting tracks on one or both surfaces. These tracks provide the connections or wiring between individual components whose leads are generally inserted into holes provided for this purpose.

Neither the conductivity of the copper conductors nor the insulating properties of the plastic board are perfect, which prompts the question:

What are the parameters of printed circuit design?

The starting material for the manufacture of a printed circuit is copper foil, or foils, laminated to a plastic base. The variations available on the current market are nearly endless, but most circuit boards are produced from laminate of either the paper-phenolic or epxoy-glass types. The most common thickness is 1/16" and material clad with .0014" of copper on one or both sides is readily available. In general the epoxy type materials are dimensionally more stable and have better electrical properties than their phenolic counterparts, which are correspondingly cheaper.

The conductivity of every conductor is limited. High current densities lead to overheating and consequent voltage drop, both of which can impair the efficiency of a printed circuit. The wider and thicker a conductor, the heavier a load it can carry. Thus, for special applications, laminates with .0028" and even .0042" of copper are available (Table 1 overleaf).

The electrical resistance of the insulating material must also be considered. Here again the epoxy glass materials are generally superior and thicknesses greater than 1/16" are also available.

The breakdown strength between adjacent conductors depends on both their spacing and the dielectric strength of the material itself. According to one specification, the standard spacing at 220V dc should be 0.1 inch between adjacent tracks.

Two conductors insulated from each other form a capacitor. The capacitance is dependent on the spacing and the effective surface area of the conductors. If printed capacitors are included in the conductor arrangement, such effects can be utilized. If, in addition, printed inductors are provided, perfect oscillating circuits can be produced for radio, television, aerials, etc., without the use of external components.

Certain mechanical considerations must also be kept in mind when designing a printed circuit. Large boards should be dimensioned so as to obtain best usage of available sheet sizes of laminate.

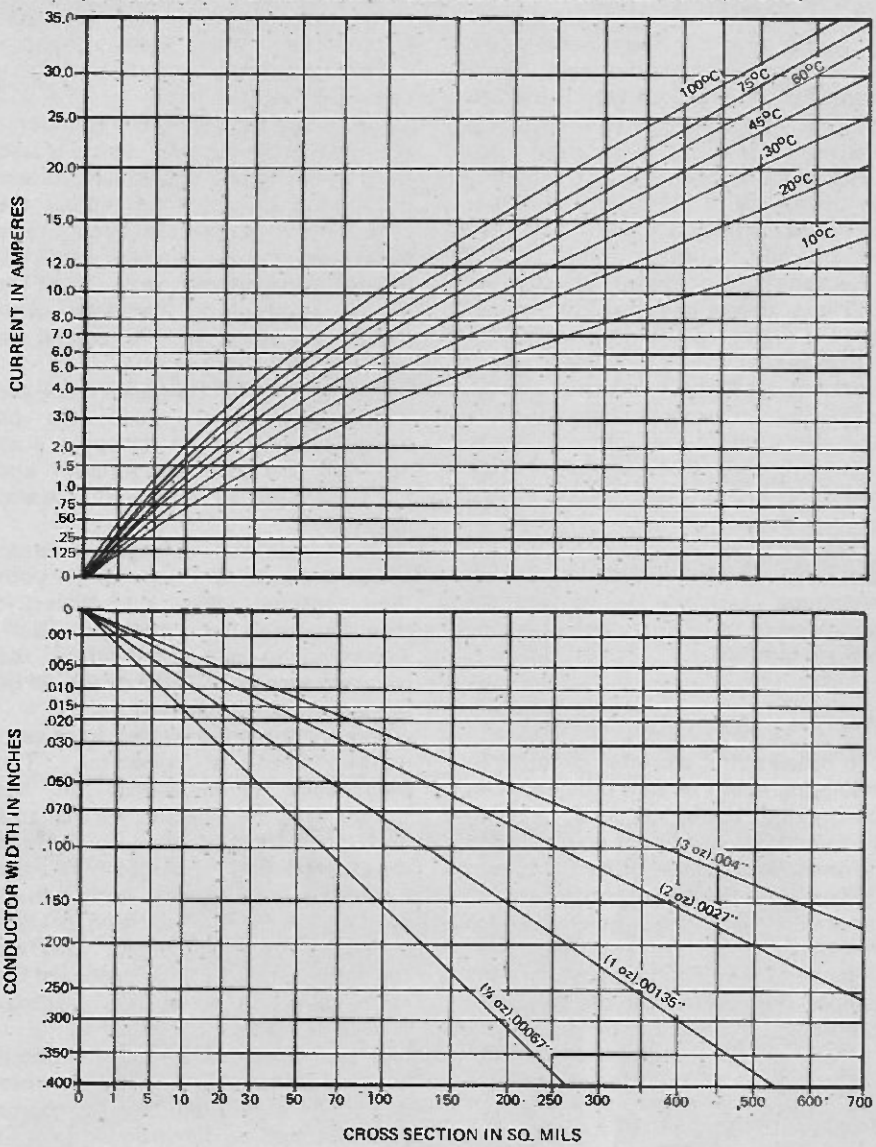
Square or rectangular blanks are recommended. Unusual and complicated shapes should only be adopted when they are essential to the design. Every contour which deviates from the normal rectangular form requires special tools and operations, and these factors invariably increase the price.

Having taken these variables into account, the printed circuit designer is ready to layout his master artwork.

CIRCUITS

PRINTED CIRCUITS

Table I (top) current carrying capacity and size of tracks for various temperature rises above ambient, (lower) conductor thicknesses and widths for different cross-sectional areas.



Producing the master artwork for a printed circuit

Simplicity is the key word in laying out printed circuit artwork. Components should be so arranged as to produce the simplest possible conductor pattern. In the majority of cases components are all located on one side of the board, while the reverse side is reserved for soldering connections.

It is not possible to cross conducting paths on a single sided board. On a double sided board this is achieved by taking the conducting path through the board, across the appropriate path and, where desired, back to the first side. The second and equally obvious advantage of a double sided layout is the greater packing density which can be attained.

It cannot be overemphasised at this point that every attempt should be made to keep tolerances as great as possible. The price of producing printed circuits to close tolerances rises very sharply. The designer will save himself or his firm a great deal if he makes track widths and spaces as wide as practical, pad diameters as great as possible, and tolerances on outside dimensions and registrations of the pattern to the holes or profile as large as possible.

For purposes of minimizing errors the conductor pattern is normally laid out at two, four, five or even ten times actual size.

The draftsman first produces an outline on the drawing board (Fig. 1). From this outline working drawings containing all the necessary machining details are developed. The last stage is the master conductor pattern, which is the 'tool' for the production of the printed board (Fig. 2).

The pattern is prepared on the basis of a standard grid of 0.1 inch or 2.5 mm. All holes for component leads should be accommodated to this grid Individual holes must be provided for each connection. This method presents advantages for the production of the original drawing and tools, as well as for subsequent fitting of the equipment. Special grid paper and plastic grids are available to assist the draftsman.

Conductor lines need not necessarily follow the grid. They should take the shortest route between solder lands, avoiding sharp corners (Fig. 3). It is common practice to reduce conductor widths only at unavoidably tight spots.

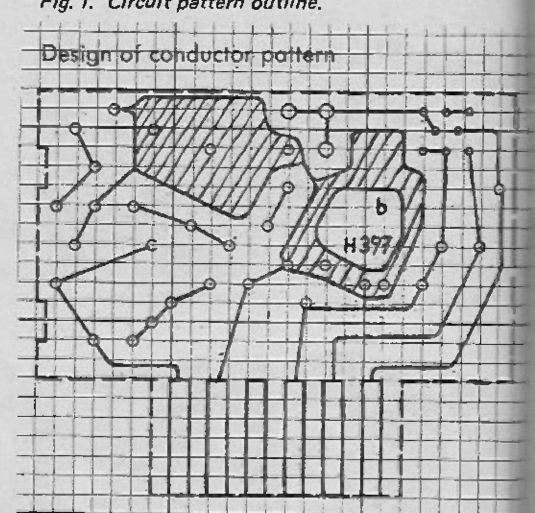
The copper ring around the wiring hole is known as a 'solder pad' or 'land' and is most generally round in shape. Pads should be a minimum of .060" greater in diameter than the hole wherever possible.

There are various options open to the draftsman for preparing the master artwork. In addition to the traditional method of ink drawing, there is also the cut and strip method and the stick-on method. In the stick-on method self-adhesive strips, pads, connectors and curves are used. A wide variety of shapes and sizes are available, and this method has become almost standard.

For double sided circuits it is possible to obtain 'stick-ons' in transparent red and blue as well as black. Pads common to both sides are laid out in black, while the conductor lines for one side are done in blue and those for the other side in red. At the photographic stage first one colour and then the other can be filtered out to produce separate films for each side from one artwork.

This method ensures proper side-to-side registration at least at the artwork stage.

Fig. 1. Circuit pattern outline.



The step-by-step preparation of artwork is as follows:

1. Choose working scale.
2. A transparent or translucent Mylar sheet is placed over a standard grid.
3. Corner marks or an outline of the board profile are marked in or taped.
4. Place the pads accurately as to grid crossings.
5. Place connectors where necessary.
6. Tape conductors lines, starting in most crowded area first.
7. Check clearances, keeping manufacturing tolerances in mind. Cut back pads only when absolutely necessary.
8. Place coding or nomenclature where applicable. Pay particular attention to scale.
9. Reducing lines in both axes, external to the board profile and proportionately equal in length to the outside dimensions of the board, are drawn in to assist the photographer.

No printed circuit can be better than the master conductor pattern. Utmost care must be taken at this stage.

Multiple head machine drills four boards at once.

What must a master drawing contain?

Printed circuits cannot be prepared from the conductor pattern alone. Depending on the type required, additional patterns for soldering marks, component coding or other printed patterns might be required. Most important, however, is the master drawing. This drawing must contain all the details necessary for the production of the printed circuit. The following information is required:

1. A full-scale view showing contours and all holes. The grid spacing must be specified, together with the hole diameters and special tolerances where they occur. Symbols may be used to identify holes of different diameters.
2. References must be given for all associated artworks and drawings.
3. Surfaces must be specified — e.g., copper fluxed, tin flash, tin or tin/lead electroplated, nickel-gold, etc. Thickness requirements and tolerances are also essential.
4. The type and thickness of base material, together with the copper thickness, must be specified. Note: Material with .0014" cu is known as 1 ounce material. Similarly .0028" cu is 2 ounce material, and so on.
5. Holes not falling on the grid must be dimensioned separately.
6. Company name, part number and modification index are also generally required.

Armed with a master artwork or artworks and a master drawing plus any additional drawings or artworks necessary for the production of his particular board, the designer can confidently approach the production department. Printed circuit users without experience in printed wiring design will generally find suppliers willing and eager to assist at design stages, as well as with manufacture. In most cases much time and effort can be saved if liason between the designer (or user) and the manufacturer is established as early as possible.

Inspection of incoming artwork

The manufacturer, upon receiving the manufacturing documents, begins his effort with a careful inspection of the artworks and drawings supplied. This may seem an obvious or even trivial point, but in the printed circuit industry it is a point too often overlooked. We find that 80% of the incoming artworks are defective in some way so as to prevent manufacture of the boards to the customer's own drawings and specifications. In these cases the customer is alerted to the problem,

Fig. 2. Master conductor pattern.

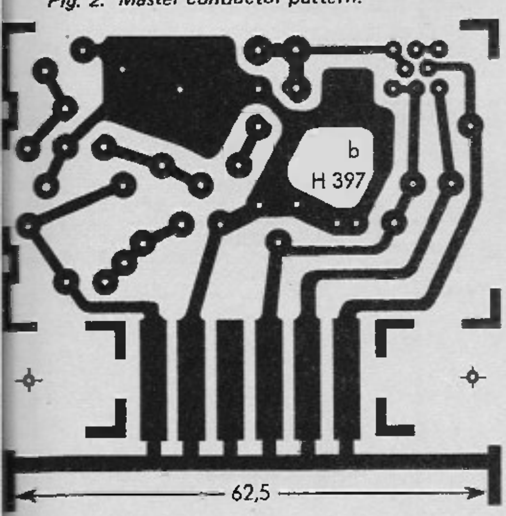


Fig. 3. Recommended pattern details.

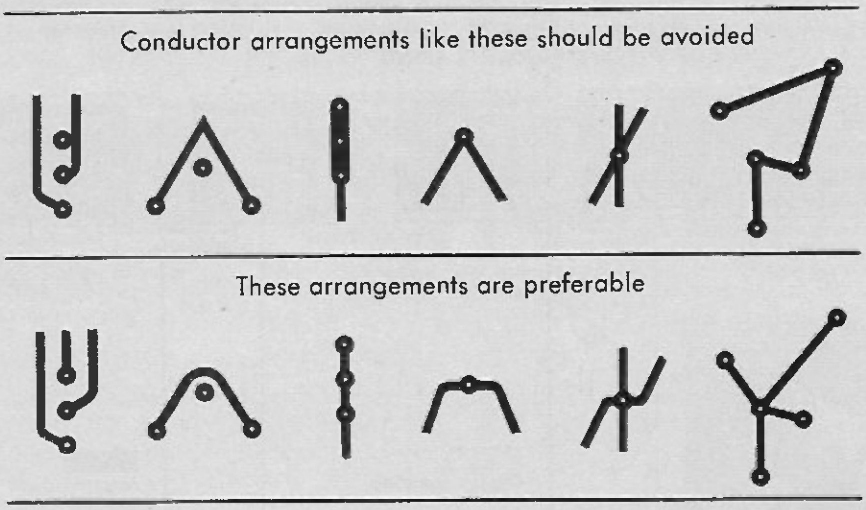


FIG. 4 (a). PHOTO–RESIST

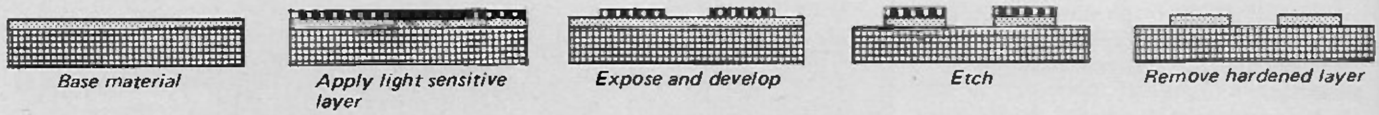
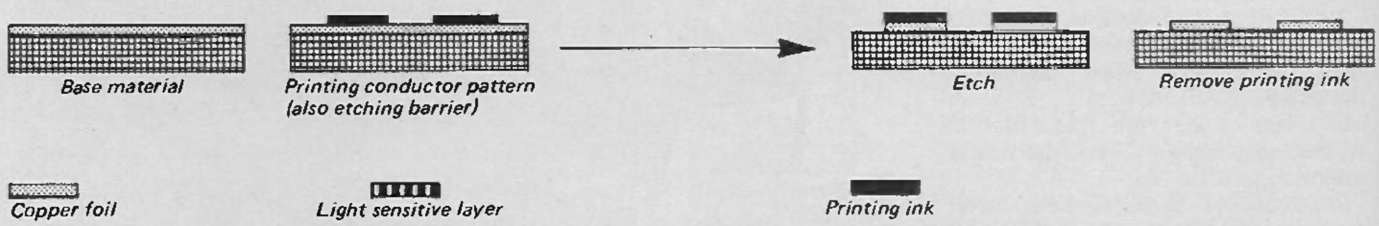


FIG. 4 (b). SCREEN–PRINTING



which may be solved by alterations to the artwork or perhaps by relaxation of tolerances.

Photography

From the master artwork a working film is produced. This is accomplished by photographic reduction, using a highly accurate process camera. With this camera, reductions of between 2:1 and 10:1 are possible to a consistent accuracy of ± .002" over 10 inches in the finished film. By applying special techniques even these accuracies can be improved upon. In view of the expansion coefficients of the available films, approximately .001"/10 inch/10°F, or .001"/10 inch/10% relative humidity, it is obvious that to obtain these accuracies one must work in airconditioned surroundings.

Production

The operations necessary for the production of printed circuits from the raw material stage have for the most part been taken over from other branches of manufacture and adapted to the purpose. The etching process is well-known in the manufacturing of printing plates in the graphic arts industry. Screen printing has also been previously employed in the manufacture of textiles, printing of signs, posters, and other fields.

Electroplating is an old-established process which found many applications in the electrical, automotive and jewelry fields prior to its use for printed circuits. All of the photographic methods were also known in principle before their application to printed circuits, as were the mechanical methods of milling, blanking, drilling, etc.

Image transfer

No matter what the final product is to look like or what approach is taken in manufacturing, the business of producing a printed circuit revolves around the transfer of the film image onto the board surface. The two methods for accomplishing this which have found nearly universal acceptance are screen printing and photo resisting.

In the screen printing process the so-called printing screen acts as a template. In practice the underside of a flat, rigid frame is covered with a taut fine mesh. This mesh was formerly of silk, hence the name 'silk screening'. However, since the advent of the polyester and stainless steel meshes, the term 'silk screening' has become a misnomer in the printed circuit industry.

Using one of several available methods, a 'stencil' is applied to the mesh. The stencil in its various forms comprises a light sensitive plastic layer which, when exposed to light at the appropriate wavelength, becomes hardened. By exposing through the working film and 'washing out' with water, the conductor image is transferred from the film to the stencil on the mesh. Using a rubber squeegee to force the 'ink' through the mesh, the image is again transferred from the printing screen to the printed circuit laminate.

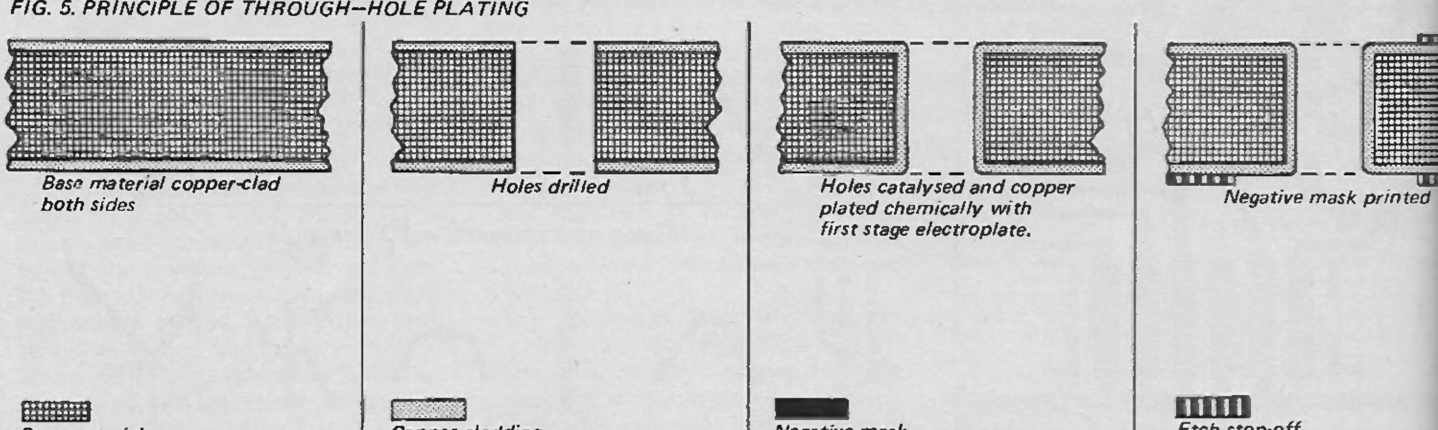
The screen printing process makes possible large-scale manufacturing with a simple tool which can be used many times.

Photo resisting, the alternative to screen printing, employs a single transfer to the conductor image to the board surface.

Commercially available photo resists are light sensitive plastics which are applied in a thin layer to the base laminate by one of a variety of methods that include dipping, spraying, hot laminating and roller coating. Resists used are said to be either positive or negative working, depending on their reaction to light. Negative working resists harden on exposure; positive working resists become soluble. The sequence of operations is generally as follows:

1. Clean laminate.

FIG. 5. PRINCIPLE OF THROUGH–HOLE PLATING



2. Coat laminate.
3. Dry resist.
4. Expose resist through working film.
5. Develop image (i.e., solvent wash).
6. Touch up.
7. Bake.

Photo resisting is an especially valuable technique where a high degree of accuracy is required. Although it is impractical in high-volume production to screen print conductor lines narrower than .015", photo resisting is so accurate that the plating or etching steps become the limiting factors in the direction of narrower lines. Lines of .005" are easily produced.

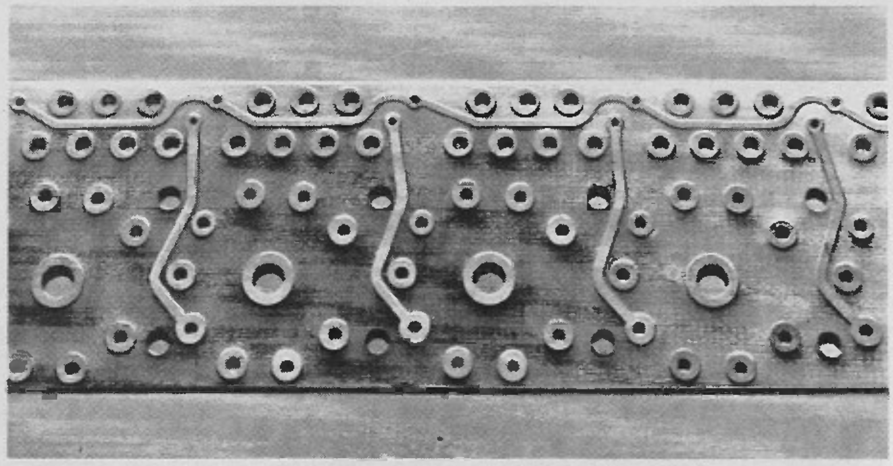
The second advantage of photo resisting is its ready application as a technique for prototype or short-run work. Because no tooling is involved, photo resisting invariably proves to be the quicker and more economical approach for small quantities of circuit boards. The cross-over point where screen printing becomes more economical depends on the board involved and the equipment available to the producer, but in general one can say that it will occur between 20 and 50 off.

Print and etch boards

The etching method has gained a secure place in the short history of printed circuits. This is known as the 'subtractive' method because the superfluous copper is removed from a fully clad base laminate by etching.

The base material (copper foil laminated to a plastic base) is provided via either screen printing or photo resisting with an etchant resistant pattern using the techniques already described. The exposed copper is then etched away (Fig. 4). This is accomplished either in vats or, in the case of more precise work, in spray etching machines. The etchant most commonly used for such work is a water solution of ferric chloride.

After etching, the protective resist or ink is removed and any necessary mechanical operations such as drilling, guillotining or blanking are performed.



Plated through holes allow component location on both sides of a circuit board.

Plate and etch boards

By altering the print and etch technique slightly, boards with electroplated surfaces can be produced. The choice of plated surfaces is based on the factors of solderability and economic feasibility. For conductor patterns in general, tin or tin/lead alloy is the usual choice. Both of these surfaces offer good solderability and are reasonably economic. Tecnico Electronics offers bright tin plating rather than tin/lead because it is felt that bright tin offers advantages in terms of appearance, shelf life before soldering, and simplicity of in-process control.

Contact surfaces for switches or plug-in connections which have been included in the conductor pattern are usually plated with hard gold or gold over nickel. For most applications .0001" of hard gold is sufficient. If, however, contact is to be made and broken repeatedly (as in the case of a printed switch or multi-insertion edge connector), it is advisable to have the added hardness provided by .0003" – .0004" of nickel under the gold.

In practice, the opposite image to that required for print and etch work is applied to the board. The conductor lines are left as exposed copper. After electroplating to the desired thickness with the specified metal, the plating resist (as such an ink or resist is known) is stripped from the board.

In this case the plated metal acts-as an etchant stop-off, in exactly the same way as the printed resist did with a print and etch board.

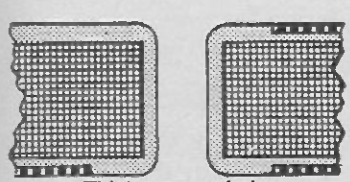
Plated boards must be etched with etchants specially formulated for the purpose, because both tin and tin/lead would be attacked by ferric chloride. Since plated boards are usually made to finer tolerances in other regards, it is also common practice to spray etch them rather than use the less precise method of vat etching. Spray etching leads to less undercutting of the conductor line by the etchant and enables closer control.

Subsequent mechanical operations are performed, and after strict inspection the boards are packed and delivered.

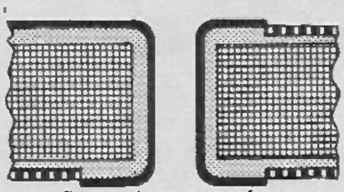
Plated through hole boards

The next step along the road to sophistication, after the plate and etch board, is the plated through hole board. The plated through hole provides electrical continuity from one board surface to the other. This feature has obvious advantages in terms of design latitude – both sides of the board become one circuit. An added bonus that comes with through hole plating is that solder tends to fill in the hole around a lead, forming a more solid connection and contact.

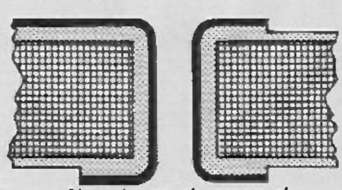
Continued on page 72



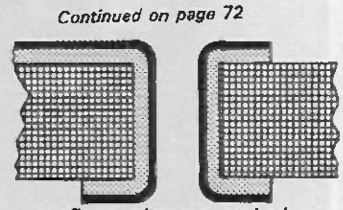
Thick copper plating build-up



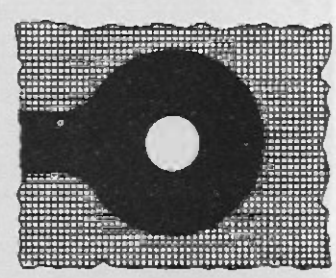
Exposed copper surfaces, tin, tin/lead or gold plated for etch stop-off.

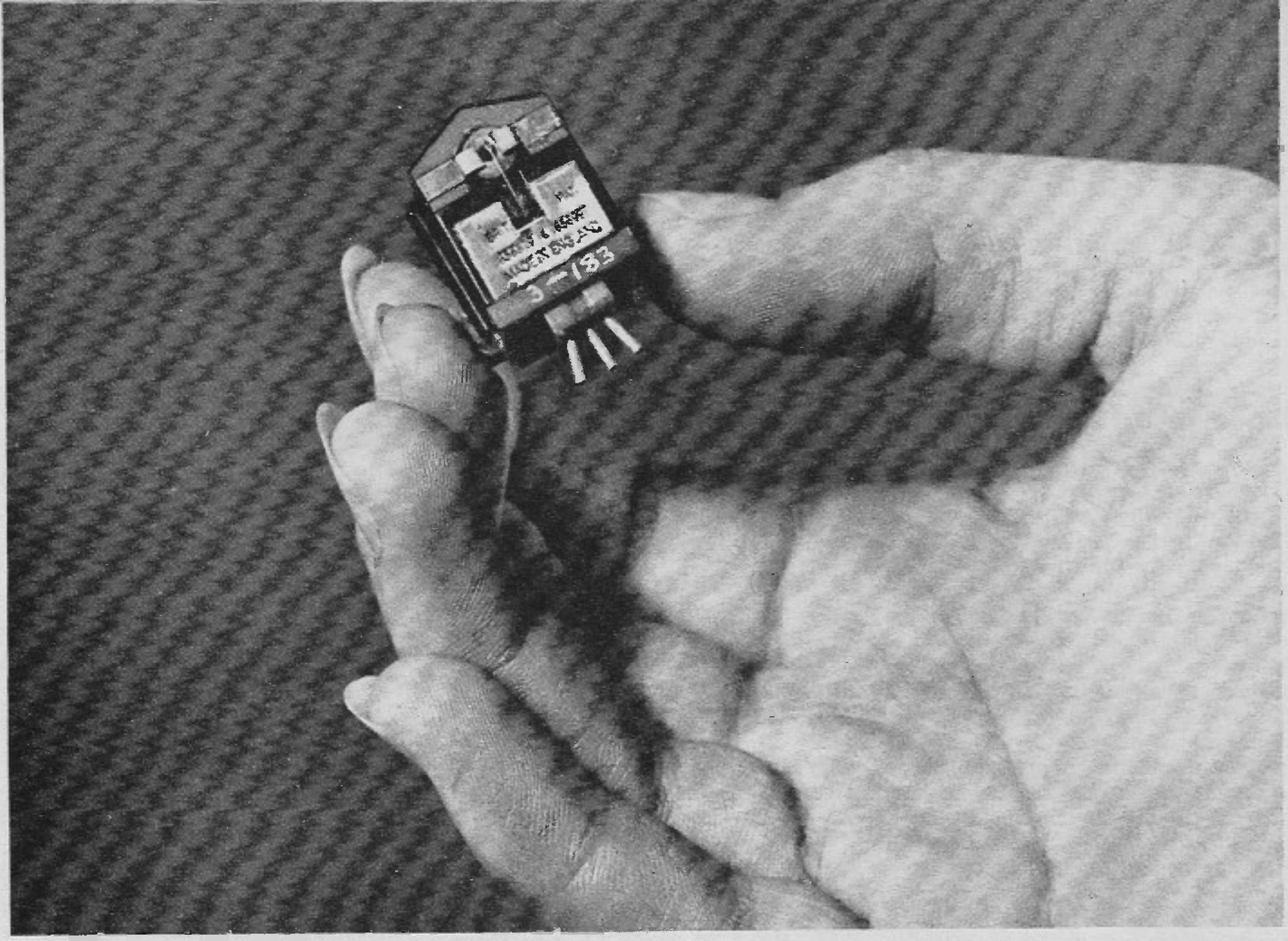


Negative mask removed



Exposed copper etched





THE DECCA 'LONDON' CARTRIDGE

electronics TODAY INTERNATIONAL
product test

This new cartridge from Decca incorporates a number of ingenious design features.

IN its design philosophy the Decca 'London' cartridge is most probably unique. It is the result of considerable research work by Decca to improve their existing cartridge designs. The 'London' cartridge incorporates the 'positive scanning' system used in the model C4E and other previous Decca cartridges.

In the normal moving magnet design the sensing coils are located well inside the cartridge housing and the stylus movement is transferred via the cantilevered stylus bar to the magnet mounted midway along the bar. The 'London' cartridge has a shaped stylus bar clamped at one end and tensioned via a nylon cord at the stylus tip. A section showing the physical relationship of the cartridge components is shown in Fig. 1. As can be seen in the drawing the lateral movement is sensed just above the stylus tip, and the vertical movement is sensed at the top of the bar. This is what the Decca sales people have labelled 'Positive Scanning'.

Induced magnet cartridges are very susceptible to external magnetic fields, and previous Decca 'Positive Scanning' cartridges were prone to hum pick-up via the sensing coils, which being located directly above the stylus tip, could not be effectively screened from stray magnetic fields. As most steel is usually magnetised to some degree these cartridges could not generally be used with steel turntables.

But nowadays most mass-produced and practically all top-quality turntables have aluminium platters, and hence the problem of hum pick-up from steel turntables has to a large extent been eliminated. Apart from this, modern hi-fi amplifiers have screened power transformers, thus reducing their magnetic radiation.

These fortuitous developments, together with the use of a more powerful magnet within the cartridge, have resulted in a generally acceptable signal to hum ratio from the new Decca cartridge under most possible situations.

In conjunction with Mullard, Decca's design engineers have considerably improved the magnet design and consequently it has been possible to markedly reduce the cartridge weight from approximately 14 grams, (the weight of other Decca cartridges), to a very respectable four grams and, at the same time, to increase the output to a claimed 7.5mV for a velocity of 5cm/second. The cartridge which we tested had an output of 10mV at a velocity of 5cm/second at 1kHz.

This increased output is primarily due to the use of the more powerful magnetic material which also results in a marked reduction of induced hum.

During the manufacturing process the armature in the London cartridge is "super cooled" in liquid nitrogen at −196°C. This process re-establishes what is known as the "Martin Site Structure" of the material. In simple terms, "super cooling" eliminates stress relaxation problems.

MEASURED PERFORMANCE OF DECCA LONDON CARTRIDGE

Frequency Response 20 to 20kHz ± 3dB
Channel Separation at 1kHz 22dB
Channel Difference at 1kHz 1dB
Output at 1kHz re 5cm/sec 10mV
Lateral Compliance – 12×10^{-6} cm/dyne (Maker's figure)
Vertical Compliance – 5×10^{-6} cm/dyne (maker's figure)

SUBJECTIVE TESTING

Subjective tests indicated that a minimum three grams tracking weight is essential to minimize mistracking and distortion. At a tracking weight of 1.5 grams, the measured frequency response exhibited numerous spikes due to minor cartridge resonances throughout the frequency spectrum.

At three grams tracking weight, the cartridge exhibited a primary resonance at approximately 12kHz which resulted in some unnatural harmonics being accentuated. This resonance also resulted in slight distortion occurring on some instrument passages containing transients.

We tried the cartridge out on some of our favourite test records. The first record, the Shure "An Audio Obstacle Course" (TTR101), gave us a good picture of the overall trackability performance. The trackability at level 4 on orchestral bells and harpsichord exhibited slight mistracking. The next record we tried, "Everything you Always Wanted to Hear on the Moog" CBS-SBR235452 showed a somewhat "leaden sound" on high frequency passages. Other records sounded quite good and it was apparent that only certain instruments (with sharp attack times) are affected to a significant degree by the dynamic characteristics of the cartridge.

We next evaluated the performance of the cartridge on a square wave test record and found that the leading edge decayed less smoothly than is desirable and not as well as most other cartridges in the same price bracket. This test correlated well with the frequency response and showed that the high frequency characteristics were not all that could be desired.

The rising treble response gives this cartridge an effective crispness which many listeners will favour, and provided the velocities above 15kHz do not exceed 10 centimetres per second its performance is exemplary.

At first sight a possible disadvantage of the Decca design is that the whole cartridge must be returned to the distributors when the stylus wears out

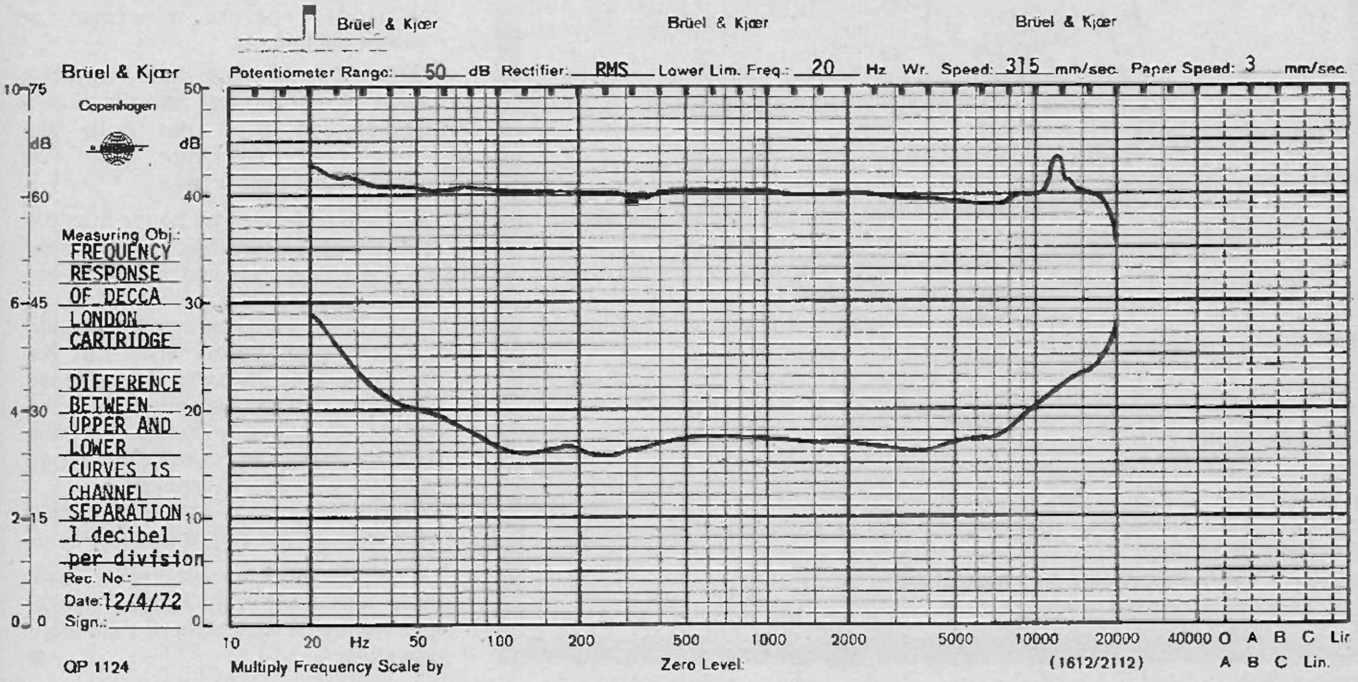
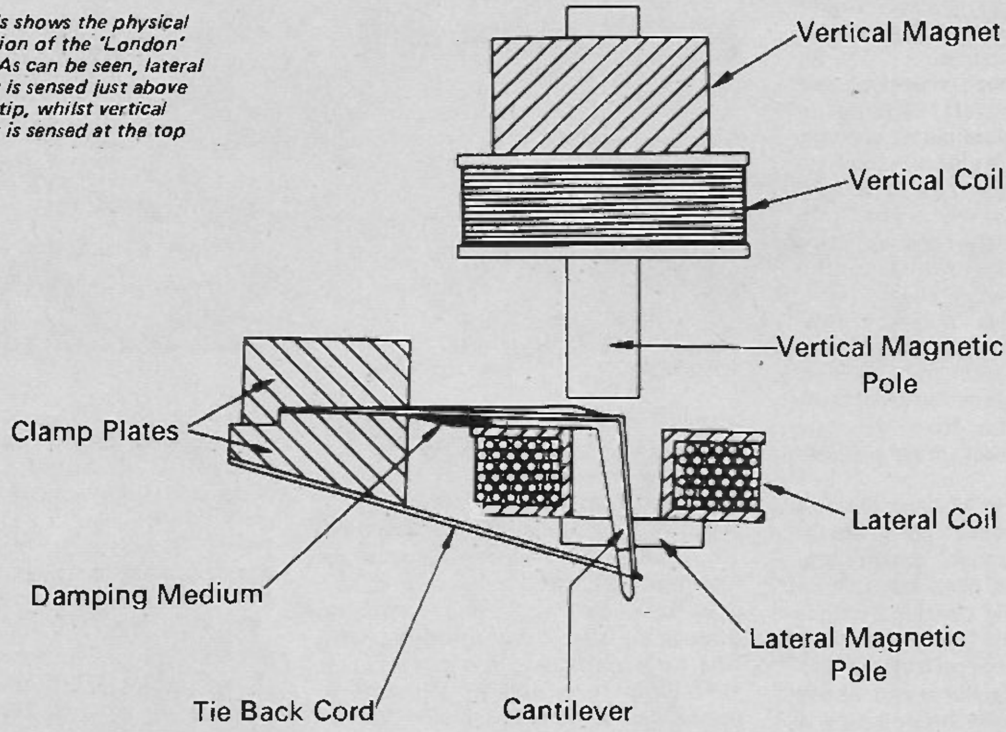


Fig. 1. This shows the physical configuration of the 'London' cartridge. As can be seen, lateral movement is sensed just above the stylus tip, whilst vertical movement is sensed at the top of the bar.



THE DECCA 'LONDON' CARTRIDGE

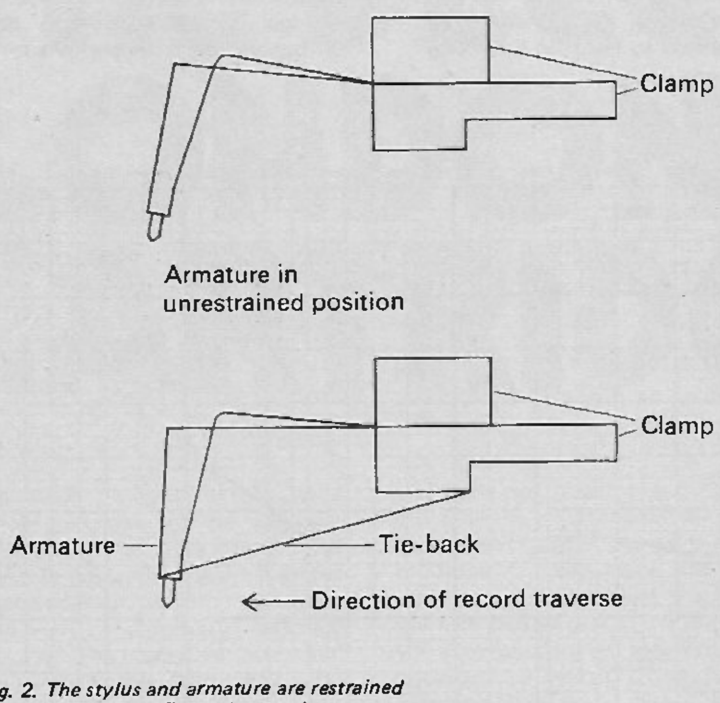


Fig. 2. The stylus and armature are restrained and tensioned by a fine nylon cord.

and exchanged for a reconditioned unit; for about the cost of a new stylus. But this is partially negated by the advantage that the reconditioned unit has been inspected and repaired by the manufacturer and carries the same 12 month warranty as a new cartridge against electrical or mechanical defects.

The Decca 'London' cartridge performs well in most respects, but in our opinion it is not quite the superlative cartridge that its manufacturer feels it to be.

Its performance is far better than the model that it superseded, nevertheless our tests have revealed a few minor deficiencies. For the great majority of users this cartridge will provide excellent crisp performance, but for the connoisseur its performance above 12-14kHz leaves something to be desired — primarily because of the resonance that can be induced by high velocities at high frequencies.

Overall we rate this cartridge as being a good performer with a few vices.

A little more development work could well result in the near perfection that we feel it is capable of ultimately providing. ●

PRACTICAL GUIDE TO TRIACS

PART 3
Zero-voltage switching

Our final article in this three part series explains how Triacs are used in zero-voltage switching circuits — and includes circuits for the control of large heating loads.

Zero voltage switching is a method of varying the power applied to a load by switching line voltage on and off only at the zero crossing points of the sinusoidal waveform.

The technique virtually eliminates the problems of rfi associated with phase control of large resistive loads.

The difference between phase control and zero voltage switching is illustrated in Fig. 27, where the upper waveform shows phase control, whilst the lower waveform shows zero voltage switching.

Zero voltage switching can only be used for applications in which the controlled load is capable of averaging bursts of complete half-cycles. Thus the response time of the load must be long compared with the period of the switching cycle, for it is quite possible that at low power settings, short bursts of say, twenty to thirty half-cycles may be applied at ten second intervals. Thus the method is acceptable for the control of loads such as heating elements, but out of the question for light dimming.

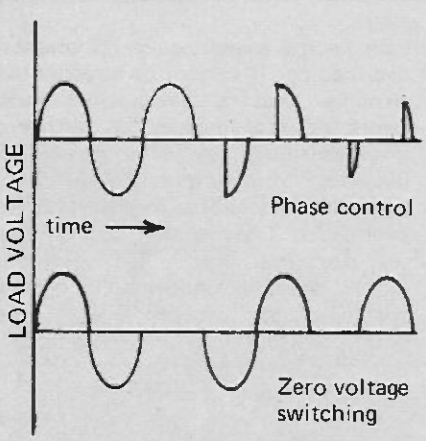


Fig. 27

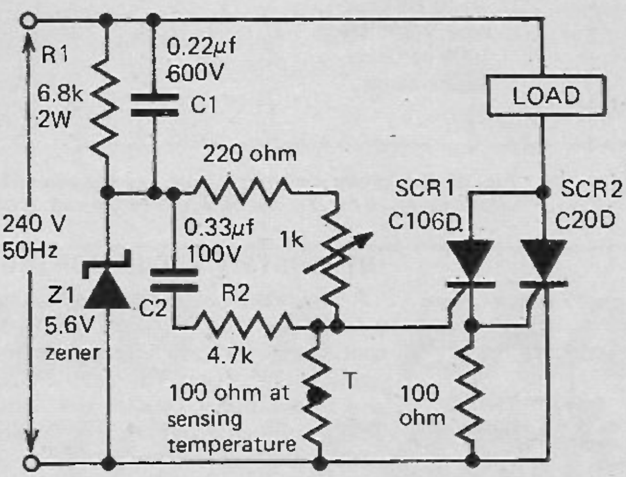


Fig. 28

Fig. 28. Simple half-wave zero-voltage switching circuit, maximum load is determined by choice of SCR2.

HALF-WAVE CONTROL

A very simple yet effective zero voltage switching is shown in Fig.28. This circuit provides half-wave control only, but is very satisfactory for commercial applications where the heating elements can be designed to suit.

The circuit is extremely stable and unaffected by quite large variations in line voltage and ambient temperature. The response time depends upon the characteristics of the thermistor which is used — times of one to two seconds are typical. The sensing differential is around ¼°F at normal ambient temperature.

The Zener diode Z1 forms a voltage pedestal of 5.6 volts nominal amplitude by clipping the incoming positive half-cycle of mains voltage. This pedestal is differentiated by R2, C2 and associated resistors to form a pedestal of reduced amplitude with a pulse superimposed on top of the pedestal (Fig.29). This waveform is applied to the gate of SCR1. The

Fig. 29. Basic waveform associated with circuit of Fig. 28.

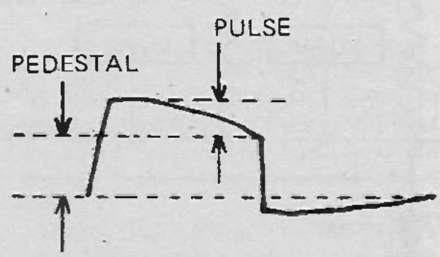


Fig. 29

capacitor C1, which is connected in parallel with R1, provides a leading phase shift to the pedestal so that SCR1 is triggered into conduction by the peak of the positive decaying pulse which is superimposed on the pedestal. It does this at the beginning of the positive going half-cycle of line voltage appearing at the anodes of both SCRs.

The thermistor controls the amplitude of the pedestal and thus provides a semi-proportional control with a small temperature differential.

The lock-in configuration of SCR1 and SCR2 reduces the effects of ambient temperature variations. The cost of this circuit is very low compared to a phase control circuit of the same power handling capacity as no rfi components are required.

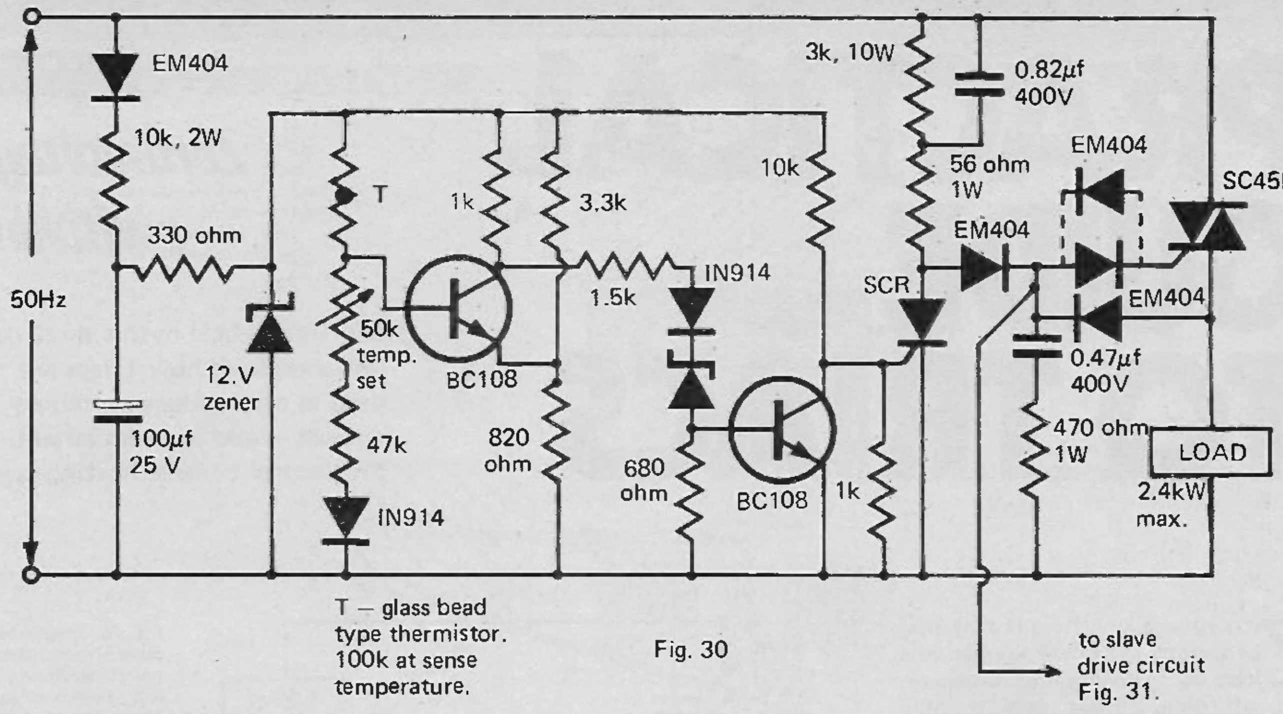


Fig. 30

PRACTICAL GUIDE TO TRIACS

Fig. 30. This circuit can control loads of a size determined only by the rating of the Triac. The slave circuit shown in Fig. 31. can be driven by the output of this circuit if required.

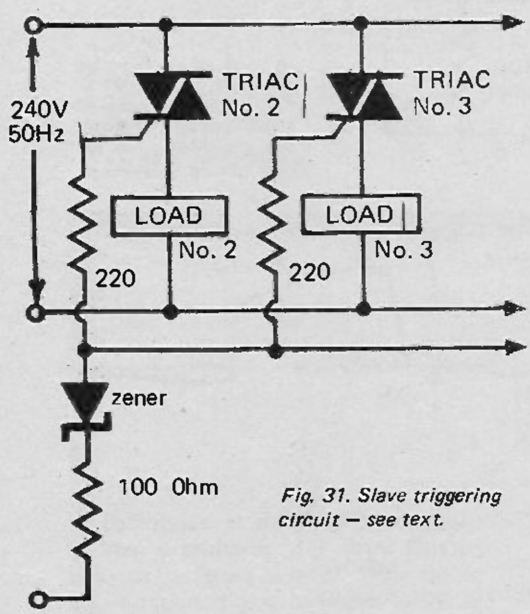


Fig. 31. Slave triggering circuit – see text.

FULL-WAVE CONTROL

The circuit shown in Fig.30 will provide full-wave control of heating loads of almost any size. The triggering circuit will drive Triacs of any size from 1 amp up to 125 amps. In addition almost any number of additional Triacs can be slave driven by the main triggering circuit. (The slave triggering circuit is shown in Fig. 31).

The differential of this circuit is approximately ± 1/6°C. This circuit has a semi-proportional action, and is suitable for applications where large amounts of power have to be controlled accurately and at low cost.

INTEGRATED CIRCUIT CONTROL

A number of companies have produced integrated circuits specifically for zero voltage switching applications. These ICs permit circuit and operational techniques which would otherwise require an unrealistic quantity of discrete components.

One typical zero voltage switching integrated circuit is the µ742 from Fairchild Semiconductor. When used with only a few passive components, plus a thermistor, this IC – develops its own power supply voltage, differentially detects sensor unbalance, detects the zero voltage crossing point and produces the required Triac triggering pulse.

Zero voltage switching integrated circuits of this type may be used in very sophisticated applications. One example of this is the 'fail-safe' control of heating (and refrigeration) loads.

In many control systems the failure (short or open circuit) of a thermistor or resistance thermometer may be almost literally catastrophic. For instance a heating control with a negative temperature coefficient thermistor would interpret shorted thermistor leads as a very high sensed temperature and would react by cutting off the power. However if the same thermistor were to go open circuit (and this is by no means unknown) the control system would see this as a low temperature and full power would be applied continuously to the load. In this case an 'open circuit' thermistor detector is required to protect the system against this condition.

A circuit that will provide this protection is shown in Fig. 32. A slightly modified version of this circuit can be used to protect against 'short circuit' failure of positive temperature coefficient thermistors.

Zero voltage switching may be used in conjunction with proportional control circuitry for both single and three phase loads. These types of systems are however necessarily complex and outside the scope of an article such as this. Full details of such circuits can be obtained from the manufacturers of zero voltage switching ICs.

TRIACS – FAULT FINDING

As far as the practical electrician is concerned, Triacs are relatively simple minded devices. They either work or they don't – there is rarely a half-way stage.

By far the greatest cause of failure is overloading. It cannot be stressed too strongly that a Triac, like most semi-conductor devices, is destroyed instantaneously by a short circuit placed across its output.

An almost infallible indication of an overloaded Triac is that gate control will have been lost, and the Triac is 'on' all the time. Checking this is quite simple, just unsolder any lead connected to the Triac's gate, and, if the Triac is still switched 'on' then the unit has lost gate control.

Before replacing the Triac, check with an ohmeter to make sure that the load is not shorted out. When the circuit is again in operation, monitor the line current for a time to check that it is within the Triac's designed rating. In particular remember that large incandescent globes have a very heavy inrush current and this may exceed the Triac's short term overload capability. (This is generally five to ten times full rated load for one half-cycle of the input waveform).

The other extreme of failure is when a Triac circuit will not trigger at all. This is generally a failure of the triggering circuit rather than the Triac.

The first obvious check is to establish that there is in fact mains voltage across the Triac. Assuming that voltage is there, a very simple check is to connect a resistor (150 ohms to 1k) between the case and the gate. This should trigger the Triac into full conduction.

If the Triac is triggered into conduction, then the fault lies in the triggering circuits; if the Triac does not trigger, then the Triac is faulty.

Finally, don't test Triacs with a Megger. ●

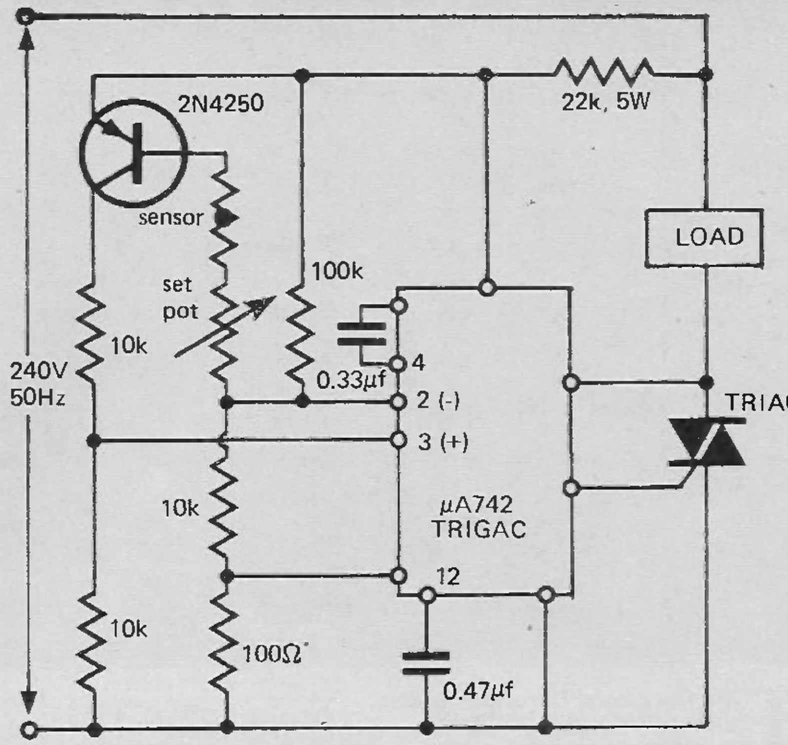


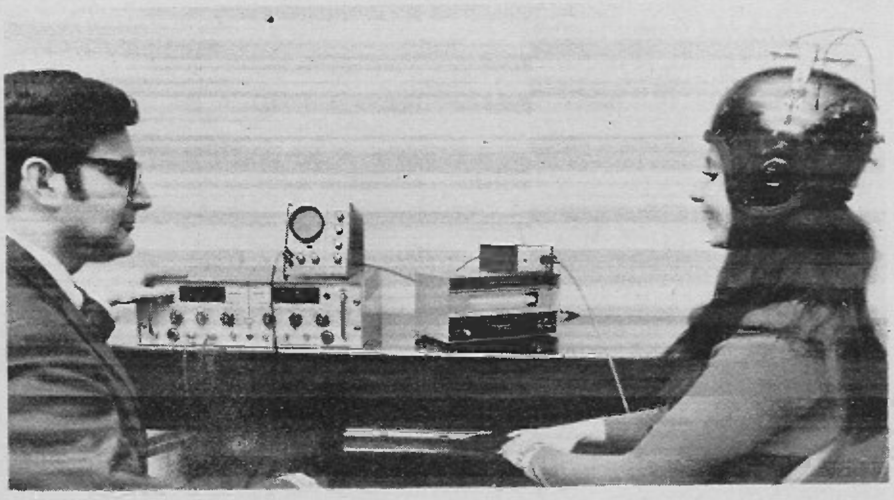
Fig. 32. This circuit using a Fairchild TRIGAC IC senses and protects heating loads against open circuit thermistors.

MEASURING A BRAIN'S ABILITY TO LEARN

Electronic equipment claimed to measure the brain's physical ability to learn has been developed by Dr. John Ertl, director of the Center of Cybernetic Studies at Ottawa University, Canada. Dr. Ertl reported at a press conference that the "neural efficiency analyzer" is available now and may be leased for educational, governmental and private use.

Until now, intelligence measurements were subject to such prejudices as social and economic background, language barriers, reading and writing problems and deafness.

This equipment measures the brain's biological efficiency within minutes, and is said to be uninfluenced by environmental, emotional and cultural factors. The testing technique utilizes an electroencephelograph, a flashing light to stimulate the brain and a computer. The subject being tested is fitted with a lightweight headpiece equipped with electrodes. Then, a strobe light flashes in front of his eyes for about two minutes — resulting in a change of the electrical activity of the brain.



These brain waves are fed into a mini-computer where they are analyzed and the result displayed in numerical form.

Results are correlated with standard IQ tests and research indicates that a short response is correlated with high IQ.

The system has been tested on some 6,500 subjects in this country and in Canada since Dr. Ertl developed the technique in 1959. Large scale research, financed in part by the U.S. Department of Health, Education and Welfare and the Ontario Mental Health Foundation, started in 1965.

Among subjects tested have been classes of retarded children, students in the public school systems in Louisiana, New Mexico and Canada, and children with known learning disabilities. ●

GOODMANS DIMENSION-8 LOUDSPEAKER SYSTEM

electronics TODAY INTERNATIONAL product test

These new Goodmans speakers have excellent stereo spread.

THE Goodmans Dimension-8 are another example of the latest generation of unconventional speakers.

The enclosure is a truncated triangular prism, finished in oiled walnut, and standing on end on a black recessed base two inches high.

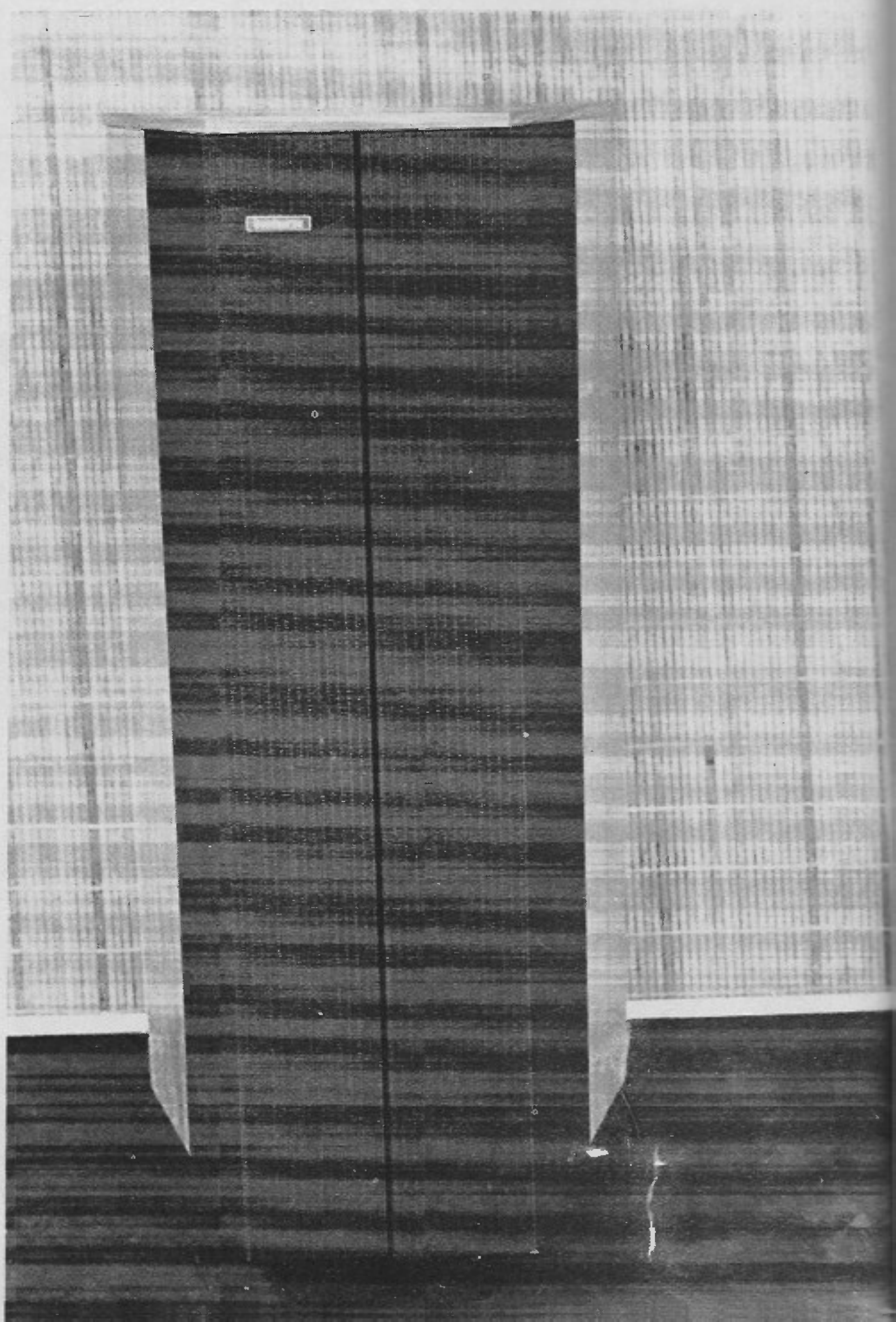
The black wrap-around grills cover the front face. This is the narrowest face and approximately half the width of the sloping sides. The rear face of the box has a square black grill recessed into it near the bottom and this covers a 12" diameter passive radiator.

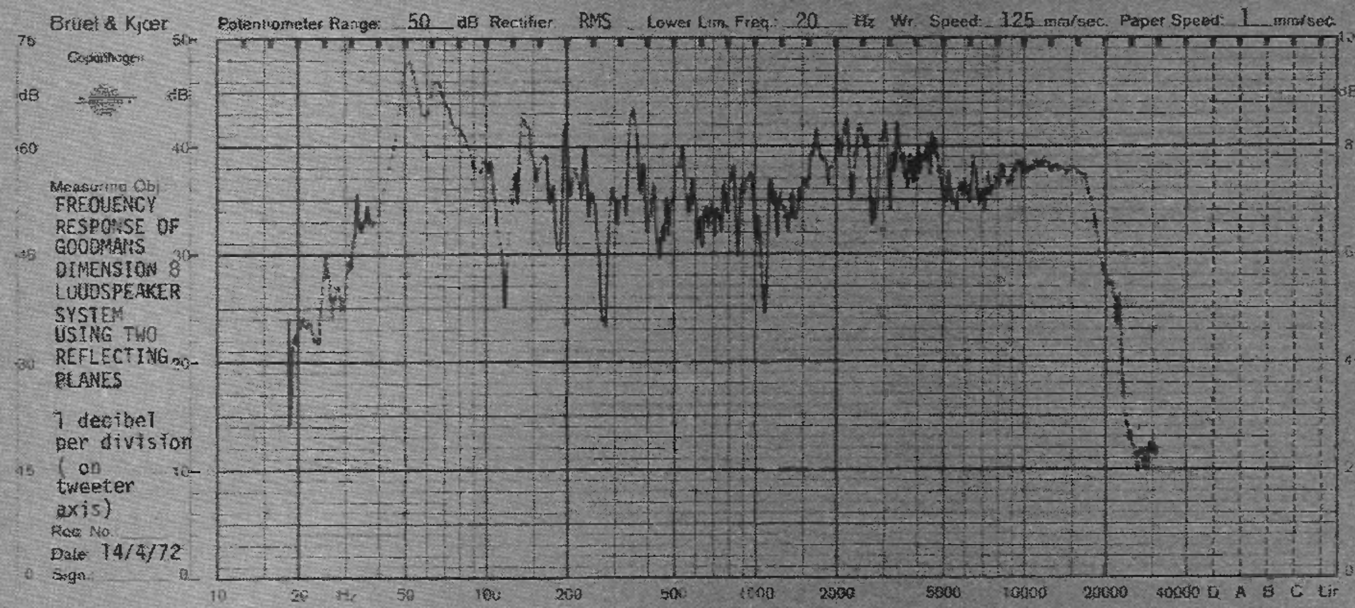
The bass response is handled by four 5" roll surround speakers and the 12" passive radiator. This radiator has two basic functions. Firstly, to dampen the movement of the woofers, secondly, to enhance the low frequency output. Normally the area of the passive radiator should be equal to the driver area. But in the Goodmans Dimension 8 enclosures the area of the passive radiator is approximately 20% larger.

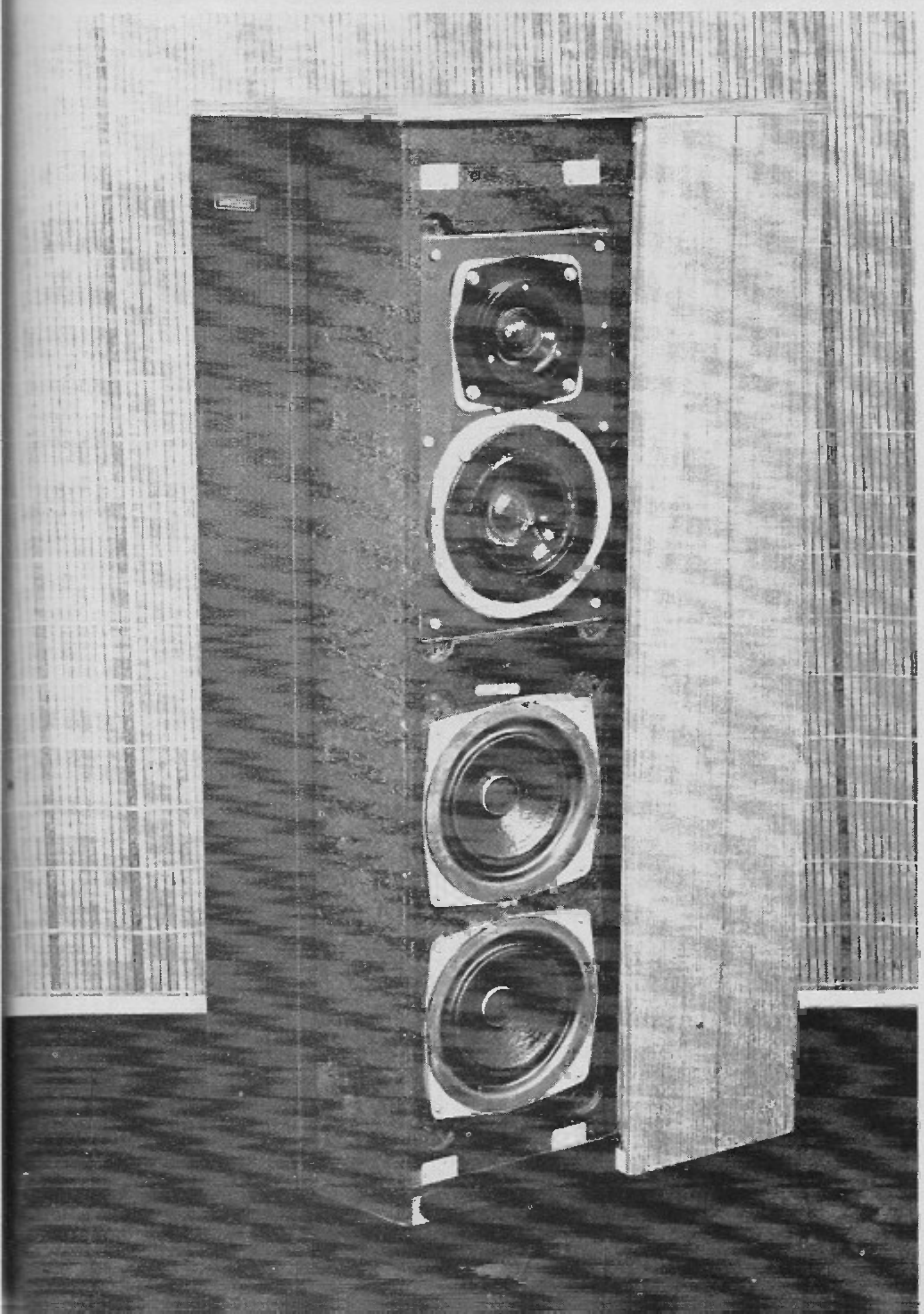
The four woofers are arranged in pairs at the bottom of each side face so that two woofers face left and two face right when viewed from the front. Directly above the woofers on each side, are a mid-range speaker and a domed tweeter. These are housed in a fibreglass enclosure to eliminate any reaction with the woofers.

The crossover networks are located in the base of the enclosure and consist of three LC circuits mounted on a printed circuit board (Fig. 1). Figure 2 clearly shows the response of each LC network with the crossover points being 700Hz and 5000Hz.

One very interesting feature of the design is the use of large blocks of foam plastic as the internal dampening medium. Most speaker manufacturers use fibrous materials such as fibreglass which have a much broader frequency







absorption characteristic and generally more effective dampening properties.

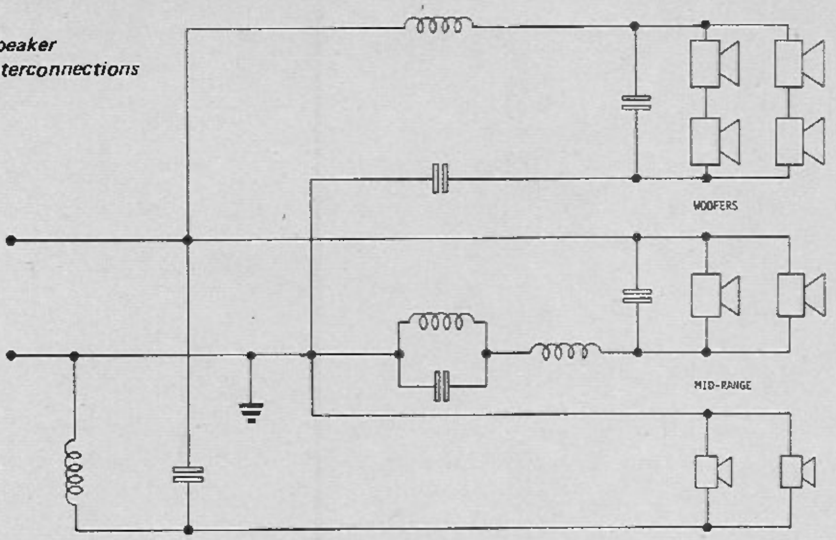
SUBJECTIVE TESTS

Subjective tests were conducted with the Warner Brothers record "Hand Made" (WB1838 CBS and "Everything You Wanted to Hear on the Moog." (CBS 235452). On both records (and others we listened to) a very distinct bass resonance was produced which could be best described as a 'boominess'. Measurements performed in the enclosure confirmed this resonance (as shown in the level recordings). The predominant point occurred at approximately 50 Hz. Except for this bass colouration the frequency response was quite smooth and extended to 20kHz.

Depending on the chosen listening position the high frequency response varied by as much as 30dB at 10 kHz as one moved from the front of the speaker enclosure to a position directly in front of the domed tweeters.

As with most unconventional speaker enclosures, the placement of the speakers is critical and can produce considerable difference in response. To obtain maximum performance the speakers should be placed in the corner of a room with hard reflecting walls and clear of any obstruction for at least four to five feet. This arrangement will provide additional short delay reflections which will reduce the loss of high frequency content directly in front of the speakers. The stereo spread produced by the Dimension 8 speakers was significantly better than that obtained with conventional speakers when arranged in this manner, and allowed greater flexibility in listening position, albeit at the expense of reducing space for other furniture.

Speaker interconnections

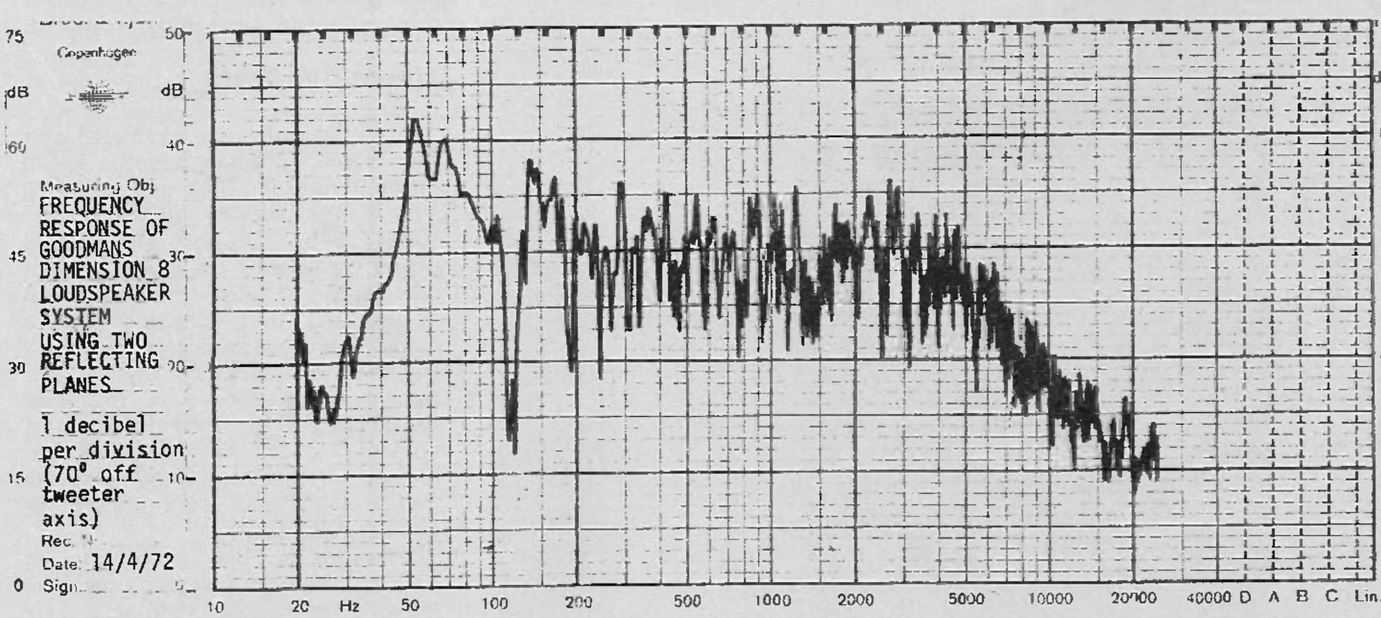


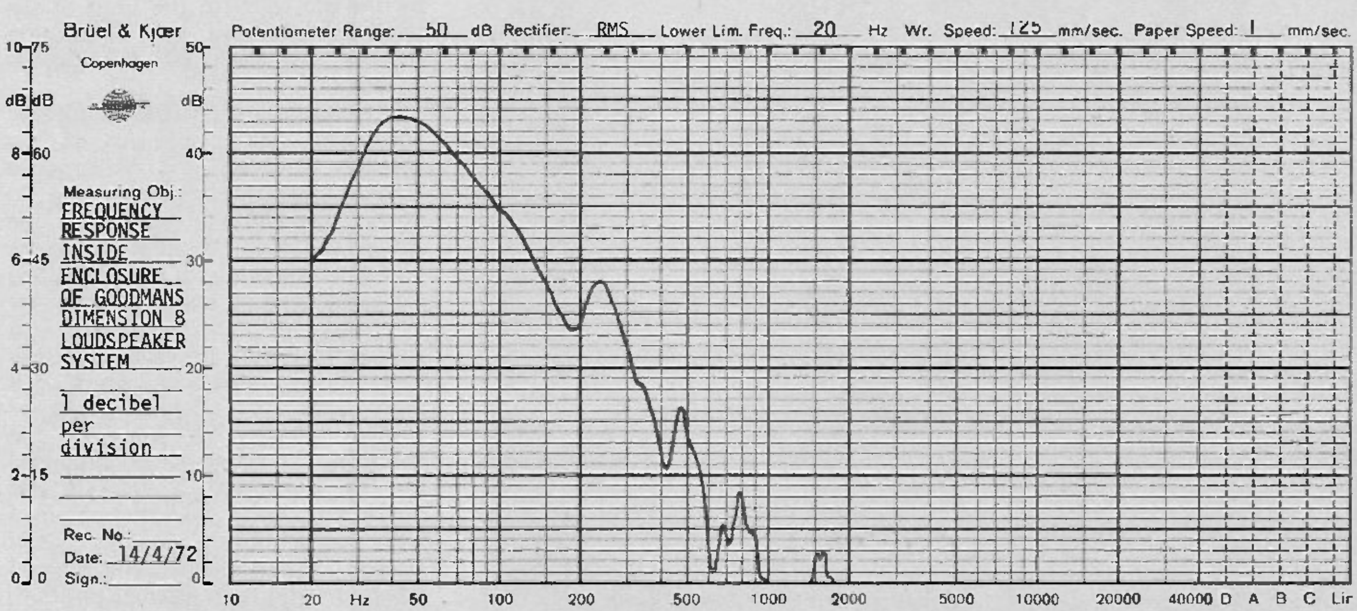
MEASURED FREQUENCY RESPONSE

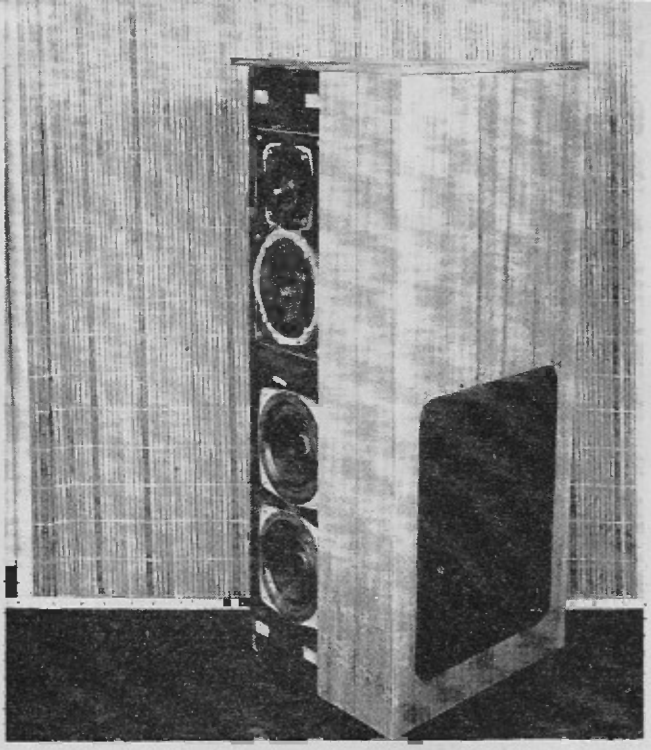
Our measured frequency response was obtained with the speaker standing on a reflecting ground plane and turned so that no face of the cabinet was parallel with the reflecting plane behind the speaker and with the microphone placed on axis with the tweeter. The measured frequency response shows a number of drop outs at the low frequency end. These are partly due to interference between direct and reflected waves. Any measurement conducted with one or more reflecting planes will produce these drop outs and peaks and these will change in frequency depending on microphone position.

With the exception of the bass resonance the performance of the Goodmans Dimension–8 speakers is quite good. Because of the low efficiency of its enclosures an amplifier with approximately 50 watts average power output would be required to obtain adequate bass response.

The bass resonance could possibly be reduced by using a more effective damping media inside the enclosure. ●







Rear face of the Dimension 8 speaker — the passive radiator is behind the woven grille.

MEASURED PERFORMANCE OF GOODMANS DIMENSION-8 SPEAKER SYSTEM

Frequency Response 70 Hz to 20kHz ± 6dB
30Hz to 20kHz ± 10dB

Total Harmonic Distortion

	100Hz	1kHz	6.3kHz
1 watt input	1.7%	1.1%	1%
5 watt input	3.5%	1.2%	1%

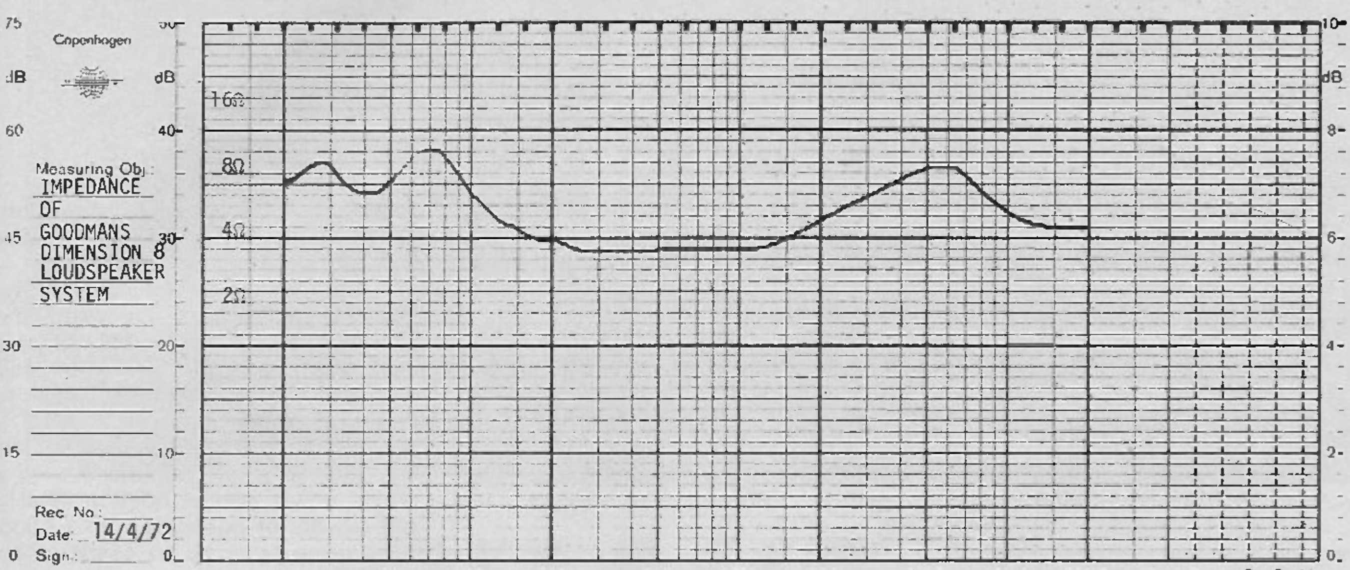
Electro-Acoustic Efficiency 0.16%

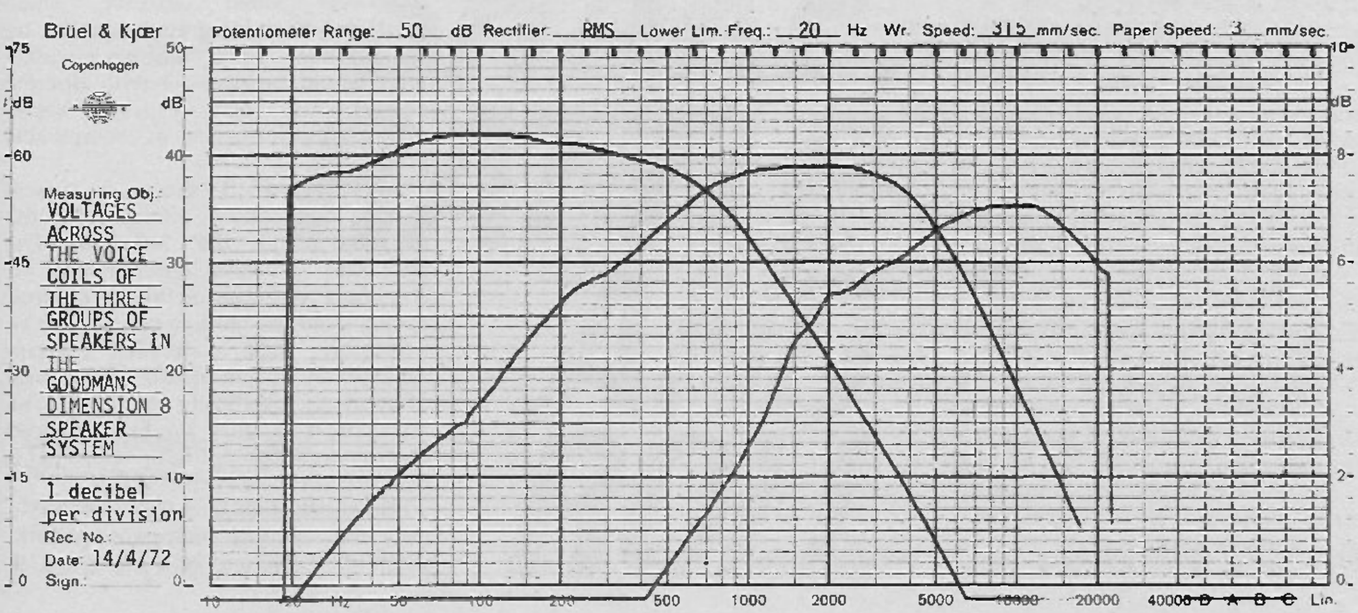
Cross Over Frequencies 700Hz, 5000Hz

Woofer Resonance in Enclosure 48Hz

Dimensions 30-3/8" High x 14" Deep x 12-1/2" Wide

Weight 44lbs





INTEGRATED CIRCUITS FOR COLOUR TELEVISION

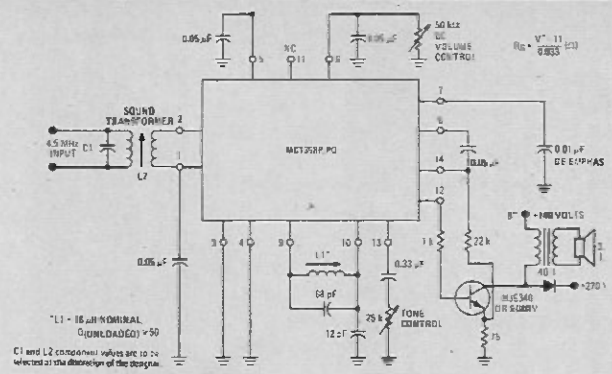


Fig. 1. Television sound IF amplifier, limiter, detector with audio driver and electronic attenuator.

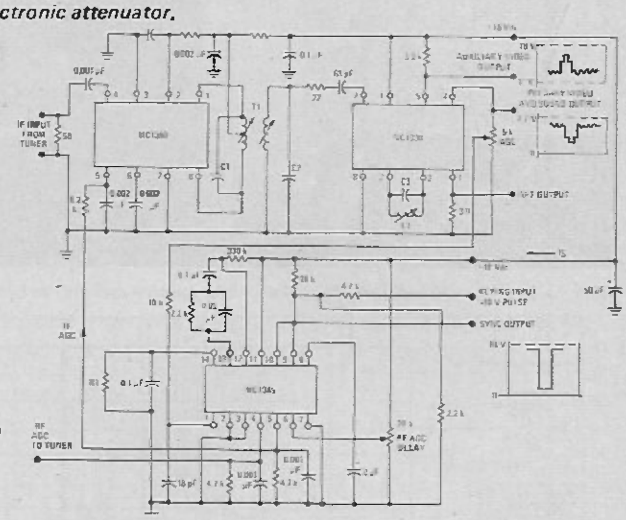


Fig. 2. Integrated circuit video IF and AGC stages use only three packages.

New low priced IC's will replace majority of low level circuitry in colour television receivers.

Some sections of the circuitry of colour television receivers are a 'natural' for integration techniques. Typical amongst these are the video IF, the sound IF, FM detector, audio amplifier, video amplifier, chrominance demodulator and sync circuitry. In fact *any* of the low level circuitry of a colour television circuit lends itself to integration.

Whether integration is used, or not, depends entirely on the relative economics when compared to discrete components. Recently the prices of IC television circuitry have become more than competitive and ICs are now appearing in ever increasing abundance in the latest-model receivers.

It is almost certain that all future receivers will contain four or five ICs which will replace a sizeable part of the discrete components required.

Motorola has invested heavily in the manufacture of ICs specifically for colour receivers and a few examples are given here to illustrate what can be done.

Integrated circuits are available in various levels of integration but the trend seems to be toward single chip colour decoders, single chip IF amplifier, detector and AGC and single chip sound IF, FM detector and audio output stages.

Although the ICs illustrated here are specifically designed for NTSC, others designed for PAL are also becoming available.

Figure 1 shows the application of the MC1358 which is a versatile monolithic device incorporating sound IF amplifiers with limiting, detection, electronic attenuation, audio amplifier and audio driver capabilities.

Figure 2 shows the application of the MC1345P TV Signal Processor, the MC1350 video IF and the MC1330 low level video detector. The MC1345P provides sync separation, noise inversion, AGC comparator and a versatile RF AGC delay amplifier. The MC1350P is an IF amplifier having a typical power gain of 50dB at 45MHz and capable of operating with a 60dB AGC range from dc to 45MHz. The MC1330P is a unique ultra-linear low-level video detector which illustrates how integrated circuits, by use of much more complex circuitry than would be possible with discrete components, can provide vastly superior performance at comparable prices.

Lastly, figure 3 shows a typical chroma applications circuit using the MC1398P and the MC1326. The MC1398P provides chrominance IF amplifiers with auto-chroma control, colour killer, dc chroma control and an injection lock reference system followed by dc hue control. This device of course is specifically for NTSC. The MC1326 is a dual doubly balanced chrominance demodulator with R,G,B matrix and chroma driver stages.

The above examples show dramatically the savings in component count when integrated circuits are used.

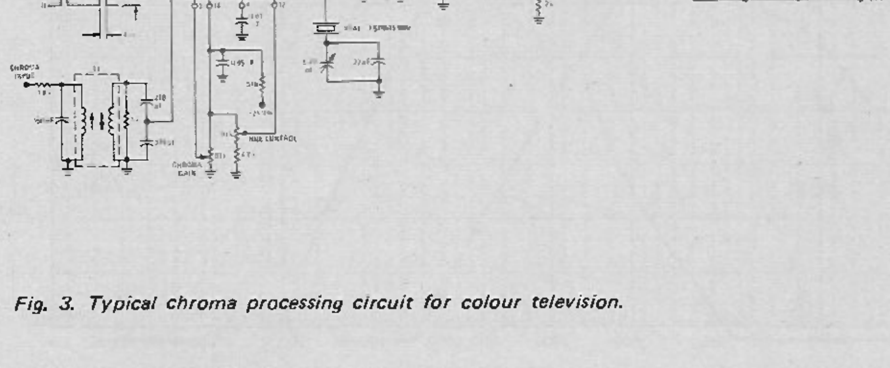
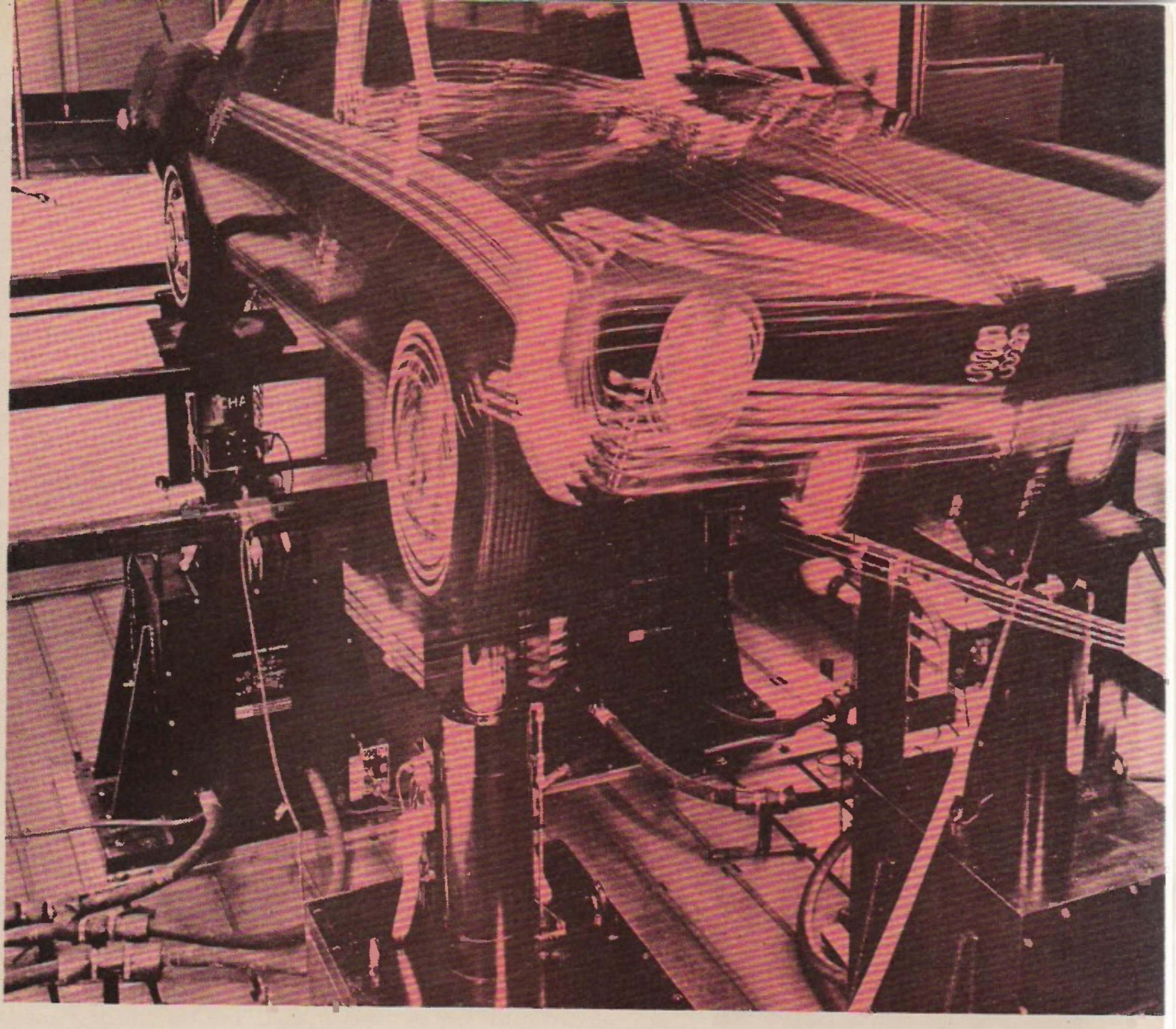


Fig. 3. Typical chroma processing circuit for colour television.



SHAKE, RATTLE AND ROLL

Latest development in automobile research enables one hundred hours of laboratory testing to equal 25,000 miles on the road.

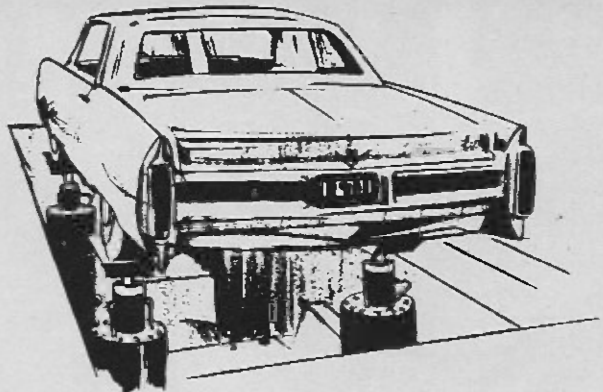
Vehicle proving grounds are great for publicity. Standard sedans and trucks thrashing around a quarter mile loop of simulated Belgian cobblestones rarely fail to impress — especially if one is inside them.

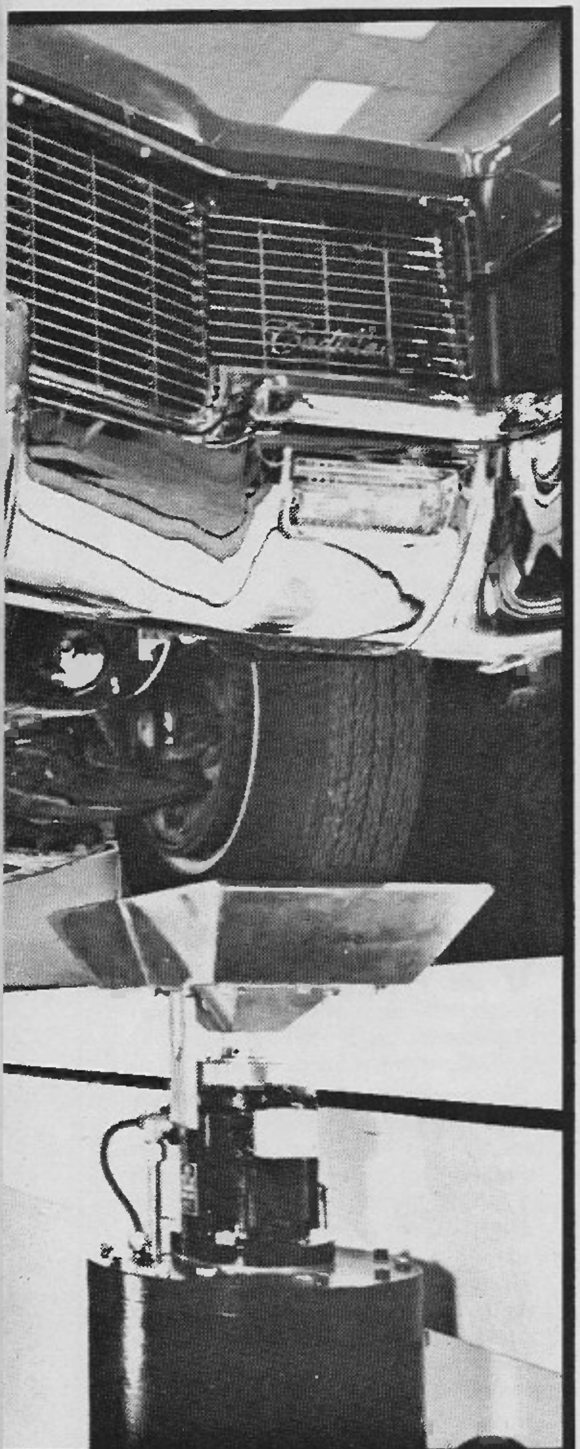
But proving grounds have a tendency to breed vehicles that can thrash around on Belgian cobblestones (simulated or otherwise) until wheels go out of fashion, yet fall to bits on African or Australian dirt roads within a year.

Given enough road surfaces and conditions, and experienced test drivers willing to go nowhere at an almost continuous 2 to 3G, proving ground evaluation has some merit.

But its drawbacks are only too well known to the automotive research engineer.

An alternative and possibly better method is to recreate actual road 'patterns' at each wheel of a stationary





Detail view of electro-hydraulic actuator, hydraulically operated floor is raised when car is driven onto the simulator, then lowered to allow access to all parts of the car during test.

vehicle. In effect tape recording a road and then playing it back to the vehicle.

Apart from the saving in operating and capital cost, the in-plant testing facility can be constructed to provide accessibility to all parts of the vehicle while the test is running. Better control and repeatability of input conditions are possible with this method.

The method can be used to test either complete vehicles, or merely sub-assemblies – such as the complete front or rear suspension.

Nevertheless the reproduction of dynamic conditions to which the vehicle is normally subjected is still quite an engineering challenge.

SUSPENSION LOADS

The front suspension members for example are subjected to a large number of different situations, leading to an enormous variety of relationships among all external forces acting upon them.

These external forces vary not only in magnitude but have different directions depending upon their origin. Therefore the magnitude and direction of the vector sum of the forces will vary accordingly.

The main force components acting on a load carrying ball joint are shown in Fig.1. These forces act at the points where the tyres make contact with the road:–

1. Dynamic force (P) acts in the vertical direction due to the combination of vehicle speed and road surfaces.
2. Centrifugal force (C) acts in the transverse direction due to the combination of vehicle speed and turning.
3 Deceleration force (B) acts in the longitudinal direction due to braking.

Each of these forces will produce at least two force components at any of the front-end members because of the geometry of the suspension system.

For example, on a load carrying ball joint, the vertical dynamic force (P) will produce vertical and transverse force components; the transverse centrifugal force (C) will produce transverse and vertical force components; and the longitudinal deceleration force (B) will produce longitudinal and vertical force components.

And as the forces involved are multi-directional, the road simulator must be able to create adequate forces simultaneously in three directions.

These required forces are generated either electrically or electro-hydraulically.

In the purely electrical system, the actuator looks like the world's biggest loudspeaker, with the exception that a longitudinal thrust rod replaces the loudspeaker cone. When a voltage is applied to the 'voice coil' – the rod produces the mechanical analogue of the input voltage.

The power required to drive these vibrators is large and inputs of up to 100 kW are common.

The electrical vibrator has a relatively fast response time, and by using suitable transducers, overall motional feedback can be applied around the complete loop.

ELECTRO-HYDRAULIC ACTUATORS

The electro-hydraulic actuators, on the other hand, consist of linear hydraulic rams controlled by servo-valves governed by an electrical signal. The forces generated by such actuators are so accurately controlled, that within their designed working load, they can provide a waveform deviation of less than 0.001 inch from a true sinusoidal input. Yet the maximum force obtainable may exceed 1,000,000 pounds.

Closed-loop control can also be obtained with electro-hydraulic systems. A transducer mounted directly on the specimen, measures actual forces or displacements on the specimen, and outputs an electronic feedback signal that represents actual forces or displacements. The servo controller compares the feedback signal with the programme input signal. Any difference between the two signals automatically boosts or reduces the signal to the servo valve, thus changing the forces on the specimen, until both signals are substantially equal.

The necessary road condition data is obtained by equipping a representative test vehicle with transducers that monitor and translate speed, torque, tyre deflection, axle displacement, body acceleration, cornering force, diagonal strain etc.

The vehicle is then driven, with various loadings, over terrain similar to that for which the vehicle was designed.

The data from the various transducers is recorded onto magnetic tape by using an FM recording technique.

The taped signals, after suitable editing, are then reproduced to programme the test. Further transducers fitted to the vehicle under test, produce a second set of data that is compared with the original data to check the accuracy of the overall loop.

RESULTS OBTAINED

The results so far have been very worthwhile, especially for sub-assembly testing. An excellent correlation of wear patterns has been obtained between assemblies tested on a simulator, and those tested under actual road conditions.

In addition to accuracy, the laboratory system has proved to be less costly and time consuming. For comparison, 100 hours of simulated running is the proving ground equivalent of 5,000 miles which in turn represents at least 25,000 miles of 'normal use'.

But let us hope that the concept will be applied to making vehicles last longer — rather than as one fears — ensuring that no one component goes on for more than 25,000 miles! ●

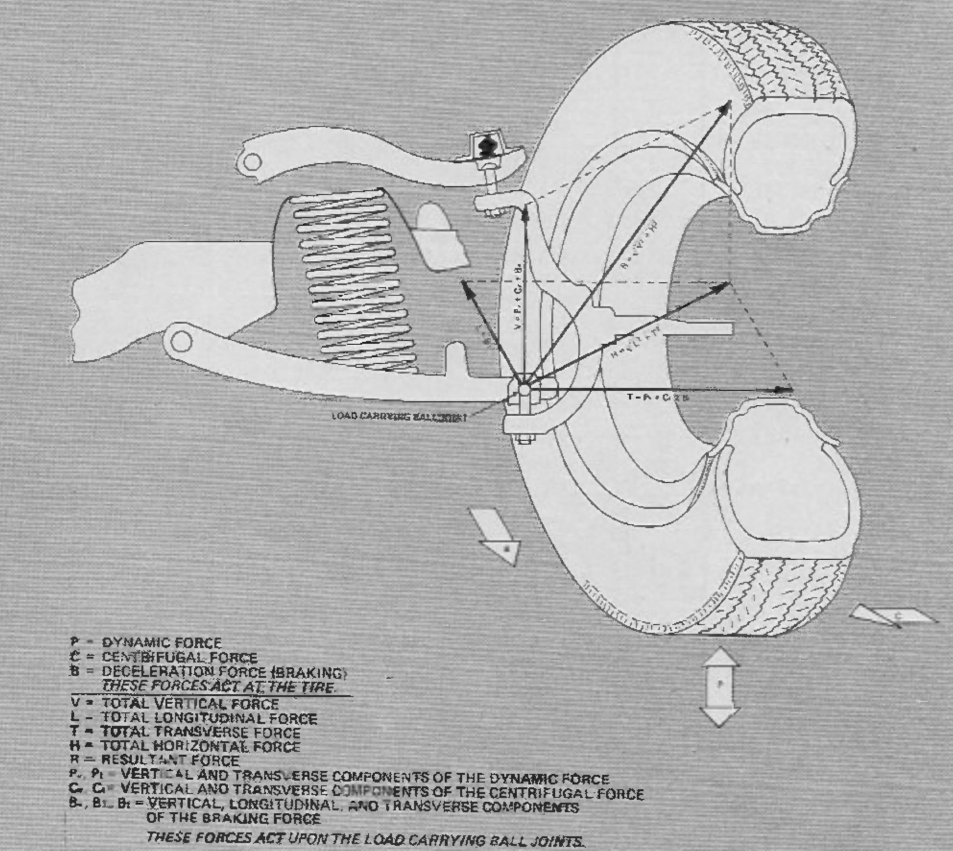


Fig. 1. Force components produced on a load-carrying ball joint.

THE 3-D LASER MICROSCOPE

A British physicist, Dr Robin Smith of Imperial College, London, has built a remarkable optical microscope based on a new principle which can provide completely undistorted three-dimensional viewing and recording of such vital events as the way in which human blood cells devour bacteria, or what happens when living cells divide.

Dr. Smith's microscope uses two exciting developments of recent years, the laser and the hologram. The laser produces an extremely intense beam of light on a single wavelength. The hologram is really a remarkable kind of photograph which, when illuminated with light from a laser, provides the human eye with a perfect three-dimensional image of the subject of the photograph.

The microscope works like this. The object under examination is mounted on a slide and positioned on the microscope stage in the usual way. But in place of the usual mirror beneath the microscope, normally put there to reflect light up through the object, there is a photographic plate. Instead of being illuminated from below the slide is illuminated from above, by a laser which shines its beam down the barrel of the microscope.

When the laser is switched on it takes a photograph of the object on the photographic plate. This photograph is a hologram. When the slide with the object under examination is removed and replaced by an empty slide, with the photographic plate still in position beneath, then if the observer looks down the barrel of the microscope it will appear as though the object is still there. It is an uncanny experience to see a perfect three-dimensional replica of the object materialise upon the empty slide. If the photographic plate is replaced by a moving film then this can provide a complete three-dimensional reconstruction of a complete event like cell division.

Perhaps the cleverest thing about this ingenious invention is that there is absolutely no distortion in the three-dimensional image created. This is because any distortions which are caused while the laser beam is taking a photograph are cancelled out when the beam is used again to illuminate the hologram and create the image.

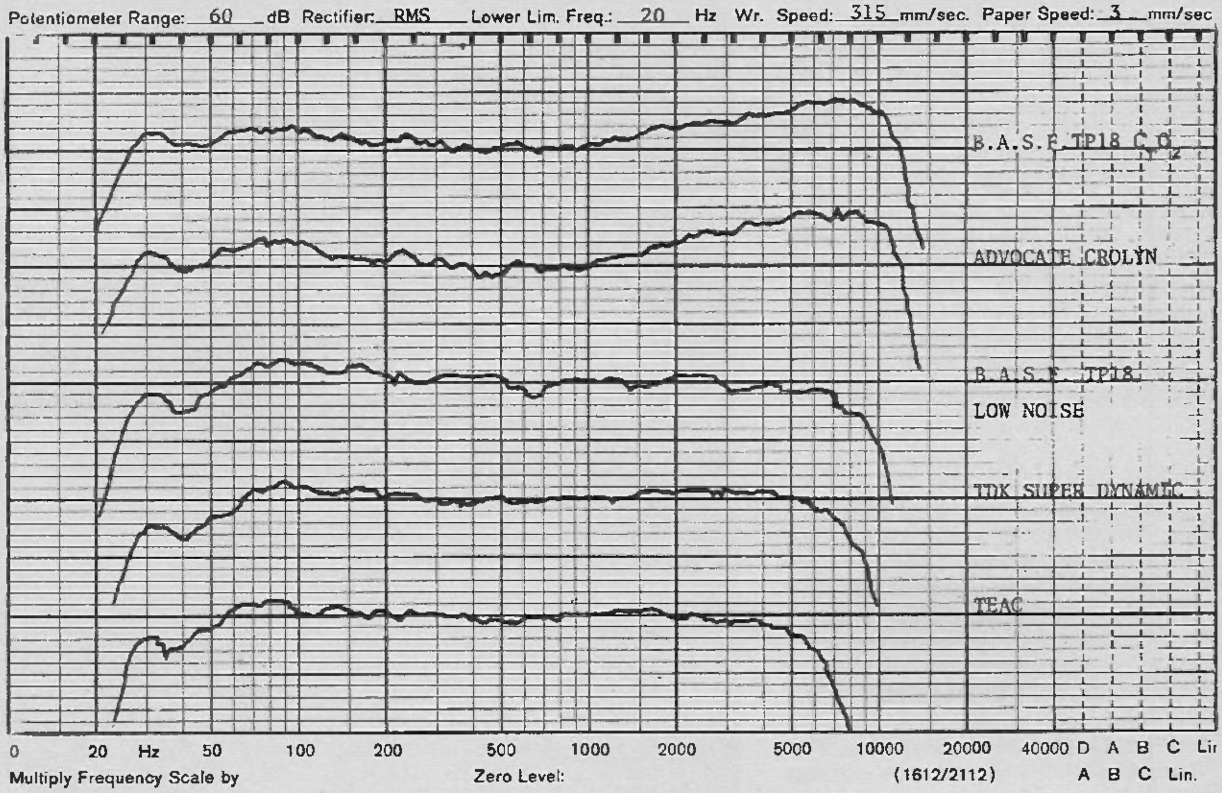
The microscope is the first of its kind in the world and biologists and metallurgists are particularly interested in seeing it developed commercially. It is too early yet to say what a production model will cost but it should be within the reach of most laboratories since the only expensive item is the cost of the cheapest form of laser — perhaps two or three hundred pounds. ●

RECORD TO REPLAY FREQUENCY RESPONSE OF COMPACT CASSETTE TAPES AT OPTIMUM BIAS

CURVES DISPLACED FOR CLARITY

1 decibel per division

ALL TAPES C 60 TYPE TESTED ON THE SAME MACHINE



electronics TODAY INTERNATIONAL product test

TAPE REVOLUTION

Latest chromium dioxide recording tapes provide dramatically improved sound — full report.

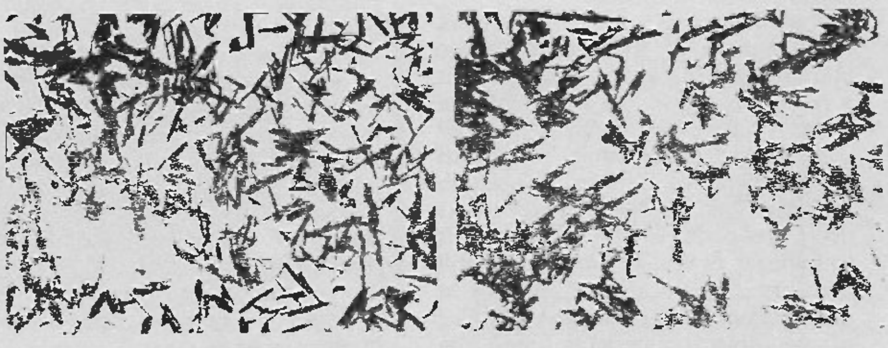


Fig. 1. Micro-photographs of (left) chromium dioxide tape, and (right) iron oxide tape.

SINCE the inception of compact cassette recorders, considerable research has been undertaken to improve their frequency response. In the early 1960s, trials were performed on chromium dioxide tapes, but the real advantages of these tapes were not evident until after 1966. This year has seen the breakthrough of chromium dioxide tapes into the compact cassette market with the Advocate and the B.A.S.F. Chromium Dioxide tapes.

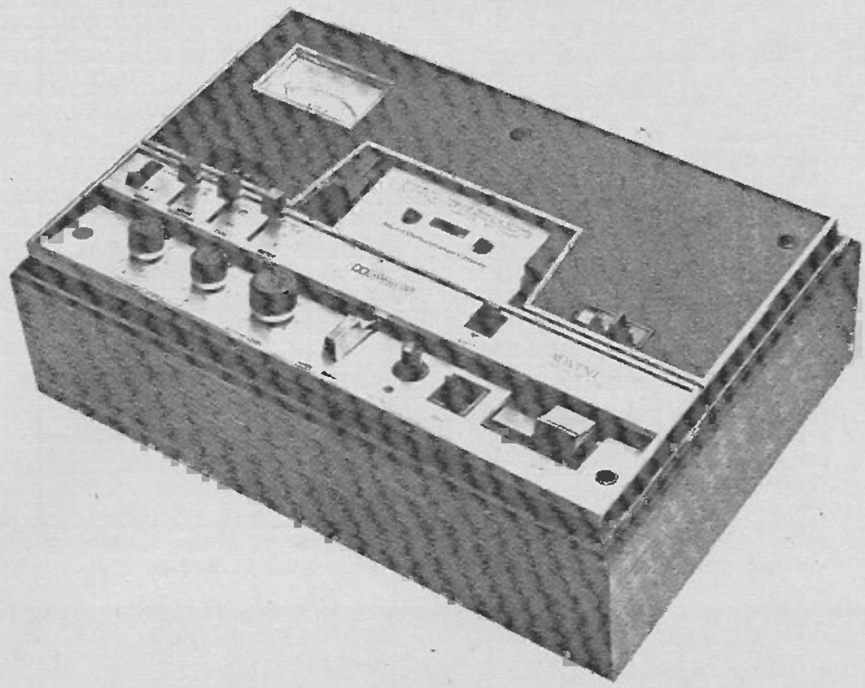
Chromium dioxide tapes offer many improvements over the conventional iron oxide tapes. The main advantages for compact cassettes using chromium dioxide tapes are:

1. Improved frequency response.
2. Improved background noise at high frequencies.
3. Improved high frequency dynamic range. (Short wave sensitivity).

One major disadvantage is the higher coercivity (coercivity is, in essence – the force required to remove any recording on the tape) of the chromium dioxide tape. This necessitates considerably greater erasure capacity and higher bias levels.

One advantage of the magnetic material, chromium dioxide, is that it is relatively easy to vary the coercivity over a wide range, making it possible to choose the appropriate optimal coercivity for a certain application. Furthermore, the desired coercivity is readily maintainable during manufacture. In addition, the form of the single particles approaches more or less an ideal needle shape so that an extremely good homogenity can be obtained, that is superior to that of conventional tapes. (Fig. 1).

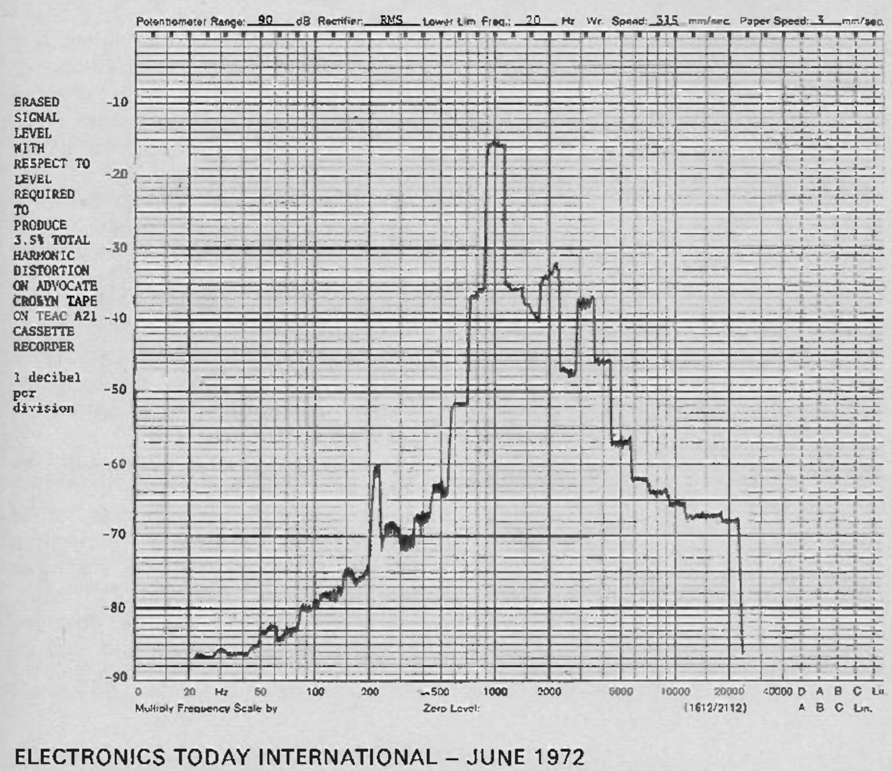
Both of these properties result in a remarkable improvement in high frequency recordability, which means that the high frequency maximum output level as well as the high frequency sensitivity are much better than those known from conventional magnetic tapes.



For optimum results, chromium dioxide tape should be used in conjunction with tape recorders – such as this Advent Model 201 – that have been specifically designed for these tapes.

The very high maximum output at high frequencies is of decisive importance for quality recording at very low tape speeds, (for example the compact cassette tape speed of 1 7/8 ips (4.75 cm/s).) As everybody who has tried to make a good recording on cassettes from a good master or a good FM broadcast knows, the major limitations of the compact cassette system are:- poor background noise and generally poor high frequency recording (lack of brilliance) especially with music that contains a predominance of high frequencies.

Chromium dioxide is a low noise oxide, which implies that at the same background noise level as obtained from modern "conventional" tapes, a significant improvement in high frequency output is available, whereas the signal to noise ratio improves because the maximum output level at lower frequencies can be better utilised. This imparts to the chromium dioxide tape cassettes a superior dynamic range, and noticeable improvement to their brilliance and transparency.

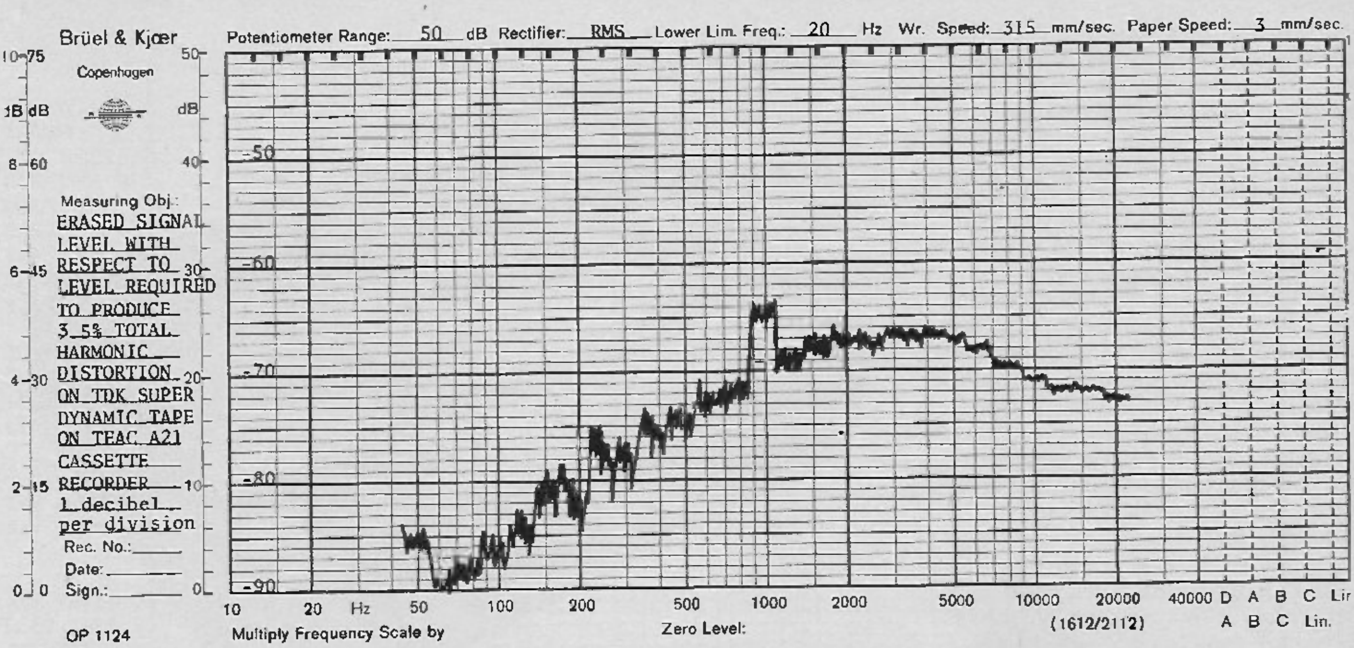


One could say that chromium dioxide tapes produce at a tape speed of 1 7/8 ips, nearly the same sound recording quality as conventional tapes on a standard tape recorder at 3¾ ips.

All of the factors considered so far have been based on the assumption that the replay parameters (or performance) of the cassette recorder will not be changed. But in practice, it is expected that cassette recorder manufacturers will use at least a part of the high frequency maximum output level advantages of the chromium dioxide tapes to improve the signal to noise ratio of the recorders.

Key to this is the replay frequency response time constants. If this time constant (which has been standardised internationally at 120 μs) could be reduced to a lower value, the background noise would be reduced in a similar manner. However, this can only be done at the cost of the maximum output level curve as a function of frequency, because under such conditions at least a part of the high frequency response is lost.

Now most of the various cassette recorder manufacturers are already solving the noise problem by incorporating the DOLBY B, or Philips noise suppression systems by means of which the signal to noise ratio of cassette recording systems can be



MANUFACTURER'S SPECIFICATION

Magnetic Properties	Typical Low Noise Tape	B.A.S.F. TP18 C_rO_2	Advocate Crolyn
Coercivity (Amps/metre)	23900	35800	39700
Retentivity (TESLAs)	0.105	0.145	0.160
Remanence Ratio	0.7	0.85	DATA NOT AVAILABLE
Remanent Flux per unit track width (nano webers/metre)		580	770

MEASURED PERFORMANCE

Make and Model No. of Cassette	Signal to Noise Ratio Following Erasure *	Erased Signal Level	Relative Levels for 3.5% Distortion	Bias Level used for 3.5% Distortion Recording
	dB	dB		
BASF TP18 LOW NOISE	68	-44	0.0	0 – reference level
BASF TP18 C_rO_2	60	-25	-3.8	+2
ADVOCATE CROLYN	55	-16	-3.9	+2
TDK SUPER DYNAMIC	56	-63	+1.5	-2
TEAC	56	-66	+1.4	-2

** with respect to level required at 1kHz to produce 3.5% total harmonic distortion.*

DROP OUT AND CONSISTENCY Maximum deviation in dB over a 60 second period.

	1kHz	4kHz	8kHz
BASF TP18 LOW NOISE	0.3	0.3	0.7
BASF TP18 C_rO_2	0.3	1.0	1.4
ADVOCATE CROLYN	1.6	1.3	1.7
TDK SUPER DYNAMIC	1.0	1.5	2.0
TEAC	1.2	0.7	1.4

TAPE REVOLUTION

improved up to approximately 9 dB.

Such systems do, however, allow the advantages of chromium dioxide tapes to be fully utilised to improve the high frequency response or brilliance of the recorders.

Because of the high coercivity of chromium dioxide cassette tapes, which is higher than that of conventional cassette tapes, it is necessary to increase the HF bias current for optimum recording. For the same reason an increase in the level of the erasure signal is required and less pre-emphasis is necessary for the standardised replay time constancy used at present.

The frequency response curves shown on the level recordings have been obtained with an increase of bias level of 2 dB but with no changes in pre-emphasis (or equalisation). The erasure capacity of the recorder has to be increased by at least 40% to 50% over that required for conventional tapes to obtain adequate signal erasure. It is therefore clear that chromium dioxide tapes are not *fully* compatible with modern "conventional" tapes, and that cassette recorders will only *completely* utilise the advantages of the new tape if some of the recorder functions are modified accordingly.

An increasingly large number of new cassette recorders marketed in recent months incorporate these modifications. Should chromium dioxide tape be used on machines optimised for conventional tapes, significant changes will be observed in the replay, record and erasure functions. The reproduction of pre-recorded cassettes with chromium dioxide tape is simple because, during the duplicating process, it is easy to take care of the properties which can be overcome with the technical facilities found in most large tape duplicating studios.

The reproduction of these cassettes on conventional cassette recorders will give an increase in high frequency output resulting in an overemphasis of the higher end. However, on recorders with a tone control, this can easily be compensated for, so that there will be a noticeable reduction in hiss.

From a theoretical point of view the different recording properties of new chromium dioxide cassettes should cause problems during recording. However, most recorders already have such a high HF bias signal that they are generally suitable for the chromium dioxide tape. A bias setting which gives maximum output at low frequencies with conventional tapes is generally close to the optimum bias for balanced utilisation of chromium dioxide tape.

It is for this reason that in most cases it will not be the bias setting which causes incorrect recording, but the relatively strong pre-emphasis (or equalisation) in the recording amplifier, resulting in an overemphasis of the high frequency spectrum. This, of course, can be corrected for by adjusting the tone controls as mentioned above.

The erasure of chromium dioxide tapes on conventional cassette recorders remains the only major problem. The level recordings of the erased signal levels for standard and chromium dioxide tape clearly show the magnitude of this problem. These results will vary considerably from recorder to recorder, depending on the intensity of the erasure signal.

We conducted tests with three new conventional cassette recorders and all failed to provide sufficient erasure signal to cope with the chromium dioxide tape (the erased signal being only -15 decibels to -30 decibels down on the three machines tested.)

All three recorders exhibited a dramatic improvement in frequency response, hiss reduction (i.e. high frequency noise reduction) and last, but not least, the subjectively clearer sound that they produced.

The big future for these tapes is as base material to be used for pre-recorded tapes, for not only will the material be better with any recorder, but, in suitable Dolby-ised form, will make sufficient difference to justify the consideration of cassette machines as high fidelity devices. ●

POLLUTION WATCHDOG

The forerunner of a buoy system which would maintain a continuous watch on water pollution levels is being tested in San Francisco Bay by Lockheed Missiles & Space Co.

If experiments with the Ecology-Data Buoy are successful, Lockheed will propose the design of an Eco-Buoy system to State and Federal agencies charged with pollution control in U.S. waters.

For a month, Lockheed's cylindrical pollution sentinel will take hourly measurements of the bay's water temperature, electrical conductivity and dissolved oxygen content — three important indicators of water pollution.

Water measurements taken by the buoy will automatically be telemetered to Lockheed's data processing center. When the information has been processed and plotted, it will be provided to the California Regional Water Quality Control Board in Oakland.

George H. Farmer. Lockheed project leader, explained that prior to the Eco Buoy tests, water pollution measurements have been taken by hand from small boats.

The time and money needed to take manual measurements and process the results is considerable. A network of relatively simple, unsophisticated buoys can automatically do the job 24 hours a day with better results and little difference in cost.

The four weeks of testing will enable the manufacturers to evaluate the buoy, its sensors and the data transmission and processing system.

The tests will also give Lockheed's Ocean Systems personnel experience in handling the buoy shape and working with a newly designed shallow water mooring system. ●

SONAB OA-5 SP

BY any standards, Sonab speakers are unconventional.

The Sonab Company, a subsidiary of a Swedish government-owned group, was formed in 1966 to develop, manufacture, and market the speaker systems designed by Stig Carlson, a professor at the Royal Institute of Technology in Stockholm.

At present, Sonab market four speaker systems, the second largest being the OA-5 reviewed in this article. (The largest is the OA-6 which incorporates a bass speaker with its own amplifier. This amplifier has a negative reactance characteristic to compensate for the frequency characteristics of the speaker drive unit).

Stig Carlson's basic design philosophy is to produce speaker systems with omni-directional characteristics in the floor plane, thus eliminating the point source characteristics of conventional speaker systems.

When we saw the Sonab speakers for the first time, we were intrigued by their unusual external appearance. The speaker enclosure is basically a column 24" high by 9½" wide and 17" deep. The top of the column is capped with a black wire mesh cover 2" high. Removing this cover exposes four Peerless tweeters at the front of the enclosure, and a Philips twin-cone speaker — horizontally mounted at the rear. The four tweeters are mounted at the ends of two mutually perpendicular diameters of a circle, each facing towards the centre with the axis of each speaker cone pointing at an angle of approximately 15° to the horizontal.

The Philips twin-cone speaker is mounted in the top panel, facing towards the ceiling, and faced with a fine black nylon mesh to prevent dust from collecting on the speaker cones. The diaphragms of the tweeters are also protected with this fabric.

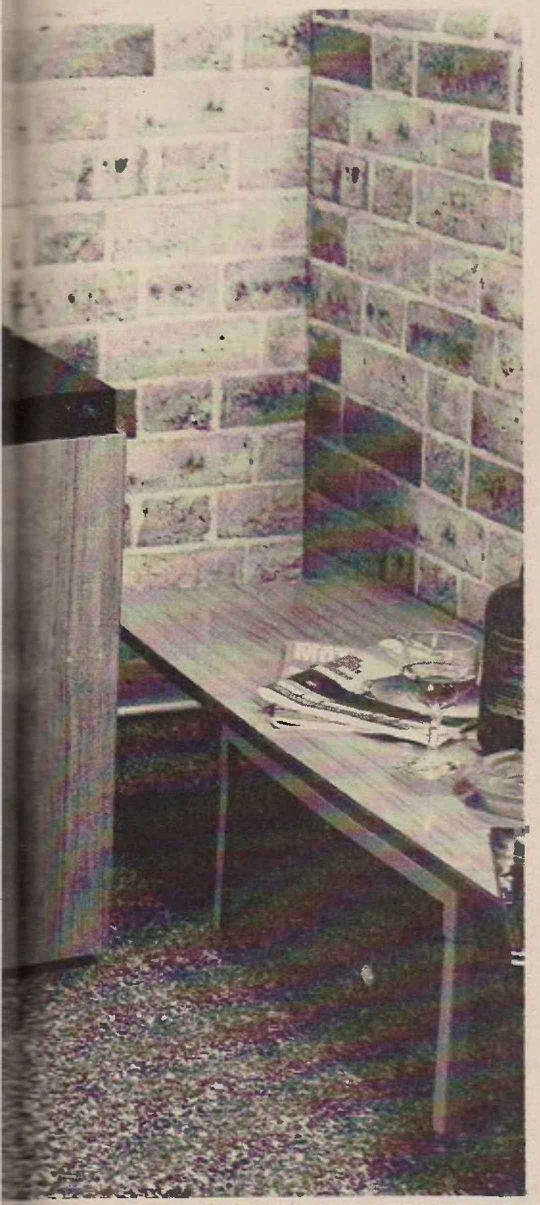
Removing the speaker mounting panel exposes a number of unique features — no doubt patented! The most interesting of these is the fibreglass lining on the rear of the Philips speaker. This lining is retained by a moulded plastic 'basket', that can be adjusted by three screws to provide different loadings on the fibreglass — correctly to dampen the speaker for optimum bass response.

Another unusual feature of the enclosure is the positioning of the vent. This is located at the bottom of the enclosure above the mounting base. The mounting base is spaced off the bottom of the enclosure by approximately ½" to allow air movement around the perimeter from the vent opening in the bottom of the enclosure.

Timber stiffening ribs 1" wide by ½" thick are glued to the internal faces of the 3/8" thick oiled teak veneer particle board in order to reduce panel resonance whilst reducing weight to the minimum. The enclosure is filled with medium density fibreglass to provide additional damping.

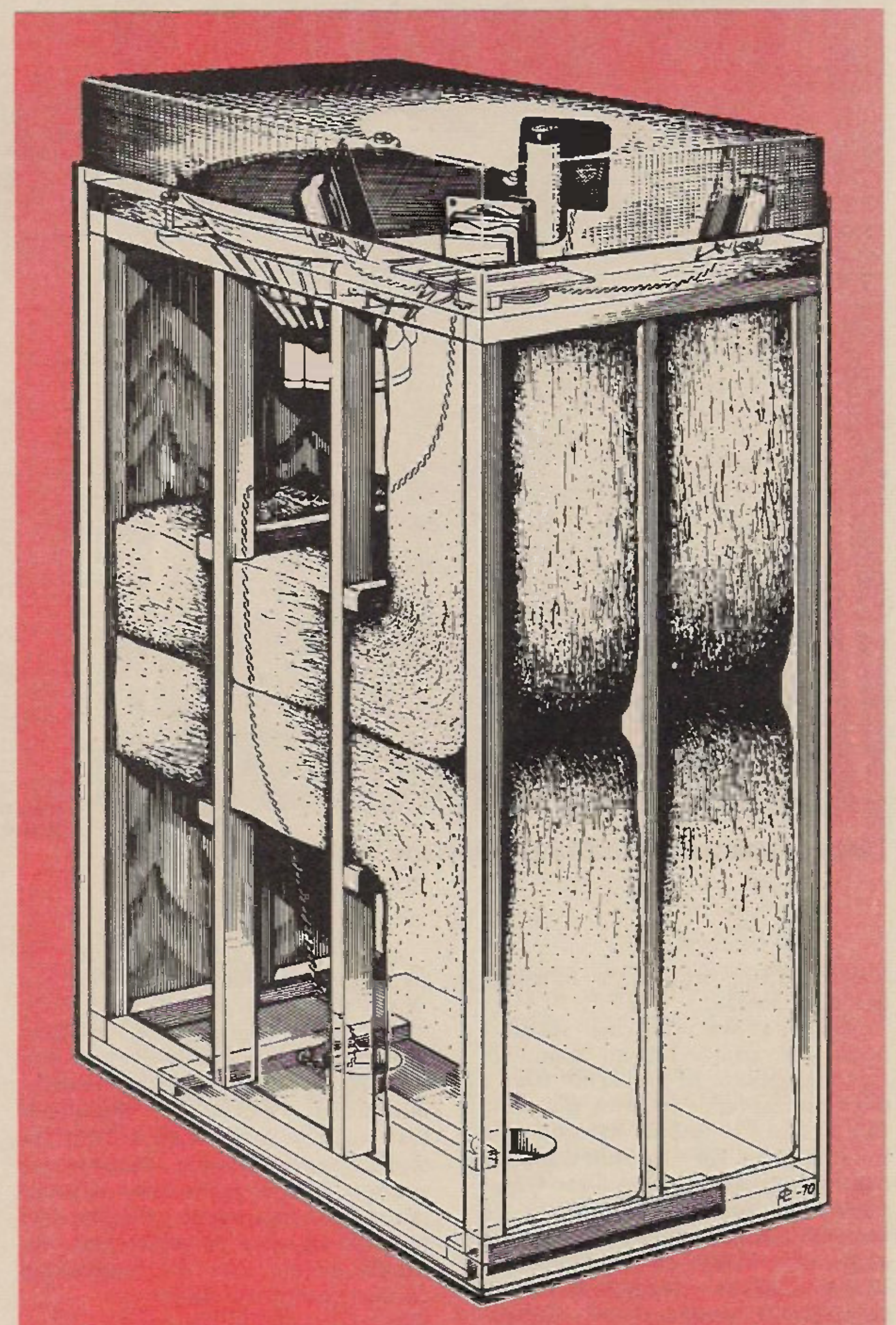
The cross-over network, consisting of two air-cored inductors and one capacitor — all mounted on a printed circuit board — is fixed to the

EAKER SYSTEM



Complete evaluation of a highly individualistic speaker from Sweden.

electronics TODAY INTERNATIONAL product test

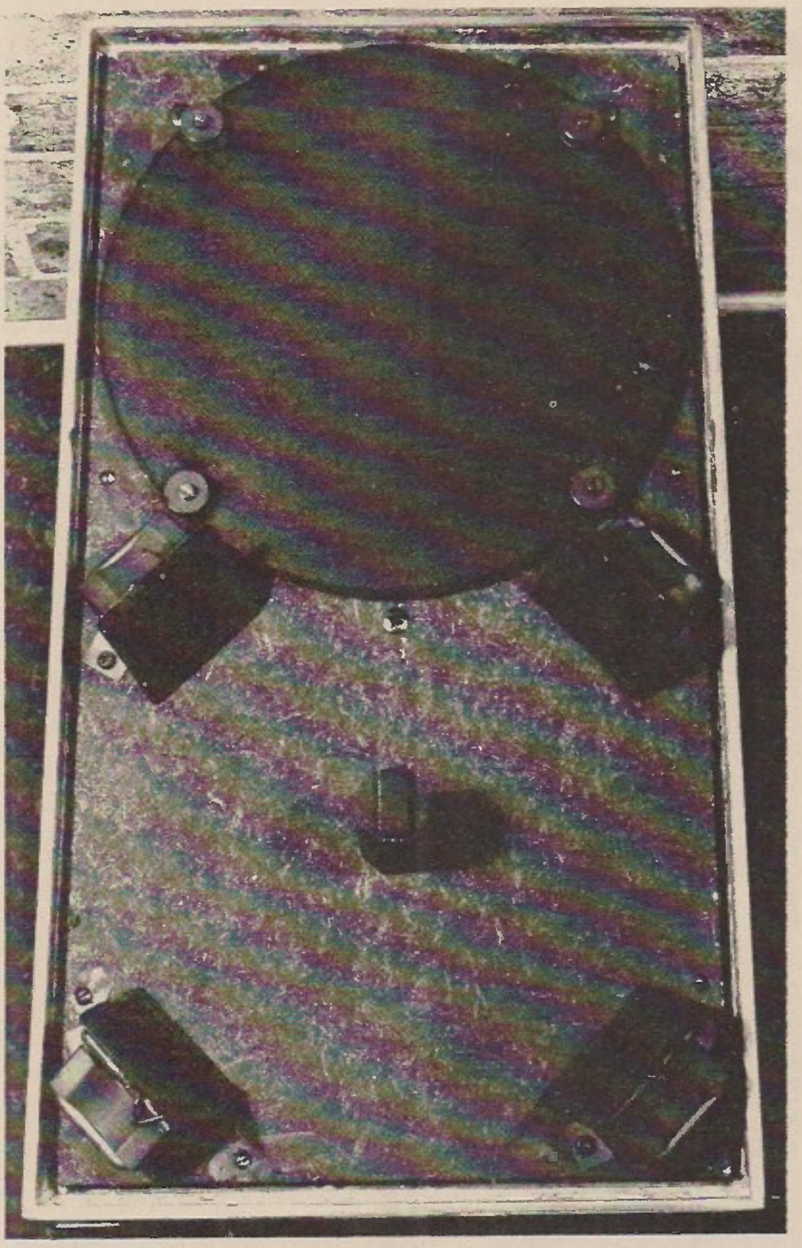


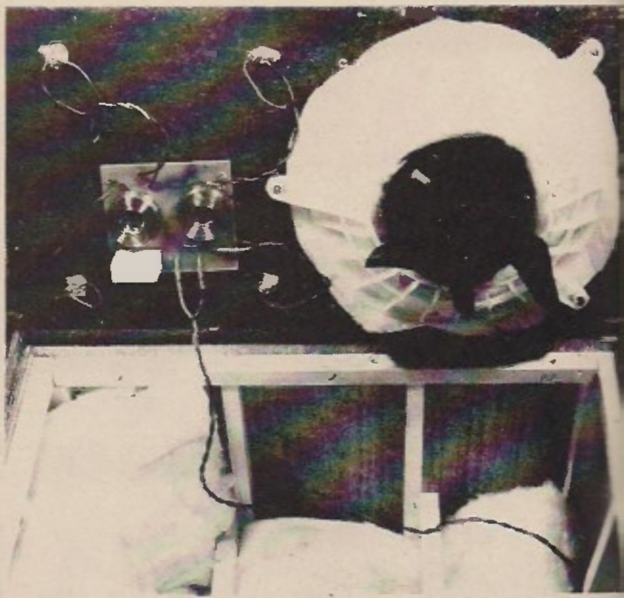
underside of the speaker mounting panel.

Although the teak veneer on the enclosure was colour matched during construction, the front and back panels of the pair that we tested had totally different grain patterns.

Preliminary subjective listening tests were unimpressive. The speakers appeared to have little bass and rather poor treble response. The lack of bass response was especially perplexing because the twin-cone speaker

SONAB OA-5 SPEAKER SYSTEM





MEASURED PERFORMANCE OF SONAB SPEAKER S/N 96225 TYPE OA-5

Frequency Response
45Hz to 14kHz ± 8dB
(Refer description of test set up in review)
Cross Over Frequency
2500Hz
Woofer Resonance in Enclosure
50Hz
Total Harmonic Distortion at 5 Watts input

100Hz	3%
1kHz	1%
6.3kHz	0.6%

Electro-Acoustic Efficiency
0.3% at 1kHz
Dimensions
24" High x 9½" Wide x 17" Deep
Weight
22lbs
Price
£67·50 (recommended retail price)

Top view of speaker enclosure with mesh cover removed, note the four diagonally mounted tweeters.

diaphragm appeared to be following the bass content.

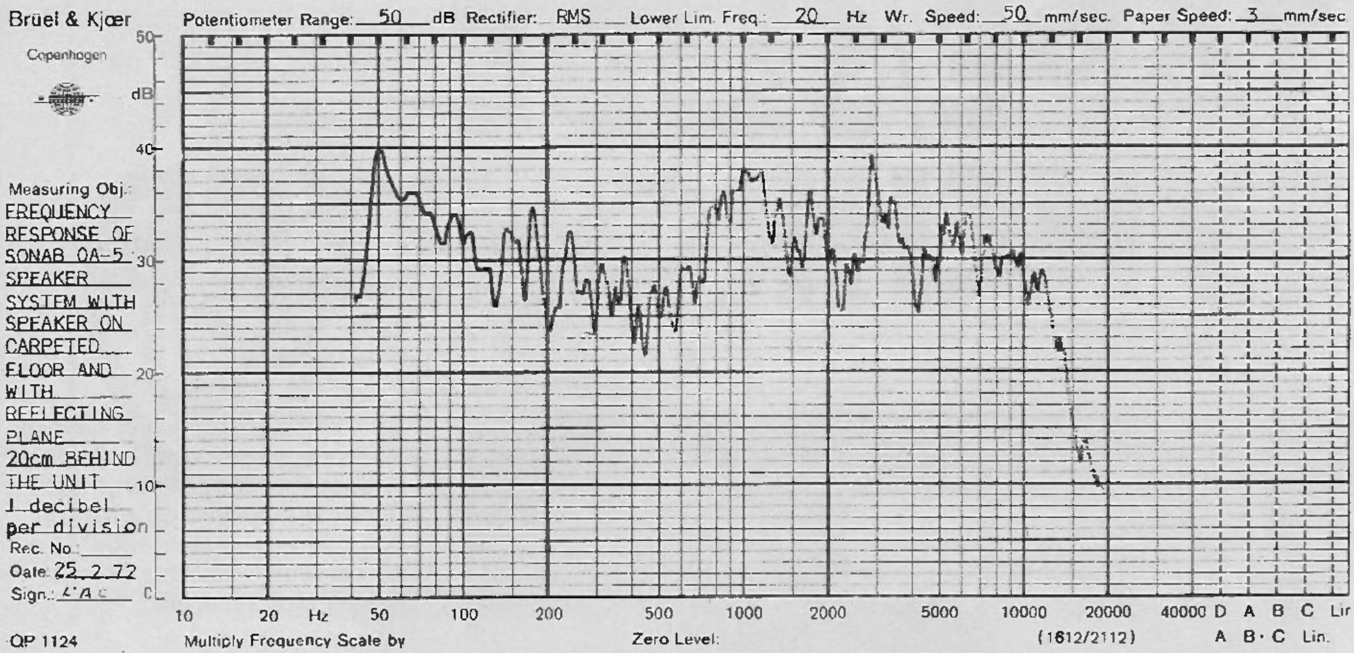
Eventually we took the speakers home and arranged them about six feet apart and eight inches out from a plain cement-rendered brick wall. And this is what we should have done in the first place, for the result was good bass performance down to about 50Hz, and room modes apart, the response was consistent in all listening positions — independent of frequency. This is uncommon because the polar response of most speaker systems becomes more directional with increasing frequency, and the best response is generally obtained on the axis of the tweeter/s.

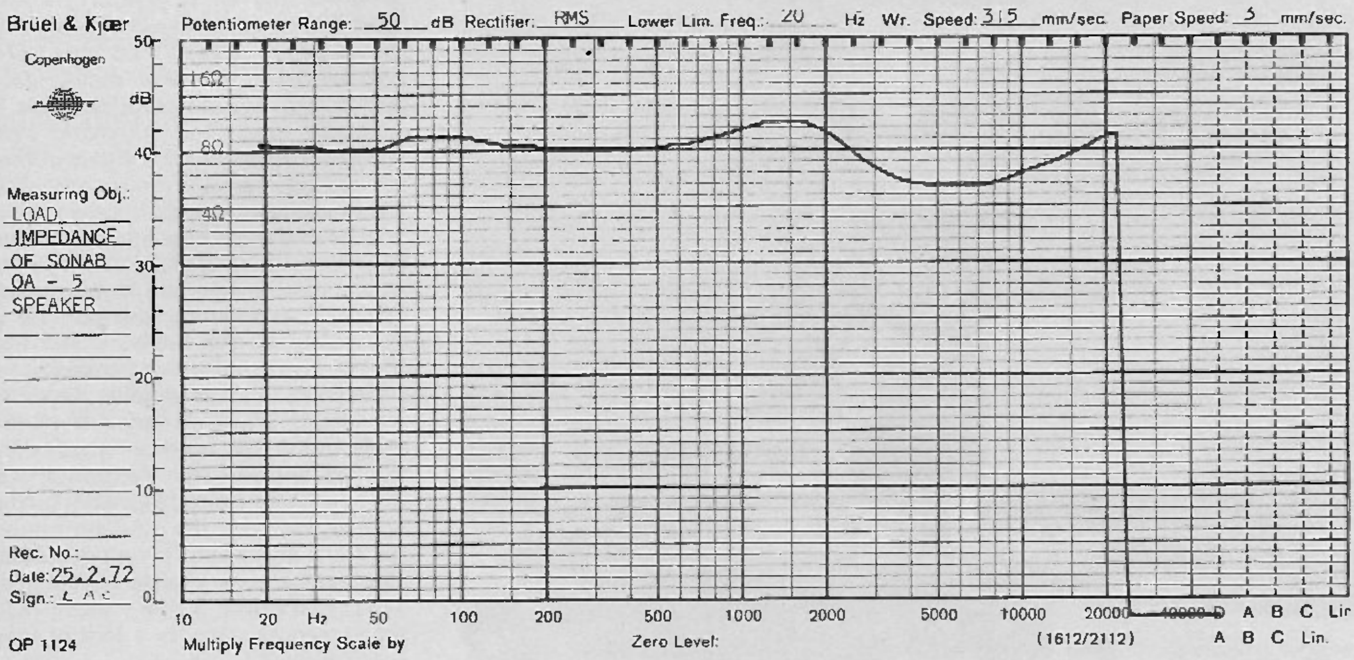
The spacing between the speakers and the wall seems fairly critical — the wall provides an additional 'dimension' introducing short-delay reflections that result in an apparent shift of the sound source to just behind the speakers. This is particularly apparent in the mid-range frequencies. The bass response appeared to radiate from the middle of the speakers, due to the unusual position of the vent.

TESTING REFLECTIVE SPEAKERS

When a speaker system is designed to utilize wall reflections to obtain the intended response, it is clear that anechoic testing conditions are unsuitable for determining the frequency response curve. We experienced the self-same problem when testing Bose speakers, when similarly, it was necessary to test the speakers in a room specially set up to provide the necessary environment.

The laboratory measurements were made firstly in a room with a reflective floor, and with the speaker positioned 20 cm from a reflective wall. This resulted in an unusual response with a predominant peak at 50Hz and





another at 5000Hz. The smoothest frequency response was obtained with the floor covered with 1" thick semi-rigid fibreglass. Under these conditions an unusual characteristic was observed in the form of a high level of sub-harmonic distortion generated at frequencies up to 10 times the speaker's resonance. Rather surprisingly at 500Hz the 50Hz sub-harmonic component was only 30dB down.

This resulted in a colouration of the bass end which was just detectable and is apparently a feature of the speaker mounting.

The speakers came complete with an instruction manual written in Dutch, English, German and French. This manual is the largest that we have seen supplied with any speaker system and has six quarto sized pages (in English) covering the following topics:—

speaker location, room acoustics, amplifier selection, tone controls, making and installing speaker leads, technical details and a 5 year guarantee.

The design approach of Sonab speakers is novel and exciting. In a large room where space is not at a premium they are more attractive and possibly more effective than most other types of speaker systems in their price range.

They have better diffusion than most, but on the other hand the frequency response may not be all that some purists would desire.

Above all else, Sonab speakers are individualistic (as much so, as in another engineering field, was the Issigonis-designed Mini-Minor). They reproduce sound as Stig Carlson believes that a speaker should. One either likes the result — or one doesn't. Either way they are interesting. ●

TAPE/SLIDE SYNCHRONIZER

This unit automatically changes slides on an automatic projector. It does this at predetermined times, synchronizing with the commentary prerecorded on a two-channel, cassette or reel-to-reel tape recorder.

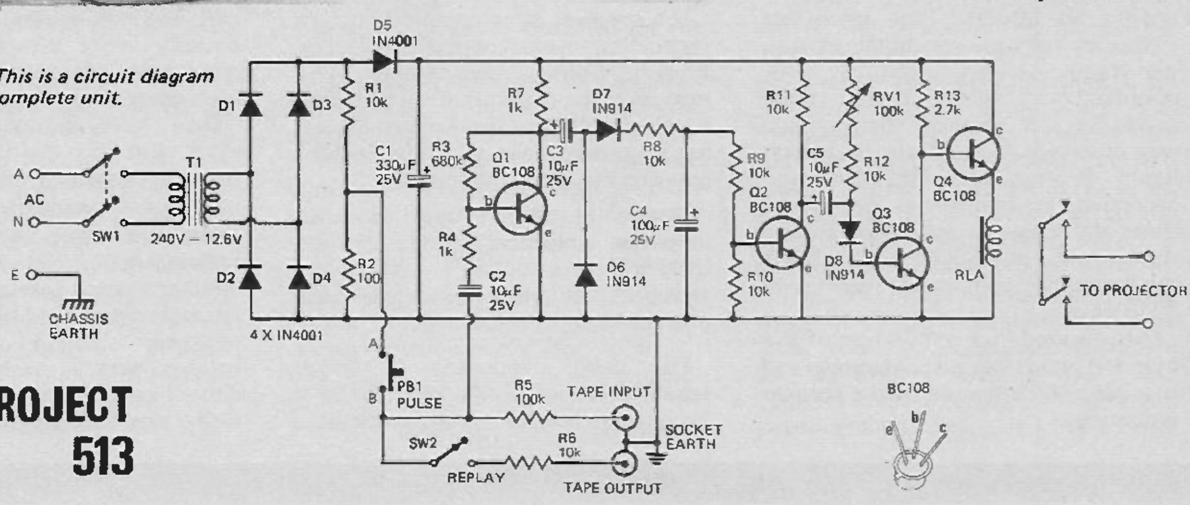
Practically all tape recorders sold today have two-channels, and when used to record commentaries for slide shows, only one of the two available channels is normally used. The automatic slide changer described in this article utilises the second, normally unused channel.

The projector's slide mechanism is actuated by short tone bursts recorded onto this second channel at the points where slide changes are required. The tone that is used for this purpose is derived from the full-wave rectified (but unsmoothed) mains frequency.

To record the tape initially, the slides are loaded into the magazine of the projector in the order in which they will be shown. The commentary is then recorded onto Channel 1 in the normal way, and the pulse button on the front of the control unit depressed whenever a slide change is required. This changes the slide and simultaneously records a control tone onto Channel 2.

Once the tape has been prepared, the control unit can be used automatically to switch the slide projector at the

Fig. 1. This is a circuit diagram of the complete unit.



ETI PROJECT 513

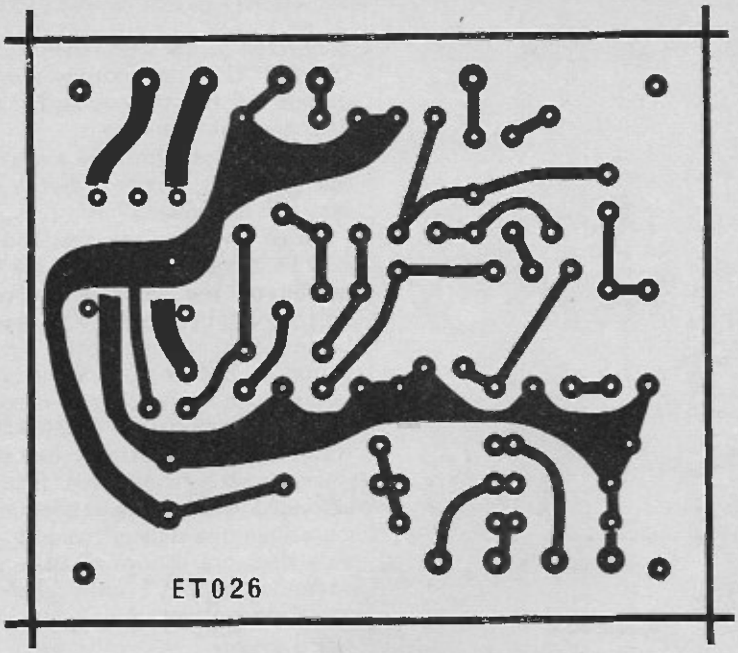


Fig. 2. Foil pattern of printed circuit board – full size.

predetermined times in synchronization with the tape recording.

CONSTRUCTION

The circuit diagram of the complete unit is shown in Fig. 1.

The unit may be assembled on matrix board, tag strips, or, preferably, on the printed circuit board, the foil pattern of which is shown in Fig. 2.

Figure 3 shows how the components are assembled on the printed circuit board. Note that resistors R5 and R6 are mounted on the front panel of the unit – as shown in Fig. 4.

Having completed assembly, check the orientation of diodes, transistors and electrolytic capacitors.

Figure 5 shows how the completed printed circuit board and remaining components are located within the case. Ensure that all wiring carrying mains voltage is adequately insulated and the metal case is well earthed.

CHECKING THE UNIT

Figure 6 shows how the various units should be interconnected – both for checking and for subsequent recording of the tape. The relay output lead of the control unit is connected to the slide projector's external control socket; the second (normally unused) input socket of the tape recorder is connected to the input socket of the control unit, and a microphone is then

HOW IT WORKS

The sync. pulse is derived from the mains. It is simply the 100 Hz rectified but unsmoothed output from the secondary of tranformer T1.

This 100 Hz signal is suitably attenuated by R1 and R2 to achieve a level suitable for recording onto the tape.

Diode D5 isolates the filter capacitor from the pulse generating network.

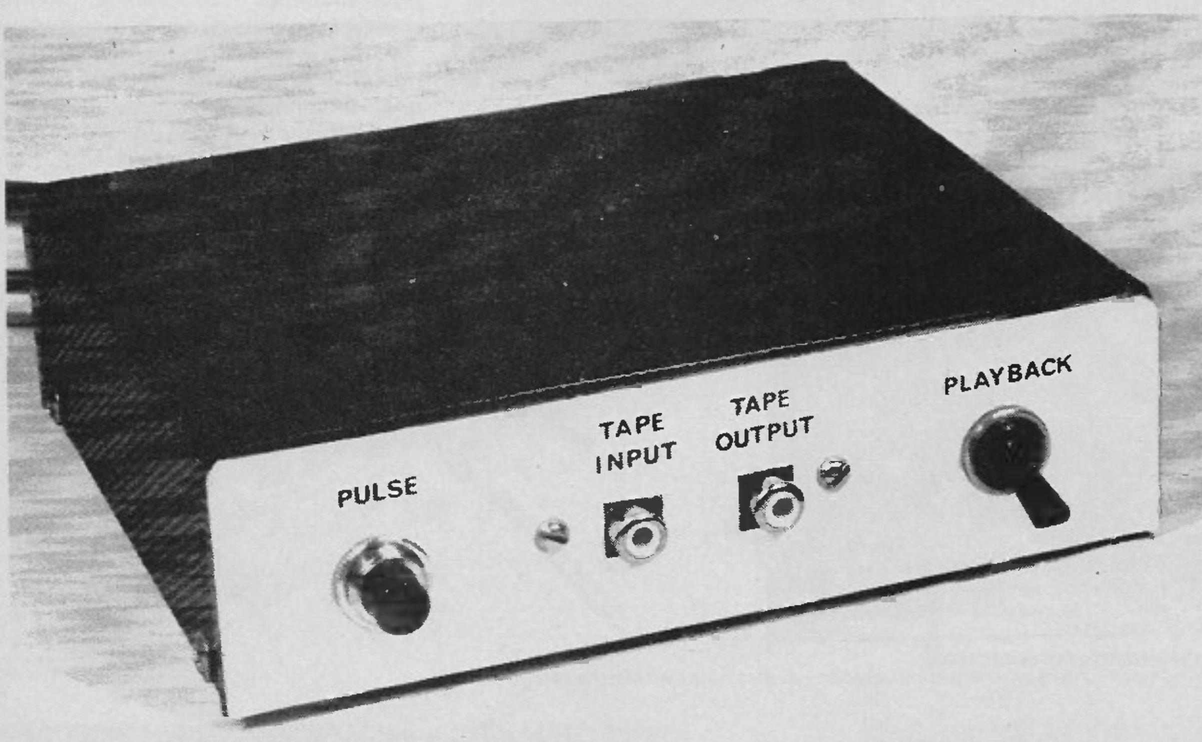
When push button switch PB1 is pressed, the signal from R1, R2 is fed to the tape recorder and also, via C2 and R4, to the remainder of the control unit.

The 100Hz signal is amplified by Q1 and then rectified and smoothed by D6, D7, C3 and C4. Capacitor C4 takes a few cycles to charge, and when it does Q2 turns on.

The action of Q2 turning on, causes C5 momentarily to remove the bias from Q3. The length of time for which the bias is removed is determined by the setting of RV1.

Transistor Q4 is an emitter follower and applies power to the output relay during the time that Q3 is turned off, and so RV1 in effect controls the length of time that the relay contacts remain closed. The contacts of this relay then actuate the slide change mechanism of the projector.

During the replay period, the control pulses from the tape recorder are fed into the control unit via R5, C2 and R4 and then actuate the unit in the same manner as described above.



TAPE/SLIDE SYNCHRONIZER

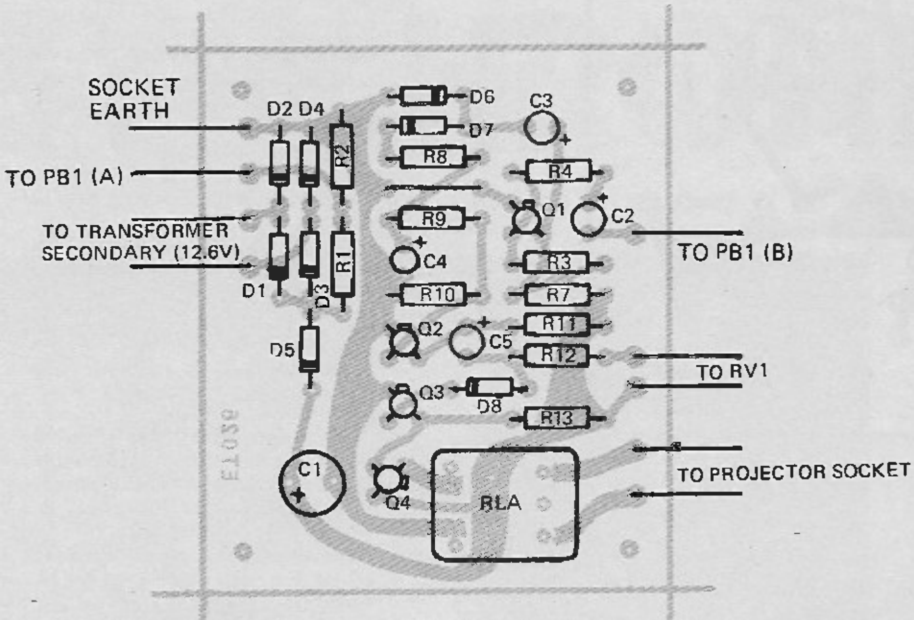


Fig. 3. How the components are assembled on the printed circuit board.

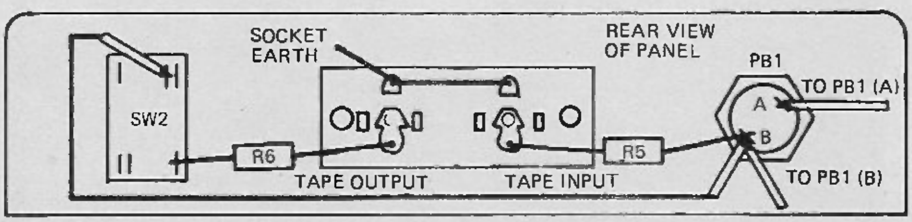


Fig. 4. This drawing shows components and wiring on the front panel of the unit.

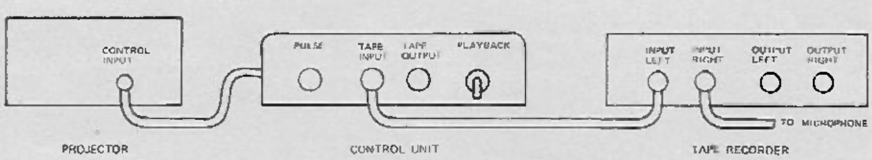


Fig. 6. Interconnections – checking and recording.

connected to the tape recorder (Input Channel 1) in the normal way. The output of the tape recorder is left disconnected at this stage.

Load the slides into the magazine of the projector in the order in which they will be shown.

Switch on all three units. Slides can now be changed by pressing the 'pulse' button on the front of the control unit. It will be necessary to press this button for about one second. The time period is not critical providing it is long enough for the slide to change.

Internal circuitry – controlled by RV1 – ensures that only one slide is changed at a time, this feature is lacking on many proprietary units. If more than one slide is changed – or a slide does not change at all – adjust potentiometer RV1 until satisfactory operation is obtained.

OPERATION

Once the unit has been checked out for satisfactory operation it is ready to use.

A minimum period of about five seconds must be allowed between slide changes to enable the control unit to reset.

Move the first slide in the required sequence into position, start the tape recorder, and record the required commentary, changing the slide whenever required by actuating the button on the control unit. Stop the tape recorder when the last slide has been shown.

Figure 7 shows how the units are interconnected for replay. As can be seen the relay output lead of the control unit is still connected to the external control socket of the slide projector, but the output from Channel 2 of the tape recorder (from preamplifier or speaker output sockets) is now connected to the tape output socket of the control unit. The input to the tape recorder Channel 2 is left disconnected.

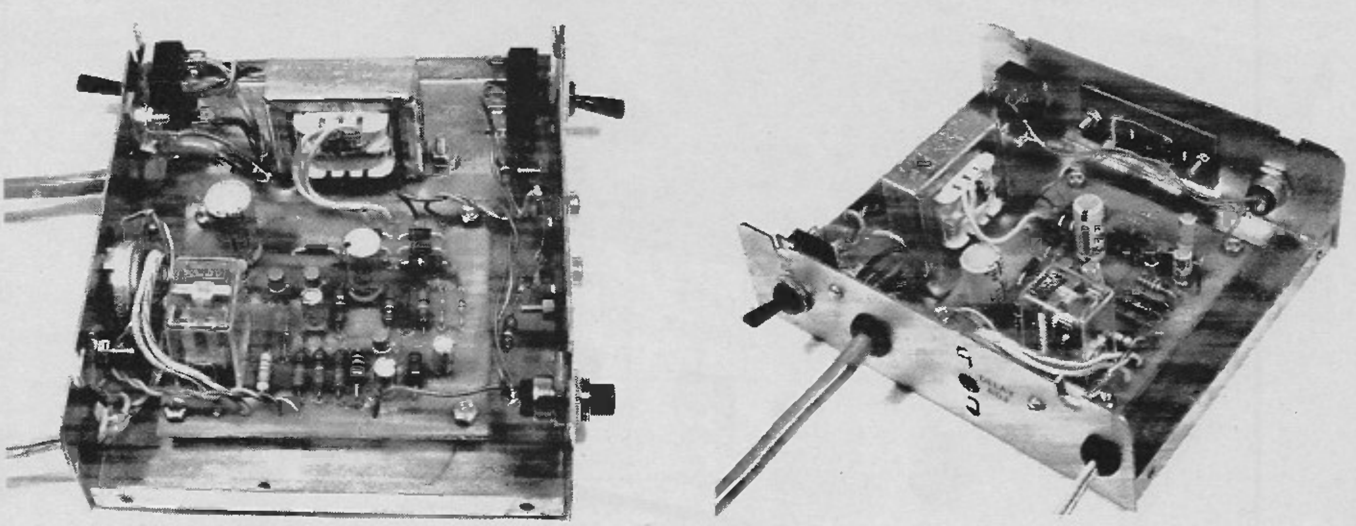
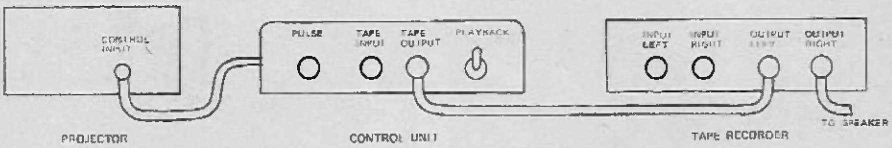


Fig. 5. The printed circuit board and remaining components assembled within the case.

Fig. 7. Interconnections – replay.



PARTS LIST ET 513

R1	—	resistor	10k	½ Watt	5%
R2	—	resistor	100ohm	½ Watt	5%
R3	—	resistor	680k	½ Watt	5%
R4	—	resistor	1k	½ Watt	5%
R5	—	resistor	100k	½ Watt	5%
R6	—	resistor	10k	½ Watt	5%
R7	—	resistor	1k	½ Watt	5%
R8-R12	—	resistor	10k	½ Watt	5%
R13	—	resistor	2.7k	½ Watt	5%
C1	—	capacitor	330µF	25V electrolytic	
C2	—	capacitor	10µF	25V electrolytic	
C3	—	capacitor	100µF	25V electrolytic	
C4	—	capacitor	10µF	25V electrolytic	
C5	—	capacitor	10µF	25V electrolytic	
Q1-Q4	—	transistors	BC108		
D1-D5	—	silicon diodes	IN4001	or equivalent	
D6-D8	—	silicon diodes	IN914	or equivalent	
RLA	—	miniature relay type VP2, 430 ohm coil (or equivalent)			
T1	—	mains transformer — 12.6V, 150 mA			
PC board	—	ET 026			
SW1	—	double pole on/off switch			
SW2	—	single pole on/off switch			
PB1	—	push button switch — press to make RCA sockets, metal case, three-core flex, cable clamp, plug to suit projector, hook-up wire etc.			

Flick the replay switch SW2 to the off position and move the first slide into position. Now start the tape recorder and switch the replay switch into the on position as soon as the commentary starts. The slides will now be changed automatically at the prerecorded times.

The 'pulse' button on the control unit may still be used to override the control unit at any time.

The replay switch must be in the off position when stopping, starting or rewinding the tape as any signal from the tape recorder will initiate a slide change. ●

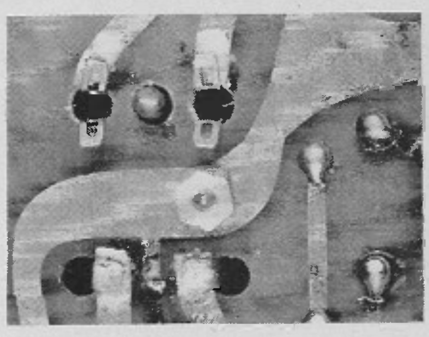
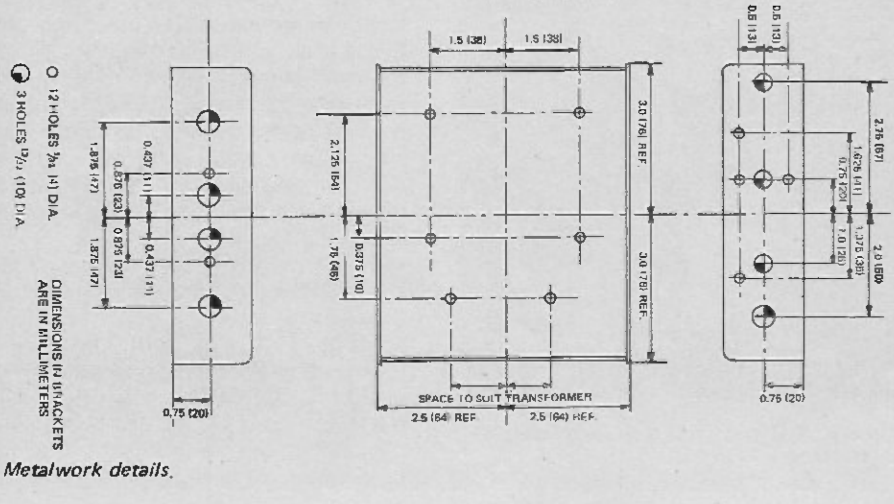


Fig. 8. The relay is soldered directly onto the printed circuit board. The two centre pins of the change-over contacts are commoned – as shown here.



Metalwork details.

PART 2

TRANSDUCERS IN MEASUREMENT AND CONTROL

In this article Peter Sydenham M.E., Ph.D, M. Inst. M.C. describes industrial and surveying length transducers.

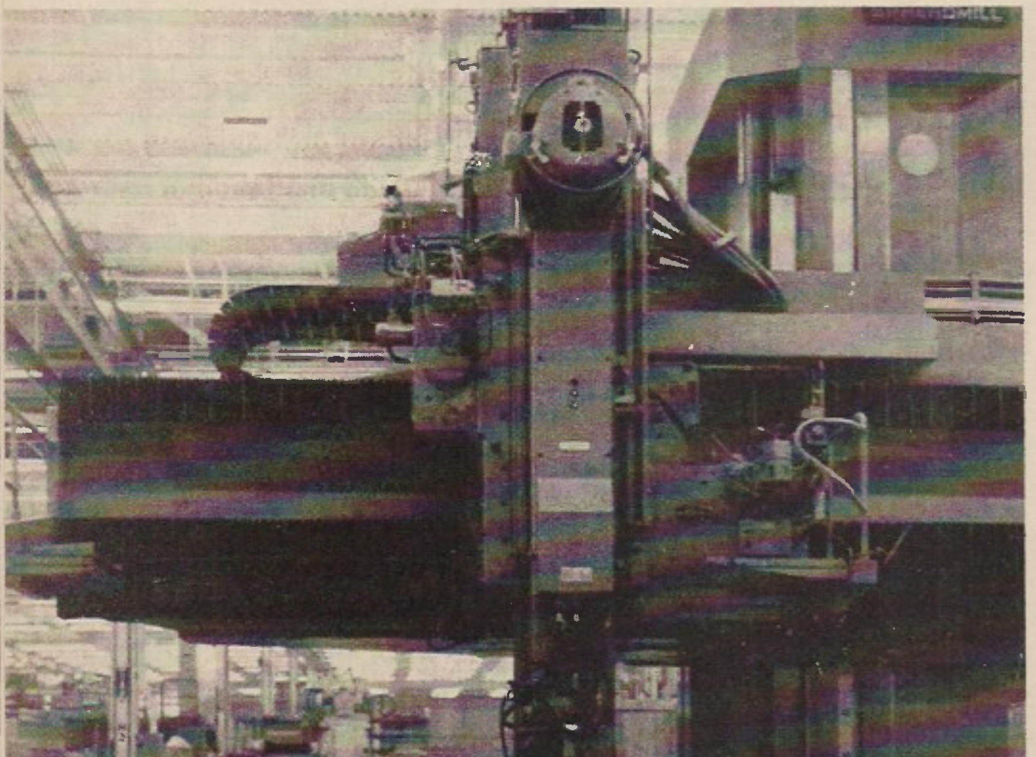


Fig. 1. A Froriep five axis numerically-controlled mill machining a fuel tank for a Saturn V Moon rocket. The finished thickness of the steel is between 0.5 and 0.8 mm.

INDUSTRIAL AND SURVEYING RANGE LENGTH TRANSDUCERS

THE first article in this series dealt with methods for converting small displacements into electrical signals. This time, longer length transducers are discussed. With only a few exceptions, the previously considered methods are unsuited to ranges greater than millimetres, so other ways have been devised.

The majority of precision length measurement of distances ranging from millimetres to several metres is performed in industry, so we use the term industrial range to assist classification.

Distances greater than 100 m or so are grouped in what could be called the surveying range, as it is mainly for land survey purposes that long distance measuring instruments have been developed.

INDUSTRIAL RANGE DISPLACEMENT TRANSDUCERS

Prior to 1950 electrical length-transducers were not often used in general industrial practice. Instead measurements were made with manually operated instruments, many having been devised to cope with specific measurement tasks. Examples are gear testing machines, projection microscopes, travelling microscopes and gauge interferometers.

Then came the change. Groups in the United States of America and in Britain foresaw the potential of an automatic machine tool that could produce a variety of different components at the command of taped digital signals. Numerical control (N.C. for short), was the subsequent development that has been accepted throughout the world.

One of the larger numerically controlled mills is shown in Figure 1.

Control techniques were reasonably well understood due to war time development of gun positioning and radar tracking, but at that time no transducer had been developed that could provide an electrical indication of a machine tool's slide position. Such a transducer needed to have a range of around a metre and a precision and accuracy close to a few parts in a million.

It did not take long for the necessary technique to be developed, for by 1955 there were dozens of such transducers in existence. Other uses for these transducers were exploited as their benefits were realised.

The simplest purpose for which they can be used is to assist the machine operator by providing a readout of length. As most devices provided a digital form of readout rather than an analogue indication, the term digital readout, or D.R.O., came into use. (One commercial D.R.O. unit does, in fact, display with a rotating meter). A milling machine with a D.R.O. facility is illustrated in Figure 2.

The trend of D.R.O. and N.C. spread to other applications. Draughting machines, chart digitizers, oxy-acetylene plate cutters, frame benders, tube benders, wiring loom production machines, rolled steel joist drilling machines, locomotive door welders and even cranes in a steel yard have had transducers fitted for readout or control purposes.

It is not ideal, however, to fit the transducer on the way of a machine, for machine constructional inaccuracies exist between the slide and the cutting point of the tool.

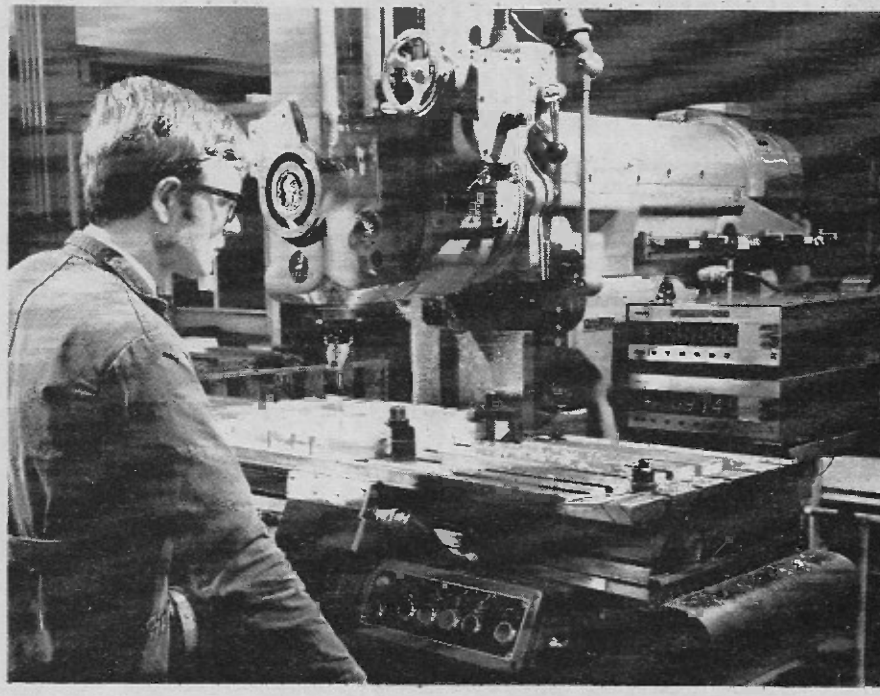


Fig. 2. This vertical milling machine has a digital readout system to assist the operator by displaying the position of both traverses.

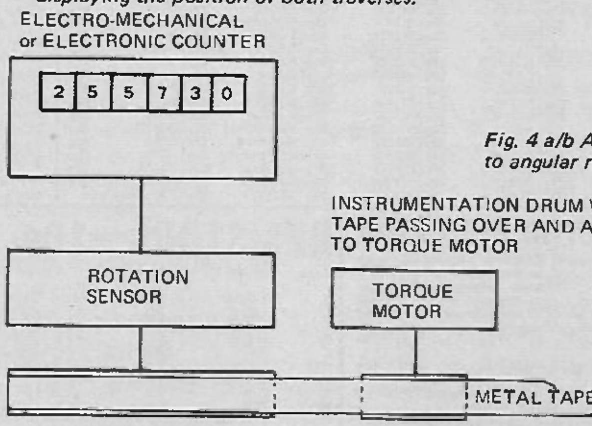
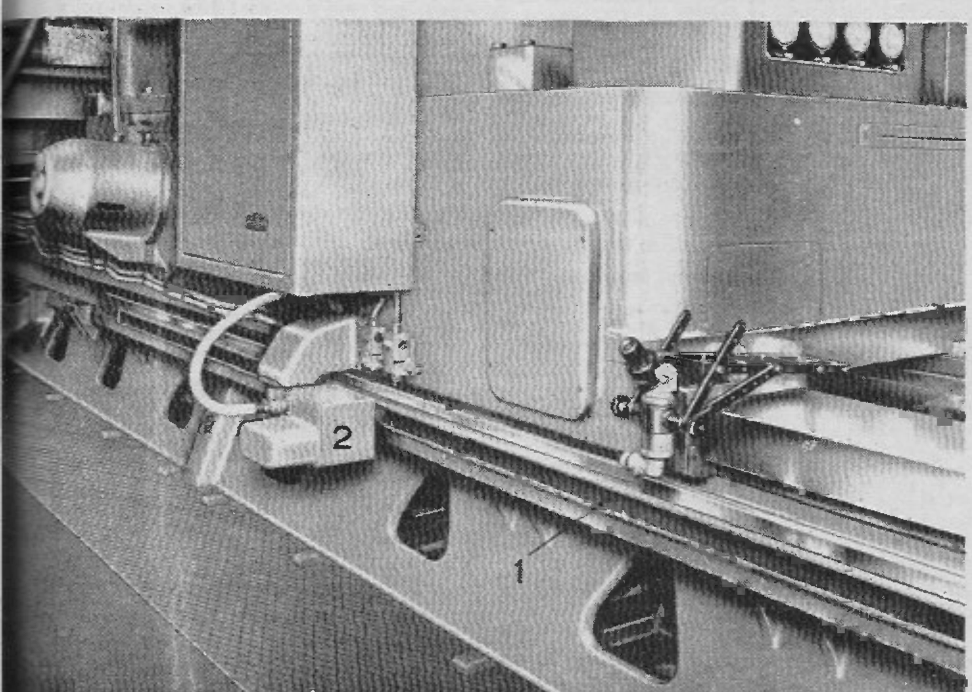


Fig. 4 a/b

Fig. 4 a/b Alternative tape/wire linear to angular rotation transducers.



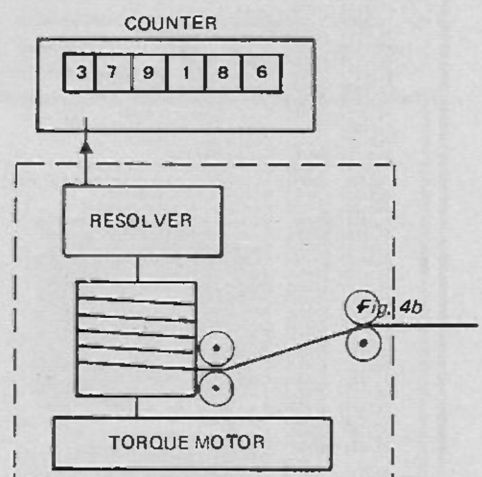


Fig. 3. Rack and pinion installation on an Innocenti boring mill.

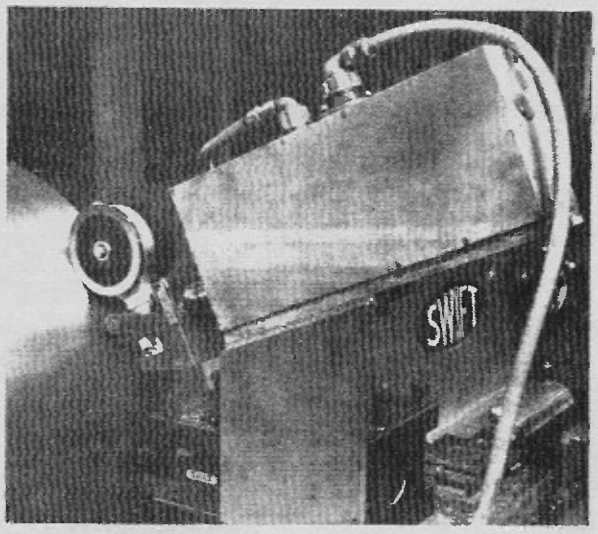


Fig. 5. Friction driven diameter measurement of a large shaft in a lathe (Rotax Ltd).

An axiom of measurement is Abbe's principle (after Professor Ernst Abbe of the famous Zeiss optical works, who lived in the 19th century). This states that a dimensional measurement made directly between the points of interest is better than one made by transferring with linkages or the like. This is illustrated by considering the measurement of length with a ruler. If the ruler is placed right on the marks, no parallax error is produced as no perpendicular transfer is needed. If the ruler is placed in line with the marks and moved from one end to the other, transferring errors are also avoided. Although this is an obvious principle, it is often impracticable to observe it as measurement is but one of the functions to be considered when designing a machine-tool.

If the size of a part is measured right at the work face, it is possible to eliminate machine structural errors. This idea has been termed the in-process technique and has found application in lathe work where a type of micrometer measures right at the tool-bit as work progresses.

Although the majority of current applications for industrial range transducers are in industry, they are not restricted to the workshop alone. In the 50's the developments in N.C. prompted many people to claim automation was around the corner. Today there are fully automatic manufacturing systems, especially in automobile production, but in the main these are not automatically controlled, but rather are preset mechanically to produce the same part many times over. Machining centres, as the fully automated systems are called, have been made and technologically, automation is possible. But social and labour pressures have prevented their greater use so far.

There are literally thousands of N.C. tools and D.R.O. units in use throughout the world so it is only to be expected that numerous ways have been devised to transduce length into control signals. Two basic approaches to the problem are possible.

In the first, the linear motion is converted into a rotary equivalent by a mechanical method. This rotation is then transduced to give either an analogue or digital, measurement signal.

The alternative method utilises measurements taken from a directly sensed linear scale attached — where mechanically convenient — to the machine.

LINEAR TO ROTARY CONVERSION

There are four mechanical devices that can convert length to angle over long distances. These are the rack and pinion, lead screw and nut, tape or wire and drum, and a friction driven wheel running on the linear surface.

Rack and Pinion — A popular technique, especially for long traverses on machine tools, uses a precision gear pinion meshing in a linear gear track which is mounted on the slide (as shown in Figure 3). Provided the mesh is accurate and back lash controlled, this method can provide accuracies around 10 parts in a million (which is the generally needed workshop accuracy). The design of the pinion gear and the pinion mounting is important, and usually springloaded split gears are used to minimize backlash.

Leadscrews — Early screws left much to be desired as backlash and friction were considerable. Nowadays the friction screw has been replaced in precision designs by the recirculating-ball screw in which ball bearings maintain contact between the screw and the nut. The nut is made in two pieces, one being wound on against the other to preload the balls into heavy contact in order to increase the stiffness of the joint. This results in improved dynamic performance. Ball screws are expensive but yield excellent precision. Better grades hold tolerances of 2μ/250mm of screw. The length of screw is limited, however, to a metre or two by the difficulties of supporting the screw and by the amount of screw wind-up under load that can be tolerated.

Tape and Wire Driven Drums — This linear to rotary conversion makes use of a tape or wire to rotate a precision measuring drum. The tape may be pulled around the drum, using the drum as a capstan (Fig. 4a), or pulled off the drum. The latter method uses a spring or an electric motor to provide a constant torque to the storage/measurement drum (Fig. 4b). This maintains a constant tension in the wire or tape and reduces elastic errors.

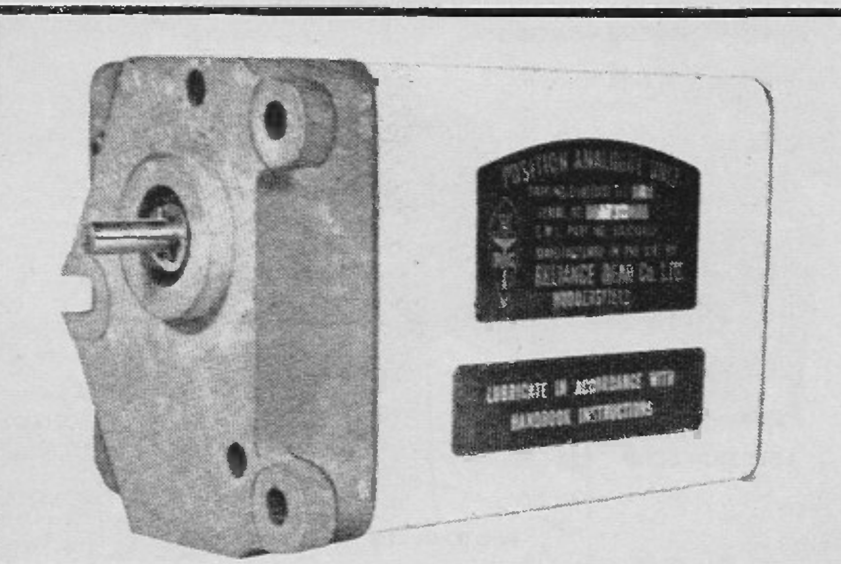
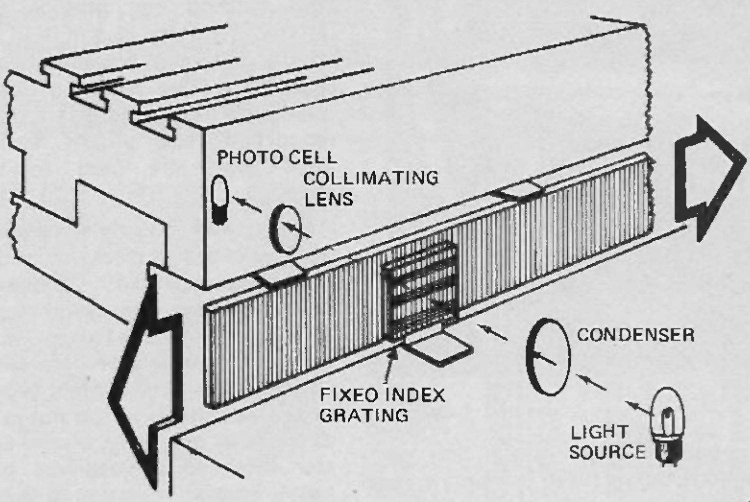


Fig. 6. The linear Inductosyn length transducer.



If two diffraction gratings consisting of ruled lines on transparent blanks are superimposed with their rulings not quite parallel to each other, dark bands called moire fringes are produced across the gratings. The spacing of the fringes is a multiple of the ruling interval and is dependent on the angle of inclination between the two sets of lines.

Movement of one grating relative to the other, in a direction perpendicular to the lines, causes the fringes to move in a direction at right angles. If, for example, the grating is moved a distance equal to the ruling interval the fringes move a distance equal to one fringe spacing, and so provide an amplified indication of the movement of the grating. In this effect lies the principle of the application of gratings to the requirements of engineering metrology.

Fig. 7. Simplified arrangement using bar-space optical transmission gratings to measure displacement.

Although this method can provide accurate measurements, comparable with the rack and pinion for instance, it is not widely used except for the measurement of fluid levels in storage tanks. An automatic positioning control system has been demonstrated that uses one of these units as only two ends (the end of the wire and the tensioning drum) need to be mounted. Alignment is far less critical than with alternative methods.

Friction Rollers — It is possible to convert a linear motion into a rotary one by using a wheel. Provided the surface is smooth and flat this method yields quite good precision. An inexpensive clock-dial output device is available for fitting to a lathe. It is also available with a digital readout device. Friction driven rollers have also been used to control shaft diameter size in in-process turning and grinding. To improve the accuracy, rotations of the roller (mounted in contact with the surface just cut) are counted and subdivided over a large number of shaft turns. Devices developed in Britain perform better than a micrometer and, of course, have the advantage of an electrical output for inspection or control purposes. The advantage of this method is that the same basic unit can measure from small to practically unlimited sizes of shaft.

In each of the above methods the resultant shaft rotation is used to rotate a mechanical pointer or an angle transducer. (Angle transducers are discussed in the next article — dealing with multi-axial position).

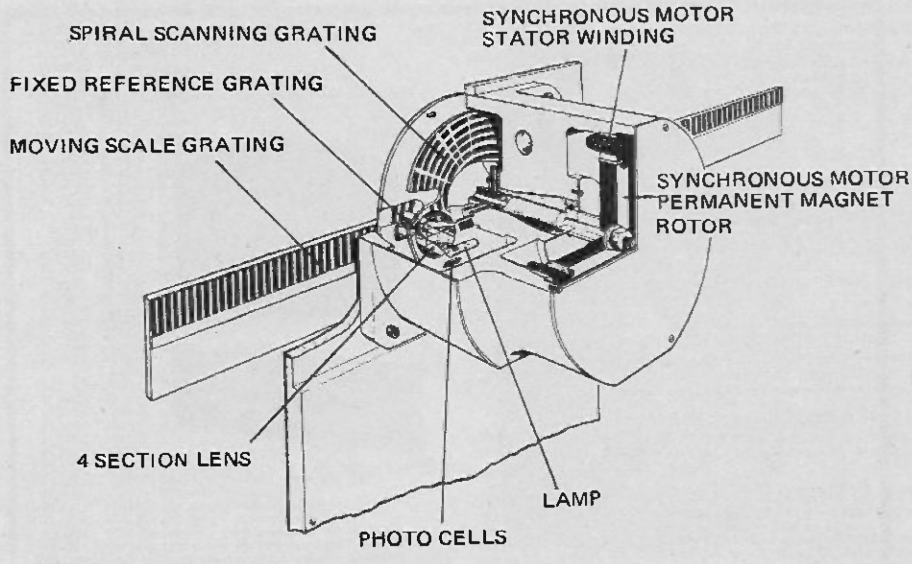


Fig. 8. Mechanical modulation of optical grating signals in the Ferranti spiral scanning head.

Direct Methods

There is often a requirement for greater precision than indirect methods can provide.

Accuracies approaching a part in a million are attainable with directly sensed linear scales. Extreme precision is, however, often demanded by persons unaware that errors of one part in a million are hard to eliminate unless the whole machine and work-piece are temperature stable to at least 1°C or better. Few machines, even precision ones, are given a special controlled environment room in which to operate.

Scales can be either a physical mechanical arrangement or a feature of a radiation beam such as in a laser interferometer.

Mechanical scales can be sensed by the primary electrical methods (resistive, inductive or capacitive) or by optical methods. In some instances the scale is simply a length with subdivision marks made along it in some way. The marks may be individually identifiable or they may all appear identical. These alternatives are known as absolute and incremental scales respectively, and the sensing technique depends much upon which type of scale it is. In the incremental version, the marks are progressively counted in order to ascertain the length traversed, whereas in the absolute scale, no action needs to be taken during movement between two points as the position information is available at the mark on which it stops.

Resistance potentiometers, described in the last article, can be made to any length but for applications requiring extreme precision, the resolution and stability are inadequate. Furthermore industrial applications offer extremely dirty and vibratory conditions which severely shorten the life of the contact and surface of the resistance material.

The inductive and capacitive techniques described in the last article are only suitable for quite small displacements. However, means have been developed by which a number of units can be cascaded side by side to cover the required length. Electronic circuitry is used to decide which unit is in operation at any one time, thereby giving the coarse position. Fine position is added to the measurement by using the output of the individual transducer then in use. This is a combination of both incremental (the coarse positions are identical) and absolute devices — it is known as a hybrid system.

Many variations exist on this theme. In one, which illustrates the general principle used, a photo-mechanically printed and etched conducting hairpin winding, (Figure 6) is formed on the surface of a precision glass plate some 300 mm long. This is attached to the slideway of the machine tool. Fastened to the moving saddle is a much shorter piece of glass having two similar patterns formed on it with a spatial phase separation of one quarter of the pitch of the grid. This slider, as it is called, moves along the fixed scale with an airgap of 0.25 mm. The long grid is fed with a 10 kHz electro-magnetic signal. The slider grids pick up this signal by inductive coupling across the airgap. Phase measurement between the slider elements and the reference oscillator yields direction of movement and position within one gridpitch. It is necessary to determine where the slider *is* upon the grid and this can be done with a rack driven encoder (which can be of lesser precision), by counting the number of full cycles traversed from a datum position, or by the use of further inductive grids as seen in Fig. 6.

This method is basically similar to many other devices — a salient feature is manufactured cyclically along the scale at precisely fixed, constant pitch positions. Position within a cycle is decided by the subdivisional method known as the phase analogue method, and the number of salient features passed is found by counting, or by reference to a second coarser measuring system. Small magnets, castellations, the thread of the lead screw, inserted slugs — all have been used with magnetic sensing and with the exception of the first, with capacitive sensing also.

Optically-sensed scales — It is also possible to sense marks by optical methods. Opaque lines, small prisms, screw threads and holes have been sensed by the light passing through. The most commonly used method is the first.

In 1950 the British firm of Ferranti Ltd developed a length transducer to facilitate machine-tool control. This employed long diffraction gratings. These were made inexpensively by resin replication from a master unit. The long diffraction grating was used in conjunction with a smaller piece, (called the index grating), to form Moire fringes which were then counted photo-electrically. The ruling pitch was typically .001 inch in the imperial measure scale. As time went by the diffraction grating was replaced by an easier to produce and use grid called the bar and space transmission-grating. This simply has nontransparent lines and transparent spaces at the same pitch. The Moire fringes, shown in Figure 7, are formed by placing the index grating at a small angle to the main grating. (These fringes are commonly seen by viewing through the two handrails of a bridge or by looking at a corrugated iron wall through a vertical paling fence). The merit of the Moire fringe is that it is produced as the average of hundreds of individual lines and, therefore, reduces local errors. Furthermore, the fringe pitch is easily arranged to be much wider than the grating pitch enabling large size photo-detectors to be employed.

As with the inductive hairpin grid, two index gratings spaced in phase at 90° give two signals that enable direction to be determined.

The interpolation methods mentioned in the article on small displacement sensing were mainly devised to subdivide relatively coarse optical gratings for it is possible to place coarse lines accurately, but impracticable to put more of them closer together. With optical gratings there is no inbuilt time-modulation as with the inductive and capacitive methods. To make use of the phase-analogue method of subdivision, modulation was added by mechanically rotating a reference grating, one method being illustrated in Figure 8.

Later, solid-state methods were evolved. One uses four photocells placed at 90° intervals across the fringe. These are cyclically interrogated and their outputs processed to give phase difference with the cyclic generator. With this technique it is possible to subdivide to one hundredth of a fringe. As subdivision is an absolute measure it is preferable to use a coarse grating and subdivide down to gain the necessary resolution. This reduces errors due to pulse counting loss.

It is also possible to use this method

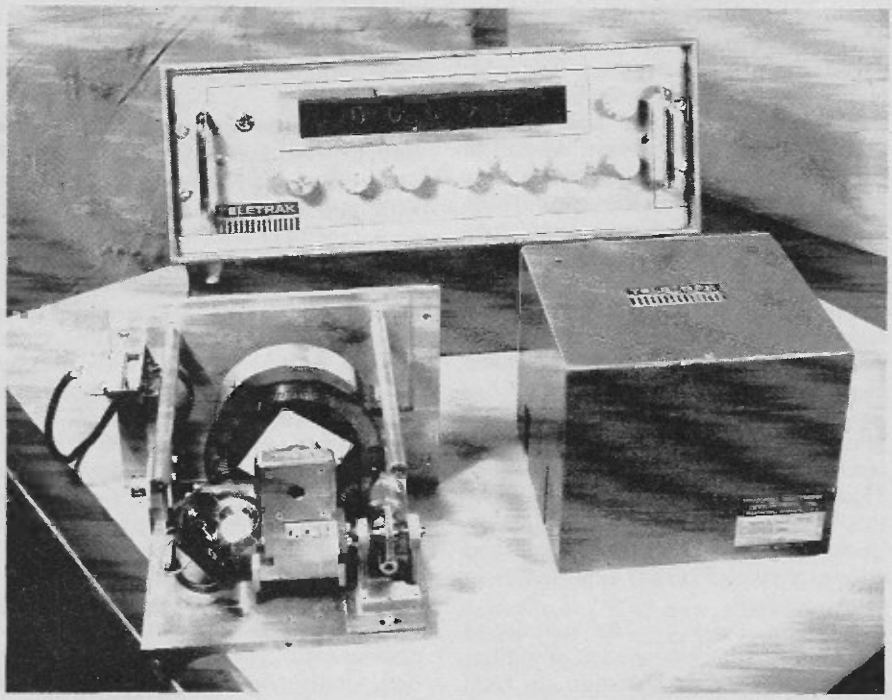


Fig. 9. A commercial version of the absolute system using incremental optical gratings.

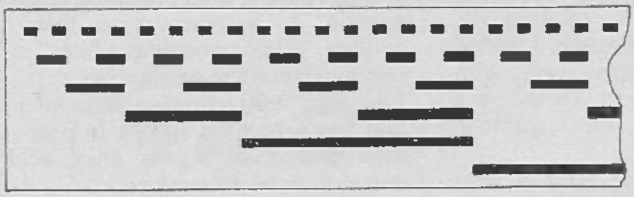


Fig. 10. Section of a 6 bit absolute digital transmission transducer scale.

Fig. 11. The University of Trieste laser earth strain meter.

with a reflection grating that has alternate non-reflective, reflective lines etched on a narrow stainless-steel tape. In precision installations the tape is spring tensioned to maintain the same length as when it was etched.

The disadvantage of the simple bar space grating is that it is incremental. An ingenious method has been devised to use them as an absolute system. Consider starting with a coarse grating having a pitch of one millimetre. Phase analogue methods could be used to subdivide the one millimetre cycle into ten absolute parts. If alongside the first grating is one ten times finer, the finer line corresponding to the subdivided position on the coarser grid can be determined by the analogue subdivision. With a third, ten times finer again, grating we can subdivide still further. The position analogue in a millimetre space is found by absolute encoders of low cost. So with incremental gratings it is possible to measure position in an absolute manner. This technique was devised in Britain several years ago and is now marketed by several companies. These successively finer tracks are seen in the angle transducer using this concept which is shown in Figure 9.

This method is tending toward absolute digital optical scales but it needs far less tracks and this eases the manufacturing cost.

Linear digitally coded tracks are available with as many as 20 or more tracks, – one with 6 bits is shown in Figure 10, – but linear transducers of this type are difficult to use in practice. However, as we shall see in the next article they are used extensively in rotary encoders.

Radiation Scales – As mentioned previously, a laser beam (or any other coherent source of radiation, in fact) can provide a spatial scale if interferometric methods are used. The coherence length of a source decides how far it can radiate and retain a satisfactory wavefront for interference. In the laser this length is such that distances of kilometres are in range. Thus the laser interferometer is especially versatile and is able to measure from millimetres to thousands of metres with the same apparatus.

In industry, the laser interferometer is far too expensive for most routine measurement. A system costs over £5,000, compared with £1,000 for a grating transducer.

Interferometers are, therefore, usually reserved for vital inspection tasks and for calibrating less accurate scales. They are easily installed – only the laser and a corner cube (or cats-eye) reflector need to be mounted. As the method is by nature, incremental, it is necessary that the reflector is moved in a straight line – within tolerances of a millimetre – to ensure correct operation at all times.

One interesting application of the laser interferometer is its use to control the ruling diamond-carriage position with respect to the moving blank on the Australian C.S.I.R.O. diffraction-grating ruling machine at the Division of Chemical Physics at Clayton in Victoria. Such engines rule, on coated glass, hundreds of thousands of lines side by side and separated by only a micrometre or so. In the C.S.I.R.O. engine, mechanical gears, etc. advance the blank by roughly five fringes. Electro-optic sensing operates a servo that pulls the blank into exactly the fifth wavelength position. A line is then ruled and the process repeated.

Another scientific application of the laser interferometer is for monitoring earth strains. In these installations the path length over which variations occur, ranges from tens to hundreds of metres. It is the small variations in the length (rarely exceeding a part in a million) that are of interest. The earth strainmeter built at the University of Trieste is shown in Figure 11. The fixed reference arm and beam splitter are enclosed in the tank. Laser radiation enters through the white tube in the foreground, passes to the far end of the tunnel in the suspended tube, then returns to produce fringes which are monitored by the two photomultipliers mounted on the brick pillar to the left of the picture.

MISCELLANEOUS INDUSTRIAL LENGTH TRANSDUCERS

So far we have been concerned with movements of machines, for this constitutes the majority of industrial range measurements. But there are times when other methods are more appropriate. Let us consider just a few.

Television Gauging – A television camera tube is able to convert an optical image size into an equivalent electrical signal by virtue of a timing process. The vidicon camera tube is the simplest of these tubes and is the most used in gauging applications. The vidicon consists of a target upon which is focussed the image of the object of interest. The intensity of the illumination on the target controls the charge distribution on its surface. At the rear of the tube is an electron gun that aims a stream of electrons at the target. This beam is electromagnetically or electrostatically deflected to scan across the target in a systematic manner. The charge on the target decides how much beam current will flow so beam current is a measure of the illumination intensity of the image. Beam current variations (the video signal) and scan position data are combined onto a common signal line and the image is reconstituted in a monitor (if needed).

The tube, therefore, converts image dimensions into time signals, so size of the image, and hence the object of interest, can be ascertained from the video signal. This method is not restricted by object size for the optical system can scale up or down as need be. Applications range from microscope slide examinations, to sizing steel billets in the rolling mill, and tracking of missiles from ground level to that height where radar is effective. Precision is limited to 0.1% of the image size, so it is not in the same accuracy class as machine tool transducers, but the advantages of fast response time and easily adjustable scaling make it attractive in many applications.

Scanned Laser Beams — If a laser beam, which has a divergence of 1 m.rad (or less when used with a telescope), is scanned across an object, the time taken for it to reappear after being vignetted by the object is a measure of size. Two ways are employed. In the first the rotation is at a fixed speed so distance is proportional to time of obscurance. Alternatively, the rotation can be locked to an angular resolver in which case scan speed is not critical.

SURVEYING RANGE

There are a number of precise techniques for determining distances greater than a kilometre. These use electromagnetic radiation and are known as electromagnetic distance measuring (EDM) devices.

During World War II both Britain and Germany developed radar to plot positions of friendly and enemy aircraft. The technique was to send a burst of carrier and time its reflected return. Electromagnetic radiation travels at around 300 mm per nanosecond, so the resolution is decided by the ability to detect small time intervals. With early equipments only several metre resolution was possible.

A more accurate way to resolve the time is to use a continuously transmitted carrier and compare the phase of the returned signal with the source. The phase-analogue method again).

No doubt the development of radar prompted subsequent developments, for in 1949 a device, called a Geodimeter, was announced. In this a modulated light beam is sent out and returned from a distant target reflector. The phase between the transmitted and received signal subdivides the whole cycles and coarse position is found by determining which coarse cycle is being used. As it is not practical to traverse the whole distance and count cycles, a method of frequency changing is used to decide the coarse distance. This light beam method can measure 20km distances to 10 mm. The latest units, (one is shown in Figure 12), use laser sources to improve the range in daylight.

Fig. 12. The EDM instrument uses a modulated laser beam to measure distances up to 60km with an accuracy of 6 mm.

Then came the Tellurometer — in 1957. This South African development uses microwave radiation. Original units used a 3000 MHz carrier modulated at 10 MHz. Distances from 150 m to 80 km can be measured to the same 10 mm resolution. The latest microwave EDM device operates on a 8 mm wavelength and gives millimetre resolution.

Numerous other devices have followed but with one exception they are modelled after the Geodimeter or Tellurometer. The exception is the Mekometer, a British development from the National Physical Laboratory near London. This uses a short burst of light in which the polarization angle is modulated (rather than the beam angle). By incorporating free air in the modulating cavity, errors due to ambient conditions are reduced. These have been used in recent land crustal movement surveys in Iceland and Greenland and to set up the 300 m diameter intersecting storage ring at Cern near Geneva.

In all EDM instruments, the path being measured is in free air, so the pressure, temperature and water vapour content alter the refractive index and hence the travel time of the radiation. These effects limit the accuracy to some two parts per million.

One approach currently under intensive investigation is to use two systems together each having a different wavelength carrier. Common elements are combined for reasons of economy as shown in the system developed by the United States Environmental Sciences Service Association (see Figure 13). The two measurements can be combined to reduce the path errors by 5 to 10 times. It should not be long before dual frequency EDM devices are commercially available.

Until 1968 there was no way to measure short distances (up to a kilometre) with comparative ease. But that year the major surveying instrument manufacturers in Europe each released a ranger which used the solid-state gallium arsenide light emitting diode. This diode is able to provide pulses of intense and highly chromatic light in the red region. In these meters, (one is illustrated in Fig. 14) the transit time technique is used in which the time between sending a pulse and its subsequent return is gated and displayed as distance on a digital readout. Resolution is limited to several millimetres but this is quite suitable for much of surveyors' requirements.

So far we have only considered using phase or gating methods used in conjunction with EM radiation. Acoustic or soundwave radiation travels slower, by a factor of at least one million, so better resolution is possible for a given technological limit on gating a pulse.

Sonar and Asdic are devices for

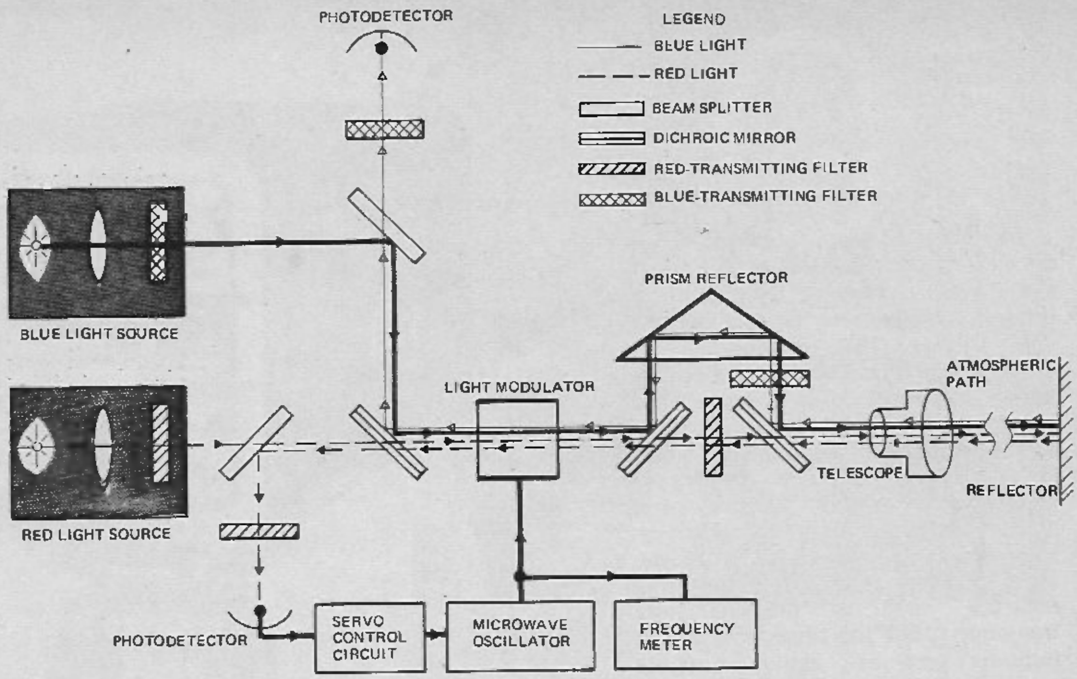


Fig. 13.

A schematic of a two-colour distance measuring technique used by ESSA in the United States of America.

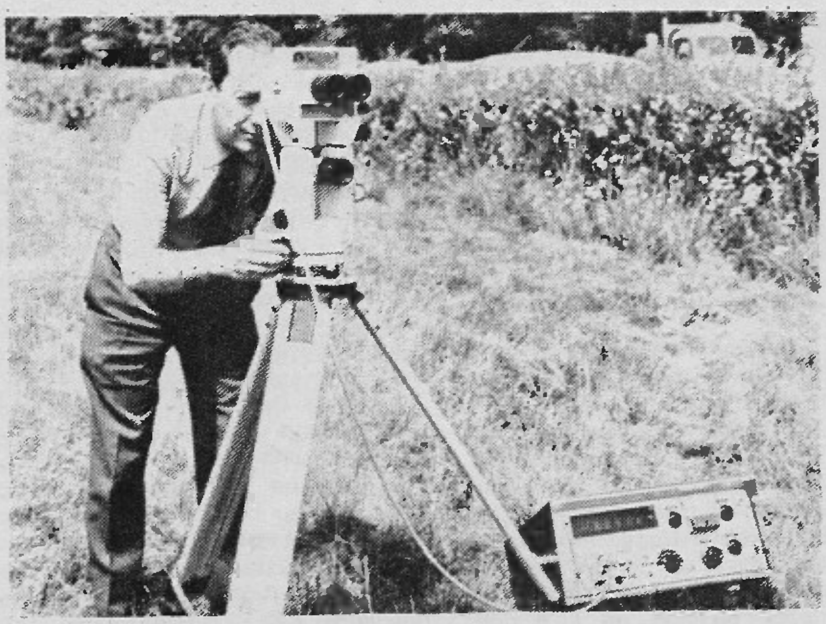


Fig. 14. Gallium-arsenide diode powered transit time ranger.

ranging under water. Ultrasonic methods work well in a dense field or a solid as the transducers can be efficiently coupled to the medium transferring the wave. Ultrasonic methods are seldom used in air as the coupling is poor.

Ultrasonic distance gauging is applicable for both long and short ranges (as mentioned in the last article). It has been used in submarine tracking, surgical probe guidance, water level sensing, determination of wheat level in silos and thickness measuring in industry. An interesting application is its use to guide a deep sea drill bit into an entry cone fastened on the sea floor many thousands of metres below a drilling platform.

CELESTIAL RANGE

As man's desire to explore space is realised, it is increasingly necessary to know where an object is with respect to another planet — for instance the Earth. Better measurements of distance are possible in space due to the absence of an atmosphere, and also because the distances are large enough to enable transit-time methods to be effectively used, for grating error is insignificant.

During the recent Moon visits, retro-reflectors were placed on the surface to return powerful pulsed laser beams back to Earth. From this method it has been possible to determine the distance to the Moon to an incredible accuracy, and we will now be able to observe such effects as the Chandler wobble of the Earth by monitoring the Earth/Moon distance variations.

A space vessel is guided to another planet by servo-systems locking onto the planets image, or by relation to certain chosen stars in the star field. Once near to the planet the vessel locks on to the horizon of the planet until its radar is within range. For the last few hundred metres of descent it might use ultrasonics, television or even a weighted tensioned cord to control the final approach velocity. These have all been used at some time or another.

So far we have described how we can transduce lengths from 10^{-14}m to 10^{20}m or more into electrical signals.

In the following article, transducers for converting angles into electrical signals are outlined — these are very much tied to the measurement of dimension and position. ●

FURTHER READING

"Linear and Angular Transducers for Positional Control in the Decametre Range". P. H. Sydenham, Proc. IEE., 1968, 115, 7, 1057-1066.

"Transducers for Positional Measuring systems". R. C. Brewer, Proc. IEE., 1963, 110, 10, 1818-1828.

"Plane and Geodetic Surveying — Vol II. D. Clark, Constable, 1963.

"Electromagnetic Distance Measuring — EDM". Hilger and Watts, 1967.

"Ultrasonic Engineering". J. R. Frederick, Wiley, 1965.

"Instrument Transducers", HKP Neubert, Oxford Press, 1963.

"Interferometry as a Measuring Tool", J. Dyson, Machinery Pub. Co, 1970.

"Handbook of Applied Instrumentation", D.M. Considine and S.D. Ross, McGraw-Hill, 1964.

"Microdisplacement Transducers", P.H. Sydenham, J. Phys. E.: Sci. Instrum, 1972.

"Position-sensitive Photocells and their application to static and dynamic Dimensional Metrology", Optica Acta, 1969, 16, 3, 377-389.

HI-POWER

ETI PROJECT

Build this high-power strobe for parties, light shows and discotheques.

This high-power strobe light is ideal for use at parties, light shows and discotheques.

It provides a short intense pulse of light adjustable in frequency between one flash per second and twenty flashes per second.

The circuit is unusual in that several strobe lights may be driven from the one basic triggering unit.

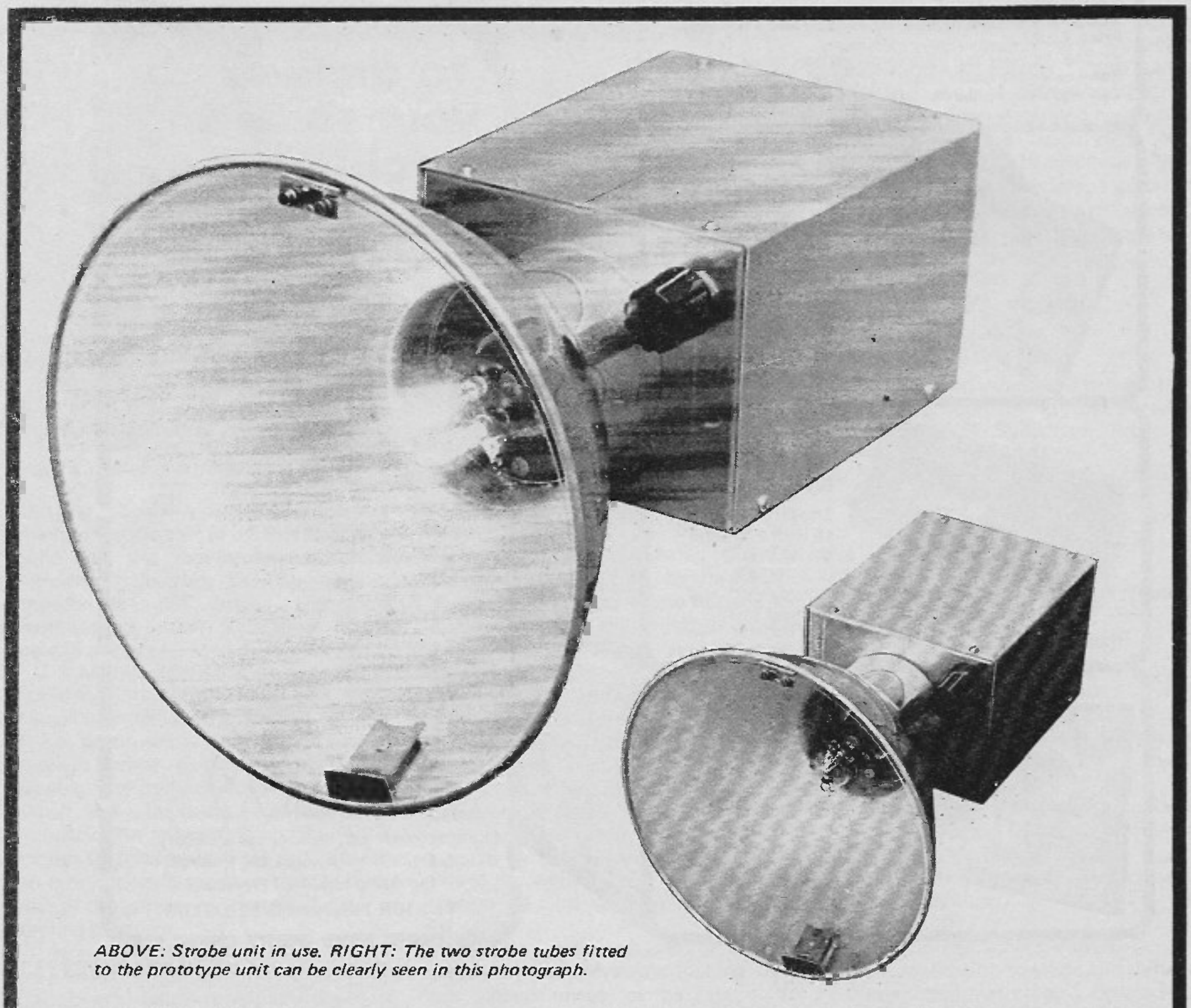
CIRCUIT DESCRIPTION

The circuit of the complete strobe unit is shown in Fig.1.

Diodes D1 to D4 produce positive voltages, at the points marked 'A' and 'B', on alternate half-cycles.

The voltage appearing at point 'A' charges the capacitors C2 and C3, these two capacitors supply the energy for the strobe tube.

Strobe operating frequency is determined by the timing circuit of SCR1, RV1, R2, C1 and LP1/2. Timing capacitor C1 is charged via RV1 and R2 by the positive voltage appearing at point 'B' on alternate half-cycles. When the charge on C1



ABOVE: Strobe unit in use. RIGHT: The two strobe tubes fitted to the prototype unit can be clearly seen in this photograph.

STROBE

exceeds the break-over voltage of the neons LP1 and LP2, these conduct triggering SCR1.

When SCR1 conducts, the timing capacitor C1 discharges through the primary winding of the pulse transformer (T1) and SCR1.

This causes a high voltage spike to be generated in the secondary winding of the pulse transformer, and it is this spike that triggers the strobe tube into conduction.

Capacitors C2 and C3 discharge practically instantaneously through the strobe tube resulting in a brilliant flash of light. Peak current may exceed 60 amps during this short period.

Since both the timing circuit and the storage capacitors are charged by an unsmoothed half-wave supply, neither can conduct for longer than one half-cycle of supply voltage.

The amount of light produced by the strobe tube during each flash is a function of the capacity of C2 and C3. Increasing the size of these capacitors will increase the amount of light but only at the expense of tube operating life. The capacitors specified will provide several hundred hours operation at a light level adequate for most purposes.

A far more satisfactory way to increasing light output is to fire two or more strobe tubes from the main triggering circuit. This is done by connecting the second and further tubes, additional 220 ohms resistors, and 6.5uf storage capacitors, as indicated by the dotted lines in Fig.1.

No modifications are required to the main timing circuit.

If desired the additional strobe tubes may be mounted within the existing single reflector.

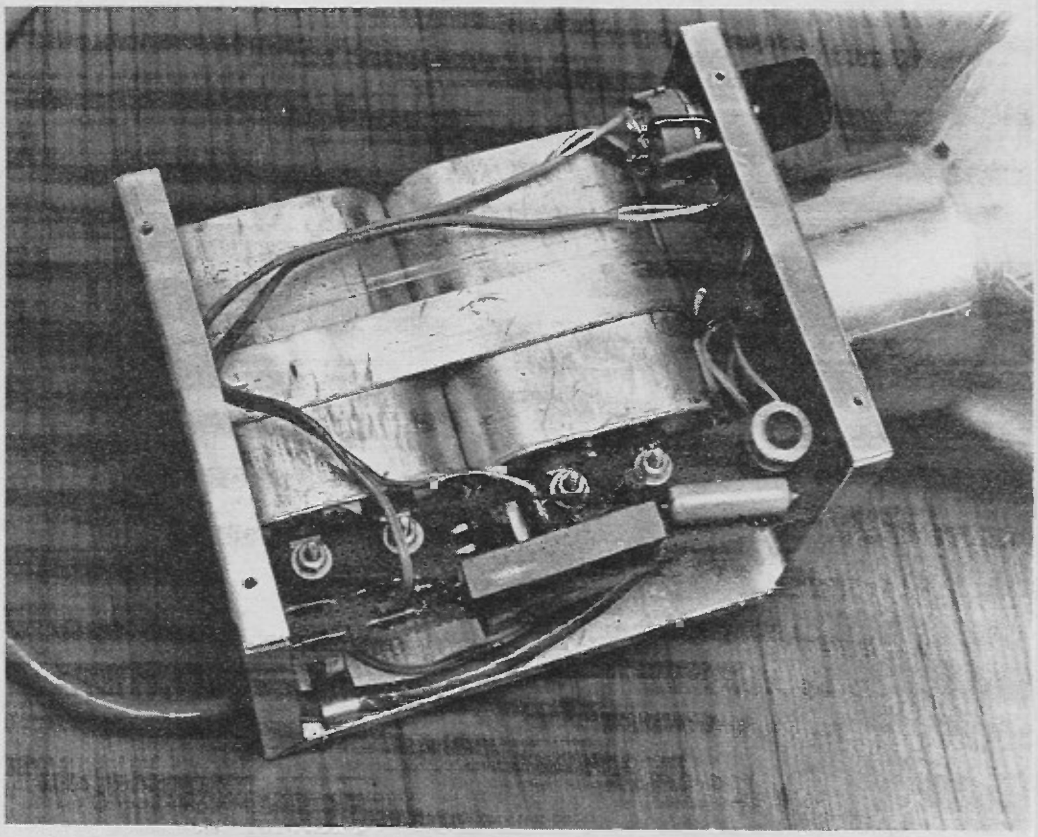


Fig. 5. Construction of the unit – this particular unit has been constructed to drive two flash-tubes. The additional capacitors and 220 ohm, 10 watt resistor referred to in the text can be clearly seen. The pulse transformer is on the extreme light of the matrix board which in turn is bolted securely to the energy storage capacitors.

CONSTRUCTION

Our prototype unit was constructed from an aluminium case 5¾" x 4½" x 3½" onto which was mounted a 7" diameter photographic type reflector.

The reflector should be fitted with a perspex cover to protect the tube. A suggested method of locating this cover is shown in Fig.2.

The strobe tube or tubes should be soldered into an octal plug. A corresponding octal socket is housed in the base of the reflector (as shown in Fig.2.) This enables the tube/s to be easily removed for replacement.

Since this unit is connected directly to the 240 volt mains, great care must be taken to earth all external metal parts. Unless you are thoroughly conversant with electrical wiring, have the finished unit checked by a licenced electrician.

Component layout is simple and non-critical. Apart from the capacitors and strobe tubes, all components may be mounted on a matrix board or on tag strips.

The storage capacitors are 6.5uf, 250 volt working, paper insulated units of the type used for power factor correction with fluorescent lights. These have been selected for this purpose because they have high discharge current ratings and are readily obtainable from electrical wholesalers. This type of capacitor is larger than the electrolytic variety.

If space is critical, electrolytics of the same capacity, but having a 450 volt dc voltage rating, may be used in their place. They will however require replacement at frequent intervals.

If the recommended type of capacitor is used, the matrix board carrying the remaining components can be bolted to these capacitors' terminals, and the capacitors securely located within the metal case.

LOCATE COMPONENTS SECURELY

All components must be fixed rigidly in position so that there is no possibility of their contacting the metal case. If there is the slightest doubt, insulate the component with tape, and line the interior of the metal case with an insulating board.

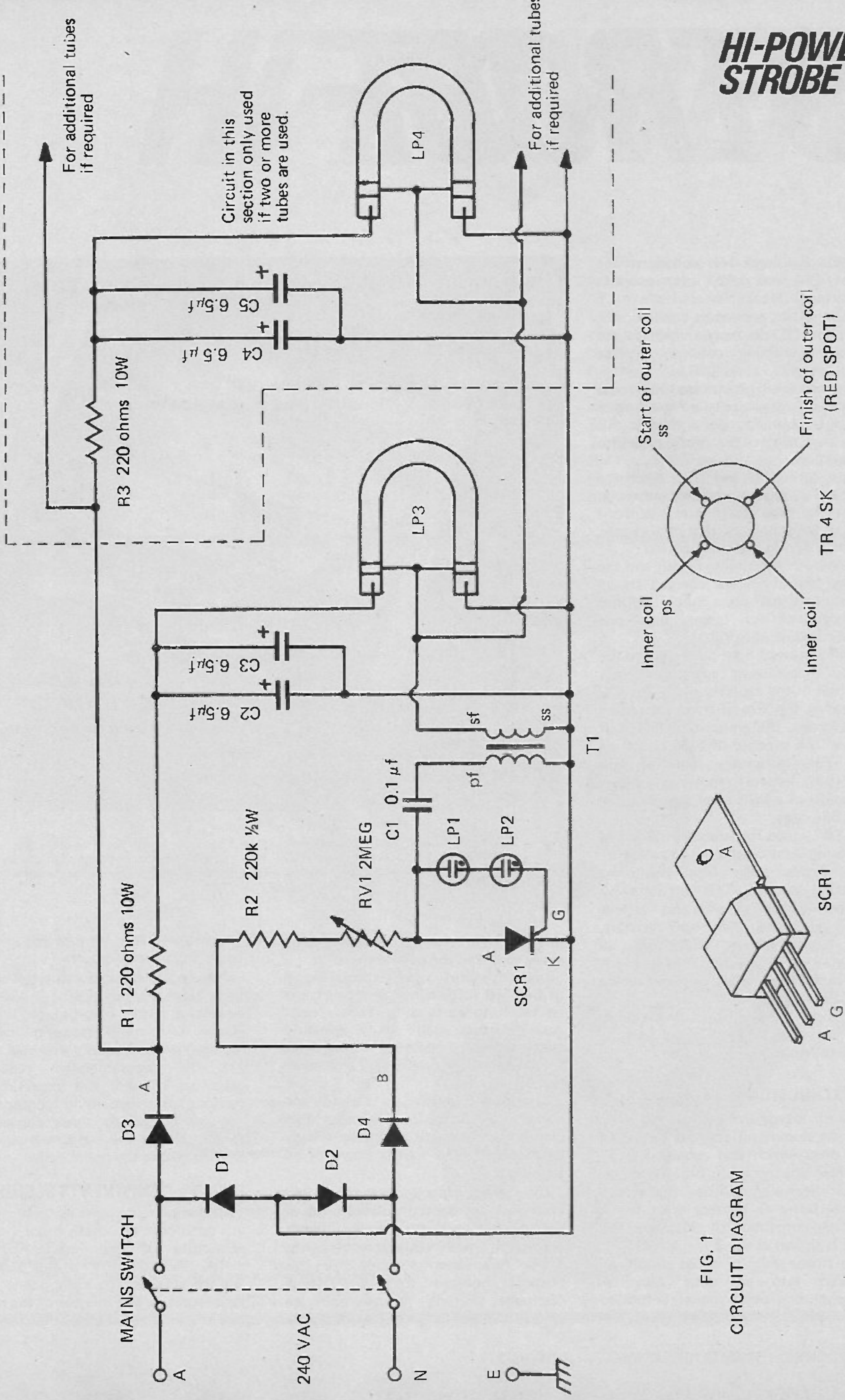


FIG. 1
CIRCUIT DIAGRAM

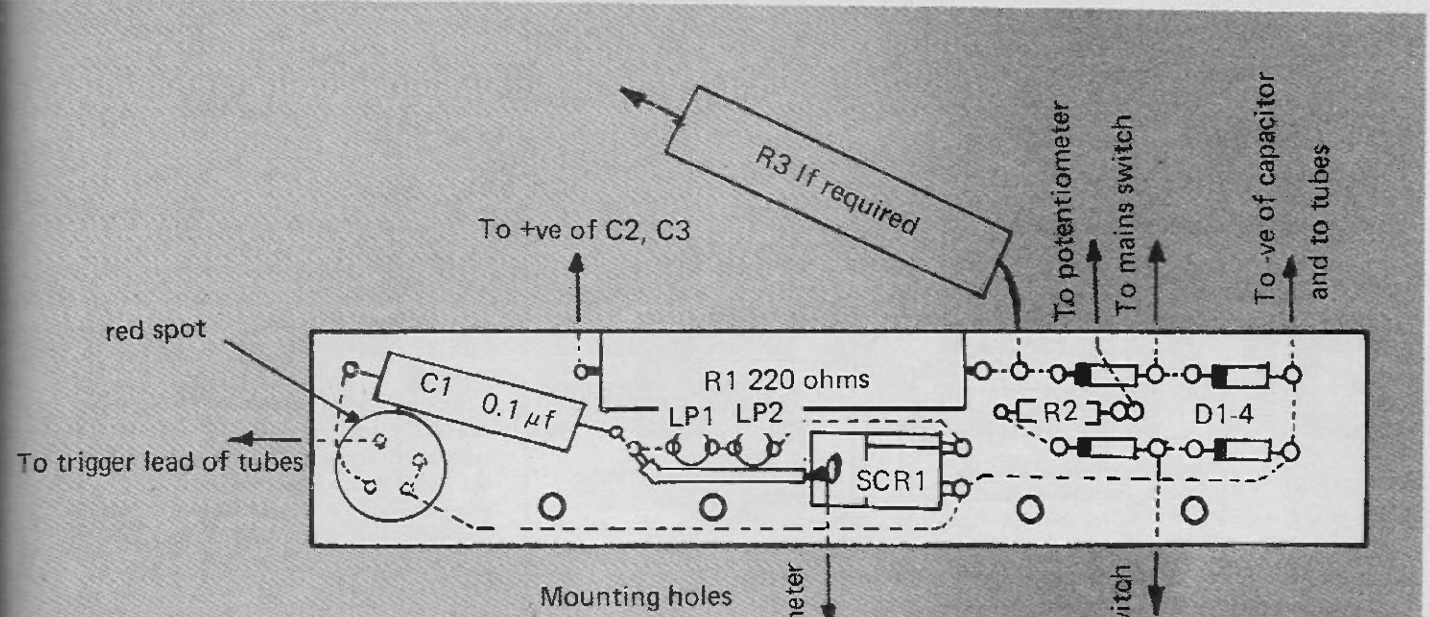


FIG. 3

COMPONENT LAYOUT

Connect components using 23/0076 240 volt insulated wire. A two-pole mains switch must be used, this may consist of a separately mounted unit, or it can be combined with the main speed-setting potentiometer (a combined switch-potentiometer is specified in the parts list).

The mains cable must be protected by a grommet at the point where it enters the case, it must also be securely attached to the case by a suitable clamp.

Many types of strobe tubes have been found to operate satisfactorily with this project. The tube used in our prototype is the Philips type 126048.
A length of tinned copper wire must be wrapped around some types of tube to act as a triggering lead (Fig. 4).

This lead is inbuilt in the Philips strobe-tube, but we have found that an additional winding may be required (in this application) to eliminate erratic triggering.

WARNING

Repetitive pulses of light – especially those occurring at frequencies around nine flashes a second – may cause epileptics to have convulsive seizures.
Those prone to grand mal, petit mal, or psychomotor attacks should avoid areas where strobe lights are used.
In the event of such an attack whilst a strobe is being used, the strobe light must be turned off immediately. — JV.

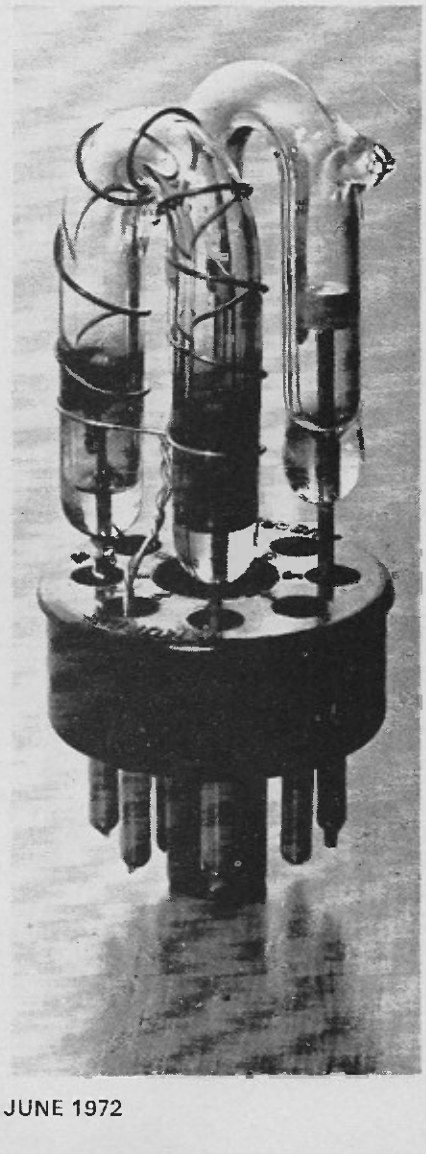
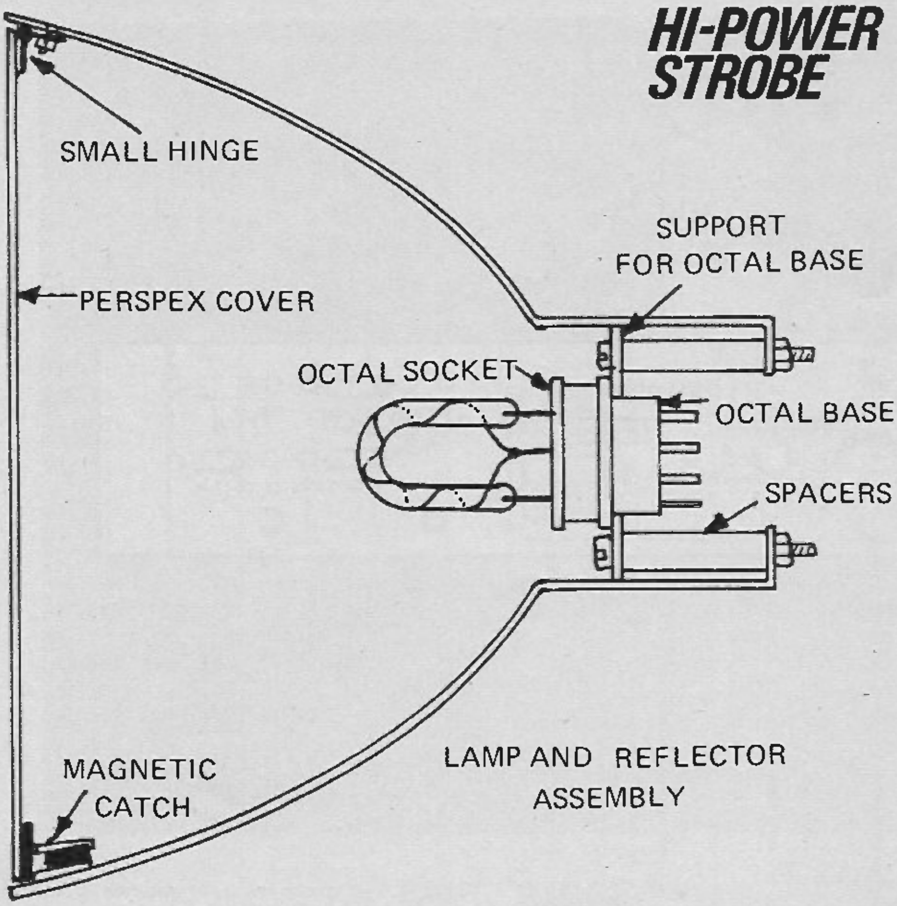


Fig. 4. Two strobe tubes are mounted in one octal holder. A triggering lead has been wrapped around one tube to show technique.

HI-POWER STROBE



LAMP AND REFLECTOR ASSEMBLY

PARTS LIST

D1,D2,D3,D4.	–	silicon diode EM 404 (or equivalent)
R1	– –	resistor 220 ohm, 10 Watt, 10%
R2	– –	resistor 220k, ½ Watt, 10%
R3 *	– –	resistor 220 Ohm, 10 Watt, 10%
RV1	– –	potentiometer, 2 Megohm, linear scale, with double pole switch.
C1	– –	capacitor, 0.1uf, 400V.
C2, C3 **	–	capacitor 6.5uf, 250 volt ac.
C4, C5 *	–	as above
LP1, LP2	–	neon indicator tube – GE-NE2
LP3	–	strobe tube, Philips type 126048
LP4 *	– –	strobe tube – as above
T1	– –	pulse transformer –
SCR1	– –	silicon controlled rectifier, C106D, BT100A 500R or equivalent.
Octal plug	–	McMurdo type L8USP1
Octal socket	–	McMurdo type RT8
Sundries	–	reflector, metal box, spacers, perspex cover, hinge, magnetic catch, hook-up wire, three-core flex, nuts, bolts, washers, etc.

** Components marked with one asterisk – only required if two or more strobe tubes are to be used.*
*** If unobtainable from your kit parts supplier, these capacitors can usually be obtained from main electrical dealers handling fluorescent lighting equipment.*

MARCONI COMPOSITE RADAR DISPLAY

A new radar display system, which will enable projected information from 35 mm colour film to be superimposed on a normal radar display, is being developed by Marconi Radar Systems Limited, a GEC-Marconi Electronics Company. The new display will be based on units from the company's existing radar display range. It will therefore be compatible with existing display systems produced by Marconi and, in some cases, by other companies. All the main features of a normal display will be retained.

The Ministry of Defence (PE) has awarded Marconi a contract to supply three prototype units. These will be for evaluation by the Royal Radar Establishment.

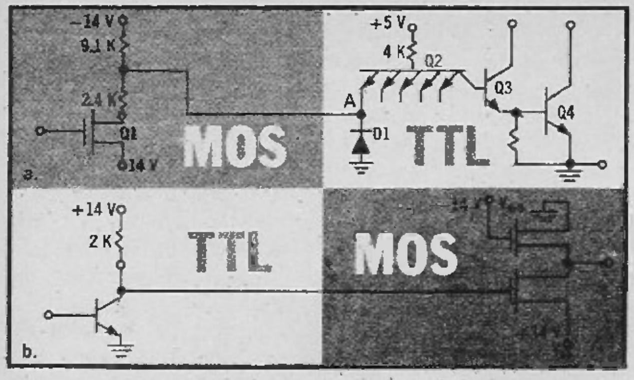
The new system is based on the Marconi 400 mm (16 inch) radar display, type S3014, which provides a high-speed, analogue radar presentation with full facilities for electronically written labels and symbols. The external appearance of the unit will be virtually unchanged. An optical window at the back of the cathode ray tube will enable pictorial or written information from 35 mm film frames to be back projected on to the tube face, and superimposed on the electronically written display.

A very wide range of maps, written instructions, emergency procedures and other essentially non-changing information is capable of being carried on film, thus saving computer processing time and storage, and allowing much more of the electronic writing time to be used for labelling aircraft traces as they move across the screen. Mapping information projected on to the display by colour film will help the operator to interpret the increasing amount of information on his display screen.

The optical system is based on the map projection unit designed by the Airadio Division of Marconi-Elliott Avionic Systems for the moving map display unit of the AD670 airborne navigation system. This very compact projection unit can carry over 1,000 separate frames on a 39 metre (130 ft) length of 35 mm film, and the unit contains a motor drive, which moves the film rapidly to select the required frame.

The system has been designed to provide good focus even at the corners of the picture, and the illumination can be varied to suit changes in the light level on the radar tube face.

The very large number of frames that can be carried on a single length of film will ensure that any possible combination of maps, including variations with different scales, markings and additional labelling information can be carried on a single loading of the film unit. At the same time it will be possible to include frames with special instructions, emergency procedures and other information. The use of colour projection will also go some way towards clarifying the more complicated maps, by providing colour identification of different components of the displayed information.



The best features of differing logic technologies may be utilised in hybrid systems. This article explains how MOS and TTL are interfaced.

INTERFACING

MOS usage is mushrooming, and the long run usefulness of the various MOS technologies depends strongly on their abilities to interface with each other and with bipolar circuitry. In some cases complete systems will be built exclusively with MOS techniques. More typically, MOS devices will be used for those portions of a system where low power and/or high density are required. In very large systems particularly, the predominant high-speed portions are likely to be implemented with faster MECL or TTL logic, with lower speed storage functions being assigned to MOS memory devices. Interface problems, therefore, take on considerable importance.

Interfacing between different MOS and bipolar circuits varies in complexity. Some low-threshold MOS processing permits MOS and bipolar devices to coexist without any special supplementary circuits. With others (as with some dynamic shift registers) a combination of clock drivers and voltage-level translators is the price of effecting a compatible union.

Two following device discussions represent the extremes of MOS-bipolar circuitry interface requirements. The high threshold, metal-gate, static register demands level translation at the input and output, as well as clock generation. Comparatively, the low-threshold silicon-gate dynamic circuit requires only clock generation. Somewhere between lie most of the possible interfacing combinations.

INTERFACING WITH HIGH-THRESHOLD MOS

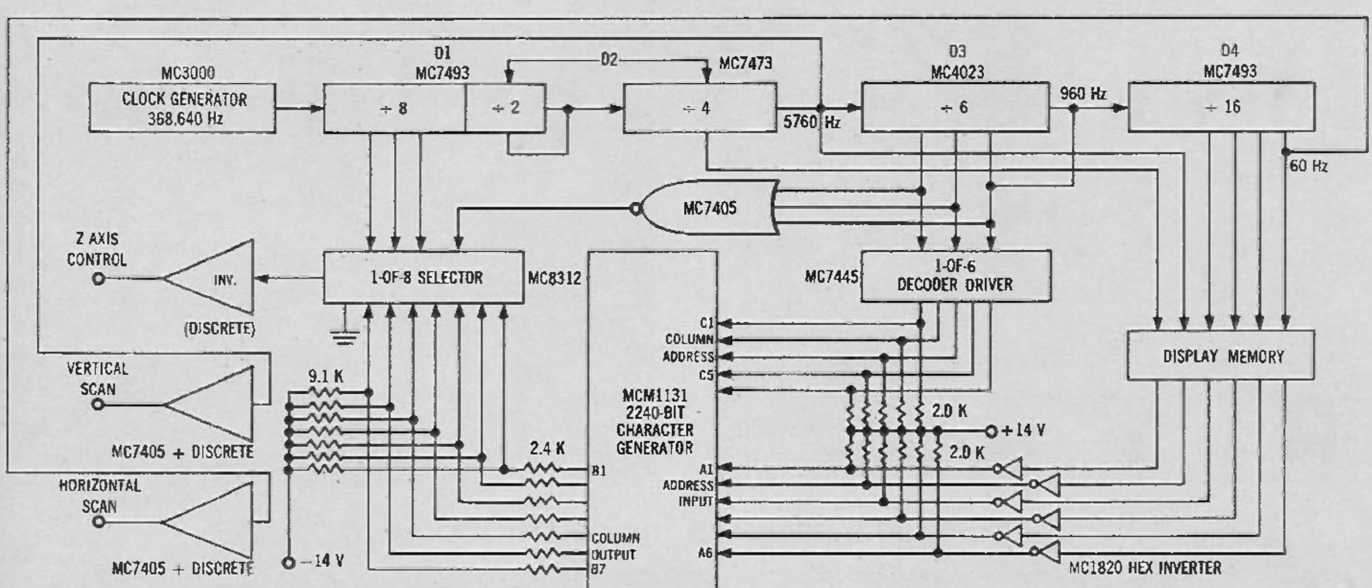
The MC1160G dual 100-bit shift register is a high-threshold device with the negative logic 1 level specified as at least 9 volts below Vss. The clock input voltage is specified as at least 25 volts below Vss. This high clock pulse amplitude is used to achieve the maximum circuit speed.

In a typical interface application, where the shift register is driven with bipolar logic, the required high operating voltages are achieved by setting Vss at + 14 V, VDD at ground, and VGG at − 14 V. This allows the use of high-voltage, open-collector DTL or TTL gates as input voltage-level translators. In a typical system of this type, the 5-volt signal levels of conventional DTL and TTL integrated circuits are converted into the necessary high-voltage drive signal for the high-threshold MOS shift register by means of an interface inverter. In turn, a line receiver or resistor divider converts the high-voltage output of the shift register to the 5-volt logic range of DTL and TTL designs.

To obtain the 25-volt (or higher) clock signals, $\phi 1$ and $\phi 2$, the clock drivers are required to swing from + 14 volts to − 14 volts. Any non-overlapping clock generation scheme which assures a clock OFF time of greater than 10 ns but less than 10 μs is suitable.

INTERFACING WITH LOW-THRESHOLD MOS

The MC2380 is a "bipolar compatible" silicon gate dynamic shift register similar in size to the MC1160. The threshold voltage is low enough so that the same operating and signal levels can be used as with bipolar saturating logic. A pull-up resistor should be used with the TTL driving



Character Display System

the shift register input to insure that the totem pole output of the TTL circuit will be pulled above the MOS threshold level.

The output transistor of the MC2380 shift register is an open drain device, tied to Vss, with sufficient drive capability to interface directly with one TTL load.

MOS MEMORIES

The unique attributes of the MOS technology lend themselves ideally to semiconductor memories. One of the first major uses of MOS in this category has been in read-only memories (ROMS), which have become available as off-the-shelf products in impressive numbers. Interesting examples of these are the standard Motorola MCM1131 column-select and the MCM1121 row-select 5 x 7 USASCII character generators.

A character generator generates the voltage patterns (of "1's" and "0's) needed to form numbers, letters and symbols to be displayed in a 5 x 7 dot matrix on cathode-ray tubes or 5 x 7 LED arrays. Each of the specific patterns for 64 different characters is stored at specific addresses in a 2240-bit ROM with each character occupying a 35-bit matrix in the memory. When the 6-bit address code associated with a particular character is applied to the six address lines (the 6 bits define 64 USASCII characters) it is decoded by an address decoder that selects the associated 5 x 7 matrix in the memory. Then, when one of the five columns of that matrix (in the "column select" version) is energized, a "word" of seven parallel bits corresponding to that particular column appears at the output. The five columns of the matrix are sequentially energized to provide a five-word sequence of seven parallel bits per word for each character selected by the address inputs.

THE INTERFACING

Of the various circuits used in the illustrated display system, only the character generator itself is an MOS device. All the others are either TTL or DTL circuits. Voltage-level translation is required at the interface points.

In this system, the first interface requirement is between the character generator, with its zero-to-14 volt output swing, and the 1-of-8 selector with its zero-to-5 volt input requirement. To simplify interfacing, the generator outputs are open-drain FETs that permit the use of external pull-down (load) resistors. The pull-down resistor at each output is a pair of series-connected resistors going to the – 14 V supply. The inputs of the TTL 1-of-8 selector are connected to the junctions of these series resistors.

The simplified schematic of this arrangement is shown for both MOS to TTL and TTL to MOS interface. In operation, when Q1 is cut off, a negative voltage appears at point A. This causes diode D1 to conduct and clamps the voltage applied to the emitter of the TTL input circuit to one diode drop, or –0.7 V. This is recognized by the TTL gate as a "zero" which defines a space, or "no dot." If the input to Q1 is negative, the FET is turned on. The voltage at A, therefore, increases to a positive (+) value between 2.5 volts and 4 volts, above the TTL input threshold.

The point is, however, that the high-voltage signal at the output of the FET has been translated to the reduced voltage swing needed at the input of the TTL circuit. The COLUMN SELECT inputs to the character generator likewise need level translation – from the low TTL output voltages to the relatively high drive voltages needed by the MOS circuit. This is achieved by the high voltage open collector DTL and TTL circuits mentioned earlier. ●

We won't compromise on quality

But you can compromise on price

Garrard's Zero-100 is a product of superb engineering.
It costs over £50.
You needn't compromise if you can't afford it.
The same unsparing attitude to precision is behind the AP76
at about £29 and the SP25 Mk III at under £17.
And there are other Garrard decks costing more or less.
They are in the finest 'ready-made' Hi-Fi systems.
Or you can put them in yourself.
Either way you can't lose, if it's a Garrard deck.
Send now for range brochure.

Garrard
A PLESSEY QUALITY PRODUCT
Garrard, Newcastle Street, Swindon, Wiltshire

Bases illustrated available July 1972

BREAKTHROUGH

IN BRAIN X-RAY

COMPUTERIZED TRANSVERSE AXIAL TOMOGRAPHY

— an exciting new approach to diagnostic radiography with a world-wide impact on clinical investigations and medical research on brain diseases and disorders, has been devoloped by EMI

This unique system has a discrimination sensitivity 100 times that of conventional X-ray techniques and reveals, in visual detail and with precise location of the disorder, information on brain conditions unobtainable hitherto by other means. It is the only satisfactory method for detecting minute variations in soft tissues of the brain which would be beyond the capabilities of other techniques and presents the vastly increased information in an accurate three-dimensional form.

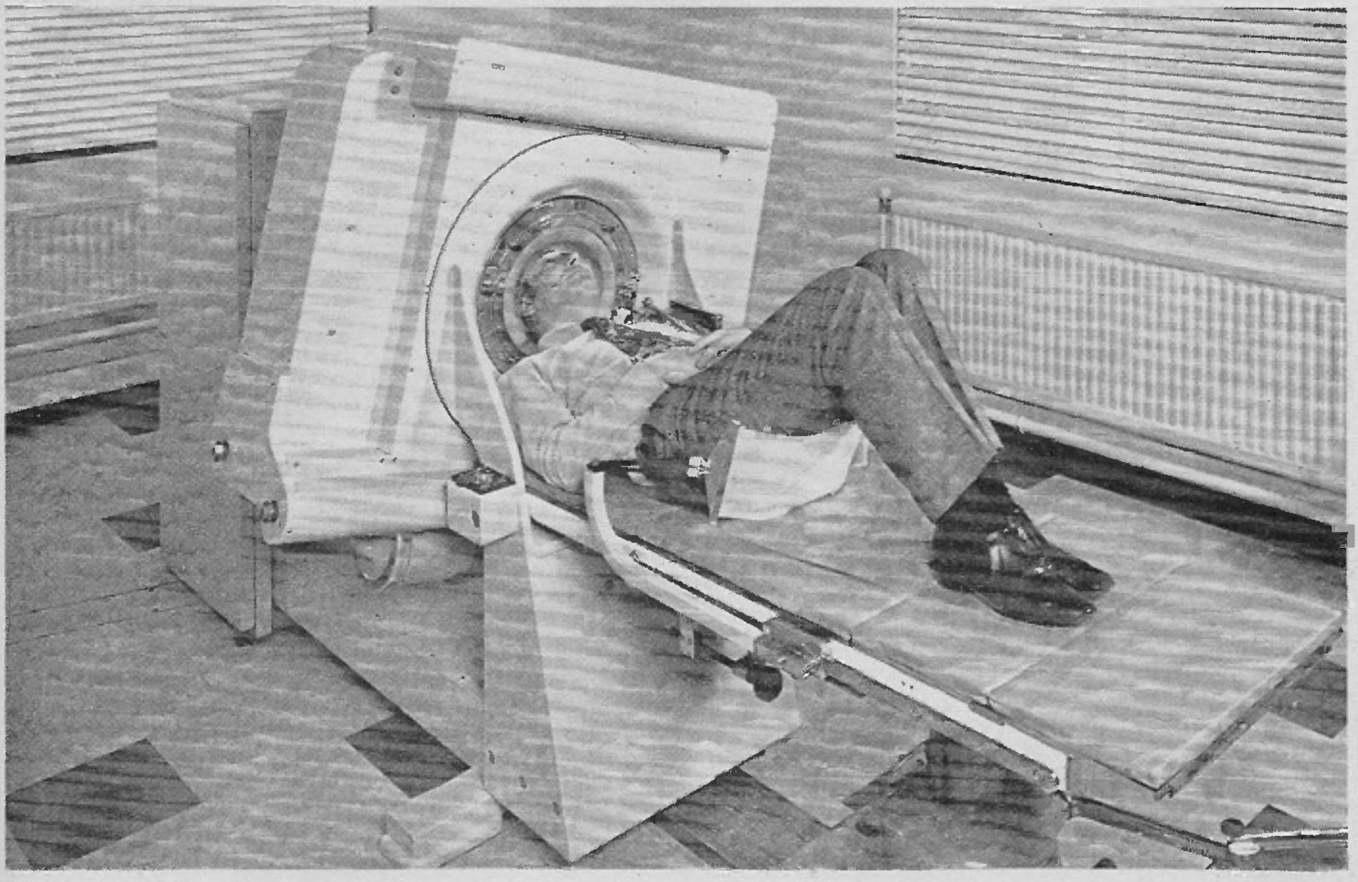
The system avoids the limitations of conventional radiological methods (see the detailed list), causes no discomfort to the patient and, for clinical and research centre managements, presents undeniably cost-effective advantages.

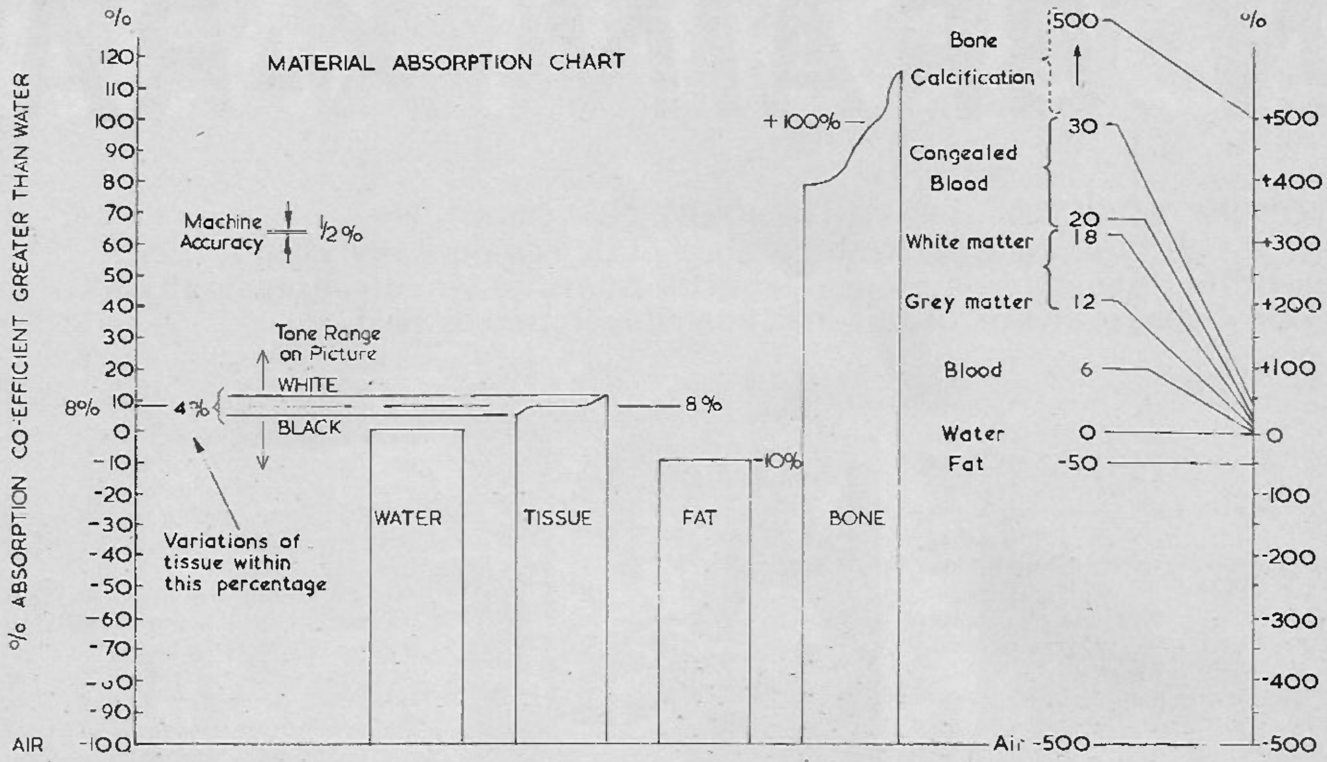
It gives the diagnostician accurate information on the nature and location of diseased or damaged tissue, revealing features (such as grey and white matter) impossible to discriminate by conventional X-ray techniques. Patients can be screened at the rate of four per hour and do not require any of the medical preparations demanded by other methods. The system is ideal for use on out-patients and as a first-line diagnostic tool on suspect cases without making demands on hospital beds or skilled medical staff. It requires only a single operator with little or no medical knowledge.

For the patients, the system eliminates the principal physical and psychological discomforts which have been unavoidable with most other techniques, such as injections, anaesthetics or hospitalization. The radiation dose received by the patient is no greater than that for a conventional X-ray picture.

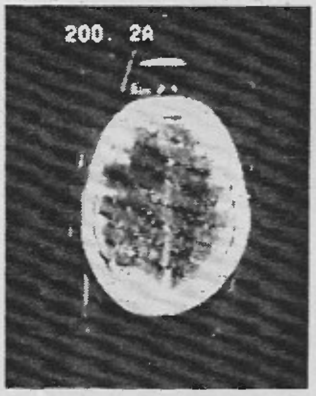
By using computer techniques to help overcome the inefficiency of conventional X-ray methods, it is able to give accurate records of tissue detail for the majority of

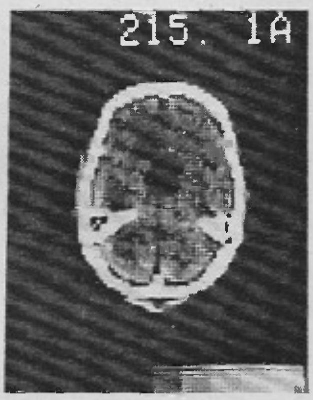
Godfrey Hounsfield who invented the system and headed the three-year programme by the Central Research Laboratories of EMI, with the support of Department of Health & Social Security specialists based at St. George's Hospital, Wimbledon, where, in the neurological and neuro-surgical units, this patented system has been installed for the past six months and has undergone successful evaluation.





BREAKTHROUGH IN BRAIN X-RAY





Illustrations on the right show some of the disorders revealed in detail by the system

Disadvantages of present methods

CONVENTIONAL X-RAYS

Insufficient sensitivity to discriminate between tissues of slightly differing densities. (As shown in the chart the absorption coefficient range between fat and tissue is only 18% wide, and the range for all types of soft tissues is a mere 4% wide.) Also confusion caused by presenting three-dimensional information on a two-dimensional photo, the dense bone-tissues and variations in skull-bone thickness obliterating soft-tissue details. Hence the realisation of only about 1% of data potentially available from the photo record.

ANGIOGRAPHY

Requires patient to be anaesthetised, contrast-media injected into the arteries of the neck, and X-ray photos taken of the head. Abnormalities in vascular pattern are interpreted for causative lesions. Attendance of highly skilled staff needed. Process most uncomfortable to patient; hospitalization required before and after; accompanied by a certain morbidity.

VENTRICULOGRAPHY (Pneumography or "Air-Study")

Requires patient to be anaesthetised, air (or gas) injected into the central ventricular system by lumbar puncture or via burr-hole in skull-bone, and positioning the head to make the injected air occupy various parts of the vascular system to study contour anatomy or structure displacement. Lengthy procedure with risk of serious complications, always accompanied by some morbidity. Demands skilled medical attendance.

RADIO-ACTIVE ISOTOPE BRAIN-SCAN

Requires injection of patient with a small amount of radio-active material which will accumulate in abnormal tissue areas (tumour, abscess, haematoma, etc.) or certain chemicals for selective absorption by certain types of tumours. Mechanical scanning with a collimated detecting device takes 25 minutes, the result plotted on a photographic plate; alternatively a gamma camera can be used. Limited to (though very good for) areas served by blood. Little discomfort to patient but process is slow and risks due to radio-active accumulation in the body not fully determined.

complaints covered by present radiological methods.

In 1969, EMI began investigations into the use of computers for more complete, precise and useable presentation of data which, in their original form, were difficult to interpret. It was realised that, in certain applications, large amounts of data which would otherwise have been discarded could be recovered by the use of computer techniques and made to yield useful information.

One such important application was medical radiology. With the full support of the Department of Health and Social Security, a laboratory machine was developed to present X-ray information more efficiently. Satisfactory initial evaluations led to the development of a clinical version for diagnosing, investigating and precisely locating in the head, the presence of cerebral disorders and diseases such as tumours, cysts, haematomas (haemorrhages), lesions, atrophy, etc.

Prior to the development of the EMI machine, the radiological methods commonly used for cerebral diagnoses did provide valuable information but there were practical and/or economic limitations as can be seen opposite.

THE HEAD-SCAN SYSTEM

With the new EMI system, the scanner rotates around the orifice in which the patient places his head in a rubber cap. Note that the patient is comfortable, relaxed and is wearing ordinary attire.

A viewing unit (illustrated on these pages) allows the operator to vary the black and white levels to cover a small range anywhere in the picture and to expand the range of numbers between "black" and "white" to cover the full range of tones seen on the display. The "Window Width" control indicates the numbers obtained on the print-out and allows specific levels of absorption coefficients to be emphasized selectively so that minute variations in absorption may be studied in detail.

Some of the picture records shown alongside are low-density disorders only revealed in detail by the EMI X-ray technique.

HOW THE SYSTEM WORKS

The equipment combines the speed and accuracy of a digital computer with highly sensitive X-ray detectors, and takes X-ray pictures of a three-dimensional body as a series of slices. The Head-Scan machine rotates around the patient's head, taking 56,000 readings from a narrow beam of X-rays passing through the head and examining two adjacent tomographic slices of the brain, each approximately 1 cm thick, in one four-minute scan. The readings are digitized and fed to a computer which, by solving some 28,000 simultaneous equations on the readings for each slice, calculates the absorption coefficients of the material in the slice to a very high order of accuracy and builds up the result as a 25,600-point (160 × 160) picture matrix where each point covers a $1\frac{1}{2}$ mm sq area in the slice.

For general clinical work, a resolution of 6,400 points (80 × 80 picture matrix) has proved quite adequate, with each point covering a 3 mm sq area.

Visual display of results is by pictures on a CR tube for direct examination and for recording on Polaroid film. Computer print-out of absorption coefficients at each point is also available, to provide detailed information on the atomic number and tissue density at each matrix-point, representing an additional aid to diagnosis.

Variations in absorption coefficients of soft tissue, too small to detect precisely till now, are easily indicated and quantified.

FURTHER POTENTIAL

With growing experience in this new technique, a marked reduction is forecast in the need to resort to the more costly, cumbersome and complex conventional methods which involve far greater discomfort to patients. In the short evaluation period in direct clinical use, it has already opened up vital new possibilities in medical research.

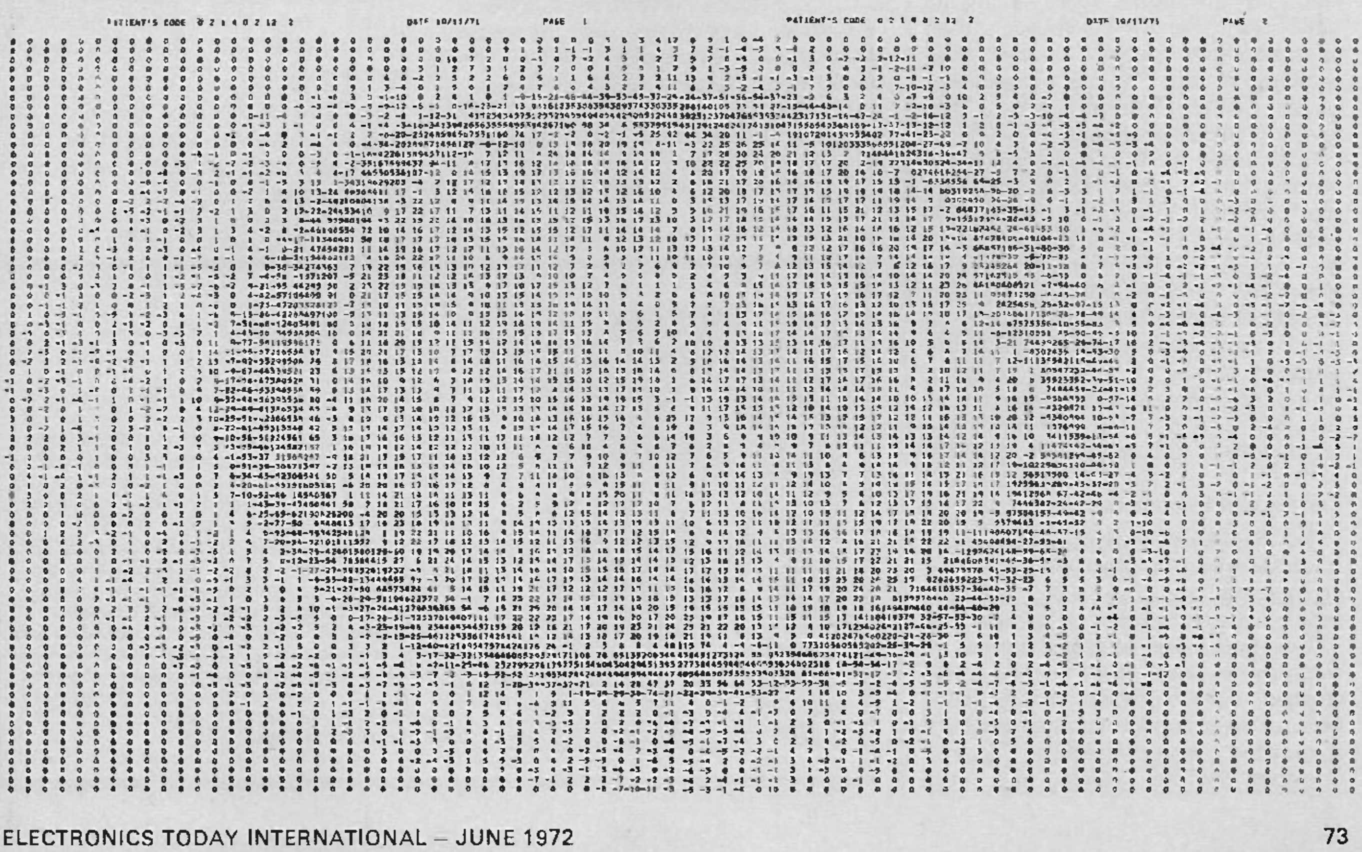
The price of the units will range from £50,000 to £100,000 depending on the degree of sophistication required.

Ten units are at now being assembled at EMI's laboratories and firm orders have been received for at least two of these.

A world market of two or three hundred machines is anticipated.

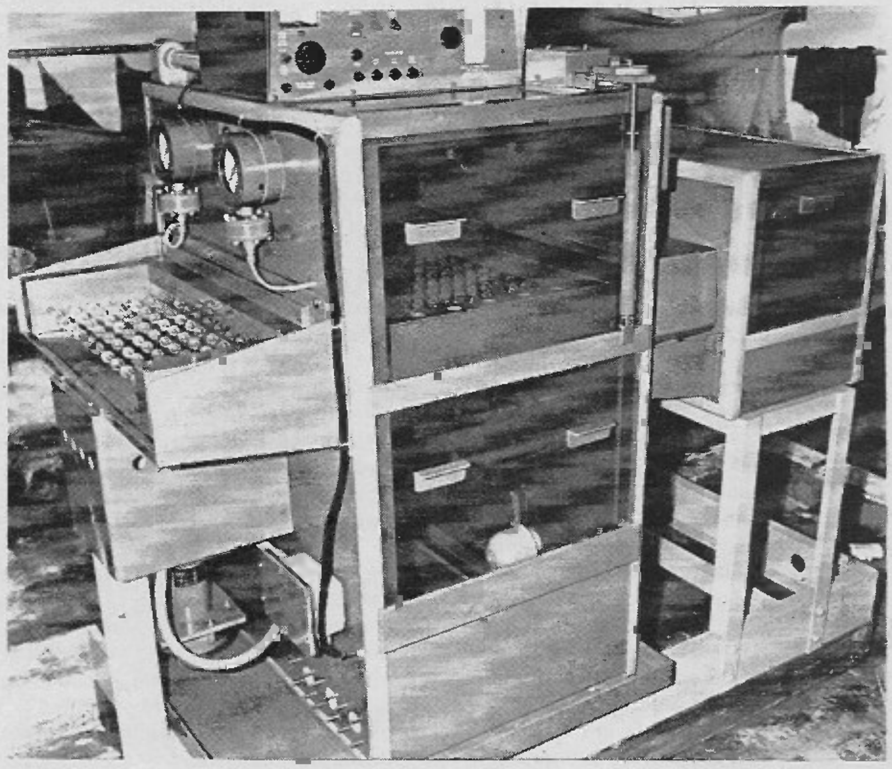
The computer used in the first prototype was EMI's own ICL 1905. But the intention is to sell the unit complete with its own mini-computer – possibly a PDP12 or equivalent 24 K store machine.

Below is a numerical print-out. Note that the pattern of numbers is a graphic impression of the indicated slice. The numbers are proportional to the absorption coefficients of the material scanned and, as a function of the atomic number and density of the material, indicate the nature of the material and facilitate precise diagnosis.



PRINTED CIRCUITS

Continued from page 25



Spray cleaning machine speeds up manufacturing process.

The sequence of operations is somewhat different from other types of boards discussed (Fig. 5). The base laminate is first drilled and then plated. By immersion in a series of solutions the entire board, including hole walls, is first cleaned, then conditioned to accept a catalyst, then catalysed, and finally chemically plated (without current) with a thin layer of 'electroless copper'.

This layer is then built up with electroplated copper to a thickness that provides the thin electroless layer with a degree of stability. The rest of the process proceeds much as with plate and etch boards, except that additional copper is electroplated onto conductor tracks and hole walls in the so-called Stage II copper plating, which takes place after printing or resisting, and prior to plating of the metal to be used as etchant stop-off.

Testing and tolerances

The manufacture of printed circuits is an exercise in precision repetitive engineering and, as such, requires sophisticated controls throughout.

The importance of close control of incoming artwork has already been stressed, but 'in-process' control must be equally exacting. Tooling must be inspected and checked against drawings before being put into production. Drilled boards are inspected 100% for missing holes or extra holes. Printed and resisted boards are inspected 100% and touched up before etching or plating. Close controls on plating solutions and etchants necessitate an in-house laboratory, preferably with the facilities of testing metal thicknesses by microsection and also by non-destructive means. All of this, plus a close final inspection to ensure that the printed circuit meets the dimensional tolerances required, make its quality control and inspection as significant a part of its successful production as almost any product that could be named.

Future of printed circuits

The immediate future of the printed circuit industry is obviously secure, and new techniques are being developed continually.

Even in the less highly-developed countries, flexible circuits on very thin laminates are already being manufactured in quantity.

Multilayer circuitry technique is also coming into general use. This technique laminates together the equivalent of several double-sided circuit boards into a single board with up to 12 layers and more. Through hole plating techniques provide the interconnections from layer to layer.

With multilayer technology in hand, it will be a simple step to flushed circuits where conductor lines are recessed into the board, flush with the surfaces, to provide a smooth running surface for switch contacts.

As for the industry overall, experts' reports are optimistic. Alfred T. Batch, special features editor of 'Electronic Packaging and Production', in an article in the December 1970 issue entitled "What's Ahead for Printed Circuits?", asks the question: "Think that microcircuitry and IC proliferation will spell the end for printed wiring?"

He answers his own question: "Not so . . . only the character of the PC has changed, while its dollar value overall has increased."

Brian Bork, the author of this article, is currently employed as Technical Manager of Tecnico Electronics' printed circuit department in Australia. Since receiving his Bachelor's degree in Chemistry from the University of Wisconsin in the U.S.A., he has spent seven years working in printed circuit technology.

At Siemens AG in Munich, Germany, he spent four years in the R. & D. Section, concentrating primarily on plating problems related to printed circuits and multilayers. Immediately before migrating to Australia just over one year ago, he was employed by the Allen Bradley Co. in Milwaukee, Wisconsin, U.S.A., where his time was split between managing the printed circuit prototype section and research into thick film technology.

FARADS GALORE

Continued from page 11

may still be acceptable. For example, when charging current is limited to 10 μA, the charge time is 25,000 seconds. When the discharge current is limited to 1mA, reset time is 250 seconds, only 1% of the time interval and quite acceptable in many applications.

When a more rapid reset time is needed, the timed period may be made equal to the *sum* of the *charge and discharge* times. In this case, the circuit is held in the required state as long as the ESD is charged *above zero* (see Fig. 1-c). In this type of design, the ESD is completely discharged and the time delay before the next period begins is a function of the system's logic speed.

Figure 2-a shows how the ESD, an op-amp and a few components can be used to make a free-running multivibrator with periods ranging from a few seconds to several *million* seconds. When power is first applied to the circuit (with the ESD fully discharged) the op-amp output V_{out} will be positive. Diode D1 is forward-biased so voltage V_{ref} (greater than zero and less than 500 mV) appears at the non-inverting input.

The ESD then charges from V_{out} (positive) through R3 at a constant-current rate I_{ESD}. Maximum I_{ESD} is 1mA and circuit values should be adjusted so $(V_{out} - V_{ref}/2)/R3$ is less than 1 mA. When the voltage across the ESD — appearing at the inverting input — is more positive than V_{ref}, V_{out} changes from positive to negative. This reverse-biases D1 and the voltage at the non-inverting input drops to zero. The ESD is then discharged from the negative V_{out} through R3. When the voltage across the ESD becomes more negative than zero, the op-amp again switches state — going from negative to positive (the starting condition) and the cycle repeats.

Thus time t1 = time t2, and if V_{ref} = 500 mV:—

$$t1 = \frac{C\ V_{ref}}{I\ (ESD)}$$

Thus with C = 0.01 farad

I_{ESD} = 1 mA

V_{ref} = 500 mV

t1 = 5 seconds.

When using the same ESD and setting I_{ESD} at 10μA the time increases to 500 seconds. By using higher ESD values and charging currents around 10μA, times up to 2½ million seconds can be reliably produced.

The circuit in Fig. 2-a provides symmetrical output (t1 = t2). Figure 2-b incorporates changes to permit the op-amp to operate from a single power supply and to provide asymmetrical output. The ratio between t1 and t2 can be as much as 100,000:1 with either t1 or t2 being the greater, depending on the input bias current of the op-amp.

The ESD is not as yet available in Britain. The eight types covering six capacitance values are US$30.00 each with a minimum order of three pieces. Orders may only be placed with the U.S. manufacturer: Gould Ionics Inc., PO Box 1377, Canoga Park, California 91304. ●

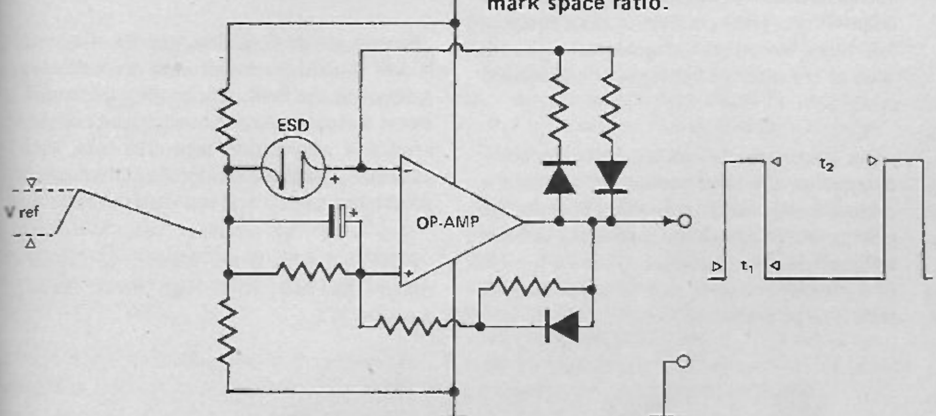


Fig. 2b. This version of ESD timer uses only one power supply and has variable mark space ratio.

ON IN JUNE:

COMMUNICATION '72

THAT long-awaited event — a British communications conference and exhibition — will be opened on June 13 by Earl Mountbatten of Burma.

Communication '72 is something for which the more far-sighted members of the industry have been calling for some time now. They proved to the sceptics that such an exhibition could succeed with Telecom '71 in Geneva.

Now it looks as if this success is to be repeated in Brighton in June, for so far there are already 100 firms presenting papers and exhibiting. These include such internationally well-known names as Pye, Racal, Cable and Wireless, EMI, Farnell, Ferranti, Hawker-Siddeley, Honeywell, Hewlett-Packard, International Aeradio, ITT, Motorola, Mullard, Muirhead, Murphy, Plessey, Rank, Redifon, Rhode and Schwarz, S.E. Labs Siemens, Solartron, Sperry, Storno, Texas, Ultra, Wayne Kerr and many more.

In March the organisers announced that the call for papers had brought in more than 66 papers, of which they could only squeeze in 33. As it is, these lucky 33 are to come from Germany, Italy, Switzerland, USA, Ireland and Britain.

Every day will have its "highlight" paper — each of which will come from a Government department or the Post Office.

On day one the Post Office will talk on data communications, day two goes to the Home Office, who will talk about point-to-point communications and mobile radio. Day three belongs to the Ministry of Defence, who will talk on military radio communications.

Although this gives some idea of the scope of Communication '72, also on show will be test equipment and some of the latest developments in components.

Due to the terrific response from potential exhibitors, the organisers — ETV Cybernetics — have had to open up extra hall space to accommodate them all.

EQUIPMENT NEWS

RACAL-THERMIONIC CLAIM DIGITAL CASSETTE BREAKTHROUGH

A technical breakthrough in digital cassette recording on magnetic tape, with high speed incremental read and write capabilities in both directions, is available for the first time in the UK. Racal-Thermionic Ltd., the Hythe-based data recording specialists of the Racal Electronics Group, introduce the new P1.70 digital cassette recorder, economically priced and offer immediate delivery from stock.

Said to be suitable for all applications where a paper-tape punch and reader is used, the P1.70 offers such features as programmable speeds in the continuous mode, absolutely silent operation, and simple interfacing.

The P1.70 uses a standard C.60 cassette with certified tape in an exceptionally easy-to-load carrier. This unique instrument provides a 9-bit parallel input/output and is said to have a maximum storage capacity for incremental working of 50,000 9-bit characters, operating at speeds up to 40 characters per second in this mode. In the continuous mode a cassette will hold 100,000 9-bit characters and will operate at speeds up to 800 characters per second.

Further details from Racal-Thermionic Limited, Hythe, Southampton, Hants. SO4 6ZH.

AUTOMATIC LEVEL MEASURING SYSTEM

The ever-increasing demands on the quality of telecommunications transmission systems require the use of high-precision measuring equipment. Moreover, the measurements should be made in the most simple, exact and time-saving manner, if possible even automatically.

Available now is a fully automatic level measuring system, introduced by Wandel & Goltermann (UK) Ltd., Acton, London W3.

Known as the PA-4 system, the basic instrument is a level measuring set which allows high-precision, absolute and differential level measurements in the frequency range 200 Hz to 2 MHz. The frequency ranges covered are the voice channels, basic primary and basic secondary groups, as well as carrier frequency systems with up to 300 voice channels.

The set comprises three sub-assemblies: a level generator, a selective level meter and a decadic control oscillator. The level generator and level meter can be synchronously tuned from the control oscillator, so that selective level measurements can be carried out both easily and rapidly.

Measuring is not limited however to carrier frequency technology but can also be used for a great number of other measuring tasks in other technological spheres, such as on selective networks or modulated systems.

The automatic system is formed by complementing the level measuring set with a programme control unit which extends the system to allow both the measuring process to be carried out automatically with the aid of a programme tape, as well as for the test results to be evaluated.

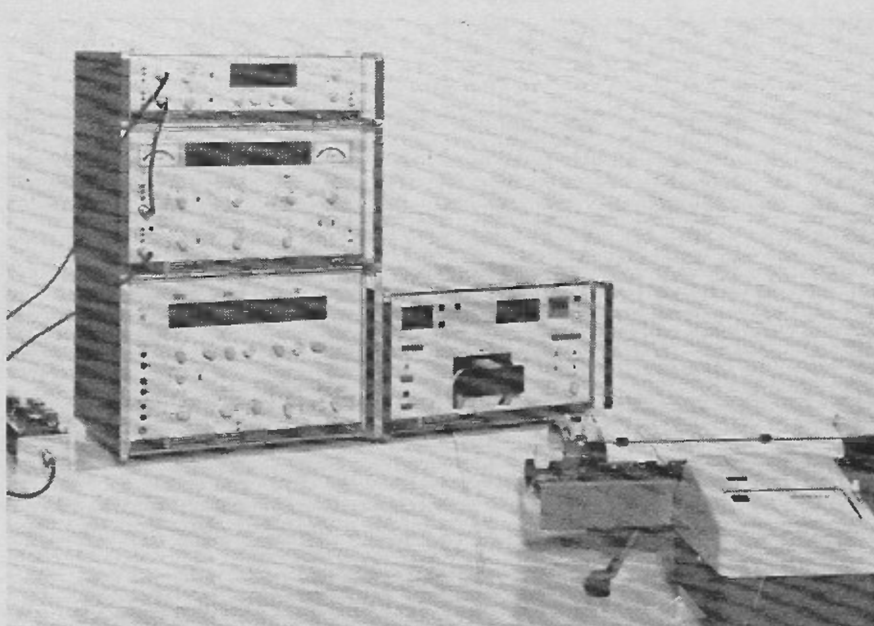
With the aid of further accessories, such as a scanner MU4, reflection coefficient meter and external recording instruments, the automatic measuring system can be matched to a variety of measuring tasks.

In order to illustrate how a considerable time-saving can be be achieved in production and test departments, it is possible, for instance, for the necessary acceptance tests (including printed protocol) of a group filter to be carried out in two minutes, whereas the same measurement would take approximately two hours using conventional manually-operated measuring instruments.

The test point number classification or a tolerance violation are directly indicated on the front panel of the control unit. These results can, however, also be protocolled in a clear, tabular form using external teleprinters, electric typewriters, tape and cardpunches which are used with the aid of an output coupler.

Because of its flexibility, the PA-4 system is not limited to monitoring transmission systems in the field of telecommunications, but is suitable also for other high-precision level and attenuation measurements, such as are required in development laboratories production plants and test departments.

Further details from Wandel & Goltermann (UK) Ltd., 40-48 High Street, Acton, London W3.



DIGITAL MULTIMETER WITH LED DISPLAY

Dana's newest digital multimeter, Model 4300, is their first with light-emitting diode display. The 5-digit number display module – one digit for 100% over-ranging – is a plug-in unit that has the facility of adjusting its own brightness according to ambient light level. The instrument is mains or battery operated and another built-in feature is that at the touch of a switch it will read out its own battery voltage. Consultation of a chart provided gives expected battery life. Should the battery ever run completely down after, for example, eight hours' continuous operation, it will recharge itself in 16 hours while the multi-meter is being operated from the mains. There is also an automatic cut-off when recharge voltage is reached, to ensure against doubtful readings and to protect the battery against over-charging.

There is built-in protection against incorrect range and mode combinations, and overload protection up to 250 V when making ohms measurements, and up to 1,000 V on both ac and dc scales. The 4300 is said to be almost unbreakable physically. It has a case moulded in high-impact plastic, and will withstand far greater shocks and g forces than previous instruments of laboratory standard.

Accuracy quoted by Dana is ±(0.03% R +0.01% full scale) for dc over 30 days. Additional accuracy specifications for all modes of operation, are provided by the makers for six and twelve months. There are five ranges of dc including a 100 mV range, four ac and five ohm ranges. All redundant zeros in the display are automatically suppressed. Accuracy of measurement from high-impedance sources is ensured by a remarkably high input resistance: 1,000 megohms. Switching from 115 V to 230 V mains operation is provided at the back of the case.

Further details from Dana Electronics Ltd., Bilton Way, Dallow Road, Luton, Beds.

PASSIVE NIGHT TELESCOPE

A night viewing telescope for military, police and civilian security use has been developed by Barr and Stroud using the latest ITT image intensifier technology.

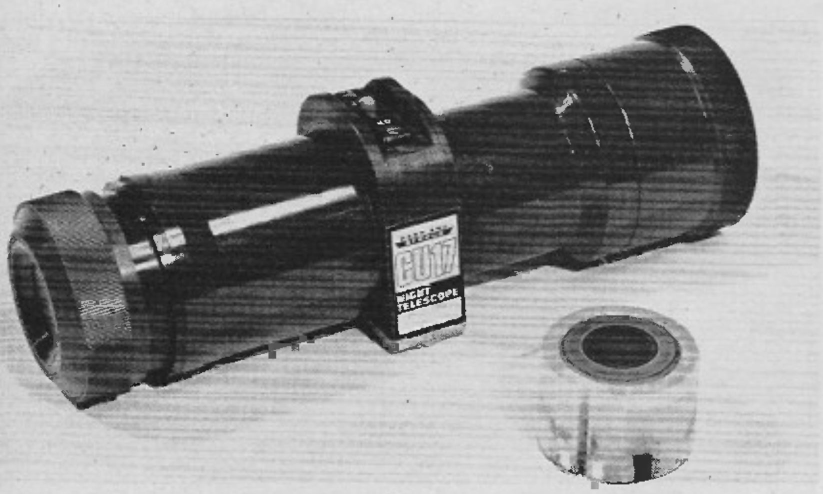
Designated the CU17, this small, compact and self-contained device uses an F4747 image intensifier supplied by ITT Components Group Europe to give a passive viewing capability down to starlight conditions (10^{-3} lux).

This image intensifier uses a channel plate amplifier matched to an input photocathode and output phospher to give maximum luminous gain and to keep the image free from loss and distortion across its whole area.

The F4747 uses proximity focusing and has major advantages in size and weight over conventional 3-stage cascade image intensifiers. Proximity focusing also results in a shorter length than could be obtained with an electrostatically-focused channel plate image intensifier.

Barr & Stroud's CU17 telescope has an overall length of 23 cm and weighs less than 1 kg. With a 10° field of view and optics giving a ×4 magnification, the telescope can detect a man at 250 m under starlight conditions. A single 2.7 V military-type dry battery provides up to a week's use under normal operational conditions.

Further details from Standard Telephones and Cables Ltd., Edinburgh Way, Harlow, Essex.



DIGITAL PANEL METER

Daystrom has developed an economy digital panel meter which is said to be priced competitively with analogue instruments. The new Model 1260 is a 2½-digit unit.

To achieve a design with a low selling price requires an approach having the simplicity of dual slope integration but with considerably fewer components. To satisfy these requirements Daystrom engineering developed a novel voltage-to-time converter capable of being packaged with its complete power supply and readout on a single side of a printed circuit board, having approximate dimensions of 4×3 ins. This new circuit achieves the cost objectives without, it is claimed, sacrificing high normal and common mode rejection with a non-blinking readout.

The Model 1260 fits into 7 square inches of panel and mounts completely from the front of the panel. The entire chassis pulls out from the front, for servicing operation. Standard features include ±5% F.S. ±1 digit accuracy and a circularly polarizing window filter. Special features such as BCD output, remote hold and special captions can be supplied on order.

Further details from Daystrom Schlumberger, Bristol Road, Gloucester GL2 6EE, England.

EQUIPMENT NEWS

NEW DANA INSTRUMENTS

Dana Electronics Ltd. are launching five new products, headed by a YIG fully programmable frequency counter that will give continuous automatic measurements from 20 Hz to 18 GHz. Other instruments are Dana's new Model 4300 digital multimeter with light-emitting diode display which adjusts its own brilliance automatically to compensate for changes in ambient lighting, the 4700 digital multimeter, a range of 8-digit counters, and a multifunction 5-digit systems DVM, Model 4800.

The new YIG counter is made by E.L.P. Inc., newly acquired by Dana. It has an 11-digit display, divided into GHz, MHz, kHz, and Hz for ease of reading, and has a read-out resolution of 1 Hz. Accuracy is ± 1 count $\pm$ the crystal time-base stability (claimed to be better than 5 parts in 10^9 for 24 hours).

The multimeter with LED display, Model 4300, has 5-digit display (one for 100% over-ranging) and is mains or battery operated.

The 4700 digital multimeter is an upgraded and improved instrument, to be sold at much the same price as the existing Model 4700.

The five instruments composing the new range of 8000B counters combine all the virtues of the Type 8000 and 7900 electronic counters. Various options are available to give customers the opportunity to have exactly the performance they desire, but at a lower cost.

Model 4800 is a systems multimeter, featuring 1 µV dc resolution, six ranges of 4-wire ohms measurements, and distortion-insensitive rms measuring facilities.

Further details from Dana Electronics Ltd., Bilton Way, Dallow Road, Luton, Beds. Tel: 0582 24236.

'TENPAC' SEMI-CONDUCTOR STRAIN GAUGES

Environmental Equipments Ltd. are offering an increased range of Tenpac semi-conductor strain gauges. Over 30 different types are available.

The principle of the gauge is a piezo resistive effect which is defined as the change of electrical resistivity of crystals with applied stress. In certain semi-conductor materials such as single crystals of germanium or silicon this effect is very large. Positive or negative gauge factors 50-100 times those of conventional strain gauges enable measurements of 10^{-2} microstrain to be accurately recorded. Whilst micro-miniature size (overall lengths of 1 mm to 5 mm are standard) will enable engineers to conduct exercises in stress analysis at levels previously not attempted.

The strain sensitive elements of Tenpac consists of extremely fine filaments sliced from single crystals which are grown under optimum control conditions at the Toyota Research Centre in Japan. Fine gold or silver lead wires are bonded to the filaments by a special process which eliminates stress concentrations caused by bonding which are often present in strain gauges of this type.

Backed or unbacked varieties for use in temperatures ranging from —30°C to +160°C and self-temperature compensated gauges with a zero shift of less than 1×10^{-6} strain/°C are available.

Further details from Environmental Equipments Ltd., Denton Road, Wokingham, Berks.

R.F. SIGNAL GENERATOR/SWEEPER

The modular concept used in the Farnell R.F. signal generator allows many combinations of facilities to be obtained with the minimum number of standard modules. It also means that it is no longer necessary to buy facilities not needed, but should the needs of the user change, the system can be extended or modified at a later date.

Design emphasis has been on electronic rather than mechanical techniques and thus size has been kept to a minimum. For instance, the attenuator utilises thick-film circuitry and reed relay switching, saving considerable space compared with conventional piston-type attenuators.

Perhaps more important to today's user, the Farnell signal generator is programmable and is suitable for building into automatic or semi-automatic testing and measuring systems such as is necessary to the large scale user of mobile radios, alert receivers etc.

Frequency coverage offered by means of four modules is from 400 Hz to 1.5 GHz. The system may be converted from signal generator to sweeper in seconds by changing one module and o.w. operation is still retained. Other new R.F. test instruments available include:

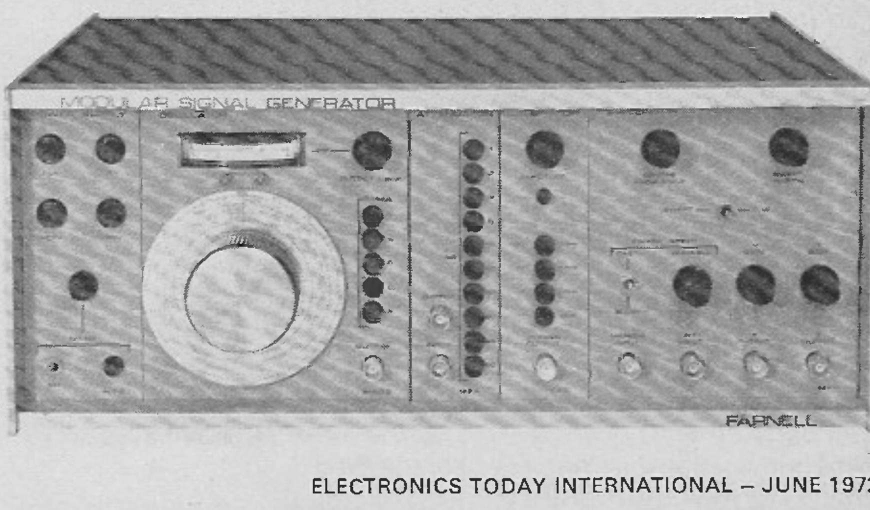
TM6 R.F. millivoltmeter which is a highly sensitive precision millivoltmeter for use at frequencies up to 1.5 GHz with useful indications up to 3 GHz. It displays rms voltages from 1 mV to 300 V fsd.

A new digital power meter. This new instrument has a frequency range up to 12.5 GHz and covers the power ranges of 10 µV, 100 µV, 1 mV, 10 mV fsd.

Programmable attenuator unit. Another new item is the attenuator module used in the Farnell R.F. signal generator but housed in a separate case with its own built-in power unit. It is for general use and manual control is from 0-122 dB in 1 dB steps. It is programmed by simply earthing any combination of 10 wires to give attenuation of 1 dB; 2 dB; 3 dB; 6 dB; 10 dB; 20 dB.

X-Y recorder. Added to the Farnell instrument range to meet demands arising from the sweep facility in the R.F. signal generator is a new X-Y recorder. Features include an 11×17 ins (A3 paper) flat bed; electrostatic holdown; disposable pens; guarded and floating inputs etc.

Further details from Farnell Instruments Ltd., Sandbeck Way, Wetherby LS22 4DH, Yorkshire, England.



BOOK REVIEWS

REVIEWER Brian Chapman

THE POPULATION BOMB, by Dr Paul R. Ehrlich. Published 1971 by Ballantine in association with Pan Books Ltd, London. Paperback. 141 pages $4\frac{5}{16}'' \times 6\frac{15}{16}''$. Price 30p.

Two books on the same subject by the same authors but different in style and approach. The first, "The Population Bomb" by Dr Paul R. Ehrlich is a paperback written in a very readable almost light style.

But Dr Ehrlich is the Professor of Biology and Director of Graduate Study at Stanford University and is an expert on the subject of ecology. The book is deliberately written in this way because Ehrlich is more than an author, he is an active campaigner for ZPG, the society formed to press for Zero Growth of the world population. His book sets out to convince and convert the reader to the society's viewpoint.

Despite Ehrlich's non-academic style, his message is serious. The world, especially the undeveloped world, is rapidly running out of food. We will not be able to prevent large-scale famines in the next decade or so and the only way to control the spread of famine is immediately to start world wide programmes of population control. Otherwise the world's population will continue to grow as long as the birth rate exceeds the death rate. The growth of population will cease eventually because food supplies and medical resources will run out. We will be unable to train enough doctors and nurses, nor provide enough services such as transport, power supplies and communication to meet the needs of the population.

And this will not only happen in countries like India. It will happen in the United States. It will happen here.

Ehrlich backs this argument with some very convincing facts and figures. He says that the two things which we can do to make the future a lot more secure for children and grandchildren is to decrease the world population and to increase food production. He has a lot to say about present methods of food production and the detrimental effects of DDT on the environment. He also discusses our present attempts at regulating the birth rate and points out the difference between family planning and population control.

Ehrlich has been lecturing on this subject for some time and seems to have encountered every possible argument against his proposal. He sets out his answers to these arguments in his book. Suggestions that we can farm the sea, cultivate the deserts, grow artificial food from petroleum, grow better quality food, migrate to another planet, all are possible in the future but too far in the future to be of value in the present crisis. Nine years is all the time we have says Ehrlich before population increase outstrips our ability to produce food.

BEGINNER'S GUIDE TO TRANSISTORS by J. A. Reddihough. Published by The Hamlyn Publishing Group for Newnes Books 1968. 160 pages $7\frac{1}{4}'' \times 5''$, hard covers. Price £1.

As the title indicates, this is a book for beginners who wish to acquire a knowledge of the application of transistors.

The book opens with the usual sections on the operation and physics of semiconductor devices, basic transistor circuits and characteristics and then provides a reasonably extensive treatment of the operation of transistors in various types of circuitry. The explanations are non-mathematical and describe the operating principles rather than the design procedure.

The book is quite adequate for those who wish to gain a knowledge of transistors and transistor circuits but do not have a great deal of background in electronics.

RADIO, TELEVISION AND AUDIO TEST INSTRUMENTS, by Gordon J. King. Published by Newnes-Butterworths, London, 1972. 199 pages, $9\frac{3}{4}'' \times 6''$, hard covers. Price £3.80.

Originally published in 1962 under the title "Radio and Television Test Instruments", this new edition complements, without overlapping, the series of servicing handbooks by the same author.

Although it is possible in the main to make do with a screwdriver and a simple multi-meter, sooner or later the technician will be faced with a situation that demands the use of more advanced test equipment.

To use test equipment correctly, and to maximum advantage, requires a knowledge of the characteristics, operating principles and limitations of the instruments concerned. It is very easy indeed to come to a wrong conclusion by not understanding the measurement errors introduced by the instrument itself – for example, the error caused by loading a circuit with a low input impedance voltmeter.

Hence it is vital that users of test equipment gain knowledge of the intruments they intend to use and perhaps more importantly – methods of measurement. This book provides an excellent introduction to test instruments in general and the way to use them.

An introduction to instruments opens the book and is followed by sections on the application of dc and ac meters. The latter sections contain all the basics concerning various types, their use, shunts and multipliers and measurements of various physical parameters.

Following are sections on specific classes of instruments such as electronic meters, signal generators, oscilloscopes and then sections on instruments for valve and transistor testing, colour television and audio equipment.

The text is clearly and simply written and is well illustrated with circuit diagrams, pictures of instruments and waveform photographs, etc.

The book is very suitable for technicians and home experimenters wishing to advance themselves in the art of measurement in electronics.

RECORDINGS... CLASSICAL

REVIEWER, John Araneta.

SCRIABIN – Piano Sonatas Nos. 4-10. Roberto Szidon (piano) 2-DGG 2707 053.

This year being the centenary of Scriabin's birth, we have already had one complete recording of the Sonatas, a rather apathetic and non-magical performance from HMV. DGG assures us that Szidon will in fact be recording the sonatas complete, so that we shall soon have at least two complete sets to choose from and I doubt very much whether this set will be the last one to be put before the recording public. Well, yes, this performance is certainly to be preferred to Ogdon's. Szidon evidently sounds like he should be fond of these works. These are very acceptable performances, but they are hardly what DGG bills them to be: "The foremost exponents of Scriabin, Horowitz, Rubinstein, and above all Sviatoslav Richter, have now been joined by Roberto Szidon." Rubbish. Scriabin not only needs almost superhuman varieties of shade (which this performance really does not have) but also an almost neurotic nervousness to produce something like what the Romans liked to call "incantatio." The player's command of the resources of the pedal must be nothing short of magnificent. Szidon is, as yet, no Horowitz, or Richter, nor even a Rubinstein in this music. All one has to do is put on Horowitz's recording of the ninth sonata and the first few chords should be enough to convince one that Szidon is not in the same class. Far from it. There is no diablerie here, only plush. Perhaps some recording company should engage the services of Moravec for another complete recording.

DGG's album format is evidently designed for the occult inclined listener, with special billing for the "WHITE" and "BLACK" Mass Sonatas. And I have seldom seen a finer collection of pretentious claptrap for notes, including some of Scriabin's own rubbish: sample – "I will be the longing of all for the bliss of supreme fulfillment." Scriabin's own reflections on the occult and art are an unbelievable fluttering and plucking of this metaphysical bit, and that for a remarkable garbage of dilettante posturing. The sort of chatter that turned away a great number from any objective appraisal of his music. We, however, live in a day when this sort of nonsense might just help Scriabin along and DGG is doubtless economically wise to play with it. No, I must finally also admit that this is not the music I take to. I always feel, despite the remarkable harmonic novelties and the tremendous expansion of pianistic technique, that Scriabin simply never learned the virtue of economy, a word, by the way, that I do not necessarily associate with austerity or sobriety. Chopin, Debussy, even Liszt did it far better and with more discipline. Still, I can feel the music deserves reappraisal. It can be interesting, or at the very least, hypnotic and image conjuring. And it deserves much more than this good performance. – J.A.A.

PAGANINI – VIOLIN CONCERTO NO. 3. Henryk Szerying, London Symphony, Alexander Gibson (cond.) PHILIPS 6500175.

Another work the world would have been better without?

If this Paganini concerto had been as readily accessible as the numerous bad Liszt we are subjected to, there would perhaps be less to do about this trivia. And not very good trivia this is. There must be other more worthy violin concertos worth recording. A new recording of the Bruch Second?

But I may be wrong.

Paganini's first two concertos are always popular and they are as wretched as this one. Now that Henryk Szerying has been allowed the premiere and first recording of this work we have five Paganini concertos readily available on record. Why have sales of this record already been so good? Is it the romantic aura surrounding its having been kept captive, as it were, by the composer's descendants? I am more inclined to believe Paganini's astute spirit is still very much around after a hundred and thirty one years.

One must be taken by surprise at the virtuosity with which this work might be played, precisely because significant musical content is notably absent. It is not enough to sound good most of the time. One must astound. Szerying here is most successful in lyrical passages, although I feel he takes things too seriously. Technique in a concerto like this is the main thing. It is a mystery to me why a violinist like Heifetz has never recorded more Paganini. His approach may be cool compared to Szerying's but of his technique there can be no question. To hear him play two of the caprices on RCA LM-2382 is perhaps to experience what audiences must have felt when they heard Paganini. The two bands on that record are quite enough to convince me of the uniqueness of Paganini's achievement. We must wait for a more virtuosic performance of this concerto. J.A.A.

BRUCKNER – Symphony No. 3 (Nowak Version). Karl Bohm, Vienna Philharmonic DECCA XL 6505

Listening to this record makes me realize all over again how suitable the Vienna Philharmonic is to Bruckner, and especially the tone of its horn and brass. Nor is Bohm exactly a stranger to Bruckner's music. If memory serves, his Seventh was one of the earliest Bruckner on LP, although surprisingly not much has been heard since then. The general tendencies of that recorded Seventh are also very much in evidence here.

Like Haitink and Szell, Bohm uses Bruckner's third revision of the score (1890) as edited by Nowak. This version, while one of the approved scores and usually heard nowadays, nevertheless omits the various quotations of Tristan and Walkune in the first movement, quotations which emphasize this symphony's tribute to Wagner. Whether these excisions are really of importance I cannot really say. Unfortunately neither of the recordings (Jochum and Schuricht) which use the 1889 and second version of the score really measure up to either this or the Haitink and Szell all of which use the 1890 score. Bohm is particularly impressive in the first movement and seldom has the structure of this movement been so clearly put forward.

Once again it is hard to resist calling attention to the beauty of the orchestra's sound. An especially moving instance is the tranquil passage shortly before the development section. In general, Bohm's approach to this movement and the symphony as a whole is certainly more compelling than Haitink's, although there is a rather gentle quality to it all which I do not think exactly suited to this work. For instance, strong as this first movement is, there seems not enough tension, and the misterioso opening is hardly mysterious. Similarly, the second movement Adagio is much too easy going. Also, while Bohm's control in the first movement seems firm enough, he does tend to let things go here much to the detriment of the movement's continuity. Nor does the side break here help matters although in all fairness no other recording does without it.

The Scherzo has Bohm once more in firm control but one is again forced to reflect Bruckner's scherzos are seldom just naive. Bohm's fourth movement is perhaps the weakest part of his performance. Once again he leaves things a bit and everything just falls short of going to pieces. Nevertheless this is the most recommendable version of the Third available in this country, certainly preferable to either the Jochum or Haitink, and the recording here is quite fine.

For a more powerful account of this symphony, one that makes sense of the work as a whole and especially of that difficult final movement, one must look elsewhere. – J.A.A.

RECORDINGS... JAZZ

REVIEWER John Clare

LOUIS ARMSTRONG – Satch Plays Fats. French CBS 62441. Honeysuckle Rose. Squeeze Me. Keepin' Out Of Mischief Now, Blue Turning Grey Over You. I'm Crazy 'Bout My Baby. All That Meat And No Potatoes. I've Got A Feeling I'm Falling Black And Blue. Ain't Misbehavin!

In the fifties when I, in my teens, first began to collect jazz records, most jazz critics that I read seemed out to convince me that I had come along in a bad time. Everything good had already happened.

This was pretty confusing. I first heard the record under review about that time. Soon came Ellington at Newport 1956, then Ellington at Newport 1958 (with one of Hodges' greatest solos and the underrated piece, 'Princess Blue'). Diz Big Band had been released early in the fifties. Later we got Dizzy at Newport (which should have been called Greatness In Mad Ones). We got Miles Ahead, Porgy and Bess and Sketches Of Spain, not to mention Workin', Relaxin', Kind Of Blue and so on. Further: Louis Armstrong Plays WC Handy, Ambassador Satch, and I think that should be enough to get you thinking.

I still have all these recordings. They all stand up with the best jazz of any period, and in a couple of cases they sound fresher and more powerful than some famous earlier performances which have begun to take on a quality of fading glory. I take them out and play them quite often – so as not to allow them to sink back into some mythical and imperfectly remembered Golden Age with which I might be tempted to compare unfavourably everything contemporary, as I am sure did many of those critics who so confused my youth.

One of the culprits was a New Yorker whose fancy style hypnotised so many fellow writers into just not seeing such gems as the following:

"Since the mid-thirties, his (Louis Armstrong's) style, hampered by an inevitable lessening of physical power, has become a mixture of his first two periods – short, simple, declamatory phrases placed end to end with uncertain, empurpling sorties into the high register."

There is a great sense of completeness to this record. I don't think that Louis has sung much better than this, and his trumpet is nearly as good as on the WC Handy album (also available in Australia through Avan Guard). It's the best I've ever heard Barrett Deems play, and Velma Middleton is alright as a foil for Satch. Trummy Young is for me, always, a complete knockout. Taste Schmaste! I have to agree with the critics who said that Barney Bigard was not at his most scintillating. He sounds like some drunk quite blissfully on the point of passing out. This more than somewhat languid quality is heightened when he follows Trummy, who sounds like a draught horse charging out of its stable, kicking the door down in the process.

Although basically the accent is on the marvellous songs and the solo performances, there are a couple of quite magic ensemble moments, the best being on Ain't Misbehavin!

Listening to Louis' rich vocal texture and superb phrasing on Blue Turning Grey, and to the great breadth of sound he gets from his trumpet once he takes out that straight tin mute he occasionally uses (and which only makes his tone thinner and more nasal), I have often thought that this was the simple but deep satisfaction one should, but rarely does get from popular music. As popular music it's up with the best of Frank Sinatra or the Beetles. As jazz it may not reach the heights of pure invention of Armstrong's earlier masterpieces, but it is just as strong and involving. – J.C.

DUKE ELLINGTON – Masterpieces By Duke Ellington. French CBS Stereo S63838 Mood Indigo, Sophisticated Lady, The Tattooed Bride, Solitude.

Mood Indigo is really an excellent vehicle for an extended arrangement. It is a most unusual popular song in that it keeps developing rather than being contained within the usual eight bar repetitions, and thirty two bars elapse before the first strain is repeated in full. This beginning is played here in time honoured fashion – though not quite the way it was first played – by muted or very closed-toned trombone, clarinet and, I think, tenor sax, while in this case a barely audible muted trumpet etches in a kind of monotonal shading at the ends of the long tones.

Russell Procope playes the middle part and then the band takes it while he exits with a series of fervent hums and decorative flourishes. My main objection to the recorded sound is founded here in the hollowness they have given to his low register. Hodges plays a beautifully lyrical and restrained chorus, building in strength over the last eight bars. There is a splendid piano interlude, which sounds as though it just might not be Duke – in which case it would be Strayhorn, with whose work I am not familiar. There is a glorious moment when remote, stealing trombones begin to play the theme behind airy surges of saxes and clarinets, then depart from it, crossing and recrossing in some rich mysterious middle distance. Gonsalves at one stage oozes with his unique tortuous fluency through the ensemble for half a chorus.

Things fall off when the singer, who is listed simply as Yvonne, delivers her sultry and unremarkable rendition. They do not quite pick up again, though there is an interesting variation of the melody at the end.

Sophisticated Lady, beautiful and strange as it is, falls into quite conventional popular song form. This does not begin so interestingly, but ends much more strongly than Mood Indigo. Carney plays the first chorus, staying close to the melody but producing his usual magnificent ornamentations. Here again I am not keen on the way he has been recorded (or perhaps it is the rechannelling for stereo) – I couldn't make up my mind at first whether he was playing baritone or bass clarinet. It is the latter. Harold Baker also stays close to the melody, displaying his lovely green-golden trumpet sound. Joe Wilder is the only other player I've heard get that strange woodland tone, though Miles had a trace of it when he recorded Walkin' and Bag's Groove. Early Clifford Brown too.

The singer comes in now, and she is in trouble from the start. Still it's good to hear the decidedly 'period' words that have been given to the song, turning it into an exotic melodrama. Very art nouveau. There is another fascinating rococo piano interlude, Ellington I'm sure, and then the band surges in as though on an air cushion, and now we are in business. There are some absolutely lovely touches by Jimmy Hamilton – I can *taste* the wood in the silvery liquid of his sound: I *dig* Jimmy Hamilton and then Lawrence Brown solos gloriously through the last chorus.

Tatooed Bride is in two sections. The first part is one of those bounding dances for the whole band – with a fantastic early climax for Cat Anderson and another beautiful solo by Hamilton. The second part starts as an irresistible surge over pounding tom-toms, abruptly cuts to a slow melodic glide with statements by Baker and Hamilton. There is a brief cadenza for Hodges, Gonsalves and Carney, then the melody starts again, with Hamilton playing the most delectable, sunny clarinet. Suddenly the tempo picks up again and it swings out to the close.

Solitude is pretty spare. Its main interest is in the solos by Gonsalves and Ray Nance – who is at his romantic best on trumpet. He too gets a beautiful sound, shining and opulent, with much more decorative vibrato than Baker.

Sound is pretty good, with a couple of odd spots: a hollow false resonance here and there. I would definitely buy it. The rhythm section, incidentally is Wendell Marshall & Sonny Greer. – J.C.

RECORDINGS... POP TRENDS

REVIEWER:
Mike Delaney

"HOT BREAD" – Kinney. Stereo. EKS. 7701.
Let Your Love Go – If – Don't Shut Me Out – Take Comfort – Too Much Love – Live In Your Love – Make It With You – The Last Time – It Don't Matter To Me – I Want You With Me – She Was My Lady.

Pop can't really have changed all that much from the original concept. Here's Bread with a mixture of effervescent rock and romantic balladeering. The effect certainly has its moments. A deft dosage of lush strings weeping and wailing in the background with constant falsetto vocals just to make it sound plaintive. You couldn't go wrong with an approach such as this. The market is assured. Bread have seen to that, with no less than three consecutive top ten ballads within a little over one year. It's the return of tear-jerkers. "It Don't Matter To Me" and "Make It With You" let the emotions run riot. Nik Cohn would have called them 'maudlin flowerpots'. This may be a harsh term but then it does come pretty close to the truth. The style is eclectic. It runs the gamut from country through to orchestrated folk.

Composer-in-chief David Gates must see himself as pop's answer to Rodgers & Hart. He's not doing a bad job, regardless. His nostalgic melodies will be around long after Bread have been forgotten. "If" is the full lovelorn evergreen. It's going to be another "Yesterday". The appeal is ageless. There's a depth in presentation that owes a great deal to the deliberate arrangements.

The group relies heavily on semi-acoustic rhythms – subtle and persuasive. "Live In Your Love" is the type of heartfelt waxing that will no doubt become a firm favourite with the cocktail set. It's right mellow – ideal for subdued evenings spent at home. I think you get the picture. Bread can turn on the heat with the best of them. "Take Comfort" and "Let Your Love Go" are simple rockers – svelte; funky to a point. "Don't Shut Me Out" is a splendid piece of well-masticated bubblegum. The formula has been the basis for so many other songs it almost defies description. There's not one repetitive cut on the album. Bread know the advantages of versatility. They make sure that the general character is least inhibited. "Hot Bread" is a composite disc. It's not great; merely exceptional. Production could be less routine. – M.D.

"20 GRANITE CREEK" – Moby Grape. Kinney. Stereo. RS. 6064.
Gypsy Wedding – I'm The Kind of Man That Baby You Can Trust – About Time – Goin' Down To Texas – Road To The Sun – Apocalypse – Chinese Song – Roundhouse Blues – Ode To The Man At The End Of The Bar – Wild Oats Moan – Horse Out In The Rain.

You'd best start to spread the good news – Moby Grape have decided to reform following their two year trial split. It looks as though they finally found a chance to resolve the labour pains that so hindered their earlier commercial acceptance. It's not quite the same group once contracted to Columbia, as all the egotism and hpye has vanished – no more superfluous trivia. Moby Grape have studiously avoided the high pressure sales sell. They've been through the gimmick machine and had their fingers burnt several times before. It won't happen again. The emphasis has been redirected back into their music and the result is possibly one of the greatest American rock'n'roll albums released over the last year. It contains the standard Grape ingredients stacked with volume and enthusiasm. The group tends to be deceptively complex, weaving textures otherwise denied to mainstream pop. There's an elaborate sense of contrast in their music that makes "20 Granite Creek" a pleasure for anyone who cares to listen. Each track expresses a brittle intensity that seldom falls short of the projected image. It's been five years since their first album and the basic approach hasn't altered in the slightest.

Moby Grape gave West Coast rock its most vibrant introduction outside the Byrds and now they're back to do it over a second time. Don't let it pass you by. This latest album has the essence of what could well be called the definitive Californian climate. They've refined each nuance down pat. "Gypsy Wedding" is orgasmic rock'n'roll – gruff and pugilant. It parallels "Road To The Sun" for drama. "Goin' Down To Texas" is one of those up-tempo road songs – spitfire; ever moving. Moby Grape keep away from self-obsessive tangents. There's no dreamlike guitar fantasies nor echo chamber choralizing. "Ode To The Man At The End Of The Bar" bops off with boozy thunder: 'Boy they're gonna hate me here/ I puked all over the floor. Now I just remembered why I got so drunk as I was walking out the door . . .' Yeah. That's Moby Grape. "Chinese Song" floats aloft a misty oriental theme supplied by double-track koto and conga percussion. It's almost an entire suite within itself.

During their absence the group expanded personnel to include Gordon Stevens. His dobro/mandolin/electric viola has added a variety to the style that no longer restricts horizon. Moby Grape encompass most of the typical rock influences ranging from folk to blues. "Apocalypse is the sensible acoustic side – smooth; velvet soft. "20 Granite Creek" is just a little short of brilliance. It bubbles like a mountain stream continually changing form and impetus. This is an album to buy. Production is superb. – M.D.

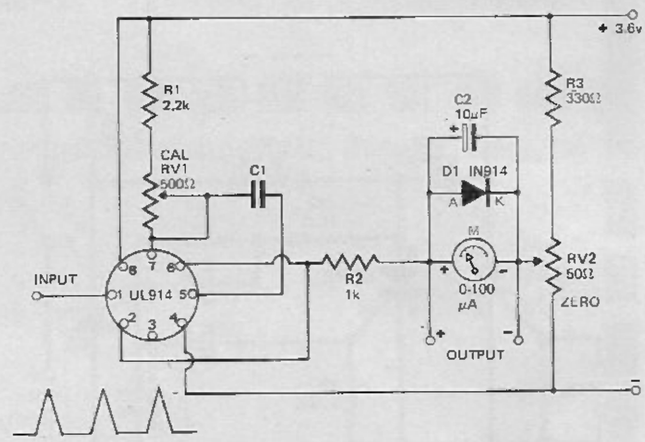
PLURIBUS FUNK – Grand Funk Railroad. EMI. Stereo. SW.853. Footstompin' Music, People Let's Stop The War, Upsetter, Come Tumblin', Save The Land, No Lies, Loneliness.

Grand Funk Railroad is the definitive American noise machine. Their music slams home like a million ton sledge hammer that literally pulverizes everything within reach. It's just so darned monotonous. You can best describe their latest album as one sordid mess of riffs that were played out and buried a good three years ago. The effect is excruciating. Grand Funk drags out the skeleton of what was once enjoyable rock'n'roll and goes to extreme lengths to dangle it about as if there was no tomorrow. The similarity between each of the seven tracks is diabolical. They manage to create a vague pressure that could have been far from tedious had the band known how to develop a sense of dramatic contrast. This Michigan trio bases its sound on pure volume – predatory and unrefined. Their approach loses all control due to the lack of natural restraint. They stalk through each song with the kind of disoriented aggression that fails to produce any valid structure or tonal identity.

Grand Funk leaves little need for argument. It's not fun. Their material runs berserk with a bunch of those tired old cliches that keep on returning with dogged regularity. "Footstompin' Music" is an insipid up-tempo cut without depth nor character to support the flagrant guitar. It rasps along full of the typical Farner expressionisms – pouted vocal and sweat. "Save The Land" is the ecology song just to show that they've found a conscience. "People Let's Stop The War" has been included as the standard political statement. It's a dreary hype. Grand Funk Railroad is a pretentious heavy rock band who've yet to overcome the audible boredom syndrome. I'll not be playing this album again. Bad news. – M.D.

TECH-TIPS

FREQUENCY TO VOLTAGE CONVERTER

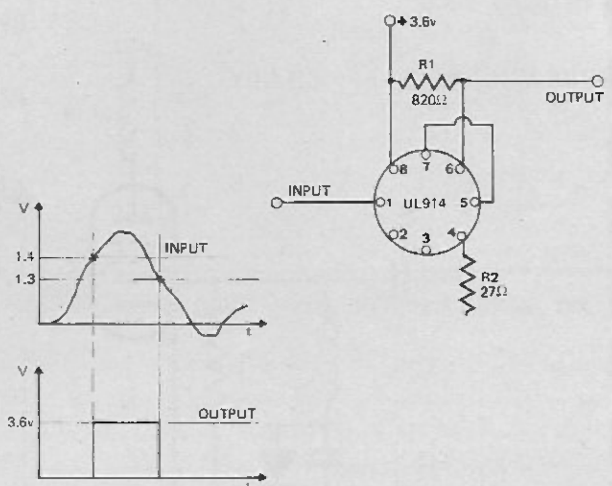


This circuit may be used as a pulse counter, tachometer, or if preceded by a Schmitt trigger, an analogue frequency meter.

Output linearity better than 2% can be obtained with duty cycles of less than 30%. The meter is selected so that it reads full scale when the duty cycle of the uL 914 is 30%. The choice of C1 and the meter sensitivity determines the range of measurement.

Potentiometer RV1 is used to calibrate the meter to full scale deflection, and resistor R2 counteracts the slight zero offset of the saturated IC. Diode D1 protects the meter.

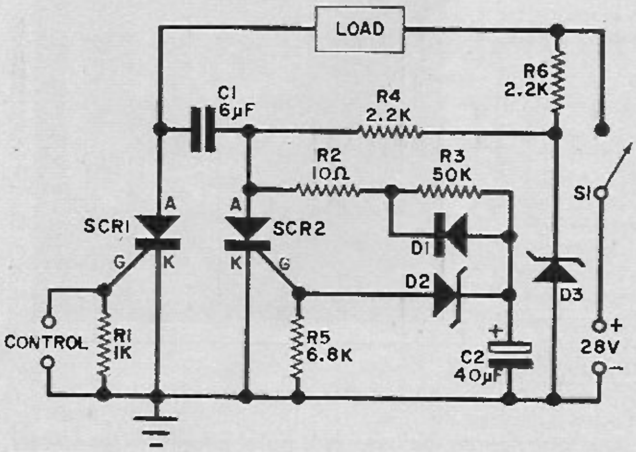
SIMPLE SCHMITT TRIGGER



One cheap IC, uL914, can be used as an extremely simple and effective Schmitt trigger suitable for many applications.
Hysterisis of the circuit is about 0.1 Volt. This may be varied by altering the values of R1 and R2.

TECH–TIPS

PULSE TIMER



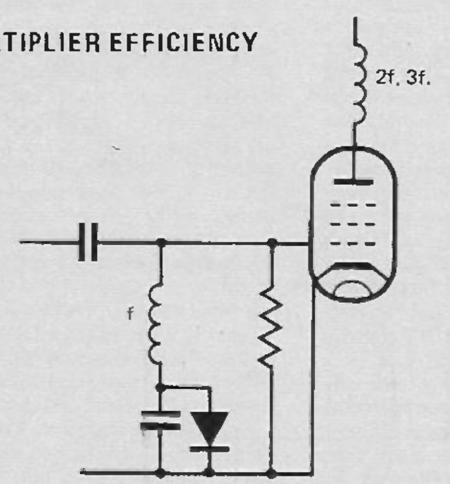
Originally developed by the Unitrode Corporation, this circuit will supply up to four Amps for a period of one second when triggered by an external positive going pulse.

The timing cycle is initiated by applying a positive going pulse of a voltage exceeding SCR1's gate voltage. This causes SCR1 to lock on and apply power to the load. In the meantime SCR2 is switched off by the commutating action of C1 and timing capacitor C2 is charged via R2, R3 and R4 and the constant voltage source D3 and R6.

When C2's charge voltage exceeds the rating of Zener diode D2 by an amount sufficient to exceed the gate voltage of SCR2, this SCR conducts, discharging both C1 and C2 and thus switching SCR1 back into its former non-conducting state.

Zener diode D2 should be rated at 6.8 Volts, and Zener D3 at 18 Volts.

IMPROVE MULTIPLIER EFFICIENCY



A cheap silicon diode may be used to improve the efficiency of a frequency multiplier.

The diode should be rated to carry the peak grid current of the multiplier stage.

READER INFORMATION SERVICE

For further information on Suppliers listed below, complete the coupon/s stating information required, including company and position held (if relevant). Cut out the coupon and post to:

ELECTRONICS TODAY INTERNATIONAL, 107 Fleet St., London, EC4.

Four reply coupons are provided here for your convenience. Please list only ONE supplier and ONE product on each coupon. If you require information on more than four individual products, make as many copies of the coupons as you like (preferably typed) – again using one coupon form for each product.

Send to ELECTRONICS TODAY INTERNATIONAL, 107 Fleet St., London, EC4.

ADVERTISER ....
PRODUCT ....
NAME ....
ADDRESS ....
....
....
COMPANY ....
POSITION ....
6:72

Send to ELECTRONICS TODAY INTERNATIONAL, 107 Fleet St., London, EC4.

ADVERTISER ....
PRODUCT ....
NAME ....
ADDRESS ....
....
....
COMPANY ....
POSITION ....
6:72

Send to ELECTRONICS TODAY INTERNATIONAL, 107 Fleet St., London, EC4.

ADVERTISER ....
PRODUCT ....
NAME ....
ADDRESS ....
....
....
COMPANY ....
POSITION ....
6:72

Send to ELECTRONICS TODAY INTERNATIONAL, 107 Fleet St., London, EC4.

ADVERTISER ....
PRODUCT ....
NAME ....
ADDRESS ....
....
....
COMPANY ....
POSITION ....
6:72

CAREER OPPORTUNITIES